Chapter 3
Affected Environment/Environmental Consequences

3.1 Introduction

This chapter describes, for each resource area, the affected environment or environmental setting for the region of the Klamath Basin potentially affected by the dam removal and connected actions, should they be implemented. This chapter presents the analyses of the impacts that would result from the No Action/No Project Alternative or implementation of the Proposed Action and alternatives described in Chapter 2. This chapter also presents mitigation measures to reduce or eliminate the impacts. The sections of this chapter, by resource area, are as follows:

- 3.2 Water Quality
- 3.3 Aquatic Resources
- 3.4 Algae
- 3.5 Terrestrial Resources
- 3.6 Flood Hydrology
- 3.7 Groundwater
- 3.8 Water Supply/Water Rights
- 3.9 Air Quality
- 3.10 Greenhouse Gases/Global Climate Change
- 3.11 Geology, Soils, and Geologic Hazards
- 3.12 Tribal Trust
- 3.13 Cultural and Historical Resources
- 3.14 Land Use, Agricultural and Forest Resources
- 3.15 Socioeconomics
- 3.16 Environmental Justice
- 3.17 Population and Housing
- 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power
- 3.19 Scenic Quality
- 3.20 Recreation
- 3.21 Toxic/Hazardous Materials
- 3.22 Traffic and Transportation
- 3.23 Noise and Vibration

Paleontological resources, which may appear in an Environmental Impact Statement (EIS) or an Environmental Impact Report (EIR) for other projects, were not considered in detail in this Klamath Facilities Removal EIS/EIR, with the exception of their potential presence in a diatomite bed near Copco Reservoir, because the Lead Agencies determined that the volcanic nature of the local geology at the dam sites precluded the presence of these resources in the project area. The potential for project related effects on paleontological resources at this diatomite deposit are described in Section 3.11, Geology, Soils, and Geologic Hazards.

3.1.1 Format of the Environmental Analysis

3.1.1.1 Area of Analysis

This document defines and describes an area of analysis for each resource area. In some cases, the area of analysis consists only of facility deconstruction/construction areas, or nearby areas that would be affected directly by the effects of deconstruction/construction, such as for the analysis of noise impacts. More often, the area of analysis includes the entire Klamath Basin. The area of analyses for water supply/water rights and for land use, agricultural and forest resources, for example, includes the entire Klamath Basin because implementation of the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA) could affect these resources not only at the project sites, but also in areas upstream of and downstream from them. In a few cases, the area of analysis is even more geographically broad, such as for socioeconomics.

3.1.1.2 Regulatory Framework

Each resource area is evaluated within the existing framework of Federal, State, and local laws, regulations, policies, and plans. For each resource area, the sub-sections of this chapter briefly list the laws and regulations that are relevant and applicable to the affected environment, area of analysis, and analysis of impacts. Chapter 6 of this EIS/EIR provides further discussion on how laws, regulations, policies, and plans would be addressed through implementation of the Proposed Action or alternatives.

3.1.1.3 Wild and Scenic River Act Component Analysis

The analysis of potential effects on Wild and Scenic River (WSR) components is presented in Section 3.20, Recreation.

3.1.1.4 Coastal Zone Management Act Consistency Determination

The Coastal Zone Management Act requires any applicant seeking a Federal License or permit that could affect land or water uses or resources of the California coastal zone to perform a Federal Consistency Determination for the proposed project. The determination provides a certification that the Proposed Action will be conducted in a manner that to the maximum extent possible is consistent with the policies of the California Coastal Management Program as outlined in the California Coastal Act (CCA) of 1976. The analysis of the consistency between the policies of the California Coastal Act and the Proposed Action is discussed in the following section:

- Discussion of CCA Section 30231 - Section 3.3.4.3 page 3.3-180
- Discussion of CCA Section 30236 - Section 3.3.4.3 page 3.3-181

The focused analysis in Section 3.3.4.3 considers at specific CCA policies; however, this information supplements the more comprehensive analysis of the near-shore impacts in Section 3.2, Water Quality and Section 3.3, Aquatic Resources.

3.1.1.5 Basis of Comparison for the Affected Environment/Environmental Setting

The analysis of impacts requires a basis for comparison of conditions during project construction and post-project. The National Environmental Policy Act (NEPA) basis of comparison is the No Action Alternative. Under the California Environmental Quality Act (CEQA), the basis of comparison is conditions at the time of the Notice of Preparation. As discussed in Chapter 2, the No Action Alternative is similar to conditions at the time of the Notice of Preparation; therefore, the basis of comparison for NEPA and CEQA are generally the same for this document. The impact analysis for each resource considered both the NEPA and CEQA basis of comparison together and, in cases where these baselines differ, further discussion is provided.

3.1.1.6 Environmental Consequences

The methods used to evaluate impacts are described for each resource area. In general, the Lead Agencies identified the impacts that would result from implementation of each of the alternatives within the context of the environmental baseline and regulatory framework. The Lead Agencies used a variety of data sources, models, design documents, interviews, and various other types of research and analysis to predict the impacts. The Lead Agencies then determined the magnitude or significance of the impacts based on significance criteria, where required.

3.1.1.6.1 Significance Criteria

For each resource area, this chapter presents specific significance criteria that the Lead Agencies used to assess the significance level of the impacts under CEQA. Pursuant to NEPA, significance is used to determine whether an EIS or some other level of documentation is required, and once the decision to prepare an EIS is made, the magnitude of the impact is evaluated and no further judgment of significance is required. Therefore, any determinations of significance are for CEQA purposes only.

3.1.1.6.2 Impact Discussion

The impacts of each alternative are discussed in Chapter 3 by resource area and alternative. Each resource area section is structured so that an *italicized* impact statement introduces potential changes that could occur from implementation of each alternative. A discussion of how the resource area would be affected by the impact then follows this initial statement. The impact discussion is concluded with a **bold** significance determination that indicates if there is no impact to a resource area or if the impact to a resource area is beneficial, less than significant, or significant.

3.1.1.6.3 Mitigation Measures

For those impacts that would be significant, the Lead Agencies identified feasible mitigation measures, if they exist, to reduce the level of the impact. The discussion of mitigation measures presented in this chapter includes an assessment of which, if any, significant impacts would remain after mitigation. Chapter 5, Other Required Disclosures, describes any irreversible and irretrievable commitments of resources that the Lead Agencies identified as part of this analysis.

Although existing adverse conditions associated with the No Action/No Project Alternative identified in this chapter would continue, it is not necessary or appropriate to formulate a mitigation measure and ascribe mitigation responsibility for these impacts. In accordance with the intent and requirements of CEQA (Guidelines Section 15126.6), delineating the nature and significance of impacts associated with the No Action/No Project Alternative serves to provide a basis for comparing the impacts of approving the proposed project with the impacts of not approving the proposed project. In particular, the evaluation of alternatives, including the "no project" alternative, serves to determine whether the significant impacts of the alternatives can be avoided or substantially lessened. The analysis presented for the No Action/No Project Alternative in this chapter has determined that the existing adverse conditions would continue for reasons not attributable to the Proposed Action or alternatives; this provides information to be considered by decisionmakers in evaluating the impacts that are attributable to the Proposed Action.

3.1.1.6.4 Scope of the KBRA Evaluation

This EIS/EIR provides a project-level analysis of the KHSA and alternatives[1], but it evaluates the KBRA on a programmatic level. While the general goals of the KBRA actions and programs are known, the specific actions that would occur are not yet defined, and additional environmental analyses according to NEPA, CEQA, and other permits and authorizations would be required as necessary once the KBRA activities are defined at a project-level. The Lead Agencies considered the goals, programs, and plans as described in KBRA Appendix C-3 (summarized in this EIS/EIR in Chapter 2) in the impact analyses to determine their anticipated direct, indirect, and cumulative effects on each resource. Additionally, each section contains an analysis of the potential combined effects of KBRA actions and facility removal actions in the KHSA. These combined effects are described as a part of the programmatic significance determination on the specific KBRA actions. The KBRA programs described at a sufficient level of detail to support the programmatic analysis completed in this EIS/EIR are outlined in Table 3.1-1:

Table 3.1-1 KBRA Plans and Programs Analyzed

KBRA Program	Sections Analyzed
Phase 1 Fisheries Restoration Plan	3.2 Water Quality, 3.3 Aquatic Resources, 3.4 Algae, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.11 Geology and Soils, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.16 Environmental Justice, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration

[1] With the exceptions of the East and Westside Facility Decommissioning, an action connected to the Proposed Action and Alternative 3, and the trap and haul program included in Alternatives 4 and 5, both of which are analyzed at the programmatic level.

Table 3.1-1 KBRA Plans and Programs Analyzed

KBRA Program	Sections Analyzed
Phase 2 Fisheries Restoration Plan	3.2 Water Quality, 3.3 Aquatic Resources, 3.4 Algae, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.11 Geology and Soils, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.16 Environmental Justice, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Fisheries Monitoring Plan	3.3 Aquatic Resources, 3.15 Socioeconomics; 3.16 Environmental Justice
Fisheries Reintroduction and Management Plan	3.2 Water Quality, 3.3 Aquatic Resources, 3.8 Water Rights/Water Supply, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.13 Cultural and Historic Resources, 3.14 Land Use, Agricultural and Forest Resources, 3.15 Socioeconomics, 3.16 Environmental Justice, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Wood River Wetland Restoration	3.2 Water Quality, 3.4 Algae, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.8 Water Rights/Water Supply, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Water Diversion Limitations	3.2 Water Quality, 3.3 Aquatic Resources, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.7 Groundwater, 3.8 Water Rights/Water Supply, 3.14 Land Use, Agricultural and Forest Resources, 3.15 Socioeconomics, 3.19 Scenic Quality, 3.20 Recreation
On-Project Plan	3.3 Aquatic Resources, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.7 Groundwater, 3.8 Water Rights/Water Supply, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Future Storage Opportunities	3.6 Flood Hydrology, 3.8 Water Rights/Water Supply, 3.15 Socioeconomics
Water Use Retirement Program	3.2 Water Quality, 3.3 Aquatic Resources, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.7 Groundwater, 3.8 Water Rights/Water Supply, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.13 Cultural and Historic Resources, 3.14 Land Use, Agricultural and Forest Resources, 3.15 Socioeconomics. 3.16 Environmental Justice, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.20 Recreation, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Power for Water Management	3.10 Global Climate Change/Greenhouse Gases, 3.14 Land Use, Agricultural and Forest Resources, 3.15 Socioeconomics, 3.18 Utilities and Public Services, Solid Waste, Power
Off-Project Water Settlement	3.8 Water Rights/Water Supply, 3.15 Socioeconomics
Off-Project Water Reliance Program	3.8 Water Rights/Water Supply, 3.15 Socioeconomics, 3.16 Environmental Justice

Table 3.1-1 KBRA Plans and Programs Analyzed

KBRA Program	Sections Analyzed
Emergency Response Plan	3.6 Flood Hydrology, 3.7 Groundwater, 3.8 Water Rights/Water Supply, 3.15 Socioeconomics, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power
Climate Change Assessment and Adaptive Management	3.6 Flood Hydrology, 3.8 Water Rights/Water Supply, 3.10 Global Climate Change/Greenhouse Gases, 3.20 Recreation, 3.15 Socioeconomics
Interim Flow and Lake Level Program	3.2 Water Quality, 3.4 Algae, 3.5 Terrestrial Resources, 3.6 Flood Hydrology, 3.7 Groundwater, 3.8 Water Rights/Water Supply, 3.15 Socioeconomics, 3.16 Environmental Justice, 3.19 Scenic Quality, 3.20 Recreation
Fish Entrainment Reduction	3.3 Aquatic Resources, 3.5 Terrestrial Resources, 3.9 Air Quality, 3.10 Global Climate Change/Greenhouse Gases, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.17 Population and Housing, 3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power, 3.19 Scenic Quality, 3.21 Toxic and Hazardous Materials, 3.22 Traffic and Transportation, 3.23 Noise and Vibration
Upper Klamath Lake and Keno Nutrient Reduction	3.2 Water Quality, 3.3 Aquatic Resources, 3.4 Algae, 3.15 Socioeconomics
Tribal Fisheries and Conservation Management Program	3.12 Tribal Trust, 3.15 Socioeconomics, 3.16 Environmental Justice
Tribal Programs Economic Revitalization	3.15 Socioeconomics, 3.16 Environmental Justice
Klamath River Tribes Interim Fishing Site	3.3 Aquatic Resources, 3.12 Tribal Trust, 3.13 Cultural and Historic Resources, 3.15 Socioeconomics, 3.16 Environmental Justice, 3.17 Population and Housing, 3.19 Scenic Quality, 3.22 Traffic and Transportation
Mazama Forest Project	3.5 Terrestrial Resources, 3.12 Tribal Trust, 3.13 Cultural and Historic Resources, 3.14 Land Use, Agricultural and Forest Resources, 3.15 Socioeconomics, 3.16 Environmental Justice
Klamath County Economic Development Plan	3.15 Socioeconomics, 3.16 Environmental Justice
California Water Bond Legislation	3.15 Socioeconomics, 3.16 Environmental Justice
Drought Plan	3.8 Water Rights/Water Supply, 3.10 Global Climate Change/Greenhouse Gases, 3.15 Socioeconomics

3.1.1.6.5 Best Available Information

The Lead Agencies have used their best efforts to identify and disclose as much relevant information as possible in the EIS/EIR based on the review of the best available information at the time of the issuance of the Notice of Intent, as well as, new information developed to support the Secretarial Determination process. Under CEQA, the Lead Agency is not required to conduct every test or perform all research, studies, or experimentation at the commenter's request (Pub. Resources Code, Section 21091(d)(2)(B), CEQA Guidelines sec. 15151 and 15204). The Lead Agencies implemented various processes to ensure that only high quality and objective science will contribute to the Secretarial Determination, including, but not limited to:

- All new Federal scientific studies used followed Federal guidance requirements on peer review and scientific integrity, including the procedures adopted by the Departments of the Interior and Commerce (DOI and DOC) in response to the 2004 Office of Management and Budget Bulletin on Peer Review, the Presidential Memorandum on Scientific Integrity dated March 9, 2009 (which was incorporated into Appendix J of the KHSA), the Office of Science and Technology Policy 2010 guidance memorandum on scientific integrity, the 2011 DOI Memorandum on Science Integrity (for DOI agencies), and as well as internal procedures used by the Bureau of Land Management (BLM), United States Geological Survey (USGS), Bureau of Reclamation (Reclamation), U.S Fish and Wildlife Service (USFWS), and the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service.
- Any new Federal scientific studies or reports were developed by a Program Manager, who was supported by a Technical Management Team, which included nine sub-teams covering various disciplines (Engineering, Geomorphology, and Constructability; Environmental Compliance; Biological; Water Quality; Tribal/Cultural; Real Estate; Recreation; and Communications). The quality and objectivity of these products and reports all benefited from the expertise of sub-team members representing multiple Federal agencies.
- During the period of project design and execution of new Federal studies, the public and stakeholders were briefed at frequent intervals via public meetings. Public input from these meetings closed data gaps, refined study approaches, and provided additional studies or data to incorporate into the analyses. This involvement of the public improved the quality and the breadth of the science, and ensured that the final reports addressed questions and concerns raised by the public, Indian tribes, and local agencies (e.g., counties).
- When warranted, new studies were undertaken to fill data gaps and to better inform the Secretarial Determination. Some example new studies included,: (1) reservoir sediment drilling and diver inspections of the dam foundations prior to preparing a feasibility engineering plan for dam removal; (2) hydrologic modeling to predict drawdown and transport of reservoir bottom sediments downstream; (3) chemical analysis of sediments and fish tissues to assess the effects of these suspended sediments on humans and biota if they were transported downstream or exposed as new land surfaces; (4) a model of the expected response of Chinook salmon to the Proposed Action; (5) economic analysis of the effects to various sectors on implementing the agreements, locally, regionally and nationally and on Indian Tribes, among many other studies.
- All scientific reports produced by the Technical Management Team (TMT) were reviewed by independent subject matter experts (outside of the Klamath Secretarial Determination process) in accordance with the policies of the agency producing the report. Peer reviews were undertaken to ensure that the reported results were reliable, objective, accurate and scientifically sound.

- In some cases, an existing report important for the Secretarial Determination process had not previously been peer reviewed. Prior to use in contributing to the Secretarial Determination, these previously unreviewed reports were assigned to an independent contractor to obtain one or more critique(s) by subject matter experts to verify their reliability, objectivity, accuracy and to verify their scientific veracity.
- An independent contractor convened four expert panels to evaluate and make findings regarding the likely trajectory of fish populations under both the Proposed Action and the No Action alternatives. The majority of panel members were not from Federal agencies, but were from universities or consulting firms. The four panels evaluated: resident native fish (trout and suckers), lamprey, coho salmon and steelhead, and Chinook salmon. These panels provided an independent evaluation of the information that was available at the time of their deliberations in preparation of their reports. These independent analyses were largely consistent with the findings in the Technical Management Team reports, which provided increased confidence in the science process and the findings relative to fish and fisheries.

One of the goals of scientific analysis is to develop new information and to increase the certainty of conclusions (i.e., reduce scientific uncertainty). Using best available information, however, cannot remove all scientific uncertainty from a decision. No amount of investigating, hypothesis testing, modeling, or peer reviewing will ensure perfect knowledge about how the Klamath River ecosystem would respond to future large changes/actions (e.g., alternatives 2 through 5) or even 50 years of "no action" (e.g., alternative 1). Scientific uncertainty is inherent in any analysis of present and future conditions, particularly in a system as complex as the Klamath Basin.

It is important to understand what is meant by the term scientific "uncertainty" because it has a very different meaning than the meaning more commonly used by the public outside the realm of science; this difference in word usage often leads to serious misunderstandings when science results are communicated. Science and engineering use the word "uncertainty" to define how well something is known, not whether it is known. Because nothing measured, estimated, modeled, or predicted can be known with perfect accuracy and certainty, scientists seek to describe the statistical variability of a number, a range of possibilities, and/or the relative level of confidence in a conclusion. By defining uncertainty, scientists seek to clarify the strength and accuracy of a conclusion. This definition of scientific uncertainty should not be confused with the more common definition of uncertainty (outside the realm of science and engineering), which typically conveys that something is completely unknown, that a result is unreliable, or that the state of knowledge is confused.

In some cases, scientific uncertainty is quantifiable and is often described as the estimated amount an observed, calculated, or modeled value may differ from the true value. For example, a study may show that we have 98 percent confidence that the true value will fall within a defined range of values. This defined range of values is referred to as the 98 percent confidence interval. For estimating the potential cost of removal of

the Four Facilities, engineers were able to determine a most probable cost, as well as the 98 percent confidence interval around the most probable cost, in order to define the range of possible removal costs.

In other cases how well something is known cannot be quantified and uncertainty is often described in relative terms, such as predicting how an ecosystem (e.g., Klamath River) may respond to a potential action (e.g., dam removal). Based on the best available information and analyses, scientists convey the likelihood of these predictions with descriptions such as "highly likely," "probable," or other caveats intended to disclose the level of certainty in a conclusion. For example, predicting the potential benefits of dam removal on juvenile salmon disease in the Klamath Basin cannot be known with perfect accuracy, but most fishery biologists believe removal of the Four Facilities would decrease the infection rates. A lack of certainty of the exact response of the ecosystem does not preclude a conclusion that juvenile salmon disease would likely decrease. This conclusion is based on studies of other river systems, investigations of salmon disease in the Klamath River, and knowledge of the specific factors contributing to salmon disease and how these factors would change if dams were removed.

In order to provide a sound foundation for a Secretarial Determination on removal of the Four Facilities, multiple strategies were used to weigh the validity of hypotheses, reach scientific conclusions, and decrease scientific uncertainty around those conclusions. These strategies included: (1) developing new studies, that test multiple hypotheses, in order to fill critical information gaps; (2) developing numerical models (when gathering empirical data is not possible) to predict the probable ecosystem response; (3) repeating investigations on critical topics to ensure past results are reproducible; (4) obtaining independent expert opinions on important topics; and (5) drawing conclusions based on the weight of evidence and multiple lines of evidence.

Using multiple lines of evidence refers to a process when conclusions are not drawn from a single study but from two or more studies that have different approaches. For example, the conclusion that dam removal and KBRA implementation could increase Chinook production in the Klamath Basin was based on a recent synthesis of previous study findings (Hamilton et al. 2011), two new independent modeling studies (Hendrix 2011; Lindley and Davis 2011), a Chinook expert panel report (Goodman et al. 2011), among others. Although the authors of each of these four peer-reviewed reports used different approaches and assumptions, as well as presented different levels of confidence in quantifying their conclusions and scientific uncertainty, they all concluded that Chinook salmon would increase in number relative to the "no action alternative" of leaving dams in place and not implementing KBRA. Considering several diverse lines of evidence decreased scientific uncertainty and strengthened this overarching conclusion.

In some situations, where studies present conflicting results, the "weight of evidence" for a conclusion considers the quantity of evidence supporting that conclusion as well as when and how studies were done; generally weight is given to more recent studies and

studies done with more scientific rigor (e.g., peer review). When there is a significant amount of conflicting information, a conclusion is often expressed with a higher degree of uncertainty.

During the period of time when the EIS/EIR was being developed, new scientific information has become available that has improved our understanding of the complicated interactions between river ecosystems, aquatic resources, and the people that rely on those resources in the Klamath Basin. That new information has been incorporated into the EIS/EIR as it has become available. Through the diligent efforts of the scientific community, the state of scientific knowledge in the Klamath Basin continues to improve and will result in valuable reports and information in the future. Therefore we fully anticipate that new scientific information will become available in the interim period between issuance of the Final EIS/EIR and the Secretarial Determination, particularly in the areas of active research on juvenile salmon disease, life cycle models of Klamath Basin salmon, causes of water quality problems in the Klamath River and Upper Klamath Lake, and the poor survival of juvenile endangered suckers in Upper Klamath Lake. An example of a draft report that will likely become finalized (and citable) in late 2012 is a Klamath coho life cycle model that analyzes the potential effects of dam removal on threatened coho salmon; a draft of this report (Cramer 2011) can be found at http://www.fishsciences.net/projects/klamathcoho/model.php. As with all EIS/EIR, however, only current best available information can form the basis of a NEPA/CEQA analysis; as new scientific information becomes available the Lead Agencies shall evaluate whether subsequent NEPA/CEQA analysis is needed before any decision is made regarding dam removal.

3.1.2 References

Cramer Fish Science. 2011. Simulated Effects of Dam Removal on Coho Salmon in the Klamath Basin, Klamath Coho Integrated Modeling Framework Version 1.4. April 2011. Available at: http://www.fishsciences.net/projects/klamathcoho/model.php .

Goodman, D., Harvey, M., Hughes, R., Kimmerer, W., Rose, K., Ruggerone, G. 2011. Klamath River Expert Panel, Addendum to Final Report, Scientific Assessment of Two Dam Removal Alternatives on Chinook Salmon. Addendum to Final Report. Prepared with the assistance of Atkins, Portland, Oregon.

Hamilton, J.B., Rondorf, D., Hampton, M., Quinones, R., Simondet, J., Smith, T. 2011. Synthesis of the Effects to Fish Species of Two Management Scenarios for the Secretarial Determination on Removal of the Lower Four Dams on the Klamath. Prepared by the Biological Subgroup for the Secretarial Determination Regarding Potential Removal of the Lower Four Dams on the Klamath River. Available at: http://klamathrestoration.gov/keep-me-informed/secretarial-determination/role-of-science/secretarial-determination-studies. Accessed on: December 21, 2011.

Hendrix, N. 2011. Forecasting the response of Klamath Basin Chinook populations to dam removal and restoration of anadromy versus no action. Review Draft Report. R2 Resource Consultants, Redmond, Washington.

Lindley, S.T., Davis H. 2011. Using model selection and model averaging to predict the response of Chinook salmon to dam removal. Review Draft Report. National Marine Fisheries Service, Fisheries Ecology Division, NMFS Southwest Fisheries Science Center, Santa Cruz, California.

3.2 Water Quality

This section describes the effects of the Proposed Action and alternatives on water temperature, suspended sediments, nutrients (total phosphorus [TP], total nitrogen [TN], ortho-phosphorus, nitrate, and ammonium), dissolved oxygen, pH, algal toxins and chlorophyll-*a*, and inorganic and organic contaminants within the area of analysis. Effects of the Proposed Action and alternatives on the algal community (phytoplankton, aquatic macrophytes, riverine phytoplankton and periphyton) in the area of analysis are discussed in Section 3.4, Algae. Algal toxins are a water quality concern that affects designated beneficial uses of water, so this section also includes a brief analysis of project effects on algal toxins as related to beneficial uses. Similarly, water quality parameters relevant to the analysis of fish disease and parasitism (e.g., water temperature, nutrient availability) are included here as part of the Proposed Action effects analysis; the full analysis of fish disease and parasitism is in Section 3.3, Aquatic Resources.

3.2.1 Area of Analysis

The area of analysis for water quality includes the three main tributaries to Upper Klamath Lake (Wood, Williamson, and Sprague Rivers), Upper Klamath Lake, Link River, and the mainstem Klamath River in the Upper Klamath Basin and the mainstem Klamath River, the Klamath Estuary, and the marine nearshore environment in the Lower Klamath Basin (see Figure 3.2-1). For the purposes of the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) the area of analysis is organized into the following analysis segments:

Upper Klamath Basin

- Wood, Williamson, and Sprague Rivers
- Upper Klamath Lake
- Link River Dam to Klamath River upstream of J.C. Boyle Reservoir
- Hydroelectric Reach (J.C. Boyle Reservoir to Iron Gate Reservoir)

Lower Klamath Basin

- Iron Gate Dam to Salmon River
- Salmon River to Klamath Estuary
- Klamath Estuary
- Marine nearshore

Table 3.2-1 lists the river mile (RM) locations of the above reaches and of features relevant to the water quality area of analysis.

Table 3.2-1. Location of Klamath Basin Features Relevant to the Water Quality Area of Analysis

Feature	River Mile[1]
Upper Klamath Basin	
Wood River	282.3+
Williamson, and Sprague rivers	272.3+
Upper Klamath Lake/Agency Lake	254.3 to 282.3
Link River Dam	253.7
Keno Impoundment/Lake Ewauna	233.0 to 253 (Lake Ewauna ≈247 to 253)
Keno Impoundment at Miller Island	246
Klamath Straits Drain (at Pumping Plant F)	240.5
J.C. Boyle Reservoir	224.7 to 228.3
Oregon-California State line	208.5
Copco 1 Reservoir	198.6 to 203.1
Copco 2 Reservoir	198.3 to 198.6
Iron Gate Reservoir	190.1 to 196.9
Lower Klamath Basin	
Klamath River confluence with Shasta River	176.7
Klamath River confluence with Scott River	143.0
Seiad Valley	129.4
Klamath River confluence with Salmon River	66.0
Hoopa Valley Tribe	≈45 to 46
Weitchpec	43.5
Klamath River confluence with Trinity River	42.5
Klamath River at Turwar	5.8
Klamath Estuary	0 to ≈2

Notes:
[1] River Mile (RM) refers to distance upstream of the mouth of the Klamath River.

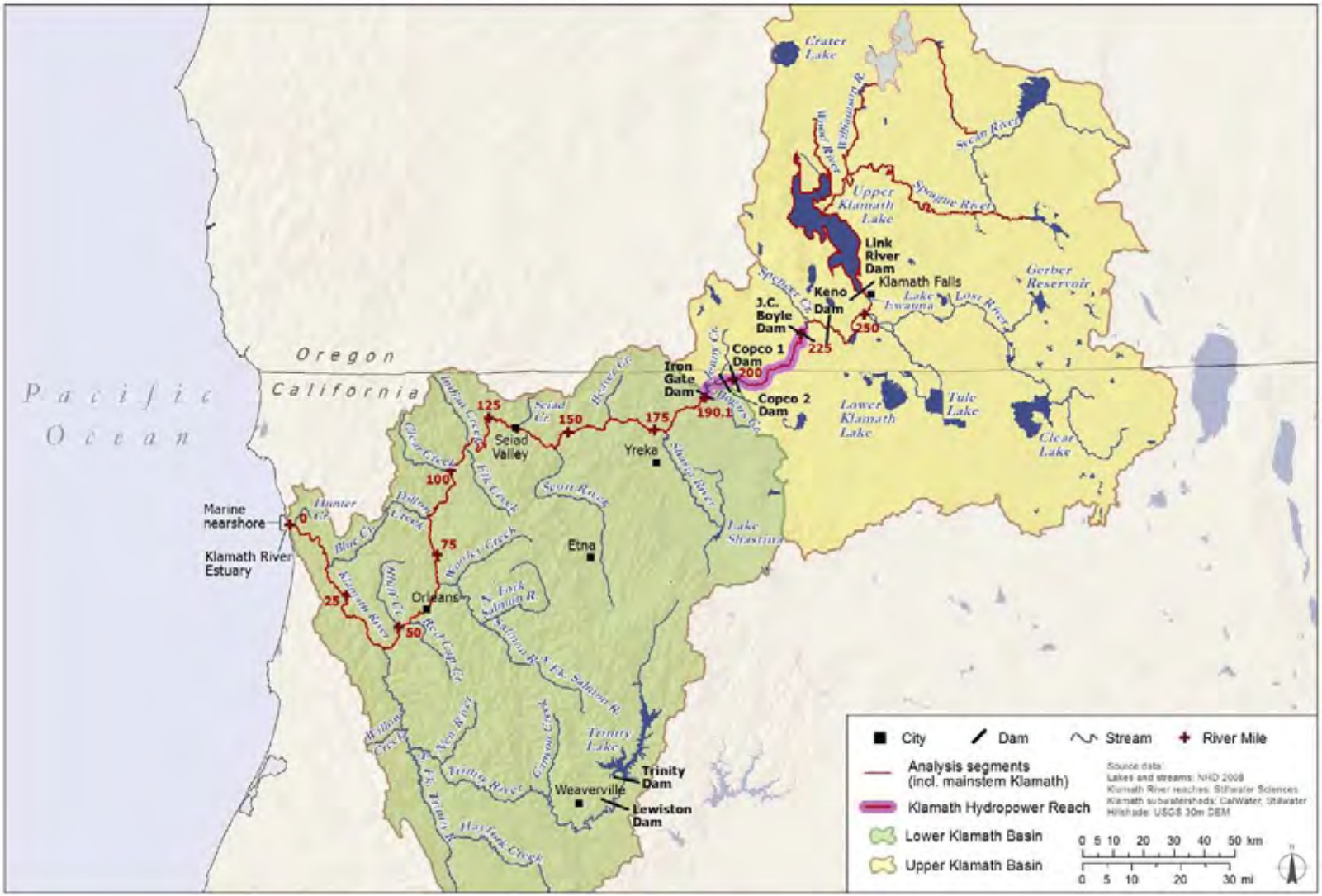


Figure 3.2-1. Water Quality Area of Analysis

3.2.2 Regulatory Framework

Multiple Federal, State, and tribal programs and planning documents are applicable to the regulation and protection of water quality in the area of analysis, including but not limited to the following:

- Clean Water Act (Title 33 U.S.C. §1313 [1972])
- Safe Drinking Water Act (Title 42 U.S.C. Chapter 6A §300f-j [1973 as amended])
- Oregon Administrative Rules for Water Pollution Control (OAR 340-041)
- North Coast Region Basin Plan (as required by Sections 13240–13247 of Porter-Cologne Water Quality Act)
- Hoopa Valley Tribe Water Quality Control Plan
- Coastal Zone Management Act
- California Ocean Plan (C.W.C. §13170.2)

3.2.2.1 Designated Beneficial Uses of Water

Beneficial uses of water are designated by the Oregon Department of Environmental Quality (ODEQ), the State and Regional Water Quality Control Boards, and the Hoopa Valley Tribe. Other tribal water quality programs, including the development and adoption of beneficial uses, are underway by the Karuk Tribe, the Resighini Rancheria, and the Yurok Tribe. These tribes have not yet completed processes for United States Environmental Protection Agency (USEPA) approved delegation under the Clean Water Act (CWA) (North Coast Regional Water Quality Control Board [NCRWQCB] 2010a). Approved beneficial uses within the area of analysis are presented below (Table 3.2-2).

Table 3.2-2. Designated Beneficial Uses of Water in the Area of Analysis

Upper Klamath Lake and Tributaries and Klamath River in Oregon (Oregon Department of Environmental Quality [ODEQ] OAR 340-41-0180)	Klamath River in California (North Coast Regional Water Quality Control Board 2011)	Hoopa Valley Tribe Beneficial Uses (Hoopa Valley Tribe Environmental Protection Agency [HVTEPA] 2008)	Ocean Plan Beneficial Uses (State Water Resources Control Board [SWRCB] 2001)[1]
Aesthetics and Cultural			
Aesthetic Quality	N/A	Wild and Scenic (W&S)	N/A[2]
N/A	Native American Culture (CUL)	Ceremonial and Cultural Water Use (CUL)**	N/A
Agricultural Water Supply			
Irrigation	Agricultural Supply (AGR)	Agricultural Supply (AGR)*	N/A
Livestock Watering			

Table 3.2-2. Designated Beneficial Uses of Water in the Area of Analysis

Upper Klamath Lake and Tributaries and Klamath River in Oregon (Oregon Department of Environmental Quality [ODEQ] OAR 340-41-0180)	Klamath River in California (North Coast Regional Water Quality Control Board 2011)	Hoopa Valley Tribe Beneficial Uses (Hoopa Valley Tribe Environmental Protection Agency [HVTEPA] 2008)	Ocean Plan Beneficial Uses (State Water Resources Control Board [SWRCB] 2001)[1]
Commercial			
Fishing	Commercial and Sport Fishing (COMM)	N/A	Commercial and Sport Fishing (COMM)
N/A	Shellfish Harvesting (SHELL)	N/A	Shellfish Harvesting (SHELL)
N/A	Aquaculture (AQUA)	N/A	Mariculture (AQUA)
Fish & Wildlife			
Fish & Aquatic Life[3]	Warm Freshwater Habitat (WARM)	N/A	N/A
	Cold Freshwater Habitat (COLD)	Cold Freshwater Habitat (COLD)	N/A
	Migration of Aquatic Organisms (MIGR)	Migration of Aquatic Organisms (MIGR)	Fish Migration (MIGR)
	Spawning, Reproduction, and/or Early Development (SPWN)	Spawning, Reproduction, and/or Early Development (SPWN)	Fish Spawning (SPAWN)
N/A	Estuarine Habitat (EST)	N/A	N/A
N/A	Marine Habitat (MAR)	N/A	Marine Habitat (MAR)
Wildlife & Hunting	Wildlife Habitat (WILD)	Wildlife Habitat and Endangered Species (WILD)	N/A
N/A	N/A	N/A	Preservation and Enhancement of Designated Areas of Special Biological Significance (BIOL)
N/A	Rare, Threatened, or Endangered Species (RARE)	Preservation of Threatened and Endangered Species (T&E)	Rare and Endangered Species (RARE)
Potable Water Supply			
Public Domestic Water Supply	Municipal and Domestic Supply (MUN)	Municipal and Domestic Supply (MUN)*	N/A
Private Domestic Water Supply			
Industrial Water Supply			
Industrial Water Supply	Industrial Service Supply (IND)	Industrial Service Supply (IND)	Industrial Water Supply (IND)
	Industrial Process Supply (PROC)	Industrial Process Supply (PROC)	

Table 3.2-2. Designated Beneficial Uses of Water in the Area of Analysis

Upper Klamath Lake and Tributaries and Klamath River in Oregon (Oregon Department of Environmental Quality [ODEQ] OAR 340-41-0180)	Klamath River in California (North Coast Regional Water Quality Control Board 2011)	Hoopa Valley Tribe Beneficial Uses (Hoopa Valley Tribe Environmental Protection Agency [HVTEPA] 2008)	Ocean Plan Beneficial Uses (State Water Resources Control Board [SWRCB] 2001)[1]
Hydro Power[4]	Hydropower Generation (POW)	N/A	N/A
Navigation			
Commercial Navigation & Transportation[4]	Navigation (NAV)	N/A	Navigation (NAV)
Replacement/Recharge			
N/A	Groundwater Recharge (GWR)	Groundwater Recharge (GWR)	N/A
N/A	Freshwater Replenishment (FRSH)	N/A	N/A
Recreation			
Water Contact Recreation	Water Contact Recreation (REC-1)	Water Contact Recreation (REC-1)	Water Contact Recreation (REC-1), including Aesthetic Enjoyment
Boating	Non-contact Water Recreation (REC-2)	Non-contact Water Recreation (REC-2)	Non-contact Water Recreation (REC-2), including Aesthetic Enjoyment

Notes:
[1] The Ocean Plan is currently before the SWRCB for amendment, including the proposed amendment of beneficial uses.
[2] See also Recreation REC-2 designation including "aesthetic enjoyment."
[3] The "Fish & Aquatic Life" use designated for the Klamath River from Upper Klamath Lake to Keno Dam is: "Cool Water Species (no salmonid use)." The "Fish & Aquatic Life" use designated for the Klamath River from Keno Dam to the Oregon-California State line is "Redband or Lahontan Cutthroat Trout." OAR 340-041-0180, Figure 180A.
[4] Applicable for mainstem Klamath River from Upper Klamath Lake to Keno Dam (RM 255 to 232.5) (ODEQ 340-041-0180)

Key:
OAR: Oregon Administrative Rules
N/A: Not applicable
* = Proposed Beneficial Use
** = Historical Beneficial Use

3.2.2.2 Water Quality Standards

3.2.2.2.1 Freshwater

Water quality standards for fresh surface waters have been established by ODEQ, NCRWQCB, and the Hoopa Valley Tribe to protect the designated beneficial uses listed in Table 3.2-2.

Oregon Revised Statutes ORS 468B.025(1) states "...no person shall: (a) Cause pollution of any waters of the State or place or cause to be placed any wastes in a location where

such wastes are likely to escape or be carried into the waters of the State by any means; and (b) Discharge any wastes into the waters of the State if the discharge reduces the quality of such waters below the water quality standards established by rule for such waters by the Environmental Quality Commission." ORS 468B.050 and 468B.053 provide for ODEQ to issue permitted exemptions from ORS 468B.025(1).

The California Porter-Cologne Act defines water quality using chemical, physical, biological, bacteriological, radiological, and other properties and characteristics of water that affect its use. It further defines water quality objectives as the limits or levels of water quality constituents or characteristics that are established for the reasonable protection of beneficial uses of water or the prevention of nuisance within a specific area.

Water quality objectives adopted by the Hoopa Valley Tribe establish water quality objectives for those portions of the Trinity and Klamath rivers under the jurisdiction of the tribe. The Yurok and Karuk Tribes have also adopted water quality objectives, as has the Resighini Rancheria; however, the associated water quality plans have not yet been approved by USEPA (NCRWQCB 2010a, see also discussion regarding tribal beneficial uses in Section 3.2.2.1). Surface-water quality objectives relevant to the Proposed Action and alternatives are listed in Table 3.2-3 through 3.2-7.

Table 3.2-3. Oregon Surface-Water Quality Objectives Relevant to the Proposed Action and Alternatives

Parameter	Criteria/Description[1]
Biocriteria OAR 340-041-0011	Waters of the State must be of sufficient quality to support aquatic species without detrimental changes in the resident biological communities.
Dissolved Oxygen OAR 340-041-0016	Sufficient concentrations of dissolved oxygen are necessary to support aquatic life.
	Coldwater aquatic life 8.0 mg/L minimum
	Cool water aquatic life 6.5 mg/L minimum
	Warm water aquatic life 5.5 mg/L minimum
	Spawning 11.0 mg/L minimum
	Spawning 8.0 mg/L minimum intergravel
Nuisance Algae Growth OAR 340-041-0019	Algal growth which impairs the recognized beneficial uses of the water body is not allowed. For natural lakes that do not thermally stratify, reservoirs, rivers and estuaries, average chlorophyll-*a* concentrations at or above 0.015 mg/l identify water bodies where phytoplankton may impair the recognized beneficial uses.
pH OAR 340-041-0021 & OAR 340-041-0185	pH values may not fall outside the range of 6.5–9.0. When greater than 25 percent of ambient measurements taken between June and September are greater than pH 8.7, and as resources are available according to priorities set by the Department, the Department will determine whether the values higher than 8.7 are anthropogenic or natural in origin.

Table 3.2-3. Oregon Surface-Water Quality Objectives Relevant to the Proposed Action and Alternatives

Parameter	Criteria/Description[1]
	Waters impounded by dams existing on January 1, 1996, which have pHs that exceed the criteria are not in violation of the standard, if the Department determines that the exceedance would not occur without the impoundment and that all practicable measures have been taken to bring the pH in the impounded waters into compliance with the criteria.
Temperature OAR 340-041-0028 & OAR 340-041-0185	Water temperature must protect designated temperature-sensitive, beneficial uses, including specific salmonid life cycle stages in waters of the State. **Redband or Lahonton cutthroat trout habitat** 20°C (68°F) **Coolwater species (no salmonids) – Basin-specific Criterion** From June 1 to September 30, no NPDES point source that discharges to the portion of the Klamath River designated for cool water species may cause the temperature of the water body to increase more than 0.3°C (0.5°F) above the natural background after mixing with 25% of the stream flow. Natural background for the Klamath River means the temperature of the Klamath River at the outflow from Upper Klamath Lake plus any natural warming or cooling that occurs downstream. This criterion supersedes OAR 340-041-0028(9)(a) during the specified time period for NPDES permitted point sources. Natural Conditions Criteria. Where the department determines that the natural thermal potential of all or a portion of a water body exceeds the biologically-based criteria, the natural thermal potential temperatures supersede the biologically-based criteria, and are deemed to be the applicable temperature criteria for that water body.
Turbidity OAR 340-041-0036	Numeric criterion generally prohibits turbidity increases which exceed 10-percent above background. Dredging, Construction or other Legitimate Activities: Permit or certification authorized under terms of CWA Section 401 or 404 (Permits and Licenses, Federal Water Pollution Control Act) or OAR 14l-085-0100 et seq. (Removal and Fill Permits, Division of State Lands), with limitations and conditions governing the activity set forth in the permit or certificate.
Toxic material OAR 340-041-0033	Toxic substances may not be introduced above natural background levels in waters of the State in amounts, concentrations, or combinations that may be harmful, may chemically change to harmful forms in the environment, or may accumulate in sediments or bioaccumulate in aquatic life or wildlife to levels that adversely affect public health, safety, or welfare or aquatic life, wildlife, or other designated beneficial uses) Levels of toxic substances may not exceed the criteria listed in Table 20 [from the OAR] and the new Table 40 [2]

Source: ODEQ (OAR 340-041).

[1] Relevant beneficial uses are shown in bold and all caps. If no beneficial use is specified, the objective or criteria applies to all beneficial uses.

[2] On June 16, 2011, ODEQ revised human health criteria for toxic pollutants using a fish consumption rate of 175 grams per day, which is based on tribal consumption rates for tribes that live in Oregon. The new criteria were approved by USEPA on October 17, 2011. This section also applies to the revised iron, manganese, and arsenic criteria the commission adopted in December 2010 and April 2011, respectively.

Table 3.2-4. California Surface-Water Quality Objectives

Parameter	Description[1]
Suspended Material	Waters shall not contain suspended material in concentrations that cause nuisance or adversely affect beneficial uses.
Settleable Material	Waters shall not contain substances in concentrations that result in deposition of material that causes nuisance or adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate of surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Turbidity shall not be increased more than 20% above naturally occurring background levels. Allowable zones of dilution within which higher percentages can be tolerated may be defined for specific discharges upon the issuance of discharge permits or waiver thereof.
Temperature	**COLD, WARM** (for nontidal waters) The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the NCRWQCB that such alteration in temperature does not adversely affect beneficial uses. The temperature of any COLD or WARM freshwater habitat shall not be increased by more than 2.8ºC (5ºF) above natural receiving water temperature.
Dissolved Oxygen	**WARM, MAR, Inland Saline Water Habitat (SAL), COLD, SPWN** Klamath River Mainstem Specific Water Quality Objectives based on natural receiving water temperatures (see Table 3.2-5 for minimum DO concentrations in mg/L) • From Oregon-California State line (RM 208.5) to the Scott River (RM 143), 90% saturation October 1-March 31 and 85% saturation April 1-September 30. • From Scott River (RM 143) to Hoopa Valley Tribe boundary (≈RM 45), 90% saturation year round. • From Hoopa Valley Tribe boundary to Turwar (RM 5.8), 85% saturation June 1-August 31 and 90% saturation September 1-May 31. • For upper and middle Klamath River Estuary (RM 0-2), 80% saturation August 1-August 31, 85% saturation September 1-October 31 and June 1-July 31, and 90% saturation November 1-May 31. • **EST** For Lower Klamath River Estuary (RM 0), DO content shall not be depressed to levels adversely affecting beneficial uses as a result of controllable water quality factors.
Biostimulatory Substances	Waters shall not contain biostimulatory substances in concentrations that promote aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.
Nitrate – N	**MUN** 45 mg/L as NO_3 [2]
Nitrate + Nitrite	**MUN** 10 mg/L as N [3]

Table 3.2-4. California Surface-Water Quality Objectives

Parameter	Description[1]
pH	The pH shall not be depressed below 6.5 units nor raised above 8.5 units
	COLD, WARM Changes in normal ambient pH levels shall not exceed 0.2 units within the range specified above.
	For the Klamath River upstream of Iron Gate Dam, including Iron Gate & Copco reservoirs, and the Klamath River downstream from Iron Gate Dam pH shall not be depressed below 7 units nor raised above 8.5 units.
Toxicity	All waters shall be maintained free of toxic substances in concentrations that are toxic to, or that produce detrimental physiological responses in human, plant, animal, or aquatic life.
Pesticides	No individual pesticide or combination of pesticides shall be present in concentrations that adversely affect beneficial uses. There shall be no bioaccumulation of pesticide concentrations found in bottom sediments or aquatic life. Waters designated for use as domestic or municipal supply shall not contain concentrations of pesticides in excess of the limiting concentrations set forth in California Code of Regulations, Title 22, Division 4, Chapter 15, Article 4, Section 64444.5 (Table 5), and listed in Table 3-2 of the Basin Plan.
Chemical Constituents	Waters designated for use as domestic or municipal supply (MUN) shall not contain concentrations of chemical constituents in excess of the limits specified in California Code of Regulations, Title 22, Chapter 15, Division 4, Article 4, Section 64435 (Tables 2 and 3), and Section 64444.5 (Table 5), and listed in Table 3-2 of the Basin Plan. Waters designated for use as agricultural supply (AGR) shall not contain concentrations of chemical constituents in amounts which adversely affect such beneficial use.

Source: NCRWQCB 2011 unless otherwise noted.

[1] Relevant beneficial uses are shown in bold and all caps. If no beneficial use is specified, the objective or criteria applies to all beneficial uses.

[2] Maximum contaminant level for domestic or municipal supply.

[3] Maximum contaminant level (shall not be exceeded in water supplied to the public) as specified in Table 64431-A (Inorganic Chemicals) of Section 64431, Title 22 of the California Code of Regulations (CCR), as of April 23, 2007.

Table 3.2-5. Minimum DO Concentrations Based on Percent Saturation Criteria[1] (NCRWQCB 2010a)

DO Concentrations (mg/L)	Jan	Feb	March	April	May	June	July	August	Sept	Oct	Nov	Dec
Stateline to Scott River – 90% October 1 through March 31 and 85% April 1 through September 30												
Stateline	10.4	9.6	8.5	7.6	7.0	6.3	6.3	6.4	6.9	7.8	9.5	10.6
Downstream Copco Dam	10.4	9.6	8.5	7.6	6.9	6.3	6.3	6.4	6.9	7.8	9.5	10.6
Downstream Iron Gate Dam	10.8	9.9	8.8	7.8	7.1	6.5	6.5	6.5	7.1	8.1	9.7	10.9
Upstream Shasta River	10.8	10.0	8.9	7.9	7.1	6.6	6.4	6.4	7.1	7.9	9.6	10.8
Downstream Shasta River	10.8	10.1	9.0	7.9	7.2	6.7	6.5	6.5	7.2	8.0	9.7	10.9
Upstream Scott River	10.9	10.2	9.1	8.1	7.2	6.7	6.4	6.5	7.1	7.9	9.8	10.9
Scott River to Hoopa – 90% all year												
Downstream Scott River	10.8	10.2	9.3	8.7	7.9	7.3	6.9	6.9	7.6	8.0	9.8	10.9
Seiad Valley	10.9	10.2	9.3	8.8	7.8	7.2	6.9	6.9	7.5	7.9	9.9	10.9
Upstream Indian Creek	11.0	10.3	9.4	8.9	8.0	7.3	7.0	7.0	7.5	7.9	9.9	10.8
Downstream Indian Creek	11.0	10.3	9.5	9.0	8.1	7.4	7.0	7.0	7.6	8.0	9.9	10.8
Upstream Salmon River	11.2	10.6	9.8	9.3	8.4	7.5	7.2	7.2	7.7	8.2	10.0	11.0
Downstream Salmon River	11.1	10.6	9.9	9.4	8.5	7.6	7.2	7.2	7.7	8.2	10.0	10.9
Hoopa to Turwar – 90% September 1 through May 31 and 85% June 1 through August 31												
Hoopa	11.0	10.6	10.0	9.5	8.5	7.2	7.0	6.9	7.8	8.3	10.1	11.0
Upstream Trinity River	11.0	10.6	10.0	9.5	8.5	7.2	7.0	6.9	7.8	8.3	10.0	11.0
Downstream Trinity River	10.9	10.6	9.9	9.5	8.6	7.4	7.1	7.0	7.9	8.4	10.0	10.9
Youngsbar	10.9	10.6	9.9	9.5	8.7	7.4	7.1	7.0	7.9	8.4	10.0	10.9
Turwar	10.9	10.5	9.9	9.5	8.6	7.2	6.9	6.8	7.6	8.1	9.8	10.8
Upper and Middle Estuary – 90% November 1 through May 31, 85% September 1 through October 31 and June 1 through July 31, 80% August 1 through August 31												
Upper Estuary	10.9	10.6	10.1	9.5	8.6	7.3	7.1	6.7	7.6	8.0	10.0	10.7
Middle Estuary	10.9	10.6	10.1	9.6	8.6	7.3	7.2	6.8	7.8	8.2	10.1	10.8
Lower Estuary – Narrative Objective												

[1] The "Alternative 3" analysis conducted by the NCRWQCB (2010a) to arrive at the DO concentrations listed in this table is not the same as the Alternative 3 referred to in the Klamath Facilities Removal EIS/EIR. Estimates of site-specific natural temperatures inherent to the DO percent saturation estimates are derived from the T1BSR run of the Klamath TMDL model (NCRWQB 2010a).

Table 3.2-6. Hoopa Valley Tribe Surface-Water Quality Objectives

Parameter	Criteria/Description[1]
Ammonia (NH3, as mg/L N)	**COLD** Because ammonia toxicity to fish is influenced by pH, waters designated for the purpose of protection of threatened and endangered fish species in cold freshwater habitat shall meet conditions for ammonia based on maximum one-hour (acute) and 30-day average (chronic) concentrations linked to pH by a formula (HVTEPA 2008).
Periphyton	150 mg chlorophyll-*a* /m^2
Dissolved oxygen[2]	**COLD** 8.0 mg/L minimum
	SPWN 11.0 mg/L minimum
	SPWN 8.0 mg/L minimum in inter-gravel water
Total Nitrogen (TN)[3,4]	0.2 mg/L
Total Phosphorous (TP)	0.035 mg/L
pH	The pH in the Klamath River shall be between 7.0 and 8.5 at all times
Microcystis aeruginosa cell density	**MUN, REC-1** <5,000 cells/mL for drinking water <40,000 cells/mL for recreational water
Microcystin toxin Concentration	**MUN, REC-1** <1µg/L total microcystins for drinking water <8 µg/L total microcystins for recreational water
Total potentially toxigenic cyanobacteria species[5]	**MUN, REC-1** <100,000 cells/mL for recreational water
Cyanobacterial scums	**MUN, REC-1** There shall be no presence of cyanobacterial scums
Nitrate	**MUN** 10 mg/L

Source: HVTEPA (2008)

[1] Relevant beneficial uses are shown in bold and all caps. If no beneficial use is specified, the objective or criteria applies to all beneficial uses.

[2] HVTEPA (2008) includes a natural conditions clause stating "If dissolved oxygen standards are not achievable due to natural conditions, then the COLD and SPAWN standard shall instead be dissolved oxygen concentrations equivalent to 90% saturation under natural receiving water temperatures." USEPA has approved the Hoopa Valley Tribe definition of natural conditions; the provision that site-specific criteria can be set equal to natural background and the procedure for defining natural background have not been finalized as of June 2011.

[3] HVTEPA (2008) includes a natural conditions clause stating "If total nitrogen and total phosphorus standards are not achievable due to natural conditions, then the standards shall instead be the natural conditions for total nitrogen and total phosphorus." USEPA has approved the Hoopa definition of natural conditions; the provision that site-specific criteria can be set equal to natural background and the procedure for defining natural background have not been finalized as of June 2011.

[4] 30-day mean of at least two sample per 30-day period.

[5] Includes: *Anabaena, Microcystis, Planktothrix, Nostoc, Coelosphaerium, Anabaenopsis, Aphanizomenon, Gloeotrichia*, and *Oscillatoria.*

3.2.2.2.2 Marine

Narrative and numeric water quality objectives to support designated beneficial uses under the Ocean Plan are listed below in Table 3.2-7.

Table 3.2-7. California Marine Water Quality Objectives Relevant to the Proposed Action and Alternatives

Water Quality Objective[1]	Description
Physical Characteristics	• Floating particulates and grease and oil shall not be visible. • The discharge of waste shall not cause aesthetically undesirable discoloration of the ocean surface. • Natural light shall not be significantly reduced at any point outside the initial dilution zone as the result of the discharge of waste. • The rate of deposition of inert solids and the characteristics of inert solids in ocean sediments shall not be changed such that benthic communities are degraded.
Chemical Characteristics	• The dissolved oxygen concentration shall not at any time be depressed more than 10% from that which occurs naturally, as the result of the discharge of oxygen demanding waste materials. • The pH shall not be changed at any time more than 0.2 units from that which occurs naturally. • The dissolved sulfide concentration of waters in and near sediments shall not be significantly increased above that present under natural conditions. • The concentration of substances set forth in Chapter II, Table B (SWRCB 2001), in marine sediments shall not be increased to levels which would degrade indigenous biota. The concentration of organic materials in marine sediments shall not be increased to levels that would degrade marine life. • Nutrient materials shall not cause objectionable aquatic growths or degrade indigenous biota. • Numerical Water Quality Objectives for discharges are listed in California State Water Resources Control Board (SWRCB 2001), including objectives for the protection of marine aquatic life (i.e., metals, inorganics, organics, chronic and acute toxicity, pesticides and PCBs, radioactivity) and objectives for the protection of human health (noncarcinogenic and carcinogenic compounds).

Source: SWRCB (2001) unless otherwise noted.

[1] WQOs for bacterial characteristics and elevated temperature (thermal) wastes are not included, as these water quality parameters are not anticipated to be affected by the Project.

3.2.2.3 Water Quality Impairments

Section 303(d) of the CWA requires States to identify water bodies that do not meet (as of February 2012) water quality objectives and are not supporting their designated beneficial uses. These water bodies are considered to be impaired with respect to water quality. ODEQ and NCRWQCB have both included the Klamath Basin and specifically, the Klamath and Lost Rivers on their CWA Section 303(d) lists of water bodies with water quality impairments (see Table 3.2-8).

Table 3.2-8. Water Quality Impaired Water Bodies within the Area of Analysis[1]

Water Body Name	Water Temperature	Sedimentation	pH	Organic Enrichment/ Low Dissolved Oxygen	Nutrients	Ammonia	Chlorophyll-*a*	Microcystin
Oregon[2]								
Sprague River and tributaries	X[s]		X[s]	X[s]				
Williamson River and tributaries	X							
Upper Klamath Lake and Agency Lake			X	X			X	
Upper Klamath River (Keno Dam to Link River Dam, including Keno Impoundment/Lake Ewauna)			X[s]	X[sp,s,f,w (3)]		X[sp,s,f,w]	X[s]	
Upper Klamath River Oregon-California State line to Keno Dam (including J.C. Boyle Reservoir)[(4)]	X[sp,s,f,w (5)]			X[sp,s,f,w (3)]				
California								
Lower Lost River (Tule Lake, Lower Klamath Lake National Wildlife Refuge, and Mt Dome)			X		X			
Middle Klamath River Oregon-California State line to Iron Gate Dam (including Copco Lake Reservoir [1 and 2] and Iron Gate Reservoir)	X			X	X			X
Middle Klamath River Iron Gate Dam to Scott River Reach[6]	X			X	X			X
Shasta River	X			X				
Scott River	X	X						
Salmon River	X							
Middle and Lower Klamath River Scott River to Trinity River Reach[7]	X			X	X			X
Lower Klamath River-Trinity River to Mouth	X	X		X	X			

Notes:

[1] While there are additional water quality impaired waterbodies in the area of analysis, the waterbodies listed in this table are the ones that are directly relevant to the water quality analysis for this Klamath Facilities Removal EIS/EIR.

[2] Oregon lists specific reaches of the Klamath River by river mile and includes specific seasons, in some cases (Kirk et al. 2010).

[3] Listed for dissolved oxygen only (non-spawning) (Kirk et al. 2010).

[4] Oregon defines particular river miles for their listings.

[5] Non-spawning (Kirk et al. 2010).

[6] Selected minor tributaries to the Middle and Lower Klamath River that are impaired for sediment and sedimentation include Beaver Creek, Cow Creek, Deer Creek, Hungry Creek, and West Fork Beaver Creek (USEPA 2010a).

[7] Minor tributaries to the Middle and Lower Klamath River that are impaired for sediment and sedimentation include China Creek, Fort Goff Creek, Grider Creek, Portuguese Creek, Thompson Creek, and Walker Creek (USEPA 2010a).

Key:

Sp = Listed for spring season

S = Listed for summer season

F = Listed for fall season

W = Listed for winter season

3.2.2.4 Total Maximum Daily Loads

For water quality impaired water bodies (i.e., 303[d]-listed water bodies), Total Maximum Daily Loads (TMDLs) must be developed by the State with jurisdiction over the water body to protect and restore beneficial uses of water. TMDLs (1) estimate the water body's capacity to assimilate pollutants without exceeding water quality standards; and, (2) set limits on the amount of pollutants that can be added to a water body while still protecting identified beneficial uses. ODEQ and the NCRWQCB cooperated on the development of TMDLs for the impaired water bodies of the Klamath Basin (see Table 3.2-8). Table 3.2-9 lists the status of TMDLs in the Klamath Basin. Table 3.2-9 is followed by a brief narrative summary of TMDLs for each water body to provide relevant context for TMDL-related discussions in Section 3.2.4.3, Effects Determinations. Additional information regarding the Oregon TMDLs can be found on ODEQ's Web site http://www.deq.state.or.us/WQ/TMDLs/klamath.htm and for the California TMDLs on the North Coast Regional Water Quality Control Board Web site: http://www.waterboards.ca.gov/northcoast/water_issues/programs/tmdls/

Table 3.2-9. Status of TMDLs in the Klamath Basin as of February 2012

Water Body	Pollutant/Stressor	Agency	Original Listing Date	TMDL Completion Date[1]
Oregon				
Upper Klamath Lake Drainage	Temperature, dissolved oxygen, and pH	ODEQ	1998	2002
Upper Klamath and Lost Rivers (in Oregon)	Temperature, dissolved oxygen, pH, ammonia toxicity, and chlorophyll-*a*	ODEQ	1998	2012
California				
Lower Lost River (Tule Lake, Lower Klamath Lake National Wildlife Refuge, and Mt Dome)[2]	pH and nutrients	USEPA	1992 (Nutrients), 2002 (pH)	2008
Klamath River	Temperature, organic enrichment/low dissolved oxygen[3], nutrient, and microcystin[4]	NCRWQCB	1992 (Temperature and nutrients), 1998 (Dissolved oxygen), 2006 and 2010 (Microcystin)	2010
Shasta River	Temperature and dissolved oxygen	NCRWQCB	1992 (Dissolved oxygen), 1994 (Temperature)	2007

Table 3.2-9. Status of TMDLs in the Klamath Basin as of February 2012

Water Body	Pollutant/Stressor	Agency	Original Listing Date	TMDL Completion Date[1]
Scott River	Temperature and sediment	NCRWQCB	1992 (Sediment), 1996 (Temperature)	2006
Salmon River	Temperature	NCRWQCB	1992	2005
Trinity	Sediment	USEPA	1992	2001
South Fork Trinity	Sediment	USEPA	1992	1998

Notes:

[1] The TMDL completion date is the year the USEPA approved or is expected to approve the TMDL.

[2] The Upper Lost River upstream of the Oregon border (i.e., in California), Clear Lake Reservoir, and tributaries were previously listed for water temperature and nutrients. In 2004, North Coast Regional Board staff completed an analysis of beneficial uses and water quality conditions in the Upper Lost River watershed (in California) and concluded that the water temperature and nutrient listings were not warranted.

[3] Listing applies only to the mainstem Klamath River.

[4] Listings occurred in 2006 for the mainstem Klamath River from the Oregon-California State line to Iron Gate Dam (including Copco and Iron Gate Reservoirs), and in 2010 for the mainstem Klamath River from Iron Gate Dam to the Trinity River.

Key:
TMDL =
Total Maximum Daily Load
ODEQ =
Oregon Department of Environmental Quality
USEPA =
U.S. Environmental Protection Agency
NCRWQCB =
North Coast Regional Water Quality Control Board

3.2.2.4.1 Upper Klamath Lake Drainage TMDLs

The Upper Klamath Lake TMDLs cover temperature, dissolved oxygen, and pH. The geographic extent of the Upper Klamath Lake TMDLs includes the northern portion of the Upper Klamath Basin, which comprises three sub-basins (i.e., Upper Klamath Lake, Williamson River, and Sprague River). TMDL targets were developed for (1) TP loading as the primary method of improving pH and dissolved oxygen conditions in Upper Klamath and Agency Lakes; (2) heat loads for anthropogenic and background nonpoint sources throughout the basin; (3) dissolved oxygen in the Sprague River (USEPA 1987); and, (4) pH in the Sprague River. Specific implementation actions, including designated Best Management Practices (BMPs), are under development by the designated management agencies (DMAs) (ODEQ 2002).

3.2.2.4.2 Upper Klamath River and Lost River (in Oregon) TMDLs

The Upper Klamath River and Lost River TMDLs cover temperature, dissolved oxygen, pH, ammonia toxicity, and chlorophyll-*a*. ODEQ approved the Upper Klamath and Lost River subbasins TMDLs in December 2010 and USEPA is expected to approve these TMDLs in 2011 (S. Kirk, pers. comm., 9 March 2011). The TMDLs cover the southern

portion of the Upper Klamath Basin including (1) the Klamath River from Upper Klamath Lake to the Oregon-California State line and (2) impounded and riverine sections of the Lost River from the State line downstream from the Malone Dam to the State line upstream of Tule Lake, and the Klamath Straits Drain from the State line to the confluence with the Klamath River. The TMDLs require reductions in phosphorus, nitrogen, and biochemical oxygen demand (BOD) loading from both point sources and nonpoint sources in the Upper Klamath River, as well as augmentation of dissolved oxygen in the impoundments. There are no permitted point sources of elevated water temperatures for these TMDLs. The heat load allocation for nonpoint sources is equivalent to 0.2°C (0.4 F) above applicable criteria. The Upper Klamath River and Lost River TMDLs were designed to ensure that Oregon's water quality criteria for the Klamath River would be attained at the point where the Lost River discharges into the Klamath River. Specific implementation actions, including designated BMPs, will be developed by the DMAs (Kirk et al. 2010).

3.2.2.4.3 Lower Lost River (in California) TMDLs

The Lower Lost River TMDLs cover pH and nutrients. The geographic extent of the Lower Lost River TMDLs in California includes the Lost River from the Oregon-California State line near Anderson-Rose Dam to the Klamath Straits Drain at the Oregon-California State line, including the Tule Lake and Lower Klamath National Wildlife Refuge areas. Water from the Lower Lost River can be diverted into the Klamath River via the Lost River Diversion Dam and the Klamath Straits Drain (after passing through Tule Lake, the P Canal system, and, in some cases, the Lower Klamath National Wildlife Refuge). The Lower Lost River TMDLs were designed to ensure that California's numeric dissolved oxygen water quality standard would be attained in the Lower Lost River. Implementation measures focus on water quality effects from Reclamation's Klamath Project, the U.S. Fish and Wildlife Service (USFWS) Klamath Refuges, and the Tulelake Wastewater Treatment Plant (USEPA 2008). Note that these TMDLs do not apply to the Upper Lost River; the Upper Lost River upstream of the Oregon border (i.e., in California), Clear Lake Reservoir, and tributaries were previously listed for water temperature and nutrients. In 2004, North Coast Regional Board staff completed an analysis of beneficial uses and water quality conditions in the Upper Lost River watershed and concluded that the water temperature and nutrient listings were not warranted.

3.2.2.4.4 Klamath River TMDLs

The Klamath River TMDLs cover temperature, organic enrichment/low dissolved oxygen, nutrient, and microcystin. The geographic extent of the California Klamath River TMDL analyses includes the river from State line to the Pacific Ocean. The TMDLs do not specifically address existing sedimentation/siltation impairments in the Klamath River from the Trinity River to the Pacific Ocean; currently, sediment TMDLs for the Trinity and South Fork Trinity Rivers address these impairments. Additionally, the Action Plans do not cover tribal lands. The TMDLs assign three load allocations to the Klamath Hydroelectric Project (KHP) in California (NCRWQCB 2010a):

- Create a compliance lens in Copco and Iron Gate Reservoirs, such that water temperature and dissolved oxygen conditions are suitable for cold water fish during the critical summer period.
- Annual TP and TN loading reduction (TP=22,367 lbs and TN=120,577 lbs) to offset the reduced nutrient assimilative capacity[1] in the reservoirs (as compared to a free-flowing river condition) that is associated with nuisance blooms of green algae and cyanobacteria in the reservoirs. TMDL targets are established for chlorophyll-*a*, *Microcystis aeruginosa* cell density, and microcystin.
- Daily average (and daily maximum) increase in water temperatures relative to inflow temperatures for reservoir tailrace waters (0.1^{o}C [0.18^{o}F] for Iron Gate and 0.5^{o}C [0.9^{o}F] for Copco 1 and 2).

The first two load allocations include a provision for the use of reservoir management measures to achieve the TMDL targets. Numerous implementation actions are described in NCRWQCB (2010b).

Even though pH infrequently meets California North Coast Basin Plan Water Quality Objectives for the Klamath River, it was not listed under the 303(d) list for the River in 2006 (Table 3.2-8), prior to the development of the 2010 TMDLs; instead it was explicitly incorporated into the TMDLs as a nutrient-related water quality impairment including the KHP. The linkage between these impairments is discussed in the TMDL Staff Report (NCRWQCB 2010a). As such, meeting the nutrient objectives will mitigate pH impairments.

3.2.2.4.5 Shasta River TMDLs

The Shasta River TMDLs for temperature and dissolved oxygen cover the Shasta River, a tributary to the mainstem Klamath River, located in the central portion of the Lower Klamath Basin. The TMDL extends from the headwaters to the confluence with the Klamath River, and includes tributaries to the Shasta River and Lake Shastina. Implementation actions build upon ongoing watershed restoration and enhancement work (e.g., increasing riparian vegetation to decrease water temperature and improve bank stability; controlling tailwater discharges to prevent the release of elevated temperature and nutrient enriched waters; promoting efficient water use to increase dedicated cold water flow; addressing proximal land use activities that contribute to low dissolved oxygen and high water temperatures in the watershed, such as timber harvest and road building) (NCRWQCB 2006, 2007).

3.2.2.4.6 Scott River TMDLs

The Scott River TMDL for temperature and sediment covers the Scott River, a tributary to the mainstem Klamath River, located in the central portion of the Lower Klamath Basin. The TMDL extends from the headwaters of the Scott River to its confluence with

[1] The phrase “assimilative capacity” here refers to the maximum amount of nutrients that can enter the reservoirs and still allow for water quality conditions in the reservoirs to meet water quality objectives (e.g., dissolved oxygen and microcystin).

the mainstem Klamath River. Implementation of the Scott River TMDL is expected to achieve water quality standards for water temperature and sediment within 40 years of plan approval. Implementation actions include the following (NCRWQCB 2011):

- Controlling road-caused sediment;
- Reviewing dredge mining effects;
- Promoting the preservation of riparian vegetation and regulating its suppression and/or removal;
- Implementing water conservation practices;
- Studying groundwater uses and effects;
- Ensuring flood control and bank stabilization activities
- Minimizing vegetation removal/suppression and sediment delivery;
- Regulating discharges related to timber harvest; and,
- Minimizing the effect of grazing.

3.2.2.4.7 Salmon River TMDL

The Salmon River TMDL for temperature covers the Salmon River, a tributary to the mainstem Klamath River located in the southern portion of the Lower Klamath Basin. The Salmon River TMDL target for water temperature applies throughout the Salmon River watershed and is necessary to achieve the Basin Plan water quality objective for temperature. The Basin Plan criterion requires no alteration of temperature without demonstrations that an increase will not adversely affect beneficial uses nor may the temperature of any cold water be increased by more than 5°F above natural receiving temperature (NCRWQCB 2005). The North Coast Regional Board signed a Memorandum of Understanding with the United States Forest Service (USFS), which manages 98 percent of the lands within the Salmon River watershed, regarding USFS activities within the basin and implementation of the Salmon River TMDL.

3.2.2.4.8 Trinity River TMDL

The Trinity River TMDL for sediment covers the portions of the mainstem Trinity River watershed governed by California water quality standards (i.e., not lands under tribal jurisdiction) in the southern portion of the Lower Klamath Basin, to the confluence of the Trinity and Klamath rivers; the TMDL does not apply to the South Fork Trinity River. The Trinity River TMDL target for sediment is a set loading capacity of 125 percent of the background sediment delivery rate (USEPA 2001). Examples of ongoing implementation actions include, but are not limited to, completing watershed and road analyses in USFS and Bureau of Land Management (BLM) lands, watershed restoration, limiting suction dredge operations, comprehensive aquatic monitoring, improving Timber Harvest Plan (THP)s, and continued road/erosion control and fuels management.

3.2.2.4.9 South Fork Trinity River TMDL

The South Fork Trinity River TMDL for sediment covers the South Fork Trinity River from its headwaters in the North Yolla Bolly Mountains in the southern portion of the Lower Klamath Basin, to the confluence with the Trinity River, and includes Hayfork Creek and other smaller tributaries. The TMDL for sediment is approximately 737 tons per square mile per year. Ongoing implementation actions include encouraging

landowner-based sediment reduction plans, specifying requirements for sediment reduction plans, and providing alternative land management guidelines (USEPA 1998). Additional actions include developing a monitoring process for the basin.

3.2.3 Existing Conditions/Affected Environment

3.2.3.1 Overview of Water Quality Processes in the Klamath Basin

Water quality in the Klamath River is affected by the geology and meteorology of the Klamath Basin, as well as current and historical land- and water-use practices. Cold air temperatures and precipitation generally occur from November to March (see Section 3.6, Flood Hydrology), corresponding to periods of higher flows and colder water temperatures. Warmer air temperatures and drier conditions occur from April to October (see Section 3.6, Flood Hydrology), corresponding to periods of lower flows and warmer water temperatures. The relatively low relief, volcanic terrain of the Upper Klamath Basin (see Section 3.11, Geology, Soils, and Geologic Hazards) supports large, shallow natural lakes (Upper Klamath Lake, Agency Lake, Tule Lake, Lower Klamath Lake) and wetlands, with soils that are naturally high in phosphorus. Human activities in the upper basin, including wetland draining, agriculture, ranching, logging, and water diversions have altered seasonal stream flows and water temperatures, increased concentrations of nutrients (nitrogen and phosphorus) and suspended sediment in watercourses, and degraded other water quality parameters such as pH and dissolved oxygen concentrations. The Lower Klamath Basin is composed of generally steeper, mountainous terrain (see Section 3.11, Geology, Soils, and Geologic Hazards), where historical hillslope and in-channel gold mining and extensive logging have occurred, along with agricultural and ranching activities that divert water in many of the lower tributary basins. These activities have altered streamflows, increased concentrations of suspended sediment and nutrients in watercourses, and increased summer water temperatures.

The presence and operation of the Four Facilities in the Klamath Hydroelectric Reach of the Upper Klamath Basin affect many aspects of water quality in the Klamath River. The most common effects of hydroelectric projects on water quality result from changes in the physical structure of the aquatic ecosystem. Dams slow the transport of water downstream, intercept and retain sediment, organic matter, nutrients, and other constituents that would otherwise be transported downstream, as well as alter seasonal water temperatures when compared to free-flowing stream reaches.

- **River and reservoir water temperatures.** The primary effects of hydroelectric project operations on the natural temperature regime of streams and rivers are related to alterations in water surface area, depth, and velocity due to water diversions into or out of the stream corridor, including reservoir impoundments and conveyance through pipelines or penstocks. These changes influence the amount of heat entering and leaving water bodies (such as from solar radiation and nighttime re-radiation), which determines the water temperature. Because reservoirs are often deep, they can retain their water temperature for weeks or months, thereby shifting the natural water temperature patterns below reservoirs.

For example, water released from reservoirs in the springtime is typically cooler than would naturally occur because the reservoir retains some of the cold water it received in the winter. Similarly, water released from reservoirs in the fall is typically warmer than would naturally occur because the reservoir still contains water that was heated during the summer months. Additionally, due to surface heating of the reservoir in the late spring and summer, a warmer, less dense water layer forms on the reservoir surface (the epilimnion), which overlies colder, denser water (the hypolimnion). This process is called thermal stratification and often persists for months.

- **Reservoir mixing and dissolved oxygen.** The water column in most deep reservoirs has a characteristic thermal and chemical structure that is independent of the size of the reservoir. With thermal stratification (in summer and fall), the isolated deeper water is not exposed to the atmosphere and often completely loses its supply of dissolved oxygen over a period of weeks or months as organic matter in bottom sediments decays. Releases of this deeper, oxygen-depleted water from the bottom of the reservoir can cause serious problems for downstream fish and other aquatic biota. In the fall, thermal stratification typically breaks down as the surface layer cools and wind mixing of the water column occurs. This process is called reservoir turnover.
- **Algae in reservoirs.** Because large reservoirs have long retention times for water and thermally stratify in the summer months, they often provide ideal conditions for the growth of suspended algae (phytoplankton) in the epilimnion. Depending upon available nutrients, extensive phytoplankton blooms can develop in these reservoirs. Algal photosynthesis during the day releases dissolved oxygen and consumes carbon dioxide. At night, algal respiration consumes dissolved oxygen and releases carbon dioxide. This can result in wide swings in dissolved oxygen and pH, which is stressful to aquatic biota. Under nutrient-rich conditions, harmful blooms of blue-green algae can occur, producing cyanotoxins (e.g., cyclic peptide toxins that act on the liver such as microcystin, alkaloid toxins such as anatoxin-a and saxitoxin that act on the nervous system). Cyanotoxins have been found to be harmful to a wide range of biota including exposed fish, shellfish, livestock, and humans. Releases of impounded waters can transport algae and/or toxins to downstream waters and algal blooms can die abruptly ("crash"), releasing cyanotoxins into the water column. The subsequent decomposition of organic matter associated with algal remains can create periods of low dissolved oxygen in reservoir bottom waters.
- **Nutrient cycling in reservoirs and internal loading.** Nutrients entering reservoirs can undergo many changes and be involved in many biochemical processes. On an annual basis, the majority of nutrients entering a reservoir from a watershed are eventually discharged downstream, with only a small fraction being retained in the reservoir bottom sediments. Dissolved nutrients (e.g., ortho-phosphorus, nitrate, and ammonium) entering a reservoir can be used directly by algae when growing conditions are good. Some of these algae eventually die and settle to the bottom of reservoirs, also contributing nutrients (and organic matter) to the bottom sediments. Under low oxygen conditions, nutrients contained within bottom sediments can be re-released to the water column, creating a source

of internal nutrient loading to the reservoir. This is particularly important for phosphorus and results in highly enriched bottom waters during periods of reservoir stratification. At turnover, these nutrient rich waters are mixed throughout the reservoir, can be released downstream, and can result in a secondary (fall) algae bloom.

- **Sediment deposition in reservoirs**. The characteristically slow-moving waters in reservoirs result in trapping of deposition of fine sediments and organic particulate matter. Contaminants found in the bottom sediments of reservoirs are typically transported from the watershed in association with particulate matter. Trace metals are mostly attached to (inorganic) clays and silts. Organic contaminants, such as pesticides and dioxin, are attached (adsorbed) to organic matter.

The following sections summarize general water quality trends by parameter in the Klamath River, from the upper basin to the lower basin. Additional detail, including data from multiple agency and tribal monitoring programs throughout the Klamath Basin, is presented in Appendix C.

3.2.3.2 Water Temperature

Water temperatures in the Klamath Basin vary seasonally and by location. In the Upper Klamath Basin, water temperatures are typically very warm in summer months as ambient air temperatures heat surface waters. Water temperatures (measured as 7-day-average maximum values) in Upper Klamath Lake and much of the reach from Link River Dam to the Oregon-California State line exceed 20°C (68°F) in June through August. Both Upper Klamath Lake and the Keno Impoundment/Lake Ewauna undergo periods of intermittent, weak summertime stratification, but water temperatures in these water bodies are generally similar throughout the water column and among the warmest in the Klamath Basin (peak values >25°C [>77°F]). Upper basin locations influenced by groundwater springs, such as the Wood River and the mainstem Klamath River downstream from J.C. Boyle Dam, have relatively constant water temperatures year-round and can be 5–15ºC (9–27ºF) cooler than other local water bodies during summer months, depending on the location.

Water temperatures in the Klamath Hydroelectric Reach are influenced by the presence of the Four Facilities. The relatively shallow depth and short hydraulic residence times in J.C. Boyle Reservoir do not support thermal stratification (Federal Energy Regulatory Commission [FERC] 2007; Raymond 2008, 2009, 2010) and this reservoir does not directly provide a source of cold water to downstream reaches during summer (National Research Council [NRC] 2004). However, current power-peaking operations at the J.C. Boyle Powerhouse contribute to the availability of cold water in the river just downstream from the dam (≈RM 221), where cold groundwater springs enter the river. During daily peaking operations at J.C. Boyle Powerhouse, warm reservoir discharges are

diverted from the Bypass Reach allowing cold groundwater to dominate flows in the river (PacifiCorp 2006a). Water temperatures in the Bypass Reach can decrease by 5–15°C (9–27°F) when bypass operations are underway (Kirk et al. 2010).

Iron Gate and Copco 1 Reservoirs are the two deepest reservoirs in the Klamath Hydroelectric Reach. These reservoirs thermally stratify beginning in April/May and the surface and bottom waters do not mix again until October/November (Raymond 2008, 2009, 2010). The large thermal mass of the stored water in the reservoirs delays the natural warming and cooling of riverine water temperatures on a seasonal basis such that spring water temperatures in the Klamath Hydroelectric Reach are generally cooler than would be expected under natural conditions, and summer and fall water temperatures are generally warmer (NCRWQCB 2010a). In the Hydroelectric Reach, maximum weekly maximum temperatures (MWMTs), which generally occur in late July, regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010a).

The temporal water temperature pattern of the Hydroelectric Reach is repeated in the Klamath River immediately downstream from Iron Gate Dam, where water released from the reservoirs is 1–2.5°C (1.8–4.5°F) cooler in the spring and 2–10°C (3.6–18°F) warmer in the summer and fall as compared to modeled conditions without the dams (PacifiCorp 2004a, Dunsmoor and Huntington 2006, NCRWQCB 2010a). This trend is discussed in more detail in Section 3.2.4.3.2.1, Lower Klamath Basin. Immediately downstream from Iron Gate Dam (RM 190.1), water temperatures are also less variable than those documented farther downstream in the Klamath River (Karuk Tribe of California 2009, 2010).

Farther downstream, the presence of the Four Facilities exerts less influence and water temperatures are more influenced by solar energy, the natural heating and cooling regime of ambient air temperatures, and tributary inputs of surface water. Meteorological control of water temperatures result in increasing temperature with distance downstream from Iron Gate Dam. For example, daily average temperatures between June and September are approximately 1–4°C (1.8–7.2°F) higher near Seiad Valley (RM 129.4) than those just downstream from the dam (Karuk Tribe of California 2009, 2010; see Appendix C for more detail). By the Salmon River (RM 66), the effects of the Four Facilities on water temperature are significantly diminished. Downstream from the Salmon River, the influence of the dams on water temperature in the Klamath River is not discernable from the modeled data (PacifiCorp 2005, NCRWQCB 2010a, Dunsmoor and Huntington 2006).

Downstream from the Salmon River (RM 66), summer water temperatures begin to decrease slightly with distance as coastal meteorology (i.e., fog and lower air temperatures) decrease longitudinal warming (Scheiff and Zedonis 2011) and cool water tributary inputs increase the overall flow volume in the river. In general, however, the slight decrease in water temperatures in this reach is not sufficient to support cold water fish habitat during summer months. Daily maximum summer water temperatures have been measured at values greater than 26°C (78.8°F) just upstream of the confluence with

the Trinity River (Weitchpec [RM 43.5]), decreasing to 24.5°C (76.1°F) near Turwar Creek (RM 5.8) (Yurok Tribe Environmental Program [YTEP] 2005, Sinnott 2010). As is the case further upstream, MWMTs in the Klamath River downstream from Iron Gate Dam to the Klamath River estuary regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010a).

Water temperatures in the Klamath River estuary are linked to temperatures and flows entering the estuary, salinity of the estuary and resulting density stratification, as well as the timing and duration of the formation of a sand berm across the estuary mouth. When the estuary mouth is open, denser salt water from the ocean sinks below the lighter fresh river water, resulting in a salt wedge that moves up and down the estuary with the daily tides (Horne and Goldman 1994, Wallace 1998, Hiner 2006). The salt water wedge results in thermal stratification of the estuary with cooler, high salinity ocean waters remaining near the estuary bottom, and warmer, low salinity river water near the surface. Under low-flow summertime conditions, when the mouth can close, surface water temperatures in the estuary have been observed at 18–24°C (64.4–75.2°F) and greater (Wallace 1998, Hiner 2006, Watercourse Engineering, Inc. 2011). Input of cool ocean water and fog along the coast minimizes extreme water temperatures much of the time (Scheiff and Zedonis 2011).

3.2.3.3 Suspended Sediments

For the purposes of the Klamath Facilities Removal EIS/EIR, suspended sediment refers to suspended material in the water column. Bed materials, such as gravels and larger substrates, are discussed in Section 3.3.3.2, Aquatic Resources – Existing Conditions/Affected Environment – Physical Habitat Descriptions. Two types of suspended material are important to water quality in the Klamath Basin and are discussed below: algal-derived (organic) suspended material and mineral (inorganic) suspended material. Sources of each type of suspended material differ, as do spatial and temporal trends for each, within the Upper and Lower Klamath Basins.

Suspended sediments in the tributaries to the Upper Klamath Lake are generally derived from mineral (inorganic) materials, with peak values associated with winter and spring high flows. Of the three main tributaries to the Upper Klamath Lake, the Sprague River has been identified as a primary source of sediment to Upper Klamath Lake. Because phosphorus is naturally high in Klamath Basin sediments, the Sprague River is also an important source of this nutrient to the lake (Gearheart et al. 1995, ODEQ 2002, Connelly and Lyons 2007). Sources of the sediment inputs within the Sprague River drainage include agriculture, livestock grazing and forestry activities, and road-related erosion (ODEQ 2002, Connelly and Lyons 2007, Rabe and Calonje 2009).

Between Link River at Klamath Falls (RM 253.1) and the upstream end of J.C. Boyle Reservoir (RM 224.7), algal-derived (organic) suspended material is the predominant form of suspended material affecting water quality. Summer and fall algal-derived (organic) suspended materials decrease with distance downstream, as algae are exported

from Upper Klamath Lake and into the Keno Impoundment/Lake Ewauna, where they largely settle out of the water column (Sullivan et al. 2009). Data from June through November during 2000–2005 indicate that the largest relative decrease in mean total suspended solids (TSS) in the upper Klamath River occurs between Link River Dam and Keno Dam (see Appendix C for more detail). Suspended materials generally continue to decrease through the Hydroelectric Reach (PacifiCorp 2004b), where further interception, decomposition, and retention of algal-derived (organic) suspended materials originating from Upper Klamath Lake occurs, as well as dilution from the springs downstream from J.C. Boyle Dam. However, increases in suspended material can occur in Copco 1 and Iron Gate reservoirs due to *in situ* summertime algal blooms, which can adversely affect beneficial uses.

In the winter months, suspended material in the Hydroelectric Reach is dominated by mineral sediment loads from several tributaries that join the river in this reach (primarily Shovel Creek, Spencer Creek, Jenny Creek, Fall Creek). The suspended materials (silts, clays with diameters < 0.063 mm), which are primarily transported during high flow events, generally settle out in the KHP reservoirs such that water column concentrations generally decrease with distance downstream in the Hydroelectric Reach (see also Appendix C, Section C.2.1). Likewise, the reservoirs trap bedload or fluvial sediment (coarse sand, gravels, and larger materials with diameters > 0.063 mm) from the tributaries. On the scale of the entire Klamath Basin, the trapping of fine sediments and suspended materials does not appear to be a critical function with respect to the overall cumulative sediment delivery including downstream tributaries (see also Section 3.11.3.3 for a discussion of basin sediment supply and transport), since a relatively small (3.4 percent) fraction of total sediment supplied to the Klamath River on an annual basis originates from the upper and middle Klamath River (i.e., from Keno Dam to the Shasta River). Beneficial uses in the upper Klamath River are currently not impaired due to mineral (inorganic) suspended material (see Table 3.2-8).

Just downstream from Iron Gate Dam (RM 190.1), summer and fall suspended sediment concentrations become relatively low. Between Iron Gate Dam and Seiad Valley (RM 129.4), suspended materials can increase due to the transport of in-reservoir algal blooms to downstream reaches of Klamath River, as well as river bed scour and resuspension of previously settled materials (YTEP 2005, Sinnott 2007, Armstrong and Ward 2008, Watercourse Engineering, Inc. 2011). Further downstream, near the confluence with the Scott River (RM 143.0) concentrations of suspended materials tend to decrease with distance as suspended materials gradually settle out of the water column farther downstream or are diluted by tributary inputs (see Appendix C for more detail).

Mineral (inorganic) suspended sediments begin to have prominence again in the Klamath River downstream from Iron Gate Dam, as major tributaries to the mainstem contribute large amounts of mineral (inorganic) suspended sediments to the river during winter and spring (Armstrong and Ward 2008). Steeper terrain and land use activities such as timber harvest and road construction result in high sediment loads during high-flow periods. Two of the three tributaries that contribute the largest amount of sediment to the Klamath River are in this reach; the Scott River (RM 143) (607,300 tons per year or 10 percent of

the cumulative average annual delivery from the basin), and the Salmon River (RM 66.0) (320,600 tons per year or 5.5 percent of the cumulative average annual delivery from the basin) (Stillwater Sciences 2010). The Trinity River contributes 3,317,300 tons per year of sediment to the Klamath River or 57 percent of the cumulative average annual delivery from the basin (Stillwater Sciences 2010) (see Appendix C for more detail).

3.2.3.4 Nutrients

Primary nutrients including nitrogen and phosphorus are affected by the geology of the surrounding watershed of the Klamath River, upland productivity and land uses, as well as a number of physical processes affecting aquatic productivity within reservoir and riverine reaches. Nitrogen arriving in Upper Klamath Lake has been attributed to upland soil erosion, runoff and irrigation return flows from agriculture, as well as *in situ* nitrogen fixation by cyanobacteria (ODEQ 2002). Although the relatively high levels of phosphorus present in the Upper Klamath Basin's volcanic rocks and soils have been identified as a major contributing factor to phosphorus loading to the lake (ODEQ 2002), land use activities in the Upper Klamath Basin have also been linked to increased nutrient loading (Kann and Walker 1999, Snyder and Morace 1997, Bradbury et al. 2004, Colman et al. 2004, Eilers et al. 2004; see Appendix C, Section C.3.1.2 for more detail), subsequent changes in its trophic status, and associated degradation of water quality. Extensive monitoring and research has been conducted for development of the Upper Klamath Lake TMDLs (ODEQ 2002) that shows the lake is a major source of nitrogen and phosphorus loading to the Klamath River (see Appendix C for additional details). Nutrient and organic matter inputs from the Lost River Basin via Klamath Straits Drain and the Lost River Diversion Channel are also an important source of nutrients to the Upper Klamath River (Sullivan et al. 2009, et al. 2011; Kirk et al. 2010) (see Appendix C, Section C.3.1.3 for additional detail).Allowing for seasonal reservoir dynamics in the Hydroelectric Reach, nutrient levels in the Klamath River generally decrease with distance downstream from Upper Klamath Lake due to particulate trapping in reservoirs, dilution, and uptake along the river channel. In a recent study of nutrient dynamics in the Klamath River, May through December nutrients for 2005–2008 followed a decreasing longitudinal pattern, with the highest concentrations (approximately 0.1–0.5 mg/L TP and 1–4 mg/L TN) measured in the Klamath River downstream from Keno Dam (RM 228–233) (Asarian et al. 2010). On an annual basis, nutrients typically decrease through the Hydroelectric Reach due to the dilution by the springs downstream from J.C. Boyle Reservoir. Nutrient concentrations in the springs, which represent natural sources, are approximately 0.22 mg/L TN (almost exclusively dissolved) and approximately 0.06 – 0.08 mg/L TP, which is also mostly dissolved (Asarian et al. 2010). Settling of particulate matter and associated nutrients in Copco 1 and Iron Gate Reservoirs also contributes to the overall decreasing trend for nutrients in the Hydroelectric Reach on an annual basis. On a seasonal basis, TP, and to a lesser degree, TN can increase in this reach due to the release (export) of dissolved forms of phosphorus (ortho-phosphorus) and nitrogen (ammonium) from reservoir sediments during periods of summer and fall hypolimnetic anoxia (see Appendix C for additional

details). The seasonal nutrient releases can occur during periods of in-reservoir algal growth, and in the case of TP can be transported downstream to the Lower Klamath River where they may stimulate periphyton growth.

Downstream from the Four Facilities, TP values typically range 0.1–0.25 mg/L in the Klamath River between Iron Gate Dam and Seiad Valley, with the highest values occurring just downstream from the dam. TN concentrations in the river downstream from Iron Gate Dam generally range from <0.1 to over 2.0 mg/L and are generally lower than those in upstream reaches due to reservoir retention and dilution by springs in the Hydroelectric Reach (Asarian et al. 2009) (see Appendix C for additional details). Further decreases in TN occur in the mainstem river due to a combination of tributary dilution and in-river nutrient spiraling processes by periphyton (Mulholland 1996). These processes strongly affect nitrogen concentrations in flowing rivers through removal processes such as denitrification and/or assimilation and storage related to biomass uptake (Asarian et al. 2010), or by late-seasonal recycling of nutrients downstream as active periphyton growth wanes. Ratios of nitrogen to phosphorus (TN:TP) measured in the Klamath River downstream from Iron Gate Dam suggest the potential for nitrogen-limitation of primary productivity with some periods of co-limitation by both nitrogen and phosphorus. However, concentrations of both nutrients are high enough that other factors (i.e., light, water velocity, or available substrate) may be more limiting to primary productivity than nutrients are, particularly in the vicinity of Iron Gate Dam (FERC 2007, Hoopa Valley Tribe Environmental Protection Agency [HVTEPA] 2008, Asarian et al. 2010) (see Appendix C for additional details). This is particularly important with regard to factors controlling periphyton growth in this portion of the Klamath River (see Section 3.4, Algae).

Downstream from the confluence with the Salmon River, nutrient concentrations continue to decrease in the Klamath River as compared with those measured farther upstream due to tributary dilution and nutrient retention. Contemporary data (2005–2008) indicate that TP concentrations in this reach are generally 0.05–0.1 mg/L with peak values occurring in September and October. For TN, contemporary data indicate that on a seasonal basis, this nutrient increases from May through November, with peak concentrations (<0.5 mg/L) typically observed during September and October. Both TP and TN are at or above the Hoopa Valley Tribe numeric criterion of 0.2 mg/L TN and 0.035 mg/L TP (see Table 3.2-6).

Nutrient levels in the Klamath Estuary experience inter-annual and seasonal variability. Measured levels of TP in the estuary are typically below 0.1 mg/L during summer and fall (June–September) and TN levels are consistently below 0.6 mg/L (June–September) (Sinnott 2011). While the California Basin Plan water quality objective for biostimulatory substances is narrative rather than numeric, as with upstream reaches, the measured levels in the Klamath Estuary may promote algal growth at levels that cause nuisance effects or adversely affect beneficial uses (see Table 3.2-4).

3.2.3.5 Dissolved Oxygen

Dissolved oxygen concentrations in the Klamath Basin depend on several factors, including water temperature (colder water absorbs more oxygen), water depth and volume, stream velocity (as related to mixing and re-aeration), atmospheric pressure, salinity, and the activity of organisms that depend upon dissolved oxygen for respiration. This last factor (respiratory consumption) is strongly influenced by the availability of nitrogen and phosphorus for supporting algal and aquatic plant growth.

In tributaries to Upper Klamath Lake, limited data indicate that dissolved oxygen varies from <7−13 mg/L (Kann 1993, ODEQ 2002). Concentrations in the lake itself exhibit high seasonal and spatial variability, ranging from less than 4 mg/L to greater than 10 mg/L. High nutrient loading is the primary cause of eutrophication and subsequent low dissolved oxygen levels in Upper Klamath Lake. Water quality data collected by the Klamath Tribes contains periods of weeks during the summer months when dissolved oxygen levels in the lake are continuously below the ODEQ criterion of 5.5 mg/L for support of warm water aquatic life (Kann et al. 2010). Low (0–4 mg/L) dissolved oxygen concentrations occur most frequently in August, the period of declining algal blooms in the lake and warm water temperatures (ODEQ 2002, Walker 2001) (see Appendix C for additional details).

In the downstream Keno Impoundment/Lake Ewauna, dissolved oxygen reaches very low levels (< 1−2 mg/L) during July−October as algae transported from Upper Klamath Lake settle out of the water and decay. Four facilities discharge treated wastewater to the Keno Impoundment/Lake Ewauna; however, these facilities contribute a very small amount (<1.5% of the organic material loading) to the overall oxygen demand in the Keno Reach. Decomposition of algae transported from Upper Klamath Lake appears to be the primary driver of low oxygen in the Keno Impoundment/Lake Ewauna Organic matter and nutrient inputs from the Lost River Basin via Klamath Straits Drain and the Lost River Diversion Channel also contribute to low dissolved oxygen levels in this reach (Sullivan et al. 2009, et al. 2011; Kirk et al. 2010) (see Appendix C, Section C.4.1.3 for additional detail).

During summer, the reservoirs of the Four Facilities exhibit varying degrees of dissolved oxygen super-saturation (i.e., >100% saturation) in surface waters (due to high rates of internal photosynthesis by algae) and hypolimnetic oxygen depletion in bottom waters (due to microbial decomposition of dead algae). Although J.C. Boyle Reservoir, a relatively long, shallow reservoir, does not stratify, large variations in dissolved oxygen are observed at its discharge due to high oxygen demand from water in the upstream reach from Link River Dam through the Keno Impoundment/Lake Ewauna, and in Upper Klamath Lake (see Appendix C for more detail). Copco 1 and Iron Gate Reservoirs thermally stratify beginning in April/May and do not mix again until October/November (FERC 2007). Dissolved oxygen in Iron Gate and Copco 1 surface waters during summer months is generally at or, in some cases above, saturation while levels in hypolimnetic waters reach minimum values near 0 mg/L by July (see Appendix C for more detail).

Based upon measurements collected immediately downstream from Iron Gate Dam, dissolved oxygen concentrations regularly fall below 8 mg/L (the Basin Plan minimum dissolved oxygen criterion is now based on percent saturation, see Table 3.2-5) (Karuk Tribe of California 2001, 2002, 2007, 2009). Continuous Sonde data collected at other Klamath River locations downstream from Iron Gate Dam during summer 2004–2006, show that roughly 45 to 65 percent of measurements immediately downstream from the dam did not achieve 8 mg/L. Daily fluctuations of up to 1–2mg/L measured in the Klamath River downstream from Iron Gate Dam (RM 190.1) have been attributed to daytime algal photosynthesis and nighttime bacterial respiration (Karuk Tribe of California 2002, 2003; YTEP 2005; NCRWQCB 2010a). Farther downstream in the mainstem Klamath River, near Seiad Valley (RM 129.4), dissolved oxygen concentrations increase relative to the reach immediately downstream from Iron Gate Dam, but continue to exhibit variability, with mean daily values ranging from approximately 6.5 mg/L to (supersaturated concentrations of) approximately 10.5 mg/L, from June through November, 2001–2002 and 2006–2009 (Karuk Tribe of California 2001, 2002, 2007, 2009).

Measured concentrations of dissolved oxygen in the mainstem Klamath River downstream from Seiad Valley (RM 129.4) continue to increase with increasing distance from Iron Gate Dam. Dissolved oxygen concentrations near Orleans (RM 59) continue to be variable, with typical daily values ranging from approximately 6.5 mg/L to (supersaturated concentrations of) 11.5 mg/L from June through November, 2001–2002 and 2006–2009 (Karuk Tribe of California 2001, 2002, 2007, 2009; Ward and Armstrong 2010; NCRWQCB 2010a). Further downstream, near the confluence with the Trinity River (RM 42.5) and at the Turwar gage (RM 5.8), minimum dissolved oxygen concentrations below 8 mg/L (the Basin Plan minimum dissolved oxygen criterion prior to 2010) have been observed for extended periods of time during late summer/early fall (YTEP 2005, Sinnott 2010). In 2010, minimum dissolved oxygen concentrations remained above 2010 amended Basin Plan minimum dissolved oxygen concentration criteria based on percent saturation (see Appendix C for additional details).

Dissolved oxygen concentrations in the Klamath Estuary vary both temporally and spatially; concentrations in the deeper, main channel of the estuary are generally greater than 6 to 7 mg/L throughout the year (Hiner 2006, YTEP 2005). Low dissolved oxygen concentrations (<1 to 5 mg/L) have been observed during summer months in the relatively shallow, heavily vegetated south slough (Hiner 2006, Wallace 1998). The low levels of dissolved oxygen observed in the slough are likely due to high rates of growth and subsequent decomposition of algae and macrophytes, which are not abundant elsewhere in the estuary.

3.2.3.6 pH

Because the Klamath River is a weakly buffered system (i.e., has typically low alkalinity <100 mg/L; PacifiCorp [2004a], Karuk Tribe of California [2010]) it is susceptible to photosynthesis-driven daily and seasonal swings in pH. In the Upper Klamath Basin, summertime pH levels are elevated above neutral (i.e., up to 8.2 in the Wood River

subbasin and 8.5–9.5 in the Sprague River). These elevated pH levels have been linked primarily to high rates of photosynthesis by periphyton (i.e., benthic or attached algae) (ODEQ 2002). During November–April, pH levels in Upper Klamath Lake are near neutral (Aquatic Scientific Resources [ASR] 2005) but increase to very high levels (>10) in summer (ODEQ maximum pH is 9.0, see Table 3.2-3). Extended periods of pH greater than 9 have been associated with large summer algal blooms in Upper Klamath Lake (Kann 2010). On a daily basis, algal photosynthesis can elevate pH levels by up to 2 pH units over a 24-hour period. Generally, pH in the reach from Link River Dam through the Keno Impoundment/Lake Ewauna increases from spring to early summer and decreases in the fall; however, there are site-dependent variations in the observed trend. Peak values can exceed the ODEQ maximum of 9.0 (see Appendix C for additional details).

In the Hydroelectric Reach, pH is seasonally variable, with levels near neutral during the winter, increasing in the spring and summer. Peak values (8–9.2) have been recorded during the months of May and September with lower values documented June through August (7.5–8) (Raymond 2010), where the ODEQ pH maximum is 9 units (for the Klamath River upstream of the Oregon-California State line; Table 3.2-3) and the California pH maximum is 8.5 units (for the river downstream from State line; Table 3.2-4). Longitudinally, the lowest pH values were recorded downstream from J.C. Boyle Reservoir and the highest values in Copco and Iron Gate Reservoirs (Raymond 2008, 2009, 2010). High pH levels typically coincide with high algal photosynthesis rates at or near the water surface during periods of thermal stratification and high nutrient concentrations in the KHP reservoirs (Raymond 2008).

In the Lower Klamath Basin, seasonally high pH values continue to occur, with the highest pH values generally occur during late-summer and early-fall months (August–September). Daily cycles in pH also occur in this reach, with pH usually peaking during later afternoon or early evening, following the period of maximum photosynthesis (NCRWQCB 2010a). The California North Coast Basin Plan pH maximum of 8.5 units (Table 3.2-4) is regularly exceeded in the Klamath River downstream from Iron Gate Dam for the May–October 2005 dataset (see Appendix C for more detail). The most extreme pH exceedances typically occur just upstream of Shasta River; values generally decrease with distance downstream (FERC 2007; Karuk Tribe of California 2007, 2009, 2010). During the summer months, pH values also are elevated in the Lower Klamath River from Weitchpec downstream to approximately Turwar Creek (see Appendix C for more detail). pH was incorporated into the Klamath River TMDLs as a nutrient-related water quality impairment including in the Project reservoirs (see Section 3.2.2.4.4) and as such, meeting the nutrient objectives of the TMDLs will mitigate pH impairments. In the Klamath Estuary, pH ranges between approximately 7.5 and 9, with peak values also occurring during the summer months (YTEP 2005). Daily variations in pH are typically on the order of 0.5 pH units, and fluctuations tend to be somewhat larger in the late summer and early fall. When large daily fluctuations are observed, they are likely caused by algal blooms that are transported into the estuary.

3.2.3.7 Chlorophyll-a and Algal Toxins

As primary producers, algae are critical components of riverine and lacustrine ecosystems. Their presence and abundance affect food web dynamics as well as physical water quality parameters (e.g., dissolved oxygen, pH, turbidity, and nutrients), the latter through rates of photosynthesis, respiration, and decay of dead algal cells (Horne and Goldman 1994). Cyanobacteria are also photosynthetic and can often be a nuisance aquatic species, occurring as large seasonal blooms that alter surrounding water quality. Some cyanobacteria species produce cyanotoxins (e.g., cyclic peptide toxins such as microcystin that act on the liver, alkaloid toxins such as anatoxin-a and saxitoxin that act on the nervous system). Cyanotoxins can cause irritation, sickness, or in extreme cases, death to exposed organisms, including humans (World Health Organization [WHO] 1999). Species capable of producing microcystin include *M. aeruginosa*, while species in the genus *Anabaena* can produce anatoxin-a and saxitoxin. More complete listings of specific toxins produced by genera of cyanobacteria worldwide are provided in Lopez et al. (2008) and ODEQ (2011).

Chlorophyll-*a*, a pigment produced by photosynthetic organisms including algae and cyanobacteria, is often used as a surrogate measure of algal biomass. Algae suspended in the water column (phytoplankton) can be represented as a concentration of chlorophyll-*a* (mg/L), while algae attached to bottom sediments or channel substrate (periphyton) can be represented as an areal biomass (mg chl-a/m^2). Periphyton data are discussed in Section 3.4, Algae.

In the tributaries to Upper Klamath Lake, algae are generally present as periphyton (i.e., benthic or attached algae) species. Periphyton in these streams can cause water quality impairments for dissolved oxygen and pH (see Appendix C for more detail). In Upper Klamath Lake, algae are dominated by phytoplankton or suspended algae. Large summertime blooms of cyanobacteria are typically dominated by *Aphanizomenon flos-aquae*, with relatively smaller amounts of *M. aeruginosa* present. Despite this, *M aeruginosa* is believed to be responsible for the production of microcystin in the lake, with concentrations in 2007–2008 equal to or greater than the WHO limit for drinking water (1 µg/L) and peaked at 17 µg/L, which is above the Oregon Department of Public Health guidelines for issuing public health advisories. Additional microcystin data collection in Upper Klamath Lake is ongoing, including studies of possible effects of algal toxins on native suckers (Vanderkooi et al. 2010, see Section 3.3, Aquatic Resources for more detail).

High (i.e., near 300 ug/L) summer chlorophyll-*a* concentrations in the Keno Impoundment/Lake Ewauna are due to large populations of algae, predominantly *A. flos-aquae*, entering the Klamath River from Upper Klamath Lake in summer (Kann 2006; Sullivan et al. 2008, et al. 2009, et al. 2010; FERC 2007). Such high concentrations do not persist farther downstream in J.C. Boyle Reservoir; however, in the two largest reservoirs (i.e., Copco 1 and Iron Gate) in the Hydroelectric Reach, chlorophyll-*a* concentrations increase again. Seasonal algal blooms and elevated chlorophyll-*a* concentrations have been observed in the Hydroelectric Reach historically, including a USEPA survey in Iron Gate Reservoir in 1975 documenting algal blooms in

March, July, and October, and including diatoms and blue green algae (USEPA 1978). More contemporary data indicates that chlorophyll-*a* levels in Copco 1 and Iron Gate Reservoirs can be 2 to 10 times greater than those documented in the mainstem river, although they are not as high as those found in the Keno Impoundment/Lake Ewauna (NCRWQCB 2010a) (see Appendix C for more detail). High levels of microcystin also occur during summer months in Copco 1 and Iron Gate Reservoirs; peak measured concentrations exceeded the California State Water Resources Control Board (SWRCB)/ Office of Environmental Health and Hazard Assessment (OEHHA) public health threshold of 8 µg/L (SWRCB et al. 2010) by over 1000 times in Copco 1 Reservoir during 2006–2009 and extremely high concentrations (1,000–73,000 µg/L) were measured during summer algal blooms in both Copco 1 and Iron Gate Reservoirs during 2009 (Watercourse Engineering 2011, see Appendix C for more detail).

Throughout the Klamath River, high chlorophyll-*a* concentrations have been shown to correlate with the toxigenic cyanobacteria blooms where *M. aeruginosa* was present in high concentrations and sharp increases in microcystin levels above WHO numeric targets (Kann and Corum 2009) and SWRCB, California Department of Public Health, and OEHHA guidelines (SWRCB et al. 2010). Since 2007, high levels of microcystin have prompted the posting of public health advisories around the reservoirs and, during certain years, along the length of the Klamath River during summer months. In 2010, the KHP reservoirs and the entire river downstream from Iron Gate Dam (including the estuary) were posted to protect public health due to elevated cyanobacteria cell counts and cyanotoxin (i.e., microcystin) concentrations.

Microcystin can also bioaccumulate in aquatic biota (Kann 2008, Kann et al. 2011); 85 percent of fish and mussel tissue samples collected during July through September 2007 in the Klamath River, including Iron Gate and Copco 1 Reservoirs, exhibited microcystin bioaccumulation (Kann 2008) (see Appendix C for more detail). Estuarine and marine nearshore effects (e.g., sea otter deaths) from cyanobacteria exposure have been reported in other California waters; however, none have been documented to date for the Klamath Estuary or marine nearshore (Miller et al. 2010). Section 3.3.3.2, Physical Habitat Descriptions - Water Quality - Algal Toxins presents a discussion of algal toxins as related to fish health.

3.2.3.8 Inorganic and Organic Contaminants

In general, information regarding contaminants in the Upper Klamath Basin upstream of the Hydroelectric Reach is unavailable. Human activities such as illegal dumping may be a source of inorganic and organic contaminants to the lower Sprague and Williamson river sub-basins (Rabe and Calonje 2009). Arsenic is an exception to this; natural geologic sources of arsenic may be causing relatively high levels of this chemical element in the Upper Klamath Basin (Smith et al. 2009; GeoEngineers 2011; D. Smith, USGS, Denver, CO, written communication, June 25, 2012), as is the case in other south central and southeastern Oregon basins (Sturdevant 2010). Generally elevated background nickel concentrations have also been found in soils in the Klamath Basin

(Smith et al. 2009; GeoEngineers 2011; D. Smith, USGS, Denver, CO, written communication, June 25, 2012; see Appendix C for more detail).

3.2.3.8.1 Water Column Contaminants

Existing water quality data are available from the California Surface Water Ambient Monitoring Program (SWAMP). SWAMP data from 2001 through 2005 indicate that at eight monitoring sites from the California-Oregon State line (RM 208.5) to Klamath River at Klamath Glen (RM 5.8) the majority of inorganic constituents (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc), were in compliance with water quality objectives. Aluminum concentrations in some samples may have been slightly elevated above USEPA freshwater aquatic life and secondary standards for drinking water, where a greater sampling frequency would be required to determine actual exceedances. Grab samples were analyzed for 100 pesticides, pesticide constituents, isomers, or metabolites; 50 polychlorinated biphenyls (PCBs) congeners; and 6 phenolic compounds. Results indicated no PCBs and only occasional detections of pesticides (NCRWQCB 2008) (see Appendix C for more detail).

3.2.3.8.2 Sediment Contaminants

To investigate the potential for toxicity of the sediments trapped in the reservoirs of the Four Facilities, Shannon & Wilson, Inc. (2006) collected sediment samples from J.C. Boyle, Copco 1, and Iron Gate Reservoirs during 2004–2005 and analyzed them for contaminants including acid volatile sulfides, metals, pesticides, chlorinated acid herbicides, PCBs, volatile organic compounds (VOCs), semi-volatile organic compounds (SVOCs), cyanide, and dioxins. No herbicides or PCBs were found above screening levels and only one sample exceeded applicable screening levels for VOCs ethyl benzenes and total xylenes (Shannon & Wilson, Inc. 2006). While cyanide was detected in multiple sediment cores, it was not found in the bioavailable toxic free cyanide form (HCN or CN^-).

Dioxin, a known carcinogen, was also measured in the Shannon & Wilson, Inc. (2006) study. Long-term exposure to dioxin in humans is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions. In the 2004–2005 reservoir samples, measured levels were 2.48–4.83 pg/g (picograms per gram or parts per trillion [ppt] expressed as Toxic Equivalent Concentrations) and did not exceed applicable screening levels for human health and ecological receptors (Shannon & Wilson, Inc. 2006, Dillon 2008, USEPA 2010b) or estimated background dioxin concentrations (2–5 ppt) for non-source-impacted sediments throughout the U.S. and specifically in the western U.S. (USEPA 2010b) (see Appendix C for more detail). The measured levels did exceed Oregon human health and bioaccumulation thresholds; however, Oregon's human health thresholds include risk-based values for subsistence fishers as well as the general consuming public and are quite a bit lower (0.0011–1.1 pg/g dry weight (DW) Toxicity equivalency quotient [TEQ]) than many other screening levels (ODEQ 2007) (see Appendix C for more detail).

As part of the Klamath Dam Removal Secretarial Determination studies, a sediment evaluation was undertaken during 2009–2011 to evaluate potential environmental and

human health impacts of the downstream release of sediment deposits currently stored behind the dams under the Proposed Action[2]. Sediment cores were collected during 2009–2010 at multiple sites and at various sediment depths per site in J.C. Boyle Reservoir, Copco 1 Reservoir, Iron Gate Reservoir, and the Klamath Estuary (Bureau of Reclamation 2010). A total of 501 analytes were quantified in the sediment samples, including metals, poly-cyclic aromatic hydrocarbons (PAHs), PCBs, pesticides/ herbicides, phthalates, VOCs, SVOCs, dioxins, furans, and polybrominated diphenyl ethers (PBDEs) (i.e., flame retardants). Samples were analyzed for sediment chemistry and elutriate (pore water) chemistry, and bioassays were conducted on the sediment and elutriate using fish and invertebrate national benchmark toxicity species (see below for discussion of the bioaccumulation component of this study). Five exposure pathways were evaluated, which generally correspond to potential effects evaluated in this Klamath Facilities Removal EIS/EIR.

Based on comparisons of sediment chemistry to (1) screening levels (SLs) within the sediment evaluation framework (SEF) and human health criteria and (2) the relatively small number of chemicals of potential concern (COPCs) identified in sediment, reservoir sediments do not appear to be notably contaminated (for an explanation of the SEF see Section 3.2.4.1). No consistent pattern of elevated chemical composition was observed across discrete sampling locations within a reservoir; however, sediment in J.C. Boyle Reservoir does have marginally higher chemical concentrations and more detected COPCs in sediment when compared to the other reservoirs and the estuary. Also, J.C. Boyle Reservoir had more COPCs based on comparison to both freshwater ecological and human health SLs. However, in the case of J.C. Boyle Reservoir and in other instances where elevated concentrations of chemicals in sediment were found, the degree of exceedance based on comparisons of measured detected chemical concentrations to SLs was small and in several cases (i.e., arsenic, mercury, 2,3,7, 8-TCDD, total PCBs) may reflect regional background conditions (see Section C.7.1.1 for more detail). Toxicity tests generally indicated low potential for sediment toxicity to benchmark benthic indicator species; the exception to this occurred in a single sample from J.C. Boyle Reservoir, where survival of the benthic amphipod *Hyalella azteca* indicated a moderate potential for sediment toxicity. Results of the laboratory bioaccumulation tests indicated no consistent pattern of contaminant distribution among chemicals, media type, or location, although some chemicals accumulated in invertebrate tissues (i.e., acenaphthene, arsenic, benzo(a)pyrene, DDD/DDE, endosulfan I, endosulfan II, endosulfan sulfate, fluoranthene, hexachlorobenzene, lead, mercury, phenanthrene, pyrene, total PBDEs, total PCBs) (CDM 2011). In all cases the differences from one reservoir to another and between reservoirs and laboratory controls were small and not likely to be ecologically significant (see Appendix C, Section C.7.1.1 for more detail).

[2] There are currently 13.1 million yd^3 of sediment deposits stored within J.C. Boyle, Copco 1 and 2, and Iron Gate Reservoirs (Reclamation 2012) (see also Section 2.2, text box on sediment weight and volume, of this Klamath Facilities Removal EIS/EIR). Prior estimates of the sediment deposits were 14.5 million yd^3 (Eilers and Gubala 2003) and 20.4 million yd^3 (GEC 2006).

3.2.3.8.3 Contaminants in Aquatic Biota

A discussion of algal toxins (i.e., microcystin) in fish tissue is presented in Section 3.2.3.7. Assessments of other contaminants in fish tissue for the Hydroelectric Reach have been undertaken by SWAMP and PacifiCorp. SWAMP data include sport fish tissue samples collected during 2007 and 2008 to evaluate accumulated contaminants in nearly 300 lakes Statewide. Sport fish were sampled to provide information on potential human exposure to selected contaminants and to represent the higher aquatic trophic levels (i.e., the top of the aquatic food web).

In the Hydroelectric Reach, fish tissue samples were collected in Copco 1 and Iron Gate Reservoirs and analyzed for total mercury, selenium, and PCBs (Iron Gate Reservoir only) (Davis et al. 2010). SWAMP data for Iron Gate and Copco reservoirs indicate mercury tissue concentrations above the USEPA criterion of 300 ng/g methylmercury (for consumers of noncommercial freshwater fish); and greater than OEHHA public health guideline levels advisory tissue levels (Klasing and Brodberg 2008) for consumption for 3 and 2 servings per week (70 and 150 ng/g wet weight, respectively) and the fish contaminant goal (220 ng/g wet weight). Measured selenium concentrations were 3–4 orders of magnitude lower than OEHHA thresholds of concern (2,500–15,000 ng/g wet weight) and PCB concentrations were below the lowest OEHHA threshold (i.e., fish contaminant goal of 3.6 ng/g wet weight) (Davis et al. 2010).

In a screening-level study of potential chemical contaminants in fish tissue in Keno, J.C. Boyle, Copco, and Iron Gate Reservoirs, and in Upper Klamath Lake, PacifiCorp analyzed metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc), organochlorine (pesticide) compounds, and PCBs in largemouth bass (*Micropterus salmoides*) and black bullhead catfish (*Ameiurus melas*) (PacifiCorp 2004c). PacifiCorp reported that, in general, contaminant levels in fish tissue were below screening level values for protection of human health (USEPA 2000) and recommended guidance values for the protection of wildlife (MacDonald 1994). Exceptions to this include some tissue samples for total mercury, arsenic, total DDTs and total PCBs, when compared to screening levels for wildlife and subsistence fishers (individual comparisons are shown in Appendix C for more detail). Dioxins were not tested.

To supplement existing fish tissue data and provide additional lines of evidence in the Secretarial Determination sediment evaluation (see above and Section C.7.1.1), two species of field-caught fish were collected during late September 2010 from J.C. Boyle, Copco 1, and Iron Gate reservoirs and analyzed for contaminant levels in fish tissue (CDM 2011, see Section C.7.1.1 for more detail). Results indicate that multiple chemicals were found in fish tissue (i.e., arsenic, DDE/DDT, dieldrin, endrin, mercury, mirex, selenium, and total PCBs) under current conditions (CDM 2011). Mercury exceeded tissue-based toxicity reference values (TRVs) for perch in Iron Gate Reservoir and bullhead samples in all three reservoirs (CDM 2011). TRVs are not available for several chemicals detected in invertebrate and fish tissue (CDM 2011, see Section C.7.1.1 for more detail). TEQs for dioxin, furan, and dioxin-like PCBs in reservoir and estuary

sediment samples were within the range of local background values and suggest a potential to cause minor or limited adverse effects for fish exposed to reservoir sediments (CDM 2011).

3.2.4 Environmental Consequences

3.2.4.1 Environmental Effects Determination Methods

The Klamath Facilities Removal EIS/EIR water quality analysis includes consideration of the effects of the Proposed Action and alternatives on water temperature, suspended sediments, nutrients (TN, TP, nitrate, ammonium, ortho-phosphorus), dissolved oxygen, pH and alkalinity, chlorophyll-*a* and algal toxins, and inorganic and organic contaminants in water and reservoir sediments. For all water quality parameters, the analysis approach for water quality effects associated with facilities removal under Klamath Hydroelectric Settlement Agreement (KHSA) is conducted at the project-level and is presented by water quality parameter. Elements of Klamath Basin Restoration Agreement (KBRA) restoration projects that would affect water quality are identified and analyzed at a program-level.

For water quality, existing conditions is generally defined as physical, chemical, and biological characteristics of water in the area of analysis at the time of the Notice of Preparation (Water Year [WY] 2010). However, while some water quality parameters to be analyzed here are well-represented by data collected during WY2010, most are represented by data collected within the past 5 to10 years (WY2000–WY2010). Further, the start of the period of analysis for the hydrology, water temperature, and suspended sediment modeling conducted as part of Secretarial Determination studies was WY2012 (Section 1.4.1). Despite several existing regulations or agreements that may be partially implemented between WY2010 and WY2012 and that would affect water quality, in general, conditions in the Klamath River are not expected to be substantially different in WY2012 than conditions during WY2000–WY2010. Therefore, for the water quality analysis, existing conditions generally encompass the 10 to12-year period prior to WY2012 (summarized in Section 3.2.3; additional detail provided in Appendix C).

The KHSA presents nine water-quality-related Interim Measures (IMs) (KHSA Section 1.2.4):

- IM 3, Iron Gate Turbine Venting
- IM 5, Iron Gate Flow Variability
- IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement
- IM 8, J.C. Boyle Bypass Barrier Removal
- IM 10, Water Quality Conference
- IM 11, Interim Water Quality Improvements
- IM 13, Flow Releases and Ramp Rates
- IM 15, Water Quality Monitoring
- IM 16, Water Diversions

As discussed in Chapter 2, IM 3 is ongoing with pilot study data available from 2008 and 2010 and thus this interim measure is included as part of existing conditions IM 5, Iron Gate Flow Variability, would alter flow variability, but the flows would stay within the range of historical flows. One year of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement is included in the No Action/No Project Alternative and was completed during November 2011. IM 8, J.C. Boyle Bypass Barrier Removal, could have construction-related water quality effects. IM 13, Flow Releases and Ramp Rates stipulates no change in the current flows from J.C. Boyle, so no water quality effects are anticipated as part of existing conditions.

Remaining IMs are included in Alternatives 2 and 3. Seven years of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could affect water quality. Planning efforts under IM 10, Water Quality Conference, and IM11, Interim Water Quality Improvements, are ongoing; however, pilot scale projects are still in the data collection or planning stage, so an assessment of water quality impacts is not yet practical. IM 16, the elimination of three screened diversions on Shovel and Negro Creeks and relocation of the points of diversion from the creeks to the Klamath River, could have construction-related water quality effects. IM 15 has been used to augment existing water quality monitoring programs in the basin by PacifiCorp, Karuk, Yurok and Reclamation. Additionally, IM 15, Water Quality Monitoring, has produced monitoring results which, as available, were incorporated into the existing conditions summary (Watercourse Engineering, Inc. 2011) that are incorporated into the existing conditions summary. Cyanobacteria monitoring reports for public health, reported by individual monitoring entities, are produced separately; these and many planning documents and reports of results from this process are posted online at: http://www.kbmp.net/collaboration/klamath-hydroelectric-settlement-agreement-monitoring/

Within the period of analysis (i.e., 50 years) reasonably foreseeable actions associated with water quality are anticipated to be the following:

- Ongoing restoration activities in the Klamath Basin (see Section 2.4.2).
- Implementation of TMDLs for Oregon and California (see Section 3.2.2.4)
- National Oceanic and Atmospheric Administration (NOAA) Fisheries Service 2010 Biological Opinion mandatory flows (see Section 2.3.1).
- California Department of Fish and Game (CDFG) Code Section 5937 instream flow mandate for tributaries to the mainstem Klamath River[3]
- Climate change (see Section 3.10.3.1).

Therefore, under the No Action/No Project Alternative, elements of ongoing restoration projects, TMDLs, and programs mandating stream flows that would affect future water quality are identified for a specific reach and/or water quality parameter and included as part of the analysis narrative in a qualitative or, if possible, a quantitative manner. Long-

[3] This action is not included in the project description (Section 2) since it will occur only in tributaries to the middle and Lower Klamath River. It may increase flows to the mainstem Klamath River, thus it is briefly discussed as part of the No Action/No Project Alternative analysis for water quality.

term quantitative analyses for the No Action/No Project Alternative rely on existing models developed by PacifiCorp for the FERC relicensing process, the NCRWQCB for development of the Klamath River TMDLs, and the Secretarial Determination studies (see Appendix D for details). Multiple numeric models are used for the water quality analyses conducted in the Klamath Facilities Removal EIS/EIR because no individual existing numeric model captures all of the long-term water quality conditions anticipated for and encompassed by the No Action/No Project Alternative.

Water quality models are inherently complex, especially ones depicting a large and variable system such as the Klamath River. In the case of the California Klamath River TMDLs, a significant five-year effort was employed by the NCRWQCB in collaboration with PacifiCorp and working jointly with USEPA Region's 9 and 10, ODEQ, and USEPA's contractor Tetra Tech on the modeling work for the TMDL. That work was subject to extensive peer review and public comment before the NCRWQCB adoption. It was further reviewed and subject to additional public comment before approved unanimously by the SWRCB. It was then subsequently reviewed and approved by the USEPA. The California Klamath River TMDL models are sufficiently reliable for the purpose in which they are used in the Klamath Facilities Removal EIS/EIR.

Under the Proposed Action and remaining alternatives, the analysis of water quality effects considers both the short term (<2 years following dam removal/construction of fish passage facilities)[4] and long term (2–50 years following dam removal/construction of fish passage facilities). While the timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects, some short-term effects are anticipated and, for water quality, would be heavily influenced by the release of fine sediment deposits currently stored behind the dams to the downstream river reaches, the estuary, and the marine nearshore environment. This is because mobilization of reservoir sediment deposits would be most intense during the first year or two following dam removal, when the majority of sediments would be eroded by river flows (Reclamation 2012, Stillwater Sciences 2008). Short-term effects would also occur as a result of construction activities related to fish passage structures and restoration activities associated with dam removal and KBRA implementation. Under the Proposed Action and other dam removal alternatives, long-term effects on water quality would be primarily characterized by the shift from lacustrine to riverine environments in the Hydroelectric Reach and the concomitant changes in physical and chemical processes on water quality in this reach and downstream river reaches. Parameter-specific analysis methods are discussed below. As described for the No Action/No Project Alternative, long-term quantitative analyses for the Proposed Action rely on existing models developed by PacifiCorp for the FERC relicensing process, the NCRWQCB for development of the Klamath River TMDLs, and the Secretarial Determination studies (see Appendix D for details). Multiple numeric models are used for the water quality

[4] Note that for the purposes of this analysis the use of "short term" as <2 years is not the same as the use of "short term (acute)" when applied to numeric water quality criteria for determining thresholds of aquatic life toxicity (i.e., 24-hr or 96-hr exposure periods).

analyses conducted in the Klamath Facilities Removal EIS/EIR because individual existing numeric model captures all of the long-term water quality conditions anticipated for and encompassed by the Proposed Action and the remaining alternatives.

3.2.4.1.1 Water Temperature

Short-term (<2 years following dam removal/construction of fish passage facilities) effects of the alternatives on water temperature are assessed based on the existing conditions understanding of the seasonal effects of the KHP reservoirs on water temperature within the Hydroelectric Reach and downstream from the dam.

For long-term (2–50 years following dam removal/construction of fish passage facilities) effects of the alternatives, quantitative Klamath River water quality model (KRWQM) results for "current conditions" and dams-out conditions are available (PacifiCorp 2004a, Dunsmoor and Huntington 2006, FERC 2007; see Appendix D for more detail), but they do not include implementation of the Oregon and California TMDLs, which are considered as reasonably foreseeable actions under the No Action/No Project Alternative (see above list). The Klamath TMDL model includes a dams-in scenario (T4BSRN) (Tetra Tech 2009), similar to the conditions for the No Action/No Project Alternative. The Klamath TMDL model T1BSR natural conditions scenario is also useful for analyzing water temperature, since this parameter relies upon a comparison to background or natural levels for regulatory water quality compliance. The Klamath TMDL TOD2RN and TCD2RN scenarios assume the removal of the Four Facilities and full TMDL implementation (Tetra Tech 2009), which is similar to the Proposed Action; to place the Proposed Action analysis in context, results of these modeling scenarios are generally interpreted in this EIS/EIR with respect to starting assumptions (i.e., model boundary conditions) about water temperature. One boundary condition that differs from the Proposed Action is that, in the T1BSR, TOD2RN, and TCD2RN scenarios (but not T4BSRN), Keno Dam is replaced by the historical natural Keno Reef, such that the Keno Reach is still partially impounded even though the reef's elevation is two feet lower than the current full pool elevation of Keno Impoundment/Lake Ewauna (Tetra Tech 2009, Kirk et al. 2010).

Since the TMDL model scenarios do not include climate change projections or changes in future hydrology included under KBRA, one additional set of water temperature modeling results is used for the Klamath Facilities Removal EIS/EIR analysis; the RBM10 model was developed as part of the Secretarial Determination studies and includes the effects of climate change and KBRA hydrology on future water temperatures (Perry et al. 2011). RBM10 model results use climate change predictions from five Global Circulation Models (GCMs) (see Appendix D for more detail).

Appendix D, Table D-1 shows the reaches where KRWQM, Klamath TMDL, and RBM10 model results are used for the water quality analysis under each alternative. Since no one existing model captures all of the elements analyzed for water temperature in this Klamath Facilities Removal EIS/EIR, where possible, model outputs are used in combination to assess similar spatial and temporal trends in predicted water temperature.

3.2.4.1.2 Suspended Sediments

The Proposed Action was optimally developed as an alternative that allows reservoir drawdown to occur during winter months when precipitation, river flows, and turbidity are naturally highest. Results from the sediment mobility analysis conducted by Reclamation are used to provide estimates of short-term (<2 years following dam removal) suspended sediment concentrations (SSCs[5]) downstream from Iron Gate Dam under the Proposed Action and other dam removal alternatives. The sediment mobility analysis used existing suspended sediment data collected by the U. S. Geological Survey (USGS) at the Shasta River near the City of Yreka (USGS gage no. 11517500), Klamath River near Orleans (USGS gage no.11523000), and Klamath River near Klamath (USGS gage no. 11530500) gages to estimate daily total SSCs (mg/L) as a function of flow (cfs) using the SRH-1D sediment transport model (Sedimentation and River Hydraulics–One Dimension Version 2.4) (Huang and Greimann 2010, Reclamation 2012). Daily total SSCs were modeled for existing conditions representing WY 1961–2008 ("background") and for short-term conditions following dam removal (WY 2020–2021). SRH-1D model output representing total sediments, including both inorganic (i.e., mineral) and organic (e.g., algal-derived) sediments, is applied herein to the suspended sediment analysis. The SRH-1D model assumes a three-phase drawdown for Copco 1 Reservoir beginning on November 1, 2019, and a single-phase drawdown for J.C. Boyle and Iron Gate Reservoirs beginning on January 1, 2020 consistent with the Proposed Action. This would allow maximum SSCs to occur during winter months when flows are naturally high in the mainstem river (Stillwater Sciences 2008, Reclamation 2012). The analysis of short-term (<2 years following dam removal) effects also considers results from previous studies (e.g., Stillwater Sciences 2010) regarding anticipated sediment release from Klamath River Dam removal within the context of sediment delivery at the basin scale.

To inform long-term (2–50 years following dam removal/construction of fish passage facilities) effects determinations on suspended materials under all of the alternatives, existing data sources for TSS and turbidity sources to the Hydroelectric Reach and the Lower Klamath River (e.g., PacifiCorp 2004a, 2004b; YTEP 2005) are used. Existing analyses of the potential effects of dam removal on long-term sediment supply (Stillwater Sciences 2010) are also considered.

3.2.4.1.3 Nutrients

Under the Proposed Action, short-term (<2 years following dam removal) nutrient loads associated with high SSCs are assessed in a qualitative manner, considering the likelihood of sediment deposition in the lower river, seasonal rates of primary productivity and microbially mediated nutrient cycling, and potential light limitation of primary producers given the high sediment concentrations in the river.

To determine general long-term spatial and temporal trends of nutrients in the Hydroelectric Reach and the Lower Klamath River under all of the alternatives, results

[5] For the purposes of this report, SSC is considered equivalent to TSS. As needed, data from multiple sources reported as either TSS or SSC are used interchangeably, despite potential differences in the numeric values reported by each method (Gray et al. 2000).

of the T4BSRN, TOD2RN and TCD2RN Klamath TMDL scenarios (Tetra Tech 2009) are presented. To place the Proposed Action analysis in context, results of the TOD2RN and TCD2RN scenarios are generally interpreted with respect to starting assumptions (i.e., model boundary conditions) about nutrient concentrations. Reaches where T4BSRN, TOD2RN and TCD2RN information is available include all reaches associated with the EIS/EIR nutrient analysis from J.C. Boyle Reservoir to the Klamath Estuary (see Appendix D, Table D-1).

Additionally, an existing analysis regarding potential nutrient dynamics under a "dams-out" scenario (i.e., Asarian et al. 2010) is used to inform the assessment of the long-term effects of the Proposed Action on nutrients. Using nutrient measurements and hydrologic data for the Klamath River, Asarian et al. (2010) constructed mass-balance nutrient budgets to evaluate nutrient dynamics in free-flowing reaches of the Klamath River, including longitudinal trends in absolute and relative retention of phosphorus and nitrogen. The analysis also compared nutrient retention rates between free-flowing river reaches and reservoir reaches and developed a range of estimates for the degree to which seasonal TP and TN concentrations downstream from Iron Gate Dam might be altered by dam removal. The analysis used hydrologic and nutrient data collected by a variety of tribal, Federal, and State agencies, and PacifiCorp, during June-October of 2005–2008. The mass balance estimates for 2005–2008 improve upon estimates for the period 1998–2002 (Asarian and Kann 2006a) by using flow- and season-based multiple regression models for predicting daily nutrient concentrations and loads and quantification of uncertainty, relatively lower laboratory reporting limits, higher sampling frequency, and nutrient speciation (i.e., not just TN and TP). The mass balance also uses improved accounting for peaking flows in the J.C. Boyle Bypass Reach and their effect on retention times and mixing dynamics in Copco 1 Reservoir. The effects of dam removal were quantified using calculated relative retention rates in river reaches and comparing them to results from a retention study of Copco 1 and Iron Gate Reservoirs by Asarian et al. (2009).

3.2.4.1.4 Dissolved Oxygen

Both short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2-50 years following dam removal/construction of fish passage facilities) dissolved oxygen effects due to the alternatives are analyzed. For short-term effects under the Proposed Action and dam removal alternatives, results of numerical modeling conducted by the Lead Agencies as part of the Klamath Dam Removal Secretarial Determination studies are used to describe predicted short-term dissolved oxygen levels in the Hydroelectric Reach and downstream from Iron Gate Dam due to oxygen demand from mobilized reservoir sediments during dam removal. In the 1-dimensional, steady-state model, the different short-term oxygen demand parameters (i.e., BOD, immediate oxygen demand [IOD], and sediment oxygen demand [SOD]) are off-set by tributary dilution and re-aeration using an approach similar in concept to Streeter and Phelps (1925) dissolved oxygen-sag. This BOD/IOD spreadsheet model also includes chemical oxygen demand generated from the conversion of ammonium and other nitrogenous

compounds in reservoir sediments to nitrate under oxic conditions. This is termed nitrogenous oxygen demand and is inherently included in the oxygen demand rate constants used in the BOD/IOD spreadsheet model (Stillwater Sciences 2011).

IOD and BOD are predicted in the spreadsheet model using empirically derived oxygen depletion rates for a particular SSC based on laboratory incubations conducted under the Secretarial Determination oxygen demand study (Stillwater Sciences 2011). Oxygen depletion rates are scaled to the level of suspended sediments expected under each of the three water year types considered for the Reclamation hydrology and sediment transport modeling assessment (i.e., typical dry, median, and typical wet water years) (see Section 3.2.4.1).

The BOD/IOD spreadsheet model assumes a three-phase drawdown for Copco 1 Reservoir beginning on November 1, 2019, and a single-phase drawdown for J.C. Boyle and Iron Gate Reservoirs beginning on January 1, 2020 consistent with the Proposed Action (Reclamation 2012). This would allow maximum SSCs to occur during winter months when flows are naturally high in the mainstem river (Stillwater Sciences 2008, Reclamation 2012). While the KHP reservoirs exhibit varying degrees of thermal stratification and hypolimnetic anoxia during summer months (see Section 3.2.3.1), all of the reservoirs tend to experience fully-mixed conditions by November/December and remain mixed through April/May. Thus, drawdown beginning in December is expected to involve a well-oxygenated water column and inflowing water and, potentially, an oxic surficial sediment layer. This is important because the spreadsheet model is highly sensitive to background concentrations of dissolved oxygen (Stillwater Sciences 2011), which are generally highest in the KHP reservoirs during winter months (see Section 3.2.3.1). The BOD/IOD spreadsheet model results encompass a 6-month period following drawdown in order to estimate potential dissolved oxygen minimums corresponding to the period of greatest sediment transport in the river under the Proposed Action.

For long-term (2–50 years following dam removal/construction of fish passage facilities) effects, existing information on water quality dynamics and physical, chemical, and biological drivers for dissolved oxygen in the river are used to inform the effects determination for all of the alternatives. Dissolved oxygen model results from PacifiCorp relicensing efforts (FERC 2007) and the California Klamath River TMDL (NCRWQCB 2010a; see Section 3.2.2.7.4) are also used for the long-term effects analysis. Where possible, the Klamath TMDL model output is used in combination with KRWQM output to assess similar spatial and temporal trends in predicted dissolved oxygen. To place the Proposed Action analysis in the context, the TOD2RN and TCD2RN model predictions (Tetra Tech 2009) are interpreted with respect to starting assumptions (i.e., model boundary conditions) about dissolved oxygen (and nutrient) concentrations. Reaches where T4BSRN, TOD2RN and TCD2RN information is available include all reaches associated with the EIS/EIR dissolved oxygen analysis from J.C. Boyle Reservoir to the Klamath Estuary (see Appendix D, Table D-1).

3.2.4.1.5 pH

Short-term (<2 years following dam removal/construction of fish passage facilities) effects of the alternatives on pH are assessed based on the existing conditions understanding of the seasonal effects of the KHP reservoirs on pH within the Hydroelectric Reach and downstream from the dam.

For long-term (2–50 years following dam removal/construction of fish passage facilities) effects, existing data on pH in the Hydroelectric Reach and the Lower Klamath Basin are used to inform the effects determination for the Proposed Action. As for water temperature, nutrients, and dissolved oxygen, T4BSRN, TOD2RN and TCD2RN Klamath TMDL scenarios (Tetra Tech 2009) are available for pH. Reaches where T4BSRN, TOD2RN and TCD2RN information is available include all reaches associated with the EIS/EIR pH analysis from J.C. Boyle Reservoir to the Klamath Estuary (see Appendix D, Table D-1).

3.2.4.1.6 *Chlorophyll-a* and Algal Toxins

Effects of the alternatives on the algal community (phytoplankton, aquatic macrophytes, riverine phytoplankton and periphyton) in the Klamath River are discussed in Section 3.4, Algae. Chlorophyll-*a* is analyzed as a separate water quality parameter in the Klamath Facilities Removal EIS/EIR because it is a surrogate measure of algal biomass and it is included as a numeric criterion associated with the Oregon nuisance algae growth water quality objective (see Table 3.2-3) and a target specific to the KHP reservoirs in the California Klamath River TMDLs (NCRWQCB 2010a). The Hoopa Valley Tribe water quality objective for chlorophyll-*a* is a measure of attached (benthic) algal growth (see Table 3.2-6) and is discussed further in Section 3.4, Algae.

Quantitative predictive tools for chlorophyll-*a* are not available for the alternatives. While the California Klamath TMDLs model includes a chlorophyll-*a* component, covering both periphyton and phytoplankton, the model appears to over predict chlorophyll-*a* under the "dams out" scenario (Tetra Tech 2008) and is therefore not used for the Klamath Facilities Removal EIS/EIR analysis. The chlorophyll-*a* target (10 ug/L) developed for the KHP reservoirs in the California Klamath TMDLs is based on a Nutrient Numeric Endpoints (NNE) analysis, which appears to be a conservative estimate of mean summer chlorophyll-*a* concentrations required to move the system toward support of beneficial uses (Creager et al. 2006, Tetra Tech 2008).

The chlorophyll-*a* effects determinations are based on a qualitative assessment of whether the alternatives would result in exceedances of the Oregon 15 ug/L water quality objective or the California 10 ug/L target for the KHP reservoirs and adversely affect beneficial uses with respect to water column concentrations of chlorophyll-*a*. Growth conditions for suspended algae (i.e., nutrient availability, impounded water) are considered as part of the qualitative analysis, where predicted changes in nutrient availability, water temperatures, and the availability of lacustrine (lake or reservoir) conditions would correspondingly affect chlorophyll-*a* concentrations.

Since algal toxins are a water quality concern and have the potential to affect designated beneficial uses of water, an analysis of project effects on algal toxins as related to water quality standards and beneficial uses is included in the water quality effects determinations. There are no quantitative models predicting algal toxin trends under a dam removal scenario, thus the effects determinations are based upon trends in the density of *M. aeruginosa* (or other toxin-producing blue-green algae) to algal toxin concentrations (see Section 3.2.3.7) discerned from data collected in the Hydroelectric Reach and the Lower Klamath Basin. This information is considered along with the potential for changes in habitat availability for *M. aeruginosa* (or other toxin-producing blue-green algae) under the alternatives.

3.2.4.1.7 Inorganic and Organic Contaminants

The determination of potential toxicity and bioaccumulation with respect to aquatic species and humans under the alternatives is based on the evaluation of existing data on inorganic and organic contaminants associated with both reservoir water quality and sediment deposits, as well as new sediment contaminant data collected as part of the ongoing Secretarial Determination studies.

The Secretarial Determination sediment evaluation process has followed screening protocols of the SEF for the Pacific Northwest, issued in 2009 by the interagency Regional Sediment Evaluation Team (RSET). The SEF is a regional guidance document that provides a framework for the assessment and characterization of freshwater and marine sediments in Idaho, Oregon, and Washington (RSET 2009). The SEF involves a data screening assessment to compare reservoir sediment data to available and appropriate sediment maximum levels, screening levels, and bioaccumulation triggers. It also provides guidance for conducting elutriate chemistry, toxicity bioassays, and bioaccumulation tests, and special evaluations such as tissue analysis and risk assessments (the latter not utilized for this evaluation). The results of the SEF-based evaluation for the 2009–2010 Klamath River sediment samples are used primarily to inform the water quality effects determinations related to inorganic and organic contaminants under the Proposed Action.

To systematically consider potential impact pathways for each of the alternatives for the Secretarial Determination process, sediment data were compared to established sediment screening values in a step-wise manner. Elutriate (sediment pore water) data were also evaluated through comparison with a suite of regional, State and Federal standards for water quality; the comparison is first performed without consideration of dilution as a conservative approach (CDM 2011).

Biological testing was also conducted, using the SEF approach, and consisted of sediment and elutriate toxicity testing and tissue analyses, or other special evaluations designed to provide more empirical evidence regarding the potential for sediment contaminant loads to have adverse effects on receptors (RSET 2009). While whole sediment toxicity tests identify potential contamination that may affect bottom-dwelling (benthic) organisms, toxicity tests using suspension/elutriates of dredged material assess potential water column toxicity. Bioaccumulation evaluation is undertaken when bioaccumulative

chemicals of concern exceed or may exceed sediment screening levels, and thus further evaluation is needed to determine whether they pose a potential risk to human health or ecological health in the aquatic environment (RSET 2009).

Results from elutriate and sediment toxicity bioassays and sediment bioaccumulation tests carried out for the Secretarial Determination studies are used to provide additional information beyond simple comparisons of sediment contaminant levels to individual-contaminant regional or national screening levels. The results of sediment and elutriate toxicity bioassays provide a direct assessment of potential toxicity that takes into account possible interactive effects of mixtures of multiple contaminants, and of potential contaminants that may be present but were not individually measured.

3.2.4.2 Significance Criteria

Significance criteria to be used for the determination of impacts on beneficial uses of water and water quality are listed below. These criteria are excerpted from the list of ten significance criteria generally applicable to hydrology and water quality environmental factors for proposed projects in California (Appendix E in California Resources Agency [2010]). The criteria also encompass elements of Oregon and California water quality standards.

Effects on beneficial uses of water and water quality will be considered significant if the Proposed Action or alternatives would do any of the following:

- Result in regular exceedances of water quality standards or waste discharge requirements.
- Result in substantial adverse effects on beneficial uses of water.

For the purposes of this EIS/EIR, substantial is defined as “of considerable importance to water quality and the support of beneficial uses”. “Substantial adverse effects” are intended to correspond to water quality parameters that are included on the CWA Section 303(d) list (see Table 3.2-8) because if a parameter is listed, it has already been determined that beneficial uses are not supported due to regular exceedances of established numeric standards or water quality objectives. Substantial adverse effects can also apply to water quality parameters that would experience degradation within the EIS/EIR short-term time from of less than 2 years.

Additional criteria related to groundwater and hydrology (i.e., drainage, runoff, stormwater, flooding, and inundation) will be addressed in Section 3.6, Flood Hydrology or Section 3.7, Groundwater.

3.2.4.2.1 Thresholds of Significance for Numeric Standards or Water Quality Objectives

Thresholds of significance for established numeric standards and water quality objectives are the numeric values themselves. The numeric values for Oregon, California, Hoopa Valley Tribe, and the Ocean Plan are presented in Tables 3.2-3 through 3.2-7.

Numeric values presented in Tables 3.2-3 through 3.2-7 are used as thresholds of significance for water temperature, dissolved oxygen, and pH. Other numeric values presented in Tables 3.2-3 through 3.2-7, including Oregon and California turbidity standards, California nitrate and nitrite standards for the support of municipal beneficial uses, the Hoopa Valley Tribe criterion for chlorophyll-*a* as periphyton, and the Hoopa Valley Tribe ammonia and nitrate standards for the support of cold freshwater habitat and municipal beneficial uses, are not used as thresholds of significance. The reasons for not using these numeric standards in the water quality effects determinations are discussed below, by parameter.

3.2.4.2.2 Thresholds of Significance for Narrative Standards or Water Quality Objectives

Suspended Sediments

Oregon has a numeric turbidity standard based upon increases relative to background levels (see Table 3.2-3), and California's water quality objective for turbidity is based upon increases relative to natural conditions (see Table 3.2-4). Turbidity levels under natural conditions are not readily available in the Klamath River data record. While a relationship between turbidity and suspended sediment can be developed on a watershed-specific basis, seasonal coincident suspended sediment and turbidity data for the Klamath Basin are not currently sufficient, either temporally or spatially, to develop a robust relationship between these two parameters for either background levels or natural conditions levels (Stillwater Sciences 2009). For these reasons, the established numeric water quality objectives for turbidity in Oregon and California are not used for the water quality effects determination; instead, the narrative sediment water quality objectives are applied to the analysis.

California's North Coast Basin Plan water quality objectives for suspended material, settleable material, and sediment are narrative and require that waters do not contain concentrations that cause nuisance or adversely affect beneficial uses (see Table 3.2-4). While the Klamath River has multiple designated beneficial uses (see Table 3.2-2), the use most sensitive to water quality is the cold freshwater habitat (COLD) associated with salmonids (NCRWQCB 2010a). In order to adequately protect this use from *short-term* (<2 years following dam removal) effects of the Proposed Action, the water quality effects determination methods focus on the suspended material water quality objective and rely upon the extensive sediment transport modeling effort undertaken for the Secretarial Determination process to quantify predicted SSCs for 1 to 2 years following dam removal (see Section 3.2.4.1). An alternative "dose-response" approach to developing a numeric suspended sediments threshold of significance for potential short-term effects has been adopted, as detailed in Appendix D, Section D.2. Based on this

approach, the water quality effects determination uses a predicted suspended sediment value of 30 mg/L over a 4-week exposure period as a general threshold of significance for analyzing the *short-term* effects of the alternatives.

A more detailed analysis of suspended sediment effects on key fish species, including consideration of specific life history stages, SSCs, and exposure period, is required for a comprehensive assessment of the impacts of the alternatives on the cold water designated beneficial use. This level of analysis is presented in Section 3.3, Aquatic Resources and appendices to this section. Further discussion of particular effects of suspended sediment on shellfish and estuarine and marine organisms is also presented in Section 3.3.4.3, Aquatic Resources.

Nutrients

Oregon does not stipulate numeric nutrient water quality standards (see Table 3.2-3). California has a narrative water quality objective for biostimulatory substances and does not stipulate numeric nutrient water quality standards for the cold water habitat beneficial use (see Table 3.2-4). California does have numeric nitrate and nitrite standards for the support of municipal beneficial uses (i.e., drinking water). However, these standards are much higher than concentrations that have been measured in the Klamath Basin, such that there is no indication that the municipal beneficial use is not being met or would not be met in the future. Hoopa Valley Tribe also has a nitrate standard for municipal beneficial uses, which is similarly high.

The California Klamath River TMDLs provide the numeric interpretation of the narrative biostimulatory substances objective for the Klamath River through numeric targets for nutrients, organic matter, chlorophyll-*a*, *M. aeruginosa* and microcystin. The numeric TMDL targets for nutrients (TP and TN) and organic matter (as carbonaceous biochemical oxygen demand [CBOD]) vary by month are established for the tailraces of Copco 2 and Iron Gate Dams. The numeric TP targets range 0.023–0.029 mg/L for May–October and 0.024–0.030 mg/L for November–April. The numeric TN targets range 0.252–0.372 mg/L for May–October and 0.304–0.395 mg/L for November–April (NCRWQCB 2010a). These targets are based on the T4BSRN scenario (Appendix D, Section D-1) and are established as the monthly mean concentrations that allow achievement of the in-reservoir chlorophyll-*a* summer mean target of 10 µg/L, the *M. aeruginosa* cell density target of 20,000 cells/mL, and the microcystin target of 4 µg/L (NCRWQCB 2010a).

For multiple locations in the Klamath River, the TMDL model results indicate large daily variability in TP and TN that exceeds the small range in the monthly TMDL targets, particularly during summer and early fall (i.e., generally June–October) (Tetra Tech 2009). Therefore, the nutrient effects analysis as part of the TMDL considers whether a general downward (or upward) trend in TP and TN toward (or away from) the numeric targets would occur and, qualitatively, whether such a trend would support or alleviate the growth of nuisance and/or noxious phytoplankton or nuisance periphyton.

Chlorophyll-a and Algal Toxins

Within the area of analysis, Oregon possesses a numeric criterion for chlorophyll-*a* that is associated with the nuisance algae growth water quality objective and applies to natural lakes that do not thermally stratify, reservoirs, rivers, and estuaries (see Table 3.2-3). The Klamath River TMDLs establish a chlorophyll-*a* target specific to the KHP of 10 µg/L during the growth season, based on a NNE analysis (NCRWQCB 2010a). The Hoopa Valley Tribe has a chlorophyll-*a* criterion (150 mg/m^2; see Table 3.2-6) for their periphyton density water quality objective, which is applicable to a short reach (≈RM 45–46) of the Klamath River upstream of the Trinity River. However, since effects of the Proposed Action on periphyton growth are addressed in Section 3.4, Algae, chlorophyll-*a* as a measure of periphyton density is not discussed further in the water quality effects analysis.

The Oregon criterion (15 ug/L) and the California TMDL target (10 ug/L) are used as chlorophyll-*a* thresholds of significance for J.C. Boyle Reservoir and Copco 1 and Iron Gate reservoirs, respectively. Anticipated regular exceedances of these thresholds would constitute a significant impact for this analysis.

For algal toxins, both Oregon and California have narrative water quality objectives for general toxicity (see Table 3.2-3 and 3.2-4). The Hoopa Valley Tribe has numeric objectives for algal toxins (see Table 3.2-6). The WHO has set numeric thresholds for recreational exposures of microcystin toxin at 4 µg/L for a low probability of adverse health effects, and 20 µg/L for a moderate probability of adverse health effects (Falconer et al. 1999, Chorus and Cavalieri 2000). The WHO thresholds are general levels representing a variety of toxigenic cyanobacteria. Oregon has adopted public health guidelines for recreational exposures similar to the WHO values, and California uses the *Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms* (SWRCB et al. 2010) developed jointly by the California Department of Public Health, SWRCB and OEHHA. To avoid conditions that lead to water quality impairments, the California Klamath River TMDLs use the WHO low probability of adverse health effects thresholds as targets specific to the California reaches of the KHP for *M. aeruginosa* and microcystin toxin (see Table 3.2-10).

Since it is common to Oregon, California, and the Hoopa Valley Tribe (see Table 3.2-10), the < 8 µg/L criterion for microcystin in recreational water is used as the threshold of significance for this Klamath Facilities Removal EIS/EIR. As is the case with chlorophyll-*a*, quantitative predictive tools for algal toxins are not available for the Proposed Action. Therefore, the algal toxin effects determinations are based on a qualitative assessment of whether the Proposed Action would result in exceedances of the criterion and adversely affect the human health recreational beneficial uses (REC-1, REC-2; Table 3.2-2). Growth conditions for toxigenic suspended algae (i.e., nutrient availability, impounded water) are considered as part of the qualitative analysis, where predicted changes in nutrient availability, water temperatures, and the availability of lacustrine (lake or reservoir) conditions would correspondingly affect algal toxin concentrations.

Table 3.2-10. Summary of Water Quality Guidance, Criteria, or Targets for Toxigenic Blue-Green Algae and Algal Toxins in the Area of Analysis

Source	Description
Oregon[1]	
Public health guidelines for recreational exposure	40,000 cells/mL *M. aeruginosa*, or 8 µg/L microcystin
California[2]	
Draft Voluntary Statewide Guidance for Blue-Green Algae Blooms	>100,000 cells/mL potentially toxigenic blue-green algae, or 40,000 cells/mL *M. aeruginosa*, or 8 µg/L microcystin
California Klamath River TMDL[3]	
Chl-*a* target for California KHP reservoirs (growth season)	< 20,000 cells/L *M. aeruginosa*, or < 4 ug/L microcystin
Hoopa Valley Tribe[4]	
Microcystis aeruginosa cell density	<5,000 cells/mL for drinking water <40,000 cells/mL for recreational water
Microcystin toxin Concentration	<1µg/L total microcystin for drinking water <8 µg/L total microcystin for recreational water
Total potentially toxigenic cyanobacteria species[5]	<100,000 cells/mL for recreational water

[1] ODEQ (2011): At these levels, water is considered impaired.
[2] SWRCB et al. (2010): At these levels, water is considered impaired.
[3] NCRWQCB (2010a): These targets are set to avoid conditions that could lead to water quality impairments.
[4] HVTEPA (2008): At these levels, water is considered impaired.
[5] Includes: *Anabaena*, *Microcystis*, *Planktothrix*, *Nostoc*, *Coelosphaerium*, *Anabaenopsis*, *Aphanizomenon*, *Gloeotrichia*, and *Oscillatoria*.

Inorganic and Organic Contaminants

Both Oregon and California have water quality objectives related to inorganic and organic contaminants. Oregon's toxicity objective has both a narrative and a numeric component (see Table 3.2-3); the numeric component has chemical-specific water-column criteria for freshwater and marine aquatic life and human health (CDM 2011). Oregon's numeric marine aquatic life criteria are not considered further because the Proposed Action would not affect the marine environment in Oregon. California's chemical constituents objective is numeric (listed in the Basin Plan [NCRWQCB 2011], as noted in Table 3.2-4 and has chemical-specific water-column criteria for freshwater and marine aquatic life and human health, including bioaccumulative chemicals such as PCBs, methylmercury, dioxins, and furans (CDM 2011). California's toxicity and pesticides objectives are narrative (see Table 3.2-4). Hoopa Valley also has an ammonia toxicity objective based on pH and temperature (see Table 3.2-6). However, since available data collected to date suggests no actual ammonia toxicity events associated with the operation of the Four Facilities (NCRWQCB 2010a), and because the increased

velocity of stream flow in the Hydroelectric Reach under dam removal would increase nitrification (i.e., oxidation of ammonia), thus minimizing the potential for ammonia toxicity, this objective is not considered further.

Thresholds of significance for the Oregon and California narrative water quality objectives focus on designated beneficial uses and are applicable for contaminants in either the water column or the sediments. For this Klamath Facilities Removal EIS/EIR, establishment of toxicity and/or bioaccumulative potential for sediment contaminants relies upon thresholds developed through regional and State efforts such as the SEF for the Pacific Northwest (Appendix D, Section D.3). The SEF includes bulk sediment screening levels for standard chemicals of concern and chemicals of special occurrence in marine and freshwater sediments for Idaho, Oregon, and Washington (RSET 2009). Additionally, Oregon has developed bioaccumulation screening level values that are used for this Klamath Facilities Removal EIS/EIR analysis. Similar numeric chemical guidelines for the assessment and characterization of freshwater and marine sediments do not exist for California. Additional information regarding applicable sediment screening levels used for the Secretarial Determination sediment evaluation process is presented in CDM (2011).

Impacts on water quality would be considered significant if results of sediment and elutriate chemical analyses and biological testing indicate that at least one chemical is detected at a level with potential for significant adverse effects based on multiple lines of evidence (CDM 2011). This evaluation is not intended to be equivalent to the SEF process.

3.2.4.3 Effects Determinations

3.2.4.3.1 Alternative 1: No Action/No Project Alternative

Under this Alternative, the Klamath Hydroelectric Project would continue current operations under the terms of an annual license until a long-term license is finalized. Some restoration actions have already been initiated and would continue under the No Action alternative. These include the Williamson River Delta Project, the Agency Lake and Barnes Ranch Project, fish habitat restoration work, and ongoing climate change assessments. The TMDLs would still be implemented under this and all other alternatives as they are an unrelated regulatory action. Hydroelectric operations would continue as they have been, providing peaking power generation during the summer as demand requires and conditions allow. The No Action/No Project Alternative would leave the Four Facilities in place. In the Upper Klamath Basin, operation of the Four Facilities would only affect water quality in the Hydroelectric Reach; however, resource management actions elsewhere in the Upper Klamath Basin (i.e., Upper Klamath Lake and tributaries) are also analyzed under this alternative because they would potentially affect water quality further downstream.

Water Temperature

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could result in short-term and long-term seasonal water temperatures that are shifted from the natural thermal regime of the river and do not meet applicable ODEQ and California Basin Plan water quality objectives and adversely affect beneficial uses in the Hydroelectric Reach. Under existing conditions, water temperatures (measured as 7-day-average maximum values) in much of the reach from Keno Dam to the Oregon-California State line exceed 20°C (68°F) in June through August and result in non-attainment of the designated beneficial use (Redband or Lahonton cutthroat trout habitat, see Table 3.2-3). The exception to this occurs in the approximately 4-mile long J.C. Boyle Bypass Reach where cold groundwater springs enter the river at a relatively constant 11-12°C (Kirk et al. 2010) and combine with flow releases from J.C. Boyle Dam (i.e., 100 cubic feet per second minimum flow release; FERC [2007]). Due to the constant groundwater input and temperature moderation due to the upstream thermal mass of J.C. Boyle Reservoir, there is also reduced diel variation in water temperatures in the Bypass Reach. Just downstream, in the J.C. Boyle Peaking Reach, water temperatures vary on a diel basis due to powerhouse peaking flows. When peaking flows are not occurring, water in the Peaking Reach is dominated by cooler water from the upstream groundwater springs. When peaking flows from J.C. Boyle Reservoir enter the reach, water temperatures can increase by several degrees (PacifiCorp 2006b). Further downstream in the California portions of the Klamath River, summer MWMTs regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010a) and result in non-attainment of designated COLD and WARM beneficial uses (see Table 3.2-4)

Under the No Action/No Project Alternative, several ongoing resource management actions in the Upper Klamath Basin represent reasonably foreseeable actions related to water temperature within the period of analysis (50 years). Underway since 2007, the Williamson River Delta Project is intended to restore wetlands for endangered fish species and improve water quality in Upper Klamath Lake (see Section 2.3.1). Thus far, the project has involved breaching over two miles of agricultural levees along the Williamson River where it flows into Upper Klamath Lake, restoring approximately 3,500 acres of wetlands in 2007 and an additional 1,400 acres in 2008. One of the project goals is to create wetlands with warmer spring water temperatures for rearing fish in the wetlands (as compared to cooler temperatures in the Williamson River or Upper Klamath Lake). The Agency Lake and Barnes Ranches Project would use historically diked and drained portions of the Barnes Ranches as interim pumped water storage areas, ultimately reconnecting them to Agency Lake (see Section 2.3.1). Breaching the dikes would convert the current 63,770 acre feet pumped storage to passive storage in Upper Klamath Lake. Specific options still need to be developed and studied as part of a separate project-level National Environmental Policy Act (NEPA) evaluation and Endangered Species Act (ESA) consultation. At a programmatic level, these activities may improve springtime water temperatures for spawning and rearing of fish in Upper Klamath Lake

and tributaries to the lake. Additional resource management actions related to spring, summer, and fall water temperatures that are ongoing in tributaries to Upper Klamath Lake (see Section 2.3.1) include the following:

- Floodplain rehabilitation
- Large woody debris replacement
- Riparian vegetation planting
- Purchase of conservation easements and/or land

Although these resource management actions may improve water temperatures in the Upper Klamath Basin under the No Action/No Project Alternative, the effects would only be local and would not measurably improve water temperatures in the Hydroelectric Reach. These resource management actions are discussed again with respect to water quality effects under the KBRA (see Section 3.2.4.3, Full Facilities Removal of Four Dams - KBRA).

In Oregon, implementation measures focused on water temperature in the Upper Klamath Lake Drainage TMDL and those in the Upper Klamath River and Lost River Sub-basins TMDLs would improve water temperatures in the Hydroelectric Reach. The Oregon TMDLs include heat load allocations for anthropogenic and background nonpoint sources, where effective shade and channel morphology targets are used as surrogate measures for controlling nonpoint source temperature loading (see Section 3.2.2.4).

To support beneficial uses in California, the North Coast Basin Plan stipulates that water temperature cannot be increased by more than 2.8^{o}C (5°F) above natural receiving temperatures (see Table 3.2-4). The NCRWQCB has determined that natural receiving water temperatures in the Klamath River are already too warm to support designated beneficial uses. Therefore, the Klamath TMDL allocates a daily average (and daily maximum) increase in water temperatures of 0.5^{o}C [0.9^{o}F] for Copco 1 and 2 reservoir tailraces and 0.1^{o}C [0.18^{o}F] for the Iron Gate Reservoir tailrace. This allocation is designed to alleviate the late summer/fall 2–10°C (3.6–18°F) warming caused by the reservoirs immediately downstream from Iron Gate Dam under existing conditions (see Section 3.2.3.2). Additionally, a compliance lens in Copco 1 and Iron Gate Reservoirs must be maintained, such that water temperature and dissolved oxygen conditions would be suitable for cold water fish in the reservoirs during the critical summer period (see Section 3.2.2.4). To date, no Proposed Action has been identified by PacifiCorp to achieve the temperature allocations assigned to Copco 1 and Iron Gate reservoirs.

The Klamath TMDL model (see Appendix D) indicates that under the No Action/No Project Alternative (similar to the TMDL T4BSRN scenario) water temperatures in the reach from Link River Dam to just upstream of J.C. Boyle Reservoir (including Keno Impoundment/Lake Ewauna and in the Hydroelectric Reach would be very similar to modeled natural conditions temperatures (TMDL T1BSR scenario) (NCRWQCB 2010a). While the Klamath TMDL model output also indicates that natural conditions would exceed the 20°C (68°F) numeric water quality objective for the support of Redband and Lahonton cutthroat trout in Oregon during June–August (see Table 3.2-3), the narrative

Oregon standard stipulates that the natural conditions criterion would supersede the numeric criterion. Thus, assuming eventual full attainment of the Oregon and California TMDLs, water temperature objectives in the Klamath Hydropower Reach can be met; however, the timeframes for achieving water temperature allocations required under the TMDLs will depend on the measures taken to improve water quality conditions. Full attainment could require decades to achieve.

The TMDL models do not address the potential effects of global climate change on water temperatures in the Klamath Basin (Appendix D).Within the period of analysis (i.e., 50 years), climate change models for the region suggest that as the western United States warms, air temperatures will increase, there will be a slight increase in overall precipitation, winter snowfall will likely shift to higher elevations, and snowpack will be diminished as more precipitation falls as rain (Oregon Climate Change Research Institute [OCCRI] 2010; see also Section 3.10.3.1). For the Sprague River watershed, increased flooding earlier in the spring and decreased summer baseflow would occur as a consequence of increased and decreased proportions of rainfall and snowfall, respectively, given climate change projections (Risley 2010). Bartholow (2005) predicted that in the Klamath Basin as a whole, increasing air temperatures and decreasing flows in the summer months would be expected to cause general increases in summer and fall water temperatures on the order of 2–3°C (3.6–5.4°F) (see also discussion under Lower Klamath Basin).

As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for future water temperatures under the No Action/No Project Alternative and the Proposed Action. RBM10 model results using climate change predictions from five GCMs indicate that future water temperatures under the No Action/No Project Alternative (where simulated flows are subject to the 2010 Biological Opinion mandatory flow regime [NOAA Fisheries Service 2010]) would be 1–2.3^{o}C (1.8–4.1^{o}F) warmer than historical temperatures in the Klamath Basin (Perry et al. 2011). While this temperature range is slightly lower than that suggested using the Bartholow (2005) historical estimates, within the general uncertainty of climate change projections, the two modeling efforts correspond reasonably well and indicate that water temperatures in the Upper Klamath Basin are expected to increase within the period of analysis on the order of 1–3°C (1.8–5.4°F).

The anticipated increases in water temperatures due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Upper Klamath Basin. The magnitude of the opposition would be slightly less than, but within the general range of, late summer/fall improvements (2–10°C [3.6–18°F]) expected by the TMDLs immediately downstream from Iron Gate Dam (see discussion under Lower Klamath Basin), such that climate change would partially offset the anticipated TMDL-related improvements.

Existing late summer/fall water temperatures in the Hydroelectric Reach are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanisms and timing unknown) would significantly improve conditions in the

Hydroelectric Reach, but climate change would partially offset TMDL-related improvements in the late summer/fall. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could result in short-term and long-term seasonal water temperatures and diel temperature variation that are shifted from the natural thermal regime of the river and do not meet applicable California North Coast Basin Plan water quality objectives and adversely affect beneficial uses in the Klamath River downstream from Iron Gate Dam. Under existing conditions, the Four Facilities shift the natural thermal regime of the river by approximately 18 days by cooling springtime water temperatures 1–2.5ºC (1.8–4.5°F) and warming late summer/fall water temperatures 2–10ºC (3.6–18°F) in the Lower Klamath River, with the largest effects occurring just downstream from Iron Gate Dam (RM 190.1) (PacifiCorp 2004a, Bartholow 2005, Dunsmoor and Huntington 2006, NCRWQCB 2010a, Perry et al. 2011). The warming effect, which can be stressful to rearing salmonids, lasts for the majority of late summer and fall months and is of larger magnitude than the cooling effect in spring (PacifiCorp 2004a). Effects diminish with distance downstream such that they are not discernable downstream from the Salmon River (RM 66) (see Section 3.2.3.2). Summer MWMTs in the Klamath River downstream from Iron Gate Dam to the Salmon River regularly exceed the range of chronic effects temperature thresholds (13–20°C [55.4–68°F]) for full salmonid support in California (NCRWQCB 2010a) and result in non-attainment of designated COLD and WARM beneficial uses (see Table 3.2-4). Although not an effect of the reservoirs at the Four Facilities, MWMTs in the mainstem from the Salmon River to the Klamath Estuary also regularly exceed these thresholds and result in non-attainment of these beneficial uses (see Section 3.2.3.2 and Appendix C for more detail).

Reservoir thermal regimes also act to reduce the magnitude of diel temperature variation in the reservoir reaches and the riverine reaches immediately downstream from Iron Gate Reservoir (RM 190.1; see Section 3.2.4.3.2, Figure 3.2-5) (Deas and Orlob 1999, PacifiCorp 2005). As discussed in Section 3.3.4.3 Alternative 1: No Action/No Project, when average temperatures are high, diel variability provides salmonids opportunities for regenerative healing and foraging during the cool hours (NRC 2004). During these periods, decreased diel temperature variation in the Klamath River downstream from Iron Gate Dam is deleterious for salmonids. As with the seasonal temperature effect, the dampening influence of the reservoirs on diel temperature variation is considerably diminished farther downstream, at the confluence with the Scott River (RM 143.9; see Section 3.2.4.3.2, Figure 3.2-6). The KRWQM indicates that the temperature influence of the Hydroelectric Reach is mostly ameliorated by RM 66 at the confluence with the Salmon River (see Section 3.2.4.3.2, Figure 3.2-7).

Within the period of analysis (i.e., 50 years), implementation of NOAA Fisheries Service 2010 Biological Opinion mandatory flows and CDFG Code Section 5937 instream flow mandate for tributaries to the mainstem Klamath River (see Section 2.3.1 and Section

3.2.4.1, No Action/No Project Alternative) would increase seasonal stream flow and may result in minor increases in water temperatures in the Klamath River downstream from Iron Gate Dam during summer and fall months[6]. The California Klamath River TMDLs were developed based on compliance with water quality objectives at the Oregon-California State line, meaning that successful implementation of water quality improvement measures under the Oregon TMDLs will improve water temperatures in the Lower Klamath Basin as well. General implementation measures under the California Klamath TMDLs associated with water temperature improvements are described in the prior section for the Upper Klamath Basin and in Section 3.2.2.4. Additionally, the Shasta, Scott, and Salmon Rivers, tributaries to the Lower Klamath River within California, have TMDLs addressing temperature (see Section 3.2.2.4).

The Klamath TMDL model indicates that as implementation of the TMDL progresses under the No Action/No Project Alternative (similar to TMDL T4BSRN scenario), water temperatures from Iron Gate Dam (RM 190.1) to the Klamath Estuary (RM 0-2) would improve towards modeled natural conditions (similar to the TMDL T1BSR scenario) (NCRWQCB 2010a). Some delayed warming of springtime water temperatures (February-March) and delayed cooling of late summer/fall (August-November) water temperatures would still occur under the No Action/No Project Alternative due to the large thermal mass of Copco 1 and Iron Gate reservoirs. This temporal shift may continue to occur under the No Action/No Project Alternative from downstream from Iron Gate Dam to approximately the Salmon River (RM 66) because while full attainment of the California Klamath TMDLs would improve water temperature, the model is unable to demonstrate full temperature compliance in the spring and fall downstream from Iron Gate Dam to the Salmon River with the Four Facilities in place. The model-predicted lack of compliance from Iron Gate Dam to the Salmon River underlies the TMDL requirement for PacifiCorp to address water temperature and dissolved oxygen improvements (NCRWQCB 2010a). The timeframes for achieving water temperature allocations required under these TMDLs will depend on the measures taken to improve water quality conditions. It is anticipated that full attainment of the TMDLs would require decades to achieve.

The Klamath TMDL model also predicts that, with full implementation, reduced diel variation in water temperature would continue to occur under the No Action/No Project Alternative immediately downstream from Iron Gate Dam due to the thermal mass of the upstream reservoirs, with the magnitude of diel variation increasing with distance downstream from Iron Gate Dam as the river approaches equilibrium with ambient air temperatures (NCRWQCB 2010a, Dunsmoor and Huntington 2006). As discussed in Section 3.3.4.3 Alternative 1: No Action/No Project – Key Ecological Attributes – Water Temperature, the decrease in diel temperature variation compared with historical conditions in the Klamath River downstream from Iron Gate Dam is deleterious for

[6] The effects of increased tributary flows on Lower Klamath River temperatures were evaluated as part of the analyses conducted for the California Klamath River TMDL development. The evaluation indicated little temperature effect on the Klamath River, and only when the tributaries were assumed to have full natural flows (see Section 4.2.4 of NCRWQCB 2010a).

salmonids. General climate change effects are discussed in Section 3.10.3.1. With respect to water temperatures in the Lower Klamath Basin, the historical data record indicates that mainstem water temperatures have increased approximately 0.05ºC (0.09ºF) per year between 1962 and 2001 (Bartholow 2005) such that climate change may already be affecting Klamath River water temperatures. Projecting the Bartholow (2005) estimate of an average annual temperature increase 50 years into the future, water temperatures would increase 2–3°C (3.6–5.4°F) by the end of the analysis period. As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for future water temperatures under the No Action/No Project Alternative and the Proposed Action. RBM10 model results using climate change predictions from five GCMs indicate that future water temperatures under the No Action/No Project Alternative (where simulated flows are subject to the 2010 Biological Opinion mandatory flow regime [NOAA Fisheries Service 2010]) would be 1–2.3 °C (1.8–4.1 °F) warmer than historical temperatures at the end of the analysis period (Perry et al. 2011). While this temperature range is slightly lower than that suggested using the Bartholow (2005) historical estimates, within the general uncertainty of climate change projections, the two projections correspond reasonably well. Considering together the available sources for climate change predictions, annual average water temperatures in the Lower Klamath Basin are expected to increase within the period of analysis on the order of 1–3 °C (1.8–5.4 °F).

The anticipated increases in water temperatures due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Lower Klamath Basin. Within the range of late summer/fall improvements expected by the TMDLs (2–10 °C [3.6–18 °F] immediately downstream from Iron Gate Dam and 2–5 °C [3.6–9 °F] just upstream of the Scott River), climate change would partially offset the anticipated TMDL-related improvements. Climate change would also completely offset the existing 1–2 °C springtime cooling effect of the reservoirs; see Section 3.3.4.3. Water Temperature for a discussion of the effect of the spring cooling on fish in the Lower Klamath River.

Existing late summer/fall water temperatures and reduced diel temperature variation in the Klamath River from immediately downstream from Iron Gate Dam to the Salmon River (RM 66) are adverse.[7] Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly improve conditions but water temperatures from Iron Gate Dam to approximately Seiad Valley (RM 129.4) would remain adverse. Climate change would partially offset TMDL-related improvements in the late summer/fall. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

[7] Water temperatures from the Salmon River to the Klamath Estuary are also adverse but this condition is not a result of the impoundment of water in the reservoirs at the Four Facilities.

Suspended Sediments

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could result in short-term and long-term interception and retention of mineral (inorganic) suspended material by the KHP dams. Under existing conditions, peak concentrations of mineral (inorganic) suspended material occur during winter and spring (November through April) due to runoff and tributary flows to the Hydroelectric Reach associated with high-flow events. The KHP dams mostly intercept and trap suspended materials (silts, clays with diameters < 0.063 mm) such that water column concentrations generally decrease with distance downstream in the Hydroelectric Reach (see Section 3.2.3.3 and Appendix C, Section C.2.1). Likewise, the reservoirs trap bedload or fluvial sediment (coarse sand, gravels, and larger materials with diameters > 0.063 mm) from the tributaries in the Hydroelectric Reach. While trapping of the suspended materials may be potentially beneficial for downstream reaches by decreasing TSS concentrations and turbidity, trapping of bedload may reduce habitat suitability below Iron Gate Dam for anadromous fish (see Section 3.3.3.3.2 Bedload for discussion of the effect of this trapping of bedload under existing conditions).

On the scale of the entire Klamath Basin, the trapping of fine sediments and suspended materials does not appear to be a critical function with respect to the overall cumulative sediment delivery including downstream tributaries (see also Section 3.11.3.3 for a discussion of basin sediment supply and transport), since a relatively small (3.4 percent) fraction of total sediment supplied to the Klamath River on an annual basis originates from the upper and middle Klamath River (i.e., from Keno Dam to the Shasta River) (see Section 3.2.3.3). Beneficial uses in the upper Klamath River are currently not impaired due to mineral (inorganic) suspended material (see Table 3.2-8).

Under the No Action/No Project Alternative, the ongoing Williamson River Delta Project and Agency Lake and Barnes Ranches Project would contribute to reduced mineral (inorganic) fine sediment inputs to Upper Klamath Lake. In the tributaries to Upper Klamath Lake, additional resource management actions for fish habitat restoration (see Section 2.4.2) related to mineral (inorganic) sediment are ongoing, including the following:

- Floodplain rehabilitation
- Large woody debris replacement
- Cattle exclusion [fencing]
- Riparian vegetation planting
- Mechanical thinning of upland areas and fire treatment
- Purchase of conservation easements/land
- Road decommissioning
- Reduction of fine sediment sources

These resource management actions are also discussed with respect to water quality effects under the KBRA (see Section 3.2.4.3, Full Facilities Removal of Four Dams - KBRA).

Anticipated climate change effects within the period of analysis (i.e., 50 years) include increased fine sediment delivery to streams due to more intense and frequent precipitation events and elevated stormwater runoff (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections). The anticipated increases would occur over a timescale of decades and may reduce anticipated improvements expected from successful implementation of the aforementioned resource management actions; however, the magnitude of the increased sediment delivery relative to the currently low levels of fine sediment production has not been assessed.

Existing interception and retention of mineral (inorganic) suspended material in the reservoirs in the Hydroelectric Reach is potentially beneficial. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Implementation of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could result in short-term (1 year) increases in mineral (inorganic) suspended material in the Hydroelectric Reach. Under this IM, suitable spawning gravel would be placed in the J.C. Boyle Bypass and Peaking reaches in the fall of 2011 using a passive approach before high flow periods, or to provide for other habitat enhancement in the Klamath River upstream of Copco 1 Reservoir. These actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal (for effects on aquatic species, see Section 3.3.4.3.2.3). Work on IM 7 began in fall 2010 with the contracting, planning, and permitting phase. Passive gravel placement is specified by IM 7, which would avoid in-stream placement of gravel and would limit turbidity increases to periods of high river flow when turbidity is naturally elevated. Under the No Action/No Project Alternative, the duration of IM 7 would only be one year and the amount of gravel to be added is therefore limited. The potential for sediments to enter the water during gravel placement along the river banks can be minimized or eliminated downstream from the enhancement sites through the implementation of BMPs for construction activities (Appendix B) (BLM 2011). Any disturbed sediments would be trapped by Iron Gate Reservoir and not transferred downstream to the Klamath River, particularly given implementation of BMPs. **Under the *No Action/No Project Alternative*, the effect of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, on SSCs in the Hydroelectric Reach would be a less-than-significant impact.**

Implementation of IM 8, J.C. Boyle Bypass Barrier Removal, could result in short-term increases in mineral (inorganic) suspended material in the Hydroelectric Reach due to deconstruction activities. Under this IM, the sidecast rock barrier located approximately three miles upstream of the J.C. Boyle Powerhouse in the J.C. Boyle Bypass Reach would be removed. The objective of IM 8 is to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead, Pacific lamprey, and redband

trout. The potential for sediments to enter the water during in-stream work associated with barrier removal and from construction site runoff could be minimized or eliminated through the implementation of BMPs for construction activities (Appendix B). Any disturbed sediments would be trapped by Copco 1 Reservoir and not transferred downstream to the Klamath River, particularly given implementation of BMPs. **Under the *No Action/No Project Alternative*, the effect of IM 8, J.C. Boyle Bypass Barrier Removal, on SSCs in the Hydroelectric Reach in the J.C. Boyle Bypass Reach would be a less-than-significant impact.**

Continued impoundment of water at the Four Facilities could result in short-term and long-term seasonal (April through October) increases in algal-derived (organic) suspended material in the Hydroelectric Reach due to in-situ algal blooms. Under existing conditions, episodic increases in suspended material occur in the KHP reservoirs during summer months as a result of *in*-situ algal productivity. These concentrations typically range 10–20 mg/L, but can be greater than 200 mg/L (see Section 3.2.3.3) and cause nuisance or adversely affect beneficial uses during intense blooms. While some settling of algal-derived (organic) suspended materials from Upper Klamath Lake may occur in the reservoirs at the Four Facilities, the majority of removal occurs further upstream in the Keno Impoundment/Lake Ewauna, with some additional decreases in concentration due to mechanical breakdown of algal remains in the turbulent river reaches between Keno Dam and Copco 1 Reservoir, and dilution from the springs downstream from J.C. Boyle Dam (see Appendix C for more detail). The high levels of seasonal suspended material caused by algal blooms in the reservoirs in the Hydroelectric Reach would continue to occur under the No Action/No Project Alternative.

Also under this alternative, the ongoing Williamson River Delta Project and Agency Lake and Barnes Ranches Project would contribute to reduced fine sediment inputs to Upper Klamath Lake. At a programmatic level, the fine sediment reductions may decrease overall sediment-associated phosphorus inputs to the lake and downstream reaches. The effects would be mostly local, but may indirectly reduce nutrient concentrations in the Hydroelectric Reach by decreasing concentrations in upstream Upper Klamath Lake. In the tributaries to Upper Klamath Lake, additional resource management actions for fish habitat restoration (see Section 2.4.2) related to sediment-associated phosphorus are ongoing, including the following:

- Floodplain rehabilitation
- Cattle exclusion [fencing]
- Riparian vegetation planting
- Mechanical thinning of upland areas and fire treatment
- Purchase of conservation easements/land
- Road decommissioning

These resource management actions are also discussed with respect to water quality effects under the KBRA (see Section 3.2.4.3, Full Facilities Removal of Four Dams - KBRA).

Full attainment of the measures in Oregon's Upper Klamath River and Lost River TMDLs may indirectly decrease algal-derived suspended material in the Link River and Klamath River upstream of the Oregon-California State line within the period of analysis (i.e., 50 years). The Oregon draft TMDLs require reductions in phosphorus and nitrogen loading from both point sources and nonpoint sources in the Upper Klamath River to address chlorophyll-*a* impairments (see Section 3.2.2.4, Upper Klamath River and Lost River TMDLs). Decreases in nutrient inputs to the upper Klamath River would decrease algal blooms and decrease algal-derived suspended material in this reach. Full attainment of the California Lower Lost River for pH and nutrients and the Klamath River TMDLs for organic enrichment/low dissolved oxygen, nutrients, and microcystin water quality impairments would decrease algal-derived suspended material in the Klamath River downstream from the Oregon-California State line to Iron Gate Reservoir and would, in the long term, be beneficial to water quality. It is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve.

Anticipated climate change effects within the period of analysis (i.e., 50 years) include longer and more intense algal blooms due to increased air temperatures (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections) and higher overall rates of photosynthesis during summer months. This may increase levels of algal-derived (organic) suspended material. The anticipated increases in suspended material due to climate change would also occur over a timescale of decades and may reduce anticipated improvements expected from successful TMDL implementation throughout the Upper Klamath Basin; however, the magnitude of the increased algal productivity with increasing temperature has not been assessed.

Existing seasonal increases in algal-derived (organic) suspended material in the reservoirs in the Hydroelectric Reach are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease algal blooms and associated suspended material in the reservoirs in this reach. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could result in short-term and long-term interception and retention of mineral (inorganic) sediments by the dams and correspondingly low levels of suspended material immediately downstream from Iron Gate Dam. Under existing conditions, during November–April, mineral (inorganic) suspended sediments tend to be <100 mg/L in the Klamath River immediately downstream from Iron Gate Dam, increasing to levels greater than 150 mg/L in the mainstem downstream from the confluence with the Trinity River during storm events (see Section 3.2.3.3). While the interception and retention of mineral (inorganic) suspended sediments may be moderately beneficial for the Klamath River immediately downstream from Iron Gate Dam, this represents a very minor portion of the load with respect to overall sediment delivery for the Klamath Basin. A relatively small (3.4 percent) fraction of total sediment supplied to the Klamath River on an annual basis,

originates from the upper and middle Klamath River (i.e., from Keno Dam to the Shasta River) (see Section 3.2.3.3) and beneficial uses in the Klamath River immediately downstream from Iron Gate Dam are currently not impaired due to mineral (inorganic) suspended material (see Table 3.2-8).

The Klamath River from the Trinity River (RM 42.5) to the mouth (RM 0) is listed as sediment impaired (see Table 3.2-8), and while the California Klamath River TMDLs do not explicitly address sediment impairments, they do identify allocations to address temperature impairments caused by excessive (primarily inorganic) sedimentation (see Section 3.2.2.4, Klamath River TMDLs). Additionally, the Trinity River and South Fork Trinity River TMDLs, which are outside of the area of analysis for the Proposed Action and alternatives, are expected to affect water quality in the Lower Klamath River. These TMDLs include a specific focus on sediment improvements. Further, the Scott River TMDL addresses sediment. General measures under the Trinity, South Fork Trinity, and Scott Rivers' TMDLs that can be associated with (primarily mineral) suspended sediment loads are described briefly in Section 3.2.2.4.

Full attainment of the measures in the Trinity River, South Fork Trinity River, and Scott River TMDLs would decrease (primarily mineral) suspended sediment loads in the sediment impaired reach of the Lower Klamath River from the Trinity River (RM 40) to the mouth (RM 0) and would, in the long term, be beneficial to water quality. Full attainment could require decades to achieve. These implementation measures would occur downstream from the Four Facilities and are not related to the KHP reservoirs under the No Action/No Project Alternative.

Anticipated climate change effects within the period of analysis (i.e., 50 years) include increased fine sediment delivery to streams due to more intense and frequent precipitation events and elevated stormwater runoff (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections). The anticipated increases would occur over a timescale of decades and may reduce improvements expected from successful implementation of the aforementioned TMDL implementation actions; however, the magnitude of the increased sediment delivery relative to the currently low levels of fine sediment production has not been assessed.

Existing interception and retention of mineral (inorganic) sediments by the dams is potentially beneficial. Continued impoundment of water in the reservoirs at the Four Facilities under the No *Action/No Project Alternative* would result in no change from existing conditions.

Continued impoundment of water at the Four Facilities could result in short-term and long-term seasonal (April through October) increases in algal-derived (organic) suspended material in the reservoirs in the Hydroelectric Reach and transport into the Klamath River downstream from Iron Gate Dam. Under existing conditions, concentrations of summer and fall (June–October) algal-derived (organic) suspended material in the Klamath immediately downstream from Iron Gate Dam tend to be less than 5–8 mg/L, reflecting the dams' capacity to intercept and retain suspended material.

Much of the algal-derived (organic) suspended material retained behind the Project dams is a result of in-reservoir algal production, as the majority of the algal material transported downstream from Upper Klamath Lake appears to be intercepted in the Keno Impoundment/Lake Ewauna (see Appendix C for more detail). However, some of the seasonal algal production that occurs in Copco 1 and Iron Gate Reservoirs is transported downstream to the Klamath River, as evidenced by chlorophyll-*a* patterns, and to a lesser degree TSS patterns, in the river from Iron Gate Dam to the Klamath Estuary (see Appendix C for more detail). While the transport occurs, TSS levels are still relatively low. This pattern would continue to occur under the No Action/No Project Alternative.

Full attainment of the measures in Oregon's Upper Klamath River and Lost River TMDLs would decrease algal blooms and decrease algal-derived suspended material in the KHP reservoirs due to decreased nutrient availability. Full attainment of the measures in California's Lower Lost River TMDLs and Klamath River TMDLs for organic enrichment/low dissolved oxygen, nutrients, and microcystin water quality impairments, would also decrease algal-derived suspended material KHP reservoirs and would, in the long term, be beneficial to water quality. It is anticipated that full attainment of the Oregon and California TMDLs would require decades to achieve.

Anticipated climate change effects within the period of analysis (i.e., 50 years) include increased fine sediment delivery to streams and earlier, longer, and more intense algal blooms (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections), which may increase levels of both mineral (inorganic) and algal-derived (organic) suspended material, the latter due to higher overall rates of photosynthesis during summer months. The anticipated increases in suspended sediments due to climate change would also occur over a timescale of decades and may offset improvements expected from successful TMDL implementation throughout the Lower Klamath Basin; however, the magnitude of the offset is unknown.

Existing transport of seasonally high algal-derived (organic) suspended material from the reservoirs to the Klamath River downstream from Iron Gate Dam is adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly improve conditions. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Nutrients

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could result in long-term interception and retention of TN and TP in the Hydroelectric Reach on an annual basis but release of TP and, to a lesser degree, TN from reservoir sediments on a seasonal basis. Under existing conditions, TN and TP decrease longitudinally through the Hydroelectric Reach on an annual basis due to dilution from the springs downstream from J.C. Boyle Dam and the settling of algal-derived (organic) material and associated nutrients in Copco 1 and Iron Gate reservoirs. On a seasonal basis, reservoir sediments can release bioavailable TP (as ortho-phosphorus), and to a lesser degree, bioavailable

TN (as ammonium), to the water column during periods of seasonal hypolimnetic anoxia (see Section 3.2.3.4). While much of the TP released from anoxic reservoir sediments appears to remain within the hypolimnion until the reservoirs begin to turn over in the fall, some release can occur during late summer and fall months when it could stimulate in-reservoir algal blooms. Nutrients infrequently meet narrative California North Coast Basin Plan water quality objective for biostimulatory substances (see Table 3.2-4) in the Hydroelectric Reach.

Under the No Action/No Project Alternative, the ongoing Williamson River Delta Project and Agency Lake and Barnes Ranches Project (see above water temperature and suspended sediment discussions) would provide long-term reductions in nutrients transported from the Agency Lake subbasin to Upper Klamath Lake. While short-term releases of nutrients are possible during the establishment of project equilibrium, at a programmatic level, these activities may decrease overall nutrient inputs to Upper Klamath Lake by inundating wetland (peat) soils and creating anaerobic conditions that support nutrient retention, particularly in the case of phosphorus (Snyder and Morace 1997). The effects would be mostly local, but may indirectly reduce nutrient concentrations in the Hydroelectric Reach by decreasing upstream nutrient concentrations in Upper Klamath Lake. These resource management actions are discussed again with respect to water quality effects under the KBRA (see Section 3.2.4.3.2, Full Facilities Removal of Four Dams - KBRA).

In Oregon, implementation of water quality improvement measures addressing nutrients in the Upper Klamath Lake Drainage TMDL and Water Quality Management Plan (WQMP) (ODEQ 2002) and the Upper Klamath River and Lost River Sub-basins TMDL and WQMP (see Section 3.2.2.4), include the following:

- Achievement of TMDL targets for TP loading as the primary method of improving dissolved oxygen (and pH) conditions in Upper Klamath and Agency lakes
- Reductions in phosphorus, nitrogen, and BOD loading from both point and nonpoint (e.g., agricultural returns) sources in the Upper Klamath River

In addition to the Oregon upstream improvements, California has promulgated load allocations for the Lower Lost River TMDLs for pH and nutrients and specific TMDL load allocations for TN and TP assigned to the KHP facilities for the Klamath River TMDLs. The California Klamath River TMDL also indicates that “alternative pollutant load reductions and/or management measures or offsets that achieve the in-reservoir targets” are possible (NCRWQCB 2010a).

The Oregon and California TMDLs in the Upper Klamath Basin are designed to meet water quality objectives; however, the timeframes for achieving nutrient allocations required under these TMDLs will depend on the measures taken to improve water quality conditions. Klamath TMDL model results for nutrient species (i.e., ortho-phosphorus, nitrate, and ammonium) are highly variable depending on location and season, likely due to rapid uptake and release of these chemical species during and following seasonal algal

blooms (see Section 3.2.3.1) and potentially due to peaking operations at the J.C. Boyle Powerhouse. Nonetheless, TMDL modeling results tend to suggest that concentrations under the No Action/No Project Alternative would be similar to modeled natural conditions in the Hydroelectric Reach in spring and summer assuming full attainment of the TMDLs. Full attainment could require decades to achieve and is highly dependent on reducing nutrient loads exiting Upper Klamath Lake and the agricultural return flows (including the Klamath Straits Drain) along the Keno Reach.

In summary, despite beneficial annual decreases in TP and TN through the Hydroelectric Reach, on a seasonal basis, internal release of TP, and to a lesser degree TN, from anoxic reservoir sediments during the summer and late fall may contribute to large blooms of toxigenic algae in the reservoirs.

Existing interception and retention of nutrients in the reservoirs on an annual basis is beneficial, but the release (export) of nutrients (particularly TP) from reservoir sediments on a seasonal basis is adverse for the Hydroelectric Reach. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease nutrients. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could result in long-term interception and retention of TP and TN in the KHP reservoirs on an annual basis and release (export) of TP to the Klamath River downstream from Iron Gate Dam on a seasonal basis. On an annual basis, nutrients in the Klamath River downstream from Iron Gate Dam currently tend to be lower than those in upstream reaches, due to dilution from the natural springs downstream from J.C. Boyle Dam and settling of particulate matter and associated nutrients in Copco 1 and Iron Gate Reservoirs (see Section 3.2.3.4). Further decreases in nutrient levels occur with distance downstream from Iron Gate Dam due to a combination of tributary dilution and in-river nutrient removal processes (see Section 3.2.3.4). Although interception and retention of nutrients in Copco 1 and Iron Gate Reservoirs on an annual basis may be beneficial to the Klamath River downstream from Iron Gate Dam, under existing conditions TP and TN concentrations from the dam to the Klamath Estuary during late summer/early fall do not meet the narrative California Basin Plan water quality objective for biostimulatory substances due to the promotion of algal growth at levels that cause nuisance effects or adversely affect beneficial uses (see Table 3.2-4), nor do they meet the Hoopa Valley Tribe numeric criteria for TP (0.035 mg/L) and TN (0.2 mg/L) (see Table 3.2-6). In late-summer and fall (i.e., August-November), TP concentrations can increase downstream from the KHP reservoirs due to release of TP (as ortho-phosphorus) which is formed during periods of seasonal hypolimnetic anoxia in Copco 1 and Iron Gate Reservoirs. This seasonal release during late summer and fall periods may stimulate periphyton growth in the Klamath River downstream from Iron Gate Dam (see Appendix C, Sections C.3.1.4 and C.3.2.1). This pattern would continue under the No Action/No Project Alternative.

In the Lower Klamath Basin, the California Klamath TMDLs include a specific focus on nutrient (TN and TP) improvements through specific load allocations assigned to the KHP facilities in California – Copco and Iron Gate reservoirs (see Section 3.2.2.4). Although specific nutrient allocations are only assigned to the KHP, the California Klamath TMDLs were developed based on compliance with water quality objectives at the Oregon-California State line, meaning that successful implementation of water quality improvement measures under the Oregon TMDLs will improve nutrients in the Lower Klamath Basin as well. General measures under the California Klamath River TMDLs that are associated with nutrients include the following:

- Developing a conditional waiver by 2012 to control discharges from agricultural activities (e.g., grazing, irrigated agriculture)
- Prohibiting the unauthorized discharge of waste that is in violation of water quality standards

Full attainment of the measures in the Oregon and California TMDLs would result in waters meeting water quality standards; however, the timeframes for achieving nutrient allocations required under these TMDLs will depend on the measures taken to improve water quality conditions. Modeling conducted for development of the California Klamath River TMDLs indicates that under the No Action/No Project Alternative (similar to the T4BSRN scenario) TN and TP in the Klamath River downstream from Iron Gate Dam would meet or be lower than modeled natural conditions due to the trapping efficiency of sediment- and algal-associated nutrients behind the dams. Nutrient levels would also meet Hoopa Valley Tribe criteria for TP (0.035 mg/L) and TN (0.2 mg/L) (NCRWQCB 2010a). Given full attainment of the measures in the Oregon and California TMDLs, actual TN concentrations under the No Action/No Project Alternative and natural conditions might be slightly lower than the model predicted concentrations, because denitrification is not included as a possible nitrogen removal term in the riverine segments of the Klamath TMDL model (Tetra Tech 2009). In contrast, dissolved nutrient species (i.e., ortho-phosphorus, nitrate, ammonium) concentrations are variable depending on location and season, with particularly high daily variation during summer months, but Klamath TMDL model results tend to suggest that concentrations under the No Action/No Project Alternative would be somewhat higher than modeled natural conditions in the Lower Klamath Basin. Use of adaptive management will be employed to refine efforts toward achieving water quality standards and TMDL targets. It is anticipated that full attainment of the TMDLs would require decades to achieve.

Existing interception and retention of nutrients in the reservoirs on an annual basis is beneficial, but the release (export) of nutrients (particularly TP) on a seasonal basis is adverse for the Klamath River downstream from Iron Gate Dam. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease nutrients. Continued impoundment of water in the reservoirs at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Dissolved Oxygen

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could result in long-term seasonal and daily variability in dissolved oxygen concentrations in the Hydroelectric Reach, such that levels do not meet ODEQ and California North Coast Basin Plan water quality objectives and adversely affect beneficial uses. Under existing conditions, dissolved oxygen concentrations in summer and fall are substantially below (i.e., do not meet) water quality objectives and infrequently support designated beneficial uses in Oregon for cool water aquatic life and redband or Lahonton cutthroat trout; see Table 3.2-3), and in California for COLD, WARM, and SPWN beneficial uses (see Table 3.2-4). Dissolved oxygen levels are particularly low during the summer in the reach from Link River Dam to upstream of J.C. Boyle Reservoir (including Keno Impoundment/Lake Ewauna), with typical levels ranging from <1 mg/L to 5 mg/L. The primary cause of low summertime dissolved oxygen in the Keno Impoundment/Lake Ewauna is settling and decomposition of algae exported from Upper Klamath Lake (see Section 3.2.3.5), in combination with warm water temperatures that support lower dissolved oxygen concentrations than cold water, including when saturated. Organic matter and nutrient inputs from the Lost River Basin via Klamath Straits Drain and the Lost River Diversion Channel also contribute to low dissolved oxygen levels in this reach (see Appendix C, Section C.4.1.3 for additional detail). In the Hydroelectric Reach, the seasonal variability in dissolved oxygen concentrations in J.C. Boyle Reservoir can be highly influenced by the high oxygen demand of water flowing downstream from the upstream Keno Impoundment/Lake Ewauna. Dissolved oxygen in hypolimnetic waters of Copco 1 and Iron Gate reservoirs reach minimum values near 0 mg/L during the summer (see Section 3.2.3.5).

Under the No Action/No Project Alternative, the ongoing Williamson River Delta Project and Agency Lake and Barnes Ranches Project may contribute to long-term improvements in seasonally low dissolved oxygen in Upper Klamath Lake. These resource management actions may decrease overall suspended sediment and nutrient inputs to Upper Klamath Lake and downstream reaches. These resource management actions are discussed again with respect to water quality effects under the KBRA (see Section 3.2.4.3.2.11).

In Oregon, implementation of TMDL water quality improvement measures focus on dissolved oxygen through reductions in water temperature and nutrient concentrations. The Upper Klamath Lake Drainage TMDL (see Section 3.2.2.4) include the following recommended measures for working toward achievement of TMDL targets for TP loading as the primary method of improving dissolved oxygen (and pH) conditions in Upper Klamath River along with Upper Klamath Lake and Agency lakes:

- Implementation of BMPs for improving dissolved oxygen in the Sprague River
- Reductions in phosphorus, nitrogen, and BOD loading from both point and nonpoint sources in the Upper Klamath River

Additionally, the Upper Klamath River and Lost River Sub-basins TMDLs require dissolved oxygen augmentation to J.C. Boyle Reservoir and several impoundments on the Lost River (the latter is not included in the area of analysis). The Lower Lost River pH and nutrient TMDLs were designed to ensure that California's numeric dissolved oxygen water quality standard would be attained. In California, one of the three TMDL load allocations assigned to the KHP is to create sufficient dissolved oxygen in Copco 1 and Iron Gate Reservoirs through a compliance lens, such that water temperature and dissolved oxygen conditions would be suitable for cold water fish during the critical summer period (see Section 3.2.2.4).

Full attainment of the measures in the Oregon and California TMDLs would result in waters meeting water quality standards; however, the timeframes for achieving dissolved oxygen (DO) allocations required under these TMDLs will depend on the measures taken to improve water quality conditions, especially reductions in nutrients. Based on Oregon numeric water quality standards, dissolved oxygen levels in the Upper Klamath Basin would need to meet natural conditions or attain 5.5 mg/L (year-round minimum for warm water aquatic life), 6.5 mg/L (year-round minimum for cool water aquatic life), 8.0 mg/L (year-round minimum for coldwater aquatic life), or 11.0 mg/L (January 1–April 15 minimum for spawning) (see Table 3.2-3). As with water temperature, the narrative Oregon standard stipulates that the natural conditions criterion supersedes the numeric criterion and is the standard for that water body (see Table 3.2-3). For California, dissolved oxygen would need to achieve 90 percent saturation based on natural receiving water temperatures during October–March and 85 percent saturation during April–September (see Table 3.2-4). The Klamath TMDL model (see Appendix D) indicates that under the No Action/No Project Alternative with full attainment of the TMDLs (similar to the T4BSRN scenario) dissolved oxygen in the riverine portions of the reach from Link River Dam to the Oregon-California State line would meet Oregon's 6.5 mg/L numeric objective for supporting the cool water aquatic life beneficial use. Dissolved oxygen predicted levels would be similar to the modeled natural conditions baseline (TMDL T1BSR scenario) (NCRWQCB 2010a).

Klamath TMDL model results for riverine conditions at the Oregon-California State line indicate a similar pattern, whereby predicted dissolved oxygen concentrations meet the 6.5 mg/L objective year round and achieve the modeled natural conditions baseline during the warm summer and fall months (Figure 3.2-17). Under full TMDL compliant conditions, the California 85 percent saturation objective (based on natural receiving water temperatures) is met at State line under the No Action/No Project Alternative (Figure 3.2-17). Thus, full attainment of the Oregon and California TMDLs would eventually be beneficial for dissolved oxygen in the Hydroelectric Reach. Full attainment could require decades to achieve and is highly dependent on improvements in dissolved oxygen, nutrients, and organic matter export from Upper Klamath Lake and the upstream reach from Link River Dam to J.C. Boyle Dam (particularly Keno Impoundment/Lake Ewauna).

Climate change is expected to cause a small decrease in dissolved oxygen due to general increases in water temperature in the Klamath Basin on the order of 2–3 °C (3.6–5.4 °F)

over the period of analysis (i.e., 50 years) (Bartholow 2005; see also the subsection, Upper Klamath Basin, in Section 3.2.4.3.1). This would decrease the 100 percent saturation level for dissolved oxygen by an estimated 0.3–0.4 mg/L, using general assumptions for water temperature (20–24 °C [68–75.2 °F]), salinity (0 ppt) and elevation (1,433 m [4,700 ft]), where the elevation of Upper Klamath Lake is used as a simplifying assumption for the calculation. Climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Upper Klamath Basin. Alternately, increased levels of algal growth and photosynthesis anticipated under climate change (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections) may increase daytime dissolved oxygen concentrations during summer months, along with the severity of bloom crashes and their negative effect on dissolved oxygen.. The magnitude of these changes is unknown.

Existing seasonal dissolved oxygen levels in the Hydroelectric Reach are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly increase dissolved oxygen. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could result in the continued release of seasonally low dissolved oxygen concentrations from Iron Gate Reservoir into the Klamath River, such that levels immediately downstream from the dam do not meet California North Coast Basin Plan water quality objectives and adversely affect beneficial uses. Under existing conditions, dissolved oxygen in the Klamath River exhibits seasonal low levels immediately downstream from Iron Gate Reservoir with frequent violations of the California water quality objective (expressed as percent saturation, see Table 3.2-5) during late summer/early fall (July–September) (see Section 3.2.3.5). Dissolved oxygen levels generally recover with distance downstream, but they still exhibit occasional minimum values below objectives during late summer/early fall downstream from the confluence with the Trinity River (RM 40). The Hoopa Valley Tribe (8 mg/L) water quality objective for dissolved oxygen, which applies at ≈RM 45–46, is also infrequently met during late summer/early fall months (see Section 3.2.3.5). Thus, dissolved oxygen conditions currently do not fully support designated beneficial uses COLD and WARM beneficial uses (see Table 3.2-4) in the Klamath River downstream from Iron Gate Dam.

Under the No Action/No Project Alternative, IM 3, Iron Gate Turbine Venting, as part of ongoing KHSA IM studies (see also Section 3.2.4.1), may be used to augment dissolved oxygen in the river downstream from the dam prior to 2020. Pilot study results from 2008 indicated that dissolved oxygen levels immediately downstream from Iron Gate Dam can be increased through the mechanical introduction of oxygen as water passes through the turbines (i.e., turbine venting). PacifiCorp reported an increase of approximately 0.5 to 2 mg/L dissolved oxygen (approximately 7 to 20 percent saturation) observed across separate tests in August and October 2008 (Carlson and Foster 2008,

PacifiCorp 2008). However, during the October 2008 test, when the upstream reservoirs were de-stratifying and dissolved oxygen concentrations in the river immediately downstream from Iron Gate Powerhouse were decreasing to levels of approximately 6.5 mg/L, turbine venting only increased concentrations at this location by approximately 0.5 mg/L and 7 percent saturation (Carlson and Foster 2008). As part of their review of PacifiCorp's requested "Authorization for Incidental Take and Implementation of KHP Interim Operations Habitat Conservation Plan for Coho Salmon", USEPA indicated that the 2008 study did not demonstrate the efficacy of the proposed turbine venting to significantly improve dissolved oxygen downstream from Iron Gate Dam (USEPA 2011). Further testing conducted in 2010 indicated that turbine venting in combination with a forced air blower was the most effective of three methods tested (i.e., turbine venting, blower, turbine venting plus blower), resulting in an initial increase in dissolved oxygen percent saturation from approximately 50 percent to just over 70 percent immediately downstream from the Iron Gate Powerhouse (PacifiCorp 2011). Throughout the 6-mile test reach downstream from the powerhouse, dissolved oxygen concentrations continued to increase for all tested methods, as well as for ambient (i.e., no treatment) conditions, due to river re-aeration. For the turbine venting plus blower treatment, dissolved oxygen concentrations achieved the reach-specific Basin Plan water quality objective of 90 percent saturation (i.e., October 1 through March 31 from Stateline to Scott River) at the end of the 6-mile test reach. Ambient conditions (i.e., no treatment) achieved approximately 88 percent saturation at the end of the 6-mile reach (PacifiCorp 2011). Although turbine venting treatments considerably improved dissolved oxygen concentrations in the 6-mile test reach, particularly in the first 1 to 3 miles downstream from the dam, the full compliance point in the river with turbine venting did not shift considerably further upstream as compared with that of ambient conditions (i.e., no treatment). Thus, although there have been improvements from the initial tests, turbine venting efforts have not yet been demonstrated to be a viable long-term solution for dissolved oxygen impairment from the reservoirs

In the Lower Klamath Basin, the California Klamath River TMDLs include a specific focus on dissolved oxygen improvements. Full attainment of water quality improvement measures under the Oregon TMDLs would improve dissolved oxygen in the California portions of the Klamath River as well, particularly since California Klamath River TMDLs were developed based on compliance with water quality objectives at the Oregon-California State line. Specific dissolved oxygen allocations are assigned to the KHP and TN, TP, and CBOD allocations are assigned to the mainstem river and tributaries to support improvement toward dissolved oxygen targets (i.e., water quality objectives for dissolved oxygen). Specific monthly dissolved oxygen numeric targets are also assigned to the Copco and Iron Gate tailraces, based on percent saturation (see Section 3.2.2.4). General measures under the California Klamath River TMDLs associated with dissolved oxygen in the Klamath River include the following:

- A conditional waiver (developed by 2012) for discharges from agricultural activities (e.g., grazing, irrigated agriculture)

- Prohibiting the unauthorized discharge of waste that is in violation of water quality standards

The Shasta River TMDLs also address dissolved oxygen. Dissolved oxygen improvements in the Shasta River would be expected to improve concentrations in the Klamath River mainstem at or downstream from the confluence with the Shasta River (RM 176.7). Multiple water quality improvement measures in the Shasta River TMDL focus on dissolved oxygen (see Section 3.2.2.4).

Full attainment of the measures in the Oregon and California TMDLs would result in waters meeting water quality standards; however, the timeframes for achieving dissolved oxygen allocations and targets required under these TMDLs will depend on the measures taken to improve water quality conditions, especially reductions in nutrients in upstream reaches. The Oregon and California with-dam TMDL scenario (T4BSRN - see Appendix D) was run in order to quantify the impacts of the dams on water quality and to determine appropriate allocations and targets. The Klamath with-dam TMDL modeling scenario indicates that, with full compliance of the TMDLs, under the No Action/No Project Alternative (similar to the TMDL T4BSRN scenario), dissolved oxygen concentrations immediately downstream from Iron Gate Dam, without additional mitigation, would not meet the North Coast Basin Plan water quality objective of 85 percent saturation (see Tables 3.2-4 and 3.2-5) during August–September, and the 90 percent saturation objective would not be met from October–November (Figure 3.2-18). Further downstream, near the confluence with the Shasta River, dissolved oxygen concentrations under the No Action/No Project Alternative would not meet the 90 percent saturation objective from October–November (Figure 3.2-19). In the Klamath River at Seiad Valley, concentrations would be mostly in compliance with the exception of modeled values in November that are just above the 90 percent saturation objective (Figure 3.2-20). The inability to achieve the water quality objectives under TMDL compliance conditions immediately downstream from Iron Gate Dam is due to the release of low dissolved oxygen water from the hypolimnion of the reservoir. This result indicates that while full attainment of the California Klamath TMDLs would result in dramatic improvements in dissolved oxygen both upstream and downstream from Iron Gate Dam, release of low dissolved oxygen water from the hypolimnion (i.e., the bottom layer within stratified reservoir) inhibits compliance immediately downstream from Iron Gate Dam with the dams in place. The TMDL does include dissolved oxygen targets for the Iron Gate Dam tailrace that meet water quality objectives. It is possible that there are management practices that PacifiCorp could use to meet the TMDL dissolved oxygen targets. However, these practices have not been demonstrated to date and the NCRWQCB could not make presumptions regarding what these practices might be. Therefore, these enhancements were not included in the with-dams TMDL modeling scenario. The TMDL Action Plan includes a requirement for PacifiCorp to submit a proposed Implementation Plan that incorporates timelines and contingencies pursuant to the KHSA. PacifiCorp may propose the use of off-site pollutant reduction measures (i.e., offsets or “trades”) to meet the allocations and targets in the context of the Interim Measures 10 and 11 of the KHSA (NCRWQCB 2010a).

By the Salmon River (RM 66.0) confluence, with full attainment of TMDL allocations, predicted dissolved oxygen concentrations would remain at or above the 85 percent saturation objective (as well as the 90 percent saturation objective, where applicable), meeting the North Coast Region Basin Plan requirements. Predicted dissolved oxygen would infrequently meet the Hoopa Valley Tribe numeric dissolved oxygen objective of 8 mg/L (see Table 3.2-6), which applies at ≈RM 45–46, because warm water temperatures during July–October would decrease the saturation level of oxygen in the water column to less than 8 mg/L (see Figure 3.2-20 and 3.2-21). However, Hoopa Valley Tribe has a natural conditions clause requiring dissolved oxygen to achieve 90% saturation if numeric values are not met; predicted dissolved oxygen concentrations would meet this natural condition clause. The Hoopa Valley Tribe's Water Quality Control Plan (HVTEPA 2008) has been approved by USEPA; however, this natural conditions clause has not yet been approved (as of July 2012). USEPA requires that a method be developed for determining that the dissolved oxygen objectives are not achievable due to natural conditions and presented for approval. Throughout the Lower Klamath River, daily fluctuations in dissolved oxygen during July–October would occur due to colonization of periphyton mats in the river and the associated photosynthesis.

As described for the Upper Klamath Basin, climate change would decrease the 100 percent saturation level for dissolved oxygen in the lower basin by increasing water temperatures. In the lower basin, this would result in an estimated 0.3–0.5 mg/L decrease in dissolved oxygen, using general assumptions for water temperature (20–24°C [68-75.2ºF]), salinity (0 ppt) and elevation at sea level as a simplifying assumption for the calculation. The small anticipated decreases in dissolved oxygen due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Lower Klamath Basin. As with the Upper Basin, increased levels of algal growth and photosynthesis anticipated under climate change (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections) may increase daytime dissolved oxygen concentrations during summer months but could increase the severity of subsequent bloom crashes and their negative effect on dissolved oxygen. The magnitude of these changes is unknown.

Existing seasonal dissolved oxygen levels immediately downstream from Iron Gate Dam are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly increase dissolved oxygen, although seasonal concentrations from Iron Gate Dam to the Shasta River would remain adverse. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

pH

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could result in long-term seasonal and daily variability in pH in the Hydroelectric Reach. Under existing

conditions, pH values in the Hydroelectric Reach range from just above neutral to greater than 9, with large (0.5–1.5 pH units) daily fluctuations occurring in reservoir surface waters during periods of intense algal blooms (see Section 3.2.6). During these periods, pH levels infrequently meet applicable ODEQ and California North Coast Basin Plan water quality objectives (see Table 3.2-3 and Table 3.2-4), and adversely affect beneficial uses.

Several ongoing resource management actions represent reasonably foreseeable actions within the period of analysis that may affect pH. Although initially resulting in increased nutrient release, the ongoing Williamson River Delta Project and Wood River Wetland Restoration are expected to eventually reduce nutrient inputs to Upper Klamath Lake which may decrease algal bloom populations and rates of photosynthesis, and correspondingly decreasing observed pH maximums in the lake and its tributaries. Additional resource management actions such as floodplain rehabilitation, riparian vegetation planting, and purchase of conservation easements/land, and which could affect nutrients, are currently ongoing in the Upper Klamath Basin (see Section 2.3.1) and are expected to continue to improve long-term pH in the Upper Klamath Lake. This may indirectly decrease pH maximums in the Hydroelectric Reach. These resource management actions are discussed again with respect to water quality effects under the KBRA (see Section 3.2.4.3, Full Facilities Removal of Four Dams - KBRA).

In Oregon, implementation of TMDL measures focused on pH in the Upper Klamath Lake Drainage TMDL and WQMP and those in the draft Upper Klamath River and Lost River Sub-basins TMDL and WQMP (see Section 3.2.2.4) include decreased loading of total phosphorous as the primary method for decreasing pH in Upper Klamath and Agency lakes and in the Sprague River. While the California Klamath River TMDLs do not include specific allocations or targets for pH, load allocations and targets for TN and TP, which include pH under the allocations for nutrients as biostimulatory substances (NCRWQCB, 2010a), are assigned to the KHP and are designed to limit algal photosynthesis. This will decrease maximum pH levels and daily variability in the Hydroelectric Reach. The California Lower Lost River TMDLs also include pH allocations.

The Oregon and California TMDLs in the Upper Klamath Basin are designed to achieve water quality objectives; however, the timeframes for achieving pH objectives will depend on the measures taken to improve water quality conditions, especially reductions in nutrients. To consistently support beneficial uses, pH cannot be below 6.5 units or above 9.0 units in Oregon (see Table 3.2-3) and cannot be depressed below 7.0 units nor raised above 8.5 units in California upstream or downstream from Iron Gate Dam (see Table 3.2-4). The pH in the reach from Link River Dam to just upstream of J.C. Boyle Reservoir, and to the Oregon-California State line in the Hydroelectric Reach, would meet water quality objectives for Oregon. Similarly, in California from the State line to Iron Gate Dam, pH is expected to trend toward achievement of water quality objectives given full attainment of the TMDLs within the period of analysis (NCRWQCB 2010a). Full attainment could require decades to achieve.

Anticipated climate change effects on pH include earlier, longer, and more intense algal blooms (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections), which may increase pH maximums due to higher overall rates of photosynthesis during summer months. The anticipated increases in pH due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Upper Klamath Basin; however, the magnitude of the opposition is unknown.

Existing seasonal fluctuations in pH occurring during periods of intense algal blooms in the Hydroelectric Reach are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly improve pH. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could result in long-term seasonal and daily variability in pH in the Klamath River downstream from Iron Gate Dam. Under existing conditions, pH during late-summer and early-fall months (August–September) in the Klamath River downstream from Iron Gate Dam ranges from just above neutral to greater than 9, with large (0.5–1.5 pH units) daily fluctuations occurring in the river during periods of high photosynthesis (see Section 3.2.3.6). In California, to consistently support beneficial uses in the Klamath, pH cannot be depressed below 7.0 units nor raised above 8.5 units (see Table 3.2-4).

While the California Klamath River TMDLs do not include specific allocations or targets for pH, load allocations and targets for TN and TP, which include pH under the allocations for nutrients as biostimulatory substances (NCRWQCB, 2010a), are assigned to the KHP and are designed to limit algal photosynthesis, which will decrease maximum pH levels and daily variability in the Klamath River downstream from Iron Gate Dam.

The timeframes for achieving pH objectives will depend on the measures taken to improve water quality conditions, especially reductions in nutrients. The Klamath TMDL model (see Appendix D) indicates that under the No Action/No Project Alternative (similar to TMDL T4BSRN scenario) pH in the reach from Seiad Valley (RM 129.4) to downstream from the mainstem confluence with Indian Creek (RM 108) would meet water quality objectives. While model results indicate that daily maximum values in some stretches of the Klamath River downstream from Iron Gate Dam may not meet the Basin Plan water quality objective of 8.5 pH units (see Table 3.2-4), within the resolution of the Klamath TMDL model these potentially occasional exceedances of the pH objective would not be expected to substantially adversely affect beneficial uses. The Hoopa Valley Tribe water quality objective for pH (7.0–8.5) (see Table 3.2-6) is met at the location that it is applicable (≈RM 45–6) (NCRWQCB 2010a). Therefore, pH under the No Action/No Project Alternative would meet pH water quality objectives for

California within the period of analysis due to full attainment of the California TMDLs (NCRWQCB 2010a). It is anticipated that full attainment of the TMDLs would require decades to achieve.

Anticipated climate change effects on pH include earlier, longer, and more intense algal blooms (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections), which may increase pH maximums due to higher overall rates of photosynthesis during summer months. The anticipated increases in pH due to climate change would also occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Lower Klamath Basin; however, the magnitude of the opposition is unknown.

Existing seasonal fluctuations in pH downstream from Iron Gate Dam, which occur during periods of intense algal blooms in the upstream reservoirs, are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly improve pH. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Chlorophyll-a and Algal Toxins

Upper Klamath Basin

Continued impoundment of water at the Four Facilities could support long-term growth conditions for toxin-producing nuisance algal species such as M. aeruginosa, resulting in high seasonal concentrations of chlorophyll-a and algal toxins in the Hydroelectric Reach. Under existing conditions, chlorophyll-*a* samples during summer and fall in Upper Klamath Lake and the two largest reservoirs at the Four Facilities (Copco 1 and Iron Gate Reservoirs) exhibit annual mean values >10 µg/L (measured May through October) with the highest values (> 100 mg/L) occurring in surface waters during late summer periods of intense algal blooms (see Section 3.2.3.7). High (>8 µg/L) seasonal levels of algal toxins (microcystin) are linked to intense blue-green algae blooms and exceed applicable ODEQ water quality objectives for toxic substances (see Table 3.2-3) and the North Coast Basin Plan water quality objectives for toxicity (see Table 3.2-4). This adversely affects beneficial uses, particularly the human health water contact recreational use (REC-1) and the cultural use (CUL).

As with other water quality parameters analyzed in this EIS/EIR (i.e., water temperature, sediment, nutrients, dissolved oxygen, pH), several ongoing resource management actions represent reasonably foreseeable actions within the period of analysis that may affect algal toxins and chlorophyll-*a* concentrations in the Upper Klamath Basin. The ongoing Williamson River Delta Project and Wood River Wetland Restoration are intended to eventually reduce nutrient inputs to Upper Klamath Lake, which may help decrease the incidence of toxic cyanobacterial algal blooms and high chlorophyll-*a* levels and algal toxins in Upper Klamath Lake and reduce those transported downstream to the Hydroelectric Reach. Additional resource management actions such as floodplain rehabilitation, riparian vegetation planting, and purchase of conservation easements/land, and which could affect nutrients, are ongoing in the Upper Klamath Basin (see

Section 2.3.1) and are expected to continue to decrease long-term levels of algal toxins and chlorophyll-*a* in Upper Klamath Lake. This may slightly decrease concentrations in the Hydroelectric Reach. These resource management actions are discussed again with respect to water quality effects under the KBRA (see Section 3.2.4.3, Full Facilities Removal of Four Dams - KBRA).

In Oregon, implementation of measures related to chlorophyll-*a* and algal toxins in the Upper Klamath Lake Drainage TMDL and WQMP and those in the Upper Klamath River and Lost River Sub-basins TMDL and WQMP (see Section 3.2.2.4) include decreased loading of TP as the primary method for decreasing the magnitude of algal productivity (blooms) affecting the high rates of photosynthesis and the related water quality problems (e.g., pH, dissolved oxygen) in the Sprague River, Upper Klamath and Agency lakes, and the Keno Reach. Decreases in upstream algal blooms would result in corresponding decreases in chlorophyll-*a* concentrations and, for toxin-producing algal species, levels of microcystin in the Hydroelectric Reach.

Additionally, the Oregon and California TMDLs include specific load allocations for TN and TP upstream of the Klamath Hydropower Facilities (see Section 3.2.2.4), which are intended to eventually limit the extensive algal blooms in Copco 1 and Iron Gate Reservoirs and thus decrease chlorophyll-*a* and algal toxin levels toward the TMDL targets of 10 µg/L chlorophyll-*a* (growing season average), *M. aeruginosa* cell density ≤20,000 cells/L, and microcystin toxin <4 µg/L (see Table 3.2-10). Full attainment of the measures in the Oregon and California TMDLs would result in waters meeting water quality standards; however, the timeframes for achieving water quality objectives with respect to algal toxins and chlorophyll-*a* will depend on the measures taken to improve water quality conditions. This would require decades to achieve and it is highly dependent on nutrient improvements in Upper Klamath Lake, Link River, and the Keno Impoundment/Lake Ewauna.

Anticipated climate change effects include earlier, longer, and more intense algal blooms (Barr et al. 2010) (see Section 3.10.3.1, Existing Conditions – Climate Change Projections), which may increase algal toxin and chlorophyll-*a* concentrations due to higher overall rates of photosynthesis and algal primary production during summer months. The anticipated effects of climate change would also occur over a timescale of decades and may slightly offset improvements expected from successful TMDL implementation throughout the Upper Klamath Basin.

Existing seasonal blooms of toxin-producing nuisance algal species and corresponding levels of chlorophyll-*a* and algal toxins in the Hydroelectric Reach are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease chlorophyll-*a* and algal toxins. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

Continued impoundment of water at the Four Facilities could support long-term growth conditions for toxin-producing nuisance algal species such as M. aeruginosa, resulting in high seasonal concentrations of chlorophyll-a and algal toxins (i.e., microcystin) transported into the Lower Klamath River and likely the Klamath Estuary and the marine nearshore environment. Under existing conditions, chlorophyll-*a* concentrations during summer through fall in the Klamath River downstream from Iron Gate Dam can be greater than those in the river directly upstream of Copco 1 Reservoir due to in-reservoir algal blooms that are transported into the lower river (see Appendix C, Section C.4.1.4 and Figure C-28). These algal blooms can be toxic and can exceed numeric thresholds for microcystin (i.e., SWRCB/OEHHA Public Health Threshold of 8 µg/L, WHO guidelines of 4 ug/L) posing a human health risk and substantially adversely affecting recreational beneficial uses, particularly water contact (REC-1) and CUL uses. The CUL beneficial use is applicable in the Klamath River from State line to the Klamath River Estuary (see Table 3.2-2). Known or perceived risks of exposure to degraded water quality conditions due to algal toxins during ceremonial bathing and traditional cultural activities have resulted in impairment of this beneficial use (see also Section 3.12.3). Additionally, Hoopa Valley Tribe water quality objectives for toxigenic cyanobacteria species and cyanobacterial scums are not consistently met during summer months (see Section 3.2.3.7 and Appendix C for more detail). Microcystin can also bioaccumulate in aquatic biota in the Lower Klamath River, including filter feeders and fish. A discussion of algal toxins as related to fish health is presented in Section 3.3.3.2, Physical Habitat Descriptions - Water Quality - Algal Toxins.

Existing information indicates that instances of elevated levels of *M. aeruginosa* and microcystin toxin in the Klamath Estuary correspond with elevated levels measured at upstream locations in the Lower Klamath River (see also Section 3.4.3.6). Continued occurrence of *M. aeruginosa* and microcystin toxin in the Lower Klamath River under the No Action/No Project Alternative would also likely result in the continued occurrence of this toxic blue-green algae and the associated toxin in the Klamath Estuary. Lastly, there is emerging evidence that cyanotoxins flushing from coastal rivers into Monterey Bay, California were responsible for numerous sea otter deaths in 2007 (Miller et al. 2010). While it is not known if conditions in Monterey Bay are similar to those in the Klamath River marine nearshore environment, there may be potential for microcystin to adversely impact marine organisms under the No Action/No Project Alternative.

Additionally, the Oregon and California TMDLs include specific load allocations for TN and TP upstream of the Klamath Hydropower Facilities (see Section 3.2.2.4), which are intended to eventually limit the extensive algal blooms in Copco 1 and Iron Gate Reservoirs and thus decrease chlorophyll-*a* and algal toxin levels toward the TMDL targets of 10 µg/L chlorophyll-*a* (growing season average), *M. aeruginosa* cell density 20,000 cells/L, and microcystin toxin <4 µg/L (see Table 3.2-10). This would subsequently decrease levels of chlorophyll-*a* and algal toxins transported into the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. This would require decades to achieve and it is highly dependent on upstream nutrient improvements.

As with the Upper Klamath Basin, anticipated effects of climate change on chlorophyll-*a* and algal toxins would occur over a timescale of decades and would act in opposition to improvements expected from successful TMDL implementation throughout the Lower Klamath Basin; however, the magnitude of the opposition is unknown.

Existing transport of seasonal blooms of toxin-producing nuisance algal species, chlorophyll-*a,* and algal toxins into the Lower Klamath River and likely the Klamath Estuary are adverse. Transport to the marine nearshore environment is potentially adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease chlorophyll-*a* and algal toxins. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Inorganic and Organic Contaminants

Upper Klamath Basin

Freshwater Aquatic Life Toxicity and/or Bioaccumulation

Effects of the No Action/No Project Alternative on potential inorganic and organic contaminants in Upper Klamath Lake and its major tributaries cannot be assessed directly due to a lack of information for these parameters (see Section 3.2.3.8, Upper Klamath Lake – Inorganic and Organic Contaminants). However, under the No Action/No Project Alternative, ongoing resource management actions (i.e., Williamson River Delta Project, Agency Lake and Barnes Ranches Project) may reduce transport of inorganic and organic contaminants into Upper Klamath Lake and downstream reaches. While Oregon and California TMDLs do not address inorganic and organic contaminants, under the No Action/No Project Alternative TMDL implementation may indirectly limit transport of inorganic and organic contaminants through mechanisms expected to reduce suspended sediments and nutrients.

Low levels of organic and inorganic contaminants have been identified in the sediment deposits trapped behind the dams in the Hydroelectric Reach (see Section 3.2.3.8). Benthic uptake and subsequent transfer through the food web is one potential pathway of contaminant exposure for aquatic organisms in the Hydroelectric Reach; exposure to water column contaminants is also a possible pathway. Sediment contaminants influenced by pH or dissolved oxygen, such as methylmercury, may flux into the water column via the low redox conditions supported by reservoir stratification and seasonal anoxia. Human exposure to methylmercury, inorganic contaminants (e.g., arsenic), and organic contaminants (e.g., pesticides, PCBs, PAHs) associated with reservoir sediments may occur through consumption of contaminated reservoir fish or shellfish. Potential effects of the No Action/No Project Alternative are further discussed below using available water column, sediment, and aquatic biota contaminant data.

Continued impoundment of water at the Four Facilities and associated interception and retention of sediments behind the dams could result in long-term low-level exposure to inorganic and organic contaminants for freshwater aquatic species in the Hydroelectric Reach.

Water Column Contaminants Water quality data collected during in Copco 1 and Iron Gate reservoirs during 2001–2005 under the SWAMP indicate that concentrations of numerous inorganic compounds (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver, and zinc) and organic compounds (i.e., pesticides, PCBs, phenols) were in compliance with water quality objectives (NCRWQCB 2008; see Section 3.2.3.1 and Appendix C, Section C.7.1.1 for more detail).

Sediment Contaminants Two studies provide data for the evaluation of sediment toxicity and bioaccumulation potential under the No Action/No Project Alternative:

- Sediment chemistry data collected during 2004–2005 from 26 cores in J.C. Boyle, Copco 1, and Iron Gate Reservoirs (Shannon & Wilson, Inc. 2006). The 2004–2005 sediment chemistry data indicate generally low levels of metals, pesticides, chlorinated acid herbicides, PCBs, VOCs, SVOCs, cyanide, and dioxins (Shannon & Wilson, Inc. 2006; see Section 3.2.3.1).
- Sediment chemistry and toxicity data collected during 2009-2010 as part of the Secretarial Determination process, including samples from J.C. Boyle, Copco 1, and Iron Gate Reservoirs, and the Klamath Estuary (Department of the Interior 2010a and "Exposure Pathway 1" in CDM [2011]). Based on comparison to appropriate freshwater sediment screening levels (see Section 3.2.3.8 and Appendix C for more detail), a limited number of COPCs were detected in reservoir sediment samples (i.e., nickel, iron, dieldrin, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, 2,3,4,7,8-PECDF, and 2,3,7,8-TCDD; see Appendix C, Section C.7.1.1 and Table 2 in CDM [2011]), indicating a low risk of toxicity to or bioaccumulation in freshwater sediment-dwelling organisms in the Hydroelectric Reach under the No Action/No Project Alternative. Based on additional lines of evidence (i.e., toxicity tests, calculation of TEQs), there does not appear to be a substantial sediment toxicity concern for national benchmark benthic indicator species from Copco 1 and Iron Gate Reservoir under the No Action/No Project Alternative. The exception to this occurred in a single sample from J.C. Boyle Reservoir, where survival of the benthic amphipod *Hyalella azteca* indicated a moderate potential for toxicity. TEQs for dioxin, furan, and dioxin-like PCBs in reservoir and estuary sediment samples were within the range of local background values and suggest a limited potential for adverse effects for fish exposed to reservoir sediments under the No Action/No Project Alternative (CDM 2011). Similarly, based on comparison to appropriate human health sediment screening levels, a limited number of COPCs were detected in reservoir sediment samples (i.e., arsenic, nickel, dieldrin, 4,4'-DDT, 4,4'-DDD, 4,4'-DDE, dioxin-like compounds, and pentachlorophenol) (see Appendix C, Section C.7.1.1 and Table 3 in CDM [2011]).

Contaminants in Aquatic Biota The potential for bioaccumulation under the No Action/No Project Alternative can also evaluated using fish tissue concentrations. Two studies provide data for the evaluation of bioaccumulation potential in freshwater fish:

- PacifiCorp (2004c) conducted a screening-level analysis looking at metals (i.e., arsenic, cadmium, chromium, copper, lead, mercury, nickel, selenium, and zinc), organochlorine pesticides, and PCBs in the Hydroelectric Reach and Upper Klamath Lake. The PacifiCorp data suggest that, with two exceptions, fish in the KHP reservoirs do not appear to be exposed to levels of contaminants that may adversely affect beneficial uses or that are toxic or detrimental to aquatic life. The exceptions include exceedances of the total mercury wildlife screening level (0.00227 ug/g) for all tissue samples in Keno, J.C. Boyle, Copco 1, and Iron Gate Reservoirs (see Appendix C for more detail), suggesting that localized mercury methylation may be occurring during periods of stratification and anoxia in the reservoirs (see Table C-1). Another exception is that exceedances of recommended wildlife screening levels for total DDTs based on p,p'-DDE found in fish tissue samples from Upper Klamath Lake, the Keno Impoundment/Lake Ewauna, J.C. Boyle Reservoir, and Copco 1 Reservoir (see Section 3.2.3.1, Inorganic and Organic Contaminants – Hydroelectric Reach), may suggest a possible broader-scale bioaccumulation effect (see Appendix C, Table C-7).
- Results from the 2009-2010 Secretarial Determination fish tissue sampling ("Exposure Pathway 1" in CDM [2011]) indicate that mercury is present in fish tissue at levels with potential to cause minor or limited adverse effects to fish; multiple other chemicals are not present at such levels, or they are present but do not possess tissue-based TRVs for comparison (see Section 3.2.3.8 and Appendix C for more detail). Fish tissue results were also below dioxin, furan, and dioxin-like PCB TEQs, indicating no adverse effect (CDM 2011). Combined with the sediment contaminant data (see above), inorganic and organic contaminants are present in reservoir sediments at levels that have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to freshwater aquatic species (Figure 3.2-2).

Existing inorganic and organic contaminant data characterizing reservoir sediments at the Four Facilities indicate that a relatively small number of chemicals (i.e., mercury, DDTs, and possibly dioxin-like chemicals) are present in reservoir sediments at levels that have the potential to cause minor or limited adverse effects (i.e., toxicity or bioaccumulation) to freshwater aquatic species in the Hydroelectric Reach. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

	Exposure Pathway	Freshwater biota	Marine biota	Terrestrial biota	Humans
Pathway 1	Short-term exposure to sediments flushed downstream	🟢	🔵	--	--
Pathway 2	Long-term exposure to exposed reservoir terrace and or river bank deposits	--	--	⚫ (1)	🔵 (2)
Pathway 3	Long-term exposure to new river channels and river bed deposits	🔵	--	--	🔵
Pathway 4	Long-term exposure to marine / near shore deposits	--	🔵	--	--
Pathway 5	Long-term exposure to reservoir sediments	🟢	--	--	🟢

⚫	No adverse effects based on lines of evidence
🔵	One or more chemicals present, but at levels unlikely to cause adverse effects based on the lines of evidence
🟢	One or more chemicals present at levels with potential to cause minor or limited adverse effects based on the lines of evidence
🔴	At least one chemical detected at a level with potential for significant adverse effects based on the lines of evidence
--	This exposure pathway is incomplete(3) or insignificant(4) for this receptor group

Note:
This does not include an evaluation of the physical effects (e.g., dissolved oxygen in the water, suspended sediment)
(1) Qualitative evaluation conducted for this exposure pathway
(2) Limited quantitative, along with qualitative evaluations conducted for this exposure pathway
(3) Incomplete - receptor group is unlikely to come in contact with sediment-associated contaminants under this exposure pathway
(4) Insignificant - exposure pathway not considered a major contributor to adverse effects in humans based on best professional judgment

Figure 3.2-2. Summary of Anticipated Effects of Inorganic and Organic Contaminants in Klamath Reservoir and Estuary Sediments Under the No Action/No Project Alternative and the Proposed Action, for Five Exposure Pathways . Source: CDM 2011.

Continued impoundment of water at the Four Facilities and associated interception and retention of sediments behind the dams could result in long-term low-level exposure to inorganic and organic contaminants in the Hydroelectric Reach for humans through the consumption of resident fish tissue. Human health exposure to inorganic or organic chemicals in reservoir sediments under the No Action/No Project Alternative is primarily through consumption of resident fish. Under the No Action/No Project Alternative, direct human exposure to sediments is not considered a reasonable exposure pathway. Three studies provide data for the evaluation of human health exposure through consumption of resident fish:

- Results from California SWAMP fish tissue sampling in Copco 1 and Iron Gate Reservoirs indicate mercury tissue concentrations of 310 and 330 ng/g wet weight, respectively (Davis et al. 2010). These data are greater than the advisory tissue levels for 3 and 2 servings per week (70 and 150 ng/g wet weight, respectively) and the fish contaminant goal (220 ng/g wet weight) (see Appendix C, Section C.7), suggesting low-level bioaccumulation potential in the two largest KHP reservoirs.
- PacifiCorp (2004c) reported that, in general, fish in the reservoirs at the Four Facilities are not exposed to levels of contaminants that may adversely affect human health via fish consumption. Exceptions to this include arsenic and total PCBs, which may equal or exceed the toxicity screening level for subsistence fishers (see Appendix C, Section C.7; PacifiCorp 2004c). Additionally, a subsequent a review of the PacifiCorp data and conversion to wet weight values found that mercury levels exceeded the screening level for subsistence fishers (0.049 ug/g) for samples from Keno, J.C. Boyle, Copco 1, and Iron Gate Reservoirs, and exceeded the screening level for recreational fishers (0.4 ug/g) for samples from samples from Copco 1 and Iron Gate Reservoirs (see Appendix C for more detail).
- Results from the 2010 Secretarial Determination fish tissue sampling indicate that a relatively small number of chemicals are present in fish tissue at levels with potential to cause minor or limited adverse effects to humans through fish consumption (Figure 3.2-2). These include arsenic, total PCBs, and dioxins in yellow perch at J.C. Boyle, Copco 1, and Iron Gate reservoirs (CDM 2011). In bullhead, the same chemicals are present, with the addition of mercury for Copco 1 Reservoir (see Section 3.2.3.8.3 and Appendix C for more details).

In summary, existing fish tissue, bioassay, and sediment chemistry data indicate that continued retention of sediments behind the KHP dams under the No Action/No Project Alternative may result in concentrations of inorganic and organic contaminants at levels that adversely affect beneficial uses or are toxic to humans in the Hydroelectric Reach. This includes possible exposure to low-level bioaccumulation of arsenic (which may be naturally elevated in the Upper Klamath Basin [see Section 3.2.3.8]) and mercury in fish residing in the lacustrine environment of the Keno Impoundment/Lake Ewauna and J.C. Boyle, Iron Gate, and Copco 1 Reservoirs.

Existing inorganic and organic contaminant data characterizing fish tissue in the reservoirs at the Four Facilities indicate that a relatively small number of chemicals (i.e., mercury, arsenic, total PCBs, and dioxins) are present at levels that have the potential to cause minor or limited adverse effects to humans through fish consumption in the Hydroelectric Reach. Continued impoundment of water at the Four Facilities under the *No Action/No Project Alternative* would result in no change from existing conditions.

Lower Klamath Basin

With the possible exception of compounds (i.e., mercury) that can be released (exported) from reservoir bottom waters under seasonally anoxic conditions, continued impoundment of water at the Four Facilities is not anticipated to result in increased exposure to inorganic and organic contaminants for freshwater aquatic species in the Klamath River downstream from Iron Gate Dam. This is because contaminants that may be present in reservoir sediments at the Four Facilities would remain in place under the No Action/No Project Alternative. There is currently insufficient information to assess whether the No Action/No Project Alternative would expose downstream aquatic biota to methylmercury released from bottom waters. Bioaccumulation of algal toxins (i.e., microcystin) has been documented in fish and mussel tissue in the Klamath River downstream from Iron Gate Dam (Kann et al. 2010) and is discussed further in Section 3.3, Aquatic Resources. Potential for the Proposed Action and alternatives to affect production and toxicity of algal toxins in discussed in Section 3.4, Algae.

3.2.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

The Full Facilities Removal of Four Dams (Proposed Action) is the removal of four major dams in the Klamath Hydroelectric Project (J.C. Boyle, Copco 1, Copco 2, and Iron Gate) along with the ancillary facilities of each installation in a 20-month period which includes an 8-month period of site preparation and partial drawdown at Copco 1 and a 12-month period for full drawdown and removal of facilities. This includes the entire dam, the powerhouses, spillways, and other infrastructure associated with the power generating facilities, as well as the transfer of the Keno Dam facilities to Reclamation and the implementation of the KBRA. Removal of the Four Facilities would not affect water quality in the following reaches in the Upper Klamath Basin: Wood, Williamson, and Sprague Rivers, Upper Klamath Lake, and Link River to the upstream end of J.C. Boyle Reservoir. In the Hydroelectric Reach of the Upper Klamath Basin, removal of the Four Facilities would result in the release of sediments currently trapped behind the dams. This release would have short-term (<2 years following dam removal) effects on suspended sediments, dissolved oxygen, nutrients, and inorganic and organic contaminant concentrations in the Klamath River. Under the Proposed Action, interception and retention of sediments behind the dams at the Four Facilities would no longer occur; this would have long-term (2–50 years following dam removal) effects on suspended sediments. Additionally, elimination of the lacustrine environment of the reservoirs under the Proposed Action would have long-term effects on water temperature, dissolved oxygen, nutrients, pH, algal toxins and chlorophyll-*a* in the river. The following sections provide detail regarding the anticipated effects. KBRA under the Proposed Action is addressed at a programmatic level in the last subsection of the Proposed Action.

Water Temperature

Upper Klamath Basin

Removal of the Four Facilities under the Proposed Action and elimination of hydropower peaking operations at J.C. Boyle Powerhouse could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) alterations in overall water temperatures and diel water temperature variation in the J.C. Boyle Bypass and Peaking Reaches. Klamath TMDL model (see Appendix D) results indicate that under the Proposed Action (similar to the TMDL TOD2RN scenario, which includes Oregon TMDL allocations), water temperatures in the Bypass Reach immediately downstream from J.C. Boyle Dam would be similar to those under the No Action/No Project Alternative, but there would be relatively *greater* diel water temperature variation during June through September (similar to the TMDL T4BSRN scenario) due to the absence of the thermal mass in J.C. Boyle Reservoir, which tends to moderate diel water temperature variation immediately downstream from the dam under existing conditions (NCRWQCB 2010a). Greater diel variation would also occur further downstream in the J.C. Boyle Bypass Reach because it would no longer be dominated by cold groundwater inputs at a relatively constant temperature of 11–12 ^{o}C (Kirk et al. 2010, data from electronic appendices of Asarian and Kann 2006b). Water temperatures in this short river reach (i.e., downstream from the cold springs) would increase during summer months due to the elimination of bypass operations and associated increase in streamflows; however, areas adjacent to the coldwater springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Proposed Action. Further, as described in Section 3.3.4.3 Alternative 2: Proposed Action – Key Ecological Attributes – Water Temperature, a shift in water temperatures toward natural diel variation would increase daily maximum temperatures, but would also increase nighttime cooling providing regular thermal relief, time for repair of proteins damaged by thermal stress, and significant bioenergetic benefits for salmonids.

In the J.C. Boyle Peaking Reach model results indicate that water temperatures under the Proposed Action would exhibit slightly lower daily maximum values (0.0–2 °C [0–3.6 °F]) as compared to those predicted under the No Action/No Project and would exhibit *lower* diel water temperature variation during June through September, moving toward the natural thermal regime (Figure 3.2-3) (NCRWQCB 2010a, data from electronic appendices of Asarian and Kann 2006b). At these locations the relative difference in diel water temperature variation between the Proposed Action and the No Action/No Project Alternative is due to the elimination of peaking operations and the associated large artificial temperature swings. Overall, the TMDL model results indicate that June through October riverine water temperatures from J.C. Boyle Reservoir to the Oregon-California State line would meet the Oregon narrative natural conditions criterion that supersedes the numeric objective (i.e., 20 °C [68 °F], see Table 3.2-3) for support of coolwater habitat.

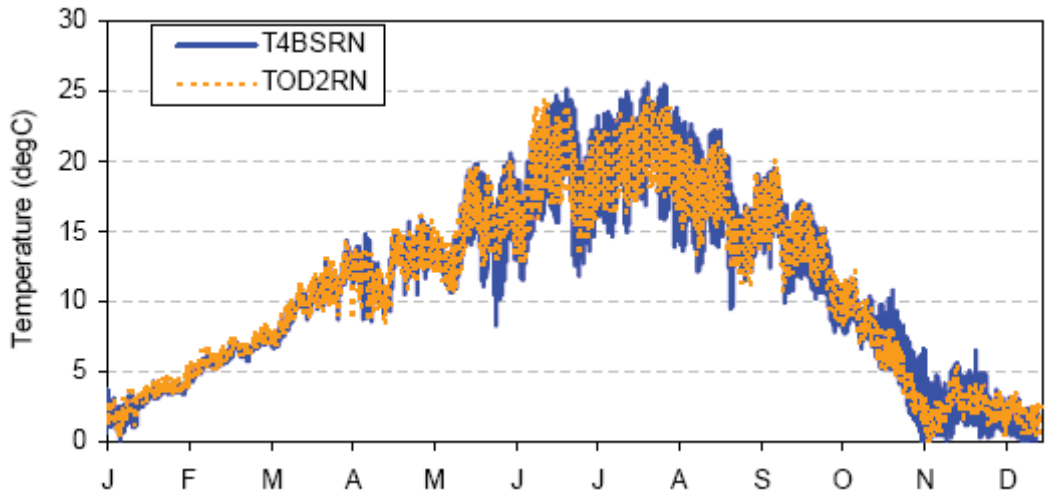


Figure 3.2-3. Predicted Water Temperature at the California-Oregon State line (RM 208.5) for the Klamath TMDL Scenarios Similar to the Proposed Action (TOD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in summer/fall water temperatures and diel temperature variation in the J.C. Boyle Bypass Reach due to the removal of J.C. Boyle Reservoir and elimination of bypass operations would be a less than significant impact. Slight decreases in long-term maximum summer/fall water temperatures and less artificial water temperature swings in the J.C. Boyle Peaking Reach would be beneficial.

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in spring water temperatures and decreases in late summer/fall water temperatures in the Hydroelectric Reach downstream from Copco 1 Reservoir.

In the California portion of the Hydroelectric Reach, the TMDL model indicates that removal of the Four Facilities under the Proposed Action would eliminate the seasonal temperature shift caused by the Four Facilities in the Hydroelectric Reach, returning the river to a more natural thermal regime. Removal of the Project reservoirs would also result in a slight increase in flow as the evaporative losses would be reduced. Evaporation from the surface of the reservoirs is currently about 11,000 acre-feet/year and after dam removal the evapotranspiration in the same reaches is expected to be approximately 4,800 acre-feet/year, resulting in a gain in flow to the Klamath River of approximately 6,200 acre-feet/year (Reclamation 2012).

The TMDL model indicates that just downstream from Copco 1 and Copco 2 Reservoirs (≈RM 198), removal of the Four Facilities would increase daily maximum temperatures that are currently up to 7°C (13°F) lower than modeled natural conditions in spring (May and June) and decrease temperatures that are up to roughly 4°C (7°F) greater than modeled natural conditions in late summer/fall (August through October), due to the presence of the reservoirs (Figure 3.2-4) (NCRWQCB 2010a). Water temperature modeling conducted for the Klamath Dam Removal Secretarial Determination Studies provides generally similar results, with RBM10 model results showing a projected shift in the annual temperature cycle that would slightly increase river temperatures in the spring, and decrease temperatures in the late summer/fall in the Hydroelectric Reach under the Proposed Action (Perry et al. 2011). Further discussion of RBM10 results is presented below for the Lower Klamath Basin.

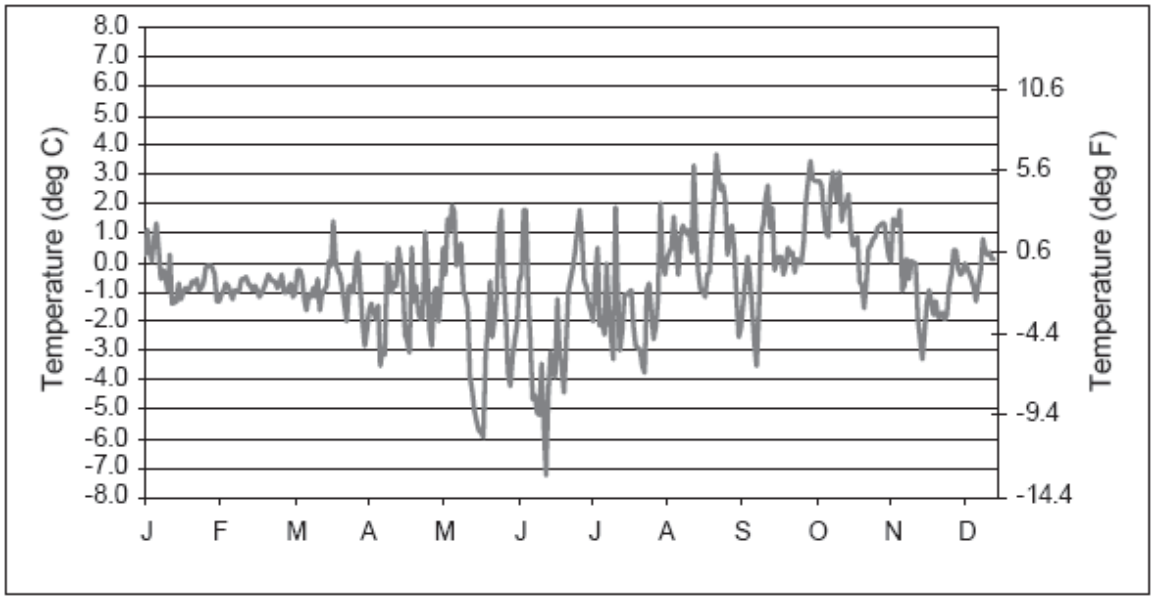


Figure 3.2-4. Estimated Changes in Daily Maximum Klamath River Water Temperatures at ≈RM 198 due to the Presence of Copco 1 and 2 Reservoirs for the 2000 Calendar Year. Positive Values Represent an Increase above Modeled Natural Conditions. Source: NCRWQCB 2010a.

Prior evaluations of the cooling effect of the Project reservoirs in spring have indicated that cooler spring water is potentially beneficial to rearing salmonids because it can reduce stress and disease for late outmigrants (PacifiCorp 2004a). However, as discussed in Section 3.3.4.3 (Alternative 2: Proposed Action), warming of spring water temperatures could lead to earlier fall-run Chinook spawning in the mainstem (reducing pre-spawn mortality) more in sync with historical spawning timing. In addition to earlier spawning, warmer spring temperatures would result in fry emerging earlier and growing

faster, which could encourage earlier emigration downstream, reducing stress and disease (Bartholow 2005, FERC 2007). Thus, the projected increase in spring water temperatures under the Proposed Action would be a less than significant effect.

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020 (i.e., prior to thermal stratification in the reservoirs), the aforementioned water temperature effects of the Proposed Action in the Hydroelectric Reach would occur, either partially or fully, within the first 1 to 2 years following dam removal and would, therefore, also be short-term effects.

The Klamath TMDL model does not address the potential long-term effects of global climate change on water temperatures in the Klamath Basin (Appendix D). As described for the No Action/No Project Alternative, climate change is expected to increase summer and fall water temperatures in the Klamath Basin on the order of 1–3 °C (1.8–5.4 °F) (Bartholow 2005, Perry et al. 2011). The Proposed Action would decrease long-term late summer/fall water temperatures and would therefore increase the likelihood that beneficial uses would be supported under climate change.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in springtime water temperatures and diel temperature variation in the Hydroelectric Reach would be less than significant while decreases in late summer/fall water temperatures would be beneficial.

Lower Klamath Basin

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in spring water temperatures, decreases in late summer/fall water temperatures, and increased diel temperature variation in the Lower Klamath River. Water temperature modeling results are available for the Lower Klamath Basin from three separate modeling efforts: the PacifiCorp relicensing efforts (KRWQM; see Appendix D); development of the California Klamath River TMDLs (see Appendix D); and, water temperature modeling conducted for the Secretarial Determination studies (RBM10; see Appendix D). KRWQM results comparing the current condition (all KHP dams in place) to four without-project scenarios (i.e., no KHP dams including Keno Dam; without Iron Gate Dam; without Copco 1, Copco 2, and Iron Gate; and without J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams) for 2001–2004 indicate that the reservoirs create a temporal shift by releasing generally cooler water from mid-January to April, variably cooler or warmer water from April through early August, and warmer water from August through November (PacifiCorp 2004a, Dunsmoor and Huntington 2006). Just downstream from Iron Gate Dam (RM 190.1), this translates to a 1–2.5°C (1.8–4.5 °F) cooling during spring and a 2–10 °C (3.6–18 °F) warming during summer and fall (Figure 3.2-5). Immediately upstream of the confluence with the Scott River

(RM 143.9), the difference between existing conditions and without-project scenarios indicates a lesser, albeit still measurable, warming of 2–5 °C (3.6–9 °F) for most of October and November (Figure 3.2-6). Because patterns in reservoir thermal structure for Iron Gate and Copco 1 indicate that stratification generally commences in April and ends in November, the effect of reservoir thermal regime on downstream water temperatures appears to be cooling during non-stratified periods and warming during stratified periods. The cooling effect in spring is potentially beneficial to rearing salmonids by reducing stress and disease for late outmigrants, although it may also have adverse effects such as a delay in emergence or outmigration (see Section 3.3.4.3.2.1.4 Water Temperature). The fall warming effect, which can be stressful to rearing salmonids, lasts for the majority of late summer and fall months and is of larger magnitude (PacifiCorp 2004a).

Reservoir thermal regimes also act to reduce the magnitude of diel temperature variation in the reservoir reaches and the riverine reaches immediately downstream from Iron Gate Reservoir (RM 190.1; see Figure 3.2-5) (Deas and Orlob 1999, PacifiCorp 2005). As with the seasonal temperature effect, the dampening influence on diel temperature variation is considerably diminished farther downstream, at the confluence with the Scott River (RM 143.9; see Figure 3.2-6). The KRWQM indicates that the temperature influence of the Hydroelectric Reach is mostly ameliorated by RM 66 at the confluence with the Salmon River (see Figure 3.2-7).

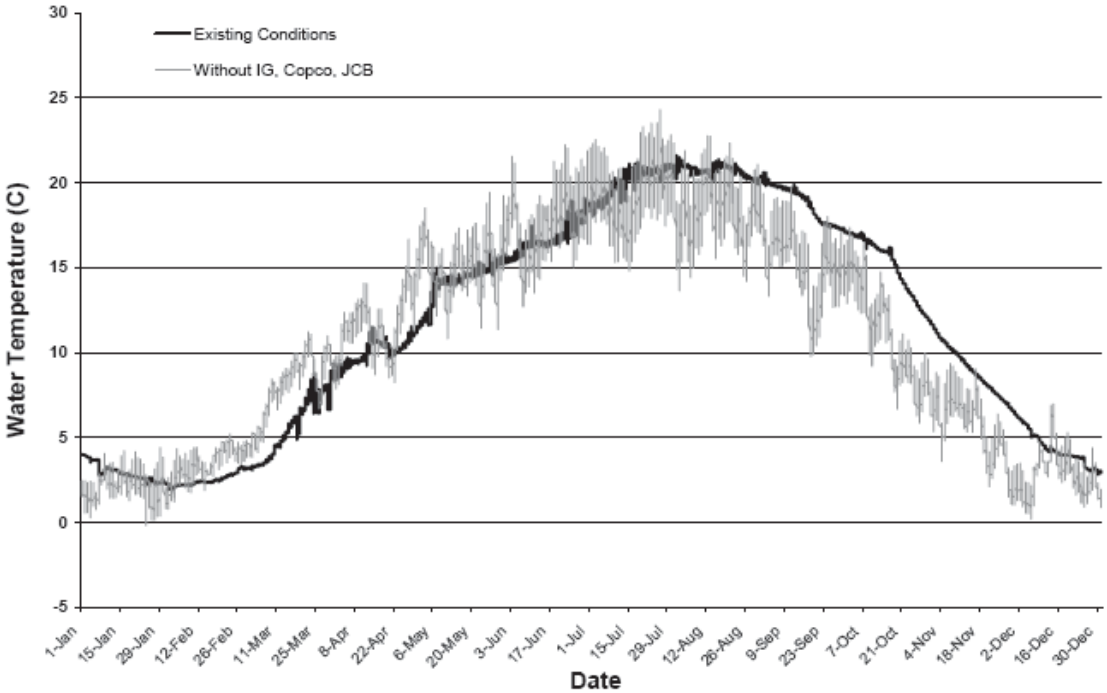


Figure 3.2-5. Simulated Hourly Water Temperature Downstream from Iron Gate Dam (RM 190.1) Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco 1, Copco 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

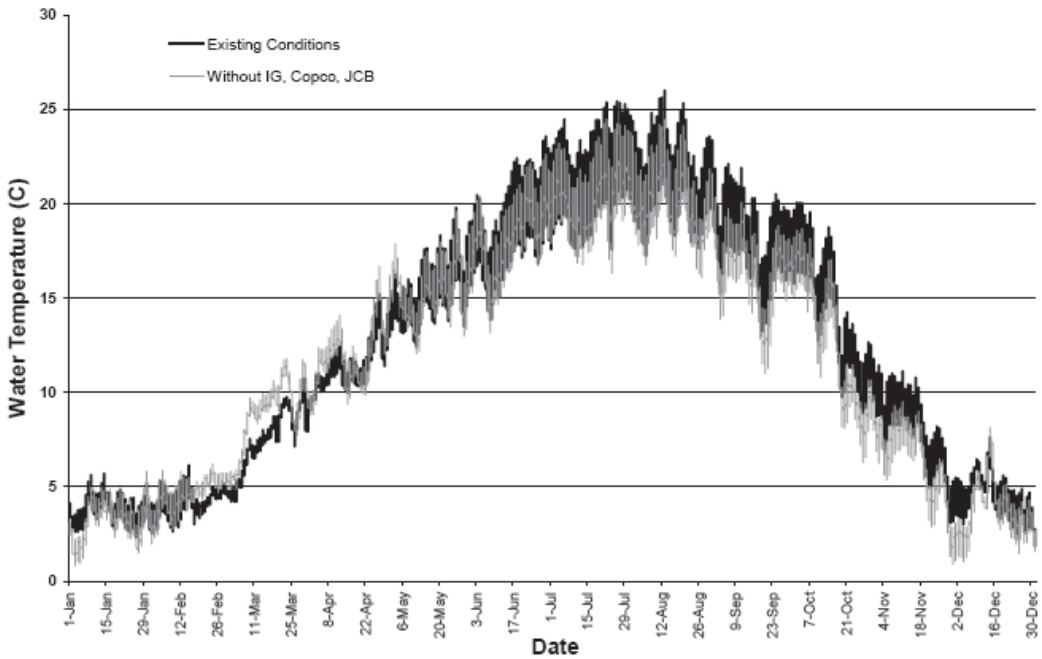


Figure 3.2-6. Simulated Hourly Water Temperature Immediately Upstream of the Scott River Confluence (RM 143.9) Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco 1, Copco 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

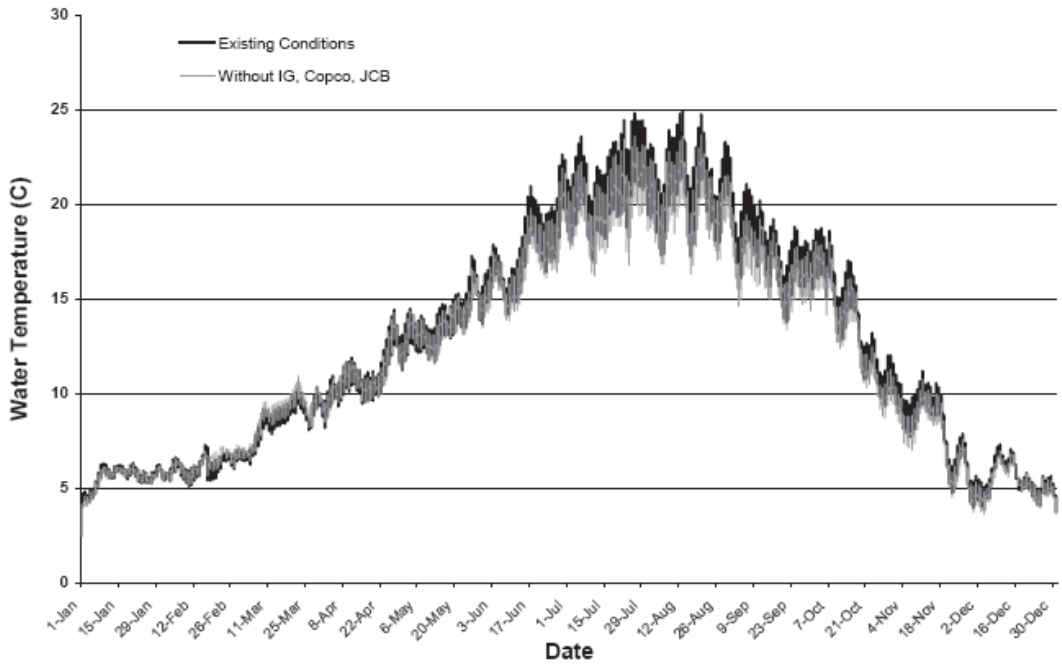


Figure 3.2-7. Simulated Hourly Water Temperature Downstream from the Salmon River Confluence (≈RM 66) Based on Year 2004 for Existing Conditions Compared to Hypothetical Conditions without J.C. Boyle (JCB), Copco 1, Copco 2, and Iron Gate (IG) Dams. Source: PacifiCorp 2005.

In agreement with KRWQM results, Klamath TMDL model (see Appendix D) results also indicate that under the Proposed Action (similar to the TMDL TCD2RN scenario), water temperature in the Klamath River downstream from Iron Gate Dam (RM 190.1) would be 2–10 °C (3.6–18 °F) lower during August through November and 2–5 °C (3.6–9°F) higher during January through March than those under the No Action/No Project (similar to the TMDL T4BSRN scenario), due to removal of the large thermal mass created by the reservoirs (NCRWQCB 2010a). The Klamath TMDL model also predicts that diel variation in water temperature at this location during this same period would be greater under the Proposed Action (TCD2RN) than the No Action/No Project Alternative (T4BSRN) as water temperatures would be in equilibrium with (and would reflect) diel variation in ambient air temperatures. As with KRWQM, these impacts of removal of the Four Facilities would decrease in magnitude with distance downstream from Iron Gate Dam, and they would not be evident in the reach downstream from the Salmon River confluence (≈RM 66) (NCRWQCB 2010a, Dunsmoor and Huntington 2006). Therefore, under the Proposed Action, water temperatures would not be directly affected in the lower river downstream from the confluence with the Salmon River, including the Klamath Estuary and the marine nearshore environment.

As part of the Klamath Dam Removal Secretarial Determination studies, the effects of climate change were included in model projections for future water temperatures under the No Action/No Project Alternative and the Proposed Action. RBM10 model results using climate change predictions from five GCMs indicate that future water temperatures under the Proposed Action (where simulated flows are subject to KBRA flows) and climate change would be 1–2.3 °C (1.8–4.1 °F) warmer than historical temperatures (Perry et al. 2011). This temperature range is slightly lower than that suggested by projecting Bartholow (2005) historical (1962–2001) estimates of 0.05 °C (0.09 °F) per year, or 2–3 °C (3.6–5.4 °F) over 50 years. However, within the general uncertainty of climate change projections, results from the two models correspond reasonably well and indicate that water temperatures in the Upper Klamath Basin are expected to increase within the period of analysis on the order of 1–3 °C (1.8–5.4 °F).

RBM10 results also indicate that, despite warming of water temperatures under climate change, the primary effect of dam removal is still anticipated to be the return of approximately 160 miles of the Klamath River, from J.C. Boyle Reservoir (RM 224.7) to the Salmon River (RM 66), to a natural thermal regime (Perry et al. 2011). Model results indicate that the annual temperature cycle downstream from Iron Gate Dam would shift forward in time by approximately 18 days under the Proposed Action, with warmer temperatures in spring and early summer and cooler temperatures in late summer and fall immediately downstream from the dam. Just downstream from Iron Gate Dam, water temperatures under the Proposed Action including climate change would average 2 °C greater in May than those under the No Action/No Project Alternative, while during October water temperatures would average 4°C cooler. At the confluence with the Scott River, the differences would be diminished, but there would still be a slight warming (<1 °C) in the spring and cooling (1–2 °C) in the late summer and fall (Perry et al. 2011). Thus, despite the anticipated warming under climate change, water temperature improvements under the Proposed Action would still help to achieve the Oregon and California temperature TMDLs for the mainstem Klamath River.

Although all of the existing water temperature model projections (KRWQM, TMDL, RBM10) indicate that spring water temperatures would increase under the Proposed Action, as discussed in Section 3.3.4.3 (Alternative 2: Proposed Action) this effect could lead to earlier spawning of natural fall-run Chinook salmon, a longer incubation period, earlier emergence and growth, and would encourage earlier emigration, thus reducing stress and disease for this species (Hamilton et al. 2011). Overall, the increase in spring water temperatures under the Proposed Action would be a less than significant.

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020 (i.e., prior to reservoir thermal stratification), water temperature effects of the Proposed Action in the Klamath River downstream from Iron Gate Dam would occur, either partially or fully, within the first 1 to 2 years following dam removal and would be a short-term effect as well as a long-term effect.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in spring water temperatures and increased diel temperature variation for the reach from Iron Gate Dam to the confluence with the Salmon River would be less than significant. Decreases in late summer/fall water temperatures would be beneficial. There would be no change from existing conditions on water temperatures for Klamath River downstream from the Salmon River, the Klamath Estuary, and the marine nearshore environment.

Sediment release associated with the removal of the Four Facilities under the Proposed Action could cause short-term (<2 years following dam removal) and/or long-term (2-50 years following dam removal) increases in sediment deposition in the Klamath River or Estuary that could alter morphological characteristics and indirectly affect seasonal water temperatures. Increased sediment deposition in the estuary under the Proposed Action may decrease the size of the salt wedge, either by increasing the frequency of mouth closure, or by elevating the bottom of the estuary above portions of the tidal range when the mouth is open. Alternately, scouring of current estuarine sediment deposits may occur during the short-term high sediment transport predicted to occur following dam removal, which may sufficiently change morphology as to effect mouth closure, salt wedge formation, and associated seasonal water temperatures. However, because little short-term settling, sedimentation, or scouring is expected to occur in the Klamath River or the estuary as a result of the Proposed Action (see Section 3.11.4.3), and estimates of baseline sediment delivery for the Klamath Basin indicate that long-term sediment delivery rates will not change substantially under the Proposed Action (Stillwater Sciences 2010), **there would be no indirect effect on water temperatures in the Klamath Estuary under the *Proposed Action*.**

Suspended Sediments

Upper Klamath Basin

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) increases in suspended material in the Hydroelectric Reach

downstream from J.C. Boyle Dam due to the release of sediments currently trapped behind the dams at the Four Facilities. Results of sediment transport modeling of the impacts of dam removal on suspended sediment in the Lower Klamath River indicate high short- term loads immediately downstream from Iron Gate Dam under the Proposed Action (Reclamation 2012, Stillwater Sciences 2008). Modeled SSCs[8] downstream from J.C. Boyle Reservoir are similarly high in the short term, although due to the relatively small volume of the sediment deposits behind J.C. Boyle Dam (i.e., 15 percent of total volume for the Four Facilities, see also Figure 3.3-8), concentrations would be considerably less than those anticipated to occur downstream from Iron Gate Reservoir. Overall, and within the general uncertainty of the model predictions, SSCs at J.C. Boyle Reservoir across the three water year types would have peak values of 2,000–3,000 mg/L and occurring within 1–2 months of reservoir drawdown. Predicted SSCs quickly decrease to less than 100 mg/L for 5–7 months following drawdown, and concentrations less than 10 mg/L for 6–10 months following drawdown (Figures 3.2-8 through 3.2-10). **Under the *Proposed Action*, the short-term (<2 years following dam removal) increases in SSCs in the Hydroelectric Reach downstream from J.C. Boyle Dam would be a significant impact.**

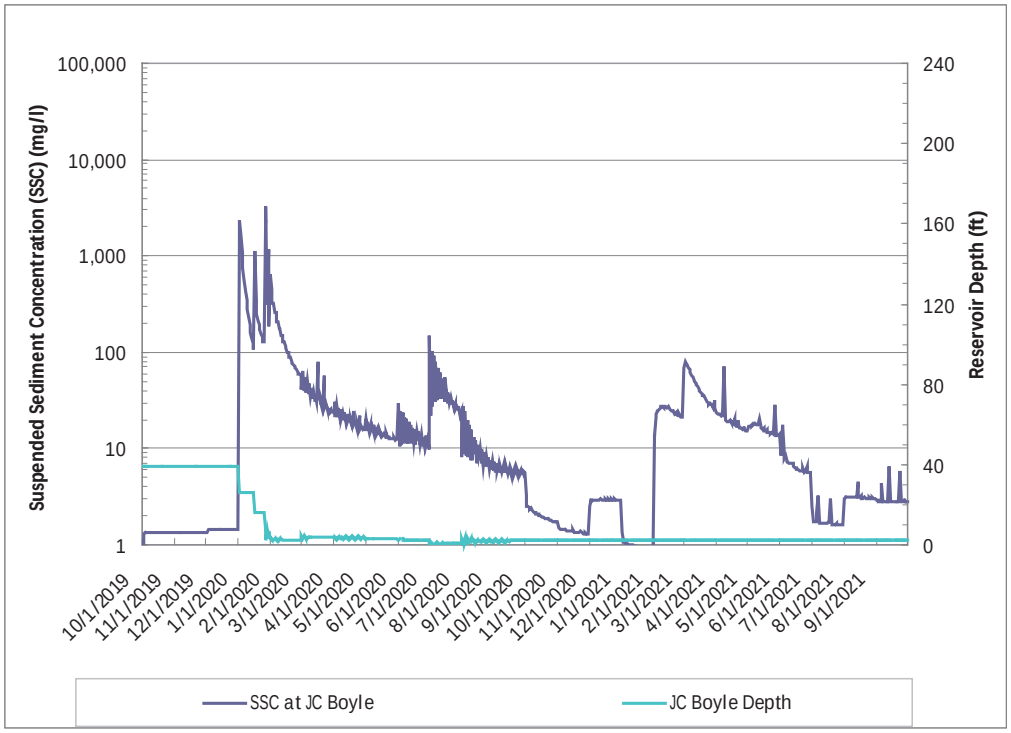


Figure 3.2-8. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Action Assuming Typical Dry Hydrology (WY2001).

[8] For the purposes of this report, SSC is considered equivalent to TSS. As needed, data from multiple sources reported as either TSS or SSC are used interchangeably, despite potential differences in the numeric values reported by each method. (Gray et al. 2000).

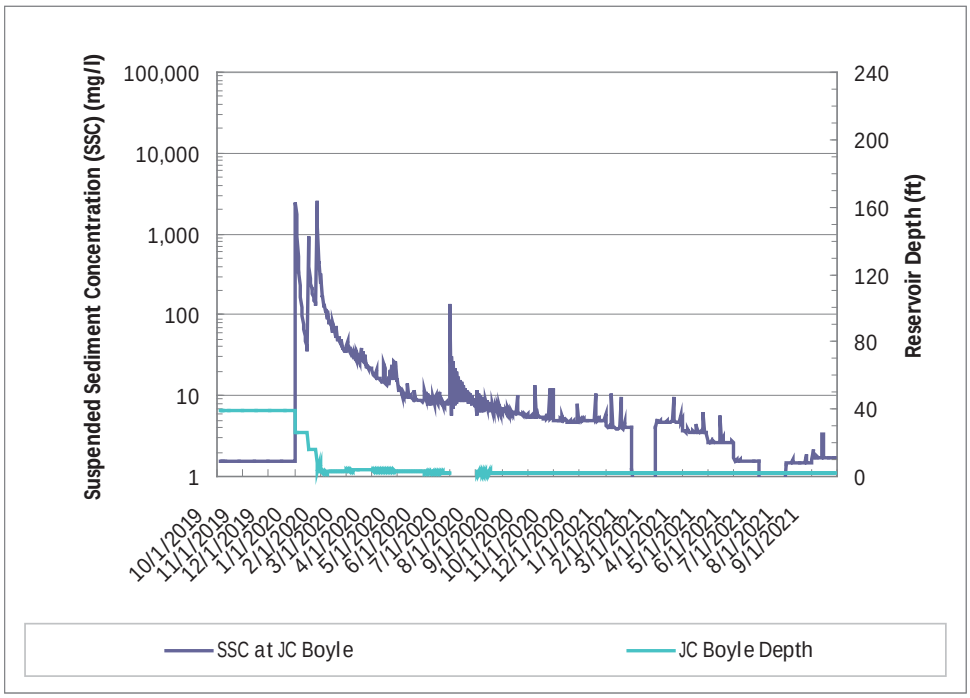


Figure 3.2-9. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Action Assuming Median Hydrology (WY1976).

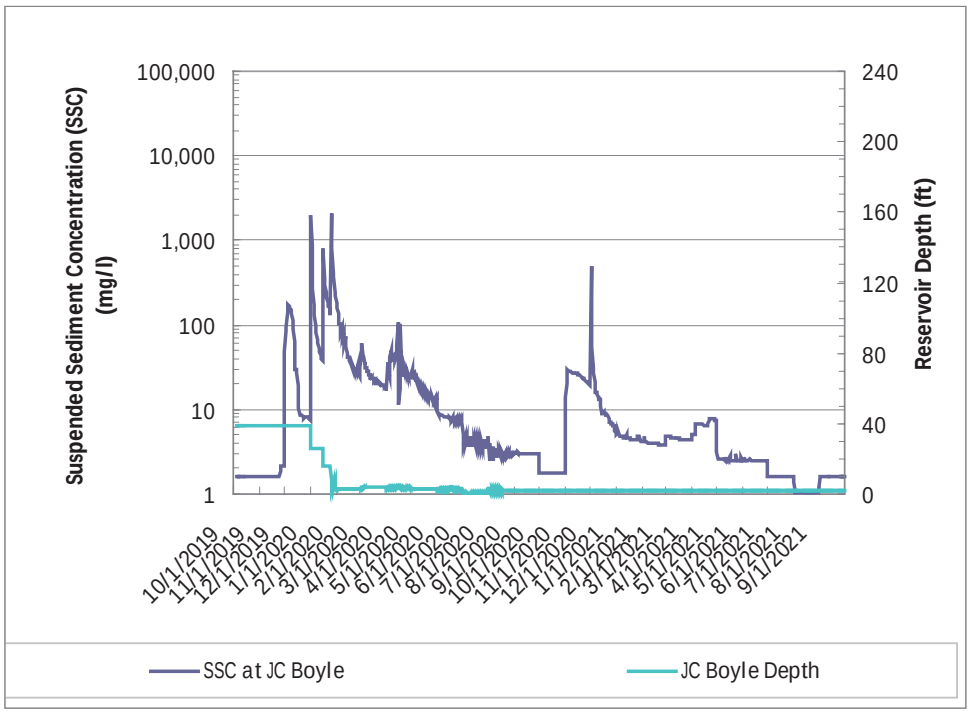


Figure 3.2-10. Suspended Sediment Concentrations Modeled at J.C. Boyle Reservoir Under the Proposed Action Assuming Typical Wet Hydrology (WY1984).

Stormwater runoff from deconstruction activities under the Proposed Action could cause short-term increases in suspended material in the Hydroelectric Reach during the deconstruction period. Deconstruction activities under the Proposed Action would include demolition of the dams and their associated structures, power generation facilities, transmission lines, installation of temporary cofferdams, road upgrading, hauling, reservoir restoration, and other activities (as described in Section 2.4.3.1). Deconstruction activities are scheduled to occur between January 10 and June 26, with cofferdam installation scheduled to occur between 2 January 2020 and 6 February 2020. Therefore, cofferdam installation would occur during the first month of reservoir drawdown and the period of peak SSCs associated with mobilization of reservoir sediment deposits during drawdown. While the magnitude of short-term effects on SSCs due to erosion of the large volume of reservoir sediment deposits trapped behind the dams would be substantially greater than those due to dam deconstruction activities, this does not alleviate the requirement to reduce impacts from deconstruction-related activities. The potential for sediments to enter the Hydroelectric Reach from deconstruction site runoff, cofferdam installation, or in-water deconstruction work can be minimized or eliminated through the implementation of BMPs for deconstruction activities that would occur in or adjacent to the Klamath River (Appendix B). **Under the *Proposed Action*, the effect of stormwater runoff from deconstruction activities on SSCs in the Hydroelectric Reach downstream from J.C. Boyle Dam would be a less-than-significant impact.**

Implementation of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could result in short-term increases in mineral (inorganic) suspended material in the Hydroelectric Reach. The Proposed Action includes seven out of the eight years of gravel placement under IM 7; the first year would be before the Secretary makes a determination, and would therefore be included in the No Action/No Project Alternative. The following seven years would be part of the Proposed Action. Under this IM, suitable spawning gravel would be placed in the J.C. Boyle Bypass and Peaking reaches. The spawning gravel would be placed using a passive approach before high flow periods, or to provide for other habitat enhancement in the Klamath River upstream of Copco 1 Reservoir. These actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal (for effects on aquatic species, see Section 3.3.4.3.2). Passive gravel placement is specified by IM 7, which would avoid in-stream placement of gravel and would limit turbidity increases to periods of high river flow when turbidity is naturally elevated. The potential for sediments to enter the water during gravel placement along the river banks could be minimized or eliminated downstream from the enhancement sites through the implementation of BMPs for construction activities (Appendix B) (BLM 2011). Any disturbed sediments would be trapped by Copco 1 Reservoir and not transferred downstream to the Klamath River prior to dam removal, particularly given implementation of BMPs. **Under the *Proposed Action*, the short-term effect of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, on SSCs in the Hydroelectric Reach would be a less-than-significant impact.**

Implementation of IM 16, Water Diversions, could result in short-term increases in mineral (inorganic) suspended material in the Hydroelectric Reach due to diversion screening deconstruction and construction activities. Under IM 16, PacifiCorp would seek to eliminate three screened diversions (the Lower Shovel Creek Diversion [7.5 cfs], Upper Shovel Creek Diversion [2.5 cfs], and Negro Creek Diversion [5 cfs]) from Shovel and Negro Creeks and would seek to modify its water rights to move the points of diversion from Shovel and Negro creeks to the mainstem Klamath River. If this were successful the screened diversions would be removed prior to dam removal in 2020. The intent of this measure is to provide additional water to Shovel and Negro creeks, thus increasing the quality and amount of suitable habitat for aquatic species within these tributaries, while not diminishing PacifiCorp's water rights. The potential for sediments to enter the water during screen removal activities is minimal if the diversions are individual pump intakes. If the diversions are larger concrete structures, the impacts would be of greater magnitude and longer duration, albeit still short-term and due to construction/deconstruction activities. In this case, impacts to SSCs can be minimized or eliminated through the implementation of BMPs for construction activities (Appendix B) stipulated during permitting of IM 16. Since IM 16 would be undertaken prior to dam removal, any disturbed sediments would be trapped by Copco 1 Reservoir and not transferred downstream to the Klamath River prior to dam removal, particularly given implementation of BMPs. The diversions would not be likely to affect other aspects of short-term or long-term water quality in the mainstem Klamath River since the water rights are relatively small (7.5 cfs, 2.5 cfs, and 5 cfs) compared to seasonal low flows in the mainstem upstream of Copco 1 Reservoir (typically >800 cfs). **Under the *Proposed Action*, the effect of IM 16, Water Diversions, on SSCs in the Hydroelectric Reach in the J.C. Boyle Bypass Reach would be a less-than-significant impact.**

Under the Proposed Action, recreational facilities currently located on the banks of the existing reservoirs will be removed following drawdown, and could release suspended sediment into the Klamath River. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities will be removed. The potential for sediments to enter the water during the facilities removal will be minimized or eliminated through the implementation of BMPs for construction activities (Appendix B). Implementation of BMPs would ensure that impacts are constrained to the individual sites and their immediate area, and not transferred downstream in the Klamath River. **Under the *Proposed Action*, the short-term impacts on SSCs from the deconstruction of the recreational facilities would be less-than-significant.**

Under the Proposed Action, revegetation associated with management of the reservoir footprint area could decrease the erosion of fine sediments from exposed reservoir terraces in the Hydroelectric Reach. Based on the reservoir area management planning currently underway, establishment of herbaceous vegetation in drained reservoir areas will be undertaken to stabilize the surface of the sediment and minimize erosion from exposed terrace surfaces following drawdown (O'Meara et al. 2010). Hydroseeding of herbaceous vegetation (i.e., grass) would be used, which typically entails applying a

mixture of wood fiber, seed, fertilizer, and stabilizing emulsion to exposed slopes. Hydroseeding would be undertaken using a barge in spring 2020 while reservoir levels are high enough to operate and access the barge. Later in spring and summer 2020, aerial application would be necessary for precision applications of material near the newly established river channel, as well as in the remaining areas (see Section 2.3.4.5). Some aerial fall seeding in 2020 might be necessary to supplement areas where spring hydroseeding was unsuccessful.

Hydroseeding would be undertaken using standard BMPs for reducing water quality impacts during deconstruction and/or construction activities and restoration projects (Appendix B). Additional BMPs specific to hydroseeding, such as avoiding over-spray onto roads, trails, existing vegetation, and the stream channel, would also be implemented so that the hydroseed mixture itself would not easily runoff or be directly sprayed into the Klamath River. **Under the *Proposed Action*, hydroseeding would decrease the short-term (<2 years following dam removal) erosion of fine sediments from exposed reservoir terraces into the river channel in the Hydroelectric Reach and would be beneficial.**

Under the Proposed Action, the lack of continued interception and retention of mineral (inorganic) suspended material by the dams at the Four Facilities could result in long-term (2–50 years following dam removal) increases in suspended material in the Hydroelectric Reach. Peak concentrations of mineral (inorganic) suspended material (silts and clays with diameter < 0.063 mm) in the Hydroelectric Reach during the winter/early spring (November through April) would likely remain associated with high-flow events and any increases due to the lack of interception by the dams would not be large; estimates of baseline sediment delivery for the Klamath Basin indicate that a relatively small fraction of total sediment (199,300 tons per year or 3.4 percent of the cumulative average annual delivery from the basin) is supplied to the Klamath River on an annual basis from the upper and middle Klamath River (i.e., from Keno Dam to the Shasta River) due to the generally lower rates of precipitation and runoff, more resistant and permeable geologic terrain, and relatively low topographic relief and drainage density of the Upper Klamath Basin as compared with the lower basin. (Stillwater Sciences 2010).**Under the *Proposed Action*, the long-term (2–50 years following dam removal) increase in mineral (inorganic) suspended material in the Hydroelectric Reach would be a less-than-significant impact.**

Under the Proposed Action, the lack of continued interception and retention of algal-derived (organic) suspended material by the dams at the Four Facilities could result in slight long-term (2–50 years following dam removal) increases in suspended material in the Hydroelectric Reach. Episodic increases (10–20 mg/L) in algal-derived (organic) suspended material resulting from in-reservoir algal productivity are not expected to

occur in the Hydroelectric Reach following dam removal. SSCs in the Hydroelectric Reach may attain levels similar to those observed upstream of J.C. Boyle Dam under existing conditions during May through October (>15 mg/L; see Appendix C), as algal-dominated suspended material is transported downstream from Upper Klamath Lake. However, similar to the No Action/No Project Alternative, interception and retention of suspended material from upstream sources would still occur to a large degree in the Keno Impoundment/Lake Ewauna, as would additional decreases in concentration due to mechanical breakdown of algal remains in the turbulent river reaches between Keno Dam and Copco 1 Reservoir, and dilution from the springs downstream from J.C. Boyle Dam. If slight long-term increases in suspended materials did occur, they would likely be offset by the loss of algal-derived suspended material previously produced in Copco 1 and Iron Gate Reservoirs and would not exceed levels that would substantially adversely affect the cold freshwater habitat (COLD) beneficial use (see discussion under Alternative 2 – Suspended Sediments – Lower Klamath Basin). **Under the *Proposed Action*, the long-term (2–50 years following dam removal) changes in algal-derived (organic) suspended material in the Hydroelectric Reach would be a less-than-significant impact.**

Lower Klamath Basin

Sediment release associated with the removal of the Four Facilities under the Proposed Action could cause short-term (<2 years following dam removal) increases in suspended material in the Lower Klamath River and the Klamath Estuary. Sediment transport modeling of the impacts of dam removal on suspended sediment in the Lower Klamath River indicates high short-term loads immediately downstream from Iron Gate Dam under the Proposed Action (Reclamation 2012, Stillwater Sciences 2008). The Proposed Action involves a three-phase drawdown for Copco 1 Reservoir beginning on November 1, 2019, and a single-phase drawdown for J.C. Boyle and Iron Gate Reservoirs beginning on January 1, 2020 (Reclamation 2012), which allows maximum SSCs[9] to occur during winter months when flows and SSCs are naturally high in the mainstem river (e.g., see Appendix C, Figure C-9). Suspended sediment model predictions downstream from Iron Gate Dam for the Proposed Action are presented in Figure 3.2-11 through 3.2-13 for the three water year types (dry, median, wet) considered as part of the Secretarial Determination process. Model predictions are discussed below and summarized in Table 3.2-11.

[9] For the purposes of this report, SSC is considered equivalent to TSS. As needed, data from multiple sources reported as either TSS or SSC are used interchangeably, despite potential differences in the numeric values reported by each method. (Gray et al. 2000).

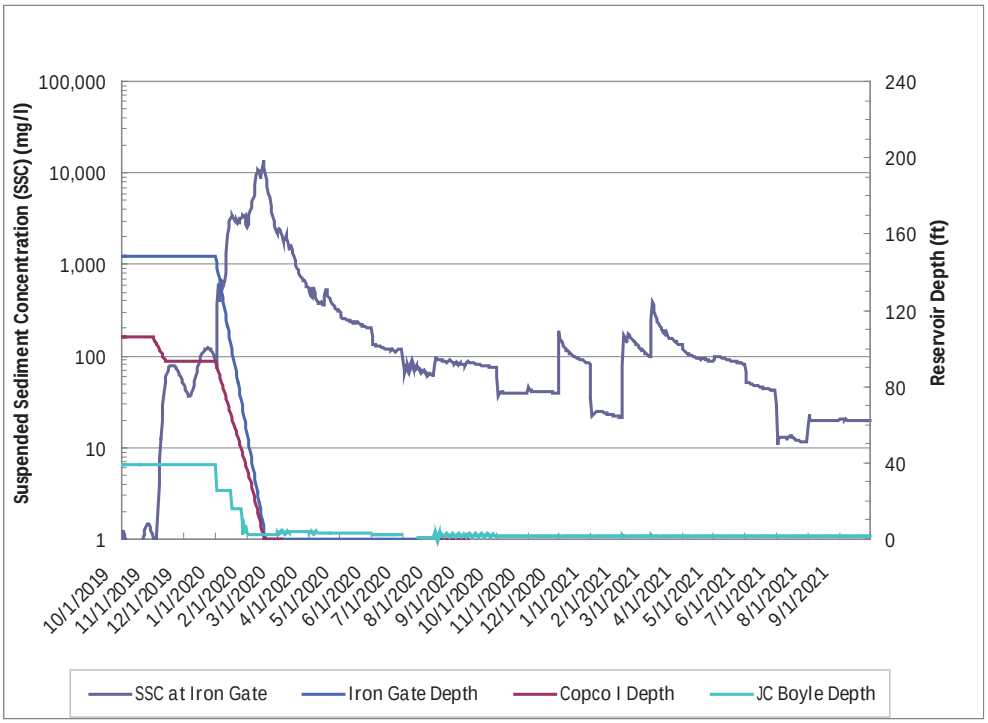


Figure 3.2-11. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Action Assuming Typical Dry Hydrology (WY2001).

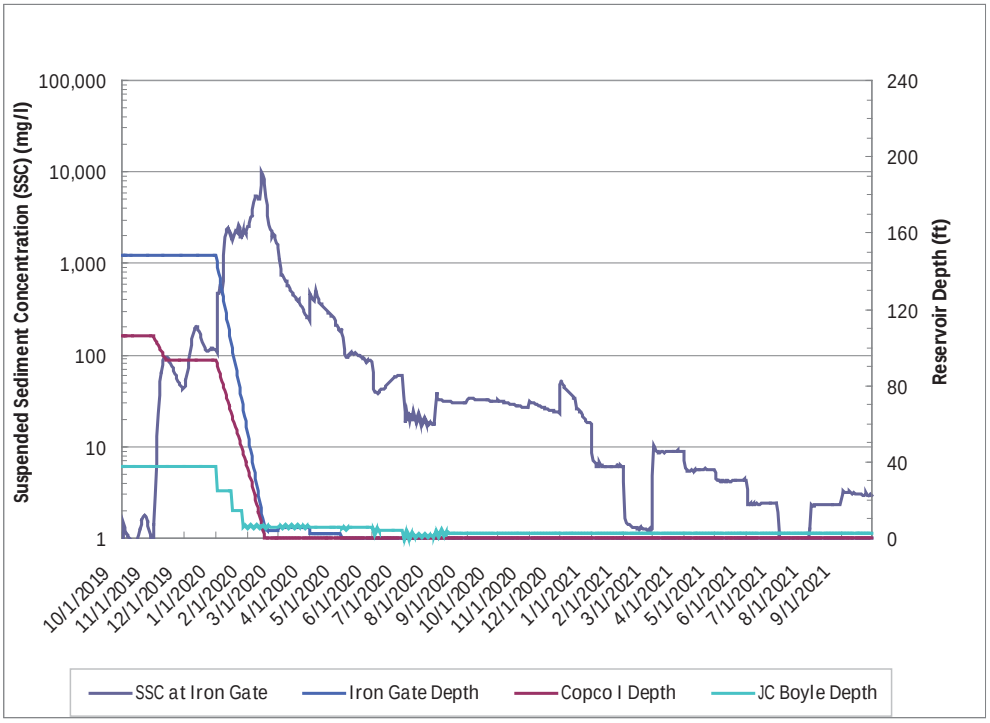


Figure 3.2-12. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Action Assuming Median Hydrology (WY1976).

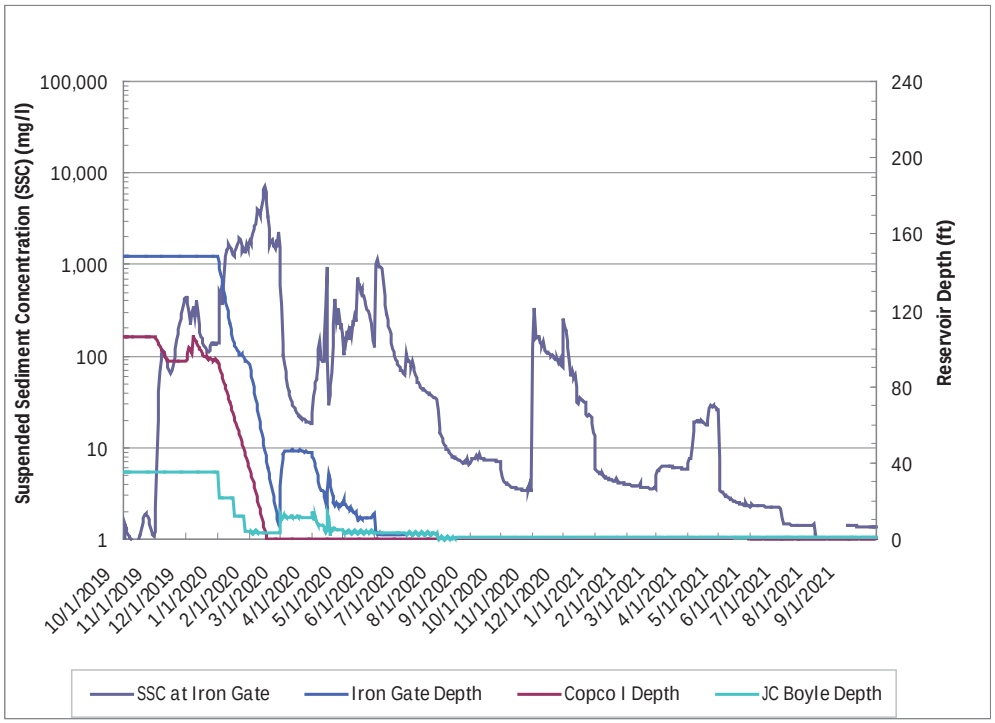


Figure 3.2-13. SSCs Modeled Downstream from Iron Gate Dam Under the Proposed Action Assuming Typical Wet Hydrology (WY1984).

Table 3.2-11. Summary of Model Predictions for SSCs in the Klamath River Downstream from Iron Gate Dam for the Proposed Action

Water Year Type	Peak SSC (mg/L)	SSC≥1,000 mg/L		SSC≥100 mg/L		SSC≥30 mg/L	
		Duration (Months)	Time Period	Duration (Months)	Time Period	Duration (Months)	Time Period
Dry (WY2001)	13,600	3	January–March 2020	6	January–June 2020	10	January–October 2020
Median (WY1976)	9,900	2	January–February 2020	5	January–May 2020	6	January–June 2020
Wet (WY1984)	7,100	2	January–February 2020 and April–July 2020	7	November 2019–February 2020 and April– June 2020	9	November 2019–July 2020

For typical dry year (WY2001) hydrologic conditions, predicted SSCs in the Klamath River immediately downstream from Iron Gate Dam (RM 190.1) experience a relatively small increase to near 100 mg/L in mid-November 2019 as Copco 1 undergoes the first phase of drawdown. A second, relatively large increase (>1,000 mg/L) would occur in early January 2020 when Iron Gate and J.C. Boyle begin drawdown and Copco 1 enters phase 2 of drawdown. Concentrations remain very high (>1,000 mg/L) for approximately 3 months from January through April 2020 (see Figure 3.2-11), with peak values exceeding 10,000 mg/L to reach approximately 13,600 mg/L for a short period (4–5 days) in mid-February 2020. SSCs generally return to less than 100 mg/L by July 2020, and to concentrations near 30 mg/L by October 2020. Predicted SSCs increase again to levels between 200–400 mg/L during winter and spring of 2021 due to flushing of sediments that were not removed during the first year following drawdown.

Model predictions for median year (WY1976) hydrologic conditions follow a pattern similar to that of a typical dry year (WY2001), with a relatively small increase in SSCs (i.e., to near 200 mg/L) in mid-December 2019, and a large (>1,000 mg/L) increase again in early January 2020. Peak SSCs downstream from Iron Gate Dam are predicted to be lower for the median year condition, reaching levels just under 10,000 mg/L. Relative to the typical dry year, the lower median year peak SSCs are a result of greater flows flushing the same volume of sediment out of the reservoir and downstream. Peak concentrations also occur in mid-February 2020 for the median year hydrologic condition (see Figure 3.2-12). Predicted SSCs downstream from Iron Gate Dam (RM 190.1) remain very high (>1,000 mg/L) for approximately 2 months following the inception of drawdown in Iron Gate and Copco 1 Reservoirs, from January through February 2020. There is a slightly earlier return to SSCs less than 100 mg/L for the median year (WY1976), with concentrations decreasing by May 2020. SSCs decrease to less than 30 mg/L by June 2020, and fluctuate between 10 mg/L and 100 mg/L through the remainder of 2020. The increases above 100 mg/L are not predicted for the typical median water year condition in the year following dam removal (2021), but fluctuating SSCs may occur in the second year following dam removal due to erosion of sediment deposits remaining in the reservoir footprint area.

Model predictions for typical wet year (WY1984) hydrologic conditions indicate a higher initial pulse of fine sediments following the first phase of Copco 1 drawdown in early to mid-December 2019, with concentrations at or near 400 mg/L. Model predictions indicate that for typical wet year conditions, the outlet capacity at Copco 1 Dam is exceeded during the same timeframe and the reservoir fills slightly (see Figure 3.2-13). Very high (>1,000 mg/L) SSCs are experienced for approximately 2 months following the inception of drawdown in the reservoirs, from January through February 2020 (see Figure 3.2-13). SSCs reach approximately 7,100 mg/L, with peak values occurring in mid-February 2020. Secondary peaks (≈1,000 mg/L) in SSCs occur in mid-April and June 2020 for wet year (WY1984) hydrologic conditions. SSCs generally return to less than 100 mg/L during the month of March 2020 and then again by July 2020. Concentrations return to less than 30 mg/L by July 2020.

For all three water year types, predicted SSCs in the Lower Klamath River decrease to 60–70 percent of their value at Iron Gate Dam by Seiad Valley (RM 129.4) and to 40 percent of their value at Iron Gate Dam by about RM 59, downstream from Orleans (Reclamation 2012).

Overall, and within the general uncertainty of the model predictions, SSCs across the three water year types would have peak values of 7,000–14,000 mg/L and would occur within 2–3 months of reservoir drawdown. SSCs in excess of 1,000 mg/L would occur on a timescale of weeks to months (see Table 3.2-11), as compared to SSCs greater than 1,000 mg/L that can occur during winter storm events on a timescale of days to weeks under existing conditions in the Klamath River downstream from Iron Gate Dam (see Appendix C, Section C.2.2.2). Predicted SSCs would remain greater than or equal to 100 mg/L for 5–7 months following drawdown, and concentrations would remain greater than or equal to 30 mg/L for 6–10 months following drawdown (Table 3.2-11). Model results also indicate that while dilution in the lower river would decrease SSCs to 60–70 percent of their initial value downstream from Seiad Valley (RM 129.4) and to 40 percent of their initial value downstream from Orleans (≈RM 59), within a factor of 2 uncertainty for the model results it can be conservatively assumed that SSCs in the Lower Klamath River would be sufficient (≥30 mg/L) to substantially adversely affect beneficial uses throughout the lower River and the Klamath Estuary for 6–10 months following drawdown (Reclamation 2012). A more detailed analysis of the anticipated suspended sediment effects on key fish species in the lower river is presented in Section 3.3.4.3.

Overall, sediment release associated with the Proposed Action would cause short-term increases in suspended material (≥30 mg/L for 6–10 months following drawdown) that would result in non-attainment of applicable North Coast Basin Plan water quality objectives for suspended material in the Lower Klamath River and the Klamath Estuary and would substantially adversely affect the cold freshwater habitat (COLD) beneficial use. **Under the *Proposed Action*, the short-term (<2 years following dam removal) increases in SSCs in the Lower Klamath River and the Klamath Estuary would be a significant impact.**

Sediment release associated with the removal of the Four Facilities under the Proposed Action could cause short-term (<2 years following dam removal) increases in sediment loads from the Klamath River to the Pacific Ocean and corresponding increases in concentrations of suspended material and rates of deposition in the marine nearshore environment. Sediment transport modeling predicted that 1.2 to 2.3 million tons of sediment (5.4 to 8.6 million yd^3, or 36 to 57 % of the total sediments deposited behind the dams by 2020) would be eroded from the reservoir areas upon dam removal (Reclamation 2012) (see also Section 2.2, text box on sediment weight and volume). The range of potential erosion volumes is due to the range in potential water year types that could occur during the year of dam removal.

To put the anticipated erosion volume due to dam removal in the context of annual basin-wide sediment discharge, Stillwater Sciences (2010) estimated that Klamath River annual

total sediment discharge to the estuary is approximately 5.8 million tons (4 million tons/yr of fine sediment and 1.8 million tons/yr of sand and larger sediment). Farnsworth and Warrick (2007) estimate that the annual average silt and clay discharge is 1.2 million tons/yr. There is considerable uncertainty in the annual average sediment load estimates because there is large variation in the measurement of suspended sediment concentrations (SSCs) and there is not a unique relationship between flow and SSCs. In addition, the annual variation in sediment loads in the Klamath River is large. A single storm in 1964-1965 is estimated to have contributed more than 15 million tons of sediment to the Pacific Ocean (Reclamation 2012; Stillwater Sciences 2010). However, in dry years the supply of sediment to the ocean could be much less than 1 million tons/yr (see Figure 3.2-14). Given these estimates, it is expected that the amount of sediment released as a result of dam removal would be similar to that transported by the Klamath River to the Pacific Ocean in year with average flow, much less than that transported by the Klamath River in a wet year, and significantly greater than that transported by the Klamath River in a dry year.

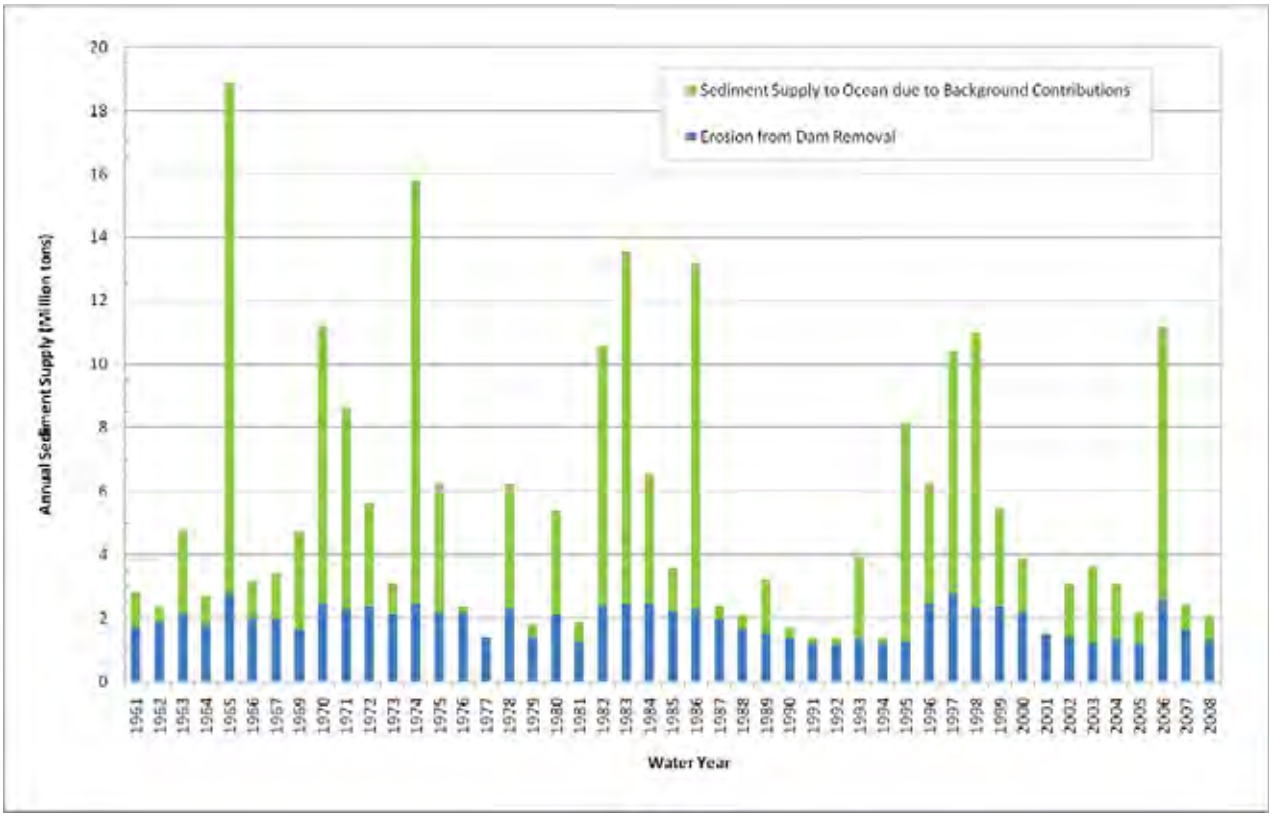


Figure 3.2-14. Annual predicted sediment delivery to the Pacific Ocean under the Proposed Action and the No Action (background conditions) by Water Year. Note: model results are only valid for the year of dam removal. No significant increase in sediment loads is predicted in years following dam removal (Source: Reclamation 2012).

After exiting the river mouth, the high SSCs (>1,000 mg/L) transported by the Lower Klamath River would form a surface plume of less dense, turbid, surface water floating on more dense, salty ocean water (Mulder and Syvitski 1995). No detailed investigations of the likely size and dynamics of the Klamath River plume have been conducted. Thus, it is not possible to predict accurately the sediment deposition pattern and location in the nearshore environment. However, the general dynamics and transport mechanisms of fine sediment can be surmised based upon regional oceanographic and sediment plume studies.

The California Marine Life Protection Act (MLPA) 2008 Draft Master Plan identifies freshwater plumes as one of three prominent habitats with demonstrated importance to coastal species (California Marine Life Protection Act 2008). The California MLPA Master Plan Science Advisory Team (2011) Methods Report designates river plumes as a key habitat to be included in marine protected areas because they harbor a particular set of species or life stages, have special physical characteristics, or are used in ways that differ from other habitats.

A recent USGS overview report on the sources, dispersal, and fate of fine sediment delivered to California's coastal waters (Farnsworth and Warrick 2007) found the following:

- Rivers dominate the supply of fine sediment to the California coastal waters, with an average annual flux of 34 million metric tons.
- All California coastal rivers discharge episodically, with large proportions of their annual sediment loads delivered over the course of only a few winter days.
- After heavy loading of fine sediment onto the continental shelf during river floods, there is increasing evidence that fluid-mud gravity flows occur within a layer 10 to 50 cm above the seabed and efficiently transport fine sediment offshore.
- Although fine sediment dominates the mid-shelf mud belts offshore of California river mouths, these mud belts are not the dominant sink of fine sediment, much of which is deposited across the inner shelf and deeper water off the continental shelf.
- Accumulation rates of fine sediment, which can exceed several millimeters per year, are generally highest near river sources of sediment and along the inner shelf and midshelf.

Farnsworth and Warrick (2007) conclude that fine sediment is a natural and dynamic element of the California coastal system because of large, natural sediment sources and dynamic transport processes.

In northern California, plume zones are primarily north of river mouths because alongshore currents and prevailing winds are northward during periods of strong runoff (Geyer et al. 2000, Pullen and Allen 2000, Farnsworth and Warrick 2007, California MLPA Master Plan Science Advisory Team 2011). Surface plumes occurring during periods of northerly (upwelling favorable) winds will thin and stretch offshore, while in

the presence of southern downwelling-favorable winds, the plume may hug the coastline and mix extensively (Geyer et al. 2000, Pullen and Allen 2000, Borgeld et al. 2008). River plume area, location, and dynamics are also affected by the magnitude of river discharge, SSCs, tides, the magnitude of winter storms, and regional climatic and oceanographic conditions such as El Niño-Southern Oscillation (ENSO) and Pacific Decadal Oscillation (PDO) climate cycles (Curran et al. 2002).

During several large flood events on the geographically proximal Eel River in the winter of 1997 and 1998, Geyer et al. (2000) found the following: flood conditions were usually accompanied by strong winds from the southern quadrant. The structure of the river plume was strongly influenced by the wind-forcing conditions. During periods of strong southerly (i.e., downwelling favorable) winds, the plume was confined inside the 50-m isobath (i.e., sea floor contour at 50-m below the water surface), within about 7 km of shore. Occasional northerly (upwelling favorable) winds arrested the northward motion of the plume and caused it to spread across the shelf. Transport of the sediment plume was confined to the inner shelf (water depths less than 50 m), during both southerly and northerly wind conditions. During southerly wind periods, fine, un-aggregated sediment was rapidly transported northward to at least 30 km from the river mouth, but flocculated sediment was deposited within 1–10 km of the river mouth. During northerly (upwelling-favorable) winds, most of the sediment fell out within 5 km of the mouth, and negligible sediment was carried offshore. The Eel River mouth is 120 km (75 miles) to the south of the Klamath River mouth and thus serves as a reasonable system for comparison.

Based upon Eel River plume studies and current knowledge of northern California oceanographic patterns, the fine sediment discharged to the marine nearshore environment under the Proposed Action would likely be delivered to the ocean in a buoyant river plume that hugs the shoreline as it is transported northward. However, since the flushing of sediments from behind the dams will occur over a number of weeks to months (and perhaps to some degree over 1-2 years), the plume carrying reservoir sediments would likely be influenced by a range of meteorological and ocean conditions (e.g., storm and non-storm periods, differing storm directions). Therefore, some of the time the plume would likely be constrained to shallower nearshore waters, while at other times it would likely extend further offshore and spread more widely. While elevated SSCs (i.e., 10–100 mg/L) created in the nearshore plume would affect physical water quality characteristics specified in the Ocean Plan (i.e., visible floating particulates, natural light attenuation, the deposition rate of inert solids [Table 3.2-7]), the effects are likely to be within the range caused by historical storm events.

A 1995 Eel River flood with a 30-yr return period delivered an estimated 25 ± 3 million metric tons of fine-grained (<62 μm) sediment to the ocean (Wheatcroft et al. 1997). Transported sediments formed a distinct layer on the sea bed that was centered on the 70-m isobath, extended for 30 km along shelf and 8 km across shelf, and was as thick as 8.5 cm. Wheatcroft et al. (1997), estimated that 75% of the flood-derived sediment did not form a recognizable sea-floor deposit, but was instead rapidly and widely dispersed over the continental margin.

A considerable amount of fine sediment in the plume is anticipated to initially deposit on the seafloor shoreward of the 60-m isobath along the coast, with greater quantities depositing in close proximity to the mouth of the Klamath River. After this initial deposition, as described by Farnsworth and Warrick (2007), resuspension during the typical winter storms would likely occur before final deposition and burial. Much of this sediment will eventually be transported further offshore to the mid-shelf and into deeper water depths off-shelf through progressive resuspension and fluid-mud gravity flows.

Because of the complexities of the transport processes, the area and depth of the deposition of fine sediment from the Proposed Action cannot be precisely predicted. However, the short-term (< 2 years following dam removal) plume effects and long-term (2–50 years following dam removal) sediment deposit effects would be less-than-significant given the relatively small amount of total sediment input, in comparison to the total annual sediment inputs to the nearshore environment, and the fact that river plume sediment inputs are a naturally occurring process. As a result, net deposition of reservoir sediments to the marine nearshore bottom substrates should be relatively less concentrated (i.e., thinner deposits in any one spot) and more widespread.

In summary, due to the relatively small magnitude of SSCs released to the nearshore environment, the anticipated rapid dilution of the sediment plume as it expands in the ocean, and the relatively low rate of deposition of sediments to the marine nearshore bottom substrates, **the short-term (< 2 years following dam removal) increases in SSCs and fine sediment deposition in the marine nearshore environment under the *Proposed Action* would be a less-than-significant impact.**

Stormwater runoff from deconstruction activities under the Proposed Action could cause short-term increases in suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment during the deconstruction period. Deconstruction activities under the Proposed Action would include demolition of the dams and their associated structures, power generation facilities, transmission lines, installation of temporary cofferdams, road upgrading, hauling, reservoir restoration, and other activities (as described in Section 2.4.3.1). Deconstruction activities are scheduled to occur between January 10 and June 26, with cofferdam installation scheduled to occur between 2 January 2020 and 6 February 2020. Therefore, cofferdam installation would occur during the first month of reservoir drawdown and the period of peak SSCs associated with mobilization of reservoir sediment deposits during drawdown. While the magnitude of short-term effects on SSCs due to erosion of the large volume of reservoir sediment deposits trapped behind the dams would be substantially greater than those due to dam deconstruction activities, this does not alleviate the requirement to reduce impacts from deconstruction-related activities. Although suspended materials from deconstruction would not likely reach the Klamath Estuary or marine nearshore environment, the potential for sediments to enter the water from deconstruction site runoff or in-water deconstruction work can be minimized or eliminated through the implementation of BMPs for deconstruction activities that would occur in or adjacent to the Klamath River. **Under the *Proposed Action*, the effect of stormwater runoff from deconstruction activities on SSCs in the Lower Klamath River and the Klamath**

Estuary would be a less-than-significant impact. There would be no change from existing conditions on the marine nearshore environment.

Under the Proposed Action, revegetation associated with management of the reservoir footprint area could decrease the transport of fine sediments eroded from exposed reservoir terraces into the Lower Klamath River and Klamath Estuary. As described for the Upper Klamath Basin, establishment of herbaceous vegetation in drained reservoir areas will be undertaken to stabilize the surface of the sediment and minimize erosion from exposed terrace surfaces following drawdown (O'Meara et al. 2010). Hydroseeding would be undertaken using standard BMPs for reducing water quality impacts during deconstruction and/or construction activities and restoration projects (Appendix B). Additional BMPs specific to hydroseeding, such as avoiding over-spray onto roads, trails, existing vegetation, and the stream channel, would also be implemented so that the hydroseed mixture itself would not easily runoff or be directly sprayed into the Klamath River. **Under the *Proposed Action*, hydroseeding would decrease the short-term (<2 years following dam removal) transport of fine sediments eroded from exposed reservoir terraces into the Lower Klamath River and Klamath Estuary and would be beneficial. There would be no change from existing conditions on the marine nearshore environment.**

Under the Proposed Action, the lack of continued interception and retention of mineral (inorganic) suspended material behind the dams at the Four Facilities could result in long-term (2–50 years following dam removal) increases in suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. As would be the case for the Upper Klamath Basin, peak concentrations of mineral (inorganic) suspended materials in the Lower Klamath Basin during the winter/early spring (November through April) would likely remain associated with high-flow events and any increases due to the lack of interception by the KHP dams would not be large; estimates of baseline sediment delivery for the Klamath Basin indicate that a relatively small fraction of total sediment (199,300 tons/yr or 3.4 percent of the cumulative average annual delivery from the basin) is supplied to the Klamath River on an annual basis from the upper and middle Klamath River (i.e., from Keno Dam to the Shasta River) (Stillwater Sciences 2010).

Under the *Proposed Action*, the long-term (2–50 years following dam removal) increases in mineral (inorganic) suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.

Under the Proposed Action, the lack of continued interception and retention of algal-derived (organic) suspended material by the dams at the Four Facilities could result in slight long-term (2–50 years following dam removal) increases in suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. While removal of the Four Facilities would eliminate the potential for downstream increases in suspended material due to seasonal algal blooms occurring within the reservoirs at the Four Facilities, overall sediment (both suspended and fluvial or bedload)

trapping in the Hydroelectric Reach would no longer occur, such that, in the long term, summertime algal-derived suspended material originating from Upper Klamath Lake may move farther downstream into the lower basin and cause a relative increase in suspended material. However, similar to the No Action/No Project Alternative, interception and retention of suspended material from upstream sources would still occur to a large degree in the Keno Impoundment/Lake Ewauna, as would additional decreases in concentration due to mechanical breakdown of algal remains in the turbulent river reaches between Keno Dam and Copco 1 Reservoir, and dilution from the springs downstream from J.C. Boyle Dam.

Because existing conditions indicate that average June–October suspended sediment values decrease from over 16 mg/L at the mouth of Link River to 6 mg/L in the Klamath River downstream from J.C. Boyle Reservoir (2001–2003), with median turbidity values following a similar pattern over the long-term historical record (1950–2001) (see Section 3.2.3.1 and Appendix C, Section C.2), it is likely that the suspended sediment signal would not increase beyond typical existing conditions concentrations of 10–15 mg/L. Therefore, summertime suspended sediment in the Lower Klamath River is unlikely to increase beyond a sustained 30 mg/L for four weeks, the water quality criterion adopted for significant adverse impacts on the cold freshwater habitat (COLD) beneficial use for the Klamath Facilities Removal EIS/EIR analysis (see Section 3.2.4.2.2.1). If slight long-term increases in suspended materials did occur, they would likely be offset by the loss of algal-derived suspended material previously produced in Copco 1 and Iron Gate Reservoirs and would not exceed levels that would substantially adversely affect the cold freshwater habitat (COLD) beneficial use.

Under the *Proposed Action*, the long-term (2–50 years following dam removal) increases algal-derived (organic) suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.

Nutrients

Upper Klamath Basin

Sediment release associated with the removal of the Four Facilities under the Proposed Action could cause short-term (<2 years following dam removal) increases in sediment-associated nutrients. Short-term increases in TN and TP concentrations in the Hydroelectric Reach would occur because particulate (primarily organic) nutrients contained in reservoir sediment deposits would be transported along with the sediments themselves. However, minimal deposition of fine suspended sediments, including associated nutrients, would occur in the river channel (Reclamation 2012, Stillwater Sciences 2008). Further, reservoir drawdown under the Proposed Action would occur during winter months when rates of primary productivity and microbially mediated nutrient cycling (e.g., nitrification, denitrification) are also expected to be low. Light limitation for primary producers that do persist during winter months is also likely to occur, further decreasing the potential for uptake of TN and TP released along with reservoir sediment deposits. Therefore, particulate nutrients released along with sediment

deposits are not expected to be bioavailable and should be well-conserved during transport through the Hydroelectric Reach. **Under the *Proposed Action*, the short-term (<2 years following dam removal) increase in nutrients in the Hydroelectric Reach would be a less-than-significant impact.**

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could cause long-term (2–50 years following dam removal) increases in nutrient levels in the Hydroelectric Reach. The Four Facilities, and primarily the two largest reservoirs (Copco 1 and Iron Gate Reservoirs), intercept and retain suspended material behind the dams, including phosphorus and nitrogen originating from Upper Klamath Lake (see Section 3.2.3.1). Under the Proposed Action, these nutrients would be transported downstream and potentially be available for uptake (e.g., by nuisance algae species). Analyses of the effects of dam removal on nutrients have been conducted by PacifiCorp for its relicensing efforts (FERC 2007), NCRWQCB for development of the California Klamath River TMDLs (NCRWQCB 2010a), and the Yurok Tribe as part of an evaluation to improve previous mass-balance estimates of nutrients in the Klamath River and increase understanding of retention rates in free-flowing river reaches (Asarian et al. 2010). While the results of all of the evaluations recognize the trapping efficiency of Copco 1 and Iron Gate Reservoirs with respect to TP and TN, such that under the Proposed Action total nutrient concentrations in the Klamath River downstream from Iron Gate Dam would increase on an annual basis, the majority of the results are focused on the Klamath Basin downstream from Iron Gate Dam.

However, modeling conducted for development of the California Klamath River TMDLs (NCRWQCB 2010a) provides some information applicable to the assessment of long-term (2–50 years following dam removal) effects of the Proposed Action on nutrients at locations in the Upper Klamath Basin (i.e., upstream of Iron Gate Dam) (Kirk et al. 2010). Klamath TMDL model results indicate that under the Proposed Action (similar to the TMDL TOD2RN scenario, which includes Oregon TMDL allocations), TP and TN in the Hydroelectric Reach immediately downstream from J.C. Boyle Dam would increase slightly (<0.015 mg/L and <0.05 mg/L, respectively) during summer months compared to those of the No Action/No Project Alternative (similar to the TMDL T4BSRN scenario) due to the absence of nutrient interception and retention in both Keno Impoundment/Lake Ewauna and J.C. Boyle Reservoir (the former because the TMDL model TOD2RN scenario includes the historic Keno Reef instead of Keno Dam [Appendix D]). At the Oregon-California State line, the situation would be much the same, although the lack of hydropower peaking operations under the Proposed Action may result in decreased daily variation in TP and ortho-phosphorus, as well as nitrate and ammonium (NCRWQCB 2010a). Overall however, the predicted increases would be very small and these increases may be at least partially due to the assumption that the historic Keno Reef exists rather than Keno Dam. Further, the TMDL model predictions generally agree with empirical data regarding J.C. Boyle Reservoir; with its shallow depth and short residence time, this reservoir does not retain high amounts of nutrients (PacifiCorp 2006a) (see Appendix C for more detail) and its removal would not be expected to increase nutrient transport further downstream in the Hydroelectric Reach.

Based on available information, the slight nutrient increases in the Hydroelectric Reach would not be expected to result in exceedances of either Oregon water quality objectives for nuisance algae growth, or California North Coast Basin Plan water quality objectives for biostimulatory substances, beyond levels experienced under the No Action/No Project Alternative. While periphyton colonization would likely increase in this reach under the Proposed Action, the increases would be due to habitat increases rather than nutrient increases (see Section 3.4.4.3.2 Algae). Further, the lacustrine environment that supports the growth of nuisance algae blooms of such as *M. aeruginosa* or other cyanobacteria would be eliminated under the Proposed Action (see Section 3.4, Algae), reducing the likelihood of uptake of the slightly increased nutrient concentrations by nuisance species of phytoplankton algae. This is mainly relevant for Copco 1 and Iron Gate Reservoirs, where the longer residence times support seasonal nuisance algae blooms (see Section 3.4, Algae). **Under the *Proposed Action*, the long-term (2–50 years following dam removal) increase in nutrients in the Hydroelectric Reach would be a less-than-significant impact.**

Lower Klamath Basin

Sediment release associated with the removal of the Four Facilities under the Proposed Action could cause short-term (<2 years following dam removal) increases in sediment-associated nutrients in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. **Under the *Proposed Action*, the short-term (<2 years following dam removal) increase in nutrients in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be the same as in the Hydroelectric Reach and would be a less-than-significant impact.**

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could cause long-term (2–50 years following dam removal) increases in nutrient levels in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. The reservoirs at the Four Facilities currently intercept and retain suspended material behind the dams, including phosphorus and nitrogen originating from Upper Klamath Lake (see Section 3.2.3.1). Under the Proposed Action, these nutrients would be transported downstream and potentially be available for uptake by algae, including nuisance algae species. Analyses of the effects of dam removal on nutrients have been conducted by PacifiCorp for its relicensing efforts (FERC 2007), NCRWQCB for development of the California Klamath River TMDLs (NCRWQCB 2010a), and the Yurok Tribe as part of an evaluation to improve previous mass-balance estimates of nutrients in the Klamath River and increase understanding of retention rates in free-flowing river reaches (Asarian et al. 2010). Results of all of the evaluations recognize the trapping efficiency of the reservoirs with respect to TP and TN, such that under the Proposed Action total nutrient concentrations in the Klamath River downstream from Iron Gate Dam would increase on an annual basis.

Based on the Yurok Tribe analysis, TP concentrations would increase approximately 2-12 percent for the June–October period under the Proposed Action, while increases in TN concentrations would be relatively larger, at an estimated 37-42 percent for June-October and 48-55 percent for July–September (see Figure 3.2-15). Asarian et al. (2010) conducted their analysis using two different approaches; 1) calculated reach-specific nutrient retention rates based on measured nutrient concentration data, and 2) predicted retention rates using an empirical relationship between observed retention rates and measured concentrations developed for the river from Iron Gate Dam to Turwar (this approach was only applicable to TN because TP data demonstrated a weak relationship between retention rate and measured TP concentrations). This calculation implicitly includes nutrient recycling processes such as assimilative uptake for algal growth and subsequent downstream release, as these processes were ongoing and inherently included in the retention estimates determined for existing conditions. Both approaches yield similar results, indicating small increases in TP and relatively larger increases in TN concentrations downstream from the Hydroelectric Reach under the Proposed Action, which diminish with distance downstream due to both tributary dilution and nutrient retention (i.e., uptake of nutrients).

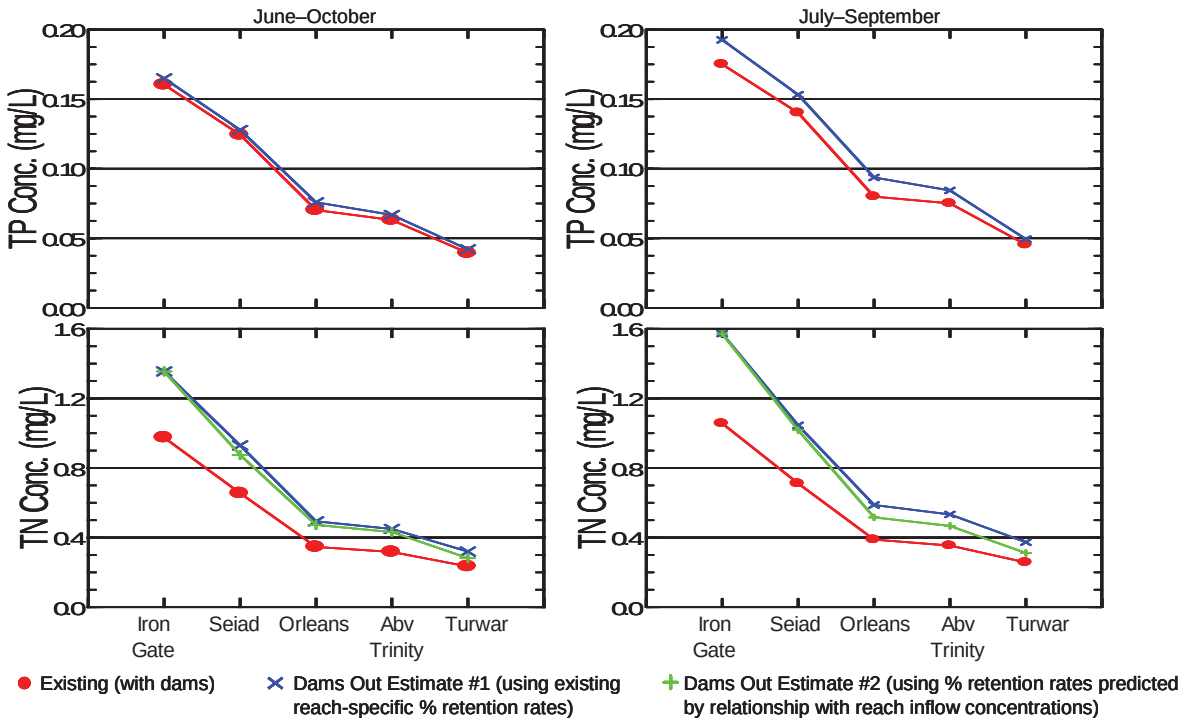


Figure 3.2-15. Comparison of TP and TN Concentrations from Iron Gate Dam to Turwar (RM 5.8) for June–October and July–September 2007–2008: (a) Measured Current Conditions (Red Circle), (b) Dams-Out Estimate using Calculated Percent Retention Rates by Reach (Blue Cross), and (c) Dams-Out Estimate using Percent Retention Rates Predicted by the Empirical Relationship between Reach Inflow Concentration and Retention (Green Cross). Source: Asarian et al. 2010.

Due to a lack of available data, the Yurok Tribe analysis does not consider other possible factors that may decrease nutrients upstream of Copco 1 Reservoir under the Proposed Action, such as TMDL implementation or elimination of peaking flows from hydropower operations (Asarian et al. 2010). If reductions in nutrient concentrations do occur upstream of Copco 1, then less nutrients would be available for removal in the reservoirs and dam removal would likely result in smaller long-term increases in nutrient concentration than predicted by the Yurok Tribe analysis (Asarian et al. 2010) analysis.

Klamath TMDL modeling efforts include an assumption of compliance with upstream TP and TN load allocations for both Oregon and California (NCRWQCB 2010a). Results are in general agreement with PacifiCorp (FERC 2007) and Yurok Tribe (Asarian et al. 2010) analyses regarding dam removal effects on nutrients, with very small annual increases in TP (0.01–0.015 mg/L) and relatively larger annual increases in TN (0.1-0.125 mg/L) immediately downstream from Iron Gate Dam (RM 190.1). Increases in nutrients would diminish with distance downstream. Note that while following the same relative trend as the Yurok Tribe analysis, the absolute increases predicted by TMDL model are much lower (e.g., 0.1–0.125 mg/L TN increase for the TMDL model vs. 0.1-0.5 mg/L TN increase for the Yurok Tribe analysis).

Continuing increased variability in TP and TN are predicted by the Klamath TMDL model (see Appendix D) during summer months, presumably due to nutrient uptake dynamics by periphyton and macrophytes. The TMDL model does not include denitrification as a possible nitrogen removal term in riverine segments (Tetra Tech 2009), meaning that TN concentrations under the Proposed Action (but also the No Action/No Project Alternative) may be overpredicted. The magnitude of this potential over-prediction would be expected to increase with distance downstream (i.e., relatively lower over-prediction at Iron Gate Dam and the Upper Klamath Basin, but relatively higher over-prediction at sites in the lowest portion of the river such as Orleans), due to a longer distance of river within which denitrification and other nitrogen removal processes would operate. Corresponding small differences in ortho-phosphorus, nitrate, and ammonium concentrations under the Proposed Action (as compared with the No Action/No Project Alternative, including TMDL compliance) are predicted by the model; however, within the uncertainty of future nutrient dynamics these differences are not clearly discernable as increases or decreases. TMDL model results indicate that while resulting TP levels would meet the existing Hoopa Valley Tribe numeric water quality objective (0.035 mg/L TP) at the Hoopa reach (≈RM 45–46) of the Klamath River, TN levels would continue to be in excess of the existing objective (0.2 mg/L TN) in some months (NCRWQCB 2010a). However, as noted previously, TN concentrations in the model may be over-predicted and therefore the Hoopa Valley Tribe objective may in fact be met.

Despite the overall increases in absolute nutrient concentrations anticipated under the Proposed Action, the relatively greater increases in TN may not result in significant biostimulatory effects on periphyton growth because it will be accompanied by only a relatively minor increase in TP. Existing data regarding TN:TP ratios suggest the potential for the Klamath River to be generally N-limited (TN:TP). However,

concentrations of both nutrients are high enough in the river from Iron Gate Dam (RM 190.1) to approximately Seiad Valley (RM 129.4) (and potentially further downstream) that nutrients are not likely to be limiting primary productivity (i.e., periphyton growth) in this portion of the Klamath River (FERC 2007, HVTEPA 2008, Asarian et al. 2010). In addition, N-fixing species dominate the periphyton communities in the lower reaches of the Klamath River where inorganic nitrogen concentrations are low (Asarian et al. 2010). Since these species can fix their own nitrogen from the atmosphere, increases in TN due to dam removal may not significantly increase algal biomass (see also Section 3.4, Algae), particularly if overall TN increases are less than those predicted by existing models due to implementation of TMDLs and general nutrient reductions in the Klamath Basin. **Under the *Proposed Action*, the long-term (2–50 years following dam removal) increase in nutrients in the Lower Klamath River and the Klamath Estuary would be a less-than-significant impact.**

Dissolved Oxygen

Upper Klamath Basin

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) increases in oxygen demand and reductions in dissolved oxygen in the Hydroelectric Reach downstream from J.C. Boyle Reservoir. While modeled oxygen demand is not available downstream from J.C. Boyle Reservoir, model results are available downstream from Iron Gate Dam as a function of SSC (see Section 3.2.4.3.2.4, Lower Klamath Basin) and can be applied to the Hydroelectric Reach downstream from J.C. Boyle Reservoir. This assumes as a worst case scenario that the effects of sediment release on short-term oxygen demand (and reductions in dissolved oxygen) in the Hydroelectric Reach downstream from J.C. Boyle Dam would be the same as those for the Lower Klamath River. This is a conservative assumption because peak SSCs downstream from J.C. Boyle Reservoir would be much lower and of shorter duration (i.e., 2,000–3,000 mg/L occurring within 1–2 months of reservoir drawdown) than those predicted downstream from Iron Gate Dam (i.e., 7,000–14,000 mg/L occurring within 2–3 months of reservoir drawdown) (see Section 3.2.4.3.2.2 and Figures 3.2-8 through 3.2-10). Like the effect determination for the Klamath River downstream from Iron Gate Dam, this would be a significant impact (see detailed analysis for Lower Klamath Basin, below).

Under the *Proposed Action*, the short-term (<2 years following dam removal) decrease in dissolved oxygen concentrations would be a significant impact on the riverine reaches of the Klamath River downstream from J.C. Boyle Dam to the Oregon-California State line.

Removal of the Four Facilities under the Proposed Action could cause long-term (2–50 years following dam removal) increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, in the Hydroelectric Reach. Modeling conducted for development of the Oregon and California Klamath River TMDLs indicates that under the Proposed Action (similar to the TMDL TOD2RN scenario), dissolved oxygen concentrations in the Hydroelectric Reach downstream from J.C. Boyle Dam and at the Oregon-California State line would be slightly greater during July through October than

those under the No Action/No Project (similar to the TMDL T4BSRN scenario), due to the removal of J.C. Boyle Reservoir (see Figure 3.2-16 and Figure 3.2-17; NCRWQCB 2010a). The same pattern is predicted for 30-day mean minimum and 7-day mean minimum dissolved oxygen criteria. The Klamath TMDL model (see Appendix D) also predicts that daily fluctuations in dissolved oxygen immediately downstream from J.C. Boyle Dam during this same period would be greater under the Proposed Action (TCD2RN) than the No Action/No Project Alternative (T4BSRN) (Figure 3.2-16) While the model-predicted increases in daily dissolved oxygen fluctuations may be linked to greater periphyton biomass and associated daily swings in photosynthetic oxygen production and respiratory consumption in the free-flowing river, the results are not entirely certain. The role of photosynthesis and community respiration from periphyton growth in the free-flowing reaches of the river replacing the reservoirs at the Four Facilities is unknown because nutrient cycling and resulting rates of primary productivity under the No Action/No Project Alternative are uncertain (see Section 3.2.1.1). Further, scouring in the free-flowing river from increased bed mobility and variable streamflows (see Section 3.4.4.3.2) may also limit primary productivity under the Proposed Action, which would decrease daily dissolved oxygen variability.

Further downstream at State line (i.e., in the Peaking Reach), the TMDL model predicts somewhat reduced daily fluctuations in dissolved oxygen under the Proposed Action (TCD2RN) as compared to the No Action/No Project Alternative (T4BSRN) (Figure 3.2-17). The predicted decreases in daily variability at State line may be due to elimination of hydropower peaking operations; however, since daily variability in dissolved oxygen is not currently an issue in the Peaking Reach, nor would the predicted reduced fluctuations result in an inability to meet water quality objectives (see below paragraph), this potential effect would be less than significant.

For the river downstream from J.C. Boyle Dam and at State line, modeling predictions are generally in compliance with the Oregon water quality objectives for supporting warm water (5.5 mg/L) and cool water (6.5 mg/L) fish beneficial uses, where lower dissolved oxygen concentrations in June–August would meet the Oregon narrative natural conditions criterion that supersedes the numeric objectives for the cold water beneficial use (8.0 mg/L). The same would occur for predicted concentrations in mid-February–May as related to the spawning (11 mg/L) beneficial use (Figure 3.2-16 and Figure 3.2-17; NCRWQCB 2010a).

For the free-flowing reaches of the river replacing the reservoirs, long-term dissolved oxygen levels would differ substantially from the super-saturation (i.e., >100% saturation) that currently occurs in surface waters and the hypolimnetic oxygen depletion in that occurs in bottom waters of Copco 1 and Iron Gate Reservoirs during the April/May through October/November period (see Section 3.2.3.5). Dissolved oxygen in the free-flowing reaches of the river replacing the reservoirs would not exhibit such extremes, instead possessing the riverine signal characteristic of primary production in lotic (flowing) ecosystems described above. Relative changes in dissolved oxygen under the Proposed Action would be less pronounced in the reach currently occupied by J.C. Boyle Reservoir, due to the lack of persistent thermal stratification in that reservoir.

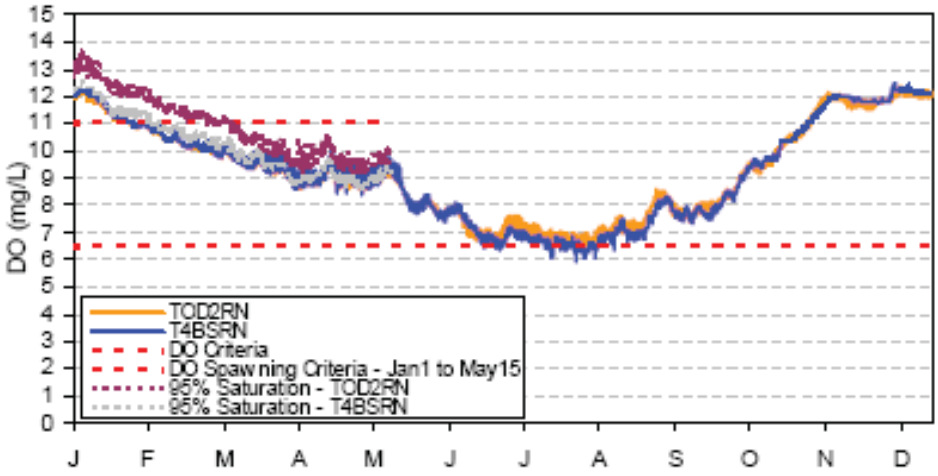


Figure 3.2-16. Predicted Dissolved Oxygen Downstream from J.C. Boyle Dam (RM 224.7 to 228.3) for the Klamath TMDL Scenarios Similar to the Proposed Action (TOD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

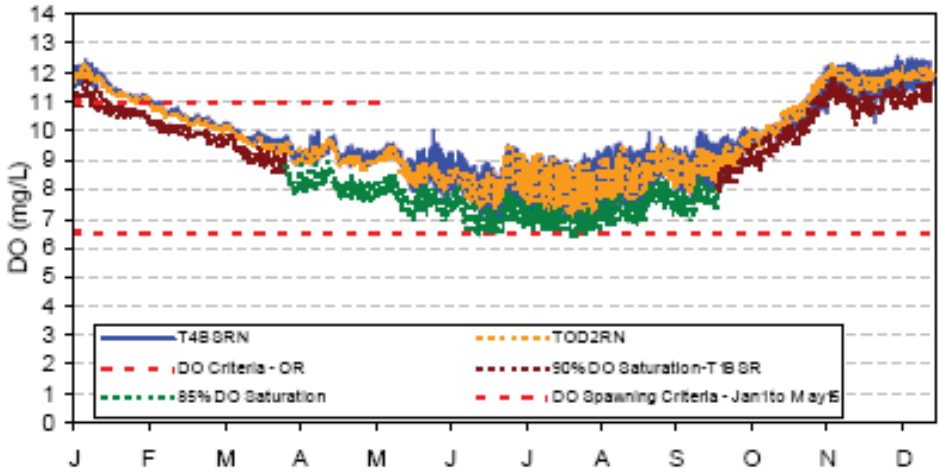


Figure 3.2-17. Predicted Dissolved Oxygen at the Oregon-California State line (RM 208.5) for the Klamath TMDL Scenarios Similar to the Proposed Action (TOD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

Under the *Proposed Action*, long-term (2–50 years following dam removal) slight increases in summer and fall dissolved oxygen concentrations and daily fluctuations downstream from J.C. Boyle Dam would be beneficial. Slight decreases in daily fluctuations at the California-Oregon State line would be less than significant. Elimination of seasonal extremes in dissolved oxygen (i.e., supersaturation in surface waters and oxygen depletion in bottom waters) in the riverine reaches replacing Copco 1 and Iron Gate Reservoirs in the Hydroelectric Reach would be beneficial.

Lower Klamath Basin

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) increases in oxygen demand (IOD and BOD) and reductions in dissolved oxygen in the Lower Klamath River, the Klamath Estuary and the marine nearshore environment. Under the Proposed Action, high SSCs are expected in the middle and Lower Klamath River immediately following dam removal (see Alternative 2 – Full Facilities Removal of Four Dams – Suspended Sediments). The high fraction of organic carbon present in the reservoir sediments (see Section 3.2.3.1) allows for the possibility of oxygen demand generated by microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal.

Based on results from a dissolved oxygen spreadsheet model (see Section 3.2.4.1), IOD downstream from Iron Gate Dam would be 0–8.6 mg/L and BOD would be 0.3–43.8 mg/L for all water year types considered (i.e., wet, median, dry) and for all six months following drawdown (see Table 3.2-12). The highest predicted oxygen demand levels (i.e., IOD and BOD) would occur during the first four to eight weeks following drawdown of Copco 1 and Iron Gate Reservoirs (i.e., in February 2020) corresponding to the peak SSCs in the river (see above section on suspended sediments). Despite the relatively high predicted IOD and BOD values, dissolved oxygen concentrations downstream from Iron Gate Dam would generally remain greater than 5 mg/L (see Table 3.2-13). Exceptions include predicted concentrations in February 2020 for median (WY1976) and typical dry year (WY2001) hydrologic conditions, which exhibit minimum values of 3.5 mg/L and 1.3 mg/L, respectively.

For all water year types (wet, median, dry), the predicted dissolved oxygen minimum values would occur by approximately RM 188–190 (≈ 1–3 km downstream from Iron Gate Dam) and would return to at least 5 mg/L by approximately RM 175–177 (within 20-25 km of the dam), or near the confluence with the Shasta River (RM 176.7) (see Table 3.2-13). The North Coast Basin Plan water quality objective for dissolved oxygen is expressed as percent saturation; at 90 percent saturation, the water quality objective for November through April, assuming average February (2009) water temperatures, would be 9.6–10.6 mg/l (see Table 3.2-5). Based on the spreadsheet model results, recovery to the North Coast Basin Plan water quality objective of 90 percent saturation would occur generally within the reach from Seiad Valley (RM 129.4) to the mainstem confluence with Clear Creek (see Figure 3.2-1 for location of Clear Creek), or within a distance of 100–150 km (62–93 mi) downstream from the Hydroelectric Reach, for all water year

Table 3.2-12. Estimated Short-term Immediate Oxygen Demand (IOD) and Biochemical Oxygen Demand (BOD) by Month for Modeled Flow and SSCs Immediately Downstream from Iron Gate Dam Under the Proposed Action

Year	Avg. Monthly Temperature (deg C)[1]	80% Dissolved Oxygen[2]	Flow (cfs)[3]	Flow (cms)	SSC (mg/L)[4]	IOD (mg/L)	BOD (mg/L)
Typical Wet Hydrology (WY 1984 Conditions Assumed)							
11/30/2019	9.9	7.29	3,343	95	444	0.3	1.6
12/1/2019	5.0	9.40	7,139	202	430	0.3	1.5
1/21/2020	3.7	9.73	8,675	246	1,962	1.2	6.9
2/15/2020	4.4	9.55	3,949	112	7,116	4.5	25.1
3/1/2020	6.7	9.00	4,753	135	593	0.4	2.1
4/15/2020	8.4	8.63	4,374	124	939	0.6	3.3
Median Hydrology (WY 1976 Conditions Assumed)							
11/12/2019	9.9	7.29	2,074	59	96.2	0.1	0.3
12/12/2019	5.0	9.40	2,156	61	202.5	0.1	0.7
1/22/2020	3.7	9.73	6,533	185	2,593.5	1.6	9.1
2/14/2020	4.4	9.55	2,933	83	9,893.2	6.2	34.8
3/1/2020	6.7	9.00	3,016	85	1,461.2	0.9	5.1
4/7/2020	8.4	8.63	2,657	75	509.3	0.3	1.8
Typical Dry Hydrology (WY 2001 Conditions Assumed)							
11/19/2019	9.9	7.29	1,141	32	79.1	0.0	0.3
12/23/2019	5.0	9.40	1,284	36	122.2	0.1	0.4
1/17/2020	3.7	9.73	4,245	120	3,513.7	2.2	12.4
2/16/2020	4.4	9.55	1,040	29	13,573.5	8.6	47.8
3/2/2020	6.7	9.00	1,344	38	2,420.7	1.5	8.5
4/5/2020	8.4	8.63	1,150	33	551.1	0.3	1.9

Source: Stillwater Sciences 2011

[1] Raw daily water temperature data for 2009 from http://www.pacificorp.com/es/hydro/hl/kr.html# (PacifiCorp 2009). Monthly summary data also presented in Table 3.2-12.

[2] Initial dissolved oxygen downstream from Iron Gate Dam calculated for 80% saturation using average monthly water temperature, salinity = 0 ppt, and elevation = 707 m (2,320 ft). An initial dissolved oxygen at 70% saturation was used for the November model runs based on 2009 conditions (Appendix C, Table C-7).

[3] Predicted daily flow values from Reclamation hydrologic model output (Reclamation 2012). Daily flow values correspond to the peak suspended sediment concentration (SSC) for each month.

[4] Predicted peak suspended sediment concentration (SSC) by month from Reclamation model output under the Proposed Action (Reclamation 2012).

Table 3.2-13. Estimated Location of Minimum Dissolved Oxygen and Location at which Dissolved Oxygen Would Return to 5 mg/L Downstream from Iron Gate Dam Due to High Short-term SSCs Under the Proposed Action

Date	Boundary Conditions at Iron Gate Dam			Spreadsheet Model Output		
	Initial Dissolved Oxygen (at 80% Saturation)[1]	IOD	BOD	Minimum Dissolved Oxygen	Location of Minimum Dissolved Oxygen	Location at which Dissolved Oxygen Returns to 5 mg/L[2]
	(mg/L)	(mg/L)	(mg/L)	(mg/L)	RM	RM
Typical Wet Hydrology (WY 1984 Conditions Assumed)						
11/30/2019	7.29	0.3	1.6	7.10	189.5	NA [3]
12/1/2019	9.40	0.3	1.5	9.18	188.9	NA
1/21/2020	9.73	1.2	6.9	8.56	188.2	NA
2/15/2020	9.55	4.5	25.1	5.21	188.9	NA
3/1/2020	9.00	0.4	2.1	8.70	188.9	NA
4/15/2020	8.63	0.6	3.3	8.11	188.9	NA
Median Hydrology (WY 1976 Conditions Assumed)						
11/12/2019	7.29	0.1	0.3	7.29	190.1	NA
12/12/2019	9.40	0.1	0.7	9.34	189.5	NA
1/22/2020	9.73	1.6	9.1	8.18	188.2	NA
2/14/2020	9.55	6.2	34.8	3.49	188.9	175.2
3/1/2020	9.00	0.9	5.1	8.19	188.9	NA
4/7/2020	8.63	0.3	1.8	8.38	189.5	NA
Typical Dry Hydrology (WY 2001 Conditions Assumed)						
11/19/2019	7.29	0.0	0.3	7.29	190.1	NA
12/23/2019	9.40	0.1	0.4	9.40	190.1	NA
1/17/2020	9.73	2.2	12.4	7.62	188.9	NA
2/16/2020	9.55	8.6	47.8	1.33	189.5	177.1
3/2/2020	9.00	1.5	8.5	7.62	189.5	NA
4/5/2020	8.63	0.3	1.9	8.39	189.5	NA

Source: Stillwater Sciences 2011.

[1] Initial dissolved oxygen downstream from Iron Gate Dam calculated for 80% saturation using average monthly water temperature, salinity = 0 ppt, and elevation = 707 m (2,320 ft). An initial dissolved oxygen at 70% saturation was used for the November model runs. See average monthly dissolved oxygen (% saturation) for 2009 in Appendix C, Table C-7. Raw daily water temperature data from http://www.pacificorp.com/es/hydro/hl/kr.html# (PacifiCorp 2009).

[2] Minimum acceptable dissolved oxygen concentration for salmonids. Although the minimum acceptable water quality objective for dissolved oxygen in the Klamath River for warm freshwater, saline, and marine habitats was previously 5 mg/L (NCRWQCB 2006), recent Basin Plan amendments require 85-90% saturation (generally ranging from 6–11 mg/L) depending on location and month (NCRWQCB 2010). Section 3.3 (Aquatics) of this EIS/EIR references a threshold of 6 mg/L for migrating adult anadromous salmonids (USEPA 1986), which is also a useful benchmark for dissolved oxygen concentrations. Based on BOD/IOD model results, a return to 6 mg/L dissolved oxygen would occur further downstream than the results presented in Table 3.2-13, on the order of 5–15 miles (10–25 km) depending on hydrologic conditions.

[3] NA = not applicable because dissolved oxygen consistently remains greater than 5 mg/L.

Under the *Proposed Action*, long-term (2–50 years following dam removal) slight increases in summer and fall dissolved oxygen concentrations and daily fluctuations downstream from J.C. Boyle Dam would be beneficial. Slight decreases in daily fluctuations at the California-Oregon State line would be less than significant. Elimination of seasonal extremes in dissolved oxygen (i.e., supersaturation in surface waters and oxygen depletion in bottom waters) in the riverine reaches replacing Copco 1 and Iron Gate Reservoirs in the Hydroelectric Reach would be beneficial.

Lower Klamath Basin

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) increases in oxygen demand (IOD and BOD) and reductions in dissolved oxygen in the Lower Klamath River, the Klamath Estuary and the marine nearshore environment. Under the Proposed Action, high SSCs are expected in the middle and Lower Klamath River immediately following dam removal (see Alternative 2 – Full Facilities Removal of Four Dams – Suspended Sediments). The high fraction of organic carbon present in the reservoir sediments (see Section 3.2.3.1) allows for the possibility of oxygen demand generated by microbial oxidation of organic matter exposed to the water column from deep within the sediment profile and mobilized during dam removal.

Under the *Proposed Action*, the short-term (<2 years following dam removal) decrease in dissolved oxygen concentrations would be a significant impact on the Lower Klamath River from Iron Gate dam possibly to Clear Creek, but would not affect dissolved oxygen in the Klamath Estuary or the marine nearshore environment.

Removal of the Four Facilities under the Proposed Action could cause long-term (2-50 years following dam removal) overall increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, in the Lower Klamath River, particularly for the reach immediately downstream from Iron Gate Dam. KRWQM (see Section 3.2.1.1 for model background) results using 2001–2004 data indicate that substantial improvements in long-term dissolved oxygen may occur immediately downstream from Iron Gate Dam if the Four Facilities are removed, with increases of 3 to 4 mg/L possible during summer and late fall (PacifiCorp 2005). KRWQM output also predicts greater daily variations in dissolved oxygen concentrations downstream from Iron Gate Dam to the Trinity River confluence (RM 42.5) in the absence of the KHP dams, based upon the assumption that periphyton growth would occur in this reach if the dams were removed and would increase daily dissolved oxygen fluctuations due to photosynthetic oxygen production and respiratory consumption. However, the KRWQM does not include nutrient retention in the mainstem river downstream from Iron Gate Dam and assumes relatively high nutrient contributions from tributaries (Asarian and Kann 2006b), which could amplify model predicted daily variations in dissolved oxygen due to periphyton growth.

The Klamath TMDL model (see Appendix D) also indicates that under the Proposed Action (similar to the TMDL TCD2RN scenario), dissolved oxygen concentrations immediately downstream from Iron Gate Dam during July through November would be greater than those under the No Action/No Project (similar to the TMDL T4BSRN scenario), due to the lack of stratification and oxygen depletion in bottom waters in the upstream reservoirs as compared with a free-flowing river condition (see Figure 3.2-18). The model also predicts that daily fluctuations in dissolved oxygen at this location during this same period would be greater under the Proposed Action (TCD2RN) than the No Action/No Project Alternative (T4BSRN) (Figure 3.2-18), a condition potentially linked to periphyton establishment in the free-flowing reaches of the river that are currently occupied by reservoirs and associated daily swings in photosynthetic oxygen production and respiratory consumption. Differences in long-term dissolved oxygen concentrations between the Proposed Action and the No Action/No Project Alternative diminish with distance downstream from Iron Gate Dam, with similar or the same predicted dissolved oxygen concentrations and similar magnitude and duration of daily fluctuations by Seiad Valley (RM 129.4) and no differences by the confluence with the Trinity River (RM 42.5) (see Figure 3.2-18 to Figure 3.2-21).

At all modeled locations, the Klamath TMDL model indicates consistent compliance with the California North Coast Basin Plan water quality objective of 85 percent saturation (see Figure 3.2-18 to Figure 3.2-21). Further downstream, near the confluence with the Trinity River (see Figure 3.2-21), results also indicate that while minimum values may occasionally dip below the current Hoopa Valley Tribe minimum water quality objective (8 mg/L) (applicable from ≈RM 45–46), they would not fall below the 80 percent saturation objective modeled for the TMDL and would likely also not fall below the 90 percent saturation Hoopa Valley Tribe objective awaiting approval by USEPA (see Table 3.2-6) (90 percent saturation objective not shown in Figure 3.2-21, but the general trend is apparent). Winter time (January–March) dissolved oxygen concentrations would be slightly lower under the Proposed Action, but would not fall below Basin Plan minimum criteria for the winter season (90 percent saturation; see Table 3.2-4).

The magnitude of the increased daily fluctuations in dissolved oxygen immediately downstream from Iron Gate Dam predicted by the PacifiCorp and Klamath TMDL modeling efforts are not entirely certain; the role of photosynthesis and community respiration from periphyton growth in the free-flowing reaches of the river replacing the reservoirs at the Four Facilities is unknown because nutrient cycling and resulting rates of primary productivity under the No Action/No Project Alternative are uncertain (see Section 3.4, Algae). Therefore, overall, the removal of the Four Facilities under the Proposed Action would cause long-term increases in summer and fall dissolved oxygen in the Lower Klamath River immediately downstream from Iron Gate Dam, along with increases in daily variability, although the magnitude of the increased variability is somewhat uncertain. Effects would diminish with distance downstream from Iron Gate Dam, such that there would be no measurable effects on dissolved oxygen by the confluence with the Trinity River. **Under the *Proposed Action*, the long-term (2–50 years following dam removal) increases in summer and fall dissolved oxygen concentrations immediately downstream from Iron Gate Dam would be beneficial.**

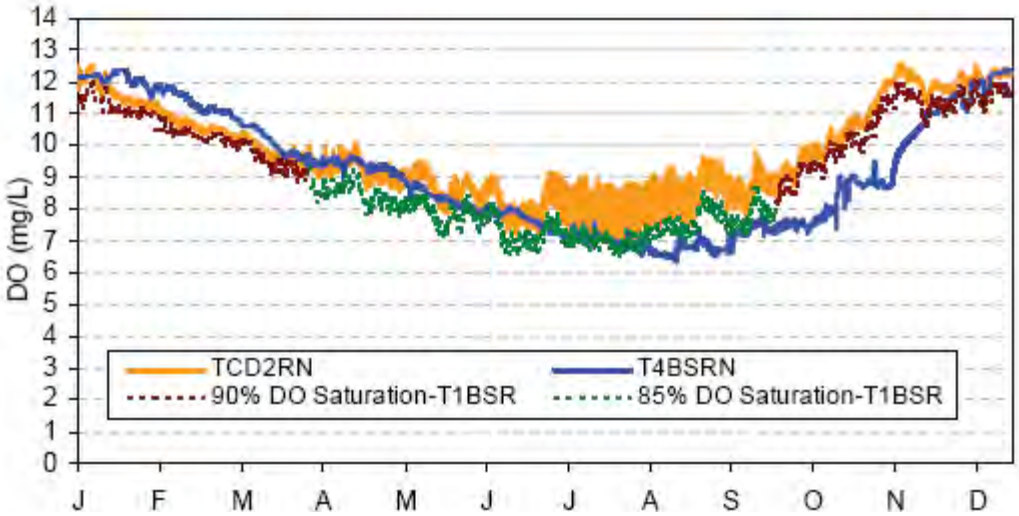


Figure 3.2-18. Predicted Dissolved Oxygen Downstream from Iron Gate Dam (RM 190.1) for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

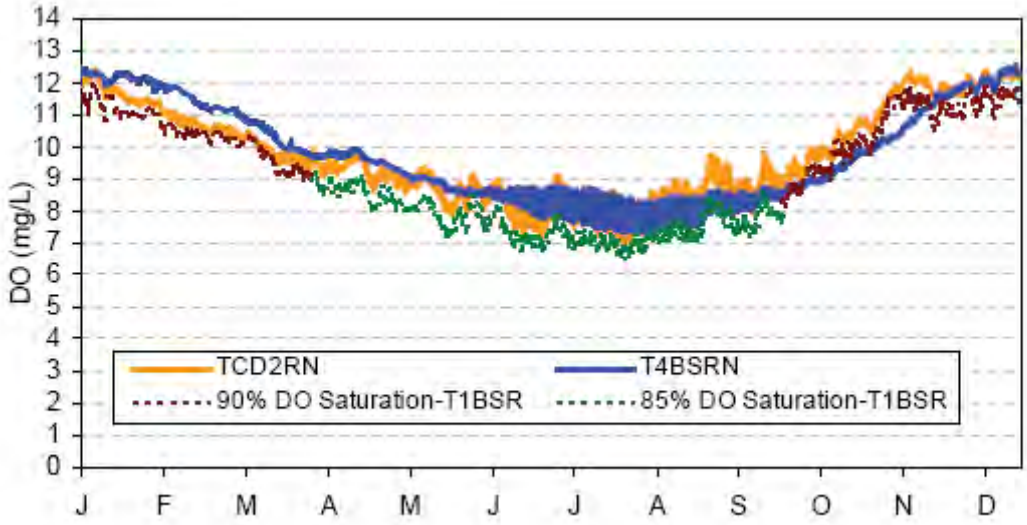


Figure 3.2-19. Predicted Dissolved Oxygen Downstream from the Mainstem Confluence with the Shasta River (RM 176.7) for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

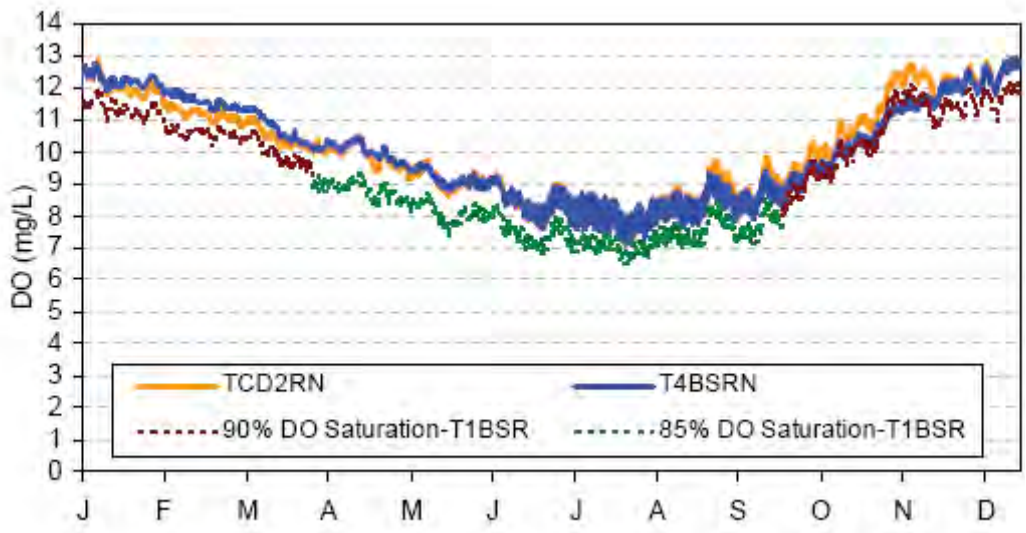


Figure 3.2-20. Predicted Dissolved Oxygen at Seiad Valley (RM 129.4) for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

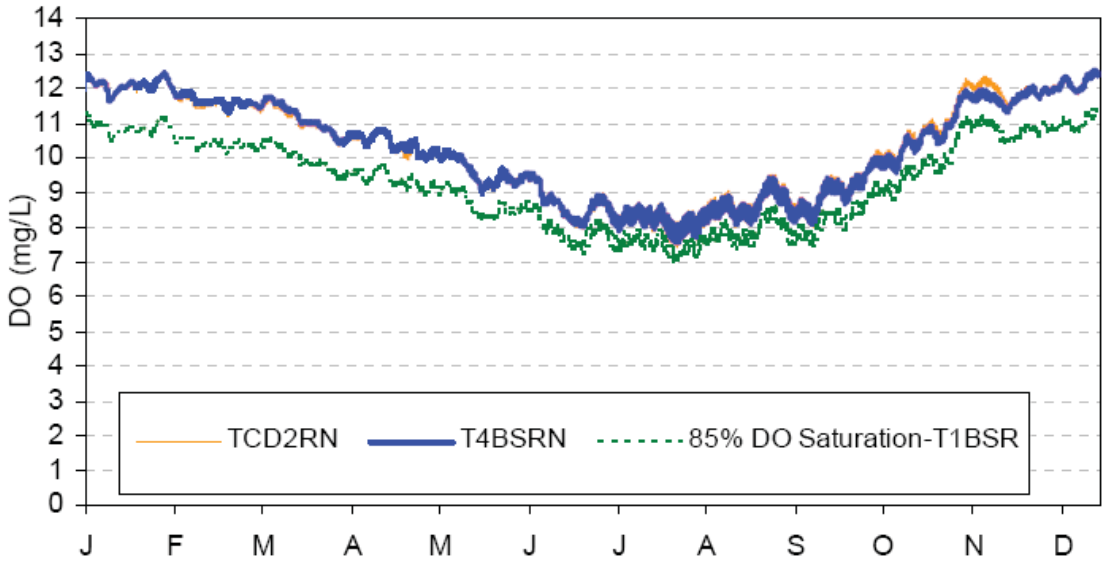


Figure 3.2-21. Predicted Dissolved Oxygen Just Upstream of the Confluence with the Trinity River (RM 42.5) for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

pH

Upper Klamath Basin

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) decreases in summertime pH in the Hydroelectric Reach. While both reservoir and riverine reaches upstream of the Hydroelectric Reach (i.e., from RM 231 to RM 251, Upper Klamath Lake, Agency Lake, and the Sprague River) are included on Oregon's 303(d) list for pH, the Hydroelectric Reach itself is not currently identified as being impaired (see Table 3.2-8). While the California Klamath River TMDLs do not include specific allocations or targets for pH, it is included under load allocations and targets for nutrients as biostimulatory substances (NCRWQCB, 2010a), which are assigned to the KHP and are designed to limit algal photosynthesis. Consistent with this, pH values in Copco 1 and Iron Gate Reservoirs can exceed 9, with large (0.5–1.5 pH units) daily fluctuations occurring in reservoir surface waters during periods of intense algal blooms (see Section 3.2.6).

Modeling of pH conducted for development of the Oregon and California Klamath River TMDLs (Kirk et al. 2010, NCRWQCB 2010a) provides information applicable to the assessment of long-term effects of the Proposed Action on pH in riverine reaches in the Upper Klamath Basin. Klamath TMDL model results indicate that under the Proposed Action (similar to the TMDL TOD2RN scenario), pH in the Hydroelectric Reach immediately downstream from J.C. Boyle Dam would be the same as pH levels modeled under the No Action/No Project (similar to the TMDL T4BSRN scenario), with the potential for some small decreases in minimum daily values (see Figure 3.2-22). At the Oregon-California State line, pH levels under the Proposed Action would exhibit less daily variability during spring (March–May) and fall (October–November) (see Figure 3.2-23), while daily variability in the river during the period June–September would be similar or somewhat greater under the Proposed Action, likely due to enhanced periphyton growth in the free-flowing river reaches previously occupied by the upstream J.C. Boyle Reservoir. The modeled increases at the Oregon-California State line would consistently meet the Oregon water quality objective of 9.0 units for support of beneficial uses and would therefore be less than significant. While there are no TMDL model results for riverine locations upstream of Copco 1 or Iron Gate Reservoirs, these locations would be expected to exhibit similar patterns as those predicted for the Klamath River at the Oregon-California State line.

The Proposed Action would also eliminate the occurrence of high pH (> 9 pH units) and large (0.5–1.5 pH units) daily fluctuations occurring in the surface waters of Copco 1 and Iron Gate Reservoirs during periods of intense algal blooms. pH in the free-flowing reaches of the river replacing these reservoirs would not exhibit such extremes, instead possessing the riverine signal described above.

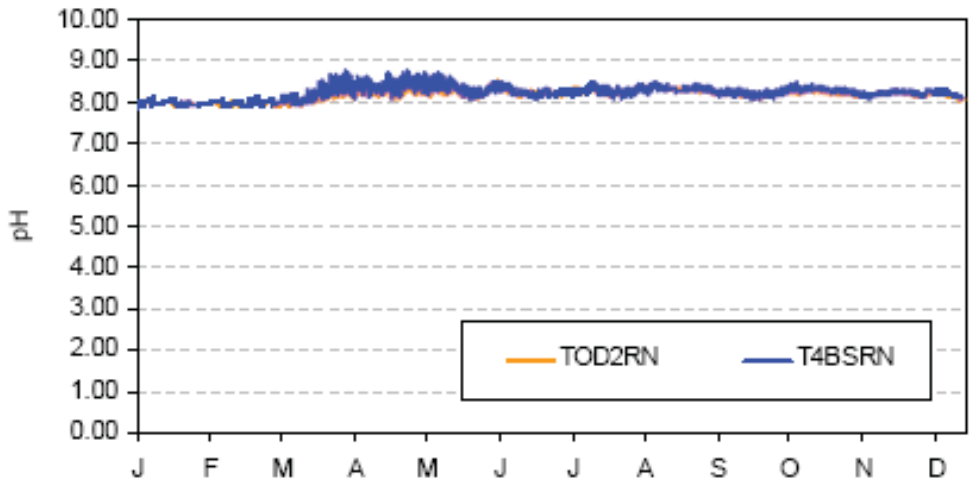


Figure 3.2-22. Predicted pH Downstream from J.C. Boyle Reservoir (RM 224.7) for the Klamath TMDL Scenarios Similar to the Proposed Action (TOD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

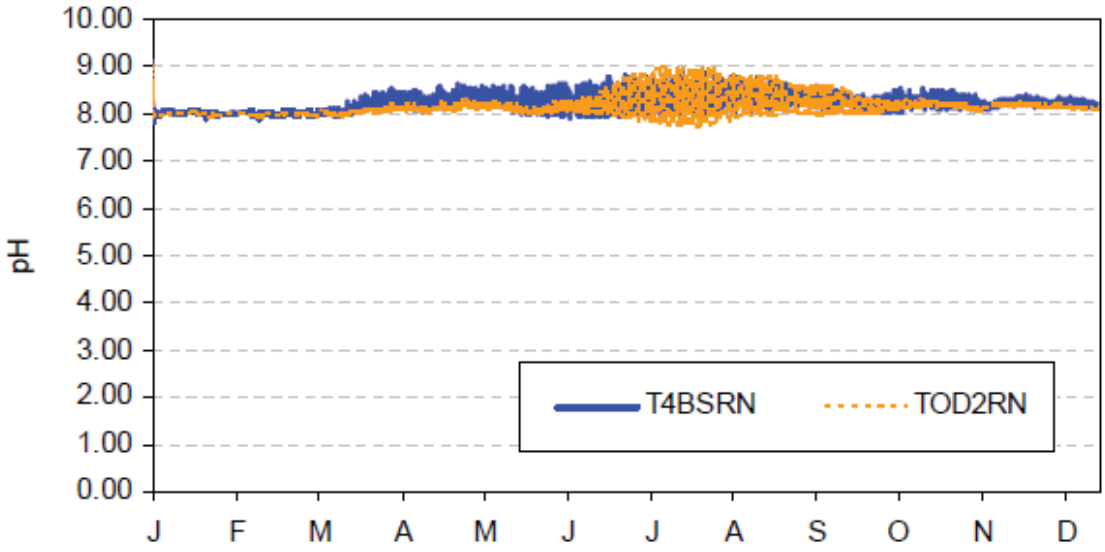


Figure 3.2-23. Predicted pH at the Oregon-California State line (RM 208.5) for the Klamath TMDL Scenarios Similar to the Proposed Action (TOD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario). Source: NCRWQCB 2010a.

Similar to dissolved oxygen (see above section), the changes in daily fluctuations for pH indicated by the Klamath TMDL modeling efforts are not entirely certain; the role of photosynthesis and community respiration from periphyton growth in the free-flowing reaches of the river replacing the reservoirs at the Four Facilities (including Keno Impoundment/Lake Ewauna as an assumption of the TOD2RN model [Appendix D]) is not well known because nutrient cycling and resulting rates of primary productivity under the No Action/No Project Alternative are not well known (see Section 3.2.1.1).

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020, pH effects of the Proposed Action in the Hydroelectric Reach would occur, either partially or fully, within the first 1 to 2 years following dam removal and be a short-term effect as well as a long-term effect. The exception to this is the potential for increased daily variability in pH due to increases in periphyton growth in the Hydroelectric Reach. However, increased daily variability due to periphyton growth likely would not occur in the short term because high SSCs and scour in the river 1-2 years following dam removal would limit the establishment of periphyton in the free-flowing river reaches.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) slight summertime increases in pH and daily pH fluctuations at the Oregon-California State line and upstream and downstream reaches that are currently riverine would be less than significant. The decrease in high summertime daily pH fluctuations in the free-flowing reaches of the river that replace Copco 1 and Iron Gate Reservoirs in the Hydroelectric Reach would be beneficial.

Lower Klamath Basin

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could result in long-term (2–50 years following dam removal) summertime increases in pH in the Lower Klamath River immediately downstream from Iron Gate Dam. Modeling of pH conducted for the development of the California Klamath River TMDLs provides information applicable to the assessment of long-term effects of the Proposed Action on pH in the Lower Klamath Basin. In general, results from the Klamath TMDL model (see Appendix D for a summary of model attributes) indicate that spikes in photosynthetic activity in the relatively low alkalinity (typically <100 mg/L; PacifiCorp 2005, Karuk Tribe of California 2010) water of the Klamath River, coupled with high air temperatures and high levels of biostimulatory nutrients during the late-summer and early-fall months, would result in large daily variation in pH and generally high pH levels in the Klamath River downstream from Iron Gate Dam (see Figure 3.2-24). This condition is not unlike current conditions, where pH during late-summer and early-fall months (August–September) in the Klamath River downstream from Iron Gate Dam (particularly upstream of the Shasta River confluence [RM 176.7]) ranges from just above neutral to greater than 9, with large (0.5–1.5 pH units) daily fluctuations occurring in the lower river during periods of high photosynthesis (see Section 3.2.3.6).

Predicted differences in pH between the Proposed Action and No Action/No Project Alternative decrease in magnitude with distance downstream from Iron Gate Dam, and are considerably dampened by the Scott River confluence (RM 143.0) (see Figure 3.2-25). The Hoopa Valley Tribe water quality objective for pH (7.0-8.5) (see Table 3.2-6) is met at all times under the Proposed Action (similar to the TMDL TCD2RN scenario) for the Klamath River at the reach of Hoopa jurisdiction (≈45–46).

Similar to the pH analysis for the Upper Klamath Basin (see prior section), the changes in daily fluctuations for pH indicated by the Klamath TMDL modeling efforts immediately downstream from Iron Gate Dam are not entirely certain because the magnitude of photosynthesis and community respiration from periphyton growth in the free-flowing reaches of the river replacing the reservoirs at the Four Facilities is not well known. The final Klamath TMDL targets and allocations are based on several lines of evidence and results from a number of different analytical tools; this is a particularly important consideration for the reach immediately downstream from Iron Gate Dam because the modeled pH changes are relatively larger than those predicted further upstream in the Hydroelectric Reach (see above discussion). The Klamath River mainstem periphyton target (150 ug/m^2 chlorophyll-*a*) was developed using the California NNE framework and calculation tools (Creager et al. 2006, Tetra Tech 2008). Building on the NNE analysis, Butcher (2008) determined that the periphyton target is met for the TMDL dams-out model scenario nutrient concentration targets (TP and TN targets are presented in Section 3.2.4.2.2.2, page 3.2-44). Because it uses a slightly different periphyton biomass estimate than the NNE framework tool, the TMDL model may overestimate summertime pH levels and variability immediately downstream from Iron Gate Dam. Additionally, based on the NNE analysis, pH is not expected to exceed the NCRWQCB Basin Plan objective of pH 8.5 on a regular basis for the dams out condition. Mitigating factors that could potentially limit periphyton densities to levels below the TMDL model estimate include increased scour and alterations in nutrient dynamics in the free flowing river due to retention from periphyton growth further upstream – see Section 3.4, Algae). As discussed under the No Action/No Project Alternative (see page 3.2-61), adaptive management strategies will be employed to refine efforts toward achieving water quality objectives and targets as part of the TMDL process. Given that there are multiple lines of evidence suggesting potentially different responses to pH from dam removal, adaptive management monitoring under the Proposed Action should include provisions for monitoring periphyton density in the reaches downstream from where Iron Gate Dam is currently located. Overall, the weight of evidence suggests that the potential for long-term pH increases during the summer months immediately downstream from Iron Gate Dam is less than significant.

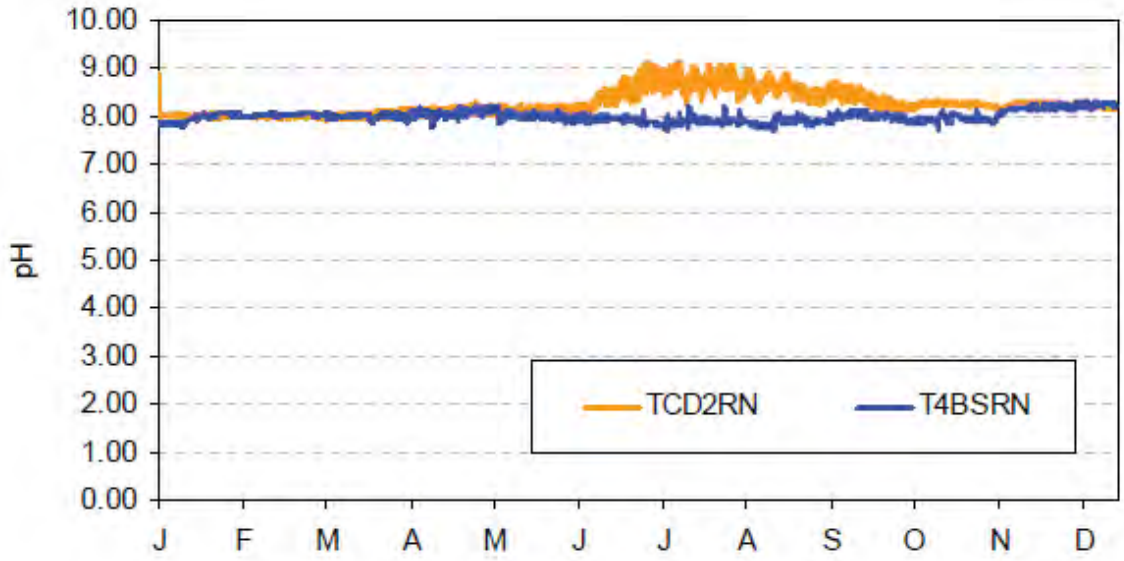


Figure 3.2-24. Predicted Klamath River pH Immediately Downstream from Iron Gate Dam for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario).
Source: NCRWQCB 2010a.

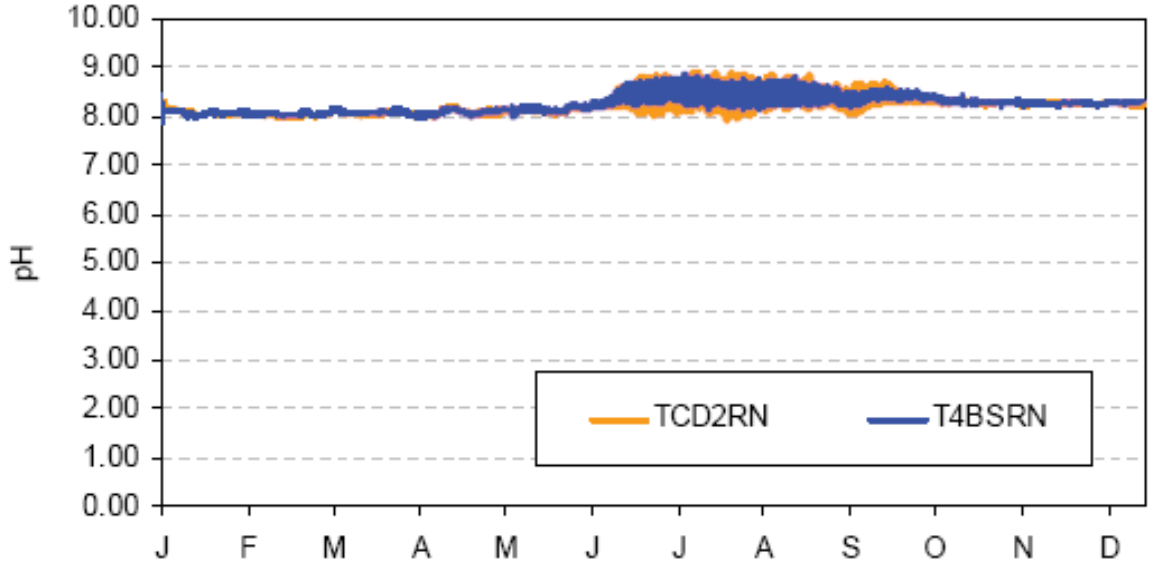


Figure 3.2.25. Predicted Klamath River pH upstream of the Scott River (RM 143.0) for the Klamath TMDL Scenarios Similar to the Proposed Action (TCD2RN Scenario) and the No Action/No Project Alternative (T4BSRN Scenario).
Source: NCRWQCB 2010a.

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020, pH effects of the Proposed Action in the Lower Klamath River would occur, either partially or fully, within the first 1 to 2 years following dam removal and be a short-term effect as well as a long-term effect. The exception to this is the potential for increases in pH due to increases in periphyton growth in the Lower Klamath River. The latter likely would not occur in the short term because high SSCs and scour in the river 1-2 years following dam removal would limit the establishment of periphyton in the free-flowing river reaches.

Long-term summertime increases in pH under the *Proposed Action* would be less than significant for the reach from Iron Gate Dam to the Scott River (RM 143). There would be no change from existing conditions on pH in the short term (<2 years following dam removal) and long-term (2–50 years following dam removal) for the Klamath River downstream from the Scott River, the Klamath Estuary, and the marine nearshore environment.

Chlorophyll-a and Algal Toxins

Upper Klamath Basin

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could substantially reduce or eliminate short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) levels of chlorophyll-a and algal toxins in the Hydroelectric Reach. Despite the slightly increased total nutrient concentrations anticipated under the Proposed Action in the Hydroelectric Reach (see Alternative 2 – Full Facilities Removal of Four Dams – Nutrients), elimination of the lacustrine (reservoir) environment that currently supports growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* would result in decreases in high seasonal concentrations of chlorophyll-*a* (>10 µg/L) and periodically high levels of algal toxins (> 8 µg/L microcystin) generated by suspended blue-green algae.

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020 (i.e., the beginning of the growth season), elimination of the lacustrine (reservoir) environment under the Proposed Action would occur, either partially or fully, within the first 1 to 2 years following dam removal. Therefore, this would be a short-term effect on chlorophyll-*a* and algal toxins in the Hydroelectric Reach as well as a long-term effect.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) decrease in chlorophyll-*a* and substantial decrease or elimination of algal toxins and in the Hydroelectric Reach would be beneficial.

Lower Klamath Basin

Removal of the Four Facilities under the Proposed Action and conversion of the reservoir areas to a free-flowing river could substantially reduce or eliminate short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) levels of chlorophyll-a and algal toxins transported into the Lower Klamath River and potentially the Klamath Estuary. In addition to the decreases in high seasonal concentrations of chlorophyll-*a* (>10 µg/L) and periodically high levels of algal toxins (>8 µg/L microcystin) generated by nuisance algal species that are described for the Hydroelectric Reach (see Section 3.2.4.3.2.6, Upper Klamath Basin), growth of *M. aeruginosa* in reaches of the Klamath River downstream from Iron Gate Dam would be reduced in the absence of significant reservoir blooms. While algal toxins and chlorophyll-*a* produced in Upper Klamath Lake (see Section 3.2.3.1) may still be transported into the Lower Klamath Basin, existing data indicate that concentrations of microcystin leaving Upper Klamath Lake have rarely, if ever, been measured at levels that exceed water quality objectives for Oregon and California. In contrast, algal production in Iron Gate and Copco Reservoirs is responsible for the observed public health exceedances occurring in the Klamath River downstream from Iron Gate Dam (see Section 3.2.3.7 and Appendix C, Section C.6). Under the Proposed Action, the *in situ* production of toxins and chlorophyll-*a* associated with suspended algae in the reservoirs would be eliminated.

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects. Because drawdown of the reservoirs would begin in winter and would be largely complete by March/April of 2020 (i.e., the beginning of the growth season), effects of the Proposed Action on chlorophyll-*a* and algal toxins in the Lower Klamath River would occur, either partially or fully, within the first 1 to 2 years following dam removal and be a short-term effect as well as a long-term effect.

Under the *Proposed Action*, the short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) decreases in the production of algal toxins and chlorophyll-*a* in upstream reservoirs and subsequent transport into the Lower Klamath River and the potentially the Klamath Estuary would be beneficial.

Inorganic and Organic Contaminants

Upper Klamath Basin

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in concentrations of inorganic and organic contaminants and result in low-level exposure for freshwater aquatic species in the Hydroelectric Reach. Due to the relatively small volume of the sediment deposits behind J.C. Boyle Dam (i.e., 15 percent of total volume for the Four Facilities, see also Figure 3.3-8), concentrations of suspended sediments downstream from J.C. Boyle Reservoir would be considerably less than those anticipated to occur downstream from Iron Gate Reservoir. Because the transport of contaminants would be associated with the elevated SSCs, as a conservative estimate, effects of sediment release on inorganic and organic contaminants in the Hydroelectric Reach downstream from J.C. Boyle Dam would be the same as those for the Lower Klamath

River. **Under the *Proposed Action*, the short-term (< 2 years following dam removal) and long-term (2–50 years following dam removal) effects of sediment release on freshwater aquatic species due to low-level exposure to sediment-associated inorganic and organic contaminants in the Hydroelectric Reach would be a less-than-significant impact.**

The Proposed Action could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) human exposure to contaminants from contact with deposited sediments on exposed reservoir terraces and river banks following reservoir drawdown. Potential human health risks associated with exposure to sediments deposited on exposed reservoir terraces and river banks within the Hydroelectric Reach were evaluated using comparisons of the 2009–2010 Secretarial Determination reservoir sediment core data to USEPA residential soil screening levels, and calculation of human/mammal TEQs and comparison to ODEQ Bioaccumulation screening level values (SLVs) ("Exposure Pathway 3" in CDM [2011]). No samples exceeded the total non-carcinogenic screening levels.

Forty-five samples exceeded the USEPA total carcinogenic screening level for residential soils for arsenic or nickel, including samples from J.C. Boyle, Copco 1 and Iron Gate Reservoirs. For arsenic, sampled concentrations in the reservoirs ranged from 4.3 to 15 mg/kg (see Appendix C, Table C-6), while the USEPA total carcinogenic screening level is 0.39 mg/kg. However, these screening levels were developed assuming residential exposure patterns (a 30-year exposure duration with soil ingestion rate of 200 mg/day for children over 6 years and 100 mg/day for adults over 24 years) (USEPA 1991), which is quite conservative and the measured values are well within the range of available soil concentrations for the Klamath Basin (arsenic may be naturally elevated in the Upper Klamath Basin [see Appendix C, Section C.7.1]). Additionally, ODEQ suggests a default background soil/sediment concentration for arsenic of 7 mg/kg (ODEQ 2007), a similar magnitude to the concentrations measured in reservoir sediments and a similar factor by which the reservoir sediments and background soils exceed the USEPA screening levels. Along these lines, ODEQ (2007) recommends the use of background concentrations as the screening levels when natural background is higher than a screening level. Lastly, under KHSA Section 7.6.4.A, the reservoir footprint areas would be designated as parcel B lands, which includes public interest purposes such as fish and wildlife habitat restoration and enhancement, public education, and public recreational access, and would not be used as residential lands. Therefore, potential exposure to arsenic measured in the reservoir sediments under the Proposed Action would be less than that assumed for the USEPA total carcinogenic screening levels, and it would be unlikely to have adverse effects under Exposure Pathway 2.

For nickel, sampled concentrations in the reservoirs ranged from 18 to 33 mg/kg (see Appendix C, Table C-6), while the USEPA total carcinogenic screening level is 0.38 mg/kg. As with arsenic, available Klamath Basin soil concentrations of nickel (median values 33 mg/kg and 65.7 mg/kg from two different studies) are in the same range as those measured in reservoir sediments (see Appendix C, Section C.7.1) and they exceed the USEPA total carcinogenic screening level for residential soils by a similar factor.

The highest concentrations of nickel were found in sediments from the Klamath River Estuary, which further suggests that release of reservoir sediments downstream would not negatively affect nickel concentrations in downstream reaches. Accordingly, the observed concentrations of nickel are unlikely to have adverse effects to humans under Exposure Pathway 2.

For 19 analytes measured during 2009–2010, laboratory analytical reporting limits were greater than the applicable human health screening levels, including PCBs, VOCs, and SVOCs (CDM 2011). It is not possible to directly confirm that these compounds are above or below applicable human health screening levels.

TEQs calculated for dioxin, furan, and dioxin-like PCBs were at concentrations above ODEQ Bioaccumulation SLVs for mammals in sediments from each of the reservoirs (CDM 2011). ODEQ Bioaccumulation SLVs are not applicable to water bodies in California; however, they provide a reference for comparison purposes. Although site-specific background data are lacking, TEQs are also only slightly above regional background concentrations and thus have limited potential for adverse effects for humans exposed to sediment deposits on reservoir terraces or river banks. The sources of the slightly elevated dioxin, furan, and dioxin-like PCB compounds are not known; however, sources may include atmospheric deposition, regional forest fires, and possibly burning of plastic items (CDM 2011).

Results from the 2009–2010 Secretarial Determination sediment chemistry analyses indicate that sediment deposits associated with the Proposed Action would cause no adverse effects on humans (terrestrial biota were also evaluated qualitatively, but are not discussed here) (see Figure 3.2-2). **Under the *Proposed Action*, the effects of sediment deposition on reservoir terraces and river banks on short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) human exposure to sediment-associated inorganic and organic contaminants in the Hydroelectric Reach would be a less-than-significant impact.**

Dam deconstruction and revegetation (i.e., hydroseeding) activities could cause short-term (<2 years following dam removal) increases in inorganic and organic contaminants from hazardous materials associated with construction and revegetation (i.e., hydroseeding) equipment in the Hydroelectric Reach. These effects would be reduced through implementation of BMPs for deconstruction and revegetation activities that would occur in or adjacent to the Klamath River. BMPs would minimize or eliminate the potential for toxic substances to enter the water. **Under the *Proposed Action*, the short-term (<2 years following dam removal) effects on inorganic and organic contaminants in the Hydroelectric Reach from dam deconstruction and restoration (i.e., hydroseeding) activities would be a less-than-significant impact.**

Under the Proposed Action, herbicide application associated with management of the reservoir footprint area could result in short-term (<2 years following dam removal) levels of organic contaminants in runoff that are toxic to aquatic biota in the Hydroelectric Reach. Based on the reservoir area management planning currently

underway, establishment of herbaceous vegetation in drained reservoir areas will be undertaken to stabilize the surface of the sediment and minimize erosion from exposed terrace surfaces following drawdown (O'Meara et al. 2010). Herbicides would be necessary during this period to control the growth of invasive plant species, with application occurring during the first year following dam removal and potentially during the second, if further treatments are necessary. Herbicide application would be required for 25 percent, 50 percent, and 75 percent of the total reservoir area for the low, most probable, and high cost restoration estimates, respectively (O'Meara et al. 2010).

The reservoir area management plan recognizes the potential water quality effects of herbicide application and calls for the use of herbicides with low soil mobility, and thus low potential to leach into groundwater or surface waters. It also calls for low use rates of herbicides and application of chemicals that pose a low toxicity risk to fish and aquatic organisms. Glyphosate is suggested in the management plan as one potential herbicide with such characteristics (O'Meara et al. 2010). To minimize use rates, spot treatments of a post-emergent herbicide such as glyphosate would be used rather than aerial application.

If glyphosate is chosen as a suitable herbicide for reservoir invasive plan management, it is recommended that glyphosate formulations containing POEA or R-11 are avoided to reduce risks to amphibians and other aquatic organisms (BLM 2010). Aquatic formulations of glyphosate (i.e., Glyfos Aquatic) are developed for use in sensitive protected environments such as habitat restoration sites and wetlands. Additionally, best management practices such as the "no rain" rule should be followed, such that glyphosate would never be applied when weather reports predict precipitation within 24 hours of application, before or after (BLM 2010). If another herbicide is chosen, it should meet the characteristics of low soil mobility and low toxicity to fish and aquatic organisms, and should be applied using BMPs such as low use rates (i.e., spot treatments), avoidance of application in the rain, avoidance of treatments during periods when fish are in life stages most sensitive to the herbicide(s) used, and adherence to appropriate buffer zones around stream channels (BLM 2010). **Under the *Proposed Action*, given implementation of applicable BMPs, the effect of herbicide application on toxicity and/or bioaccumulation in the Hydroelectric Reach during the revegetation period would be a less-than-significant impact.**

Lower Klamath Basin

Freshwater Aquatic Life Toxicity and/or Bioaccumulation

Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in concentrations of inorganic and organic contaminants and result in low-level exposure for freshwater aquatic species in the Lower Klamath River. Organic and inorganic contaminants have been identified in the sediment deposits currently trapped behind the dams (see Section 3.2.3.1). Under the Proposed Action, short-term (<2 years following dam removal) pathways of contaminant exposure for freshwater aquatic species include exposure during sediment transit through the Lower Klamath Basin river reaches ("Exposure Pathway 2" in CDM [2011]), while long-term (2-50 years following dam

removal) pathways include exposure following deposition of sediments along river beds and the estuary bottom (exposure "Scenario 4" in CDM [2011]).

As described for the No Action/No Project Alternative, existing sediment chemistry data (2004–2005) collected from 26 cores in J.C. Boyle, Copco 1, and Iron Gate Reservoirs indicate generally low levels of metals, pesticides, chlorinated acid herbicides, PCBs, VOCs, SVOCs, cyanide, and dioxins (Shannon & Wilson, Inc. 2006; see Section 3.2.3.8). Collection of additional sediment cores in 2009–2010 for the Secretarial Determination process indicates no positive exceedances of applicable screening levels indicating a low risk of toxicity to freshwater sediment-dwelling organisms in the Lower Klamath River under the Proposed Action. Results from acute (10-day) sediment bioassays for two national benchmark toxicity species (see above discussion under No Action/No Project Alternative) indicate generally equal or greater survival in reservoir sediments as compared with laboratory control samples. The exception is J.C. Boyle Reservoir, which exhibited considerably lower survival for *Chironomus dilutus* in the on-thalweg sample as compared with the laboratory control (64 percent versus 95 percent) and somewhat lower survival for the off-thalweg sample (83 percent versus 95 percent) (CDM 2011).

Although this result suggests potential for toxicity to freshwater benthic organisms downstream from the dams, under the Proposed Action, sediments from all three reservoirs will mix as they move downstream, exposing downstream aquatic biota to an "average" sediment composition rather than a reservoir-specific composition. Further, under current conditions, the total volume of erodible sediments in Copco 1 and Iron Gate Reservoirs (7.4 million yd^3 and 4.7 million yd^3, respectively; see Section 2.5.1) is considerably greater than that of J.C. Boyle Reservoir (1 million yd^3; see Section 2.5.1), diminishing the potential influence of J.C. Boyle Reservoir sediments downstream biota exposure (also see Section 2.2, text box on sediment weight and volume). Finally, fine sediments released during drawdown and dam removal will be transported by large water volumes, and are unlikely to settle along the riverbed (Reclamation 2012, Stillwater Sciences 2008); therefore, downstream freshwater benthic organisms are unlikely to experience the same intensity of exposure to sediment elutriate concentrations or reservoir sediments as during the bioassays themselves. Overall, the freshwater sediment bioassays indicate a low likelihood of acute toxicity to downstream benthic organisms due to sediment release under the Proposed Action.

Elutriate chemistry results indicate that before consideration of dilution, aluminum, chromium, copper, lead, and mercury are present at concentrations above fresh water quality criteria for samples from J.C. Boyle, Copco 1, and Iron Gate Reservoirs (CDM 2011). However, as described above, dilution of mobilized sediments with reservoir and river water is anticipated during drawdown and dam removal activities, with further dilution occurring downstream from Iron Gate Dam due to tributary inflows. Thus, water column toxicity due to the concentrations under the Proposed Action is unlikely (CDM 2011).

Elutriate bioassay results indicate no statistically significant reduction of mean 96-hour rainbow trout survival for exposure to samples from Copco 1 and Iron Gate Reservoirs tested at 1 percent and 10 percent elutriate treatments, but a significant reduction from Copco 1 at 100 percent elutriate treatment and from Iron Gate at 50 percent and 100 percent elutriate treatments. Of these, the 1 percent and 10 percent treatments are considered to be most representative of field conditions upon reservoir drawdown due to the expectation of substantial mixing and dilution with river water and tributary inputs (CDM 2011). For J.C. Boyle Reservoir, elutriate bioassay results indicate that no further dilution would be required to prevent water column toxicity to freshwater fish, even without considering the dilution that will take place during drawdown and dam removal (CDM 2011).

Combined, results from the 2004–2005 Shannon & Wilson, Inc. (2006) study and the 2009–2010 Secretarial Determination study (CDM 2011) indicate that in the short term (<2 years following dam removal), one or more chemicals are present at levels with potential to cause minor or limited adverse effects on freshwater aquatic species (see Figure 3.2-2). In the long-term, one or more chemicals present, but at levels unlikely to cause adverse effects based on the lines of evidence.

Under the *Proposed Action*, the short-term (< 2 years following dam removal) and long-term (2–50 years following dam removal) effects of sediment release, transit, and potential downstream river-bank deposition on freshwater aquatic species due to low-level exposure to sediment-associated inorganic and organic contaminants in the Lower Klamath River would be a less-than-significant impact.

Marine Aquatic Life Toxicity and/or Bioaccumulation
Sediment release associated with the Proposed Action could cause short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) increases in concentrations of inorganic and organic contaminants and result in low-level exposure for aquatic species in the Klamath Estuary and marine nearshore environment. Organic and inorganic contaminants have been identified in the sediment deposits currently trapped behind the dams (see Section 3.2.3.8). Under the Proposed Action, short-term pathways of contaminant exposure for marine aquatic species include short-term exposure during sediment transit through the Klamath Estuary and marine nearshore environment as well as exposure following deposition in the marine nearshore environment (”Exposure Pathway 5” in CDM [2011]).

For the 2009–2010 Secretarial Determination study, there were no positive exceedances of the applicable and available maximum marine screening levels (CDM 2011), with the exception of a small number of sediment samples from J.C. Boyle Reservoir, which exceeded the applicable marine screening level for dieldrin and 2,3,4,7,8,-PECDF (CDM 2011). As the marine screening levels are designed to be protective of direct toxicity to benthic and epibenthic organisms, corresponding to a “no adverse effects level,” the vast majority of 2009–2010 samples indicate a low risk of toxicity to sediment-dwelling organisms. Additionally, the Proposed Action would result in mixing and dilution during sediment release and transit through the Klamath River estuarine

and/or marine nearshore environment, exposing downstream aquatic biota to an "average" water column concentration rather than a reservoir- or site-specific concentration. For 33 analytes, laboratory analytical reporting limits were greater than the marine screening level itself (CDM 2011). For these analytes, it is not possible to determine whether these compounds are present in reservoir sediments either above or below levels of concern.

Sediment bioassays from a single upper Klamath Estuary sample indicate greater survival (89–99 percent survival) of national benchmark toxicity species in the estuary sediment sample as compared with the laboratory control samples (81–94 percent survival) (see CDM 2011). A simple comparison between the estuary area composite acute toxicity results and the reservoir super-composite results indicates similar survival for *Chironomus dilutus* (89 percent vs. 64–94 percent, respectively) and greater survival for *Hyalella azteca* (99 percent vs. 80–94 percent, respectively). The similarity in results is suggestive that under the Proposed Action, no further acute toxicity would be anticipated in the estuarine and/or marine environment as compared with that of the reservoir sediments; however, additional toxicity testing using estuarine and marine test organisms is needed to confirm this assumption. Elutriate chemistry results (prior to consideration for mixing and dilution) do not indicate likely toxicity in the marine nearshore environment under the Proposed Action (CDM 2011).

With respect to bioaccumulation potential, there are no exceedances of applicable marine bioaccumulation screening levels (CDM 2011). Further, with the exception of four samples in J.C. Boyle Reservoir (CDM 2011), levels of other known bioaccumulative compounds did not exceed ODEQ bioaccumulation SLVs for marine fish. Note that ODEQ bioaccumulatory screening levels are not strictly applicable in the California marine offshore environment; however, they are indicative of potentially bioaccumulative compounds.

Elutriate chemistry results indicate that several chemical concentrations in elutriate exceed one or more water quality criteria for evaluation of surface water exposures for marine biota. Chemicals that exceed marine surface water criteria include those generally considered to be nontoxic (e.g., phosphorus) as well as those with substantial potential for contributing to adverse effects (e.g., copper). Exposures to suspended sediment with elevated concentrations of potentially toxic chemicals are of lower concern for marine receptors than exposures to elevated concentrations of dissolved chemicals. The chemicals with the greatest potential to cause adverse effects in elutriate (e.g., copper) are, under field conditions associated with this exposure pathway, expected to bind to particulate matter and therefore are unlikely to contribute substantially to elevated concentrations of dissolved forms in the water column. Further, substantial dilution of river water and associated suspended sediments in the marine environment would reduce the amount of sediment suspended in the water column compared to conditions directly below Iron Gate Dam (CDM 2011).

Although not conducted specifically for estuarine or marine organisms, additional lines of evidence from the 2009–2010 Secretarial Determination study including the evaluation of

elutriate toxicity bioassay results for rainbow trout, sediment toxicity bioassay results for benthic invertebrate national benchmark species, comparisons of tissue-based TRVs to chemical concentrations in laboratory-reared freshwater clams and worms exposed to field collected sediments (see prior discussion of Proposed Action potential effects on freshwater aquatic species), and comparisons of tissue-based TRVs and TEQs to chemical concentrations in field collected fish tissue (see discussion under No Action/No Project, Section 3.2.4.3.1.7), exposure to inorganic and organic compounds in sediments released from the reservoirs under the Proposed Action is unlikely to cause adverse long-term impacts on estuary and marine near shore aquatic species (see Figure 3.2-2).

Under the *Proposed Action*, the short-term (< 2 years following dam removal) and long-term (2–50 years following dam removal) effects of sediment release, transit, and deposition on aquatic species due to low-level exposure to sediment-associated inorganic and organic contaminants in the Klamath Estuary and marine nearshore environment would be a less-than-significant impact.

Human Health
Sediment release associated with the Proposed Action could result in short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) human exposure to contaminants from contact with deposited sediments on downstream river banks following reservoir drawdown. Under the Proposed Action, potential human exposure to inorganic and organic chemicals during periods of drawdown and near-term flushing of elevated SSCs in the Lower Klamath River (i.e., through ingestion of contaminants from drinking water withdrawals or dermal contact with water) is likely to be of limited occurrence and shorter duration and is not further addressed.

Short-term human exposure through fish consumption (i.e., a food web pathway) cannot be assessed with the available data. Resident fish species in the reservoirs are considered unlikely to survive and populate the riverine environment following the Proposed Action (see Section 3.3, Aquatic Resources). Exposure and bioaccumulation by resident riverine species in the Lower Klamath River and estuary from water and suspended sediments transported under the Proposed Action is understood to be short term (<2 years following dam removal). Human exposure to contaminants from contact with residual sediments deposited on downstream river banks is possible and the mechanism for exposure is the same as that for potential contaminants deposited on exposed reservoir terraces and river banks in the Hydroelectric Reach (see Section 3.2.4.3.2.7, Upper Klamath Basin and Figure 3.2-2).

Under the *Proposed Action*, the effects of sediment release on human health due to short-term (<2 years following dam removal) and long-term (2–50 years following dam removal) exposure to sediment-associated inorganic and organic contaminants in the Lower Klamath River would be a less-than-significant impact.

Dam deconstruction and restoration (i.e., hydroseeding) activities could cause short-term (<2 years following dam removal) increases in inorganic and organic contaminants from hazardous materials associated with construction and restoration (i.e., hydroseeding)

equipment in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. These short-term effects would be a significant impact. However, the impacts may be reduced through implementation of BMPs for deconstruction and restoration activities that would occur in or adjacent to the Klamath River. BMPs would minimize or eliminate the potential for toxic substances to enter the water during the deconstruction and revegetation period. **Under the *Proposed Action*, the short-term (<2 years following dam removal) effects on inorganic and organic contaminants in the Lower Klamath River and the Klamath Estuary from dam deconstruction and restoration (i.e., hydroseeding) activities would be a less-than-significant impact. There would be no change from existing conditions on the marine nearshore environment.**

Keno Transfer

Implementation of the Keno Transfer could cause adverse water quality effects. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on water quality compared with existing facility operations. Following transfer of title, Reclamation would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (see KHSA Section7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measure

Decommissioning the East and Westside Facilities could result in slight decreases in ammonia levels in the Keno Impoundment/Lake Ewauna). Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA will redirect water flows currently diverted at Link River Dam into the two canals, back into Link River. Redirection of water flows under the Proposed Action could potentially result in additional nitrification of Upper Klamath Lake outflows that would otherwise not have occurred in the East and Westside canals and hydropower facilities. The additional water flowing through the 0.6-mile long reach between the Link River Dam and the upstream end of the Keno Impoundment/Lake Ewauna could experience slightly increased dissolved oxygen in the river due to turbulent mixing. While this process occurs under existing conditions, it would affect a greater volume of water under the Proposed Action than under existing conditions (i.e., existing conditions flows plus the redirected flows). While the reaeration potential of this reach has not been quantified, it is possible that increased dissolved oxygen in the river would increase nitrification, the microbially mediated process that, in the presence of oxygen, coverts ammonia into nitrate and nitrite. Deas (2008) reported that nitrification of Klamath River water occurs in the five-mile reach between Keno Dam and the upper end of J.C. Boyle Reservoir. The Link River reach is substantially shorter than the reach from Keno Dam to J.C. Boyle Reservoir, thus there would be relatively less increased nitrification potential due to the redirection of flows at Link River Dam. Nevertheless, there is potential for a slight long-term benefit in reduced ammonia toxicity in the Keno Impoundment/Lake Ewauna due to decommissioning of the East and Westside canals and hydropower facilities.

While increased dissolved oxygen could occur in the Link River due to the decommissioning, it may not translate into increased dissolved oxygen concentrations in the Keno Impoundment/Lake Ewauna itself since river turbulence would also break up algal cells and cause increased biological oxygen demand in the slow moving waters of the impoundment. Some of this algal cell destruction may also have occurred in the powerhouse turbines, therefore it is not clear whether there would be a net difference in the breakup of algal cells from Upper Klamath Lake outflows and how this would affect dissolved oxygen in the Keno Impoundment/Lake Ewauna. Further, there may be a slight decrease in daytime dissolved oxygen production in the Keno Impoundment/Lake Ewauna during large algal blooms due to the lost photosynthesis potential of algal cells that were destroyed in transit in the Link River. The increase in nitrification could also offset a portion of the oxygenation that occurs in the river, by chemically depleting the oxygen. Overall, given the competing dissolved oxygen effects and the relatively short extent of the Link River, it is likely that the East and Westside Facility Decommissioning action would result in no long-term change from existing conditions with respect to dissolved oxygen concentrations in the Keno Impoundment/Lake Ewauna. **Therefore, implementation of the East and Westside Facility Decommissioning action would be potentially beneficial due to slight decreases in ammonia levels.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

Construction of the City of Yreka Water Supply Pipeline under the Proposed Action could cause short-term increases in suspended material in the Hydroelectric Reach during the construction period. For construction of the City of Yreka Water Supply Pipeline, Dam Removal Entity (DRE) would construct a new, elevated pipeline and steel pipeline bridge to support the pipe above the river at the upstream end of Iron Gate Reservoir (see Section 2.4.3). The pipeline bridge would require in-water work in 2019 to build three concrete piers to support the bridge. Additional construction would occur along the Iron Gate Reservoir banks at each end of the new bridge where the new pipeline would be connected to the existing buried pipeline. The potential for sediments to enter the water during in-water pier construction and from construction site runoff can be minimized or eliminated in Iron Gate Reservoir through the implementation of BMPs for construction activities (Appendix B). Since the construction work will be undertaken in 2019, prior to dam removal, any disturbed sediments would be trapped by Iron Gate Reservoir and not transferred downstream to the Klamath River, particularly given implementation of BMPs. **Under the *Proposed Action*, the effect of City of Yreka Water Supply Pipeline construction activities on SSC in the Hydroelectric Reach at the upstream end of Iron Gate Reservoir would be a less-than-significant impact.**

KBRA – Programmatic Measures

The KBRA, which is a connected action to the Proposed Action, encompasses several programs that could affect water quality, including:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration

- Water Diversion Limitations
- Water Use Retirement Program
- Interim Flow and Lake Level Program
- Upper Klamath Lake and Keno Nutrient Reduction

Implementation of restoration actions, programs, and/or plans presented in the KBRA would accelerate restoration actions currently underway throughout the Klamath Basin (with the exception of the Trinity Basin) including KHSA implementation (i.e., dam removal) and could affect short-term (i.e., during construction activities) and long-term water quality. Within the KBRA, the Fisheries Program and the Water Resources Program encompass the majority of the restoration actions envisioned under the agreement (see Section 2.4.3.8). Many of the KBRA implementation actions are for fisheries restoration, reintroduction, and actions that enhance the amount and timing of water available for fish. Restoration actions include, but are not limited to, prevention of fish entrainment, rehabilitation of uplands, flood plains, riparian habitats, and stream channels, provision of fish passage, and re-introduction of fish to the Upper Klamath Basin, and instream riparian, and upslope actions that protect water quality, improve water quality and/or increase habitat complexity. KBRA elements under both the Fisheries Program and Water Resources Program are also likely to affect water quality in the basin. Some actions will affect water quality through flow augmentation, while others, including the restoration and permanent protection of riparian vegetation, are anticipated to have non-flow-related water quality effects. The following sections present a programmatic analysis of potential KBRA effects on water quality.

Phase I Fisheries Restoration Plan

Implementation of the Phase I Fisheries Restoration Plan could result in long-term reductions in fine sediment inputs, reduced summer water temperatures, improved nutrient interception, and increased dissolved oxygen levels. Several ongoing resource management actions related to water quality may be amplified under the Phase I Plan (see Section 2.4.3.8). The following sections describe the ongoing actions and types of new programs that could be implemented, and their anticipated short-term and long-term effects at a programmatic level.

Floodplain Rehabilitation

Floodplain rehabilitation work would include activities to improve or restore connections between channels and floodplains to create and maintain off-channel habitat accessible to overwintering juvenile salmonids. Floodplain rehabilitation may also include activities such as riparian planting and understory thinning to facilitate the development of mature riparian stands that would provide streamside shade and large and small wood to stream channels and floodplains. Additionally, wetland restoration and levee setback or dike removal may be used to reconnect floodplain hydrology.

In the short term (i.e., during construction activities), these activities may involve the use of backhoe equipment to dig channels, remove/reposition levees and dikes, and conduct mechanical planting. These activities could increase suspended sediments and increase the potential for inorganic and organic contaminants from hazardous materials associated

with construction activities. In the long term, increased seasonal off-channel habitat, wetland restoration, and levee setbacks, may reduce fine sediment deposition in the main channel by allowing sediments and associated nutrients to deposit on floodplains and in wetlands during high flows. Increased stream shading would decrease summer temperatures and increase dissolved oxygen concentrations.

Wetland and Aquatic Habitat Restoration
Upstream of Upper Klamath Lake, activities would include the purchase of restoration easements and the creation of grass banks to facilitate habitat improvement and landowner economic stability. In the short term (i.e., during construction activities), these activities may involve the use of hydroseeding to conduct grass planting. In the long term, restoration easements may reduce fine sediment deposition in the main channel by allowing sediments and associated nutrients to deposit along streambanks and wetlands protected by easements and grass banks during high flows.

Woody Debris Placement
In-stream and streambank large woody debris placement may include both mobile wood (i.e., unanchored) and complex stationary (i.e., anchored) structures and may be used to create off-channel fish habitat or provide cover in deeper pools. In the short term, these activities may involve the use of construction equipment to place large wood in the stream channel or along banks.

Fish Passage Correction
Correction of fish passage issues throughout the Klamath Basin may include culvert upgrades or replacement to meet current fish passage standards and correction of other fish blockages to restore access to new or historical habitats. In the short term, these activities may include in-channel construction of culverts through existing roadways.

Cattle Exclusion Fencing
Cattle exclusion would include the construction of fencing as allowed by Federal and State regulations and local land management plans to prevent cattle from trampling stream banks and would allow the regeneration of riparian vegetation and improving channel structure. Cattle exclusion may be conducted in conjunction with riparian planting as part of the aforementioned floodplain rehabilitation activities. In the long-term, these activities would decrease fine sediment inputs and associated nutrients (primarily phosphorus) to water bodies in the Klamath Basin and promote increased stream shading and reduced summer water temperatures.

Mechanical Thinning and Prescribed Burning
Mechanical thinning and prescribed burning of upland forest areas may be used to mimic some of the functions and characteristics historically provided by a natural fire regime. In the long term, thinning and prescribed burning may reduce the potential for catastrophic fires and the associated high rates of erosion and nutrient release (primarily phosphorus) to tributaries and the main-stem Klamath River.

Purchase of Conservation Easements and/or Land
Purchase of conservation easements and land from willing sellers may allow for more direct land management for habitat enhancement purposes, where the majority of the land involved would be agricultural land. In the long term, these activities would remove acreage from fertilizer and pesticide/herbicide applications, and would decrease nutrients (primarily nitrogen) and organic contaminants runoff to the Klamath River.

Road Decommissioning
Road decommissioning would reduce road densities in areas with a high potential for slope failure and would stabilize hillsides. These activities would decrease the incidence of road failure and would minimize a source of chronic fine sediment and nutrient (primarily phosphorus) input into water bodies in the Klamath Basin.

Treatment of Fine Sediment Sources
Treatment of fine sediment sources would include management of stormwater runoff from roads and improved agricultural and forestry management practices. In the long term, these activities would help decrease the input of fine sediment and associated nutrients (primarily phosphorus) into water bodies in the Klamath Basin.

Gravel Augmentation
Gravel augmentation involves the direct placement of spawning size gravel into the stream channel. Gravel augmentation can increase spawning habitat in systems by increasing the amount of area with suitable substrate. Gravel augmentation activities may involve transportation of gravel from an off-site source using dump trucks and placement in the stream using backhoes. In the short term, these activities would increase suspended sediments in waters proximal to the gravel deposition site and would increase the potential for inorganic and organic contaminants from hazardous materials associated with construction activities.

Individual resource management actions under the Phase I Fisheries Restoration Plan would require separate project-level evaluations under NEPA and ESA; at the programmatic level considered for this EIS/EIR, there is insufficient information to evaluate project-specific short-term (i.e., during construction activities) effects on water quality from these actions. The timing of and specific locations where these resource management actions could be undertaken is not certain, but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Although negative short-term effects of increased suspended sediments and increased potential for inorganic and organic contaminants from hazardous materials associated with construction equipment could occur, implementation of construction-related BMPs would occur as part of the Phase I Fisheries Plan resource management actions. **Given these BMPs (including the BMP requiring biodegradable oils in construction equipment used in streams or rivers, see Appendix B.1.1 Water Quality, the short-term effects on suspended sediment concentrations and inorganic and organic contaminants would be less-than-significant.**

In the long term, most of the above resource management actions would reduce fine sediment inputs into streams in the Klamath Basin. Treatment of fine sediment sources may also include other management actions, including managing stormwater runoff from roads and other developed areas, improved agricultural and forestry management practices, and other specific actions depending on the sources of fine sediments. The Phase I Fisheries Restoration Plan activities would also improve shading and thus cool summer water temperatures, increase riparian and wetland nutrient interception and transformation, and increase dissolved oxygen levels (through decreased water temperatures and decreased nutrient loading). As noted above the timing of and specific locations where these resource management actions could be undertaken is not certain, but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. **Resource management actions implemented under the KBRA Phase I Fisheries Restoration Plan would accelerate long-term improvements in fine sediment, water temperature, nutrients, and dissolved oxygen in the Klamath Basin and would be beneficial.**

Phase II Fisheries Restoration Plan

Implementation of the Phase II Fisheries Restoration Plan under the KBRA (see KBRA Section 10.2) would include a continuation of the same types of resource management actions as under Phase I along with provisions for adaptive management of these actions and would therefore have the same short-term (i.e., during construction activities) and long-term impacts as Phase I. Individual resource management actions under the Phase II Fisheries Restoration Plan would require separate project-level evaluations under NEPA and ESA; at the programmatic level considered for this EIS/EIR, there is insufficient information to evaluate project-specific short-term (i.e., during construction activities) effects on water quality from these actions. The timing of and specific locations where these resource management actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Although short-term adverse effects of increased suspended sediments and increased potential for inorganic and organic contaminants from hazardous materials associated with construction equipment could occur, implementation of construction-related BMPs would occur as part of the Phase II Fisheries Plan resource management actions. **Given these BMPs (see Appendix B.1.1 Water Quality), the short-term effects on suspended sediment concentrations and inorganic and organic contaminants would be less-than-significant. Resource management actions implemented under the KBRA Phase II Fisheries Restoration Plan would accelerate long-term improvements in fine sediment, water temperature, nutrients, and dissolved oxygen in the Klamath Basin and would be beneficial.**

Fisheries Reintroduction and Management Plan

Implementation of the trap and haul element of the Fisheries Reintroduction and Management Plan could affect water quality during construction. In the short term (i.e., during construction activities), constructing fish handling facilities downstream from Keno Dam and at Link River Dam would involve the use of construction equipment

for site work and building construction. These activities could increase suspended sediments and increase the potential for inorganic and organic contaminants from hazardous materials associated with construction activities. Although negative short-term effects could occur, implementation of construction-related BMPs would reduce these effects. **Given these BMPs (see Appendix B.1.1 Water Quality), the short-term effects on water quality would be less-than-significant.**

Wood River Wetland Restoration

Implementation of Wood River Wetland Restoration could result in warmer long-term spring water temperatures and reduced fine sediment and nutrient inputs to Upper Klamath Lake. Under the KBRA, the Wood River Wetland Restoration Project (see KBRA Section 18.2.3) would be a new project designed to provide additional water storage for a total of 16,000 acre-feet (AF) of storage in or adjacent to Agency Lake (see Section 2.4.3.8). Wood River Wetland is approximately 3,200 acres in size and is adjacent to Agency Lake and to the north of Agency Lake Ranch. Over 3,000 acres of wetland and two miles of Wood River channel have or are undergoing restoration actions. Options for water management may include using diked areas for pumped storage or breaching levees to reconnect former wetland areas to Agency Lake. Long-term water quality effects associated with the Wood River Restoration Project include the creation of warmer spring temperatures that would be beneficial for rearing juvenile fish in the wetlands (as compared to the cooler temperatures in the Wood River or Upper Klamath Lake) and improved interception and treatment of fine sediment from the Wood River, prior to entering Agency Lake. This may decrease overall nutrient inputs to Upper Klamath Lake by inundating wetland (peat) soils and creating anaerobic conditions that support nutrient retention, particularly in the case of phosphorus (Snyder and Morace 1997). Specific options still need to be developed and studied as part of a separate project-level NEPA evaluation and ESA consultation. There is insufficient information to evaluate project-specific construction-related effects on water quality from the Wood River Wetland Restoration project. The geographic location and timing of this project reduce the potential for any negative water quality effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. Although negative short-term effects could occur, implementation of construction-related BMPs would occur. **Given these BMPs (see Appendix B.1.1 Water Quality), the short-term effects would be less-than-significant. Under the KBRA, the Wood River Wetland Restoration Project would accelerate ongoing long-term improvements in water temperature, fine sediment, and nutrients in Agency Lake and would be beneficial.**

Water Diversion Limitations

Implementation of Water Diversion Limitations could result in long-term decreased summer water temperatures in the Klamath River upstream of the Hydroelectric Reach. Under the KBRA, the Water Diversions Limitations (see KBRA Section 15.1) would be a new project that provides specific allocations of water for refuges and limitations on specific diversions for Reclamation's Klamath Project (see Section 2.4.3.8). Actions reducing availability of irrigation water would increase stream flow and decrease summer

water temperatures in the Klamath River upstream of the Hydroelectric Reach, as needed for fisheries. The water quality improvements generated by these water diversion limitations would contribute to the long-term improvements anticipated from hydroelectric facility removal. Diversion limitations under KBRA would also provide a more reliable water supply to the National Wildlife Refuges (NWRs) and would be beneficial (see Section 3.14.4.3). **In the short term, there would be no change from existing conditions on water quality. In the long term, the KBRA Water Diversion Limitations would decrease summer water temperatures in the Klamath River upstream of the Hydroelectric Reach and would be beneficial.**

Water Use Retirement Program

Implementation of the Water Use Retirement Program could result in long-term decreases in summer water temperature and nutrient inputs to Upper Klamath Lake. Under the KBRA, the Water Use Retirement Program (WURP) (see KBRA Section 16.2.2) would be a new project that seeks to increase the inflow to Upper Klamath Lake by 30,000 acre-feet on an average annual basis (see Section 2.4.3.8). Actions reducing surface water use, such as the sale and retirement of irrigation surface water rights, split season irrigation, shift to dryland crops, and fallowing of crop land, would overall increase stream flows and lake levels in Upper Klamath Lake through deceased surface water withdrawals and increased groundwater recharge (see also Reclamation 2012). Overall increased stream flows and lake levels in Upper Klamath Lake would improve water quality by decreasing summer water temperatures and decreased irrigation. Fallowing of crop land would decrease fertilizer (nutrient) and pesticide/herbicide (inorganic and organic contaminants) inputs.

Water elevations in Upper Klamath Lake affect water elevations in the emergent wetlands of Upper Klamath NWR, with the wetlands approximately 90% dry at lake elevations below 4,139.50 feet (Mauser and Mayer 2011). In an analysis of the potential effects of KBRA on Upper Klamath NWR, Mauser and Mayer (2011) found that the frequency in which Upper Klamath Lake levels fall below 4,139.50 feet would be greater under the KBRA (82% of years) compared to the No Action/No Project Alternative (68% of years). This means that the frequency of wetland drying at Upper Klamath NWR would increase under KBRA. However, according to the analysis presented by Mauser and Mayer (2011), the duration of the drying episodes would be less than currently occur. Therefore, drying of soils could be more extensive or complete under the No Action/No Project Alternative than the Proposed Action, which could affect phosphorus cycling and release to Upper Klamath Lake. Note that the potential impacts of the KBRA on waterfowl and migrating birds in Upper Klamath NWR are discussed in Section 3.14.4.3 of this Klamath Facilities EIS/EIR.

Mauser and Mayer's (2011) projections for future lake levels did not account for the 2008 Biological Opinion (USFWS 2008), which dictates lake levels under the current conditions including the No Action/No Project Alternative. According to the Biological Opinion, lake levels currently are allowed to go below 4,139.50 feet during July through January, or about 7 out of 12 months during a year. Therefore, the difference in number of months that the Upper Klamath NWR could go dry as described by Mauser and Mayer

(2011) would be partially dictated by Biological Opinion minimum values. Under the 2008 Biological Opinion, this represents only a one month difference in lake level management between KBRA (6 of 12 months) and the No Action/No Project Alternative (7 of 12 months). Thus the hydrologic effect on the Upper Klamath Lake NWR under KBRA could be less than described by Mauser and Mayer (2011).

According to research conducted on wetlands around Upper Klamath Lake, drying of wetland soils and associated aerobic decomposition of peat can contribute to release of phosphorus (Snyder and Morace 1997, Aldous et al. 2005). However, the degree to which this occurs is not universal, and in fact appears to be substantially less in "undisturbed" wetlands, including Upper Klamath NWR, than "restored" wetlands that had been previously diked and drained (Aldous et al. 2005).

If Upper Klamath NWR dries more frequently in the summer and fall, but for shorter periods that allow wetlands soil to remain wet in the root zone below the water level, the breakdown of peat soils may be minimized if not completely negated. Aldous et al. (2005) tested different hydrologic treatments for cores from undisturbed and restored wetlands around Upper Klamath Lake. If wetlands were allowed to remain moist, rather than dry completely, the release of phosphorus was minimized, and the undisturbed wetlands, which included Upper Klamath NWR, effectively had no phosphorus release. Because KBRA-flows and their effects on Upper Klamath Lake water elevation cannot be conclusively predicted at this time, it is not possible to determine whether the NWR wetlands or their soils would remain moist even if they are drained more frequently, which would minimize phosphorus release, or if they would dry out significantly more, which could foster some phosphorus release.

An additional consideration is the magnitude of potential phosphorus release from NWR wetlands compared to the magnitude of other external and internal nutrient loading sources to the lake. As a conservative calculation, the phosphorus loads from the Upper Klamath NWR and from Upper Klamath Lake internal loading can be estimated for the period of potential drying as shown in Mauser and Mayer (2011) (i.e., July–October). Phosphorus flux from the refuge was initially taken as the median phosphorus release rate from diked and drained wetlands (3.7 pounds per acre per day; Table 13 from Snyder and Morace [1997]), which should be significantly greater than the actual phosphorus release rate from the NWR because it represents "disturbed" wetlands. This rate is about a factor of 10 greater than what was found when the Williamson River Delta was breached and reflooded (Wong et al. 2011), reinforcing the conservative nature of this analysis. Assuming a wetland area of 13,000 acres in the refuge (Snyder and Morace 1997), and accounting for unit changes (i.e., from English units to SI units), Upper Klamath NWR could contribute as much as about 7200 kg of phosphorus to Upper Klamath Lake during this 120 day period. These estimates were compared with estimated loads in Upper Klamath Lake from data collected by the Klamath Tribes (Kann and Walker 1999), averaged over the same 120 day period from 1991 to 1998. Median total external loading to Upper Klamath Lake during the same 120 day periods from 1991 to 1998 was approximately 39,200 kg. Thus, Upper Klamath NWR could provide a significant additional load of phosphorus to Upper Klamath Lake compared to existing

July-October external loading (i.e. about 18%) if the soils are allowed to dry significantly. However, the summertime nutrient and bloom dynamics of Upper Klamath Lake are dominated by internal loading; median July to October internal loading is about 163,000 kg, with total external and internal loading being about 201,000 kg. Therefore, loading from Upper Klamath NWR would be about 4.5% of the internal load, and 3.5% of the total load, as conservative estimates. Finally, whether this would actually represent a significant increase from current loading is unlikely, as the refuge can dry out for considerable periods under existing lake level management, as dictated by the NOAA Fisheries Service 2008 Biological Opinion, and therefore likely contributes nutrients in a similar fashion. Therefore, even if KBRA-related drying of Upper Klamath NWR wetland soils did increase the release phosphorus as hypothesized, the effect on water quality or algal blooms in the lake would be negligible compared to other sources and ongoing loading from the wetlands, and the increase from current conditions would also be negligible.

There are timing issues associated with the hypothesized loading as well, depending on management of Upper Klamath Lake under the WURP. If the wetlands dry from July to October, the release of nutrients would most likely occur in the fall when the soils are rewetted. This is after the most sensitive period in the lake, when algal blooms typically drive dissolved phosphorus concentrations to limiting levels and additional phosphorus could spur additional algal growth. Instead, added nutrients would have little effect on algal growth and might be largely exported from the lake during the winter.

In summary, conservative calculations based on available research for Upper Klamath Lake and surrounding wetland areas suggests that, if additional nutrients are released as a result of an increased frequency of drying events under KBRA, concentrations will be small compared to other loading sources, notably the large internal load that occurs in most summers, and would have minimal effect on the water quality or algal blooms in the lake. As noted previously, the hydrologic effect on the Upper Klamath Lake NWR under KBRA could be less than described by Mauser and Mayer (2011), hence any associated nutrient effect could also be less. Further, KBRA is analyzed in this EIS/EIR at the programmatic level and future environmental compliance would be necessary to implement the various projects. As part of these future analyses, measures to limit potential adverse effects would be developed and some of those measures could include keeping the refuge soils moist during the summer periods to minimize unintended release of phosphorus, or keeping the drying periods relatively short to reduce the amount of phosphorus released, possibly even compared to current conditions (i.e., provide a net benefit).

Since decreased irrigation and fallowing of crop land under WURP would decrease nutrient inputs via fertilizer use, while increased drying of wetland soils in Upper Klamath NWR would only slightly increase nutrient (phosphorus) input to the lake (or could have no effect), overall, the water quality improvements generated by the WURP in Upper Klamath Lake would translate downstream to the Klamath River and would contribute to the long-term improvements anticipated from hydroelectric facility removal.

In the short term, there would be no change from existing conditions on water quality. The KBRA Water Use Retirement Program would decrease long-term water temperatures, nutrients, and pesticides and herbicides in Upper Klamath Lake and would be beneficial.

Interim Flow and Lake Level Program

Implementation of the Interim Flow and Lake Level Program could result in long-term decreases in summer water temperature and nutrient inputs to Upper Klamath Lake. Under the KBRA, the Interim Flow and Lake Level Program (see KBRA Section 20.4) would be an interim program of water purchase and lease to further the goals of the fisheries programs during the interim period prior to full implementation of the On-Project Plan and WURP. Because it is focused on reducing surface water use, it would have the same effects on water quality as the WURP. The water quality improvements generated by the Interim Flow and Lake Level Program would contribute to the long-term improvements anticipated from hydroelectric facility removal. **In the short term, there would be no change from existing conditions on water quality. The KBRA Interim Flow and Lake Level Program would decrease long-term water temperatures and decrease nutrients in Upper Klamath Lake and would be beneficial.**

Upper Klamath Lake and Keno Nutrient Reduction

Implementation of the Upper Klamath Lake and Keno Nutrient Reduction Program could result in long-term decreases in nutrient inputs, increases in seasonal dissolved oxygen, and decreases in concentrations of nuisance algal species in these waterbodies. KBRA (Appendix C-2, line 11) includes a program to study and reduce nutrient concentrations in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake in order to reduce dissolved oxygen and nuisance algal problems in both water bodies. Restoration actions to control nutrients have not been developed, and there are many possible actions that could require construction of treatment wetlands, construction of facilities, or chemical treatments of bottom sediment, among other possibilities. A nutrient reduction program in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake would be designed to improve water quality (increasing seasonally low dissolved oxygen and reducing seasonal algal blooms) and fish passage through the Keno Impoundment/Lake Ewauna in summer and fall months, however implementation of this nutrient reduction program will require future environmental compliance investigations and a determination on significance cannot be made at this time.

3.2.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

The Partial Facilities Removal of Four Dams Alternative would remove enough of the material from each dam to allow the river to retain a free-flowing condition and volitional fish passage under all river stages and flow conditions. Some portion of each dam and much of the appurtenant infrastructure would remain, such as the dam foundations, power houses, buildings, tunnels, and pipes. All tunnel openings would be sealed with concrete, remaining buildings would be fenced, and all hazardous materials would be removed from the site. This alternative would include the transfer of the Keno Facility to the Reclamation and implementation of the KBRA. The Partial Facilities Removal of Four

Dams Alternative would result in the release of sediments trapped behind the dams and would have the same short-term (<2 years following dam removal) effects on suspended sediments, dissolved oxygen, nutrients, and inorganic and organic contaminant concentrations in both the Upper and Lower Klamath Basin as the Proposed Action, as follows:

- **The short-term increases in SSC in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a significant impact.**
- **The short-term decrease in dissolved oxygen concentrations would be a significant impact on the Lower Klamath River from Iron Gate Dam to approximately Clear Creek (≈RM 100). There would be no change from existing conditions on the Klamath Estuary or the marine nearshore environment.**
- **The short-term increase in nutrients in the Hydroelectric Reach, the Lower Klamath River, and the Klamath Estuary would be a less-than-significant impact.**
- **The short-term effects on organic and inorganic contaminants in the Hydroelectric Reach, the Lower Klamath River, and the Klamath Estuary would be a less-than-significant impact.**

Dam deconstruction activities under the *Partial Facilities Removal of Four Dams Alternative* would have the same short-term effects on suspended sediments in the Hydroelectric Reach, the Lower Klamath River, and the Klamath Estuary as the Proposed Action and would be a less-than-significant impact. There would be no change from existing conditions on the marine nearshore environment.

Construction activities associated with implementation of IMs 7 (J.C. Boyle Gravel Placement and/or Habitat Enhancement) and 16 (Water Diversions) would have the same short-term effects on suspended sediments in the Hydroelectric Reach as the Proposed Action and would be a less-than-significant impact. There would be no change from existing conditions on the Lower Klamath River, Klamath Estuary, or the marine nearshore environment.

Revegetation activities (i.e., hydroseeding) under the *Partial Facilities Removal of Four Dams Alternative* would have the same short-term effects on erosion of fine sediments from exposed reservoir terraces in the Hydroelectric Reach and transport into the Lower Klamath River and Klamath Estuary as the Proposed Action and would be beneficial. There would be no change from existing conditions on the marine nearshore environment.

Under the Partial Facilities Removal Alternative, interception and retention of sediments and nutrients behind the dams at the Four Facilities would no longer occur and would have the same long-term (2–50 years following dam removal) effects in both the Upper and Lower Klamath Basin as the Proposed Action. **Long-term increases in suspended sediments and nutrients in the Hydroelectric Reach, the Lower**

Klamath River, the Klamath Estuary, and the marine nearshore environment as the Proposed Action and would be a less-than-significant impact.

Additionally, elimination of the lacustrine environment of the reservoirs would have the same long-term (2–50 years following dam removal) effects on water temperature, dissolved oxygen, pH, algal toxins and chlorophyll-*a*, and inorganic and organic concentrations in both the Upper and Lower Klamath Basin as the Proposed Action, as follows:

- **The long-term increases in summer/fall water temperatures and diel temperature variation in the J.C. Boyle Bypass Reach due to the elimination of hydropower peaking operations would be a less than significant impact. Slight decreases in long-term summer/fall water temperatures and less diel temperature variation in the J.C. Boyle Peaking Reach would be beneficial. Downstream from Copco 1 and Iron Gate Dams, the long-term increase in spring water temperatures would be less than significant, and the decrease in late summer/fall water temperatures would be beneficial for the Hydroelectric Reach and the Lower Klamath River from Iron Gate Dam to the confluence with the Salmon River. There would be no direct effect on water temperature for Klamath River downstream from the Salmon River, the Klamath Estuary, or the marine nearshore environment.**
- **Long-term increases in summer and fall dissolved oxygen concentrations in the Hydroelectric Reach and immediately downstream from Iron Gate Dam would be beneficial. There would be no change from existing conditions on dissolved oxygen by the confluence with the Trinity River.**
- **Long-term slight summertime increases in pH and daily pH fluctuations at the Oregon-California State line and upstream and downstream reaches that are currently riverine would be less than significant. The decrease in high summertime daily pH fluctuations in the free-flowing reaches of the river that replace Copco 1 and Iron Gate Reservoirs in the Hydroelectric Reach would be beneficial. The summertime increases in pH in the Lower Klamath River from Iron Gate Dam to the Scott River would be less than significant. There would be no change from existing conditions on pH for Klamath River just downstream from Seiad Valley, the Klamath Estuary, and the marine nearshore environment. The long-term decrease in chlorophyll-*a* and substantial decrease or elimination of algal toxins and in the Hydroelectric Reach and subsequent transport into the Lower Klamath River and the Klamath Estuary would be beneficial.**
- **Long-term effects on inorganic and organic contaminants in the Hydroelectric Reach, the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.**

Keno Transfer

Implementation of the Keno Transfer could cause adverse water quality effects. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the Reclamation. This transfer would not result in the generation of new impacts on water

quality compared with existing facility operations. Following transfer of title, Reclamation would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (see KHSA Section7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measure

Decommissioning the East and Westside Facilities could result in slight decreases in ammonia levels in the Keno Impoundment/Lake Ewauna. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would have the same effect as described under the Proposed Action. **Therefore, implementation of the East and Westside Facility Decommissioning action would be potentially beneficial due to slight decreases in ammonia levels.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

Construction activities for the City of Yreka Water Supply Pipeline under the *Partial Facilities Removal of Four Dams Alternative* would have the same short-term effects on suspended sediments in the Hydroelectric Reach as the Proposed Action and would be a less-than-significant impact. There would be no change from existing conditions on the Lower Klamath River, Klamath Estuary, or the marine nearshore environment.

KBRA – Programmatic Measures

KBRA Actions under the Partial Facilities Removal of Four Dams Alternative would be the same as those under the Proposed Action. **Therefore, under the *Partial Facilities Removal of Four Dams Alternative*, KBRA actions would accelerate long-term improvements in water quality (i.e., suspended sediment, water temperature, nutrients, and dissolved oxygen) anticipated under KHSA implementation (i.e., dam removal) and would be beneficial.**

3.2.4.3.4 Alternative 4: Fish Passage at Four Dams

The Fish Passage at Four Dams Alternative would provide upstream and downstream fish passage at the Four Facilities, but would not include implementation of the KBRA. The ongoing restoration actions, described in the No Action alternative, would continue. The alternative would incorporate the mandatory prescriptions from the Departments of the Interior and Commerce imposed during the FERC relicensing process, including fishway installation for both upstream and downstream migrations at all facilities and barriers to prevent juvenile salmonid entrainment into turbines. In addition to the fishways, there is a series of flow-related measures, including a condition that requires at least 40 percent of the inflow to the J.C. Boyle Reservoir to be released downstream. This alternative would limit generation of peaking power at J.C. Boyle Powerhouse to one day per week as water supplies allow, and would include recreation flows one day a week. The flow requirements would reduce the overall power generation.

Short-term effects on water quality from construction activities associated with new fish passage facilities would occur, including increased suspended sediments and increased

potential for inorganic and organic contaminants from hazardous materials associated with construction equipment. These short-term effects would be a significant impact. However, the impacts would be reduced through implementation of BMPs for construction activities that occur in or adjacent to the reservoirs and the Klamath River. BMPs would minimize in-water work and would minimize or eliminate the potential for sediment or toxic substances entering the water. The short-term effects would likely follow the schedule prescribed in the FERC relicensing process (see Table 2-26), which would allow downstream facilities to be installed prior to upstream passage facilities and would take place over a 4 to 8 year period. Accordingly, short-term construction related effects on water quality would occur in association with construction activities for each of the fish passage improvements (i.e., upstream fish passage, spillway modifications, tailrace barriers, screens and bypass structures).

Under the *Fish Passage at Four Dams Alternative*, short-term increases in SSCs and potential inorganic and organic contaminants in the Hydroelectric Reach, the Lower Klamath River, the Klamath Estuary and the marine nearshore environment due to construction activities would be a less-than-significant impact.

Under the Fish Passage at Four Dams Alternative, the overall higher flow releases would result in more reservoir water entering the Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Action; however, as with the Proposed Action, areas adjacent to the coldwater springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Fish Passage at Four Dam Alternative. Since J.C. Boyle Reservoir, with its large thermal mass, would remain in place, effects on diel temperature variation in the Bypass Reach under the Fish Passage at Four Dams Alternative would be similar to those described for the No Action/No Project Alternative (i.e., reduced diel temperature variation). Similar to the Proposed Action, maximum water temperatures in the Peaking Reach would be slightly cooler and temperatures would be less artificially variable, also due to higher overall flows and the lower frequency of peaking operations at the J.C. Boyle Powerhouse.

Under the *Fish Passage at Four Dams Alternative*, long-term (2–50 years following construction of fish passage facilities) increases in summer/early fall water temperatures in the J.C. Boyle Bypass Reach, due to the higher overall flow releases would be a less than significant impact. Continued reduced diel temperature variability in the Bypass Reach would be similar to those under the No Action/No Project Alternative (i.e., no change from existing conditions). Slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would be beneficial. Long-term water temperature effects in the remainder of the Hydroelectric Reach (i.e., Copco 1 and Iron Gate Reservoirs) would be similar to those under the No Action/No Project Alternative (i.e., no change from existing conditions).

The altered (more stable) flow regime in the J.C. Boyle Peaking Reach may also affect dissolved oxygen, pH, and nutrients due to increased periphyton growth at this location. However, changes in these parameters are not certain; the role of photosynthesis and community respiration from periphyton growth in the Peaking Reach is unknown because nutrient cycling and resulting rates of primary productivity under the No Action/No Project Alternative are uncertain (see Section 3.2.1.1). Other than this potential and unknown effect related to the flow regime downstream from J.C. Boyle Dam, the presence of fish passage facilities at each of the Four Facilities would not affect other long-term water quality parameters in the Hydroelectric Reach. **Under the *Fish Passage at Four Dams Alternative*, long-term (2–50 years following construction of passage facilities) effects on water quality in the Upper or Lower Klamath Basin would be the same as effects under the No Action/No Project Alternative (i.e., no change from existing conditions).**

Trap and Haul – Programmatic Measure

Implementation of the trap and haul measure could affect water quality during construction. In the short term (i.e., during construction activities), constructing fish handling facilities downstream from Keno Dam and at Link River Dam would involve the use of construction equipment for site work and building construction. These activities could increase suspended sediments and increase the potential for inorganic and organic contaminants from hazardous materials associated with construction activities. Although negative short-term effects could occur, implementation of construction-related BMPs would reduce these effects. **Given these BMPs (see Appendix B.1.1 Water Quality), the short-term effects on water quality would be less-than-significant.**

3.2.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative proposes to remove the two largest dams in the Hydroelectric Reach and install fishways for volitional fish passage on the remaining installations. Most of the mandatory prescriptions associated with fish passage would still apply to the remaining dams, including flow requirements and standards for fish passage facilities. Alternative 5 would include no peaking power generation or release of flow for recreation at J.C. Boyle Powerhouse because Copco 1 and Iron Gate Dams would not be present to reregulate flows downstream. For the purposes of this analysis, alternatives that would not result in full implementation of the KHSA do not include the KBRA as a connected action to the alternative. In the Hydroelectric Reach of the Upper Klamath Basin, this alternative would result in the release of sediments trapped behind Copco 1 and Iron Gate Dams. This release would have short-term (<2 years following dam removal/construction of fish passage facilities) effects on sediment and turbidity, dissolved oxygen, nutrients, and inorganic and organic contaminant concentrations in the Klamath River.

Interception and retention of sediments would still occur behind J.C. Boyle and Copco 2 Dams; this would have long-term (2–50 years following dam removal/construction of fish passage facilities) effects on sediment and turbidity. Additionally, elimination of the lacustrine environment of Copco 1 and Iron Gate Reservoirs under this alternative would

have long-term effects on water temperature, dissolved oxygen, nutrients, pH, algal toxins and chlorophyll-*a* in the downstream river. The following sections provide detail regarding the anticipated effects of this alternative on water quality.

Water Temperature

Upper Klamath Basin

Since the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would include no peaking power generation or release of flow for recreation at J.C. Boyle Dam, water temperature effects in the J.C. Boyle Bypass Reach would be similar to those under the Fish Passage at Four Dams Alternative (see Section 3.2.4.3.4) because the Fish Passage at Four Dams Alternative also keeps J.C. Boyle Reservoir in place and includes significantly increased flow releases over the No Action/No Project Alternative, approaching the flow conditions for this alternative (i.e., no peaking power generation or release of recreation flows). Thus, the effects would be continued low diel temperature variation and overall warmer water temperatures in the Bypass Reach during summer and early fall, and cooler temperatures in late fall and winter. In the Peaking Reach, water temperature effects would be the same as under the Proposed Action (i.e., slightly lower maximum water temperatures and less artificial diel temperature variation during summer and early fall) since no peaking flows would occur and the effect of J.C. Boyle thermal mass on water temperatures does not extend this far downstream. The effects of removing Iron Gate and Copco 1 Reservoirs and converting the reservoir areas to a free-flowing river under this alternative would be similar to effects for the Lower Klamath River immediately downstream from Iron Gate Dam under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, long-term (2–50 years following dam removal/construction of fish passage facilities) increases in summer/fall water temperatures in the J.C. Boyle Bypass Reach due to the elimination of bypass flows and increased dilution of cold spring water with warmer reservoir water would be a less than significant impact. Slight decreases in long-term maximum summer/fall water temperatures and less artificial diel temperature variation in the J.C. Boyle Peaking Reach would be beneficial. From Copco 1 Reservoir to Iron Gate Reservoir, long-term increases in spring water temperatures would be less than significant and decreases in late summer/fall water temperatures in the Hydroelectric Reach would be similar to the Proposed Action and would be beneficial.

Lower Klamath Basin

While model results analyzed for the Proposed Action do not explicitly isolate the effects of the four individual reservoirs on water temperatures, the KRWQM includes a scenario in which only Iron Gate, Copco 1, and Copco 2 Dams are removed but J.C. Boyle remains in place ("WIGC" PacifiCorp 2004b, Dunsmoor and Huntington 2006, see also Appendix D). This scenario is analogous to the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative because Copco 2 Reservoir has no active storage and thus has a negligible effect on hydraulic residence time and water temperature. KRWQM WIGC results indicate that compared with removal of all four

reservoirs ("WIGCJCB"), the long-term effects of removing Iron Gate and Copco 1 Reservoirs and converting the reservoir areas to a free-flowing river under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to effects on water temperature for the Lower Klamath Basin under the Proposed Action (see Figure 3.2-26).

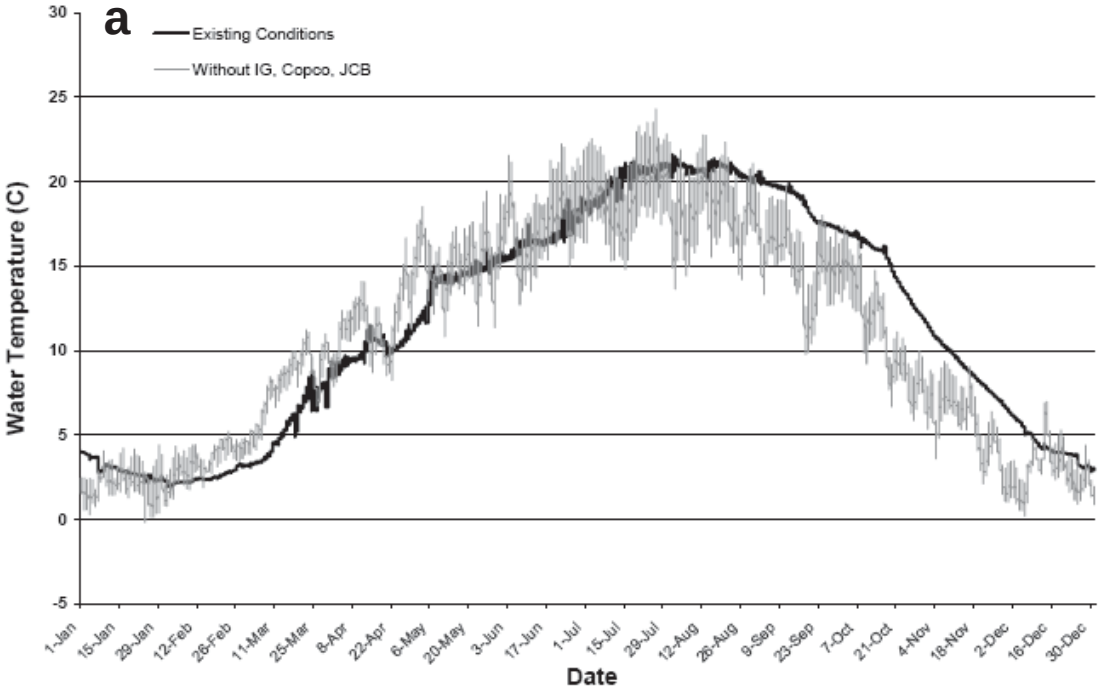
3.2.4.3.6 Suspended Sediments

Upper Klamath Basin

Upstream of Copco 1 Dam, short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) SSCs under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as SSCs under the No Action/No Project Alternative. However, because Copco 1 and Iron Gate Reservoirs contain 85 percent of the total erodible sediment contained with the reservoirs at the Four Facilities (CDM 2011), the short-term effects of sediment release on SSCs downstream from Copco 1 Dam under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to effects for the Hydroelectric Reach under the Proposed Action. Compared to the Proposed Action, there would be approximately 15 percent less sediment mobilized from the reservoirs at the Four Facilities (sediments in J.C. Boyle would remain in place) and short-term SSCs within the Hydroelectric Reach may exhibit somewhat lower peaks. However, the overall pattern and duration of high SSCs would be the same, as would the general magnitude of the effect.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, short-term (<2 years following dam removal/construction of fish passage facilities) increases in SSC in the Hydroelectric Reach due to mobilization of sediment deposits from Copco 1 Reservoir and Iron Gate Reservoir would be a significant impact.

Stormwater runoff from deconstruction activities under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 2 and Iron Gate Alternative may cause increases in suspended material in the Hydroelectric Reach during the deconstruction period. Dam deconstruction effects on suspended sediments would be limited to Copco 1 and Iron Gate Reservoirs and downstream river reaches, while fish passage construction effects would be limited to J.C. Boyle and Copco 2 Reservoirs and downstream river reaches. However, both dam deconstruction and fish passage construction activities would be complex and overlapping in terms of resulting river concentrations of suspended sediments and would require implementation of BMPs at each reservoir site. Therefore, dam deconstruction and fish passage construction activities in the Hydroelectric Reach under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be essentially the same as those for the Hydroelectric Reach under the Proposed Action.



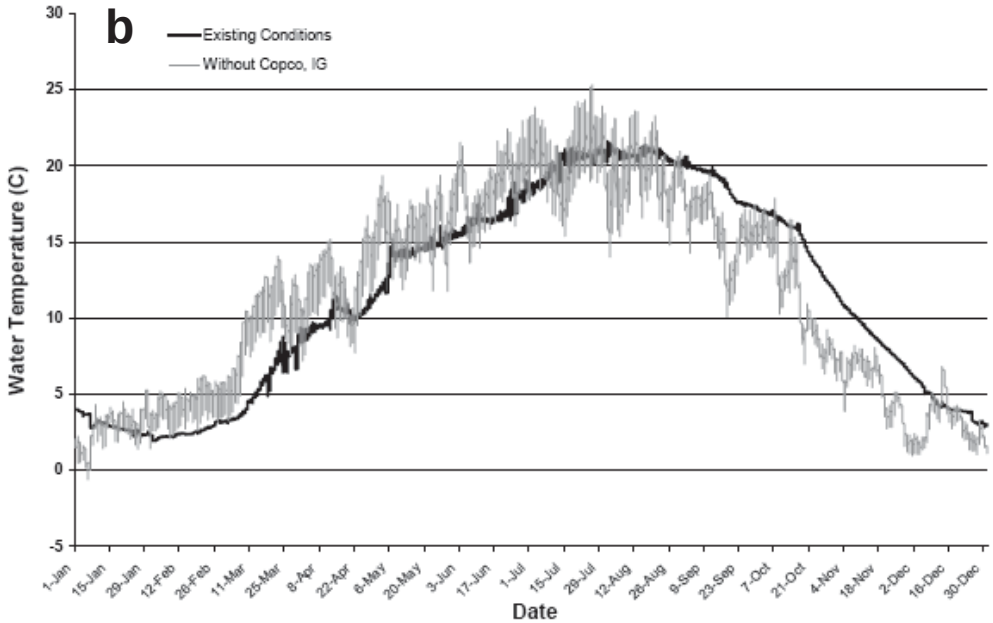


Figure 3.2-26. Simulated Hourly Water Temperature Downstream from Iron Gate Dam (RM 190.1) Based on Year 2004 for Current Conditions Compared to Hypothetical Conditions: (a) without Iron Gate (IG), Copco 1 and 2, and J.C. Boyle (JCB) Dams and (b) without Iron Gate (IG) and Copco 1 and 2 Dams. Source: PacifiCorp 2005.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, short-term (<2 years following dam removal/construction of fish passage facilities) deconstruction-related increases in SSC in the Hydroelectric Reach would be a less-than-significant impact.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, revegetation activities (i.e., hydroseeding) would have the same short-term (< 2 years following dam removal) effects on erosion of fine sediments from exposed reservoir terraces in the Hydroelectric Reach as the Proposed Action and would be beneficial.

Due to the lack of continued interception and retention of mineral (inorganic) and algal-derived (organic) suspended materials behind Copco 1 and Iron Gate Dams under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, long-term (2-50 years following dam removal/construction of fish passage facilities) effects on SSCs for the Hydroelectric Reach would be similar to those for the Hydroelectric Reach under the Proposed Action. **Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, long-term (2–50 years following dam removal/construction of fish passage facilities) increases in mineral (inorganic) and algal-derived (organic) suspended material in the Hydroelectric Reach would be a less-than-significant impact**.

Lower Klamath Basin

Because Copco 1 and Iron Gate Reservoirs contain 85 percent of the total erodible sediment contained with the reservoirs at the Four Facilities (CDM 2011), the short-term (<2 years following dam removal/construction of fish passage facilities) effects of sediment release on concentrations of suspended sediments in the Lower Klamath Basin under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to those for the Lower Klamath Basin under the Proposed Action. Because there would be approximately 15 percent less sediment mobilized (sediments in J.C. Boyle would remain in place), short-term (<2 years following dam removal/construction of fish passage facilities) SSCs in the Lower Klamath Basin may exhibit somewhat lower peaks. However, the overall pattern and duration of high SSCs would be the same, as would the general magnitude of the effect.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, short-term (<2 years following dam removal/construction of fish passage facilities) increases in SSC in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.

Stormwater runoff from deconstruction activities under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate alternative may cause increases in suspended material in the Klamath River downstream from Iron Gate Dam during the deconstruction period. Dam deconstruction effects on suspended sediments would be limited to Copco 1 and Iron Gate Reservoirs and downstream river reaches, while fish

passage construction effects would be limited to J.C. Boyle and Copco 2 Reservoirs and downstream river reaches. However, both dam deconstruction and fish passage construction activities would be complex and overlapping in terms of river SSCs and would require implementation of BMPs at each reservoir site. Therefore, dam deconstruction and fish passage construction activities would have the same effects on SSCs in the Lower Klamath Basin as the Proposed Action and the Fish Passage at Four Dams Alternative.

***Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, deconstruction-related increases in SSC in the Lower Klamath River and the Klamath Estuary would be a less-than-significant impact. There would be no change from existing conditions on the marine nearshore environment.**

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, revegetation activities (i.e., hydroseeding) would have the same short-term (< 2 years following dam removal) effects on erosion of fine sediments from exposed reservoir terraces in the Hydroelectric Reach and transport into the Lower Klamath River and Klamath Estuary as the Proposed Action and would be beneficial. There would be no change from existing conditions on the marine nearshore environment.

Under this alternative, long-term (2–50 years following dam removal/construction of fish passage facilities) effects on mineral (inorganic) and algal-derived (organic) suspended materials in the Lower Klamath Basin due to the lack of continued interception and retention of sediment behind Copco 1 and Iron Gate Dams would be similar to those for the Lower Klamath Basin under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the long-term (2–50 years following dam removal/construction of fish passage facilities) increases on mineral (inorganic) and algal-derived (organic) suspended materials in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.

Nutrients

Upper Klamath Basin

Upstream of Copco 1 Reservoir, effects on nutrients under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as effects under the No Action/No Project Alternative because J.C. Boyle Dam would remain in place. However, Copco 1 and Iron Gate Reservoirs are the largest and deepest reservoirs in the Hydroelectric Reach with the longest residence times (FERC 2007), and the short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) the effects of removing them and converting the reservoir areas to a free-flowing river under this alternative would be similar to removing all four dams for the reach from Copco 1 Reservoir to Iron Gate Reservoir. Therefore, under this alternative, effects on nutrients

for the reach from Copco 1 Reservoir to Iron Gate Reservoir would be the same as effects for the Lower Klamath River immediately downstream from Iron Gate Dam under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) increases in nutrients in the Hydroelectric Reach would be a less-than-significant impact.

Lower Klamath Basin

Copco 1 and Iron Gate Reservoirs are the largest and deepest reservoirs in the Hydroelectric Reach with the longest residence times, so the short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) effects of removing them and converting the reservoir areas to a free-flowing river under this alternative would be similar to removing all four dams. Therefore, under this alternative, effects on nutrients would be the same as effects for the Lower Klamath River under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) increases in nutrients in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment would be a less-than-significant impact.

Dissolved Oxygen

Upper Klamath Basin

Upstream of Copco 1 Dam, short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) dissolved oxygen under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as dissolved oxygen under the No Action/No Project Alternative. However, because Copco 1 and Iron Gate Reservoirs contain 85 percent of the total erodible sediment contained within the reservoirs at the Four Facilities (CDM 2011), the short-term effects of sediment release on dissolved oxygen concentrations downstream from Copco 1 Dam under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to effects for the Hydroelectric Reach under the Proposed Action. Compared to the Proposed Action, there would be approximately 15 percent less sediment mobilized (sediments in J.C. Boyle would remain in place) and short-term SSCs in the Lower Klamath Basin may exhibit somewhat lower peaks. However, the overall pattern and duration of high SSCs would be the same, as would the general magnitude of the effect on dissolved oxygen. The short-term effects of sediment release on oxygen demand and dissolved oxygen concentrations in the Hydroelectric Reach under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be essentially the same as those for the Lower Klamath Basin under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative,* short-term (<2 years following dam removal/construction of fish passage facilities) decreases in dissolved oxygen in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir would be a significant impact. The long-term (2-50 years following dam removal) increase in summer and fall dissolved oxygen concentrations in the Hydroelectric Reach would be beneficial.

Lower Klamath Basin

Because Copco 1 and Iron Gate Reservoirs contain 85 percent of the total erodible sediment contained within the reservoirs at the Four Facilities (CDM 2011), the short-term (<2 years following dam removal/construction of fish passage facilities) effects of sediment release on concentrations of dissolved oxygen in the Lower Klamath Basin under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to those for the Lower Klamath Basin under the Proposed Action. Because there would be approximately 15 percent less sediment mobilized (sediments in J.C. Boyle would remain in place), short-term SSCs in the Lower Klamath Basin may exhibit somewhat lower peaks and dissolved oxygen demand may also decrease. However, the overall pattern and duration of high SSCs would be the same, as would the general magnitude of the effect on dissolved oxygen.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the short-term (<2 years following dam removal/construction of fish passage facilities) decrease in dissolved oxygen concentrations would be a significant impact on the lower basin from Iron Gate Dam to approximately Clear Creek (≈RM 100), but would not affect dissolved oxygen in the Klamath Estuary or the marine nearshore environment. The long-term (2–50 years following dam removal) increases in summer and fall dissolved oxygen concentrations immediately downstream from Iron Gate Dam would be beneficial.

pH

Upper Klamath Basin

Upstream of Copco 1 Reservoir, effects on pH under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as effects under the No Action/No Project Alternative because J.C. Boyle Dam would remain in place. The effects of removing Iron Gate and Copco 1 Reservoirs and converting the reservoir areas to a free-flowing river under this alternative would be similar to effects on pH for the Lower Klamath River immediately downstream from Iron Gate Dam under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the long-term (2–50 years following dam removal/construction of fish passage facilities) decrease in high summertime daily pH fluctuations in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir would be beneficial.

Lower Klamath Basin

Because J.C. Boyle Reservoir does not currently appear to substantially alter pH in the river downstream from the dam (see Figure 3.2-22.) having this dam in place would not affect pH downstream from the Hydroelectric Reach in the Lower Klamath Basin. However, apparent seasonal and daily pH fluctuations in Copco 1 and Iron Gate Reservoirs would be altered once these reservoir areas were converted to a free-flowing river. Therefore, effects on pH under this alternative would be similar to effects on pH for the Lower Klamath River immediately downstream from Iron Gate Dam under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, long-term (2–50 years following dam removal/construction of fish passage facilities) summertime increases in pH would be less than significant for the Lower Klamath River from Iron Gate Dam to the confluence with the Scott River. There would be no change from existing conditions on pH for the Klamath River just downstream from Seiad Valley, the Klamath Estuary, and the marine nearshore environment.

Chlorophyll-a and Algal Toxins

Upper Klamath Basin

Upstream of Copco 1 Reservoir, effects on algal toxins and chlorophyll-*a* under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as effects under the No Action/No Project Alternative because J.C. Boyle Dam would remain in place. Copco 1 and Iron Gate Reservoirs are the largest reservoirs in the Hydroelectric Reach with the longest hydraulic residence times (FERC 2007) and potential for *in situ* algal growth, so the effects of removing them and converting the reservoir areas to a free-flowing river under this alternative would be similar to removing all four dams. Therefore, under this alternative, effects on algal toxins and chlorophyll-*a* would be the same as effects for the Upper Klamath Basin under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the long-term (2–50 years following dam removal/construction of fish passage facilities) decrease in chlorophyll-*a* and substantial decrease or elimination of algal toxins and in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir would be beneficial.

Lower Klamath Basin

Copco 1 and Iron Gate Reservoirs are the largest reservoirs in the Hydroelectric Reach with the longest residence times (FERC 2007) and hence potential for *in situ* algal growth, so the effects of removing them and converting the reservoir areas to a free-flowing river under this alternative would be similar to removing all four dams. Therefore, under this alternative, effects on algal toxins and chlorophyll-*a* would be the same as effects for the Lower Klamath Basin under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the long-term (2–50 years following dam removal/construction of fish

passage facilities) decrease in production of algal toxins and chlorophyll-*a* in upstream reservoirs and subsequent transport into the Lower Klamath River and the Klamath Estuary would be beneficial.

Inorganic and Organic Contaminants

Upper Klamath Basin

Under this alternative, continued retention of sediments behind J.C. Boyle Dam and release of sediments trapped behind Copco 1 and Iron Gate Dams would occur. In J.C. Boyle Reservoir, short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) effects of sediment retention on concentrations of inorganic and organic contaminants, and the potential for bioaccumulation and/or toxicity to freshwater aquatic biota and humans, would be the same as those for the Hydroelectric Reach under the No Action/No Project Alternative. However, for the two largest reservoirs in the Hydroelectric Reach, Copco 1 and Iron Gate Reservoirs, short-term and long-term effects of sediment release on concentrations of inorganic and organic contaminants under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as those for the Hydroelectric Reach under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) increases in potential inorganic and organic contaminants in the Hydroelectric Reach due to sediment release would be a less-than-significant impact.

Dam deconstruction and fish passage construction activities could cause increases in inorganic and organic contaminants from hazardous materials associated with construction equipment that could exceed applicable ODEQ and North Coast Basin Plan water quality objectives and adversely affect beneficial uses in the Hydroelectric Reach. These effects would be a significant impact. However, the impacts would be reduced through implementation of BMPs for deconstruction and construction activities that would occur in or adjacent to the Klamath. BMPs would minimize or eliminate the potential for toxic substances to enter the water.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the effects on inorganic and organic contaminants in the Hydroelectric Reach due to construction/deconstruction activities would be a less-than-significant impact.

Lower Klamath Basin

Under this alternative, release of the sediments trapped behind Copco 1 and Iron Gate Dams) would occur. Because Copco 1 and Iron Gate Reservoirs contain 85 percent of the total erodible sediment contained within the reservoirs at the Four Facilities (CDM 2011), the short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage

facilities) effects of sediment release on concentrations of inorganic and organic contaminants, and the potential for bioaccumulation and/or toxicity to freshwater aquatic biota, marine aquatic biota, and humans in the Lower Klamath Basin, would be similar to those for the Lower Klamath Basin under the Proposed Action.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the short-term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) increases in potential inorganic and organic contaminants due to sediment release would be a less-than-significant impact.

Dam deconstruction and fish passage construction activities could cause increases in inorganic and organic contaminants from hazardous materials associated with construction equipment that could exceed applicable North Coast Basin Plan water quality objectives and adversely affect beneficial uses in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment. These effects would be a significant impact. However, the impacts would be reduced through implementation of BMPs for deconstruction and construction activities that would occur in or adjacent to the Klamath River. BMPs would minimize or eliminate the potential for toxic substances to enter the water.

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the increases in potential inorganic and organic contaminants due to construction/deconstruction activities would be a less-than-significant impact.

Trap and Haul – Programmatic Measure

The impacts from the trap and haul measure under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as those under the Fish Passage at Four Dams Alternative. **Therefore, under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, the short-term effects on water quality would be less-than-significant because of implementation of BMPs (see Appendix B.1.1 Water Quality).**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

Under the *Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative*, construction activities for the City of Yreka Water Supply Pipeline would have the same short-term effects on suspended sediments in the Hydroelectric Reach as the Proposed Action and would be a less-than-significant impact.

3.2.5 Mitigation Measures

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects (i.e., high SSCs, low DO) (see also Section 2, Proposed Action and Description of the Alternatives). While the Alternatives Formulation Report identified the option of mechanical sediment removal as mitigation for sediment erosion

impacts associated with removal of the Four Facilities, subsequent analysis found this measure to be infeasible (Lynch 2011).

3.2.5.1 Mitigation Measures Associated with Other Resource Areas

Several other mitigation measures require construction, including mitigation measures H-2 (flood-proof structures), GW-1 (deepen or replace affected wells), WRWS-1 (modify or screen affected water intakes), PHS-4 (repair damaged roads), PHS-5 (construct water storage tanks for fire fighting), REC-1 (develop new recreational facilities and access to river), TR-6 (assess and improve roads to carry construction loads), and TR-7 (assess and improve bridges to carry construction loads). Short-term effects on water quality from construction activities may include increased suspended sediments and inorganic and organic contaminants from hazardous materials associated with construction equipment to enter nearby or adjacent water bodies. Implementation of deconstruction and/or construction-related BMPs would also apply to these construction efforts. **Implementation of BMPs would reduce effects of these mitigation measures to less-than-significant levels.**

3.2.6 Summary of Short-term and Long-term Impacts on Water Quality

Table 3.2-14 summarizes the short term (<2 years following dam removal/construction of fish passage facilities) and long-term (2–50 years following dam removal/construction of fish passage facilities) impacts of the Proposed Action and alternatives on water quality.

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Water Temperature				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could cause short-term and long-term seasonal water temperatures that are shifted from the natural thermal regime of the river and do not meet applicable ODEQ and California Basin Plan water quality objectives and adversely affect beneficial uses in the Hydroelectric Reach.	1	NCFEC	None	NCFEC
Dam removal and/or reduction or elimination of hydropower peaking operations at J.C. Boyle Powerhouse could cause short-term and long-term alterations in overall water temperatures and diel temperature variation in the J.C. Boyle Bypass and Peaking Reaches.	2, 3, 4, 5	LTS for J.C. Boyle Bypass Reach in summer/fall B for J.C. Boyle Peaking Reach in summer/fall	None	LTS for J.C. Boyle Bypass Reach in summer/fall B for J.C. Boyle Peaking Reach in summer/fall
Dam removal and conversion of the reservoir areas to a free-flowing river could cause short-term and long-term increases in spring time water temperatures and decreases in late summer/fall water temperatures in the Hydroelectric Reach downstream from Copco 1 Reservoir.	2, 3, 5	LTS for springtime B for late summer/fall	None	LTS for springtime B for late summer/fall

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Lower Klamath Basin				
Draining the reservoirs and release of sediment could cause short-term and long-term increases in sediment deposition in the Klamath River or Estuary that could alter morphological characteristics and indirectly affect seasonal water temperatures.	2, 3, 5	NCFEC	None	NCFEC
Continued impoundment of water in the reservoirs could cause short-term and long-term seasonal water temperatures and diel temperature variation that are shifted from the natural thermal regime of the river and do not meet applicable California North Coast Basin Plan water quality objectives and adversely affect beneficial uses in the Klamath River downstream from Iron Gate Dam.	1, 4	NCFEC	None	NCFEC
Dam removal and conversion of the reservoir areas to a free flowing river could result in short-term and long-term increases in spring water temperatures, decreases in late summer/fall water temperatures, and increased diel temperature variation in the Lower Klamath River.	2, 3, 5	LTS – Iron Gate Dam to Salmon River for springtime and B – in late summer/fall NCFEC – Klamath River downstream from Salmon River, the Klamath Estuary, and marine near shore environment	None	LTS – Iron Gate Dam to Salmon River for springtime and B – in late summer/fall NCFEC – Klamath River downstream from Salmon River, the Klamath Estuary, and marine near shore environment

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Suspended Sediments				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could result in short-term and long-term interception and retention of mineral (inorganic) suspended material by the KHP dams.	1, 4	NCFEC	None	NCFEC
Implementation of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could result in short-term increases in mineral (inorganic) suspended material in the Hydroelectric Reach.	1, 2 ,3	LTS	None	LTS
Implementation of IM 8, J.C. Boyle Bypass Barrier Removal, could result in short-term increases in mineral suspended material in the Hydroelectric Reach due to deconstruction activities.	1	LTS	None	LTS
Implementation of IM 16, Water Diversions, could result in short-term increases in mineral (inorganic) suspended material in the Hydroelectric Reach due to diversion screening deconstruction and construction activities.	2, 3	LTS	None	LTS
Continued impoundment of water in the reservoirs could cause short-term and long-term seasonal (April through October) increases in algal-derived (organic) suspended material in the Hydroelectric Reach due to in-reservoir algal blooms.	1, 4	NCFEC	None	NCFEC
Draining the reservoirs and release of sediment could cause short-term increases in suspended material in the Hydroelectric Reach downstream from J.C. Boyle Dam.	2, 3, 5	S	None	S
Construction/deconstruction activities could cause short-term increases in suspended material in the Hydroelectric Reach due to stormwater runoff from	2, 3, 4, 5	LTS	None	LTS

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
construction/deconstruction areas.				
Removal of Iron Gate Dam would require relocation of the City of Yreka Water Supply Pipeline which could cause short-term increases in suspended material in the Hydroelectric Reach during the construction period.	2, 3, 5	LTS	None	LTS
Construction/deconstruction activities would include the demolition of various recreation facilities which could cause short-term increases in suspended material in the Hydroelectric Reach from stormwater runoff from the demolition areas.	2, 3, 5	LTS	None	LTS
Revegetation associated with management of the reservoir footprint area after dam removal could decrease the short-term erosion of fine sediments from exposed reservoir terraces in the Hydroelectric Reach.	2, 3, 5	B	None	B
Dam removal could eliminate the interception and retention of mineral (inorganic) suspended material behind the dams and result in long-term increases in suspended material in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Dam removal could eliminate the interception and retention of algal-derived (organic) suspended material behind the dams and result in slight long-term increases in suspended material in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Lower Klamath Basin				
Draining the reservoirs and release of sediment could cause short-term increases in suspended material in the Lower Klamath River and the Klamath Estuary.	2, 3, 5	S	None	S

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Draining the reservoirs and release of sediment could cause short-term increases in sediment loads from the Klamath River to the Pacific Ocean and corresponding increases in concentrations of suspended material and rates of deposition in the marine nearshore environment.	2, 3, 5	LTS	None	LTS
Continued impoundment of water in the reservoirs could cause short-term and long-term interception and retention of mineral (inorganic) sediments by the dams and correspondingly low levels of suspended material immediately downstream from Iron Gate Dam.	1, 4	NCFEC	None	NCFEC
Continued impoundment of water in the reservoirs could result in short-term and long-term seasonal (April through October) increases in algal-derived (organic) suspended material in the KHP reservoirs and subsequent transport into the Klamath River downstream from Iron Gate Dam.	1, 4	NCFEC	None	NCFEC
Construction/deconstruction activities could cause short-term increases in suspended material in the Lower Klamath River, Klamath Estuary, and marine nearshore environment due to stormwater runoff from construction/deconstruction areas.	2, 3, 5	LTS NCFEC (Marine Nearshore Environment	None	LTS
Revegetation associated with management of the reservoir footprint area after dam removal could decrease the short-term erosion of fine sediments from exposed reservoir terraces into the Lower Klamath River and Klamath Estuary.	2, 3, 5	B NCFEC (Marine Nearshore Environment	None	B
Dam removal could eliminate the interception and retention of mineral (inorganic) suspended material behind the dams and result in long-term increases in suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment.	2, 3, 5	LTS	None	LTS

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Dam removal could eliminate the interception and retention of algal-derived (organic) suspended material behind the dams and result in long-term increases in suspended material in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment.	2, 3, 5	LTS	None	LTS
Nutrients				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could result in long-term interception and retention of TN and TP in the Hydroelectric Reach on an annual basis but release of TP and, to a lesser degree TN from reservoir sediments on a seasonal basis.	1, 4	NCFEC	None	NCFEC
Draining the reservoirs and release of sediment could cause short-term increases in sediment-associated nutrients in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Lower Klamath Basin				
Continued impoundment of water in the reservoirs could cause long-term interception and retention of TP and TN on an annual basis and release (export) of TP on a seasonal basis	1, 4	NCFEC	None	NCFEC

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Draining the reservoirs and release of sediment to the Lower Klamath River could cause short-term increases in sediment-associated nutrients in the river, the Klamath Estuary, and the marine nearshore environment.	2, 3, 5	LTS	None	LTS
Dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment.	2, 3, 5	LTS	None	LTS
Dissolved Oxygen				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could cause long-term[1] seasonal and daily variability in dissolved oxygen concentrations in the Hydroelectric Reach, such that levels do not meet ODEQ and California North Coast Basin Plan water quality objectives and adversely affect beneficial uses.	1, 4	NCFEC	None	NCFEC
Draining the reservoirs and release of sediment could cause short-term[2] increases in oxygen demand (Immediate Oxygen Demand [IOD] and Biological Oxygen Demand [BOD]) and reductions in dissolved oxygen in the Hydroelectric Reach downstream from J.C. Boyle Reservoir.	2, 3, 5	S	None	S
Dam removal and conversion of reservoir areas to free-flowing river conditions could cause long-term slight increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, in the Hydroelectric Reach downstream from J.C. Boyle Dam, and would eliminate seasonal extremes in dissolved oxygen (i.e., supersaturation in surface waters and oxygen depletion in bottom waters) in the riverine reaches replacing Copco1 and Iron Gate Reservoirs.	2, 3	B	None	B

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Dam removal and conversion of reservoir areas to free-flowing river conditions could cause long-term slight decreases in daily variability in dissolved oxygen in the Hydroelectric Reach at State line.	2, 3	LTS	None	LTS
Lower Klamath Basin				
Continued impoundment of water at the Four Facilities could result in continued release of water with seasonally low dissolved oxygen concentrations from Iron Gate Dam into the Klamath River such that levels immediately downstream from the dam do not meet California North Coast Basin Plan water quality objectives and adversely affect beneficial uses.	1, 4	NCFEC	None	NCFEC
Dam removal and sediment release could cause short-term increases in oxygen demand (IOD and BOD) and reductions in dissolved oxygen in the Lower Klamath River, the Klamath Estuary, and the marine nearshore environment.	2, 3, 5	S (Lower Klamath River from Iron Gate Dam to Clear Creek) NCFEC (Klamath Estuary or Marine Nearshore Environment)	None	S (Lower Klamath River from Iron Gate Dam to Clear Creek) NCFEC (Klamath Estuary or Marine Nearshore Environment
Dam removal and conversion of reservoir areas to a free-flowing river could cause long-term overall increases in dissolved oxygen, as well as increased daily variability in dissolved oxygen, in the Lower Klamath River, particularly for the reach immediately downstream from Iron Gate Dam.	2, 3, 5	B	None	B
pH				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could cause long-term elevated seasonal pH and daily variability in pH due to large algal blooms in the reservoirs in the Hydroelectric Reach.	1, 4	NCFEC	None	NCFEC

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Dam removal and conversion of the reservoir areas to a free-flowing river could cause short-term and long-term slight increases in pH and daily pH fluctuations in riverine reaches in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Dam removal and conversion of the reservoir areas to a free-flowing river could cause short-term and long-term decreases in high summertime daily pH fluctuations in the free-flowing reaches of the river that replace Copco 1 and Iron Gate Reservoirs in the Hydroelectric Reach.	2, 3, 5	B	None	B
Lower Klamath Basin				
Continued impoundment of water in the reservoirs could cause long-term elevated seasonal pH and daily variability in pH in the Lower Klamath River immediately downstream from Iron Gate Dam due to large algal blooms in the reservoirs in the Hydroelectric Reach.	1, 4	NCFEC	None	NCFEC
Dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term summertime increases in pH in the Lower Klamath River immediately downstream from Iron Gate Dam.	2, 3, 5	LTS for Lower Klamath River from Iron Gate Dam to confluence with the Scott River NCFEC for the Lower – Klamath River downstream from the Scott River, the Klamath Estuary, and the Marine Nearshore Environment	None	LTS for Lower Klamath River from Iron Gate Dam to confluence with the Scott River NCFEC for the Lower Klamath River downstream from the Scott River, the Klamath Estuary, and the Marine Nearshore Environment

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Chlorophyll-a and Algal Toxins				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs could support long-term growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa*, resulting in high seasonal concentrations of chlorophyll-*a* and algal toxins (i.e., microcystin) in the Hydroelectric Reach.	1, 4	NCFEC	None	NCFEC
Dam removal and conversion of the reservoir areas to a free-flowing river would cause short-term and long-term decreases in levels of chlorophyll-a and substantially reduce or eliminate algal toxins (i.e., microcystin) in the Hydroelectric Reach.	2, 3, 5	B	None	B
Lower Klamath Basin				
Continued impoundment of water in the reservoirs could support long-term growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa*, resulting in high seasonal concentrations of chlorophyll-a and algal toxins (i.e., microcystin) transported into the Klamath River from downstream from Iron Gate Dam to the Klamath Estuary, and likely to the marine nearshore environment.	1, 4	NCFEC	None	NCFEC
Dam removal and conversion of the reservoir areas to a free-flowing river would cause short-term and long-term decreases in levels of chlorophyll-a and substantially reduce or eliminate algal toxins (i.e., microcystin) in the Lower Klamath River and the Klamath Estuary.	2, 3, 5	B	None	B

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Inorganic and Organic Contaminants				
Upper Klamath Basin				
Continued impoundment of water in the reservoirs and associated interception and retention of sediments behind the dams could cause long-term low-level exposure to inorganic and organic contaminants for freshwater aquatic species in the Hydroelectric Reach.	1, 4, 5	NCFEC	None	NCFEC
Continued impoundment of water in the reservoirs and associated interception and retention of sediments behind the dams could cause long-term low-level exposure to inorganic and organic contaminants in the Hydroelectric Reach for humans through the consumption of resident fish tissue.	1, 4, 5	NCFEC	None	NCFEC
Draining the reservoirs and sediment release could cause short-term increases in concentrations of inorganic and organic contaminants and result in low-level exposure for freshwater aquatic species in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Draining the reservoirs and sediment release could cause short-term and long-term human exposure to contaminants from contact with deposited sediments on exposed reservoir terraces and river banks within the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Construction/deconstruction activities could cause short-term increases in inorganic and organic contaminants from hazardous materials associated with construction and revegetation equipment in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Reservoir area restoration activities could include herbicide application which could cause short-term levels of organic contaminants in runoff that are toxic to aquatic biota in the Hydroelectric Reach.	2, 3, 5	LTS	None	LTS
Lower Klamath Basin				
Dam removal and sediment release could cause short-term and long-term increases in concentrations of inorganic and organic contaminants and result in low-level exposure for freshwater aquatic species in the Lower Klamath River and aquatic species in the Klamath Estuary and marine nearshore environment.	2, 3, 5	LTS	None	LTS
Draining the reservoirs and sediment release could cause short-term and long-term human exposure to contaminants from contact with deposited sediments on exposed downstream river terraces and downstream river banks following reservoir drawdown.	2, 3, 5	LTS	None	LTS
Construction/deconstruction activities could cause short-term increases in suspended sediments and the potential for inorganic and organic contaminants from hazardous materials associated with construction equipment to be transported into the Lower Klamath River, Klamath Estuary, and the marine nearshore environment.	2, 3, 4, 5	LTS for Lower Klamath River and the Klamath Estuary NCFEC for Marine Nearshore Environment	None	LTS
Trip and Haul Operations				
Implementation of the trap and haul operations would affect water quality during construction.	4, 5	LTS	None	LTS

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Keno Transfer				
Implementation of the Keno Transfer could cause adverse water quality effects.	2, 3	NCFEC	None	NCFEC
East and West Side Facilities				
Decommissioning the East and West Side Facilities could result in slight decreases in ammonia levels in the Keno Impoundment/Lake Ewauna.	2, 3	B	None	B
KBRA				
Implementation of the Phase I Fisheries Restoration Plan could result in short-term construction-related increases in suspended materials and long-term reductions in fine sediment inputs, reduced summer water temperatures, improved nutrient interception, and increased dissolved oxygen levels. .	2, 3	LTS (short term) B (long term)	None	LTS (short term) B (long term)
Implementation of the Phase II Fisheries Restoration Plan under the KBRA (KBRA Section 10.2) would include a continuation of the same types of resource management actions as under Phase I along with provisions for adaptive management of these actions and would therefore have the same short-term (i.e., during construction activities) and long-term impacts as Phase I.	2, 3	LTS (short term) B (long term)	None	LTS (short term) B (long term)
Implementation of the trap and haul element of the Fisheries Reintroduction and Management Plan could affect water quality during construction.	2, 3	LTS	None	LTS
Implementation of Wood River Wetland Restoration could result in short-term construction-related increases in suspended materials and long-term warmer spring water temperatures and reduced fine sediment and nutrient inputs to Upper Klamath Lake.	2, 3	LTS (short term) B (long term)	None	LTS (short term) B (long term)

Table 3.2-14. Summary of Short-term (<2 years) and Long-term (2–50 years) Water Quality Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation	Significance After Mitigation Pursuant to CEQA
Implementation of Water Diversion Limitations could result in decreased summer water temperatures in the Klamath River upstream of the Hydroelectric Reach.	2, 3	NCFEC (short term) B (long term)	None	NCFEC (short term) B (long term)
Implementation of the Water Use Retirement Program could result in decreases in summer water temperature and nutrient inputs to Upper Klamath Lake.	2, 3	NCFEC (short term) B (long term)	None	NCFEC (short term) B (long term)
Implementation of the Interim Flow and Lake Level Program could result in decreases in summer water temperature and nutrient inputs to Upper Klamath Lake.	2, 3	NCFEC (short term) B (long term)	None	NCFEC (short term) B (long term)
Implementation of the Upper Klamath Lake and Keno Nutrient Reduction Program could result in long-term decreases in nutrient inputs, increases in seasonal dissolved oxygen, and decreases in concentrations of nuisance algal species in these waterbodies.	2, 3	Not determined at this time	None	Not determined at this time

[1] Long term is defined as 2-50 years.
[2] Short term is defined as <2 years.

Key:
NCFEC = No change from existing conditions; B = Beneficial; LTS = Less than significant; S = Significant
CEQA = California Environmental Quality Act

3.2.7 References

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3.3 Aquatic Resources

This section describes the effects that the Proposed Action and alternatives would have on aquatic resources, and specifically fish, freshwater mussels, and aquatic macroinvertebrates.

3.3.1 Areas of Analysis

This section of the Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) analyzes impacts on fish populations, fish species recovery, and changes to habitat in the Klamath River watershed, excluding the Lost River watershed, Tule Lake watershed, and most of the Trinity River. However, because the lower quarter-to-half mile of the Trinity River could be used as a refuge by Klamath River fish attempting to avoid exposure to sediment pulses that would result from dam removal, this use of the Trinity River was considered in the analysis.

The Lead Agencies assessed potential impacts within and across five study reaches of the Klamath Basin separated by changes in physiography (e.g., Upper and Lower Klamath Basins), the presence of Klamath Hydroelectric Project facilities, and degree of marine influence (Figure 3.3-1). The five study reaches within the area of analysis are as follows:

1. Upper Klamath River: upstream of the influence of J.C. Boyle Reservoir, including the following:
    a. Upper Klamath Lake, Agency Lake, Keno Impoundment/Lake Ewauna, and Tule Lake
    b. Tributaries to Upper Klamath Lake (Sprague, Wood, and Williamson rivers)
    c. Bureau of Reclamation (Reclamation) Klamath Project facilities (e.g., Link River Dam)
2. Hydroelectric Reach: from the upstream end of J.C. Boyle Reservoir to Iron Gate Dam, including the following:
    a. Tributaries to the Klamath River (examples include Jenny, Spencer, Shovel, and Fall Creeks)
    b. J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs
    c. J.C. Boyle Bypass and Peaking Reaches
    d. Copco 2 Bypass Channel
3. Lower Klamath River: downstream from Iron Gate Dam, including the following:
    a. Major tributaries to the Klamath River (Shasta, Scott, and Salmon Rivers)
    b. Minor tributaries to the Klamath River (examples include Bogus, Beaver, Humbug, and Cottonwood Creeks)
    c. The lower portion of the Trinity River
4. Klamath River estuary
5. Pacific Ocean nearshore environment

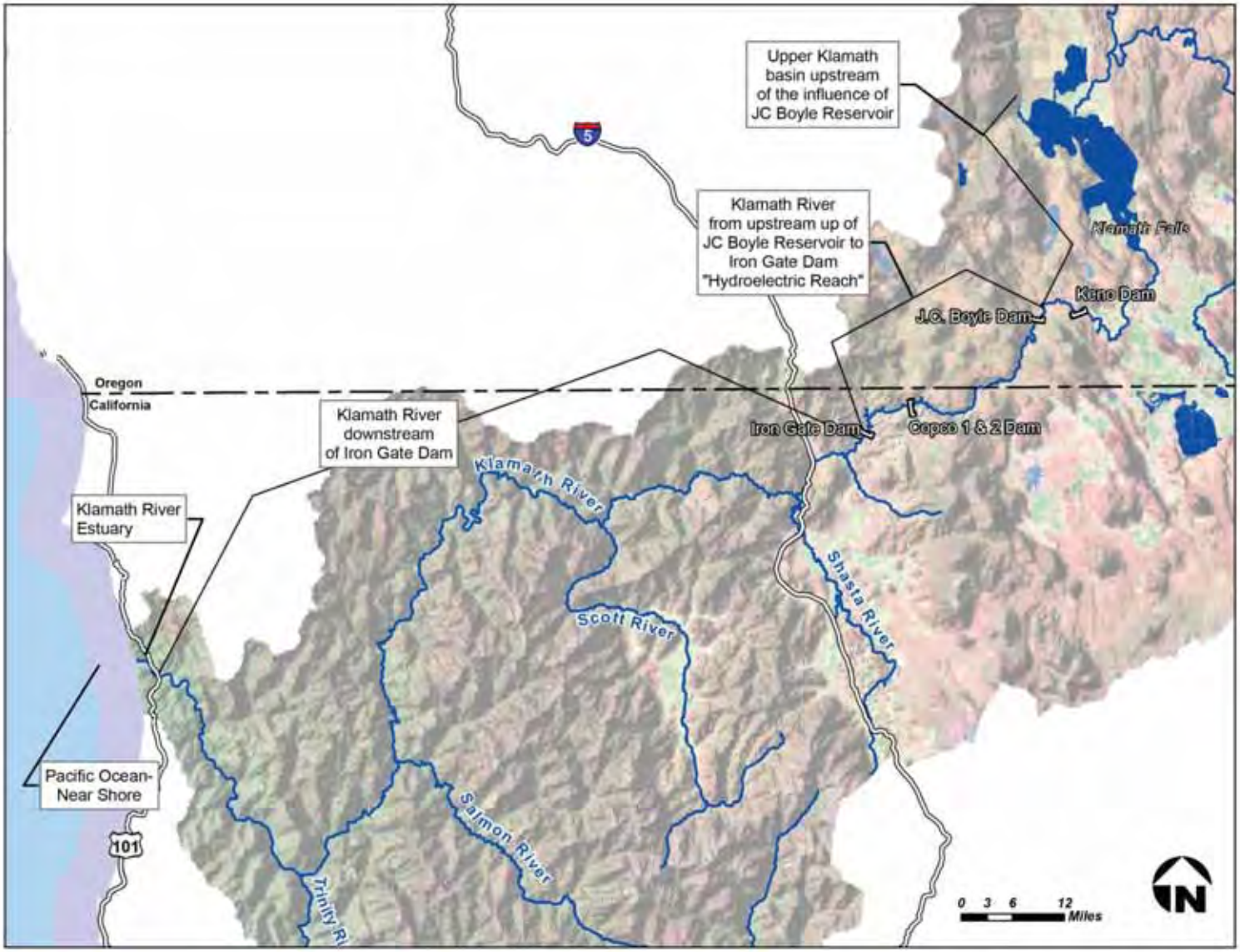

Figure 3.3-1. Five Study Reaches within the Area of Analysis for the Aquatic Resources Analysis.

The Klamath Basin has traditionally been divided into the Upper and Lower Klamath Basins at Iron Gate Dam (Natural Resources Council [NRC] 2004, 2008). For purposes of this evaluation, the Upper Basin was subdivided into two reaches at the upstream influence of J.C. Boyle Reservoir. The area upstream of the influence of J.C. Boyle Reservoir could experience some changes in flow in riverine reaches or water surface elevation in lakes and reservoirs due to changes in Reclamation's Klamath Project operations under some of the alternatives, but the physical structure of the habitat would remain similar to existing conditions (with the exception of habitat restoration efforts described for some alternatives). The Hydroelectric Reach encompasses the four dams proposed for removal. Under several of the alternatives, the physical structure of some or all reservoir habitat within the Hydroelectric Reach would be changed from lacustrine (lake) to riverine habitat. The Lower Klamath River: downstream from Iron Gate Dam corresponds to the traditional “Lower Basin” designation.

3.3.2 Regulatory Framework

Aquatic species within the area of analysis are regulated by several Federal and State laws and regulations, which are listed below.

3.3.2.1 Federal Authorities and Regulations

- Federal Endangered Species Act
- Fish and Wildlife Coordination Act
- Magnuson-Stevens Fishery Conservation and Management Act
- Marine Mammal Protection Act
- Wild and Scenic Rivers Act
- Federal Power Act
- Coastal Zone Management Act

3.3.2.2 State Authorities and Regulations

- California Endangered Species Act
- California Fish and Game Code
- Oregon Endangered Species Act
- Oregon Removal-Fill Law
- Oregon Statewide Planning Program
- Oregon Threatened and Endangered Species
- Oregon Wildlife and Commercial Fishing Codes
- Oregon Fish Passage Law
- Oregon Screening and By Pass Devices Law
- Oregon Klamath River Basin Fish Management Plan
- Oregon Native Fish Conservation Policy
- Oregon Fish and Wildlife Habitat Mitigation Policy
- Oregon Klamath River Basin Anadromous Re-Introduction Plan
- Oregon - Reauthorization of Hydroelectric Projects.
- Oregon Wildlife Policy

3.3.2.3 Local Authorities and Regulations

- Klamath Act

The regulation and protection of water quality including beneficial uses for aquatic species is discussed in Section 3.2, Water Quality.

3.3.3 Existing Conditions/Affected Environment

This section describes existing conditions in the area of analysis, including discussion of aquatic species (Section 3.3.3.1); physical habitat, water bodies within the different regions for the analysis (Section 3.3.3.2); and important factors affecting aquatic resources that the Lead Agencies anticipate would likely change if the Proposed Action or the alternatives are implemented (Section 3.3.3.3).

The species descriptions include a brief account of the current and historical distribution, life-history patterns, and habitat requirements of aquatic species. This section is subdivided into anadromous fish, native riverine fish, introduced species, estuarine species, and listed species. The last category includes species that would otherwise be included in the anadromous, riverine, or estuarine species.

The description of physical habitat provides information on the physical structure of the habitat. It contains a brief description of the water quality and other factors that may limit fish production in those water bodies, and describes the species that occur in these water bodies. This section also describes Federal Endangered Species Act (ESA) critical habitat and Magnuson-Stevens Fishery Conservation Management Act Essential Fish Habitat (EFH) occurring within the area of analysis.

Section 3.3.3.3, *Habitat Attributes Expected to be Affected by the Project*, provides a more detailed description of existing conditions for factors that are thought to have a major influence on aquatic resources. These factors form the basis for the effects evaluation in Section 3.3.4.

3.3.3.1 Aquatic Species

3.3.3.1.1 Fish

Numerous fish species use the Klamath Basin during all or some portion of their lives, including salmonids, lamprey, sturgeon, suckers, minnows, and sculpin. Many other species are present in the estuary. Species that have been introduced into the Basin include non-native yellow perch, largemouth bass, spotted bass, sunfish, and catfish. The species include introduced resident species, estuarine species, and species listed under the Federal or State ESAs. The number of species prohibits evaluation of each species. To address the impacts and benefits of the Proposed Action, target species have been selected for analysis based on their legal status or importance for tribal, commercial or recreational fisheries, and based on adequate data to conduct analysis. These target species are discussed below.

Anadromous Fish Species

The Klamath Basin provides habitat for many species of anadromous fish, many of which are salmonids, but which also include green sturgeon (*Acipenser medirostris* Ayres), Pacific lamprey, and American shad (non-native). Anadromous fish within the Klamath River watershed have nearly all declined compared to their historical abundance (Table 3.3-1). Although historical data are not available, green sturgeon appear to be in less decline than other fish species. Van Eenennaam et al. (2006) carefully suggests that based on reports of sturgeon captures during Yurok Tribal Chinook salmon gill-net fishery, the Klamath River green sturgeon population appears strong and stable, while cautioning against conclusions based on short time frames relative to their life history.

Table 3.3-1. Declines in Klamath River Anadromous Fish

Species	Historical run estimate	Reduction from historical numbers	Current run estimate	Source
Pacific lamprey	Unknown	98% (percent reduction in tribal catch per effort)	Unknown	Petersen Lewis 2009
Steelhead	400,000[1]	67%	130,000	Leidy and Leidy 1984; Busby et al. 1994
Coho salmon	15,400–20,000	52% to 95%	760 to 9,550	Moyle et al. 1995; Ackerman et al. 2006
Fall-run Chinook salmon	500,000[3]	92% to 96%	20,000–40,000	Moyle 2002
Shasta River Chinook salmon[4]	20,000–80,000	88% to 95%	A few hundred to a few thousand	Moyle 2002
Spring-run Chinook salmon	100,000	98%	2,000[2]	Moyle 2002

[1] Estimate from 1960. Anadromous fish numbers were already in decline in the early 1900s (Snyder 1931)
[2] Includes Klamath River and Trinity River Chinook salmon
[3] Excludes hatchery-influenced escapement
[4] Shasta River is a subset of the overall Klamath River Chinook salmon population

Anadromous salmonids in the Klamath River include fall- (including late-fall) and spring-run Chinook salmon; coho salmon; fall-, winter-, and summer-run steelhead; and coastal cutthroat trout. Anadromous salmonids share many similar life-history traits, but the timing of their upstream migrations, habitat preferences, and distributions differ. All anadromous salmonids spawn in gravel or cobble substrates that are relatively free of fine sediment with suitable surface and subsurface flow to carry oxygen to the eggs and carry metabolic waste away from the eggs. Once suitable spawning habitat is found, the adult female digs one or more nests and deposits up to 3,000 eggs. Her mate(s) will simultaneously fertilize the eggs and fend off other males and egg-eating predators. The female continues digging upstream of the nest, which forms a distinctive pit just upstream and a protective mound of gravel and cobble over the eggs. The female will continue the mound-building process and defend her nest location until her demise. Steelhead and coastal cutthroat trout have similar life histories, but may survive spawning, re-enter the

ocean, and return to spawn the following year(s). The eggs hatch several weeks or months after spawning, depending on species and water temperature. The resulting yolk-sac fry, also referred to as alevins, reside in the gravel for several more weeks until their yolk sac is depleted. The fry then emerge from the redd and seek slow shallow areas near shoreline or vegetative cover, gradually moving into deeper and faster water as they grow. Anadromous salmonids are generally considered "juveniles" when they have grown to a size of approximately 55 millimeters (mm). Juveniles feed and grow on their way downstream and may also rear for some time in the estuary prior to entering the ocean, but before entering brackish or salt water, they must undergo a physiological process called smoltification. After entering the ocean, smolts range up and down the coast as they grow to adulthood. Most adult salmonids return to spawn in the stream where they were born, although some straying does occur. Specific details of life history and distribution are described for each run of anadromous salmonid in the following section.

Chinook Salmon

Two Chinook salmon Evolutionarily Significant Units (ESUs) occur in the Klamath Basin—the Southern Oregon and Northern California Coastal ESU, which includes all naturally spawned Chinook salmon in the Lower Klamath River downstream from its confluence with the Trinity River, and the Upper Klamath and Trinity Rivers ESU, which includes all naturally spawned populations of Chinook salmon in the Klamath and Trinity rivers upstream of the confluence of the Klamath and Trinity Rivers. A status review in 1999 determined that neither ESU warranted listing (National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service 1999a).

Another petition to list Chinook salmon in the Upper Klamath and Trinity Rivers ESU under the Endangered Species Act was submitted to the NOAA Fisheries Service in January 2011 (Center for Biological Diversity (CBD) et al. 2011). In the petition NOAA Fisheries Service was asked to consider one of three alternatives for the listing of Chinook salmon in the Upper Klamath and Trinity River ESU: 1) list spring-run only as a separate ESU, 2) list spring-run as a distinct population segment within the Upper Klamath and Trinity River Chinook Salmon ESU, or 3) list the entire Chinook salmon Upper Klamath and Trinity River ESU including both spring-run and fall-run populations. In April 2011, NOAA Fisheries Service announced that the petition contained substantial scientific information warranting Federal review as to whether Chinook salmon within the Upper Klamath and Trinity River ESU should be listed as threatened or endangered (http://www.noaanews.noaa.gov/stories2011/20110411_chinook.html). As a result, the NOAA Fisheries Service formed a Biological Review Team (BRT) to assess the biological status of the species and determine if listing under the Endangered Species Act may be necessary. The BRT (Williams et al. 2011) found that recent spawner abundance estimates of both fall-run and spring-run Chinook salmon returning to spawn in natural areas are generally low compared to historical estimates of abundance; however, the majority of populations have not declined in spawner abundance over the past 30 years (i.e., from the late 1970s and early 1980s to 2010) except for the Scott and Shasta rivers where there have been modest declines (Williams et al. 2011). In addition, Williams et al. (2011) found that hatchery returns did not track escapement to natural spawning areas and they concluded

that there has been little change in the abundance levels, trends in abundance, or population growth rates since the review conducted by Myers *et al.* (1998). The BRT also noted that recent abundance levels of some populations are low, especially in the context of historical abundance estimates. This was most evident with respect to two of the three spring-run population units that were evaluated (Salmon River and South Fork Trinity River). Although current levels of abundance are low when compared to historical estimates of abundance, the current abundance levels do not constitute a major risk in terms of ESU extinction.

The BRT also concluded that spring-run Chinook salmon did not warrant designation as a separate ESU or distinct population segment within the Upper Klamath and Trinity River ESU. This finding was based in part on new genetic evidence that indicates that spring-run and fall-run life histories have evolved on multiple occasions across different coastal watersheds located north and south of the Klamath River. Kinziger et al. (2008) found that there are four genetically differentiated and geographically separated groups of Chinook salmon populations in the Upper Klamath and Trinity River basins and that spring-run and fall-run Chinook life histories have evolved independently and in parallel within both the Salmon and Trinity rivers. In addition, spring-run and fall-run populations in the Salmon River were nearly indistinguishable genetically and spring and fall-run populations in the South Fork Trinity were extremely similar to each other and to Trinity River hatchery stocks. Williams et al. (2011) concluded that spring-run and fall-run Chinook salmon within the Upper Klamath and Trinity River basins are genetically similar to each other and that the two runs are not substantially reproductively isolated from each other. In addition, ocean type and stream type life history strategies are exhibited by both run types, further suggesting that spring-run Chinook salmon in the Upper Klamath and Trinity River basins do not represent an important component in the evolutionary legacy of the species.

Regardless of the determination that spring-run and fall-run Chinook salmon comprises a single ESU, these two runs have different life history strategies and habitat requirements (NRC 2004) and a more detailed discussion of the two run types is described below.

Fall-Run Chinook Salmon. Fall-run Chinook salmon (*Oncorhynchus tshawystcha*) are distributed throughout the Klamath River downstream from Iron Gate Dam. Historical records reviewed by Hamilton et al. (2005) and genetic information obtained from archaeological sites analyzed by Butler et al (2010) indicate that prior to the construction of Copco 1 Dam, Chinook salmon (both fall- and spring-run) spawned and were abundant in tributaries of the Upper Klamath Basin, including Jenny, Fall, and Shovel Creeks, as well as the Sprague, Williamson, and Wood rivers (Administrative Law Judge 2006).

Adult upstream migration through the estuary and Lower Klamath River peaks in early September and continues through late October (Moyle 2002; FERC 2007; Strange 2008). Spawning peaks in late October and early November, and fry begin emerging from early February through early April (Stillwater Sciences 2009a), although timing may vary somewhat depending on temperatures in different years and tributaries.

Fall-run Chinook salmon in the Klamath Basin exhibit three juvenile life-history types: Type I (ocean entry at age 0[1] in early spring within a few months of emergence), Type II (ocean entry at age 0 in fall or early winter), and Type III (ocean entry at age 1 in spring) (Sullivan 1989). Based on outmigrant trapping at Big Bar on the Klamath River from 1997 to 2000, 63 percent of natural Chinook salmon outmigrants are Type I, 37 percent are Type II, and less than 1 percent are Type III (Scheiff et al. 2001). Although, trapping efforts are not equal among seasons, the results are consistent with scale analysis of adult returns by Sullivan (1989).

Critical stressors on fall-run Chinook salmon in the basin include water quality and quantity in the mainstem and within spawning tributaries. Downstream from Iron Gate Dam, the mainstem Klamath River undergoes seasonal changes in flows, water temperature, dissolved oxygen, and nutrients, as well occasional blooms of *Microcystis aeruginosa*. During outmigration, juvenile Chinook salmon are vulnerable to contracting disease from pathogens, including the bacterium *Flavobacterium columnare*, and myxozoan parasites *Parvicapsula minibicornis* and *Ceratomyxa shasta*.

Spring-Run Chinook Salmon. Spring-run Chinook salmon in the Klamath Basin are distributed mostly in the Salmon and Trinity Rivers and on the mainstem downstream from these tributaries during migratory periods, although a few fish are occasionally observed in other areas (Stillwater Sciences 2009a). Based on data from 1992 to 2001 (California Department of Fish and Game [CDFG], unpublished data 2004), the Salmon River contributions to the overall escapement ranged from 1 to 20 percent of the total escapement, and from 2 to 35 percent of the natural escapement. No spawning has been observed in the mainstem Klamath River (Shaw et al. 1997). As described above, the BRT (Williams et al. 2011) concluded that while abundance is low compared with historical abundance (Table 3.3-1), the current Chinook salmon population (which includes hatchery fish) appear to have been fairly stable for the past 30 years. However, the BRT noted, as did Myers et al. (1998), that the recent spawner abundance levels of two of the three spring-run population components (Salmon River and South Fork Trinity River) are very low compared to historical abundance (less than 1,000 fish). The BRT was concerned about the relatively few populations of spring-run Chinook salmon and the low numbers of spawners within those populations (Williams et al. 2011).

The BRT (Williams et al. 2011) found the decline in spring-run fish especially troubling given that the spring-run population may have been equal to, if not larger than the fall-run (Barnhart 1994). Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Spring Chinook salmon spawned in the tributaries of the Upper Klamath Basin (Moyle 2002; Hamilton et al. 2005 with large numbers of Chinook salmon spawning in the basin above Klamath Lake in the Williamson, Sprague, and Wood Rivers (Snyder 1931). Large runs of spring Chinook salmon also returned to the Shasta, Scott, and Salmon rivers (Moyle et al. 1995). The runs in the Upper Klamath Basin are thought to have been in substantial decline by the early 1900s, and then were

[1] A fish emerging in spring is designated as age 0 until January 1st of the following year, when it is designated as age 1 until January 1st of the next year, when it is designated age 2.

eliminated by the completion of Copco Dam in 1917 (Snyder 1931). The cause of the decline of the Klamath River spring-run Chinook salmon prior to Copco 1 Dam has been attributed to dams, overfishing, irrigation, and largely to commercial hydraulic mining operations (Coots 1962; Snyder 1931). These large scale mining operations occurred primarily in the late 1800's, and along with overfishing, left spring-run Chinook salmon little chance to recover prior to dam construction in early 1900's. Dam construction eliminated much of the historical spring-run spawning and rearing habitat and was partly responsible for the extirpation of at least seven spring-run populations from the Klamath-Trinity River system (Myers et al. 1998). The construction of Dwinnell Dam on the Shasta River in 1926 was soon followed by the disappearance of the spring Chinook salmon run in that tributary (Moyle et al. 1995).

Wild spring-run Chinook salmon from the Salmon River appear to primarily express a Type II life history, based on scale analyses of adults returning from 1990 to 1994 in the Salmon River (Olson 1996), as well as otolith analyses of Salmon River fry and adults (Sartori 2006). A small number of fish employ the Type III life history, although apparently not nearly as prevalent as the Type II.

Spring-run Chinook salmon upstream migration is observed during two time periods—spring (April through June) and summer (July through August) (Strange 2008). Snyder (1931) also describes a run of Chinook salmon occurring in Klamath River during July and August under historical water quality and temperature conditions. Adults spawn from mid-September to late-October in the Salmon River and from September through early November in the South Fork Trinity River (Stillwater Sciences 2009a). Emergence takes place from March and continues until early-June (West et al. 1990). Age-0+ juveniles rearing in the Salmon River emigrate at various times of the year, with one of the peaks of outmigration occurring in April through May (Olson 1996), which would be considered Type I life history. Based on outmigrant trapping from April to November in 1991 at three locations in the South Fork Salmon River, Olson (1996) reported that the greatest peak in outmigration of age-0+ juveniles (69 percent) was in mid-October, which would be considered Type II life history. Scale circuli patterns of adults with an identified Type II life history were consistent with those from juveniles outmigrating in mid-October. Sullivan (1989) reported that outmigration of Type II age-0+ juveniles can occur as late in the year as early-winter. On the South Fork Trinity River outmigration occurs in late-April and May with a peak in May (Dean 1994, 1995), although it is not possible to differentiate between spring and fall race juveniles and so the spring-run may have different run timing. Age-1 juveniles (Type III) have been found to outmigrate from the South Fork Trinity River during the following spring (Dean 1994, 1995).

It is unclear how much time outmigrating age-0+ juveniles spend in the Klamath River mainstem and estuary before entering the ocean. Sartori (2006) did identify a period of increased growth (estimated mean of 24 days) just prior to reaching an estuarine environment based on otolith analyses of returning adults to the Salmon River, but this period was never clearly linked to mainstem residence. From March to May, there were fair numbers of age-1 juvenile outmigrants captured in the Klamath River estuary

(Wallace 2004). Most were identified to be hatchery age-1 juvenile fall-run Chinook salmon, but nearly half were identified to be of natural origin, based on tag expansions.

Stressors on spring-run Chinook salmon related to water quality and quantity are similar to those for fall-run Chinook salmon in the mainstem Klamath River. Although water quality tends to improve in the mainstem downstream from the confluence with the Salmon River (the upstream-most spawning tributary), degradation of water quality (especially temperature and dissolved oxygen) can create critically stressful conditions for spring-run Chinook salmon for much of the summer (June through September). Production in the Salmon River is primarily controlled by high water temperatures that reduce adult holding and summer rearing habitat in the mainstem Salmon River, while increased fine sediment input within the watershed reduces spawning and rearing habitat quality in some locations (Elder et al. 2002).

Steelhead

Klamath Basin summer steelhead and winter steelhead (*O. mykiss irideus*) populations both belong to the Klamath Mountain Province ESU. NOAA Fisheries Service (2001) status review found that this ESU was not in danger of extinction or likely to become so in the foreseeable future, based on estimated populations for the ESU and lower estimates of genetic risk from naturally spawning hatchery fish than estimated in previous reviews, and consideration of existing conservation efforts that are benefiting steelhead in the ESU (NOAA Fisheries Service 2001).

Summer Steelhead. Summer steelhead are distributed throughout the Klamath River downstream from Iron Gate Dam and in its tributaries, and historically used habitat upstream of Upper Klamath Lake prior to the construction of Copco 1 Dam (Hamilton et al. 2011). Based on available escapement data, approximately 55 percent of summer steelhead spawn in the Trinity River and other lower-elevation tributaries. Most remaining summer steelhead are believed to spawn in tributaries between the Trinity River (River Mile [RM] 43) and Seiad Creek (RM 129), with high water temperatures limiting their use of tributaries farther upstream (NRC 2004). The mainstem Klamath River is used primarily as a migration corridor for adult summer steelhead to access holding and spawning habitat in tributaries to the Klamath River.

Summer steelhead adults enter and migrate up the Klamath River from March through June while sexually immature (Hopelain 1998), then hold in cooler tributary habitat until spawning begins in December (United States Fish and Wildlife Service [USFWS] 1998). Forty to 64 percent of summer steelhead in the Klamath River exhibit repeat spawning, with adults observed to migrate downstream to the ocean after spawning (also known as “runbacks”) (Hopelain 1998). Summer steelhead in the basin also have a “half-pounder” life-history pattern, in which an immature fish emigrates to the ocean in the spring, returns to the river in the fall, spends the winter in the river, then emigrates to the ocean again the following spring (Busby et al. 1994; Moyle 2002).

Juvenile summer steelhead in the Klamath Basin may rear in freshwater for up to 3 years before outmigrating. Although many juveniles migrate downstream at age 1+ (Scheiff

et al. 2001), those that outmigrate to the ocean at age 2+ appear to have the highest survival (Hopelain 1998). Juveniles outmigrating from tributaries at age 0+ and age 1+ may rear in the mainstem or in non-natal tributaries (particularly during periods of poor water quality) for 1 or more years before reaching an appropriate size for smolting. Age-0 juvenile steelhead have been observed migrating upstream into tributaries, off-channel ponds, and other winter refuge habitat in the Lower Klamath River (Stillwater Sciences 2010b). Juvenile outmigration can occur from the spring through fall. Smolts are captured in the mainstem and estuary throughout the fall and winter (Wallace 2004), but peak smolt outmigration normally occurs from April through June, based on estuary captures (Wallace 2004). Temperatures in the mainstem are generally suitable for juvenile steelhead, except during periods of the summer, especially upstream of Seiad Valley (for more species information see USFWS 1998; Moyle 2002; NRC 2004; and Stillwater Sciences 2009a). Critical limiting factors for summer steelhead are believed to include degraded habitats, fish passage, predation, and competition (Moyle et al. 2008).

Winter Steelhead. Moyle (2002) describes steelhead in the Klamath Basin as having a summer- and winter-run. Some divide the winter-run into fall and winter runs (Barnhart 1994; Hopelain 1998; USFWS 1998; Papa et al. 2007). In this section, "winter steelhead" refers to both fall and winter runs except in cases when the distinction is pertinent to the discussion. Effects on winter-and fall-run steelhead were differentiated wherever data was sufficient to analyze them separately.

Winter steelhead are widely distributed throughout the Klamath River and its tributaries downstream from Iron Gate Dam, and historically used habitat upstream of Upper Klamath Lake (Hamilton et al. 2011). The Trinity, Scott, Shasta, and Salmon Rivers are the most important spawning streams for winter steelhead. Winter steelhead adults generally enter the Klamath River from July through October (fall run) and from November through March (winter run) (USFWS 1998; Stillwater Sciences 2010b). Winter steelhead primarily spawn in tributaries from January through April (USFWS 1998), with peak spawn timing in February and March (ranging from January to April) (NRC 2004). Adults may repeat spawning in subsequent years after returning to the ocean. Half-pounders typically utilize the mainstem Klamath River until leaving the following March (NRC 2004), although they also utilize larger tributaries such as the Trinity River (Dean 1994, 1995).

Fry emerge in spring (NRC 2004), with fry observed in outmigrant traps in Bogus Creek and Shasta River from March through mid-June (Dean 1994). Age-0+ and 1+ juveniles have been captured in outmigrant traps in spring and summer in tributaries to the Klamath River above Seiad Creek (CDFG 1990a, b). These fish are likely rearing in the mainstem or non-natal tributaries before leaving as age-2+ outmigrants.

Juvenile outmigration appears to primarily occur between May and September with peaks between April and June, although smolts are captured in the estuary as early as March and as late as October (Wallace 2004). Most adult returns (86 percent) originate from fish that smolt at age 2+, representing 86 percent of adult returns; in comparison with only 10 percent for age-1 juveniles and 4 percent for age 3+ juveniles (Hopelain 1998).

Similar limiting factors listed for summer steelhead also affect winter steelhead populations, including degraded habitats, decreased habitat access, fish passage, predation, and competition (for more species information see USFWS 1998; NRC 2004; Wallace 2004; and Stillwater Sciences 2009a).

Coastal Cutthroat Trout

Klamath River coastal cutthroat trout (*Oncorhynchus clarki clarki)* belong to the Southern Oregon California Coasts ESU. In a 1999 status review, NOAA Fisheries Service determined that the Southern Oregon California Coasts ESU did not warrant ESA listing (Johnson et al. 1999). Coastal cutthroat trout are distributed primarily within smaller tributaries to the lower 22 miles of the Klamath River mainstem above the estuary (NRC 2004), but also within tributaries to the Trinity River (Moyle et al. 1995).

Cutthroat trout have not been extensively studied in the Klamath Basin, but it has been noted that their life history is similar to fall and winter steelhead in the Klamath River (NRC 2004). Both resident and anadromous life histories are observed in the Klamath Basin. Anadromous adults enter the river to spawn in the fall. Generally, spawning of anadromous and resident coastal cutthroat trout may occur from September to April (Moyle 2002). Sea-run adults may either return in summer to feed, or return in September or October to spawn and/or possibly overwinter (NRC 2004). Moyle (2002) noted that upstream migration in northern California spawning streams tends to occur from August to October after the first substantial rain.

Juveniles may spend anywhere from one to three years in freshwater to rear. Juveniles outmigrate during April through June, at the same time as Chinook salmon juvenile downstream migration (Moyle 2002; NRC 2004). Juveniles also appear to spend at least some time rearing in the estuary. Wallace (2004) found that estuary residence time ranged from 5 to 89 days, with mean of 27 days, based on a mark-recapture study.

Pacific Lamprey

Pacific lamprey are the only anadromous lamprey species in the Basin. Pacific lamprey, along with three other lamprey species, was petitioned for ESA listing in 2003 (Nawa 2003). Although the USFWS halted species status review in December 2004 due to inadequate information (USFWS 2004), efforts to list Pacific lamprey are anticipated to resume as more information is obtained. No current status assessments are available for any Klamath lampreys and little is known of their biology or sensitivity to environmental changes in the Klamath drainage (Hamilton et al. 2011).

Pacific lamprey are found in Pacific coast streams from Alaska to Baja California. They occur throughout the mainstem Klamath River downstream from Iron Gate Dam and its major tributaries: the Trinity, Salmon, Shasta, and Scott River Basins (Stillwater Sciences 2009a). Although the evidence is inconclusive as to whether Pacific lamprey were historically present above Iron Gate Dam, the record evidence shows that access to habitat would benefit that species of fish by providing it with additional spawning and rearing grounds (Administrative Law Judge 2006). Pacific lamprey are capable of

migrating long distances, and show similar distributions to anadromous salmon and steelhead (Hamilton et al. 2005).

Pacific lamprey are anadromous nest builders that die shortly after spawning. They enter the Klamath River during all months of the year, with peak upstream migration occurring from December through June (Stillwater Sciences 2009a). Spawning occurs at the upstream edge of riffles in sandy gravel from mid-March through mid-June (Stillwater Sciences 2009a). After lamprey eggs hatch, the larvae (ammocoetes) drift downstream to backwater areas and burrow into the substrate, feeding on algae and detritus (FERC 2007). Based on observations and available habitat, most ammocoete rearing likely occurs in the Salmon, Scott, and Trinity Rivers, as well as in the mainstem Klamath River. The Klamath River upstream of the Shasta River appears to have less available spawning and rearing habitat, and Pacific lamprey are not regularly observed there. Juveniles remain in freshwater for 5 to 7 years before they migrate to the ocean and transform into adults (Moyle 2002). They spend 1 to 3 years in the marine environment, where they parasitize a wide variety of ocean fishes, including Pacific salmon, flatfish, rockfish, and pollock. For more species information see Close et al. 2010; Stillwater Sciences 2009a; and PacifiCorp 2004a.

Major factors believed to be affecting their populations include barriers to upstream migration at dams, dewatering of larval habitat through flow regulation, stranding due to rapid downramping, reducing larval habitat by increasing water velocity and/or reducing sediment deposition areas, and mortality due to exposure to contaminants in the larval stage (Close et al. 2002, as cited in Hamilton et al. 2011).

Green Sturgeon

Green sturgeon (*Acipenser medirostris Ayres*) are an anadromous species that occurs in coastal marine waters from Mexico to the Bering Sea. NOAA Fisheries Service has identified two distinct population segments (DPSs): the Northern Green Sturgeon DPS, which includes populations spawning in coastal watersheds from the Eel River north, which is not listed as threatened or endangered but is on NOAA Fisheries Service's Species of Concern list, and the Southern Green Sturgeon DPS, encompassing coastal or Central Valley populations spawning in watersheds south of the Eel River, which is listed as threatened under the Federal ESA (NOAA Fisheries Service 2006a). Although the Southern DPS is considered a separate population from the Northern DPS based on genetic data and spawning locations, their ranges outside of the spawning season tend to overlap (CDFG 2002b; Israel et al. 2004; Moser and Lindley 2007). The Klamath Basin may support most of the spawning population of green sturgeon (Adams et al. 2002). Although Southern DPS green sturgeon may enter west coast estuaries to feed in the summer and fall, there has been no evidence of them entering the Klamath River estuary (Reclamation 2010).

Northern DPS green sturgeon in the Klamath River sampled during their spawning migration ranged in age from 16 to 40 years (Van Eenennaam et al. 2006). It is believed that in general green sturgeon have a life span of at least 50 years, and spawn every 4 years on average after around age-16, for a total of around eight spawning efforts in a

lifetime (Klimley et al 2007). Green sturgeon enter the Klamath River to spawn from March through July. Green sturgeon spawn primarily in the lower 67 miles of the mainstem Klamath River (downstream from Ishi Pishi Falls), in the Trinity River, and occasionally in the lower Salmon River (Klamath River Basin Fisheries Task Force [KRBFTF] 1991; Adams et al. 2002; Benson et al. 2007). Most green sturgeon spawning occurs from the middle of April to the middle of June (NRC 2004). After spawning, around 25 percent of green sturgeon migrate directly back to the ocean (Benson et al. 2007), and the remainder hold in mainstem pools in the Klamath River from RM 13 to 65 through November.

During the onset of fall rainstorms and increased river flow, adult sturgeon move downstream and leave the river system (Benson et al. 2007). Juvenile green sturgeon may rear for 1 to 3 years in the Klamath River system before they migrate to the estuary and ocean (NRC 2004; FERC 2007; CALFED 2007), usually during summer and fall (Emmett et al. 1991, as cited in CALFED 2007; CH2M Hill 1985; Hardy and Addley 2001).

The timing and magnitude of high flows downstream from Iron Gate Dam that are related to Project operations have the potential to reduce green sturgeon survival in the mainstem. Adult green sturgeon that have held over the summer in the river after spawning appear to migrate downstream in conjunction with increases in discharge in the fall. Attenuation of high flows downstream from Iron Gate Dam may affect a key environmental cue used to stimulate the fall outmigration of adult green sturgeon that have remained in holding pools over the summer (Benson et al. 2007). This lower portion of the river was quite responsive to discharge increases related to rainfall events; the timing of peak flows changed significantly following the construction of the Project (Balance Hydrologics, Inc. 1996). Under existing conditions, the Project results in higher flows in October compared with historical conditions and lower flows in late spring and summer (Balance Hydrologics, Inc. 1996). Because temperatures in the lower river are close to lethal for eggs and embryos in dry years, reductions in flows related to the Project may exacerbate the effects of temperature on reproductive survival in these years, as would any temperature increases occurring as a result of climate change in the future. Shifts in the timing of seasonal life-history cues could also affect survival rates by changing the timing of their entry into habitats, such as entry of juveniles into the estuary.

Resident Riverine Fish Species

Rainbow and Redband Trout

Rainbow trout (*Oncorhynchus mykiss*) exhibit a wide range of life-history strategies, including anadromous forms (steelhead, described above) and resident forms, described here. The Klamath Basin has two subspecies of rainbow trout. Behnke (1992) identifies the inland form as the Upper Klamath redband trout, *Oncorhynchus mykiss newberrii*, but considers steelhead and resident rainbow trout downstream from Upper Klamath Lake to be primarily coastal rainbow trout, *Oncorhynchus mykiss irideus*. Since construction of Copco 1 Dam and Iron Gate Dam, resident trout upstream of Iron Gate Dam are

considered redband trout, and resident trout downstream from Iron Gate Dam are considered coastal rainbow trout (FERC 2007). Behnke (2002) indicates that two distinct groups of redband trout may be in the Upper Klamath Basin: one that is adapted to lakes and another that is adapted to streams. The area upstream of Iron Gate Dam, and particularly Upper Klamath Lake, supports populations of redband trout. These fish support a substantial recreational fishery.

The Upper Klamath Basin supports the largest and most functional adfluvial redband trout population of Oregon's interior basins (Hamilton et al. 2011). Adfluvial adult redband trout migrate from lake habitats into tributaries to spawn. Peak spawning occurs in December and January, but redband trout in Spring Creek have been documented to spawn nearly year-round, in all months from October through August. Their progeny typically spend one year rearing in tributaries before migrating back to the lake. In the Hydroelectric Reach, most redband trout spawning is thought to occur in Spencer and Shovel Creeks. Redband trout need to migrate among habitats, mainstem, tributaries, and reservoirs to meet their life-history requirements. Redband trout are not susceptible to *C. shasta* or other diseases potentially brought upstream by anadromous fishes (Hamilton et al. 2011). For more species information, see USFWS (1998); USFWS (2000); Behnke (2002); Moyle (2002); NRC (2004); PacifiCorp (2004a); Starcevich et al. (2006); Messmer and Smith (2007); and Stillwater Sciences (2009a).

Resident Lampreys

In addition to the anadromous Pacific lamprey, described above, at least five or six resident species are present in the Klamath Basin (PacifiCorp 2006; Hamilton et al. 2011):

- Pit-Klamath brook lamprey (*Entosphenus lethophagus*)
- Modoc brook lamprey (*Entosphenus folletti*)
- Western brook lamprey (*Lampetra richardsoni*)
- Klamath River lamprey (*Entosphenus similis*)
- Miller Lake lamprey (*Entosphenus minima*)
- "Klamath Lake lamprey," an undescribed, parasitic species

All lamprey species have a similar early life history where ammocoetes drift downstream to areas of low velocity with silt or sand substrate and proceed to burrow into the stream bottom and live as filter feeders (USFWS 2004). After they transform into adults, the non-parasitic species do not feed, while the parasitic species feed on a variety of fish species (FERC 2007).

Klamath River lamprey are found both upstream and downstream from Iron Gate Dam, from Spencer Creek downstream, and are common in the Lower Klamath River and the low-gradient tributaries there (NRC 2004). They are also found in the Trinity River, and in the Link River of the Upper Klamath Basin (Lorion et al. 2000, as cited in Close et al. 2010). "Klamath Lake lamprey," an as yet undescribed species, reside in Upper Klamath Lake and migrate upstream in the Sprague River to spawn (Close et al. 2010). Klamath Lake lamprey ammocoetes are reported to metamorphose in the fall, spend 12 to

15 months in Upper Klamath Lake parasitizing fish, and then spawn in the spring in the Sprague River (FERC 2007).

Cyprinids

The blue chub (*Gila coerulea)* and tui chub (*Gila bicolor*) are both found in the Klamath Basin. These species prefer habitat with quiet water, well-developed beds of aquatic plants, and fine sediment or sand bottoms. Although chubs can withstand a variety of conditions including cold, clear lake water, and can also tolerate low dissolved oxygen levels, they are most often found in habitats with summer water temperatures higher than 20°C. These fish are omnivores and can play an important role in nutrient cycling. Chub spawning takes place from April through July, in shallow rocky areas in temperatures of 15 to 18°C (Moyle 2002).

Sculpin

Several sculpin (*Cottidae*) species are found in coastal streams and rivers from Alaska to southern California. At least 7 species of sculpin are known to occur in the Klamath River or its estuary, including Pacific staghorn, prickly, slender, sharpnose, coastrange, marbled, and Klamath Lake sculpin. Mainstem river habitat may be important to sculpin populations as it can provide an important migration corridor (White and Harvey 1999). Pacific staghorn sculpin are found predominantly in brackish waters of the estuary. Coastal populations of prickly and coastrange sculpin are generally assumed to be estuary-dependent for part of their early life history (White and Harvey 1999). The marbled sculpin (*Cottus klamathensis*) is a relatively wide-ranging species found in a variety of habitats in northern California and southern Oregon (Daniels and Moyle 1984). Marbled sculpin are found mainly in low gradient, spring-fed streams and rivers where the water temperature is less than 20°C in the summer and in habitat with fine substrate that can support beds of aquatic plants. They are typically found in 60 to 70 centimeters (cm) of water and are in velocities around 23 centimeters per second (cm/sec) (Moyle 2002).

Smallscale Sucker

The Klamath smallscale sucker (*Catostomus rimiculus*) is common and widely distributed in the Klamath River and its tributaries downstream from the city of Klamath Falls, Oregon, and in the Rogue River (Moyle 2002). They tend to inhabit deep, quiet pools in mainstem rivers and slower-moving reaches in tributaries; however, they can be found in faster-flowing habitats when feeding or breeding (Moyle 2002). McGinnis (1984) reported that this species spawns in small tributaries to the Klamath and Trinity Rivers. Spawning in tributaries to Copco Reservoir has been observed from mid-March to late April (Moyle 2002). Juveniles are most commonly found in the streams that are used for spawning. This species does not achieve a large size and is relatively long-lived. Fish measuring 45 cm have been aged through scale analysis as being 15 years old (Scoppetone 1988, as cited in Moyle (2002). Moyle (2002) speculated that dams and diversions have benefitted this species by increasing the availability of its preferred warmer, low-velocity habitat.

Electrofishing by PacifiCorp and Oregon Department of Fish and Wildlife (ODFW) in the J.C. Boyle Peaking Reach revealed the existence of a good population of smallscale suckers in moderate velocity habitat—smallscale sucker dominated the fish assemblage in most samples (W. Tinniswood, June 2011, pers. comm.). The dams have increased reservoir habitat that does not appear to be conducive to a riverine sucker species such as smallscale suckers. The J.C. Boyle Dam blocks the migration of suckers to spawning habitat in Spencer Creek. Spawning now occurs in the mainstem Klamath River where smallscale suckers are exposed to flow fluctuations that can displace their broadcast eggs or desiccated them during power peaking (Dunsmoor 2006). Electrofishing in Jenny Creek revealed adult smallscale suckers occupying deep, moderate-velocity habitat among boulders (W. Tinniswood, June 2011, pers. comm.).

Non-native Fish Species

Goldfish

Goldfish (*Carassius auratus)* are abundant in J.C. Boyle Reservoir and Keno Impoundment/Lake Ewauna; in September 2010, they were the most abundant species captured during ODFW electrofishing surveys.

Yellow Perch

Yellow perch (*Perca flavescens*) prefer weedy rivers and shallow lakes. They are found in reservoirs and ponds along the Klamath River. Optimal temperature for growth is 22–27°C but yellow perch can survive in temperatures up to 30–32°C. They can survive low levels of dissolved oxygen (less than 1 milligram per liter [mg/L]) but are most abundant in areas with high water quality, as they are visual feeders. Larval and juvenile yellow perch feed on zooplankton; adults are opportunistic predators that may feed on larger invertebrates and small fish (Knight et al. 1984). The preferred habitat of the yellow perch includes large beds of aquatic plants for spawning and foraging. Their spawning takes place in 7 to 19°C water in April and May and usually occurs in their second year (Moyle 2002).

Bass and Sunfish

Several species of bass (*Micropterus* spp.) and sunfish (*Lepomis* spp.) have been introduced into the Klamath Basin, including largemouth bass, white and black crappie, bluegill, pumpkinseed and green sunfish. Largemouth bass and sunfish (*Centrarchidae*) prefer lakes, ponds, or low-velocity habitat in rivers. They prefer habitats with aquatic vegetation and will spawn in a variety of substrates. They prefer water temperatures above 27 degrees Celsius (ºC). Juvenile and adult largemouth bass tend to feed on larger invertebrates and fish (Moyle 2002). Smaller members of the family, such as sunfish, are opportunistic feeders and eat a variety of aquatic insects, fish eggs, and planktonic crustaceans (Moyle 2002).

Sacramento Perch

Sacramento Perch (*Archoplites interruptus)* occur in J.C. Boyle Reservoir and Keno Impoundment/Lake Ewauna. The species is native to the Sacramento-San Joaquin watershed of California's Central Valley, from which they were extirpated.

Catfish

Several species of catfish have been introduced into the Klamath Basin, including black, brown, and channel catfish, and yellow bullhead (NRC 2004). Catfish prefer slow moving, warm water habitat. Brown bullhead (*Ameiurus nebulosus*) can tolerate a wide range of salinities and live at temperatures of 0 to 37°C, but their optimum temperature range is 20 to 33°C. Brown bullhead are most active at night and form feeding aggregations. Catfish are opportunistic omnivores and scavenge off the bottom of their habitat (Moyle 2002).

Trout

Brook trout (*Salvelinus fontinalis)* is an introduced species in the Upper Klamath Basin (FERC 2007) found in clear, cold lake and stream habitats. They prefer temperatures between 14 and 19°C but can survive in temperatures ranging from 1 to 26°C. Brook trout feed predominantly on terrestrial insects and aquatic insect larvae, though they may also opportunistically feed on other types of prey such as crustaceans, mollusks, and other small fish. Brook trout spawn in the fall and prefer habitats with small-sized gravel and nearby cover (Moyle 2002).

Brown trout (*Salmo trutta*) has also been introduced to the Klamath River and are found in both the Upper and Lower Klamath Basin. Brown trout prefer clear, cold water and can utilize both lake and stream habitats. Like brook trout, they spawn in the fall in streams with areas of clean gravel. Brown trout become piscivorous (fish eaters) once they reach a size where their gape can accommodate small fish available as prey.

Kokanee

Kokanee are landlocked sockeye salmon *(Oncorhynchus nerka)* that have been found in Upper Klamath Lake and Fourmile Creek.

American Shad

American shad (*Alosa sapidissima*) are an introduced, anadromous fish species that enjoys some popularity as a sport fish.

Fathead Minnow

Fathead minnow (*Pimephales promelas*) are an introduced bait fish widely distributed in the Upper Klamath Basin; however, it is thought that their introduction into the upper Klamath lakes may be a result of their use for pollution bioassays (Simon and Markle 1997, Moyle 2002).

Estuarine Species

The estuary is the mixing zone for freshwater and ocean water. The balance of fresh and saltwater changes over the course of the day with tides and is also strongly influenced by river flows. Because of this, both marine and freshwater species can often be found in different portions of the estuary at different times. All anadromous fish pass through the estuary during their migrations from freshwater to the sea and back again, and juvenile salmonids may rear in the estuary for varying periods of time, prior to moving into the ocean. CDFG surveys in the freshwater portion of the estuary commonly find Klamath speckled dace, Klamath smallscale sucker, prickly sculpin, and Pacific staghorn sculpin.

Other fairly common species include northern anchovy, saddleback gunnel, and bay pipefish. Other species in the estuary include federally listed eulachon, State listed longfin smelt (described under listed species), silversides, surf smelt, stickleback, and several gobies. Impacts to the estuarine species were assessed based on effects on EFH for groundfish and pelagic fish, as described in subsequent sections.

3.3.3.1.2 Freshwater Mollusks

Four species of native freshwater mussels have been observed within the Klamath Basin (FERC 2007; Westover 2010). PacifiCorp surveys in 2002 and 2003 found Oregon floater (*Anodonta oregonensis*), California floater (*A. californiensis*) and western ridged mussel (*Gonidia angulata*) along Klamath River reaches from the Keno Impoundment/ Lake Ewauna to the confluence of the Klamath and Shasta Rivers. Westover (2010) found western pearlshell mussel (*Margaritifera falcata*) in addition to these species along the Klamath River from Iron Gate Dam to the confluence of the Klamath and Trinity Rivers.

Anodonta spp. are habitat generalists, more tolerant of lentic conditions than other native species (Nedeau et al. 2005). *Anodonta* spp. are also more tolerant of siltier substrates, as their thin shells allow individuals to "float," or rest on top of silt-dominated streambeds (these species are commonly referred to as "floaters"). *G. angulata* is the largest and most common type of freshwater mussel found within the Klamath Basin (Nedeau et al. 2005). Known fish hosts include hardhead (*Mylopharodon conocephalus*), Pit sculpin (*Cottus pitensis*), and tule perch (*Hysterocarpus traski*), but a full list of host fish species for *G. angulata* is unknown (Jepsen et al. 2010). *G. angulata* is known to prefer cold, clean water, but can tolerate seasonal turbidity, and can be found in aggrading, or depositional areas as it can partially bury itself within bed sediments without affecting filter feeding (Vannote and Minshall 1982; Westover 2010). A full understanding of *G. angulata*'s former and current distribution is particularly lacking, but it is believed to have been extirpated in central and southern California and has probably declined in many other watersheds, including the Columbia and Snake River basins (Jepsen et al. 2010). The Klamath River appears unusual in that *G. angulata* dominates its mussel community, unlike other rivers in the Pacific Northwest (Westover 2010). *M. falcata* has also been observed within the Klamath Basin downstream from Iron Gate Dam, though in lesser abundance than other species (Westover 2010). *M. falcata* occupies low shear stress habitats (e.g., pools and near banks) and interstices within bedrock and cobble (Howard and Cuffey 2003).

Adult freshwater mussels are generally found wedged into gravel, rock substrate or partially buried in finer substrates, using a muscular foot to maintain position. Freshwater mussels filter feed on plankton and other organic material suspended in the water column.

While life history traits of individual species of freshwater mussels have not been fully studied, the general life cycle is as follows. Eggs within female freshwater mussels are fertilized by sperm that is brought into the body cavity. From April through July thousands of tiny larvae, called glochidia, are released into the water where they must

encounter a host fish for attachment within hours, otherwise they perish (Haley et al. 2007). Most juvenile freshwater mussels from these species drop off the fish hosts to settle from June to early August. They may spend an undetermined amount of time buried in the sediment where they grow to the point where they can maintain themselves at or below the substrate surface in conditions that are optimal for filter feeding (Nedeau et al. 2009). Freshwater mussels are fed upon by muskrats, river otters, and sturgeon (Nedeau et al. 2009). They were also a food of cultural significance for the Karuk Tribe (Westover 2010) and The Klamath Tribes.

Seven to eight species of fingernail clams and peaclams (Family: Sphaeriidae) were also found in the Hydroelectric Reach and from Iron Gate Dam to Shasta River during re-licensing surveys. One of the clam species, the montane peaclam (*Pisidium ultramontanum)*, has special status as a Federal species of concern and a United States Forest Service (USFS) sensitive species. The montane peaclam is generally found on sand-gravel substrates in spring-influenced streams and lakes, and occasionally in large spring pools. The original range included the Klamath and Pit Rivers in Oregon and California, as well as some of the larger lakes (Upper Klamath, Tule, Eagle, and possibly, lower Klamath lakes). On USFS lands they are currently present or suspected in streams and lakes of Lassen and Shasta-Trinity National Forests. Fingernail clams and peaclams are relatively short-lived (1 to 3 years) compared to freshwater mussels (10 to 15 years or 100 plus years for some species). These small clams live on the surface or buried in the substrate in lakes, ponds or streams. They bear small numbers of live young several times throughout the spring and summer (Thorp and Covich 2001).

There are also many species of freshwater snails, some of which are endemic to the Klamath Basin and have restricted ranges, often associated with cold-water springs. Several of these have recently been petitioned for listing. However, based on their restricted distribution outside of any areas that could be affected by the Proposed Action they were considered, but not included in any additional analysis.

3.3.3.1.3 Benthic Macroinvertebrates

Benthic macroinvertebrates (BMIs) include immature, aquatic stages of insects such as midges, mayflies, caddisflies, stoneflies, dragonflies, and damselflies. They also include immature and adult stages of aquatic beetles; crayfish, amphipods and isopods (crustaceans); clams and snails; aquatic worms and other major invertebrate groups. Many BMIs are the primary consumers in riverine food webs, feeding on primary producers—algae, aquatic plants, phytoplankton, bacteria, as well as leaves and other materials from terrestrial plants, and detritus. By converting organic material into biomass available to a wide variety of consumers, these organisms form an important component of the aquatic food web. Some BMIs are secondary consumers, feeding on the primary consumers. Together the BMIs are the primary food source for most fish species, and changes in abundance, distribution, or community structure can negatively affect fish populations. BMIs are also used as general indicators of water quality in indices of biological integrity based upon the richness or diversity of pollution tolerant and resistant species. BMIs are also particularly sensitive to changes in fine and coarse sediment load, which could occur under the Proposed Action and alternatives. Food

supply can limit growth of salmonids, and this is especially true at higher temperatures; i.e., as water warms, a fish needs more food to sustain growth (Brett 1971; McCullough 1999). Growth is critical to juvenile salmonids because a larger size often confers a survival advantage during the overwintering period, smolt outmigration, or ocean residence. If fish are chronically exposed to warmer temperatures and food availability is low, growth may cease, fish may experience physiological stress, and mortality from disease, parasites, and predation may increase. But in a productive system with high densities of macroinvertebrates or forage fish, a high rate of growth can be sustained at temperatures higher than would be considered optimal under conditions where food is limiting.

Relicensing studies evaluated BMIs from Link River Dam to the Shasta River and on Fall Creek in 2002 and 2003 (FERC 2007). These studies show that macroinvertebrates are abundant, with densities of 4,000 to 8,000 individuals per square meter.

Macroinvertebrate densities in fall of 2002 ranged from a low of 4,000 per square meter downstream from the powerhouse on the Klamath River to 21,000 per square meter below Keno Dam (PacifiCorp 2004b). Abundance of macroinvertebrates in the peaking reach of the Klamath River was as low as 500 per square meter in the spring of 2003. Dominant species in the riverine areas were caddisflies, blackflies, midges, beetles, and mayflies. The reservoirs had high abundance of invertebrates but low diversity, and were dominated by species tolerant of impaired water quality conditions.

3.3.3.1.4 Listed Species

Coho Salmon

The Southern Oregon/Northern California Coast (SONCC) coho salmon (*O. kisutch*) ESU is listed as federally threatened (NOAA Fisheries Service 1997a). This ESU includes all naturally spawning populations between Punta Gorda, California and Cape Blanco, Oregon, which encompasses the Trinity and Klamath Basins (NOAA Fisheries Service 1997a). Three artificial propagation programs are considered to be part of the ESU: the Cole Rivers Hatchery, Trinity River Hatchery, and Iron Gate Hatchery coho salmon programs. NOAA Fisheries Service has determined that these artificially propagated stocks are no more than moderately diverged from the local natural populations. In addition, coho salmon in the Klamath Basin have been listed by the California Fish and Game Commission as threatened under the California Endangered Species Act (CESA) (CDFG 2002a).

Coho salmon are native to the Klamath Basin. Williams et al. (2006) described nine historical coho salmon populations within the Klamath Basin, including the Upper Klamath River, Shasta River, Scott River, Salmon River, Mid-Klamath River, Lower Klamath River, and three population units within the Trinity River watershed (upper Trinity River, lower Trinity River, and South Fork Trinity River). Although coho salmon are native to the Klamath River, documentation of coho salmon in the Klamath River is scarce prior to the early 1900's due, in part, to the apparent difficulty in recognizing there were different species of salmon inhabiting the rivers of the area (Snyder 1931). Snyder (1931) reported that coho salmon were said to migrate to the headwaters of the Klamath

River to spawn, but that most people did not distinguish between the species. During 2006 administrative hearings it was concluded that coho salmon migrated past the present site of Iron Gate Dam based on historical records and tribal accounts (Administrative Law Judge 2006).

Coho salmon are currently widely distributed in the Klamath River downstream from Iron Gate Dam (RM 190), which blocks the upstream migration of coho salmon to historically available habitat in the upper watershed. Before the construction of the dams, coho salmon were apparently common and widely distributed throughout the watershed, probably in both mainstem and tributary reaches up to and including Spencer Creek at RM 228 (NRC 2004, as cited in NOAA Fisheries Service 2007; Hamilton et al. 2005). Coho salmon utilize the mainstem Klamath River for some or all of their life history stages (spawning, rearing and migration). However, the majority of returning adult coho salmon spawn in the tributaries to the mainstem (Magneson and Gough 2006, NOAA Fisheries Service 2010a).

Coho salmon adults in the Klamath Basin migrate upstream from September through late December, peaking in October and November. Spawning occurs mainly in November and December, with fry emerging from the gravel in the spring, 3 to 4 months after spawning (Trihey and Associates 1996; NRC 2004).

Some fry and age-0+ juveniles enter the mainstem in the spring and summer following emergence (Chesney et al. 2009). Large numbers of age-0 juveniles from tributaries in the mid-Klamath River move into the mainstem in the fall (October through November) (Soto et al. 2008; Hillemeier et al. 2009). Juvenile coho salmon have been observed to move into non-natal rearing streams, off-channel ponds, the Lower Klamath River, and the estuary for overwintering (Soto et al. 2008; Hillemeier et al. 2009). Some proportion of juveniles generally remain in their natal tributaries to rear.

Age 1+ coho salmon migrate from tributaries into the mainstem Klamath River from February through mid-June with a peak in April and May, which often coincides with the descending limb of the spring hydrograph (NRC 2004; Chesney and Yokel 2003; Scheiff et al. 2001). Once in the mainstem, smolts appear to move downstream rather quickly; Wallace (2004) reported that numbers of coho salmon smolts in the Klamath River estuary peaked in May, the same month as peak outmigration from the tributaries.

The major activities identified as responsible for the decline of coho salmon in Oregon and California and/or degradation of their habitat included logging, road building, grazing, mining, urbanization, stream channelization, dams, wetland loss, beaver trapping, artificial propagation, overfishing, water withdrawals, and unscreened diversions for irrigation (NOAA Fisheries Service 1997a). In 2007, NOAA Fisheries Service published a Klamath River Coho Salmon Recovery Plan to comply with Magnuson-Stevens Fishery Conservation and Management Reauthorization Act of 2006 (not equivalent to recovery plans under ESA); the plan includes the following actions identified as high priority for recovery:

- Complete and implement the NOAA Fisheries Service recovery plan for the SONCC coho salmon under the ESA.
- Restore access for coho salmon to the Upper Klamath Basin by providing passage beyond existing mainstem dams.
- Fully implement the Trinity River Restoration Program.
- Provide incentives for private landowners and water users to cooperate in (1) restoring access to tributary streams that are important for coho spawning and rearing; and (2) enhancing mainstem and tributary flows to improve instream habitat conditions.
- Continue to improve the protective measures already in place to address forestry practices and road building/maintenance activities that compromise the quality of coho salmon habitat.
- Implement restorative measures identified through fish disease research results to improve the health of Klamath River coho salmon populations.

Eulachon

Eulachon (*Thaleichthys pacificus*) is an anadromous fish that occurs in the lower portions of certain rivers draining into the northeastern Pacific Ocean, ranging from northern California to the southeastern Bering Sea in Bristol Bay, Alaska (McAllister 1963; Scott and Crossman 1973; Willson et al. 2006, as cited in NOAA Fisheries Service 2010b). The southern population of Pacific eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California (NOAA Fisheries Service 2009a). On March 18, 2010, NOAA Fisheries Service listed the southern DPS of eulachon as threatened under the ESA (NOAA Fisheries Service 2010b). Final critical habitat was designated in October of 2011 (NOAA Fisheries Service 2011).

Historically, the Klamath River was described as the southern limit of the range of eulachon (Gustafson et al. 2010). Other accounts have described large spawning aggregations of eulachon occurring regularly in the Klamath River (Fry 1979, Moyle et al. 1995, Larson and Belchik 1998, Moyle 2002, Hamilton et al. 2005), and occasionally in the Mad River (Moyle et al. 1995, Moyle 2002) and Redwood Creek (Moyle et al. 1995). In addition, small numbers of eulachon have been reported from the Smith River (Moyle 2002). The only reported commercial catch of eulachon in northern California occurred in 1963 when a combined total of 25 metric tons (56,000 lbs) was landed from the Klamath River, the Mad River, and Redwood Creek (Odemar 1964). Since 1963, the run size has declined to the point that only a few individual fish have been caught in recent years. Moyle (2002) indicates that eulachon have been scarce in the Klamath River since the 1970s, with the exception of three years: they were plentiful in 1988 and again in 1989 and 1998. After 1998, they were thought to be extinct in the Klamath Basin until a small run was observed in the estuary in 2004. According to accounts of Yurok Tribal elders, the last noticeable runs of eulachon were observed in the Klamath River in 1988 and 1989 by Tribal fishermen (Larson and Belchik 1998). Larson and Belchik (1998) reported that eulachon have not been of commercial importance in the Klamath in recent years and that their current run strength is unknown. However, in

January 2007, six eulachon were reportedly caught by tribal fishermen on the Klamath River. Another seven were captured between January and April of 2011 at the mouth of the Klamath River (NOAA Fisheries Service 2011).

Historically, eulachon runs in northern California were said to start as early as December and January and peak in abundance during March and April. Historically, large numbers of eulachon migrated upstream in March and April to spawn, but they rarely moved more than 8 miles inland (NRC 2004). Spawning occurs in gravel riffles, with hatching about a month later. The larvae generally move downstream to the estuary following hatching.

Southern Green Sturgeon DPS

The Southern Green Sturgeon DPS is listed as threatened under the Federal ESA (NOAA Fisheries Service 2006a). Juvenile and adult Southern Green Sturgeon enter many estuaries along the West Coast during the summer months to forage, but their use of the Klamath River estuary has not been documented. No sturgeon tagged by the Yurok Tribe within the Klamath River have ever been detected in the range of Southern Green Sturgeon DPS (primarily San Francisco Bay) despite the presence of numerous receivers that would have detected Klamath River tagged fish if they had ventured there (McCovey 2011). No Southern Green Sturgeon tagged in the Sacramento/San Joaquin and/or San Francisco Bay region have ever been detected in the Klamath River. Southern Green Sturgeon have been detected immediately offshore of the Klamath River, but have not been detected in the Klamath River estuary or mainstem despite the presence of functioning acoustic receivers in the Klamath River estuary (McCovey 2011). Overall, it appears unlikely that sturgeon from the Southern Green Sturgeon DPS currently occur within the Klamath River.

Lost River and Shortnose Suckers

Lost River (*Deltistes luxatus*) and shortnose (*Chasmistes brevirostris*) suckers are endemic to the Upper Klamath Basin of southern Oregon and northern California (Moyle 2002). These species are listed as endangered under the ESA (USFWS 1988), and are endangered under CESA, as well as fully protected species under California Fish and Game Code Section 5515(a)(3)(b)(4) and (6), respectively; thus any take of these species is prohibited. Threats to the population include: the damming of rivers, instream flow diversions, hybridization, competition and predation by exotic species, dredging and draining of marshes, water quality problems associated with timber harvest, the removal of riparian vegetation, livestock grazing, agricultural practices, and low lake elevations, particularly in drought years. Reduction and degradation of lake and stream habitats in the Upper Klamath Basin is considered by USFWS to be the most important factor in the decline of both species (USFWS 1993).

The Lost River sucker historically occurred in Upper Klamath Lake (Williams et al. 1985) and its tributaries and the Lost River watershed, Tule Lake, Lower Klamath Lake, and Sheepy Lake (Moyle 1976). Shortnose suckers historically occurred throughout Upper Klamath Lake and its tributaries (Williams et al. 1985; Miller and Smith 1981). The present distribution of both species includes Upper Klamath Lake and its tributaries (Buettner and Scoppettone 1990), Clear Lake Reservoir and its tributaries (USFWS

1993), Tule Lake and the Lost River up to Anderson-Rose Dam (USFWS 1993), and the Klamath River downstream to Copco Reservoir and probably to Iron Gate Reservoir (USFWS 1993). Shortnose sucker occur in Gerber Reservoir and its tributaries, but Lost River sucker do not.

Lost River and shortnose suckers are lake-dwelling, but spawn in tributary streams or springs (USFWS 1988). They spawn from February through May, depending on water depth and stream temperature (Buettner and Scoppettone 1990; Andreasen 1975, USFWS 2008). When spawning occurs over cobble and armored substrate, eggs fall between crevices or are swept downstream (Buettner and Scoppettone 1990). Larval Lost River and shortnose suckers spend relatively little time in tributary streams, migrating back to the lake shortly after emergence, typically in May and early June (Buettner and Scoppettone 1990). Adults return to Upper Klamath Lake soon after spawning. Lake fringe emergent vegetation is the primary habitat used by larval suckers (Cooperman and Markle 2004). Juvenile suckers utilize a wide variety of near-shore habitat including emergent vegetation, non-vegetated areas and off-shore habitat (Hamilton et al. 2011). Refugial areas of relatively good water quality are important for fish in Upper Klamath Lake during the summer and early fall, when dissolved oxygen and pH levels can be stressful or lethal in much of the lake (Coleman and McGie 1988). A recovery plan for Lost River and shortnose suckers was completed in 1994 and revised in 2011 (USFWS 2011a). Critical habitat was proposed but not finalized in 1994 (USFWS 1994) and reproposed for the two species on December 7, 2011 (USFWS 2011b). More detailed information for this species can be found in USFWS (2008).

Bull Trout

Bull trout (*Salvelinus confluentus*) are listed as threatened under the ESA in 1999 (USFWS 1999), and a recovery plan for the Klamath River Bull Trout DPS was published in 2002 (USFWS 2002). Historically, bull trout occurred throughout the Klamath Basin in Oregon. Currently bull trout are found in two streams in the Upper Klamath Lake watershed (Sun and Threemile creeks), six streams in the Sprague River watershed (Deming, Brownsworth, Leonard, Boulder, Dixon, North Fork Sprague), and one stream in the Sycan River watershed (Long Creek).

The distribution and numbers of bull trout are believed to have declined in the Klamath Basin due to habitat isolation, loss of migratory corridors, poor water quality, and the introduction of nonnative species. The geographic isolation of the Klamath populations places them at greater risk of genetic effects and extirpation (NRC 2004). Bull trout exhibit two basic life-history strategies: resident and migratory. Migratory bull trout live in larger river and lake systems and migrate to small stream headwaters to spawn. In general, migratory fish are larger than resident fish. Research indicates that various types of bull trout interbreed at times, which helped maintain viable populations throughout the fish's range (Rieman and McIntyre 1993).

Bull trout reach sexual maturity in 5 to 7 years and spawn from the end of August through November. Spawning may occur annually for some populations, and every other year for the rest. Bull trout require particularly clean gravel substrates for spawning.

High sediment levels suffocate eggs by reducing dissolved oxygen (Rieman and McIntyre 1996). Bull trout eggs incubate over the winter and hatch in the late winter or early spring. Emergence usually requires an incubation period of 120 to 200 days.

Juvenile bull trout migrate upstream of spawning areas to grow and take advantage of cool headwater temperatures. Bull trout less than 1 year old are generally found in areas along stream margins and inside channels. Most migratory juvenile bull trout remain in headwater tributaries for 1 to 3 years before emigrating downstream to larger stream reaches. Emigration usually takes place from June to August (Rieman and McIntyre 1996).

Southern Resident Killer Whale

The Southern Resident Killer Whale (*Orcinus orca*) DPS is designated as endangered under the ESA (NOAA Fisheries Service 2005). This DPS primarily occurs in the inland waters of Washington State and southern Vancouver Island, particularly during the spring, summer, and fall, although individuals from this population have been observed off coastal California in Monterey Bay, near the Farallon Islands, and off Point Reyes (Heimlich-Boran 1988; Felleman et al. 1991; Olson 1998; Osborne 1999; NOAA Fisheries Service 2005). Southern Resident Killer Whale survival and fecundity are correlated with Chinook salmon abundance (Ward et al. 2009; Ford et al. 2009). Southern Resident Killer Whales could potentially be affected by changes in salmon populations in the Klamath River caused by the Proposed Action (food abundance is one of the elements of their critical habitat, as described in the Critical Habitat Section). Hanson et al. (2010) found that Southern Resident Killer Whale stomach contents included several different ESUs of salmon, including Central Valley fall-run Chinook salmon.

Longfin Smelt

Longfin smelt (*Spirinchus thaleichthys*) are a State-listed threatened species throughout their range in California, but the USFWS denied the petition for Federal listing because the population in California (and specifically San Francisco Bay) was not believed to be sufficiently genetically isolated from other populations (USFWS 2009). This species generally has a 2 year lifespan, although 3-year-old fish have been observed (Moyle 2002). They typically live in bays, estuaries and have sometimes been observed in the nearshore ocean from San Francisco Bay to Prince William Sound, Alaska, including the Klamath River. They prefer salinities of 15 to 30 ppt, although they can tolerate salinities from freshwater to full seawater. They prefer temperatures of 16 to 18°C and generally avoid temperatures higher than 20°C. Longfin smelt may occur in the Klamath River throughout the year. They would only be expected to use the estuary and the lowest reaches of the river. Longfin smelt spawning occurs primarily from January to March, but may extend from November into June, in fresh or slightly brackish water over sandy or gravel substrates. Temperatures during spawning in the San Francisco estuary are 7 to 14.5 ºC. Embryos hatch in 40 days in 7 ºC water temperature (25 days in 10.6 ºC water) and are quickly swept downstream by the current to more brackish areas. The importance of ocean rearing is unknown. Little is known about longfin smelt populations in the Klamath River, except that they are presumably small.

3.3.3.2 Physical Habitat Descriptions

3.3.3.2.1 Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

Aquatic habitat in the Upper Klamath Basin includes both lacustrine and riverine habitats, and also includes large, thermally stable coldwater springs. The Upper Klamath River upstream of Iron Gate Dam once supported large populations of anadromous salmon and steelhead by providing spawning and rearing habitat (Hamilton et al. 2005). Further, Butler et al. (2010) documented fish remains from six archaeological sites located upstream of Upper Klamath Lake to provide an independent record of Chinook salmon the Upper Klamath Basin.

Upper Klamath Lake is the most prominent feature in this part of the Basin, although other lakes and reservoirs are also present. Lake Ewauna, another lake on the Klamath River mainstem, is connected to Upper Klamath Lake via the Link River. The Keno Impoundment/Lake Ewauna is formed by Keno Dam, which regulates water surface elevations in the impoundment to facilitate agricultural diversions. Implementation of the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA) would result in the reintroduction of anadromous fish into these lakes and their tributary streams. The KBRA has substantial funding designated to improve water quality above Keno Dam.

Lower Klamath Lake, Tule Lake, Clear Lake and Gerber Reservoir in the Upper Klamath Basin could be affected by changes in water management associated with the Proposed Action and alternatives. The KBRA includes provisions for specific water allocations and delivery obligations for the Lower Klamath Lake and Tule Lake National Wildlife Refuges, which will increase availability and reliability of water supplies above historical refuge use in most years (Hetrick et al. 2009). These two refuges contain important habitat for Pacific Flyway waterfowl and waders (see Section 3.5). Tule Lake, Clear Lake, and Gerber Reservoir support populations of shortnose and Lost River suckers (FERC 2007; USFWS 2007a, b; NRC 2008).

Upper Klamath Lake and Lake Ewauna are affected by poor water quality conditions. During the summer months these water bodies exhibit episodic high pH, broad daily shifts in dissolved oxygen, and elevated ammonia concentrations (Hamilton et al. 2011). In Upper Klamath Lake several incidents of mass adult mortality of shortnose and Lost River sucker have been associated with low dissolved oxygen levels (Perkins et al. 2000, Banish et al. 2009). Instances of pH levels above 10 and extended periods of pH levels greater than 9 lasting for several weeks are associated with large algal blooms occurring in the lake (Kann 2010). On a diel basis, algal photosynthesis can elevate pH levels during the day, with changes exceeding 2 pH units over a 24-hour period. During November–April (non-growing season) pH levels in Upper Klamath Lake are near neutral (Aquatic Scientific Resources 2005). Additional detail is provided in Section 3.2, Water Quality.

Fish passage over Link Dam is provided by a ladder. This ladder is designed to modern standards to allow the passage of shortnose and Lost River suckers, salmonids and other

migratory fish, including anadromous salmonids and Pacific lamprey, if present. Keno Dam is equipped with a 24-pool weir and orifice type fish ladder, which rises 19 feet over a distance of 350 feet, designed to pass trout and other resident fish species (FERC 2007). The fishway at Keno Dam currently complies with passage criteria for salmonid fish, but plans are being developed to have the fishway rebuilt to criteria for lamprey and for greater anadromous salmonid runs if the Keno facility is transferred to the government as part of settlement (T. Hepler, Reclamation, pers. comm., as cited in Hamilton et al. 2011). Although suckers have been observed to use the Keno Dam fish ladder, the ladder was not designed for sucker passage and is considered generally inadequate for sucker passage (Reclamation 2002).

The Williamson and Wood Rivers are the largest tributaries to Upper Klamath Lake, with the Williamson River being the largest tributary. The Sprague River is tributary to the Williamson River, and the Sycan River is tributary to the Sprague River (Hamilton et al. 2011). These tributaries currently provide habitat for redband trout, bull trout, shortnose sucker and Lost River sucker, as well as other species. Historically these tributaries provided substantial habitat for Chinook salmon and steelhead (Hamilton et al. 2005, 2011). Important flow contributions from springs into these tributaries provide cool summer baseflows with water temperatures and dissolved oxygen levels generally adequate to support coldwater fish habitat requirements (Hamilton et al. 2011); though these tributaries suffer from some water quality impairments as described in Section 3.2, Water Quality.

In addition to redband trout, shortnose and Lost River sucker, the Upper Klamath Basin supports many other fish species. Resident fishes include several species of minnow, sucker, sculpin, and salmonids. At least 18 species have been introduced into the Upper Klamath Basin including several species of minnow, catfish, sunfish, largemouth bass, and spotted bass, as well as yellow perch.

3.3.3.2.2 Hydroelectric Reach: J.C. Boyle Reservoir Downstream to Iron Gate Dam

The hydroelectric reach, from the upstream extent of J.C. Boyle Reservoir to Iron Gate Dam, includes four reservoirs (J.C. Boyle, Copco 1, Copco 2, and Iron Gate) and two riverine reaches. Several coolwater tributaries enter the Klamath River and reservoirs in this reach. The reservoirs are productive and nutrient rich. They tend to be warm during the summer months, with mean daily temperatures sometimes reaching 23ºC (FERC 2007). Water quality in the Copco 1 and Iron Gate Reservoirs during the summer is generally quite poor due to warm surface waters and annual blooms of the *Aphanizomenon flow-aquae, Anabaena flos-aquae,* and *M. aeruginosa* (see Section 3.4). *M. aeruginosa,* and to an unknown extent *Anabaena flos-aquae,* produce toxins that could be harmful to fish and other animals and humans. Routine sampling from areas frequented by recreational users of the reservoirs has documented cell counts up to 4,000 times greater than what the World Health Organization considers a moderate health risk (see Section 3.4). This has resulted in Copco and Iron Gate reservoirs being posted by local health officials during each summer since 2005.

The 22 miles long riverine reach between J.C. Boyle and Copco 1 Reservoirs, is divided into two reaches: a 4-mile long Bypass Reach, which receives bypass flows from J.C. Boyle Dam, and a 17-mile long "peaking reach," which receives variable flow from hydroelectric operations. The downstream 6.2 miles is designated by CDFG as a Wild Trout Area with the whole reach managed for wild trout (FERC 2007) and the reach from the J.C. Boyle Powerhouse to the California-Oregon border is designated as a National Wild and Scenic River. Approximately 100 cubic feet per second (cfs) is released from J.C. Boyle Dam through a minimum flow outlet and the ladder. This is augmented by inflows from Big Springs of about 220 to 250 cfs (FERC 2007). In the peaking reach, this flow is added to flows from the powerhouse, which can range from 0 to over 3,000 cfs, depending on water availability (FERC 2007). Depending on water availability, power demands and whitewater boating needs, peaking operations can occur daily, or cycles may extend over several days. The 1.4 mile long Copco 2 Bypass Reach, has flows of about 5 cfs provided below Copco 2 Dam. Disregarding flow requirements, both of these riverine reaches provide complex physical habitat suitable for salmonid spawning and rearing.

A number of tributary streams come into this reach, including Spencer, Shovel, Fall, Spring, and Camp Creeks. These streams provide suitable coldwater spawning and rearing habitat for riverine fish.

The reservoirs currently provide a recreational fishery for non-native fishes including largemouth bass, trout, catfish, crappie, and sunfish (Hamilton et al. 2011). Fishing is popular in Copco 1 and Iron Gate Reservoirs, especially for yellow perch; this area is known locally as the best yellow perch fishery in California (Hamilton et al. 2011). These reservoirs also support small numbers of native shortnose and Lost River suckers that are believed to be individuals that have migrated down from the upstream reservoirs and that are not thought to be self-sustaining populations or to be contributing to populations in upstream areas (Hamilton et al. 2011). Fish collections by Oregon State University in Copco 1 Reservoir during 1998 and 1999 found about 13 percent of all adult fish caught were listed suckers, primarily shortnose sucker. One percent of the adult fish in Iron Gate Reservoir were listed sucker, and those were only shortnose sucker. Riverine sections between reservoirs support populations of speckled dace, marbled sculpin, tui chub, and rainbow and redband trout. This area historically supported anadromous fish populations, including Chinook and coho salmon, steelhead, and Pacific lamprey. These fish can no longer access this area because of the lack of adequate facilities for fish passage at the dams.

3.3.3.2.3 Klamath River from Iron Gate Dam Downstream to Estuary

The Lower Klamath River flows unobstructed for 190 miles downstream from Iron Gate Dam before entering the Pacific Ocean. Downstream from Iron Gate Dam, the Klamath River has a gradient of approximately 0.0025 and four major tributaries enter this reach: the Shasta, Scott, Salmon, and Trinity Rivers.

The Klamath Basin downstream from Iron Gate Dam supports anadromous fish, including fall-run and spring-run Chinook salmon, coho salmon, steelhead, green

sturgeon, American shad, and Pacific lamprey. Most of the anadromous salmonid species spawn primarily in the tributary streams, although fall-run Chinook salmon and coho salmon do spawn on the mainstem. The mainstem also serves as a migratory corridor and as rearing habitat for juveniles of many salmonid species (FERC 2007). The amount of time spent on the mainstem varies with species, run, temperature and hydrologic conditions in the mainstem and the tributaries. Pacific lamprey are also found throughout the mainstem Klamath River and its major tributaries downstream from Iron Gate Dam. Green sturgeon (belonging to the Northern Green Sturgeon DPS) spawn and rear in the Klamath River downstream from Ishi Pishi Falls, and in the Salmon and Trinity Rivers. Tributaries to the Klamath River provide hundreds of miles of suitable habitat for anadromous fish. Anadromous fish stocks have declined substantially from historical abundance (NRC 2004, FERC 2007). The ability of the mainstem Klamath River to support the rearing and migration of anadromous species is reduced by periodic high water temperatures during summer, poor water quality (low dissolved oxygen and high pH; see Sections 3.2.3.5 and 3.2.3.6), and disease outbreaks during spring. Habitat quality in the tributaries is also affected by high temperatures. The Shasta and Scott Rivers also are impaired by low flows, high water temperatures, stream diversions, non-native species, and degraded spawning habitat (Hardy and Addley 2001; FERC 2007; North Coast Regional Water Quality Control Board [NCRWQCB] 2010). In the Salmon River, past and present high severity fires and logging roads in the Watershed contribute to high sediment yields, and continued placer mining has disturbed spawning and holding habitat (NRC 2004).

The Trinity River (RM 42.8) is not expected to be directly affected by conditions in the mainstem Klamath River, but the lower one-quarter to one-half mile of the river may be used by fish as refuge from water quality impacts during implementation of the Proposed Action. Fish populations in the Trinity River are expected to be directly affected by the Proposed Action while migrating along the mainstem Klamath River, and indirectly affected by potential changes in salmonid escapement to the Basin.

3.3.3.2.4 Klamath River Estuary and Pacific Ocean Nearshore

Wallace (1998) surveyed the Klamath River Estuary, and noted formation of a sand berm at the river mouth each year in the late summer or early fall, raising the water level in the estuary, reducing tidal fluctuation, and restricting saltwater inflow. The surveys found a brackish water layer along the bottom of the estuary may be extremely important to rearing juvenile salmonids, as they appeared to be more abundant near the freshwater/saltwater interface. Juvenile Chinook salmon may also use the cooler brackish water layer as a thermal refuge

The Klamath River Estuary supports a wide array of fish species and may also serve as breeding and foraging habitat for marine and estuarine species. These species include, but are not limited to all of the anadromous fish listed previously, federally threatened Southern DPS green sturgeon, Pacific herring, surf smelt, longfin smelt, eulachon, top smelt, starry flounder and other flatfish, Klamath speckled dace, Klamath smallscale sucker, prickly sculpin, and Pacific staghorn sculpin, northern anchovy, saddleback gunnel, and bay pipefish.

3.3.3.3 Habitat Attributes Expected to be Affected by the Project

The action alternatives would affect the physical, chemical, and biological components of habitat throughout the Klamath River watershed, from the tributaries to Upper Klamath Lake downstream to the Pacific Ocean. These effects would result from changes in suspended sediment, bedload sediment, water quality, water temperature, disease and parasites, and flow related habitat. As described in the following sections, these changes would act in both beneficial and harmful ways on species, critical habitat, and EFH. Appendices E and F provide more detailed technical descriptions of suspended sediment and bedload sediment. Changes in water quality are discussed in greater detail in Section 3.2, Water Quality and its associated appendices, and a description of the effects of the action alternatives on algae is found in Section 3.4, Algae. A description of these parameters, water temperature, and disease and parasites under existing conditions is provided in the following sections.

3.3.3.3.1 Lower Klamath River: Downstream from Iron Gate Dam

The downstream transport of suspended sediment can affect species through elevated suspended sediment concentrations (SSCs) that may clog or abrade the gills of fish, or reduce foraging efficiency and as the material settles on the stream bed during declining flows, it can reduce the survival of incubating eggs and developing alevins in salmonid redds by impeding intergravel flow as well as the emergence of fry. Everest et al. (1987) concluded all salmonids can cope with the natural variability in sediments, but salmonid populations can be reduced by persistent fine sedimentation that exceeds the natural levels under which salmonids evolved. Suspended sediments under existing conditions in the Klamath River upstream and downstream from Iron Gate Dam are summarized in Section 3.2.3.3. In general, the data indicate that SSCs downstream from Iron Gate Dam range from less than 5 mg/L during summer low flows to greater than 5,000 mg/L during winter high flows. During large winter storms or following landslides in the Klamath Basin, extremely high SSCs have been observed in the Klamath River mainstem and tributaries. Appendix E provides a detailed analysis of the effects of suspended sediment on aquatic species downstream from Iron Gate Dam under existing conditions. To provide a reliable basis for a relative comparison of SSCs to the alternatives, SSCs under existing conditions were calculated using the SRH-1D model (Reclamation 2011) based on hydrology data from 1961 to present. SSCs were developed for two conditions meant to represent the existing range of variability under existing conditions, defined as follows:

- **Normal conditions:** SSCs and durations with a 50 percent exceedance probability for the mainstem Klamath River downstream from Iron Gate Dam (i.e., the probability of these concentrations and durations being equaled or exceeded in any one year is 50 percent). Exceedance probabilities were based on modeling SSC for all water years subsequent to 1961 with facilities in place. To assess "normal conditions" the median (50 percent) SSC and duration from these results was estimated (Figure 3.3-2).

- **Extreme conditions:** SSCs and durations with a 10 percent exceedance probability (i.e., the probability of these concentrations and durations being equaled or exceeded in any 1 year is 10 percent). This represents an extreme condition with high SSCs, such as a flood (Figure 3.3-3).

Under both normal and extreme conditions, SSCs of the magnitude and duration modeled are expected to cause major stress to migrating adult and juvenile salmonids primarily during winter (Newcombe and Jenson 1996, Appendix E). SSC generally increases in a downstream direction from the contribution of tributaries, and since Iron Gate Dam currently effectively traps most suspended sediment.

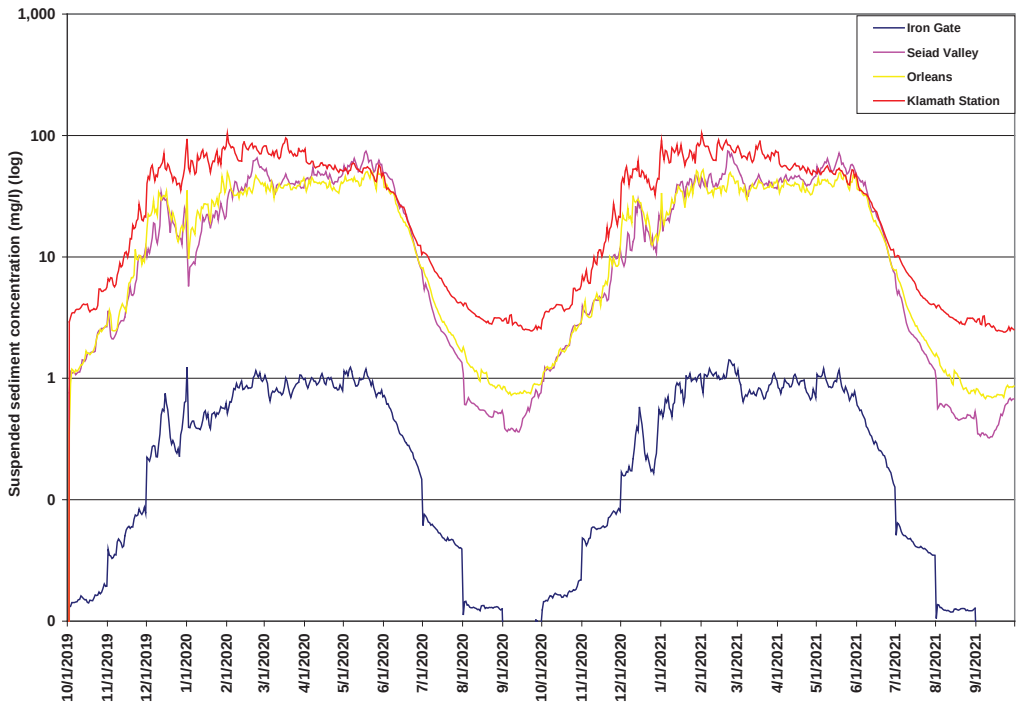

Figure 3.3-2. Normal conditions (50 Percent Exceedance Probability) SSCs for Three Locations Downstream from Iron Gate Dam under Existing Conditions, as Predicted Using the SRH-1D Model.

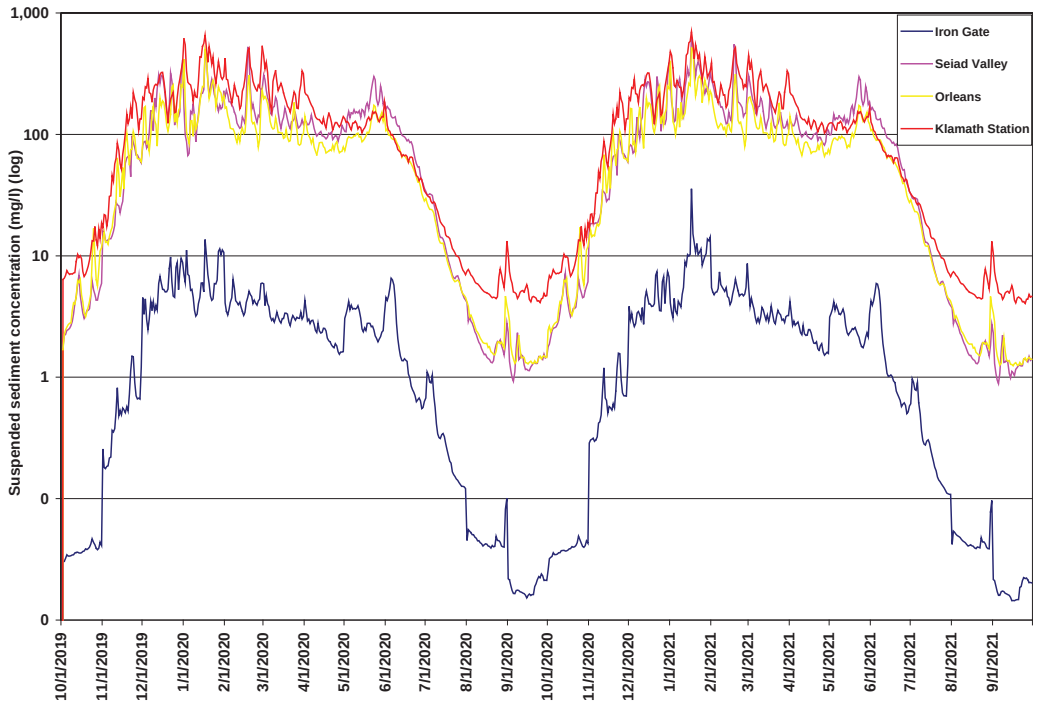

Figure 3.3-3. Extreme conditions (10 Percent Exceedance Probability) SSCs for Three Locations Downstream from Iron Gate Dam under Existing Conditions, as Predicted Using the SRH-1D Model.

Klamath River Estuary

Under existing conditions SSCs within the Klamath River Estuary are relatively high compared to SSC observed further upstream (Figures 3.3-2 and Figure 3.3-3). As described in Section 3.2.4.3.1.2, the Lower Klamath River downstream from the Trinity River confluence to the estuary mouth is currently listed as sediment impaired under Section 303(d) of the Clean Water Act, as related to protection of the cold freshwater habitat beneficial use associated with salmonids (NCRWQCB 2010). Modeling in the Klamath River (from Seiad Valley at approximately RM 128 downstream to the Klamath Station at RM 5) indicates that under normal conditions SSCs are relatively high during winter (typically 50 to 100 mg/L), and lower (< 10 mg/L) during summer. Under extreme conditions the SSC is generally 10 to 100 mg/L in summer and fall, with peaks between 100 and 1,000 mg/L during winter and spring (Figure 3.3-3).

Pacific Ocean Nearshore Environment

Under existing conditions a “plume” exists within the nearshore environment in the Klamath River vicinity that is subject to strong land runoff effects following winter rainfall events. The plume can create areas of low-salinity, high levels of suspended particles, high sedimentation, and low light (and potential exposure to land-derived contaminants). The extent and shape of the plume is variable, and influenced by wind patterns, upwelling effects, shoreline topography (especially Point Saint George), and longshore currents. High SSCs events contribute to the plume, especially during floods.

As described in detail in Section 3.2.4.3.2, in northern California, plume zones are primarily north of river mouths because alongshore currents and prevailing winds are northward during periods of strong runoff (Geyer et al. 2000, Pullen and Allen 2000, Farnsworth and Warrick 2007). River plumes and the associated habitat conditions they create are considered to be areas of high productivity for marine organisms (Grimes and Finucane 1991, Morgan et al. 2005), and create abrupt changes in marine water quality conditions (e.g., water temperature, salinity, sediment) that support salmonids (Schabetsberger et al. 2003, DeRobertis et al. 2005).

3.3.3.3.2 Bedload

Appendix F describes current habitat conditions and assesses the changes to bedload sediment within the analysis area for existing conditions, and under each Klamath River EIS/EIR alternative. The sections below provide a brief summary of the analysis provided in Appendix F. Bedload sediment movement and transport are vital to create and maintain functional aquatic habitat. Bedload sediment, in the form of sand, gravels, cobbles and boulders is naturally delivered to and transported in streams and rivers. Natural sediment pulses that result from heavy rainfall and snowmelt events are incorporated by stream and river processes into spawning beds, gravel bars, side channels, pools, riffles and floodplains that provide habitat and support food chains of aquatic species. These periodic inputs of bedload sediments are necessary for the long-term maintenance of aquatic habitats. Salmonids evolved with bedload sediment transport and depend on continued sediment delivery to provide substrate suitable for spawning and early rearing in streams and rivers. As described in detail below, these processes have been disrupted in the Klamath River by the construction of dams.

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

For all practical purposes, the amount of inorganic, fluvial sediment supplied to the Klamath River from the Klamath Basin upstream of Keno Dam is negligible (Reclamation 2012). Upper Klamath Lake, with its large surface area, traps nearly all inorganic sediment delivered from upstream tributaries, although some finer material may be transported through the lake during high runoff events.

Hydroelectric Reach: Klamath River from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

The Project reservoirs are the dominant feature in this 38-mile reach, with a 22-mile riverine section between J.C. Boyle Dam and Copco 1 Reservoir and a 1.4-mile riverine reach between Copco 2 Dam and Iron Gate Reservoir. Fluvial sediment (>0.063 mm) supply from the reach between Keno Dam and Iron Gate Dam is around 24,160 tons/year, which is 1.3 percent of the cumulative average annual basin wide sediment delivery to the Pacific Ocean (Stillwater Sciences 2010a). The four Project reservoirs currently store 13.1 million cubic yards (yd^3) of sediment (Reclamation 2012), with Copco 1 Reservoir storing the largest amount of sediment (Table 3.3-2). The sediment stored behind the dams has high water content and 85 percent of its particles are silts and clays (particle size less than 0.063 mm) while 15 percent are sand or coarser (particle size higher than 0.063 mm) (Gathard Engineering Consulting 2006; Stillwater Sciences 2008; Reclamation 2012).

Table 3.3-2. Estimated Volume of Sediment Currently Stored within Hydroelectric Reach Reservoirs (Reclamation 2012)

Reservoir	Current Sediment Volume (yd^3)
J.C. Boyle	1,000,000
Copco 1	7,440,000
Copco 2	0
Iron Gate	4,710,000
Total	**13,150,000**

Lower Klamath River: Downstream from Iron Gate Dam

Downstream from Iron Gate Dam, channel conditions reflect the interruption of sediment flux from upstream by Klamath Hydroelectric Project dams and the eventual re-supply of sediment from tributaries entering the mainstem Klamath River (PacifiCorp 2004a; Reclamation 2012). The reach from Iron Gate Dam to Cottonwood Creek (RM 182.1) is characterized by coarse, cobble-boulder bars immediately downstream from the dam, transitioning to a cobble bed with pool-riffle morphology farther downstream near Cottonwood Creek (Montgomery and Buffington 1997; PacifiCorp 2004a; Stillwater Sciences 2010a). Cottonwood Creek to the Scott River is a confined channel with a cobble-gravel bed and pool-riffle morphology (PacifiCorp 2004a). The median bed material ranges from 45 to 50 mm, but bar substrates become finer in the downstream direction, with median sizes of 49 mm and 25 mm at the upstream and downstream ends, respectively. Downstream from the Scott River, including through the Seiad Valley, the Klamath River is cobble-gravel bedded with pool-riffle morphology (PacifiCorp 2004a). PacifiCorp (2004a) also noted increasing quantities of sand and fine gravel on the bed surface with distance downstream, likely reflecting the resupply of finer material from tributaries to the Klamath River.

Upper Klamath Lake, Keno Impoundment/Lake Ewauna, and the Klamath Hydroelectric Project dams trap most of the finer sediment produced in the low sediment yielding, young volcanic terrain upstream of the dams, which results in coarsening of the channel bed downstream from the dams until tributaries resupply the channel with finer sediment. Most (≈98 percent) of the sediment supplied to the mainstem Klamath River (Stillwater Sciences 2010a) currently is delivered from tributaries downstream from Cottonwood Creek, limiting the effects of interrupting upstream sediment supply to the reach between JC Boyle Reservoir and approximately the Scott River.

This sediment interception has disrupted geomorphic and vegetative processes that form channel habitats and create spawning gravels downstream from Iron Gate Dam (Buer 1981; PacifiCorp 2004a; Klamath River Basin Fisheries Task Force 1991). Since the construction of the Project, sediment and spawning gravel have been intercepted by Project reservoirs and cut off by the Iron Gate Dam. The resultant reduction in spawning gravels downstream from Iron Gate Dam has been identified as one of the causes of the decline in salmonid fry production in this reach of the Klamath River (Buer 1981). In

response to this recognized limiting factor, the California Department of Water Resources initiated gravel augmentation programs for spawning gravel downstream from Iron Gate Dam (Buer 1981).

Reclamation (2011a) used reach average hydraulic properties and previously collected grain size data to estimate the flow magnitude and return period at which sediment mobilization occurs downstream from Iron Gate Dam. The estimates did not include the reach from Iron Gate Dam to Bogus Creek, for which there were no grain size data. Reclamation (2011a) assumed this reach to be fully armored because there has been no sediment supplied to this reach in the past 50 years because the dams capture sediment from upstream. From downstream from Bogus Creek to Willow Creek, flows to mobilize median substrate sizes (D50) ranged from 6,800 to 12,700 cfs, and recur every 2.6 to 7.5 years, on average (Figure 3.3-4).

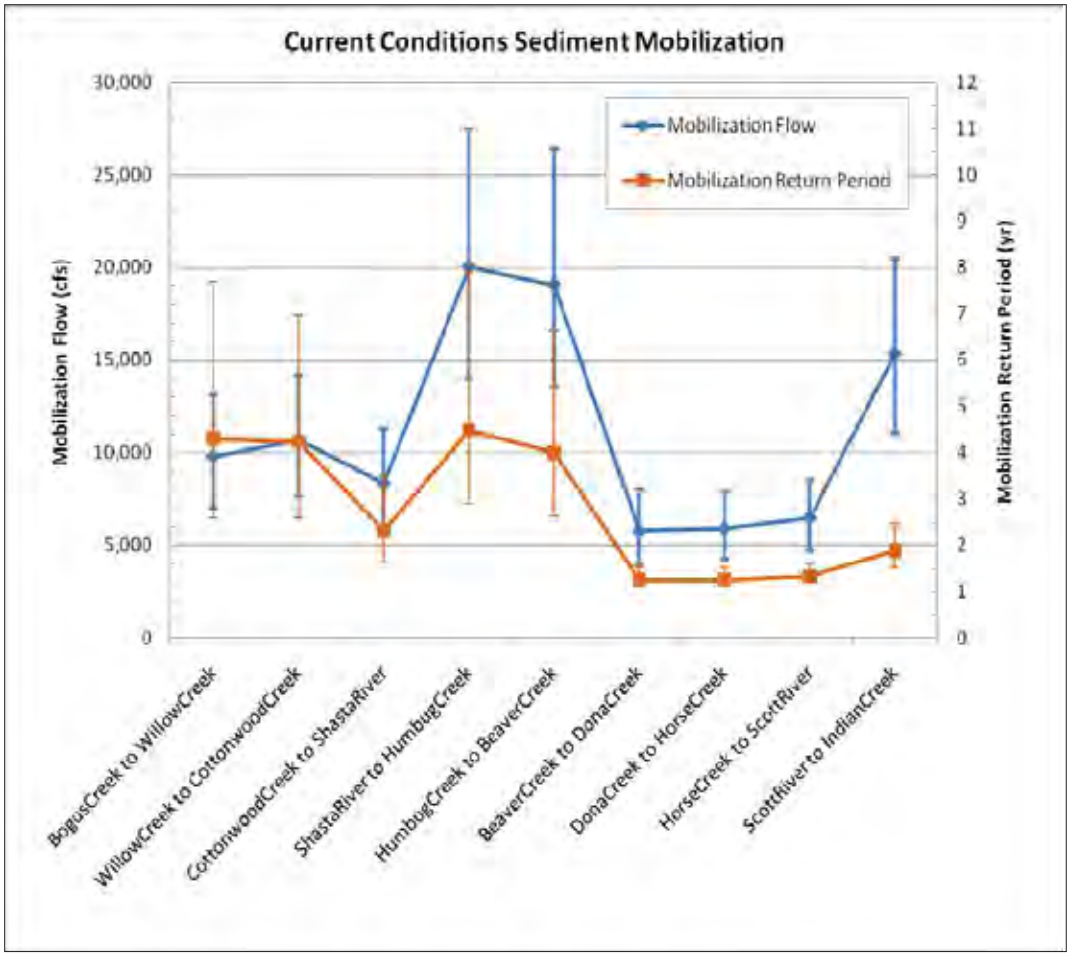

Figure 3.3-4. Mobilization Flow and Return Period at which Sediment Mobilization Occurs (Reclamation 2012).

3.3.3.3.3 Water Quality

Sections 3.2.2 and 3.2.3 provide information regarding regulatory considerations and existing conditions for water quality in the area of analysis, including those that can directly affect beneficial uses for aquatic species (i.e., water temperature, suspended sediments, dissolved oxygen, pH, and algal toxins such as microcystin). As described therein, multiple water bodies in the area of analysis, including the mainstem Klamath River, are listed under Section 303(d) of the Clean Water Act (CWA) for a variety of water quality parameters such as water temperature, sedimentation, nutrients, dissolved oxygen, pH, ammonia, chlorophyll-*a*, and microcystin (Table 3.2-8 in Section 3.2., Water Quality). Existing conditions for water temperature and algal toxins are evaluated in greater detail below with respect to implications on fish health and survival in the Klamath Basin. Microcystin concentrations are also addressed in Section 3.4, Algae.

3.3.3.3.4 Water Temperature

As described in Section 3.2, Water Quality, the entire Klamath River from the Klamath Estuary to Keno Dam has been listed as impaired for water temperature (Table 3.2-8 in Section 3.2, Water Quality). Water temperatures in the Klamath River are of special concern as they are elevated with a greater frequency and they remain elevated for longer periods of time than temperatures in adjacent coastal anadromous streams, and they are seasonally marginal in the lower mainstem for anadromous salmonids (Bartholow 2005). These elevated temperatures are especially detrimental to anadromous species during the warmer portions of the year (ODEQ 2002). Acute thermal effects for salmonids are expected to occur as mean daily water temperatures begin to exceed 20°C (Bartholow 2005). Bartholow (2005) expressed concern that if water temperature trends in the mainstem Klamath River downstream from Iron Gate Dam continue, some stocks may decline to levels insufficient to ensure survival. Klamath River salmonids are generally more tolerant of high water temperatures than salmonids from other basins (FERC 2007, Foott et al. 2012). Moreover, the Administrative Law Judge (2006) found that juvenile steelhead trout can withstand incrementally higher temperatures exceeding 22 °C provided food is abundant and by finding thermal refuge or by living in areas where nocturnal temperatures drop below the thermal threshold. Elevated temperatures can affect the timing of different life-history events, altering migration patterns, delaying and shortening the spawning season, impairing reproductive success, reducing growth, and result in an ongoing lack of temporal diversity (Hamilton et al. 2011). High water temperatures can contribute to low dissolved oxygen events by reducing dissolved oxygen solubility and accelerating oxygen-demanding processes, and can facilitate the spread of disease (Wood et al. 2006). Stress associated with high water temperatures can make cold water species more vulnerable to disease and parasites, and have been associated with fish kills in the Klamath River downstream from Iron Gate Dam during low flow periods in late summer (Hardy and Addley 2001).

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

Both Upper Klamath Lake and the Keno Impoundment/Lake Ewauna are relatively shallow; temperatures in Upper Klamath Lake, the Keno Impoundment/Lake Ewauna, and J.C. Boyle Reservoir are generally warm during the late spring through early fall (see Section 3.2.3.2). In the summer, instantaneous maximum water temperatures of 22 to

24 °C are common in the upper 3 to 6 feet of Upper Klamath Lake and temperatures can approach a maximum of 30 °C near the surface (PacifiCorp 2004a). Although prolonged exposure to these high temperatures could be lethal for some species, these temperatures remain within tolerance criteria for migrating adult anadromous salmonids during the period when migration would be expected (Dunsmoor and Huntington 2006, Hamilton et al. 2011). In addition, anadromous salmonids successfully navigated through the lake to spawn in the Upper Klamath Basin prior to their access being blocked by the Project. Temperatures in Upper Klamath Lake are actually cooler than those downstream from Iron Gate Dam in the late summer and early fall when fall-run Chinook salmon are migrating. In addition, thermal refugia are available in this reach where fish can moderate the temperatures they are exposed to. Upper Klamath Lake supports a population of redband trout that move into cooler tributary habitats in the summer, but which have high growth rates while in the lake. Those in the lake over the summer can find thermal refuge in Pelican Bay, which is fed by springs and remains cool (Dunsmoor and Huntington 2006). Wetlands surround this bay and would be expected to provide juvenile salmonids with excellent rearing habitat (Dunsmoor and Huntington 2006).

The Keno Impoundment/Lake Ewauna has generally poor water quality in the summer, with instantaneous maximum water temperatures exceeding 25 °C and low dissolved oxygen (Hamilton et al. 2011). These warm temperatures are also present downstream from Keno Dam. However, from November through mid-June, the reach from Link River Dam to Keno Dam is cooler (below 20 °C) and meets criteria for migrating adult anadromous salmonids (Hamilton et al. 2011). Temperatures in the Link River and the Keno Impoundment/Lake Ewauna tend to increase in the summer; maximum water temperatures (22 to 25 °C) are still within the preferred range for warm- and some cool-water species found in the Upper Klamath Basin (yellow perch, catfish, sunfish, largemouth bass, and spotted bass).

Hydroelectric Reach: Klamath River from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

Water temperatures through the Hydroelectric Reach are generally warm in the reservoirs from late spring through early fall, but tributaries in this reach are generally cool. In addition, numerous cold-water springs contribute flows to both Copco 1 and Iron Gate Reservoirs. Average monthly water temperatures within reservoirs from 2001 to 2004 ranged from just over 5 °C in November to more than 22 °C in June through August (FERC 2007), with thermal stratification in Copco 1 and Iron Gate reservoirs resulting in relatively warm discharge waters during summer months. Water temperatures at the downstream end of the J.C. Boyle Bypass Reach and in the Klamath River upstream of Shovel Creek are consistently cooler than other sites sampled between Link Dam and the Shasta River (PacifiCorp 2004b) (see Section 3.2.3.2). Temperatures in the J.C. Boyle Bypass Reach are cooled by the contribution of 200 to 250 cfs of groundwater within the reach. The cool water input from the bypass reach during the summer results in a relatively lower daily water temperature range in the Klamath River in the J.C. Boyle Peaking Reach (FERC 2007).

Temperature data for tributary reaches are based on a limited study period as described in PacifiCorp (2004a). Fall Creek, which flows into Iron Gate Reservoir, is generally cold year-round and does not exceed 14 °C degrees during the summer (Pacificorp 2004a). Temperatures in Jenny Creek, which also flows into Iron Gate Reservoir, vary seasonally, ranging from less than 10°C in the spring to more than 22 °C in July and August (PacifiCorp 2004a). Temperatures in Shovel Creek are generally low year-round and do not exceed 15 °C in the summer (PacifiCorp 2004a). Spencer Creek temperatures are low during spring (<15 °C) and are generally below 18°C, but can exceed 20 °C for short durations (Pacificorp 2004a).

Copco 1 and Iron Gate Reservoirs reach maximum temperatures exceeding 20 °C near their surfaces during the summer while maintaining average temperatures near 8 °C or 10 °C when stratified (PacifiCorp 2004a). These cooler water temperatures at a depth >6–8 m below the surface (see Appendix C, Section C.1.1.4) are a result of the retention of cold water in Copco 1 and Iron Gate reservoirs during the winter, and the relatively shallow outlets of both reservoirs (PacifiCorp 2004a). Summertime thermal stratification in Copco1 and Iron Gate reservoirs is typically accompanied by hypoxia (Appendix C, Section C.4.1.4). Although water temperatures increase in the summer months (see Section 3.2.3.2), temperatures documented in the Hydroelectric Reach are within the tolerance ranges of the species observed there, but would be considered seasonally stressful for cold water species.

Lower Klamath River: Downstream from Iron Gate Dam

Water temperatures in spring in the Lower Klamath Basin downstream from Iron Gate Dam can be slightly cooler from reservoir releases than those upstream of Iron Gate Dam (see Section 3.2.3.2), with this difference diminishing downstream from Iron Gate Dam with no noticeable difference just upstream of the Salmon River confluence. Summer weather conditions, however, can be severe from June through September, and rising ambient air temperatures can lead to increased water temperatures (Hamilton et al. 2011). Downstream from Iron Gate Dam, mean monthly temperatures in the river are 3 to 6 °C in January and 20 to 22.5 °C in July and August (Bartholow 2005). Substantial losses of juvenile salmonids have occurred during their migration through the Lower Klamath River, and were especially severe during low-water years with periods of sustained high water temperatures, which may cause them to crowd into thermal refugia and may reduce the resistance of these fish to disease and other stressors (Scheiff et al. 2001). Summary statistics compiled by the United States Environmental Protection Agency (EPA) indicate that water temperatures at locations between Iron Gate Dam and the Klamath River's confluence with the Scott River range from about 16 to 22 °C in June, and from 16 to 26 °C in July (FERC 2007). The Klamath Basin downstream from Iron Gate Dam (i.e., the Lower Klamath Basin) supports a variety of species of anadromous fish including fall and spring Chinook salmon, coho salmon, steelhead, green sturgeon, and Pacific lamprey. From May through September (peaking in June–August) summer temperatures begin to warm to stressful levels for cold water species such as salmon, steelhead, and Pacific lamprey.

Klamath River Estuary and Pacific Ocean Nearshore Environment

Water temperatures in the estuary range from 5 to 12 °C from December through April (Hiner 2006). Warmer air temperatures and lower flows in summer and fall months result in increased water temperatures ranging from 20 to 24°C (Hiner 2006). Under summer low-flow conditions, water temperatures in the Klamath Estuary exceed those for optimal growth as well as critical thermal maxima for Chinook salmon, coho salmon, and steelhead (Stillwater Sciences 2009a). However, this effect is reduced by input of cool ocean water and a high prevalence of coastal fog.

3.3.3.3.5 Disease and Parasites

Fish diseases, specifically the myxozoan parasites *Ceratomyxa shasta* (*C. shasta*) and *Parvicapsula minibicornis*, periodically result in substantial mortality for Klamath River salmon, (steelhead are generally resistant to *C. shasta*). Additional diseases that may affect fish in the Klamath Basin include *Ichthyophthirius multifis* (Ich) and *Flavobacterium columnare* ("columnaris disease"). These parasites and diseases occur throughout the watershed, but appear to cause the most severe mortality in the Lower Klamath Basin where *C. shasta* has been observed to result in high rates of mortality in salmon. Ich and columnaris occasionally result in substantial mortality (e.g., the 2002 fish kill of primarily adult Chinook salmon). The effects of Ich and columnaris are generally not as harmful on a population level as the myxozoan parasites, although impacts on juvenile salmonids and other species have not been well studied.

Both *P. minibicornis* and *C. shasta* spend part of their life cycle in an invertebrate host and another part in a fish host. Transmission of these parasites is limited to areas where the invertebrate host is present. In the Klamath River, their invertebrate host is the annelid polychaete worm *Manayunkia speciosa* (Bartholomew et al. 1997, 2007). Once the polychaetes are infected, they release *C. shasta* actinospores into the water column. Actinospores are generally released when temperatures rise above 10°C and remain viable from 3 to 7 days at temperatures from 11 to 18ºC, with temperatures outside that range resulting in a shorter period of viability (Foott et al. 2007). The longer the period of viability, the wider the distribution of the actinospores within the river, and thus the higher the risk of exposure for salmon (Bjork and Bartholomew 2010). Actinospore abundance, a primary determinant of infectious dose, is controlled by the number of polychaetes and the prevalence and severity of infection within their population.

Salmon become infected when the actinospores enter the gills, eventually reaching the intestines where the parasite replicates and matures to the myxospore stage. Myxospores are shed by the dying and dead salmon, and the cycle continues with infection of polychaete worms by the myxospores (Bartholomew and Foott 2010). The polychaete host for the parasite is present in a variety of habitat types, including runs, pools, riffles, edge-water, and reservoir inflow zones, as well as sand, gravel, boulders, bedrock, aquatic vegetation, and is frequently found among mats of filamentous periphytic algal species (e.g. Cladophora) that traps fine sediment and organic detrital matter.

(Bartholomew and Foott 2010). Slow-flowing and more stable, depositional habitats (e.g., pools with sand) may support higher densities of polychaetes, (Bartholomew and Foott 2010), especially if instream flows remain constant. The mobilization of particles on the bed of the channel downstream from Iron Gate Dam depends directly upon the size of the substrate and magnitude of peak flows. The greater the flows, the larger the particles likely to be moved, and the smaller the particle, the lower the flow required for mobilization. Polychaetes are more persistent if the substrate remains immobile for long periods (on the order of years). Under historical conditions frequent flood events and natural sediment supply, combined with considerable intra-annual flow variability, ensured that the substrate was frequently mobilized. Under existing conditions with dams in place, sediment supply is reduced, flow variability is decreased, and conditions supporting the persistence of polychaetes are more prevalent.

Native populations of salmonids in waters where *C. shasta* is endemic generally develop a high degree of resistance to the disease. Stocking et al. (2006) conducted studies of the seasonal and spatial distribution of *C. shasta* in the Klamath River. The study included the exposure of fall Chinook salmon (*Oncorhynchus tshawytscha*; Iron Gate Hatchery strain). The study found the polychaete host, *M. speciosa*, from Upper Klamath Lake to the mouth of the river. Although infection rates were high in non-native, non-resistant, rainbow trout, used as sentinel fish in the upper Klamath River upstream of Iron Gate Dam and downstream from the Williamson River, mortality rates were very low (Stocking et al. 2006). Chinook salmon at this location did not become infected. Minimal mortality in both was likely due to low levels of parasites in this area and a predominance of Type 0 genotype of *C. shasta* (see below). Because the parasites are endemic to the watershed, the native salmonid populations have some level of resistance to the disease. However, an altered river channel downstream from Iron Gate Dam, where the bed has been atypically stable, has provided favorable habitat for the polychaete worm host, likely increasing the parasite load to which the fish are exposed. High parasite loads are believed to lead to higher rates of mortality.

Susceptibility to *C. shasta* is also influenced by the genetic type of *C. shasta* fish encounter. Atkinson and Bartholomew (2010) conducted an analysis of the genotypes of *C. shasta* and the association of these genotypes with different salmonid species, including Chinook and coho salmon, steelhead, rainbow trout, and redband trout. In the Williamson River, although parasite densities had been found to be high, Chinook salmon were resistant to infection because the genotype specific to Chinook salmon was absent. In a genetic analysis, the *C. shasta* genotypes were characterized as Type 0, Type I, Type II and Type III (Table 3.3-3):

Table 3.3-3. Ceratomyxa shasta genotypes in the Klamath Basin.

C. shasta Genotype	Distribution	Affected Species	Notes
Type 0	Upper and Lower Klamath Basin	native steelhead, rainbow, and redband trout	Usually occurs in low densities, is not very virulent, and causes little or no mortality
Type I	Lower Klamath Basin	Chinook salmon	If the Type I genotype were carried into the Upper Klamath Basin, only Chinook salmon would be affected
Type II	Klamath Lake, Upper and Lower Klamath Basin	coho salmon and non-native rainbow trout	The "biotype" found in the Upper Klamath Basin does not appear to affect coho salmon, and risks to native rainbow/redband trout are low[1]
Type III	Assumed widespread in Klamath Basin based on presence in fish	all salmonid species	Prevalence of this genotype is low and it infects fish but does not appear to cause mortality

[1] (J. Bartholomew, pers. comm. 2010)

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

Fish in the upper Klamath River are exposed to disease and parasites. Many of the diseases and parasites described above can occur here. *C. shasta* and *P. minibicornis* are both known to occur in the Upper Klamath Basin (Administrative Law Judge 2006), and *C. shasta* densities have been reported to be as high in the Williamson River (Hurst et al. 2012) as in the area downstream from Iron Gate Dam (Hallett and Bartholomew 2006). In the section of the river upstream of J.C. Boyle Reservoir, however, *C. shasta* does not have the same serious effects as it does downstream from Iron Gate Dam, because of the genotype of the parasite and the higher resistance of the redband trout to the disease. Historically *C. shasta* and *P. minibicornis* occurred in the Upper Klamath Basin and resident fish above the dams evolved with these parasites. The current infectious zone and high parasite loads below Iron Gate Dam are the result of a synergistic effect of numerous factors (FERC 2007; Hamilton et al. 2011). Factors associated with the current infectious zone and high parasite loads include: 1) close proximity of myxospores-shedding carcasses (concentration of carcasses), 2) abundant polychaete populations that are found in atypically stable habitats, 3) permissible temperatures (>15 C) during periods when juvenile salmonids are present, and 4) low flow variability (Bartholomew and Foott 2010). . This synergy would be unlikely in the Upper Klamath River.

Results from the large amount of recent research on Klamath River fish diseases remain consistent with the previous finding that the movement of anadromous fish above Iron Gate Dam presents a relatively low risk of introducing pathogens to resident fish (Administrative Law Judge 2006, USFWS/NOAA Fisheries Service Issue 2(B)).

Hydroelectric Reach: Klamath River from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

As described above, Stocking et al. (2006) found the polychaete host for *C. shasta* and *P. minibicornis* throughout the mainstem Klamath River, including the reach from J.C. Boyle Reservoir to Iron Gate Dam (the Hydroelectric Reach), and within all four

Project reservoirs. However, these polychaete populations are most abundant at reservoir inflow areas with densities decreasing with distance from reservoir/river interface, but not disappearing entirely (Stocking and Bartholomew 2007). Stocking and Bartholomew (2007) noted that the ability of some polychaete populations to persist through disturbances (e.g., large flow events) indicates that the lotic populations are influenced by the stability of the microhabitat they occupy. In order for an area to develop as an infectious zone, several factors need to coincide, including microhabitats with low velocity, and stable flows (Bartholomew and Foott 2010).

Lower Klamath River: Downstream from Iron Gate Dam

In the Lower Klamath River, the polychaete host for *C. shasta* and *P. minibicornis* is aggregated into small, patchy populations. The reach of the Klamath River from the Shasta River to Seiad/Indian Creek is known to be a highly infectious zone with high actinospores exposure, particularly from May through August (Beeman et al. 2008, Bartholomew and Foott 2010). This portion of the river contains areas of dense populations of polychaetes within low-velocity habitats with *Cladophora* (a filamentous green periphytic algae), sand-silt, and fine benthic organic material in the substrate (Stocking and Bartholomew 2007). As described above, the reduced bedload mobility has increased the persistence of polychaetes under existing conditions. High parasite prevalence in the Lower Klamath River is considered to be a combined effect of high spore input from heavily infected, spawned adult salmon that congregate downstream from Iron Gate Dam and Iron Gate Hatchery and the proximity to dense populations of polychaetes (Bartholomew et al. 2007). The highest rates of infection occur in the Lower Klamath River downstream from Iron Gate Dam, generally the reach from Shasta River to Seiad (Stocking and Bartholomew 2007; Bartholomew and Foott 2010).

Despite potential resistance to the disease in native populations, salmon (particularly juvenile salmon, and more so at higher water temperatures) exposed to high levels of the parasite may be more susceptible to disease. Chinook and coho salmon migrating downstream have been found to have infection rates as high as 90 percent and 50 percent, respectively (Bartholomew and Foott 2010). The number of juvenile salmon that become infected is estimated to be 10 to 70 percent annually based on surveys of fish captured in the river (True et al. 2010). High disease infection rates are apparently resulting in high mortality of outmigrating smolts. Studies of outmigrating coho salmon smolts by Beeman et al. (2008) estimated that disease-related mortality rates were between 35 and 70 percent in the Klamath River near Iron Gate Dam. Their studies suggested that higher spring discharge increased smolt survival (Beeman et al. 2008). In 2008, mortality rates were as high as 85 percent in May (7-day exposure for age 1+ coho smolts), and 96 percent (age 0+ coho smolts) and 84 percent (0+ Chinook smolts) in June (3-day exposure). In May 2004, the USFWS, the Yurok Tribe and the Karuk Tribe, reported high levels of mortality and disease infections among naturally produced juvenile Chinook salmon captured in downstream migrant traps fished in the Klamath River (Nichols and Foott 2005). The symptoms observed included bloated abdominal cavities, pale gills, bloody vents, and pop-eye. Infected fish also exhibited lethargic behavior, poor swimming ability and increased vulnerability to handling stress. The primary cause of the disease was found to be *C. shasta*, with *P. minibicornis* observed as well. The

2004 mortality event was not quantified, because of limited resources and other problems associated with sampling small fish in a large river system. Other recent fish kills include the June 2000 and June 1998 fish kills. CDFG (2000) estimated 10,000 to 300,000 individuals, mostly young-of-year killed in the June 2000 event, believed to be infected with *C. shasta* and columnaris. However in 2010 through 2012, years with lower river temperatures and conditions less conducive to juvenile disease, prevalence of *C. shasta* in emigrant Chinook salmon during the peak migration period was less than 35 percent.

For adult salmon disease risk have been less frequent and of a different nature. Ich and columnaris have occasionally had a substantial impact, particularly when habitat conditions include exceptionally low flows, high water temperatures, and high densities of fish (such as adult Chinook salmon migrating upstream in the fall and holding at high densities in pools). The effects of Ich and columnaris are generally not as harmful as the myxozoan parasites, although the 2002 fish kill in the lower Klamath provided dramatic evidence of the ability of Ich and columnaris to cause significant salmon mortality, .with more than 33,000 adult salmon and steelhead were lost during a disease outbreak. Most of the fish affected by the 2002 fish die-off were fall-run Chinook salmon in the lower 36 miles of the Klamath River (CDFG 2004). Based on a review of available literature and historical records, this was the largest known pre-spawning adult salmonid die-off recorded on the Klamath River and possibly the Pacific Coast (USFWS 2003). Subsequent reviews of the 2002 fish kill by CDFG (2004), NRC (2004), and USFWS (2003) determined several factors contributed to the epizootic of Ich and columnaris. An above average number of Chinook salmon entered the Klamath River during this period. Flows in September 2002 were among the lowest recorded in the last 50 years (CDFG 2004), which may have caused crowding in holding areas that increased transmission of disease. Low flows can also be associated with high water temperature and lower than normal dissolved oxygen concentrations (NRC 2004). Low river discharges were apparently unsuitable for migrating adult salmon, resulting in a large number congregating in the warm water of the Lower Klamath River (USFWS 2003). Fish passage may also have been impeded by low flows, contributing to crowding (CDFG 2004). The NRC did not rule out low flows as a contributing factor but hypothesized that high water temperatures may have also inhibited the fish from moving upstream (NRC 2004). Whether inhibited by low flows, high temperatures, or both, fish in the Lower Klamath River stopped migrating upstream, resulting in crowded, stressful conditions and possibly longer residence times in a confined reach of the river.

Although losses of adult salmonids can be substantial when events such as the 2002 fish die-off occur, the combination of factors that leads to adult infection by Ich and columnaris disease are not be as frequent as the annual exposure of juvenile salmon to *C. shasta* and *P. minibicornis*, as many juveniles must migrate each spring downstream past established populations of the invertebrate polychaete worm host.

FERC (FERC 2007) concluded that Klamath Hydroelectric Project has likely contributed to conditions that foster disease losses in the Lower Klamath River by (1) increasing the density of spawning adult fall Chinook salmon downstream from Iron Gate Dam; (2) promoting the development of attached algae beds that provide favorable habitat for

the polychaete alternate host for *C. shasta*, with *P. minibicornis*; and (3) contributing to water quality conditions that increase the stress level of juvenile and adult migrants and increase their susceptibility to disease. The water quality conditions that may increase stress levels include: (1) increased water temperatures in the late summer and fall; (2) elevated ammonia concentrations and swings in DO and pH associated with algal blooms in project reservoirs; and (3) effects of exposure to elevated levels of microcystin produced from microcystis blooms in Project reservoirs, which may also result in direct mortality.

Klamath River Estuary and Pacific Ocean Nearshore

While disease and parasites occur in the Klamath Estuary and Pacific Ocean, these areas are not known to be important source areas for these stressors. Juvenile salmonids that are weakened by disease or parasites upstream may succumb to those diseases once they enter the estuary or ocean as a result of the additional stress created by adapting to the saline environment.

3.3.3.3.6 Algal Toxins

Algae produced in Upper Klamath Lake and the reservoirs in the Klamath Hydropower Reach (Copco 1 and Iron Gate Reservoirs) may be deleterious to the health of aquatic organisms in Upper Klamath Lake and the Klamath River. Some cyanobacteria species, such as *M. aeruginosa*, produce toxins that can cause irritation, sickness, or in extreme cases, death to exposed organisms (see Section 3.2.3.7 and Appendix C, Section C.6). While direct links to fish health are still somewhat unclear, recently collected data from the Klamath Basin indicates that algal toxins bioaccumulate in tissue from fish and mussels at concentrations that may be detrimental to the affected species (Fetcho 2011), as discussed below.

In Upper Klamath Lake, a reconnaissance study was conducted to evaluate the presence, concentration, and dynamics of microcystin exposure by Lost River sucker (*Deltistes luxatus*) and shortnose sucker (*Chasmistes brevirostris*). The U.S. Geological Survey (USGS) collected water samples at multiple lake sites from July to October 2007 and June through September 2008 and found evidence of gastro-intestinal lesions in juvenile suckers sampled from around the lake, although organ damage was also absent from many fish, and most of the affected fish were collected in the northern portion of the lake. The pathology of the lesions was consistent with exposure to microcystin, and evidence of a route of exposure was suggested by gut analysis showing that juvenile suckers had ingested chironomid larvae, which had in turn ingested *A. flos-aquae* and colonies of *M. aeruginosa*. The lesions were observed when liver necrosis was either present or absent suggesting that the gastro-intestinal tract was the first point of toxin contact. The authors hypothesized that the lesions were caused by algal toxins, and that the route of exposure to toxins was an oral route through the food chain, rather than exposure to dissolved toxins at the gills (VanderKooi et al. 2010). However, there were other possible explanations for the lesions, including the potential for an undetected viral infection. Conclusive pathology experiments demonstrating that exposure of juvenile suckers to algal toxins via the described oral routes can cause the types of lesions observed have not yet been done. The pathologies and evidence therefore are consistent

with the hypothesis of exposure to algal toxins but do not constitute proof of a causal mechanism. Additional work to describe the observed pathologies is ongoing.

In the Hydroelectric Reach and the Klamath River downstream from Iron Gate Dam, the occurrence of microcystin toxin in fish and mussel tissue has been studied since 2005 (Fetcho 2006; Kann 2008; CH2M Hill 2009a, 2009b; Prendergast and Foster 2010; Kann et al. 2010 a, b; Fetcho 2011). Samples of muscle and liver tissues from resident fish (i.e., yellow perch [*Perca flavescens*] and crappie [*Pomoxis nigromaculatus*]) in Copco 1 and Iron Gate Reservoirs in 2007 and 2008 indicate that two of eight microcystin congeners (i.e., chemically different forms of microcystin) were detected in muscle and liver tissues of yellow perch (total samples = 36) during September 2007 (Kann 2008) but unbound or "free" microcystin was not detected in muscle tissues of yellow perch and crappie during May-June, July, September, and November 2008 (total samples = 196) (CH2M Hill 2009a). Yellow perch muscle tissue samples collected from Copco 1 and Iron Gate Reservoirs in August and September 2009 (total samples = 43) did not exhibit microcystin (Prendergast and Foster 2010).

Rainbow trout muscle tissue samples collected upstream of Copco 1 Reservoir and immediately downstream from Iron Gate Reservoir during May-June, July, September, and November 2008 (total samples = 76) indicated that no un-bound or "free" microcystin was detected before, during, or after the 2008 bloom period in the reservoirs (CH2M Hill 2009a). Chinook salmon tissue samples from Iron Gate Hatchery in September and October 2005 did not contain detectable levels of microcystin (Fetcho 2006) and Chinook salmon and steelhead liver and muscle samples from the hatchery in October 2007 (total samples = 6) did not contain detectable levels of un-bound or "free" microcystin (CH2M Hill 2009b). However, Kann (2008) reported that one of eight microcystin congeners was detectable in three composite samples of liver, stomach, and muscle tissue from six juvenile Chinook salmon obtained at Iron Gate Hatchery in August 2007.

Further downstream in the Lower Klamath River, Fetcho (2006) reported that liver and muscle tissue samples from five Chinook salmon and two steelhead specimens taken from the Klamath River at or near Weitchpec (near RM 43) in 2005 did not contain detectable levels of microcystin. PacifiCorp collected liver and muscle tissue samples from five Chinook salmon and three steelhead in the middle Klamath River and the Lower Klamath River downstream from the Trinity River in October 2007 and reported that no detectable levels of un-bound or "free" microcystin were found (CH2M Hill 2009b). However, preliminary results from salmonid tissue samples collected in September and October 2010 near Happy Camp show that microcystin was detected in multiple Chinook salmon livers and one steelhead liver at levels which exceeded public health guidelines (Kann et al. 2011). Since livers are not typically consumed, the tested fish did not likely pose a public health concern with respect to consumption. However, results indicate that direct effects to fish health due to microcystin exposure such as stress and/or disease are a possibility (Kann et al. 2011). During the October period that Chinook salmon samples were collected, the 2010 longitudinal microcystin sampling in

river-water showed very high microcystin levels being exported from Iron Gate Reservoir and transported downstream to areas where Chinook salmon were migrating upstream.

Overall, the variation in fish tissue results in Copco 1 and Iron Gate Reservoirs and the Klamath River downstream from Iron Gate Dam indicates that the presence of *M. aeruginosa* and microcystin does not necessarily correlate to microcystin concentrations in fish tissue. Reasons for this lack of correlation may include, but are not limited to, the patchy distribution of algal blooms within the reservoirs, the ability of fish to move in and out of algal bloom areas where microcystin is likely most prevalent, and the fact that uptake of toxins into fish tissue occurs through the food chain and not directly from the water (Prendergast and Foster 2010). Microcystin can also bioaccumulate in mussel tissue in the Lower Klamath River.

Kann (2008) reported on the concentrations of eight individual microcystin congeners in freshwater mussel tissue samples obtained from the Klamath River in July and November 2007. Microcystin congeners were detected in July in composite and individual tissue samples from the Klamath River near the Klamath Highway Rest Area (at RM 178), near Seiad Valley (at RM 129) and at Big Bar (near RM 51). Individual mussel samples taken later in the year in November from the Klamath River near Orleans (at RM 59), near Happy Camp (at RM 108), near Seiad Valley (at RM 129), at the Brown Bear River Access (at RM 157.5), and near the Klamath Highway Rest Area (at RM 178) did not contain detectable levels of microcystin congeners. Overall, for the 2007 *M. aeruginosa* bloom, 85 percent of fish and mussel tissue samples collected during July through September 2007 in the Klamath River, including Iron Gate and Copco 1 Reservoirs, exhibited microcystin bioaccumulation (Kann 2008). Results indicated that all of the World Health Organization (WHO) total daily intake guideline values were exceeded, including several observations of values exceeding acute total daily intake thresholds (Kann 2008). In a retrospective letter to PacifiCorp (August 6, 2008), the California Office of Environmental Health Hazard Assessment (OEHHA) stated that they "would have recommended against consuming mussels from the affected section of the Klamath River, and yellow perch from Iron Gate and Copco Reservoirs, because their average concentrations exceeded 26 nanograms per gram (ng/g)," which is the OEHHA upper bound of advisory tissue levels fish or shellfish consumption (for a single serving per week based on 8 ounces uncooked fish). Additional public health advisories were issued in 2009 and 2010 in Copco 1 and Iron Gate Reservoirs, as well as downstream locations in the Klamath River (including locations on the Yurok Reservation), for microcystin levels in ambient and/or freshwater mussel tissue (Kann et al. 2010a,b, Fetcho 2011).

3.3.3.3.7 Aquatic Habitat

One of factors that influence habitat availability for aquatic species is instream flow. Reclamation manages Upper Klamath Lake to meet the requirements of biological opinions (BOs) from the USFWS (2008) and NOAA Fisheries Service (2010a) and its contract requirements for the Reclamation's Klamath Project (Reclamation 2010). If implemented, the Proposed Action would result in changes in the operations of Upper Klamath Lake (see Section 2.4.3.9). These changes would affect reservoir elevations in

Upper Klamath Lake, and river flows in downstream reaches. These hydrologic changes would result in changes to instream habitat. Studies to determine how fish habitat changes with flow have been conducted in areas of the Klamath River, including two reaches between J.C. Boyle Reservoir and Iron Gate Dam, for selected life stages of rainbow trout (Bureau of Land Management 2002) and seven locations between Iron Gate Dam and the estuary for selected life stages of Chinook salmon, coho salmon, and steelhead (Hardy et al. 2006).

The following sections describe the amount of flow-related habitat in various portions of the Basin for the species for which information exists. Where specific information is not available for a species or area, the Lead Agencies used hydrologic changes, species habitat requirements, and comparisons with those species for which the Lead Agencies does have specific information to qualitatively assess changes in flow-related habitat. This information was used to evaluate how the Proposed Action and alternatives might result in changes to the amount of flow-related habitat. The Lead Agencies determined that the hydrologic record of the past decade was insufficient for describing the amount of habitat available under existing conditions because of management actions made over the past eight years to protect listed fish species (minimum lake elevations; minimum flows downstream from Iron Gate Dam). These changes are described in BOs from USFWS (2008) and NOAA Fisheries Service (2002, 2010a). The flows under existing conditions and with the various alternatives are described in Section 3.6, Flood Hydrology.

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

This area was not evaluated for flow-related habitat, as no known flow-related habitat relationships exist for the Klamath or Link Rivers in this area. Some changes in flow-related habitat in tributaries to Upper Klamath Lake may occur; however, the location and magnitude of these changes are unknown at this time.

Water surface elevations in Upper Klamath Lake are expected to vary as a result of implementation of the Proposed Action and alternatives. The USFWS BO (2008) provides information on the amount of habitat provided for Lost River and shortnose suckers at different lake elevations, with higher elevations providing increased habitat for all life stages of sucker. It requires that Reclamation maintain the lake at minimum elevations from February through October each year to protect shortnose and Lost River suckers.

Under existing conditions (as indicated by the hydrologic modeling for the No Action/No Project Alternative), lake elevations are maintained at elevations ranging from about 4,138 to 4,142.2 feet in drier conditions (90 percent exceedance) and 4,139.8 to 4,143.3 feet under wetter conditions (20 percent exceedance). Lake elevations increase during the fall and winter, peak in April or May, and then decline until October.

Hydroelectric Reach: Klamath River from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

Under its existing license, PacifiCorp operates the J.C. Boyle Powerhouse in peaking mode, meaning that water is run through the powerhouse to generate electricity cyclically depending on water availability and power demand. Flows through the reach downstream from Copco 2 Dam are only about 5 cfs unless spill is occurring as a result of high runoff or project maintenance (PacifiCorp 2004a). Based on an Indicators of Hydrologic Alteration (IHA) Analyses (Richter et al. 1996) of flows within the reach downstream from J.C. Boyle Powerhouse, Huntington (2004) found a high rate of deviation from conditions that would be expected without the project influencing conditions. Substantial changes in flow (350 to 3,000 cfs) can occur within the course of a single day in the 17-mile long J.C. Boyle Peaking Reach (the reach of the Klamath River between J.C. Boyle Powerhouse and Copco 1 Reservoir). These flow fluctuations can result in temperature fluctuations in this reach ranging 5–15°C during the summer months (ODEQ 2010). These extreme flow fluctuations may also result in stranding of fish and invertebrates (Dunsmoor 2006), reductions in aquatic invertebrate production (City of Klamath Falls 1986, as cited in Hamilton et al. 2011), displacement of fish, and higher energetic costs to fish to maintain their position (FERC 2007). In the Trial-type Hearing for the relicensing of the Klamath Hydroelectric Project (Administrative Law Judge 2006), it was found that this reach had lower macroinvertebrate drift rates, indicating a reduced food base for fish.

Lower Klamath River: Downstream from Iron Gate Dam

A universal feature of the historical hydrographs of the Klamath River and its tributaries is a season of high spring flows, triggered by melting snow, followed by recession to a base flow condition by late summer (NRC 2004). This main feature of the hydrographs has undoubtedly influenced the adaptations of native organisms, as reflected in the timing of their key life-history features (NRC 2004). The natural flow regime of a river is the characteristic pattern of flow quantity, timing, rate of change of hydrologic conditions, and variability across time scales (hours to multiple years), all without the influence of human activities (Poff *et al.* 1997). It is this diverse hydrology, with the range of hydraulic conditions and habitats supported, that allowed the various anadromous fish species and life history strategies to evolve and flourish in the Klamath River over time. Therefore, to fully understand the habitat requirements for anadromous fish species, the historical flow patterns under which these species developed must also be understood.

There is a long history of water development in the Klamath Basin dating back to the late 1800's and early 1900's (See Chapter 1). Farmers introduced irrigation to the Upper Basin as early as 1882. Irrigation was necessary to the farmers because lack of timely and sufficient rain made watering crops a challenge. The earliest irrigation project in the Upper Klamath Basin occurred when residents of the town of Linkville dug a low capacity ditch connecting the town to the Link River, two miles above the present-day town of Klamath Falls. The ditch was later extended and enlarged, turning it into a high capacity canal, known as the Ankeny-Henley Canal. The first hydroelectric facility was constructed 1895 along the east side of Link River, below Upper Klamath Lake, to provide electricity to the town of Klamath Falls. The first major changes to the natural

hydrology of the Klamath River began after Congress authorized Reclamation's Klamath Project in 1905. The A canal was first completed in 1907, however, major diversions of flow from the Klamath River did not begin until after the construction of Link River Dam at the outlet of Upper Klamath Lake in 1921. Further downstream, the first major power peaking hydroelectric facility, Copco No. 1, was constructed in 1918, followed closely by construction of Copco No. 2 just downstream in 1925. JC Boyle Dam, which is the most upstream of the four mainstem dams, was completed in 1958 and also operates as a power peaking facility. Finally, Iron Gate Dam was constructed in 1962 to re-regulate power peaking flow releases from Copco No. 1 and 2 hydroelectric facilities just upstream. For more detail on the physical characteristics of each hydroelectric facility please refer to Chapters 1 and 2, and Section 3.6.3.2, Basin Hydrology.

The following provides a brief description of changes to Klamath River hydrology that have occurred through development of water management features related to irrigation, power generation, and environmental requirements over the years. The major hydrologic time periods discussed include a description of natural hydrology prior to development of major reclamation or hydroelectric facilities (pre 1913); a description of major hydrologic alterations caused by development of power peaking facilities (1913 to 1960); a description of hydrology following construction to Iron Game Dam through 2000, when ESA flow requirements began to influence water releases downstream from Iron Gate; and finally, a description of more recent events that led up to the development of KBRA flow recommendations (Proposed Action) and the 2010 NOAA Fisheries Service Biological Opinion's, Reasonable and Prudent Alternative (RPA) for flow releases downstream from Iron Gate Dam (No Action Alternative).

Owing to the long history and early development of water resources within the basin, little hydrologic data exist to describe the natural flow patterns that existed prior to construction of Reclamation's Klamath Project. The first streamflow records on the Klamath River began on June 1, 1904, when the United States Geological Survey (USGS) began operating an instream flow gage on the Klamath River at Keno (USGS Gage #11509500). River flow data for the USGS Gage at Keno are available for water years 1905 through 1912, after which the gage was discontinued until 1930. The Lost River Diversion Dam was completed in 1912, which can affect Klamath River hydrology (Hecht and Kamman 1996). Therefore, flow data collected at Keno from 1905 through 1912 provide the best source of information to describe those unaltered hydrologic characteristics that supported the rivers natural ecological processes prior to construction of major irrigation facilities in the upper basin. Although this period is known to be slightly wetter than normal, the general shape of the hydrograph is still useful for illustrating the general timing, magnitude, and duration of flow throughout the year under near natural conditions. Over this eight year period the total annual discharge at Keno ranged from a low of 1,345,000 acre Feet to a high of 1,952,000 acre feet and averaged about 1,558,000 acre Feet. Examination of three different water years, representing conditions that range from dry to wet, provide a sense of the natural flow variation that existed under natural conditions (Figure 3.3-5). Average daily flows for the 1905-1912 water years therefore provide the most reasonable set of data to assess hydrologic

changes in the Klamath Basin through time as various irrigation and hydropower generation facilities were constructed. For the purposes of the following discussion, the

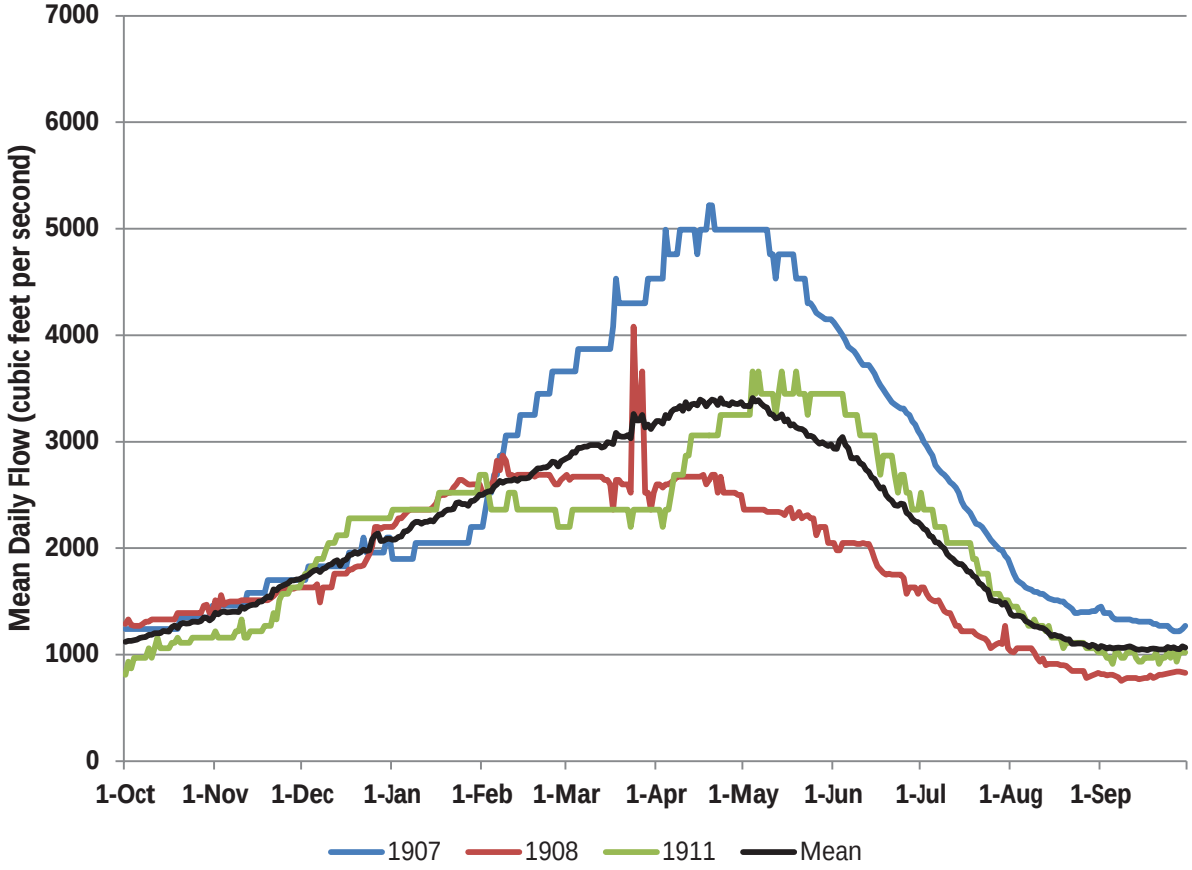

Figure 3.3-5. Mean daily flows (cubic feet per second) for the Klamath River at the USGS Gage at Keno for three different water years, generally representing drier (1908), more normal (1911) and wetter (1907) conditions. Mean daily flows for water years 1905 through 1912 are also displayed to illustrate the natural flow regime that existed prior to development of major Reclamation or hydroelectric projects.

term "natural" applies to the period prior to construction of either the hydroelectric or irrigation systems in the Klamath Basin, with river flows best represented by the 1905-1912 data.

Although there are no empirical river discharge data downstream from Keno prior to implementation of Reclamation's Klamath Project, modeling results of flows near Iron Gate Dam without Reclamation's Klamath Project show similar patterns to the natural discharge at Keno (Reclamation 2005). Spring peaks from snowmelt in tributary basins reliably provided an increase in discharge, typically near the end of April (NRC 2004), with base flows subsequently declining to a minimum in the beginning of September.

Under these conditions flows gradually increased during fall and winter months when Chinook salmon, followed closely by coho salmon, migrate upriver and spawn. Their eggs incubate over the winter when sporadic short duration high flows related to storm events typically occur. Fry emerge in late winter and early spring when flows are typically be near their highest level. These spring flows inundate side channel, off channel and backwater habitats along the flood plain creating abundant rearing habitat for salmonids. Fry grow during the spring and many smolt during that first spring and migrate downriver in late spring and early summer. Others seek out suitable rearing areas in colder tributary streams or in spring fed habitats to rear over the summer and smolt the following fall or spring when water temperatures are cool and flows are either increasing or are high once again.

As described in Section 3.6.3.1, a rock reef originally controlled the elevation of Upper Klamath Lake and river flows downstream to Link River. Link River is only 1.3 miles long and ends at the upper extent of Lake Ewauna and the Keno Impoundment. Historical accounts describe the occurrence of extremely low flows in Link River during prolonged dry spells (Dickens & Dickens, 1985). These extremely low flow conditions were most likely caused by strong south winds forming seiches within Upper Klamath Lake which greatly diminished flows to Link River for brief periods of time. The Klamath Indians referred to Link River as “Yulalona” which translates to “back and forth” (Donnelly 2002) and this is probably related to these natural seiches. Inputs from tributary streams and natural springs downstream from Keno would have maintained flow in the Klamath River and prevented it from drying completely further downstream near the current location of Iron Gate Dam. A second rock reef formed a natural hydraulic control for Lake Ewauna and provided an ideal location for the construction of Keno Dam.

Farther downstream in the coastal zone of the Lower Klamath Basin, the hydrologic pattern of the Klamath River is primarily dominated by rainfall events in the fall, winter and spring. In the middle and lower portions of the Klamath River, discharge responds rapidly to rainfall due to the relatively short length of lower tributary sub-basins (*e.g.*, Salmon River). The natural Klamath River hydrology was therefore diverse, with a range of hydraulic conditions affected by both the Upper Klamath Basin patterns previously described (e.g. Figure 3.3-5) and lower basin tributary inputs (see Section 3.6.3.3 Historic Stream Flows). As a result, habitats were also diverse, supporting a variety of different anadromous salmonid life history strategies throughout the year (Figure 3.3-6).

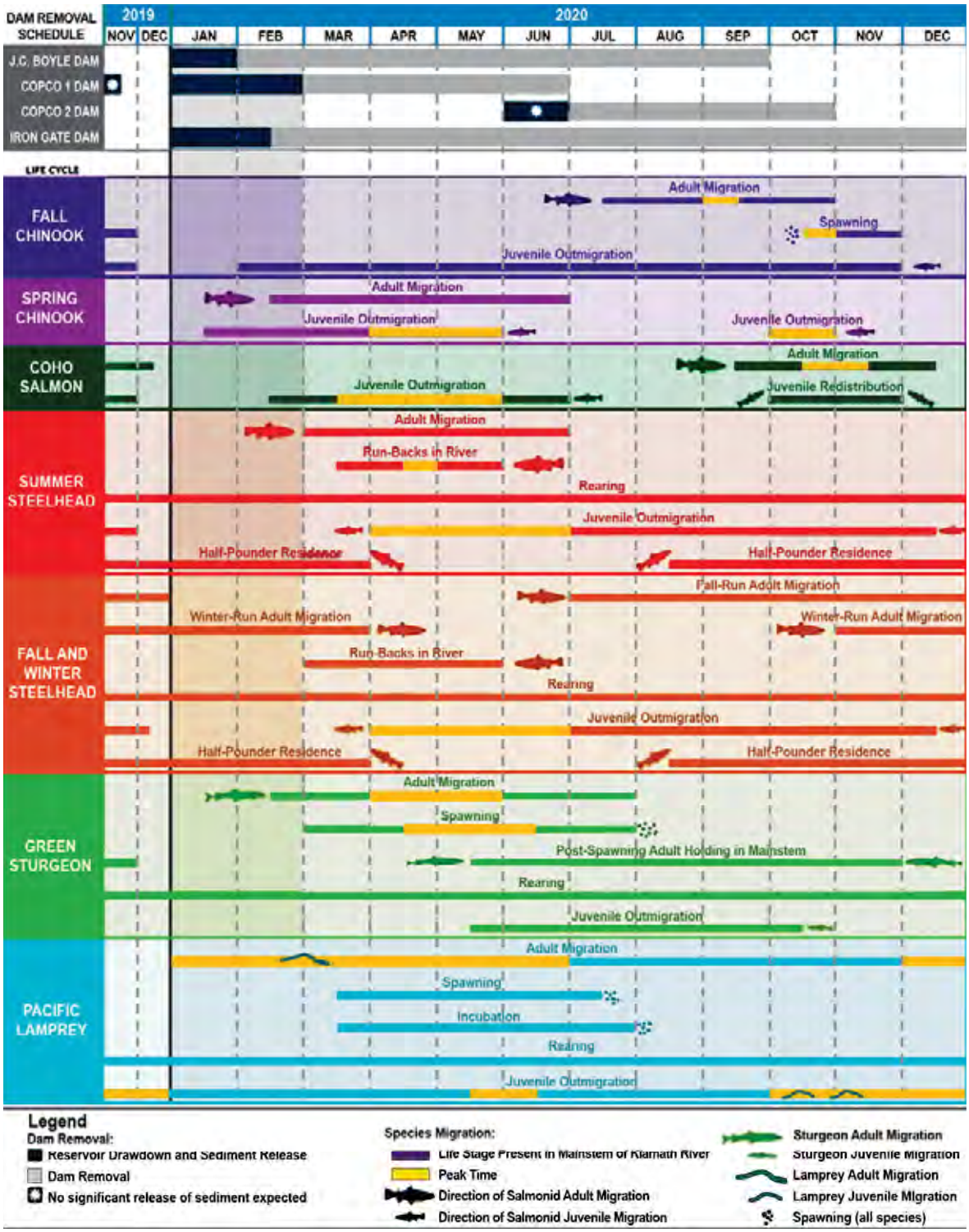

Figure 3.3-6. Timeline Depicting the Timing of Salmon Lifecycles in the Mainstem of the Klamath River Coinciding with Dam Removal Plans.

Copco No. 1 and Copco No. 2 facilities were constructed to generate hydroelectric power and their operation greatly altered flow patterns downstream. The USGS installed a gage on the Klamath River near Fall Creek downstream from Copco No. 1 and 2 and began recording flows at this location in October 1923 (USGS Gage #11512500). Flow data is available at this location until 1962 when construction of Iron Gate Dam inundated the river at this location. Hydroelectric power peaking operations at Copco No. 1 and 2 cause major changes to the hydrograph downstream from the powerhouse (Figure 3.3-7). Rapid changes in flow associated with hydropower generation, commonly referred to as power peaking, created both hazardous conditions for recreational fishermen and also created inhospitable conditions for aquatic species downstream. Rapid changes in flow associated with daily hydropower generation, commonly referred to as power peaking, created both hazardous conditions for recreational fishermen and also created difficult conditions for aquatic species downstream. Fish studies have shown considerable biological impacts due to Project peaking (City of Klamath Falls 1986; FERC 2007; BLM 2002; Wales and Coots 1950). From June 1948 to May 1949, Wales and Coots (1950) estimated that Project peaking operations resulted in the loss of over 1.8 million salmonid fingerlings downstream from Copco No. 1 and 2 facilities. Mean daily flows fell below 100 cubic feet per second in the Klamath River near Fall Creek (USGS Gage #11512500), downstream from Copco No. 2 Dam, on fifty occasions between water years 1931 and 1937. Instantaneous flow levels may have been lower. Thus, hydropower peaking between 1918 and the construction of Iron Gate Dam to re-regulate flows in 1962 may explain some anecdotal accounts of the occurrence of low flows in the Klamath River in the past that were submitted by several citizens during public scoping.

Iron Gate Dam was completed in 1962 to re-regulate peaking flow releases from the Copco facilities upstream. At that time minimum flow releases downstream were stipulated by the Federal Energy Regulatory Commission (FERC) under Article 52 of the FERC License for operation of Project No. 2082. Article 52 required the following minimum flows downstream from Iron Gate Dam: September 1 through April 30, 1,300 cfs; May 1 through May 31, 1,000 cfs; June 1 through July 31, 710 cfs; and August 1 through August 31, 1,000 cfs. These requirements provided more stable flow conditions downstream, however, they also altered the timing of base flows and did not attempt to restore or simulate the natural “pre-project” hydrograph. Fall flows were slightly increased while spring and summer flows were substantially reduced compared to natural flows.

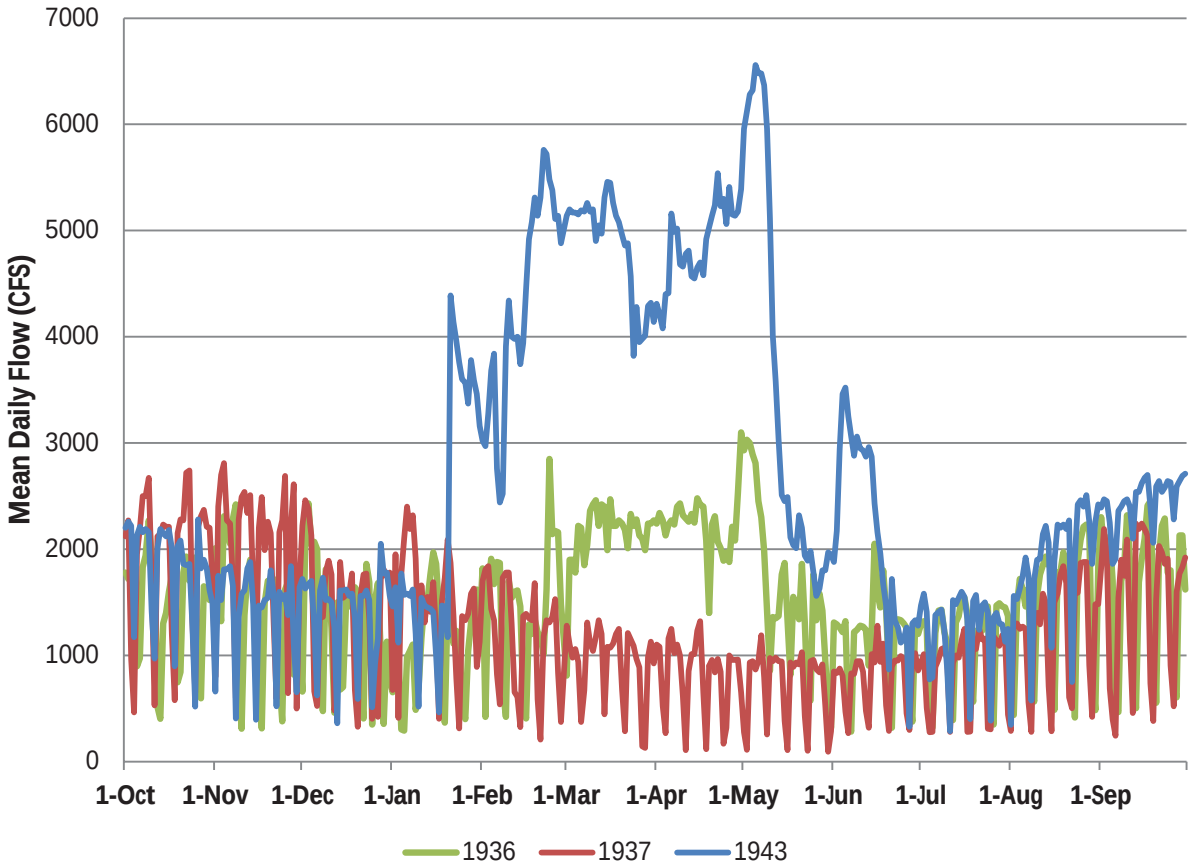

Figure 3.3-7. Mean daily flows (cubic feet per second) for the Klamath River at the USGS Gage near Fall Creek (Gage #11512500) for three different water years, generally representing drier (1937), normal (1936) and wetter (1943) conditions.

Hecht and Kamman (1996) analyzed the hydrologic records for similar water years (pre- and post-Project) at several locations along the Klamath River. The authors concluded that the timing of peak and base flows changed significantly after construction of Reclamation's Klamath Project, and that the operation of Reclamation's Klamath Project increases flows in October and November and decreases flows in the late spring and summer as measured at Keno, Seiad, and Klamath USGS gage sites. Comparison of mean daily flows recorded at Keno (USGS Gage #11509500) from 1905 to 1912 with mean daily flows recorded at Keno and Iron Gate (USGS Gage #11516430) in more recent years (1961-2000) provide visual confirmation of these findings (Figure 3.3-8).

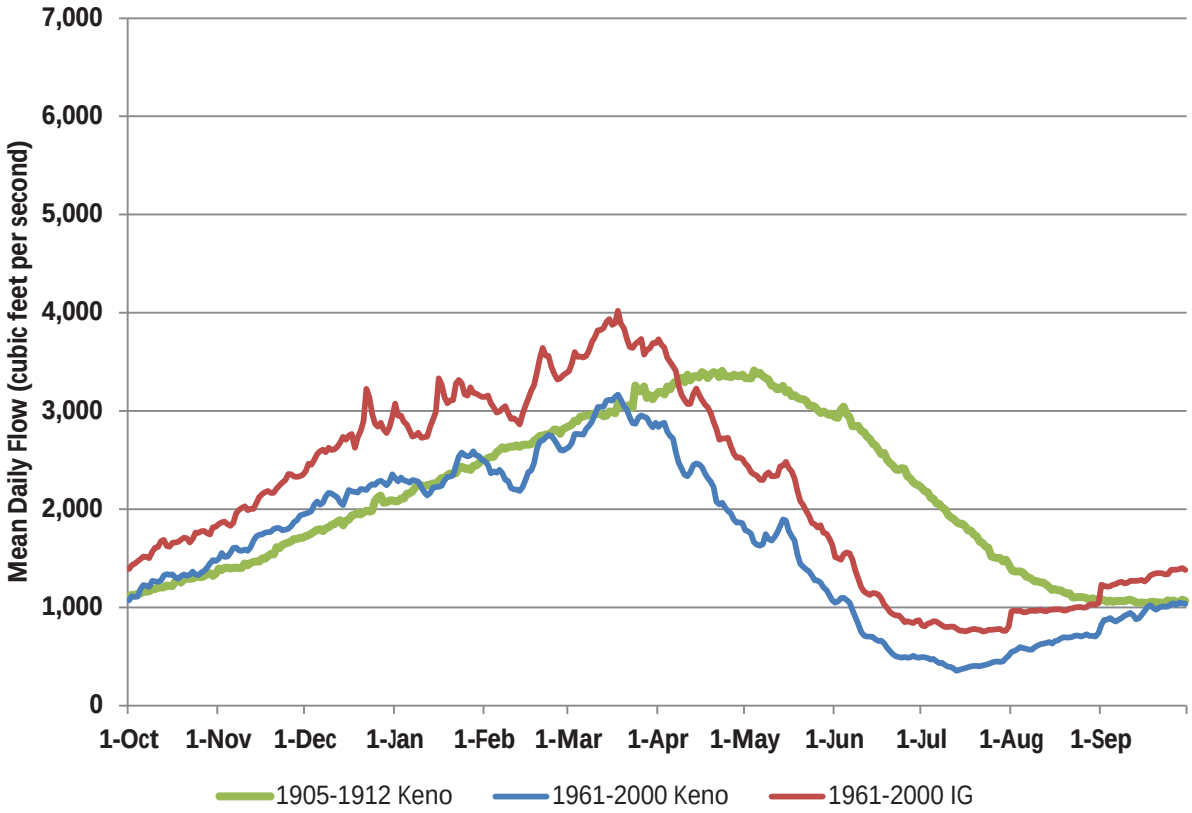

Figure 3.3-8. Comparison of mean daily flows recorded at Keno (USGS Gage # 11509500) historically (1905-1912) with more recent conditions (1961-2000). Mean daily flows recorded at Iron Gate (USGS Gage #11516530) are shown to depict both the mean daily accretions and similarities that exist in the hydrograph between Keno and Iron Gate.

As shown in Figure 3.3-8, for the period from 1961 through 2000, the timing and magnitude of average flows in the Klamath River at Keno have changed relative to the natural flow regime. Reclamation's Klamath Project diverts water from the Klamath River beginning in the spring and significantly reduces flow volumes in the Klamath River from April until September. The extraction of water significantly accelerates the decline of flow rates during the spring runoff and has the effect of moving the spring runoff peak from the end of April and beginning of May to the middle of March, a shift of more than one month. Although most of the diverted water remains within the basin, about 30,000 acre feet of water is diverted from Jenny Creek (tributary to the Klamath River at Iron Gate Reservoir) to the Rogue River Valley annually. Under natural conditions, river discharge did not reach base (minimum) flow, until September. Operation of Reclamation's Klamath Project has caused a shift in the onset of minimum base flow levels by about two months earlier in the summer from September to July. Tributary inflows and spring flow accretions, the most prominent being Big Springs (about 250 cfs) in the JC Boyle bypass reach, would account for difference in mean daily

flow between Keno and Iron Gate were it not for the operation Reclamation's Klamath Project.

The Southern Oregon Northern California Coast (SONCC) coho salmon Evolutionarily Significant Unit (ESU) was listed as threatened under the Federal Endangered Species Act (ESA) on May 6, 1997 (62 FR 24588). In 2001, NOAA Fisheries Service determined that the operation of Reclamation's Klamath Project jeopardized the continued existence of SONCC coho salmon. To reduce impacts to levels that avoid jeopardy to SONCC coho salmon, NOAA Fisheries Service proposed Reasonable and Prudent Alternative (RPA) flows for the Klamath River downstream from Iron Gate Dam (NOAA Fisheries Service 2001). Because of the expectation that additional information and analyses relevant to the relationship between Iron Gate Dam flows and suitable salmonid habitat (e.g., the Hardy Phase II Report) would become available within a few months following the issuance of the NOAA Fisheries Service 2001 Biological Opinion, the RPA only included minimum Iron Gate Dam flows for the April through September 2001 period. In the 2001 Opinion (NOAA Fisheries Service 2001), NOAA Fisheries Service stated their intention to prepare a supplemental biological opinion and RPA, addressing all water year types. In addition, NOAA Fisheries Service stated that the supplemental biological opinion could include a more refined minimum Iron Gate Dam flow regime for future "critically dry" water years, based on any new information or analyses that may become available in the near future. NOAA Fisheries Service's reasonable and prudent alternative for 2001 included the following instantaneous minimum flow releases to the Klamath River downstream from Iron Gate Dam, by time step, for the April through September period:

Time Step	Iron Gate Dam Discharge (CFS)
April	1,700
May	1,700
June 1-15	2,100
June 16-30	1,700
July	1,000
August	1,000
September	1,000

In 2002, Reclamation requested formal consultation under ESA for ongoing operation of the Klamath Reclamation Project from 2002 through 2012. In the Biological Opinion, NOAA Fisheries Service (2002) found that the operation of Reclamation's Klamath Project as proposed in Reclamation's Biological Assessment would likely jeopardize the continued existence of SONCC coho salmon and would also adversely modify their critical habitat. To avoid the likelihood of jeopardizing the continued existence of SONCC coho salmon or cause adverse modification to their critical habitat, NOAA Fisheries Service developed a reasonable and prudent alternative which included development of a water bank and water supply enhancement program to improve flows to benefit coho salmon habitat and long-term flow targets (Table 3.3-A).

Table 3.3-A. Summary of the Iron Gate Dam long-term flow targets expected to be achieved by water year 2010 unless modified by study results. These flow targets are instantaneous minimum flows (Table 9, NOAA Fisheries Service 2002).

* Convene "Between Year Transition Group"

Recommended Long Term Iron Gate Dam Discharge By Water year Type					
Month	Dry	Below Average	Average	Above Average	Wet
October	1,300*	1,300*	1,300	1,300	1,300
November	1,300*	1,300*	1,300	1,300	1,300
December	1,300*	1,300*	1,300	1,300	1,300
January	1,300*	1,300*	1,300	1,300	1,300
February	1,300*	1,300*	1,300	1,300	1,300
March	1,450	1,725	2,750	2,525	2,300
April	1,500	1,575	2,850	2,700	2,050
May	1,500	1,400	3,025	3,025	2,600
June	1,400	1,525	1,500	3,000	2,900
July	1,000	1,000	1,000	1,000	1,000
August	1,000	1,000	1,000	1,000	1,000
September	1,000	1,000	1,000	1,000	1,000

Concerns over the health of anadromous fish populations and their habitat in the Klamath River downstream from Iron Gate Dam lead the Department of the Interior (DOI) to fund development of a study to determine instream flows required to support the ecological needs of aquatic resources, with particular attention given to anadromous fish species. After several years of data collection, development of various draft reports, and extensive review of the biological findings by agency and public scientists, the final report "Evaluation of Instream Flow Needs in the Lower Klamath River, Phase II" was completed by Hardy et al. in July, 2006. Subsequent to its release, the National Research Council's Committee on Hydrology, Ecology, and Fishes of the Klamath River Basin also conducted a thorough review of the report (NRC 2008). The report, commonly referred to as the Hardy Phase II Report, provides recommendations for flow releases downstream from Iron Gate Dam to provide for the long-term protection, enhancement and recovery of the aquatic resources. The recommendations are intended to benefit all anadromous species and life stages on a seasonal basis and are not focused on a single species or life stage (Hardy et al. 2006). The recommendations were intended to provide guidance to the Department of the Interior in meeting their Public and Tribal Trust responsibilities, as well as meeting responsibilities described under the Endangered Species Act. A summary of the Hardy Phase II flow recommendations are presented in Table 3.3-B. It is important to note that these recommendations are for base flows only.

Hardy recommendations include higher flows levels to satisfy important physical and ecological requirement to provide diverse habitat and floodplain maintenance. These components were broadly defined by NRC (2004) as: Over Bank Flows (infrequent high flow event that overtops the riverbanks); High Pulse Flows (short duration high flow within the stream channel during or immediately after storm events); Base Average Flows (base flows in the absence of significant precipitation or runoff event); and, Subsistence Minimum Flows (stream flows needed to maintain tolerable water quality conditions and provide minimal aquatic habitat).

Table 3.3-B. Instream flow recommendations by annual exceedence* levels for net inflows to Upper Klamath Lake on a monthly basis below Iron Gate Dam (Table 27, Hardy et al. 2006)

% Exceed	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP
5	1,735	2,460	3,385	3,990	4,475	4,460	4,790	3,845	3,185	2,215	1,560	1,565
10	1,715	2,415	3,280	3,835	4,285	4,355	4,585	3,710	3,055	2,140	1,540	1,545
15	1,700	2,365	3,205	3,795	4,210	4,285	4,425	3,615	2,975	2,075	1,495	1,515
20	1,680	2,315	3,120	3,705	4,215	4,160	4,230	3,480	2,850	2,000	1,405	1,490
25	1,660	2,260	3,015	3,645	4,080	3,990	4,065	3,390	2,755	1,925	1,375	1,465
30	1,645	2,220	2,945	3,510	3,925	3,940	3,930	3,225	2,660	1,830	1,335	1,430
35	1,635	2,160	2,870	3,405	3,660	3,860	3,705	3,115	2,540	1,740	1,305	1,405
40	1,625	2,110	2,800	3,215	3,435	3,685	3,485	2,960	2,455	1,635	1,255	1,370
45	1,575	2,060	2,690	3,015	3,220	3,585	3,245	2,815	2,340	1,515	1,215	1,335
50	1,565	2,000	2,545	2,820	3,015	3,380	3,030	2,675	2,225	1,330	1,170	1,305
55	1,545	1,935	2,385	2,630	2,810	3,150	2,815	2,510	2,070	1,265	1,105	1,275
60	1,525	1,875	2,235	2,420	2,565	2,910	2,590	2,385	1,980	1,205	1,055	1,235
65	1,510	1,830	2,090	2,210	2,335	2,630	2,405	2,165	1,840	1,135	1,020	1,195
70	1,490	1,775	1,950	2,015	2,135	2,350	2,260	2,050	1,635	1,070	1,005	1,160
75	1,470	1,710	1,815	1,825	1,950	2,050	2,045	1,905	1,465	1,015	975	1,120
80	1,450	1,670	1,650	1,620	1,770	1,835	1,940	1,690	1,320	945	935	1,080
85	1,430	1,600	1,520	1,460	1,615	1,585	1,740	1,415	1,160	905	910	1,045
90	1,415	1,545	1,380	1,245	1,485	1,410	1,530	1,220	1,080	840	895	1,010
95	1,395	1,500	1,260	1,130	1,415	1,275	1,325	1,175	1,025	805	880	970

* For example, a 10 percent exceedence would be equivalent to the inflow value to Upper Klamath Lake that is exceeded 10 percent of the time for the existing hydrologic record, a more wet condition.

The Hardy Phase II flow exceedence recommendations incorporate the principles of "Ecological Base Flow" requirements. Ecological Base Flows are intended to provide adequate protection for aquatic resources. Human induced reductions in flow below this level are believed to result in unacceptable levels of risk to the health of aquatic resources

(Hardy et al. 2006). Flow volumes equal to those identified for the 95 percent exceedence flows listed in Table 3.3-A (Table 27, Hardy et al. 2006) are intended to be representative of Ecological Base Flows for the Klamath River downstream from Iron Gate Dam under conditions with dams in place. It is important to recognize that the monthly column headings in Table 27 in the Hardy Phase II Report are not intended to be interpreted as monthly time steps for implementation of instream flows. Under real time management, the exceedance flow recommendations would ideally be implemented using daily time steps as recommended in Hetrick et al (2009) and discussed by Hardy (2008). The findings of Hardy et al. (2006) provide the best available science on the relationship between anadromous fish habitat and instream flow in the Klamath River at this time.

During the negotiation of the Klamath Basin Restoration Agreement (KBRA) a Technical Team consisting of staff from the U.S. Fish and Wildlife Service, National Marine Fisheries Service, the California Department of the Fish and Game as well as technical experts from other participants in the negotiation, was formed to evaluate potential impacts that may occur to either anadromous fish or listed suckers during the interim period (between the dates of a positive Secretarial Determination, should one occur, and dam removal) for various management alternatives that were under consideration by the negotiating parties. This Technical Team should not be confused with the Technical Advisory Team (TAT) described in Section 20.4.3 of the KBRA or the Federal Team for the Secretarial Determination assembled to conduct technical studies requested in the KHSA or to conduct the environmental analysis required under the National Environmental Policy Act (NEPA) or the California Environmental Quality Act (CEQA). A full description of the analytical methods used by the Technical Team is described in detail in Hetrick et al. (2009). The Technical Team's approach to development of instream flow recommendations for the Klamath River considered both the Hardy Phase II instream flow recommendations in conjunction with instream flows that provide a minimum of 80 percent of the maximum habitat values for priority species and life stages for five different water year types ranging from dry to wet (Hetrick et al. 2009). The resulting flow recommendations were labeled Alt X by the Technical Team.

An alternative to the Alt X flow recommendations was proposed for KBRA by biologists from the Yurok Tribe, labeled the ALT-X Yurok flow schedule. The ALT-X Yurok schedule was designed to increase water storage in the fall and winter to increase the likelihood of filling Upper Klamath Lake. Filling the lake early in the water year increases the probability of spill and the availability of water to maximize, to the extent possible, river flows in the spring and early summer to provide better habitat conditions for Chinook salmon emergence and Chinook and coho salmon fry and juvenile rearing during the critical spring months of March through June. To accomplish this objective within the management regime described under the KBRA, the ALT-X Yurok flow schedule would maintain steady flows from October through February at 1,000 cfs for 90% exceedence years and 1,100 cfs for 70% exceedence years, and at levels reduced from the ALT-X schedule for the October to December period during higher inflow conditions (see Figure I-3 in Hetrick et al. 2009). The ALT-X Yurok flow schedule adopts the ALT-X flow schedule throughout the remainder of the water year. While the conservative fall/winter flow period of the ALT-X Yurok flow schedule increases the

likelihood of spill occurring later in the year, it does not provide flow variability through a substantial portion of the fall/winter period, nor does it mimic the natural flow regime as recommended throughout the current literature regarding instream flow management (Poff et. al. 1997). Differences in total flow volume between the ALT-X and ALT-X Yurok flow schedules during this period were, however, not considered to be of a magnitude that would preclude a real-time approach to water management that would provide desired variability in fall/winter flows.

The Technical Team used the Water Resources Integrated Modeling System (WRIMS) to provide the hydrologic data (river flow and lake levels) necessary to analyze potential impacts to anadromous fish habitat in the river and sucker habitat in Upper Klamath Lake under numerous water management scenarios (Hetrick et al. 2009). The WRIMS model is capable of simulating river flows at Iron Gate Dam as they would have happened under various management scenarios and allows for comparisons to be made between alternatives and historical conditions. The analysis was limited to hydrologic conditions present during water years 1961 – 2000. The WRIMS Run-32 Refuge model run provides simulated Klamath River flows at Iron Gate and Upper Klamath Lake elevations using target flows provided by Alt X Yurok, Upper Klamath Lake elevation targets (Alt Y) described in Hetrick et al. (2009), and management objectives provided in the KBRA with the model priorities set to provide agricultural irrigation deliveries to Klamath Reclamation Project irrigators as described in Part IV of the KBRA. This also includes those benefits associated with both the Water Use Retirement Program (additional 30,000 acre feet) and increased water storage capacity in Upper Klamath Lake through restoration of Williamson River Delta, Agency Lake and Barnes Ranches, and Wood River wetlands. The model results do not include any additional benefits that may occur as a result of the implementation of a drought plan, which had not been developed at the time of this analysis. The results of WRIMS Run 32 Refuge are presented in Table I-5 and I-7 in Hetrick et al. (2009). Appendix E-5 of the KBRA also provides the results for three similar WRIMS (referred to as KLAMSIM) model simulations for Klamath River flows at Iron Gate and Upper Klamath Lake elevations.

As described in Hetrick et al. (2009), percent habitat area available using the flow-habitat relationships in the Hardy Phase II Report, for WRIMS Run-32 Refuge model output flows, were consistently higher than percent habitat area calculated for actual flow releases observed below Iron Gate Dam during water years 1961-2000 for the March – May emergence and rearing life stages of Chinook salmon, and for the June juvenile rearing period for coho salmon for exceedences greater than 10 percent (extremely wet years or drier). Percent habitat areas calculated for the WRIMS Run-32 Refuge model output flows and Hardy Phase II flow recommendations for the March – April period differed little, if at all, for all exceedence levels with the exception of the March time step for a 10 percent (extremely wet year) exceedence level, in which case the habitat value for the Hardy Phase II flow was about 25 percent higher than the habitat value calculated for the WRIMS Run-32 Refuge model output flows. Chinook salmon spawning percent habitat areas in October and November from WRIMS Run-32 Refuge were generally higher for the 10 percent (extremely wet year) exceedence level, similar for the 30, 50, and 70 percent (wet, normal, and dry) exceedences, and less at the 90 percent (critically

dry year) exceedence level than the percent habitat areas calculated for actual flows downstream from Iron Gate from 1961-2000 and Hardy Phase II flow recommendations. Both the WRIMS Run-32 Refuge modeled flow outputs and the Hardy Phase II flow recommendations provide habitat values above 70 percent of the maximum available habitat for priority anadromous fish species and life stages for a greater length of time (more time steps) than were provided under the actual flows below IGD during water years 1961-2000. For Upper Klamath Lake, the WRIMS Run 32 Refuge model run predicted that, in general, the lake would fill to elevations necessary to allow Lost River and shortnose sucker unrestricted access to critical spawning locations (Hetrick et al. 2009).

Results of the WRIMS Run 32 Refuge simulation indicate that in critically dry water years (similar to 1992 and 1994) there is a substantial reduction in Upper Klamath Lake elevations resulting in corresponding reductions in habitat that would negatively impact anadromous fish in the Klamath River and suckers in Upper Klamath Lake (Hetrick et al. 2009). These results demonstrated the critically important need for the development and effective implementation of a drought plan capable of reducing these potential impacts to both anadromous fish and suckers when critically dry conditions at the 95 percent exceedence level exist. Section 19.2 of the KBRA describes the process used for development of a drought plan (KBCC. 2011) that may reduce some of these potential impacts.

Appendix E of Reclamation (2011a) contains a description of the methods and assumptions that were incorporated into the hydrology simulations for the No Action Alternative (2010 Biological Opinion flows) and the Dam Removal Alternative (KBRA flows) used in the analysis. Previous hydrology simulations conducted by the Technical Team using the WRIMS (WRIMS Run 32 Refuge) model and described by Hetrick et al. (2009) were used to simulate conditions during the interim period prior to dam removal and did not incorporate several aspects of the KBRA (Drought Plan), and therefore were not appropriate for use in the EIS/EIR analysis of the Proposed Action or other alternatives. At the time when the Technical Team was conducting their analysis, the KBRA was still being developed and the Drought Plan had not been written. Under KBRA, the Technical Advisory Team (TAT) would also implement management of environmental water in real time; therefore, simulation of unknown future hydrologic and biological conditions is problematic. In addition, the previous analysis only addressed flows downstream from Iron Gate and did not consider flow needs that would likely be required for anadromous fish that would have access to areas upstream of Iron Gate Dam after proposed dam removal in 2020 as well as protections that may be required in future Biological Opinions under the ESA. Therefore, the Federal Team for the Secretarial Determination needed to incorporate several assumptions into the KBRA hydrology model simulations that attempt to provide adequate protections for anadromous fish and suckers that may be representative of potential recommendations by the TAT in the future that would include additional conservation measures that could be anticipated through implementation of a Drought Plan in critically dry water years. To meet these requirements the following assumptions, which are also described in Appendix E of Reclamation (2011a), were incorporated into the KBRA flow simulations:

- Incorporation of a minimum flow of 100 cfs at Link River to provide adequate passage through the fish ladder and stream channel.
- Incorporation of a minimum flow at Keno Dam of 300 cfs to provide adequate fish passage.
- Minor adjustment of KBRA flow targets for use in the hydrology model for the time steps from July 1 through the end of September to improve flow conditions for adult migration and reduce the potential for fish die off. The changes that were implemented include reducing the target from 921 to 840 cfs for July 1 to 15, increasing the target from 806 to 840 cfs for July 16 to 31, increasing the target from 895 to 1110 cfs in August, and increasing the targets from 1010 to 1110 cfs in September.
- Incorporation of minimum Ecological Base Flow (EBF) levels during the periods from March 1 through June 30 and during the months of August and September. The EBF volumes are those proposed by the Hardy Phase II 95% exceedence flow levels.
- Incorporation of pulse flows into the disaggregated daily data to realize potential benefits of these flows to reduce disease infection rates through disruption of the parasite's life cycle.
- Minor adjustment to the flow targets for the month of March for water years represented by the 70% Exceedence. These adjustments include reductions in the targets from 2358 to 2085 cfs (March 1-15) and from 2343 to 2149 cfs (March 16-31). The change is consistent with rate of change for wetter water years.
- Incorporation of minimum base flows of 800 cfs during the months of October through February. The minimum of 800 cfs is considered to be necessary to prevent adverse impacts to salmonids during the winter months.
- Redistribution of irrigation and refuge supplies during shortage years to reflect KBRA language. KPSIM does adjustments on annual basis as a post process. Monthly adjustments are done as a post process in a workbook by the data manager which runs both models.
- Minor adjustments were made to UKL elevation criteria in association with shortage adjustments.
- Net evaporation and riparian evapotranspiration gain was added.
- A method was implemented to create imperfect knowledge of forecasts. Because operational decisions are made based upon forecasts and not perfect knowledge of future flows, it is necessary to simulate this process in the model.

The Hardy et al. (2006) Phase II flow exceedence recommendations do not consider physical, biological, and chemical alterations to the Klamath system resulting from dam removal. The anticipated future changes to the system that would occur under the KHSA and KBRA led Hardy (2008) to conclude that future flow releases as described in the KBRA are a logical extension of the Hardy Phase 2 Flow recommendations, balancing multiple needs, including those of anadromous salmonids. Improved water quality conditions (primarily increased minimum dissolved oxygen and more natural water temperatures), restoration of sediment transport processes, potential reductions in disease,

restored access to thermal refugia and instream habitats upstream are all factors that led Hardy (2008) to conclude "that the threshold flow at which significant concerns over thermal and disease factors will drop well below 1000 cfs to something on the order of 700 to 800 cfs." Consistent with these findings the Federal Team for the Secretarial Determination incorporated minimum base flows of 800 cfs into the KBRA flow simulations during the period from October through February (Reclamation 2011, Appendix E). Base flows of 800 cfs at Iron Gate Dam, along with tributary accretions downstream, currently provide greater than 75 percent of the available Chinook salmon spawning habitat from the R-Ranch study site downstream to the Brown Bear study site (Hardy et al. 2006) and flow levels of this magnitude would be adequate for adult coho salmon to migrate freely upstream. However, real time flow management envisioned by Hetrick et al. (2009) under KBRA would create variable flows during the spawning season that would actually have potential to increase the abundance of spawning habitat above what could be provided under a single static flow condition (Hetrick et al. 2009).

In the mid 2000s, NOAA Fisheries Service, FWS and Reclamation worked together to better understand and consider the conservation needs of listed fish (SONCC coho salmon, Shortnose and Lost River suckers) that reside in the Klamath River or in the Upper Klamath Basin. The agencies worked to improve inter-agency cooperation to promote efficient utilization of limited water resources for listed species, refuges and Project water users and to better harmonize the analyses and any potential conditions imposed by the final biological opinions prepared by the FWS and NOAA Fisheries Service. In October of 2007 Reclamation requested formal consultation under section 7 of the ESA for operation of Reclamation's Klamath Project from 2008 through 2018. In the years immediately following, NOAA Fisheries Service worked collaboratively with Reclamation and FWS, and met with technical experts from Klamath Basin Tribes, to develop a reasonable and prudent alternative to avoid jeopardizing listed coho salmon. The final biological opinion which includes a reasonable and prudent alternative that addresses instream flow needs for SONCC coho salmon was released in 2010 (see Section 3.6.3.2 and Table 3.6-1 for additional description).

Under the No Action Alternative, Klamath River flows were simulated following the instream flow requirements established for operation of Reclamation's Klamath Project under the reasonable and prudent alternative (RPA) described with in the 2010 Biological Opinion (NOAA Fisheries Service 2010a). In developing the RPA, NOAA Fisheries Service concluded that the implementation of Hardy Phase II flow exceedence recommendations at Iron Gate Dam will sufficiently provide fluvial conditions necessary for the conservation of coho salmon. NOAA Fisheries Service also adopted flows for certain time periods that reflect Hardy Phase II flows and determined that this action provided both a reasonable and prudent approach consistent with avoiding jeopardy of Southern Oregon and Northern California Coast (SONCC) coho salmon. As a result, the hydrology simulation results used in the analysis of the EIS/EIR for the No Action Alternative (NOAA Fisheries Service 2010a BO flows) and the Proposed Project (KBRA Flows) are similar in many aspects as described in Reclamation (2011a).

However, one aspect of the RPA flows that could not easily be incorporated into the hydrologic model for the No Action Alternative is the requirement to include a fall and winter flow variability program. The purpose of the Fall Winter Flow Variability Program, included in the RPA, is to enhance flow variability that would result from additional tributary inflow during fall and winter rainfall events. To accomplish this purpose, the RPA sets aside 18,600 acre feet of water for this purpose (NOAA Fisheries Service 2010a). In projection of the no-action Alternative, rather than attempt to simulate uncertain future implementation of this fall and winter flow variability program, the hydrologic modeling increased the base flow for the month of October from 1,000 cfs to 1,300 cfs which is roughly equivalent to the 18,600 acre feet provided under the RPA. Incorporation of this assumption increases simulated flows during the month of October under the No Action Alternative.

Klamath River Estuary and Pacific Ocean

Flow-related habitat has not been described for the Klamath River estuary.

3.3.3.3.8 Critical Habitat

The ESA requires that USFWS and NOAA Fisheries Service designate critical habitat[2] for the listed species they manage. Critical habitat has been designated for three species within the area of analysis: coho salmon, green sturgeon, and bull trout, and has been proposed for an additional two: shortnose and Lost River suckers. An endangered population of killer whales that includes Klamath River salmon in its diet is also discussed here.

Coho Salmon

Critical habitat for the SONCC Coho ESU was designated on May 5, 1999 and includes all river reaches accessible to listed coho salmon between Cape Blanco, Oregon and Punta Gorda, California, and includes water, substrate, and adjacent riparian zones of estuarine and riverine reaches, including off-channel habitat. "Accessible reaches" are defined as those within the historical range of the ESU that can still be occupied by any life stage of coho salmon. Specifically, in the Klamath Basin, all river reaches downstream from Iron Gate Dam on the Klamath River and Lewiston Dam on the Trinity River are designated as critical habitat (NOAA Fisheries Service 1999b).

Features of critical habitat considered essential for the conservation of the SONCC ESU (NOAA Fisheries Service 1997b) include (1) substrate, (2) water quality, (3) water quantity, (4) water temperature, (5) water velocity, (6) cover/shelter, (7) food, (8) riparian vegetation, (9) space, and (10) safe passage conditions. Primary Constituent Elements (PCEs) for SONCC coho salmon are described in NOAA Fisheries Service (1999b) as follows: "In addition to these factors, NOAA Fisheries Service also focuses on the known physical and biological features (PCEs) within the designated area that are

[2] The ESA defines critical habitat as "the specific areas within the geographical area occupied by the species, at the time it is listed, on which are found those physical or biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection; and specific areas outside the geographical area occupied by the species at the time it is listed that are determined by the Secretary to be essential for the conservation of the species."

essential to the conservation of the species and that may require special management considerations or protection. These essential features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation."

Shortnose Sucker and Lost River Sucker

Critical habitat was originally proposed but not finalized by the USFWS for the Lost River sucker and shortnose sucker in 1994 (USFWS 1994). Critical habitat for the two species was reproposed on December 7, 2011 (USFWS 2011b). The proposed new critical habitat area is within Klamath and Lake Counties, Oregon, and Modoc County, California. The two proposed critical habitat units include: (1) approximately 146 stream miles (234 km) and 117,848 acres (47,691 ha) of lakes and reservoirs for Lost River sucker; and (2) approximately 128 stream miles (207 km) and 123,590 acres (50,015 ha) of lakes and reservoirs for shortnose sucker (USFWS 2011b). The USFWS considers the physical and biological features essential to the conservation of the species which may require special management considerations or protection when proposing critical habitat. These include, but are not limited to: (1) space for individual and population growth and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing (or development) of offspring; and (5) habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species. PCEs are the specific elements of physical and biological features that are essential to the conservation of the species. The PCEs identified in the critical habitat proposal are as follows: (1) water in sufficient depths and quantity; (2) spawning and rearing habitat; and (3) areas contain abundant food (USFWS 2011b). A revised draft recovery plan was released in 2011 (USFWS 2011a) and is expected to be finalized with the new critical habitat in 2012 once public comments are addressed. The draft recovery plan cites predominant threats to these suckers as lack of spawning habitat, continued loss of habitat, lake elevation fluctuations that reduce access to vegetative habitat, water diversions, competition and predation by introduced species, hybridization with other sucker species, isolation of remaining habitats, and drought (USFWS 2011a). Decreases in water quality resulting from timber harvest, dredging activities, removal of riparian vegetation, and livestock grazing may also cause problems for these species (USFWS 2011a).

Green Sturgeon

In 2009, NOAA Fisheries Service designated critical habitat for the Southern DPS of green sturgeon, which encompasses all coastal marine waters of the United States less than 60 fathoms deep (approximately 110 m) from Monterey Bay, California north to Cape Flattery, Washington. The estuary portion of the Eel and Klamath/Trinity Rivers was specifically excluded from the critical habitat designation (NOAA Fisheries Service 2009b).

Bull Trout

Critical habitat designations for bull trout were finalized in 2005, but were then remanded in 2009 and republished in 2010. The final 2010 rule designates 277 miles of stream shoreline and 9,329 acres of reservoirs or lakes as critical habitat within the Klamath

River Recovery Unit. This habitat includes Agency Lake and its tributaries and an assortment of headwater streams. A designated critical habitat map is available from the USFWS (http://www.fws.gov/oregonfwo/Species/Data/BullTrout/Maps/final_krb.pdf). Critical habitat areas have at least one PCE essential to the conservation of bull trout. These features are the PCEs laid out in the appropriate quantity and spatial arrangement for conservation of the species. These include: (1) Space for individual and population growth and for normal behavior; (2) Food, water, air, light, minerals, or other nutritional or physiological requirements; (3) Cover or shelter; (4) Sites for breeding, reproduction, or rearing (or development) of offspring; and (5) Habitats that are protected from disturbance or are representative of the historical, geographical, and ecological distributions of a species.

Eulachon

Critical habitat for the Southern DPS eulachon in the Klamath River was designated by the NOAA Fisheries Service on 20 October 2011 (NOAA Fisheries Service 2011). NOAA Fisheries Service designated approximately 539 miles of riverine and estuarine habitat in California, Oregon, and Washington within the geographical area occupied by the southern DPS of eulachon. The designation includes 16 rivers and creeks extending from and including the Mad River, California to the Elwha River, Washington. NOAA Fisheries Service did not identify any unoccupied areas as being essential to conservation and thus, did not designate any unoccupied areas as critical habitat. NOAA Fisheries Service excluded from designation all lands of the Lower Elwha Tribe, Quinault Tribe, Yurok Tribe, and Resighini Rancheria. In the Klamath River, designated critical habitat extends from the mouth of the Klamath River upstream to Omogar Creek, a distance of 10.7 miles, and includes only the Federal, State, and private lands within the Yurok Reservation and Resighini Rancheria. The physical or biological features essential for conservation of this species include: (1) Freshwater spawning and incubation sites with water flow, quality, and temperature conditions and substrate supporting spawning and incubation, (2) Freshwater and estuarine migration corridors free of obstructions with water flow, quality and temperature conditions supporting larval and adult mobility, and with abundant prey items supporting larval feeding after the yolk sac is depleted, and (3) nearshore and offshore marine foraging habitat with water quality and available prey, supporting juveniles and adult survival.

Southern Resident Killer Whale

In November 2006, NOAA Fisheries Service designated critical habitat for Southern Resident Killer Whales (NOAA Fisheries Service 2006b). Critical habitat includes all waters relative to a contiguous shoreline-delimited by the line at a 20-foot depth relative to extreme high water within three designated areas: (1) the Haro Strait and waters around the San Juan Islands; (2) Puget Sound; and (3) the Strait of Juan de Fuca. Coastal and offshore areas have not been designated as critical habitat, though they are recognized as important for the Southern Resident Killer Whales and NOAA Fisheries Service anticipates additional information on coastal habitat use from research projects in the coming years (NOAA Fisheries Service 2006b).

Based on the natural history of the Southern Residents and their habitat needs, the following physical or biological features were identified as essential to conservation: (1) water quality to support growth and development; (2) prey species of sufficient quantity, quality, and availability to support individual growth, reproduction, and development, as well as overall population growth; and (3) passage conditions to allow for migration, resting, and foraging (71 FR 69054). There is the potential for Southern Resident Killer Whales to feed on Klamath River salmonids during the period from about September through May when they spend more time in outer coastal waters and may range from central California to northern British Columbia (Hanson et al. 2010). Southern Resident Killer Whales would not be expected to be affected by any of the alternatives, apart from their effects on salmon production.

3.3.3.3.9 Essential Fish Habitat

EFH is designated for commercially fished species under the Magnuson-Stevens Fishery Conservation and Management Reauthorization Act (Magnuson-Stevens Act). The Magnuson-Stevens Act requires Federal fishery management plans, developed by NOAA Fisheries Service and the Regional Fishery Management Councils, to describe the habitat essential to the fish being managed and to describe threats to that habitat from both fishing and nonfishing activities. To protect EFH, Federal agencies are required to consult with the NOAA Fisheries Service on activities that may adversely affect EFH.

EFH has been designated for 3 species of salmon, 83 groundfish species, and 5 pelagic species. Descriptions of EFH within the area of analysis are provided below.

Chinook and Coho Salmon

Coho salmon are also managed under the Magnuson-Stevens Act, under the authority of which EFH for coho salmon is described in Amendment 14 to the Pacific Coast Salmon Fishery Management Plan (50 CFR 660.412). EFH for Chinook salmon is also described in the same management plan, and is identical to that for coho salmon in the Klamath Basin. EFH has been designated for the mainstem Klamath River and its tributaries from its mouth to Iron Gate Dam, and upstream to Lewiston Dam on the Trinity River. EFH includes the water quality and quantity necessary for successful adult migration and holding, spawning, egg-to-fry survival, fry rearing, smolt migration, and estuarine rearing of juvenile coho and Chinook salmon.

Groundfish

The Magnuson-Stevens Act defines EFH to include those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity (16 USC 1802 (10)). EFH for Pacific Coast groundfish includes all waters and substrate within areas with a depth less than or equal to 3,500 m (1,914 fm) shoreward to the mean higher high water level or the upriver extent of saltwater intrusion (defined as upstream and landward to where ocean-derived salts measure less than 0.5 ppt during the period of average annual low flow). The Klamath River Estuary, which extends from the river's mouth upstream to near the confluence with Ah Pah Creek, is included in the Pacific groundfish EFH (50 CFR § 660.395).

Pelagic Fish

EFH for coastal pelagic species, including finfish (northern anchovy, Pacific sardine, Pacific (chub) mackerel, and jack mackerel) and market squid occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone and above the thermocline where sea surface temperatures range from 10 to 26ºC. During colder winters, the northern extent of EFH for coastal pelagic species may be as far south as Cape Mendocino, and during warm summers it may extend into Alaska's Aleutian Islands. In each of these seasonal examples the Klamath Estuary and coastline would be included as EFH for these species.

3.3.4 Environmental Consequences

3.3.4.1 Environmental Effects Determination Methods

This section provides a brief overview of the methods used in the evaluation of important factors to aquatic resources. More complete descriptions are provided in the Methods and Criteria Technical Memorandum (Reclamation 2012), Appendix E for suspended sediment and Appendix F for bedload sediment.

3.3.4.1.1 Suspended Sediment

As described in Appendix E, the potential effects of suspended sediment on anadromous fish species for the Proposed Action and alternatives were assessed using SRH-1D (Huang and Greimann 2010, as summarized in Reclamation 2011). The SRH-1D model provides an estimate of SSCs at different points on the river on a daily average estimate. This information is used to assess the impacts of SSCs on fish based on the concentration and duration of exposure using Newcombe and Jensen's (1996) approach. Duration of exposure is based on the time a species and lifestage would be exposed to elevated SSCs. These effects are compared to those that fish would be expected to encounter under baseline conditions. Estimated existing conditions were also simulated using the SRH-1D model, to provide a comparison of what SSCs would be with and without dam removal in the years 2020 and 2021 (No Action/No Project Alternative). This approach is similar to that used in Stillwater Sciences (2008, 2009a, 2009b).

Daily durations of SSC concentrations were modeled assuming the Proposed Action occurred within each of the 48 years in the available hydrology record since 1961. For each simulation year in the 48 year record, the duration of SSCs over a given threshold was calculated for each species and life-history stage (e.g., duration of SSC over 1,000 mg/L during spring-run Chinook salmon adult upstream migration). The results of modeling all potential years were summarized for each life-stage of each species assessed. Because the suspended sediment varies with hydrology, and in order to account for (and compare) the range of results and impacts that might occur under each alternative, two scenarios were analyzed for the Proposed Action, and for action alternatives, with the goal of predicting the potential impacts to fish that has either a 50 percent (likely to occur) or 10 percent (unlikely, or worst case) probability of occurring, defined as follows:

3.3.4.1.2 For Existing Conditions and the No Action/No Project Alternative:

- **Normal conditions:** SSCs and durations with a 50 percent exceedance probability for the mainstem Klamath River downstream from Iron Gate Dam (i.e., the probability of these concentrations and durations being equaled or exceeded in any one year is 50 percent). Exceedance probabilities were based on modeling SSC for all water years subsequent to 1961 with facilities in place. To assess "normal conditions" the median (50 percent) SSC and duration from these results was estimated (Appendix II, Volume E, page E-3). "Normal conditions" is a description of the SSCs that commonly occur under existing conditions during most years, such as during typical winter flows.
- **Extreme conditions:** SSCs and durations with a 10 percent exceedance probability (i.e., the probability of these concentrations and durations being equaled or exceeded in any 1 year is 10 percent). "Extreme conditions" is a description of infrequent SSCs events in the Klamath River under existing conditions, such as a flood (Appendix II, Volume E, page E-4).

3.3.4.1.3 For the Proposed Action– Full Facilities Removal of Four Dams:

- **Most likely scenario:** SSCs and durations with a 50 percent exceedance probability for the mainstem Klamath River downstream from Iron Gate Dam (i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any one year is 50 percent). Exceedance probabilities were based on the results of modeling suspended sediment in the Klamath River downstream from Iron Gate Dam in all water years observed since 1961 with facility removal. To predict the "most likely scenario" that will occur under the Proposed Action, the median (50 percent exposure concentration) was estimated.

- **Worst-case scenario:** SSCs and durations with a 10 percent exceedance probability (i.e., the probability of these concentrations and durations being equaled or exceeded for each assessed species and life-stage in any 1 year is 10 percent). "Worst-case scenario" is a prediction of an unlikely, but potential scenario of high SSCs that could occur under if the Proposed Action occurs under a sequence of rare hydrologic conditions.

3.3.4.1.4 Bedload Sediment

As described in Appendix F, the analysis of potential changes to bedload sediment also relied upon output from the SRH-1D model (Huang and Greimann 2010). The changes in bedload were evaluated for a range of hydrologic conditions for short-term (2-year) and long-term (5-, 10-, 25-, 50-year) changes using a range of flows taken from historical hydrology. A long-term simulation was not conducted for the Klamath River upstream of Iron Gate Dam under the assumption that the bedload sediment conditions at the end of 2 years are representative and would persist through time, allowing for mild fluctuations as a function of hydrology (Reclamation 2012).

The effects determination used results from the analysis and knowledge of habitat requirements of affected fish species to determine how changes in bed elevation and

substrate composition would affect aquatic resources (e.g., pool habitat, spawning gravel, benthic habitat). Changes in substrate composition occurring as a result of dam removal that decreased habitat suitability were assumed to be deleterious to salmonids. Bedload transport in the area upstream of the influence of J.C. Boyle Reservoir are not anticipated to be affected by dam removal and are not expected to be substantially affected by the Proposed Action, and are not evaluated further in this document. Link and Keno Dams would remain in place and would continue to affect hydrology and sediment transport in much the way they do currently.

3.3.4.1.5 Water Quality

The analysis of potential short- and long-term water quality-related effects on fish is based on the corresponding water quality effects determinations (see Section 3.2, Water Quality) for parameters to which fish are most sensitive (i.e., water temperature, sediment and turbidity, dissolved oxygen, pH, and ammonia toxicity), as well as effects determinations for State and approved tribal designated beneficial uses that are directly related to fish (see Table 3.2-3).

As described in Section 3.2., Water Quality, implementation of the Oregon and California Total Maximum Daily Loads (TMDLs) is considered to be a reasonably foreseeable action associated with water quality during the period of analysis (i.e., 50 years) (see Section 3.2.4.1, Environmental Effects Determination Methods), and is expected to generally improve water quality conditions in the Klamath River. Modeling efforts for development of the TMDLs included four simulated scenarios and both “dams in” and “dams out” conditions (see Appendix D, Section D.1 for additional detail on modeling scenarios). TMDL model results for water temperature, dissolved oxygen, pH, and nutrients provide one set of quantitative, predictive information under the alternatives and so these results are discussed as part of the water quality analysis (Section 3.2.4.3, Effects Determinations) and the corresponding aquatics analysis (below). However, since no one existing model captures all of the elements analyzed for water quality in this Klamath Facilities Removal EIS/EIR, where possible, model outputs are used in combination to assess similar spatial and temporal trends in predicted water quality parameters (Section 3.2.4.1, Environmental Effects Determination Methods).

Potential effects of sediment-associated toxins on fish under the dam removal alternatives were evaluated using the results of multiple screening level comparisons of sediment contaminant levels identified in reservoir sediments that are currently trapped behind the dams. These water quality methods are described in greater detail in Section 3.2.4.1.7.

3.3.4.1.6 Water Temperature

Potential impacts of water temperature on species within each analysis area were evaluated using available modeled water temperatures (PacifiCorp 2004c; Dunsmoor and Huntington 2006; FERC 2007; Tetra Tech 2009, Perry et al. 2011). Because model results were not developed for scenarios covering each of the alternatives, this evaluation assumes that the Partial Facilities Removal Alternative would result in temperatures similar to those that would occur under the Proposed Action. It is assumed that the Fish Passage at Four Dams Alternative would result in similar temperatures to existing

conditions. The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative was assumed to result in temperatures intermediate to the Proposed Action and existing conditions. Because the remaining reservoirs are small relative to Copco 1 and Iron Gate Reservoirs, with correspondingly lower amounts of thermal heating and residence time, the temperatures under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would likely be more similar to those under the Proposed Action than they would be to the No Action/No Project Alternative. Water temperature data were compared to the thermal tolerances of focal species and associated life stages as determined from the literature to determine relative suitability for these species under the various alternatives.

No one available water temperature model includes all of the reasonably foreseeable actions associated with water temperature. Implementation of TMDLs is included in the TMDL models (Tetra Tech 2009) and climate change and KBRA hydrology are incorporated into the RBM10 model (Perry et al. 2011) (see Section 3.2.4.1.1 and Appendix D for additional detail). Neither implementation of total maximum daily loads (TMDLs) nor climate change was incorporated into the existing models, including the Chinook salmon life cycle model (EDRRA) developed by Hendrix (2011). For purposes of the water quality and aquatics analyses it is assumed that TMDL water temperature objectives can be met; however the timeframes for achieving allocations required under the TMDLs will depend on the measures taken to improve water quality conditions (see Section 3.2.4.3.1). It is also assumed that climate change would result in 1.0 to 3.0°C warming of median air temperature by the end of the analysis period (Snyder et al. 2004; Bartholow 2005; Perry et al. 2011) (see also Section 3.2.4.1.1).

3.3.4.1.7 Fish Disease and Parasites

Fish diseases, specifically *C. shasta* and *P. minibicornis*, can contribute to mortality and have periodically contributed to substantial mortality for Klamath River salmon. Generally, Klamath River steelhead are resistant to *C. shasta* (Administrative Law Judge 2006). Environmental variables such as temperature, flow, sediment (bedload composition and stability), plankton (high quality food abundance), and nutrients are thought to affect the abundance of *P. minibicornis* and *C. shasta* via habitat for the intermediate host; therefore, differences in river habitat conditions that could occur under the Proposed Action and alternatives could affect the abundance of these parasites and their infection rates in Klamath Basinsalmon. Bartholomew and Foott (2010) prepared a compilation of available information regarding Myxozoan disease relative to the Klamath River and, in their analysis they considered several factors that could, if co-occurring, lead to high disease infection rates of fish:

- Physical habitat components that support the invertebrate host species (pools, eddies, sediment, mats of filamentous green algae [periphyton])
- Microhabitats with low velocity and unnaturally stable flows
- Close proximity to spawning areas
- Water temperatures higher than 15 °C

3.3.4.1.8 Aquatic Habitat

Changes to habitat area were assessed for each life stage qualitatively, using knowledge of habitat requirements and expected changes under the alternatives. Quantitative descriptions of the relationship between fish habitat and flow are available for the current channel configuration at some locations (Bureau of Land Management 2002; Hardy et al. 2006). However, extrapolation of these relationships to describe the habitat changes that would be anticipated under each of the proposed alternatives would not provide an appropriate method to assess the effects of the project alternatives because the channel configuration itself is anticipated to change as a result of alterations to sediment supply and the temporal resolution (mean monthly or biweekly time steps) of modeled flows would not accurately represent daily flow conditions. Qualitative analyses relied on data evaluated for other affected factors (water temperature and fish passage) and expected changes in geomorphic processes, such as short- and long-term changes in sediment transport and deposition, to determine increases or decreases in habitat relative to existing conditions for the different species and life stages in the various reaches.

3.3.4.1.9 Critical Habitat

NOAA Fisheries Service has designated critical habitat for coho salmon, Southern Resident Killer Whales, and eulachon, and the USFWS has designated critical habitat for bull trout. Within critical habitat, NOAA Fisheries Service has determined that the PCEs essential for the conservation of these species are those sites and habitat components that support one or more life stage. Critical habitat for Southern Resident Killer Whales does not extend into coastal or offshore habitats (71 FR 69054).The effects of each alternative on critical habitat were based on evaluation of the physical, chemical and biological changes that were expected to occur to designated critical habitat within the area of analysis and how those changes would affect the PCEs for that critical habitat in the short and long term.

3.3.4.1.10 Essential Fish Habitat

The effects of each alternative on EFH were based on evaluation of the physical, chemical and biological changes that were expected to occur to EFH within the area of analysis and whether those changes would have beneficial effects on this habitat in terms of its quantity and quality in the short and long term.

3.3.4.1.11 Freshwater Mussels

Increased levels of fine sediment, both suspended in the water column and along the channel bed, can inhibit the growth, production, and abundance of freshwater mussels and clams. Therefore, the analysis of impacts associated with dam removal focused on short- and long-term changes in SSCs (Aldridge et al. 1987, as cited in Henley et al. 2000) and stream substrate texture (Howard and Cuffey 2003; Vannote and Minshall 1982). The evaluation focuses on freshwater mussels because of the lack of information regarding the effects of SSCs and sediment transport on clams. Suspended sediment impacts on freshwater mussel species were evaluated using output from the SRH-1D (Huang and Greimann 2010) sediment transport model as discussed above for suspended and bedload sediment.

Aldridge et al. (1987, as cited in Henley et al. 2000) showed that exposure to SSCs of 600-750 mg/L led to reduced survival of freshwater mussels found in the eastern United States. No duration of exposure was cited in the study. No comparable data are available for the species in the Klamath River. Using 600 mg/L as the minimum SSCs that would be detrimental to freshwater mussels, alternatives were compared to each other by determining the number of days during which this criterion threshold would be exceeded.

Analysis of impacts due to changes in bedload transport on the four species of freshwater mussels considered modeled changes in median sediment size, under the Proposed Action and each project alternative. The effects of changes in water quality on freshwater mussels were evaluated in the same manner as described for fish. The analysis presented here, focuses on effect on freshwater mussels because of their longer lifespan and a lack of information on the effects of water quality on clams.

3.3.4.1.12 Benthic Macroinvertebrates

Suspended sediment and turbidity can cause stress to benthic macroinvertebrates (BMI) populations through impaired respiration, reduced feeding, growth, and reproductive abilities, and reduced primary production (Lemly 1982; Vuori and Joensuu 1996). Therefore, potential short-term and long-term effects of the Proposed Action and alternatives on BMIs were evaluated for both short- and long-term changes in SSCs and bedload sediment. Suspended sediment impacts on BMIs were evaluated using output from the SRH-1D (Huang and Greimann 2010) sediment transport model as discussed above for suspended and bedload sediment.

Changes in substrate size or embeddedness may influence the distribution, abundance, and community structure of BMIs (Bjornn et al. 1977; McClelland and Brusven 1980; Ryan 1991). Bed texture changes that would occur under the Proposed Action and alternatives were qualitatively evaluated to determine whether changes in substrate composition would likely decrease macroinvertebrate abundance or alter the community composition to the extent that these communities could no longer support sufficient fish populations in the Klamath system.

The effects of changes in water quality, Biochemical Oxygen Demand/Immediate Oxygen Demand, and toxicity effects on BMIs were based on water quality determinations (see Section 3.2, Water Quality) and evaluated in the same manner as described for fish and mollusks. Potential toxicity to BMIs was also evaluated using the results of bioassays.

3.3.4.2 Significance Criteria

The Proposed Action and alternatives could affect aquatic resources directly or indirectly through a variety of mechanisms, as described in the preceding section. These effects could be additive or offsetting. For purposes of this evaluation, the Lead Agencies considered the total effect of the factors described above on native fish populations and their habitat. These impacts could vary substantially in intensity, geographic extent, and duration. The intensity of an impact refers to how severely it affects an organism. This severity can range from sublethal behavioral adaptations such as avoidance of a specific

condition, to mortality. The geographic extent refers to how much of the species' potential habitat and what proportion of the total population is expected to be affected. The temporal duration refers to how long the effect is anticipated to persist (hours, days, months, or years). The Lead Agencies considered effects in the short term (less than 2 years) and the long term (more than 2 years), but either short- or long-term impacts could be significant.

For the analysis of Aquatic Resources in this EIS/EIR, the following determinations were considered:

- No from existing conditions: Effect would not result in alterations to existing conditions.
- Significant: As defined below.
- Less-than-significant: Effect influences an aquatics species, but does not result in a significant effect.
- Beneficial: Results in a substantial increase in the abundance of a year class in the short or long term.

For the purposes of this EIS/EIR, effects would be significant if they would result in the following:

Short term:

- Substantially reduce the abundance of a year class in the short term.
- Substantially decrease the habitat quality or availability for a native species over a large proportion of the habitat available to it in the short term.
- Substantially decrease the quality or availability of a large proportion of critical habitat under the ESA or EFH under the Magnuson-Stevens Fishery Conservation and Management Act in the short term.

Long term:

- Substantially reduce the population of a native species for more than two generations after removal of all dams (if removed all at once) or after the last dam (if removed sequentially).
- Substantially decrease the habitat quality or availability for a native species or community in the long term.
- Substantially decrease the habitat quality or availability for a native species over a large proportion of the habitat available to it in the long term.
- Substantially decrease the habitat quality or availability of a large proportion of critical habitat under the ESA or EFH under the Magnuson-Stevens Fishery Conservation and Management Act in the long term.
- Continue or worsen conditions that are currently causing a species to decline in the long term.
- Eliminate a year class of salmon or steelhead, thereby impacting the long-term viability within the Klamath Basin. Because of the fixed, 3-year timing of the

coho salmon life cycle, which has little to no plasticity, this criterion was added for the protection of coho salmon in particular.

3.3.4.3 Effects Determinations

3.3.4.3.1 Alternative 1: No Action/No Project

Under this alternative, none of the actions under consideration would be implemented. The Klamath Hydroelectric Project would continue current operations under the terms of an annual license until a long-term license is finalized. Annual licenses would not include actions associated with the KHSA and KBRA. Several Interim Measures (IMs) from the KHSA would be implemented through other PacifiCorp's Habitat Conservation Plan or other means; these measures are included in the No Action/No Project Alternative. In addition, continued expenditures of $10 to 20 million a year on various basin-wide restoration projects (e.g., stream habitat improvements), and other basin conservation plans will continue to provide aquatic habitat improvements. Some KBRA actions have already been initiated and would continue under the No Action/No Project Alternative. These include the Williamson River Delta Project, the Agency Lake and Barnes Ranch Project, fish habitat restoration work, and ongoing climate change assessments. The TMDLs would be implemented under all alternatives as they are an unrelated regulatory action; however, TMDL goals would likely be met at a later date than under alternatives with KBRA. Hydroelectric operations would continue as they have been, providing peaking power generation during the summer as demand requires and conditions allow. Iron Gate Hatchery would continue to operate at current levels of production in order to meet mitigation requirements.

Key Ecological Attributes

Suspended Sediment

Suspended sediment effects under the No Action/No Project Alternative are described in detail in Appendix E, and summarized here. Under the No Action/No Project Alternative, suspended sediment would be the same as under existing conditions. Most suspended sediment is supplied by tributaries; Iron Gate Dam currently interrupts both fine and coarse sediment transport, so suspended sediment generally increase in a downstream direction. The Lower Klamath River downstream from the Trinity River confluence (RM 40.0) to the estuary mouth is listed as sediment impaired under Section 303(d) of the CWA (see Table 3.2-8). Under both normal and extreme conditions, the magnitude and duration of the SSCs modeled for the No Action/No Project Alternative are expected to cause major stress to migrating adult and juvenile salmonids primarily during winter, with a Newcombe and Jensen (1996) Severity Index predicted to be higher than 8 for most of the winter (see Appendix E for detailed analysis).

Bedload Sediment

Bedload sediment effects under the No Action/No Project Alternative are described in detail in Appendix F, and summarized here.

Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

Under the No Action/No Project Alternative, the Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. The No Action/No Project

Alternative would have no effects associated with bedload sediment relative to existing conditions for any aquatic species in this reach.

Lower Klamath River: Downstream from Iron Gate Dam Under the No Action/No Project Alternative, the Project dams would continue to interrupt the transport of bedload. These periodic inputs of bedload sediments are necessary for the long-term maintenance of aquatic habitats. As a result of the interception of sand, gravel and coarser sediment supply from sources upstream of Iron Gate Dam the channel downstream from Iron Gate Dam would continue to coarsen and decrease in mobility (Reclamation 2012), providing fewer components of habitat, in particular spawning habitat, and decreased quality habitat over time. This effect would gradually decrease in the downstream direction as coarse sediment is resupplied by tributary inputs (Hetrick et al. 2009), and would be substantially reduced at the Cottonwood Creek confluence (PacifiCorp 2004b). As occurs under existing conditions, the coarser bed material is mobilized at higher flows that occur less frequently, resulting in channel features that are unnaturally static and provide lower value aquatic habitat (Buer 1981).

Klamath River Estuary The No Action/No Project Alternative would not change bedload transport to the estuary or Pacific Ocean, relative to existing conditions.

Water Quality

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir As described in Section 3.2, Water Quality, long-term dissolved oxygen levels under the No Action/No Project Alternative would continue to exhibit seasonal variability. Dissolved oxygen levels are particularly low during the summer in this reach, with typical levels ranging from <1 mg/L to 5 mg/L. Such low levels do not meet Oregon water quality objectives for dissolved oxygen, and they do not consistently support designated beneficial uses in Oregon for cold-water aquatic life, cool-water aquatic life, warm-water aquatic life, and spawning.

Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly increase dissolved oxygen in this reach. Klamath TMDL model results for riverine conditions between Link River Dam and the upstream end of J.C. Boyle Reservoir predict that dissolved oxygen concentrations would meet the 6.5 mg/L objective year round, including the warm summer and fall months (see subsection to Section 3.2.4.3.1, Upper Klamath Basin). Full attainment could require decades to achieve and it is highly dependent on improvements in dissolved oxygen in Upper Klamath Lake.

Additionally, restoration activities such as floodplain rehabilitation, riparian vegetation planting, and purchase of conservation easements/land related to nutrients under the No Action/No Project Alternative are currently ongoing in the Upper Klamath Basin and are expected to continue to improve long-term dissolved oxygen in the Upper Klamath Basin. These restoration actions and implementation of water quality improvement measures under Oregon TMDLs to address water quality impairments are also expected

to improve pH during the period of analysis (50 years) by decreasing algal bloom populations and rates of photosynthesis and correspondingly decreasing observed pH maximums in the Upper Klamath Lake and its tributaries.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Under the No Action/No Project Alternative, continued high rates of algal photosynthesis in the two largest reservoirs in the Hydroelectric Reach (Copco 1 and Iron Gate) would result in dissolved oxygen and pH values that would not consistently meet applicable ODEQ and California Basin Plan water quality objectives (see Section 3.2, Water Quality). The bottom waters (i.e., hypolimnion) of Copco 1 and Iron Gate Reservoirs would continue to have very low oxygen levels (< 1 mg/L to 5 mg/L) during summer stratification periods (FERC 2007). Based on existing conditions, pH during summer through fall in Copco 1 and Iron Gate Reservoirs would continue to range from just above neutral (7) to greater than 9 (slightly basic), with the highest values occurring during algal blooms. The ongoing presence of the two largest reservoirs in the Hydroelectric Reach (Copco 1 and Iron Gate) would also continue to provide the conditions necessary for large seasonal blue-green algae blooms, including *M. aeruginosa*, which can produce a toxin and contribute to reduced health and increased mortality rates for fish and other aquatic resources both within the reservoirs and in areas downstream. As with the upstream reach, full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly improve seasonal dissolved oxygen and pH levels in the Hydroelectric Reach. Full attainment could require decades to achieve and it is highly dependent on improvements in dissolved oxygen in Upper Klamath Lake and the Keno Impoundment/Lake Ewauna.

Lower Klamath River: Downstream from Iron Gate Dam Ongoing efforts to improve water quality conditions are underway through the TMDL process and considerable efforts to improve habitat are also underway (Hamilton et al. 2011). Once implemented, these efforts could reduce existing conditions that contribute to reduced health and increased mortality rates for aquatic resources (described below) to some extent, but this process would be slower and more challenging than with the dams removed. In the interim, water quality conditions that may reduce survival of fish and other aquatic resources would persist downstream from Iron Gate Dam.

Given existing conditions, long-term dissolved oxygen levels under the No Action/No Project Alternative would continue to exhibit seasonal variability and would not consistently meet California Basin Plan and Hoopa Valley Tribe water quality objectives for dissolved oxygen and they would not consistently support designated beneficial uses in the Lower Klamath River downstream from Iron Gate Dam.

Modeling conducted for development of the California Klamath River TMDL indicates that under the No Action/No Project Alternative, dissolved oxygen concentrations immediately downstream from Iron Gate Dam, without additional mitigation, would not meet the North Coast Basin Plan water quality objective of 85 percent saturation (see Tables 3.2-4 and 3.2-5) during August–September and the 90 percent saturation objective from October–November (Figure 3.2-18). Further downstream, near the confluence with

the Shasta River, dissolved oxygen concentrations under the No Action/No Project Alternative would not meet the 90 percent saturation objective from October–November (Figure 3.2-19). In the Klamath River at Seiad Valley, concentrations would be mostly in compliance, with the exception of modeled values in November that are just above the 90 percent saturation objective (Figure 3.2-20). By the Salmon River (RM 66.0) confluence, with full attainment of TMDL allocations, predicted dissolved oxygen concentrations would remain at or above the 85 percent saturation objective (as well as the 90 percent saturation objective, where applicable), meeting the North Coast Region Basin Plan requirements.

Under the No Action/No Project Alternative, continued high rates of algal photosynthesis in the reservoirs would result in high pH values in the Lower Klamath River downstream from Iron Gate Dam (see Section 3.2, Water Quality). Under the No Action/No Project Alternative, pH would continue to be elevated with high diurnal variability during summer and early fall months.

The overall anticipated effect on dissolved oxygen in the Lower Klamath River under the No Action/No Project Alternative would be an increasing trend toward compliance with water quality objectives and support of designated beneficial uses, but with possible continued seasonally low dissolved oxygen downstream from Iron Gate Dam, and so would not consistently meet California Basin Plan and Hoopa Valley Tribe water quality objectives for dissolved oxygen. The No Action/No Project Alternative would continue to periodically result in dissolved oxygen levels that may be deleterious to aquatic resources downstream from Iron Gate Dam, but this effect would be similar to or less than that which currently occurs.

Water Temperature

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the No Action/No Project Alternative, water temperature in the upper Klamath River would remain similar to existing conditions in the near term, but would be expected to show a gradual cooling trend through implementation of the TMDLs. However, climate change would partially offset temperature improvements (see also the subsection of Section 3.2.4.3.1). Climate change impacts on the Klamath River and Estuary are based on current estimates of potential future changes in air temperature and precipitation patterns for the California North Coast hydrologic region (Stillwater Sciences 2009a). Regional climate models estimate that median annual air temperature would increase 1.0 to 3 ºC by 2050 (Snyder et al. 2004). These ambient air temperatures could in turn raise water temperatures. Additionally, decreases in snowpack from higher air temperatures from January to March are also predicted, resulting in a more modest spring runoff peak. In the Klamath Basin as a whole, increasing air temperatures and decreasing flows in the summer months would be expected to cause general increases in summer and fall water temperatures on the order of 2–3 °C (3.6–5.4 °F) (Bartholow 2005). Despite climate predictions, temperatures in Upper Klamath Lake have exhibited a downward trend from 1990 to 2009 (Jassby and Kann 2010).

As described in the subsection of Section 3.2.4.3.1, based on a programmatic assessment the Williamson River Delta Project and the Agency Lake and Barnes Ranches Project represent a reasonably foreseeable set of actions under the No Action/No Project Alternative that would provide favorable springtime water temperatures for rearing fish in the Upper Klamath Basin. Specific options for both projects still need to be developed and studied as part of a separate project-level National Environmental Policy Act (NEPA) evaluation and ESA consultation.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Under the No Action/No Project Alternative, the effects of ongoing and future upstream water quality improvements under the TMDLs would improve water temperatures below Keno Dam. However, climate change would partially offset anticipated temperature improvements. The river's thermal regime downstream from the reservoirs would continue to be out of phase with the natural temperature regime (Hamilton et al. 2011). Unnatural temperature fluctuations would continue downstream from the J.C. Boyle Bypass Reach, from the mixture of cold-water inflow from Big Springs and the warmer water discharge from the J.C. Boyle Powerhouse (Hamilton et al. 2011). Similar impacts from climate change as described above are also predicted to occur in this reach; therefore, water temperatures are expected to remain similar to existing conditions.

Lower Klamath River: Downstream from Iron Gate Dam The Lower Klamath River downstream from Iron Gate Dam would continue to have elevated water temperatures in the summer and fall in the near term. The reservoirs have the effect of changing the timing and magnitude of the thermal regime by increasing water temperatures in the fall as a result of the increased hydraulic residence time and thermal mass (Bartholow et al. 2005). Bartholow et al. (2005) and PacifiCorp (2004a) showed that the reservoirs delay seasonal thermal signatures by 18 days. Implementation of the TMDLs in these mainstem and tributaries is expected to result in lower water temperatures over time; however, these improvements would be partially offset by the effects of climate change, as described above. In the long term, water temperatures in the mainstem and tributaries are expected to remain similar to existing conditions.

Under the No Action/No Project Alternative, dams would continue to increase late summer and early fall water temperatures in the Klamath River downstream from Iron Gate Dam (subsection of Section 3.2.4.3.1). Under existing conditions in the fall, the dams do not decrease temperatures of water that is transported downstream from Upper Klamath Lake. This is due to the fact that powerhouse withdrawals for Copco 1 and Iron Gate Dams are primarily from the epilimnion (surface waters) (see Appendix C, Section C.1.1.4) which is heated by ambient air under existing reservoir operations. Unlike Shasta Dam or other deep reservoirs that support downstream tailwater fisheries by release of cool water from low level outlets, the location of dam outlets in the Klamath River cannot be adjusted to access large volumes of cool water in the bottom of the reservoirs (hypolimnion).

Under this alternative, the current phase shift and lack of temporal temperature diversity will persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). This phase shift and warm fall temperatures results in delayed adult upstream migration, which is speculated to delay fall spawning (Dunsmore and Huntington 2006). Current cooler temps in spring likely delay emergence, and reduce growth rates of juveniles (Hardy et al. 2006). In addition, juveniles and adults migrating in late summer and fall would continue to experience warm temperatures that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and prespawn mortality (Hetrick et al. 2009).

In addition, the decrease in diel temperature variation compared with historical conditions is deleterious for salmonids. Historically, diel temperature variation would result in regular nighttime cooling of water, offering daily relief with significant bioenergetic benefits that helped fish persist under marginal conditions (NRC 2004). The current lack of diel temperature variation reduces the value of thermal refuge habitat (Dunsmoor and Huntington 2006) and reduces the suitability of rearing habitat in the mainstem Klamath River (NRC 2004).

In addition to direct thermal stress, the potential for continued elevated water temperatures in the late summer/fall (due to potential for climate change to offset anticipated TMDL temperature improvements) could result in indirect stressors on salmonids including an increased intensity and duration of algal blooms, decreased dissolved oxygen levels, and conditions conducive to disease (Bartholomew and Foott 2010). These effects would adversely impact cold-water fish communities and would be deleterious to warm-water fish communities as well.

Klamath River Estuary and Pacific Ocean Nearshore Environment Under the No Action/No Project Alternative, water temperatures in the Klamath River Estuary and Pacific Ocean would remain similar to the existing conditions and climate change would continue to play a role in future temperatures as described above.

Fish Disease and Parasites

The ongoing presence of the dams under the No Action/No Project Alternative would continue to contribute to the static flows, immobile substrate, seasonally warm water temperatures, and planktonic food sources that are favorable for polychaetes and for *C. shasta* and *P. minibicornis* (Hetrick et al. 2009) Salmon carcasses would continue to concentrate downstream from Iron Gate Dam, where the polychaete hosts are abundant, facilitating the cross infection between the fish and the polychaetes. Based on this scenario, mortality associated with *C. shasta* and *P. minibicornis* would be expected to worsen or remain similar to existing conditions. In particular these conditions would continue to adversely affect outmigrants from tributaries downstream from Iron Gate Dam, including those from the Shasta and Scott rivers. If temperatures warm over time with climate change, these infection rates could increase. The No Action/No Project Alternative would result in continued substantial deleterious effects on salmon in terms of fish disease.

Algal Toxins

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the No Action/No Project Alternative, high nutrient inputs supporting the growth of toxin-producing nuisance algal species such as *M. aeruginosa* in Upper Klamath Lake would remain similar to existing conditions for decades into the future. This would result in the potential for continued bioaccumulation of microcystin in suckers in Upper Klamath Lake and could be deleterious to fish health. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species would likely decrease (see Sections 3.2.4.3.1.6 Chlorophyll-a and Algal Toxins – Lower Klamath Basin and 3.4.4.3.1 Alternative 1: No Action/No Project Alternative –Phytoplankton for additional detail regarding TMDLs and algal growth). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in suckers in the lake would be expected.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Continued impoundment of water at the Four Facilities under the No Action/No Project Alternative would support growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* in Copco 1 and Iron Gate Reservoirs, resulting in high seasonal concentrations of algal toxins in the Hydroelectric Reach for decades into the future. This would result in continued bioaccumulation of microcystin in fish tissue for species in the Hydroelectric Reach and could be deleterious to fish health. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species would likely decrease in the Hydroelectric Reach (see subsection of Section 3.2.4.3.1, Chlorophyll-a and Algal Toxins – Upper Klamath Basin, and Section 3.4.4.3.1, Alternative 1: No Action/No Project Alternative –Phytoplankton, for additional detail regarding TMDLs and algal growth in the Hydroelectric Reach). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in fish in the Hydroelectric Reach would be expected.

Lower Klamath River: Downstream from Iron Gate Dam Continued impoundment of water at the Four Facilities under the No Action/No Project Alternative would continue to support growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* in Copco 1 and Iron Gate Reservoirs and subsequent transport of high seasonal concentrations of algal toxins to the Klamath River downstream from Iron Gate Dam. This would also support continued bioaccumulation of microcystin in fish and mussel tissue for species downstream from the dam. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species would decrease in the Hydroelectric Reach (see subsection of Sections 3.2.4.3.1, Chlorophyll-a and Algal Toxins – Lower Klamath Basin, and Section 3.4.4.3.1, Alternative 1: No Action/No Project Alternative – Phytoplankton, for additional detail regarding TMDLs and algal growth in the Klamath River downstream from Iron Gate Dam). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in fish in the Klamath River downstream from Iron Gate Dam would be expected.

Aquatic Habitat

Under the No Action/No Project Alternative, hydrology and aquatic habitat of the Klamath River from its headwaters to the estuary would generally remain the same as under existing conditions, subject to the influence of climate change (discussed under Section 3.10, Greenhouse Gases/Global Climate Change). As described in the subsection of Section 3.3.3.3.7, Under the No Action Alternative, Klamath River flows were simulated following the instream flow requirements established for operation of Reclamation's Klamath Project under the reasonable and prudent alternative (RPA) described with in the 2010 Biological Opinion (NOAA Fisheries Service 2010a).

Activities currently underway to improve aquatic habitat and recover salmonid and sucker populations within the Klamath Basin would continue at their current levels. The ongoing Wood River Wetland Restoration, Agency Lake and Barnes Ranches Project, and the Williamson River Delta Project would likely improve resident fish habitat in the Upper Klamath Basin. Recovery actions to improve aquatic habitat under the Klamath River Coho Salmon Recovery Plan would continue, depending on available funding. These actions are anticipated to improve aquatic habitat conditions over time relative to current conditions. However, anadromous fish would continue to be blocked from access to historical habitat.

Under the No Action/No Project, PacifiCorp would need to obtain a long-term operating license for the Klamath Hydroelectric Project from FERC to continue operating the Project (FERC 2007). Until a new license is issued, operations would continue under the annual license terms, and effects on aquatic habitat would continue as described in Section 3.3.3.3.7.

Aquatic Resources Effects

Critical Habitat

As described below, continued impoundment of water within reservoirs under the No Action/No Project Alternative could alter the water quality and habitat suitability within critical habitat.

Coho Salmon As described above in detail, under the No Action/No Project Alternative, habitat supporting PCEs for coho salmon will continue to be degraded (NOAA Fisheries Service 1999b, NOAA Fisheries Service 2010a). Spawning habitat would continue to be impaired by sediment and instream flows within tributary streams, with little mainstem spawning. Rearing habitat with food resources would continue to be impaired as result of habitat degradation, high water temperature, and disease within tributaries and the mainstem. Water quantity supporting PCEs would continue to be depleted both within tributaries and within the mainstem. The quality of PCEs would likely improve gradually over time, through the actions undertaken under the Klamath River Coho Salmon Recovery Plan. TMDL implementation is anticipated to result in improved water quality to meet PCEs; however, this could take decades to achieve, and water quality initially would be reduced and remain poor similar to that under existing conditions. Also, full attainment of the water temperature TMDLs would be partially offset by climate

change. **The effect of the No Action/No Project Alternative would be no change from existing conditions for coho salmon critical habitat in the short and long term.**

Bull Trout Because bull trout are restricted in distribution to the headwaters of limited number of streams, under the No Action/No Project Alternative, PCEs of critical habitat supporting bull trout are not expected to be affected by implementation of the Oregon TMDL processes. Over the long-term, climate change would be expected to result in warmer temperatures, although the headwater streams supporting bull trout may be affected less than other environments due to influence of groundwater. **The effect of the No Action/No Project Alternative would be no change from existing conditions for bull trout critical habitat in the short and long term.**

Southern Resident Killer Whale The Klamath River may affect PCEs of critical habitat for Southern Resident Killer Whales through its potential contribution of Chinook salmon to the food supply for Southern Resident Killer Whales, the survival and fecundity of which appears dependent upon the abundance of this species (Ward et al. 2009; Ford et al. 2009). Chinook salmon originating from the Fraser River are the dominant prey of resident killer whales in the summer months when they are usually in inland marine waters (Hanson et al. 2010). Less is known of their diet during the remainder of the year (September through May) when they spend much of their time in outer coastal waters, but it is believed likely that they preferentially feed on Chinook salmon when available, and roughly in proportion to their relative abundance (Hanson et al. 2010). The contribution of Klamath-origin salmonids to the diet of Southern Residents is unknown, but during this period they may travel from central California to northern British Columbia (Krahn et al. 2004, as cited in Hanson et al. 2010). No change from existing conditions is expected in the short term.

TMDL implementation in the Basin is expected to improve water quality conditions over time although they could take decades to achieve. Such improvements in water quality might result in increased Chinook salmon production over time. However, full attainment of the water temperature TMDL would be partially offset by climate change. **The effect of the No Action/No Project Alternative would be no change from existing conditions for Southern Resident Killer Whale critical habitat in the short and long term.**

Eulachon

Under the No Action/No Project Alternative, PCEs of critical habitat supporting eulachon are not anticipated to change relative to existing conditions. **The effect of the No Action/No Project Alternative would be no change from existing conditions for Eulachon critical habitat in the short and long term.**

Essential Fish Habitat

Dams and the continued impoundment of water within reservoirs under the No Action/No Project Alternative could alter the availability and suitability of EFH.

Chinook and Coho Salmon EFH Under the No Action/No Project Alternative, EFH for Chinook and coho salmon would be expected to remain similar to its current condition. Access to habitat would be limited to its current levels; water quality would improve through TMDL implementation, but would be partially offset by warming expected as a result of climate change. The amount of suitable habitat in currently accessible tributaries would likely be reduced by climate change. Conditions under the No Action/No Project Alternative would continue to contribute to elevated concentrations of disease parasites and would provide the conditions required for the cross infection of fish and polychaetes (Hetrick et al. 2009; Hamilton et al. 2011). These interacting factors could decrease the viability of Chinook and coho salmon populations in the future (Hetrick et al. 2009; Hamilton et al. 2011). **The effect of the No Action/No Project Alternative would be no change from existing conditions for Chinook and coho salmon EFH in the short and long term.**

Groundfish EFH Under the No Action/No Project Alternative, sediment and habitat conditions in the estuary and nearshore ocean would remain the same as they are under existing conditions. **The effect of the No Action/No Project Alternative would be no change from existing conditions for groundfish EFH in the short and long term.**

Pelagic Fish EFH Under the No Action/No Project Alternative, sediment and habitat conditions in the estuary and nearshore ocean would continue to be the same as they are under existing conditions. **The effect of the No Action/No Project Alternative would be no change from existing conditions for pelagic fish EFH in the short and long term.**

Species-Specific Impacts

As described below, continued impoundment of water within reservoirs under the No Action/No Project Alternative, and the continued blockage of habitat access at project dams, could affect aquatic species.

Species-specific impacts are based upon existing conditions for key ecological attributes summarized above.

Fall-Run Chinook Salmon To help determine if the Proposed Action will advance restoration of the salmonid fisheries of the Klamath Basin, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action compared with existing conditions (Goodman et al. 2011). In response to comments the Panel stated with certainty that under the No Action/No Project Alternative, fall-run Chinook salmon within the Klamath River will continue to decline[3]. However, as described in detail in Section 3.3.3.1.1.1.1, although abundances are low compared to historical numbers (Table 3.3-1), in a recent review of the population status of Chinook salmon, the BRT (Williams et al. 2011) concluded that the current population (which includes hatchery fish) appear to have been fairly stable for the past 30 years and is not currently in decline.

[3] Page 69 of Appendix C of the July 20, 2011 Addendum to Goodman et al. 2011.

As described in Section 3.2, Water Quality, long-term dissolved oxygen levels under the No Action/No Project Alternative would continue to exhibit seasonal variability. These dissolved oxygen levels would not consistently meet Oregon and California Basin Plan water quality objectives for dissolved oxygen, and would not consistently support designated beneficial uses in Oregon for cold-water aquatic life, cool-water aquatic life, warm-water aquatic life, and spawning and in California for cold freshwater habitat, warm freshwater habitat, and spawning habitat beneficial uses. In addition, the thermal regimes downstream from Iron Gate Dam would continue to be altered as a result of project facilities and operations, particularly retention time of water in the reservoirs. As a result, fall-run Chinook salmon spawning downstream from Iron Gate Dam would likely continue to be delayed, and prespawn mortality will continue to occur (Hetrick et al. 2009).

Under the No Action/No Project Alternative, Iron Gate Dam would continue to block fall-run Chinook salmon access to hundreds of miles of historical habitat, which used to extend upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This includes around 76 miles of potential habitat within the Klamath Hydroelectric Project, based on approximately 53 miles of potential anadromous fish (steelhead) habitat in the Project Reach (Administrative Law Judge 2006)[4], taking into consideration the more limited distribution of Chinook salmon relative to steelhead (United States Department of the Interior (DOI) 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). The consequences of this ongoing loss of habitat to the population could include reduced resilience to recover from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills. Under the No Action/No Project Alternative access to cold water habitat would continue to be severely limited. Because areas upstream of the Iron Gate Dam include cold-water refugia, refugia for outmigrating smolts, and opportunities for the population to adapt to changing temperatures are reduced, whether these temperatures are a result of short- or long-term changes. Under the No Action/No Project Alternative, the system of reservoirs and dams in the hydroelectric reach will continue to create conditions conducive to the spread of parasites among the fall-run Chinook salmon population downstream from Iron Gate Dam, especially where adults (and carcasses) tend to congregate in high numbers, just downstream from Iron Gate Dam (Stocking and Bartholomew 2007, Bartholomew and Foott 2010), but also in other locations further downstream. Additional factors related to the project would continue to exacerbate the situation downstream from Iron Gate Dam, including increased water temperatures and dampened flow and thermal variability, reduced dissolved oxygen concentrations, loss of sediment transport through the reach due to capture of sediment by the dams, and reservoirs contributing plankton to the filter-feeding polychaete hosts of the myxozoan parasites (Hamilton et al. 2011). Under the No Action/No Project Alternative, downstream-migrating juvenile Chinook salmon may

[4] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness.

Effects of suspended sediment on fall-run Chinook salmon under the No Action/No Project Alternative and existing conditions are described in Appendix E, Section E.3.1.1. Overall, fall-run Chinook salmon use the mainstem Klamath River for spawning, rearing, and as a migratory corridor. Although SSCs under existing conditions and the No Action/No Project Alternative are relatively high in the mainstem downstream from Orleans, and even more so downstream from the Trinity River (California State Water Resources Control Board [SWRCB] 2006, NCRWQCB 2010) (see Section 3.2.3), they are relatively low in the reach downstream from Iron Gate Dam where most mainstem spawning occurs. Suspended sediment concentrations and durations during upstream and downstream migration, even under extreme conditions, are low enough that they have limited effects on fish, although physiological stress and reduced growth rates are possible. In general, fall-run Chinook salmon appear relatively unaffected by current SSCs because smolt outmigration primarily occurs when SSCs are naturally low.

Under the No Action/No Project Alternative, ongoing hatchery operations would continue to mitigate for habitat lost due to construction of Iron Gate Dam by releasing millions of juvenile and yearling Chinook salmon annually. These fish may compete with the progeny of naturally spawned fish for food and other limited resources, such as thermal refugia. In addition, hatchery releases can increase disease infection rates through crowding and, where mortality occurs, concentrated release of myxospores on top of the area of highest polychaete densities. In addition, some adult fish may stray and spawn with wild fish, which can reduce genetic and phenotypic diversity and reproductive success within the wild population (McLean et al. 2003, Araki et al. 2007, Araki et al. 2009, all as cited in Hamilton et al. 2011).

Under the No Action/No Project Alternative, the interruption of sediment transport processes by the dams would continue, reducing spawning gravel supply to downstream reaches and changing the dynamics of channel morphology and riparian vegetation communities that create and maintain rearing habitats for fry and juvenile fall-run Chinook salmon. Lack of sediment transport is also likely to be contributing to the high densities of polychaetes downstream from Iron Gate Dam that host salmonid parasites, through reduction of scour that would otherwise help limit periphyton growth (FERC 2007; Hetrick et al. 2009).

The effect of the No Action/No Project Alternative would be no change from existing conditions for fall-run Chinook salmon in the short and long term.

Spring-Run Chinook Salmon In a recent review of the population status of Chinook salmon, the BRT (Williams et al. 2011) concluded that the current Chinook population (which includes hatchery fish) appear to have been fairly stable for the past 30 years and is not currently in decline, despite dramatic reductions in comparison to historical

abundance (Table 3.3-1). However, the BRT was concerned about the relatively few populations of spring-run Chinook salmon and the low numbers of spawners within those populations (Williams et al. 2011).

Under the No Action/No Project Alternative, poor water quality conditions caused partly by nutrient enrichment during spring-run Chinook salmon upstream and downstream migration may cause high stress. Water quality in the mainstem Klamath River downstream from Iron Gate Dam is characterized by altered seasonal water temperature patterns, dissolved oxygen, and increased nutrient input, as well occasional blooms of *M. aeruginosa*. Although water quality tends to improve downstream from the Salmon River (current upstream extent of spring-run distribution in the Klamath River), the effect of water quality alterations is that conditions (especially water temperature and dissolved oxygen) are critically stressful for spring-run Chinook salmon for much of the summer if they were present during the period June through September. Maximum temperatures often reach 25 °C during summer, considered lethal for most Pacific salmon (Sullivan et al. 2000). Spring Chinook salmon that are stressed by high temperatures, whether adults or juveniles, likely have lower survival rates, especially when challenged by additional water quality factors, such as low dissolved oxygen, the presence of toxic blue-green algae (*M. aeruginosa*) and fish diseases, and high pH and unionized ammonia. Under the No Action/No Project Alternative, downstream-migrating juvenile Chinook salmon may continue to have high disease infection rates (Bartholomew and Foott 2010) during summer months in some years. Heavy parasite loads may increase disease-related mortality in outmigrant smolts, particularly when water temperatures are high, or may reduce ocean survival by affecting growth or fitness.

High water temperatures during summer may also reduce the growth of juvenile fish that are rearing and migrating downstream to the ocean due to greater metabolic requirements. Because size is correlated with ocean survival, this could lead to reduced smolt survival and subsequently, reduced escapement. Finally, high temperatures can selectively reduce the survival of fish migrating later in the summer (the “summer run”), thus reducing genetic and life-history diversity. High water temperatures likely limit adult holding and summer rearing habitat for spring Chinook salmon in main spawning tributaries, the Salmon and Trinity Rivers, which would likely reduce overall production. Low flows in dry years can cause migration barriers to form, reducing habitat available to spawning and rearing fish.

Under the No Action/No Project Alternative, Iron Gate Dam would continue to block spring-run Chinook salmon access to their historical habitat, which used to extend upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This includes around 76 miles of potential habitat within the Project reach, based on approximately 53 miles of potential anadromous fish (steelhead) habitat in the Project Reach (Administrative Law Judge 2006)[5], taking into consideration the more limited distribution of Chinook salmon relative to steelhead (DOI 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009), and

[5] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

habitat within the bypass reaches. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). In addition, access would continue to be blocked to hundreds of miles of habitat upstream of J.C. Boyle Reservoir (Hamilton et al. 2005). The consequences of this ongoing loss of habitat to the population could include reduced resilience to recover from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills. Because areas upstream of Iron Gate Dam include cold-water refugia, opportunities for the population to adapt to changing climate are reduced, whether these changes are a result of short- or long-term cycles or trends.

Effects of suspended sediment on spring-run Chinook salmon under the No Action/No Project Alternative and existing conditions are described in Appendix E, Section E.3.1.2. Overall, spring-run Chinook salmon mostly use the mainstem Klamath River as a migratory corridor during adult migration, and downstream smolt migration. Although suspended sediment under existing conditions and the No Action/No Project Alternative is relatively high in the mainstem Klamath River downstream from Orleans, and especially downstream from the Trinity River (Appendix E), increases in suspended sediment in the mainstem Klamath River during critical migratory periods are low enough in concentration and short enough in duration that effects are limited to physiological stress and possibly inhibited growth, even during extreme conditions.

One of the main spawning streams for spring-run Chinook salmon, the Salmon River has dramatically increased sediment production over historical conditions as a result of road construction, timber harvest, and wildfire disturbance (Elder et al. 2002). Habitat degradation is believed to be the primary cause of the decline of the spring-run salmon population in the Klamath River system. Under the No Action/No Project Alternative, spawning and rearing habitat would continue to be reduced in both quantity and quality, and production may be low in some years.

As described in the subsection of Section 3.3.3.1.1, the extirpation of at least seven spring-run populations from the Klamath-Trinity River system has been attributed to dams, overfishing, irrigation, and commercial hydraulic mining operations (Coots 1962; Snyder 1931; Myers et al. 1998). Under this alternative, dams would continue to block access to historical habitat, and spring-run Chinook salmon are likely to remain at significantly suppressed levels over the years of analysis (50 years).

The effect of the No Action/No Project Alternative would be no change from existing conditions for spring-run Chinook salmon in the short and long term.

Coho Salmon As described in Section 3.2, Water Quality, long-term dissolved oxygen levels under the No Action/No Project Alternative would continue to exhibit seasonal variability. These dissolved oxygen levels would not consistently meet Oregon and California Basin Plan water quality objectives for dissolved oxygen, and would not consistently support designated beneficial uses in Oregon for cold-water aquatic life, cool-water aquatic life, warm-water aquatic life, and spawning and in California for cold

freshwater habitat, warm freshwater habitat, and spawning habitat beneficial uses. In addition, the thermal regimes downstream from Iron Gate Dam would continue to be altered as a result of project facilities and operations, particularly due to retention time of water in the reservoirs.

Under the No Action/No Project Alternative, Iron Gate Dam would continue to block coho salmon to historical habitat which used to extend upstream at least as far as Spencer Creek (Hamilton et al. 2005), including an estimated 76 miles of potential habitat within the Klamath Hydroelectric Project, based on approximately 53 miles of potential anadromous fish (steelhead) habitat in the Project Reach (Administrative Law Judge 2006),[6] taking into consideration the more limited distribution of coho salmon relative to steelhead (DOI 2007), and including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009), and habitat within the bypass reaches. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). The consequences of this ongoing loss of habitat to the population would include reduced resilience to recover from catastrophic disturbances of natural or anthropogenic origin, such as wildfire or chemical spills (Hamilton et al. 2011). Under the No Action/No Project Alternative access to cold water habitat would continue to be severely limited. Because areas upstream of the Iron Gate Dam include cold-water refugia, refugia for outmigrating smolts, and opportunities for the population to adapt to changing temperatures are reduced, whether these temperatures are a result of short- or long-term changes. The above factors could reduce the natural genetic and life-history diversity found in Klamath Basin subpopulations of coho salmon that make them ideally suited to adapting to changing watershed conditions.

Under the No Action/No Project Alternative, upstream-migrating adult coho salmon will continue to be exposed to high water temperatures and poor water quality in the mainstem Klamath River, which can cause physiological stress, delay migration, reduce coldwater refugia, and increase mortality from disease. Low flows and increased sedimentation in tributaries can create barriers at the mouths of spawning streams, which would reduce spawning habitat area and production under the No Action/No Project Alternative in some years.

Effects of suspended sediment on coho salmon under the No Action/No Project Alternative and existing conditions are described in Appendix E Section E.3.1.3. Overall, under existing conditions and the No Action/No Project Alternative, SSCs in the mainstem are sufficiently high and of long enough duration that major physiological stress and reduced growth of coho salmon are anticipated in most years. Suitable rearing habitat for juvenile coho salmon under the No Action/No Project Alternative would continue to be restricted by high temperatures in some areas. High water temperatures may promote higher incidence of disease or parasitism, which may increase direct and indirect mortality (Stutzer et al. 2006, NOAA Fisheries Service 2010a). During a 2008 PIT-tag study of juvenile coho salmon in the Shasta River, Chesney et al. (2009) found

[6] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

juvenile coho salmon only in areas where temperatures were moderated by cold springs; the remainder of potential rearing habitat was too warm (>20°C). Rearing habitat would continue to be compromised by livestock grazing and the legacy of logging impacts in riparian habitat that simplify channel and floodplain interactions that are conducive to creating habitat for rearing coho salmon in the winter.

Under historical, unregulated conditions, an annual spring pulse flow occurred in the Klamath River and in its tributaries (NRC 2004). Under current conditions a spring pulse still occurs, but is altered by water management. The magnitude of the spring flow is believed to have historically resulted in higher survival of coho salmon juvenile outmigrants and smolts relative to current conditions through several mechanisms, including (1) reduced rates of infection in juvenile salmon by *C. shasta* and *P. minibicornis*, (2) a reduced period of residency spent in the mainstem prior to smolting, and (3) greater habitat availability in the mid-Klamath River (Hardy et al. 2006), especially in the reach between Shasta River and Scott River where survival is particularly poor (Beeman et al. 2008). It is speculated that this low outmigrant survival limits habitat restoration efforts on the Shasta and Scott rivers from realizing their potential to increase population abundance.

High numbers of hatchery fish may affect wild coho salmon in the Klamath Basin under the No Action/No Project Alternative. The vast majority of coho salmon that spawn in the Klamath Basin are believed to be of hatchery origin, although the percentage varies among years (Ackerman et al. 2006).

Coho salmon populations in the Klamath Basin are in decline; less than 70 percent of streams historically used by coho salmon in the Basin still contain small populations (NRC 2004). The No Action/No Project Alternative would likely continue to produce the types of habitat alterations that have helped to cause this decline.

More detail on current conditions for coho salmon can be found in NOAA Fisheries Service's (2010a) *BO on operation of the Klamath Project between 2010 and 2018*.

The effect of the No Action/No Project Alternative would be no change from existing conditions for coho salmon from all populations within the Klamath River watershed in the short and long term.

Steelhead As described in Section 3.2, Water Quality, long-term dissolved oxygen levels under the No Action/No Project Alternative would continue to exhibit seasonal variability. These dissolved oxygen levels would not consistently meet Oregon and California Basin Plan water quality objectives for dissolved oxygen, and would not consistently support designated beneficial uses in Oregon for cold-water aquatic life, cool-water aquatic life, warm-water aquatic life, and spawning and in California for cold freshwater habitat, warm freshwater habitat, and spawning habitat beneficial uses. In addition, the thermal regimes downstream from Iron Gate Dam would continue to be altered as a result of project facilities and operations, particularly by the retention time of water in the reservoirs.

Summer steelhead use the mainstem Klamath River primarily as a migration corridor because most spawning and rearing occurs in the tributaries. Under the No Action/No Project Alternative, summer steelhead spawning and rearing habitat availability and distribution would continue to be restricted during summer and fall to reaches downstream from Seiad Valley by high water temperatures farther upstream. Conditions in the mainstem are generally suitable for adult upstream migration; however, high water temperatures in the late summer and fall may restrict movements and spawning distribution of later-arriving adults. Under a more normative flow regime, temperatures would be cooler in the summer and fall months for adult migrating fish (Bartholow et al. 2005; FERC 2007). Altered flow patterns downstream from Iron Gate Dam may thus be affecting the population by selecting for earlier-arriving fish, potentially reducing life-history diversity in the population. In addition, this represents an ongoing loss of habitat that might otherwise be contributing to smolt production, survival, and escapement. Water temperatures are likely to rise over the next decades as a result of climate change, which could result in further reduction of suitable habitat, with potential consequences for steelhead population abundance.

Fall and winter steelhead are more widely distributed than any other anadromous salmonid downstream from Iron Gate Dam. Under the No Action/No Project Alternative, they would continue to be restricted from 360 miles of historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Huntington 2006), including access to cold-water refugia that could buffer the population to effects from climate change (Hamilton et al. 2005). In addition, there are around 80 miles of potential habitat within the Klamath Hydroelectric Project, based on around 53 miles of anadromous habitat with the Project reach (Administrative Law Judge 2006), including over 22 miles inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009), and habitat within the bypass reaches. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). As with summer steelhead, fall and winter steelhead use the mainstem primarily as a migration corridor to access tributaries for spawning. Increases in fine sediment in tributaries used by steelhead for spawning could be reducing egg-to-emergence survival in some tributaries. Under the No Action/No Project Alternative, high summer water temperatures in the summer months can cause density-independent mortality on juveniles that have left spawning tributaries to rear in the mainstem.

Effects of suspended sediment on steelhead under the No Action/No Project Alternative and existing conditions are described in Appendix E, Section E.3.1.4. Overall, steelhead use the mainstem Klamath River as a migratory corridor during adult migration, and downstream smolt migration, and for juvenile rearing. Although SSCs under existing conditions and the No Action/No Project Alternative are relatively high in the mainstem Klamath River downstream from Orleans, and especially downstream from the Trinity River (SWRCB 2006, NCRWQCB 2010) (see Section 3.2.3), SSC in the mainstem Klamath River during critical migratory periods, even during extreme conditions, are low enough and exposure times short enough that effects are likely limited to physiological stress and possibly reduced growth rate. Conditions for fish rearing in the mainstem are

likely worse, but in general steelhead appear resilient to suspended sediment regimes under existing conditions and the No Action/No Project Alternative.

Habitat conditions for juvenile steelhead rearing in the mainstem are generally suitable, except for reaches upstream of Seiad Valley where summer water temperatures are considered stressful. Juvenile outmigration peaks in the spring and extends through the summer and fall. Growth during their rearing and outmigration may be reduced by high temperatures due to increased metabolism, which can reduce ocean survival. High summer water temperatures causing physiological stress to fish can also make them more vulnerable to mortality from disease or other compounding factors.

The effect of the No Action/No Project Alternative would be no change from existing conditions for steelhead in the short and long term.

Pacific Lamprey Pacific lamprey populations appear to have been in decline since the late 1980s in the Klamath Basin; (Larson and Belchik 1998; Moyle et al. 2009; all as cited in Hamilton et al. 2011), and are considered "vulnerable" throughout their range by the American Fisheries Society (Jelks et al. 2008, as cited in Hamilton et al. 2011). Major factors believed to be affecting their populations include barriers to upstream migration at dams; dewatering of larval habitat through flow regulation; reducing larval habitat by increasing water velocity and/or reducing sediment deposition areas; and susceptibility to contaminants in the larval stage (Close et al. 2002, as cited in Hamilton et al. 2011).

Under the No Action/No Project Alternative, Iron Gate Dam would continue to form a barrier to Pacific lamprey migration, which represents an ongoing loss of available habitat and productive capacity. Although the exact upstream extent of suitable habitat for Pacific lamprey prior to the completion of the Four Facilities is unknown, it is believed that Pacific lamprey would have migrated at least as far as Spencer Creek (Hamilton et al. 2005, as cited in Hamilton et al. 2011). The loss of this portion of spawning and larval rearing habitat reduces the Basin's population viability through contracting their distribution within the watershed and reducing abundance.

Under the No Action/No Project Alternative, the dams would continue to reduce sediment supply to the mainstem Klamath River downstream from Iron Gate Dam, which may limit availability of gravel-cobble substrates for nest building and fine sediment for burrowing; armoring of substrate would also be expected to reduce spawning habitat quality. The overall effect on the Basin population is likely to be small because (1) the effects of the dam on fine sediment and gravel/cobble substrates diminish with distance downstream because of input from tributaries and become less significant downstream from Cottonwood Creek (RM 182.1), and (2) a large proportion of the population may spawn and rear in large tributaries to the mainstem, such as the Trinity, Salmon, Shasta, and Scott Rivers.

Effects of suspended sediment on Pacific lamprey under the No Action/No Project Alternative and existing conditions are described in Appendix E, Section E.3.1.5. Overall, under both normal and extreme conditions, Pacific lamprey are anticipated to

suffer from stressful levels of suspended sediment while rearing and migrating through the mainstem Klamath River, with exposure durations generally much longer under extreme conditions. Because there are multiple year-classes of lamprey in the mainstem Klamath River at any given time, and since adults may migrate upstream throughout the year, Pacific lamprey populations may be well-adapted to persisting through years when SSCs are high, especially since they remain within the sublethal range.

The effects of dams and reservoirs would continue to affect water quality downstream from Iron Gate Dam under the No Action/No Project Alternative, which may reduce habitat quality for spawning and rearing Pacific lamprey, as well as reproductive success. Stone et al. (2002) found dissolved oxygen to be positively associated with lamprey presence at the reach scale ($P = 0.0002$). Meeuwig et al. (2005) reported that survival of larval Pacific lamprey under laboratory conditions was optimal at 18°C, but declined sharply at 22°C, with eggs and larvae at these higher temperatures also exhibiting deformities. Under existing conditions and the No Action/No Project Alternative water quality would improve through TMDL implementation, but would be partially offset by warming expected as a result of climate change.

Flow management under a No Active/No Project Alternative would continue to modify temperature and instream flow patterns from pre-project conditions. Movements of adult, ammocoete, and macropthalmia Pacific lamprey life stages tend to occur in association with discharge, while temperature and day length may be of less importance as life-history cues (Stone et al. 2002, Luzier et al. 2009). Stone et al. (2002) observed downstream migration of macropthalmia (juvenile phase) in Cedar Creek in association with summer low flows, with larger ammocoetes also moving downstream during this period as well, indicating that such movements were voluntary. In contrast, Beamish and Levings (1991, as cited in Stone et al. 2002) found that macropthalmia downstream movements to be associated with high flows, but also observed greater downstream movement of larger, older ammocoetes during these periods.

High discharge appeared to result in involuntary downstream displacement of ammocoetes (especially of smaller individuals) and macropthalmia outside of their normal migration period, which may reduce survival (Stone et al. 2002).

Under the No Action/No Project Alternative, Pacific lamprey populations in the Klamath Basin may remain at current levels or population numbers may continue to decline over the long term (Close et al. 2010). Because so little is known of Pacific lamprey life history and habitat requirements compared to those of anadromous salmonids, it is more difficult to predict the potential effects of alternatives on their abundance and distribution. **The effect of the No Action/No Project Alternative would be no change from existing conditions for Pacific lamprey in the short and long term.**

Green Sturgeon Green sturgeon spend a majority of their lives in estuaries, bays, and nearshore waters, with adults only returning to fresh water to spawn after more than

15 years, and spawning every 4 years on average (Klimley et al. 2007). In the Klamath River mainstem, green sturgeon spawn and rear in the lower 67 miles, downstream from Ishi Pishi Falls.

The Klamath Basin supports the largest spawning population of Northern Green Sturgeon (Moyle 2002), so it plays a critically important role in the viability and persistence of the entire DPS. Concentration of spawning to only a very few areas renders these spawning populations vulnerable to local catastrophic impacts. A loss of any of the few spawning areas would have much greater effects than the loss of a spawning population of salmon that spawn in other streams throughout their range.

Under the No Action/No Project Alternative, temperatures in the Lower Klamath River in dry years may be reducing reproductive success of green sturgeon (Van Eenennaam et al. 2005). Studies conducted by Van Eenennaam et al. suggest that temperatures above 17–18 °C are suboptimal for hatching and embryonic development, with temperatures from 23 °C to 26 °C resulting in 100 percent pre-hatching mortality. Cech et al. (2000) put the lethal temperature for embryos at 20 °C.

Effects of suspended sediment on green sturgeon under the No Action/No Project Alternative and existing conditions are described in Appendix E. Overall, under existing conditions and the No Action/No Project Alternative, green sturgeon in the Klamath River mainstem are regularly exposed to SSCs documented to cause major physiological stress, reduced growth, and mortality in other fish species, especially during their egg and larval stages, and the year-round juvenile rearing period. However, based on the persistence of their population under these conditions, these metrics likely overestimate effects on green sturgeon.

The effect of the No Action/No Project Alternative would be no change from existing conditions for green sturgeon in the short and long term.

Lost River and Shortnose Sucker

Upper Klamath Lake, one of the primary habitats of Lost River and shortnose suckers, has long been recognized as eutrophic, characterized by extremely high temperatures and pH in the summer, accompanied by huge daily fluctuations in dissolved oxygen and high ammonia concentrations. Recent land use disturbances and changes in hydrology have led to hypereutrophic conditions in Upper Klamath Lake that frequently violate water quality standards and place designated beneficial uses in the lake and in the receiving waters of the Klamath River at risk (Section 3.2.3.4). Although eutrophic conditions in Upper Klamath Lake have caused fish die-offs since the late 1800s, these have become more frequent and severe in recent years with the hypereutrophic conditions, with chubs and suckers being perhaps the hardest hit species (Perkins et al. 2000, Buchanan et al. 2011a, as cited in Hamilton et al. 2011). Upper Klamath Lake inflows and outflows have declined since the 1960s while demand for water has increased for both agriculture and endangered fish species recovery. Along with direct mortality, poor water quality in

Upper Klamath Lake affects endangered sucker species through suppressing growth, reducing resistance to disease and parasites, and reducing reproductive success (Hamilton et al. 2011).

Under current conditions, suckers in reaches of the Four Facilities suffer mortality by entrainment in hydroelectric project turbines (Gutermuth et al. 2000). (Partially effective fish screens at J.C. Boyle facility would continue to contribute to entrainment (Administrative Law Judge 2006)). Suckers would continue to be stranded due to Four Facilities operations and peaking.

Shortnose and Lost River suckers would continue to be subject to poor water quality within reservoirs. However, with little or no successful reproduction (Buettner et al. 2006), populations downstream from Keno Dam contribute minimally to conservation goals and insignificantly to recovery (Hamilton et al. 2011). Under the No Action/No Project Alternative this population would persist, providing some additional insurance, no matter how small, that fish would be available for recolonization efforts if for some reason their primary populations underwent catastrophic decline. This would only be feasible with a species of this type, which is extremely long-lived.

Under the No Action/No Project Alternative, existing efforts to restore habitat for shortnose and Lost River sucker and improve water quality conditions would continue. These actions would be expected to improve conditions for these species over time and their populations would be expected to increase. **The effect of the No Action/No Project Alternative would be no change from existing conditions for Lost River and shortnose sucker populations in the short and long term.**

Redband Trout Resident trout upstream of Iron Gate Dam are considered to be redband trout. Before construction of the Four Facilities, redband trout in the area belonged to one population, with no migration barriers isolating populations from one another (Administrative Law Judge 2006). Under the No Action/No Project Alternative, genetic exchange and movement between reaches would continue to be limited by the J.C. Boyle fish ladder (Administrative Law Judge 2006) and lack of fish ladders at the Copco 1 and 2 Dams, as will access to productive spawning habitat in Spencer Creek by redband trout in the J.C. Boyle Bypass and Peaking Reaches (Administrative Law Judge 2006). The isolation of this population into several smaller subpopulations renders each more vulnerable to extinction due to stochastic events (wildfire, landslides, disease outbreaks, etc.) and limits genetic exchange among subpopulations.

Redband trout populations in the Four Facilities reaches and reservoirs are generally isolated from the larger populations upstream of Upper Klamath Lake, such as in the Williamson and Wood Rivers; little to no natural recruitment from the Upper Klamath Basin to populations in project-affected reaches can occur, as may have occurred historically.

Under the No Action/No Project Alternative, water quality in the Keno Reach would continue to be influenced by Keno Impoundment/Lake Ewauna upstream. In the

summer, problems with low dissolved oxygen, high nutrients, and warm temperatures (occasionally exceeding 21°C) may increase physiological stress on redband trout, making them more vulnerable to mortality from other stressors. Measures implemented to meet TMDL targets would likely improve water quality in this area to some degree.

Under the No Action/No Project Alternative, habitat connectivity for redband trout in the Klamath River would continue to be compromised by structural features of the Four Facilities as well as project operations. Fish downstream from J.C. Boyle Dam would continue to be hindered or obstructed from migrating to spawning grounds in Spencer Creek by requiring them to ascend a fish ladder at J.C. Boyle Dam (Hamilton et al. 2011). Spencer Creek is a highly productive spawning and rearing habitat for rainbow/redband trout. The stock of rainbow/redband trout in the bypass and peaking reaches below J.C. Boyle Dam is currently restricted from Spencer Creek and other suitable habitat upstream of the J.C. Boyle Dam (Administrative Law Judge 2006). Factors influencing their movements include the necessity of passage at the J.C. Boyle Dam fish ladder as well as stresses resulting from power peaking operations downstream from the dam. Migration over the Copco 1 and 2 Dams is in the downstream direction only, as there is no fishway at this Project feature.

The lack of functioning fish screens at Iron Gate, Copco 1 and 2 Dams minimizes recruitment of redband trout to downstream reaches, another factor adding to isolation of subpopulations in the Four Facilities area. At the J.C. Boyle facility, the partially effective fish screens would continue to contribute to entrainment (Administrative Law Judge 2006). The J.C. Boyle facility uses Francis turbines, at an operational head of 440 feet. A 1987 report prepared by the Electric Power Research Institute (EPRI) concluded that fish mortality from entrainment at hydroelectric projects using Francis turbines averaged 24 percent. The EPRI report found that entrainment mortality at hydroelectric projects using Francis turbines with operational head greater than 335 feet ranged from 33-48 percent (Administrative Law Judge 2006). It is estimated that “several tens of thousands of resident fish” are annually entrained at “each of the Projects” facilities (Administrative Law Judge 2006).

The health and productivity of redband trout in the J.C. Boyle Peaking Reach and J.C. Boyle Bypass Reach would continue to be affected under the No Action/No Project Alternative. Obstruction of sediment transport at J.C. Boyle Dam has altered substrates and channel features in the peaking and bypass reaches. High flows have mobilized and removed sediment from storage sites and transported them downstream, reducing habitat quality for redband trout as well as for the macroinvertebrates they feed on. In the J.C. Boyle Peaking Reach, redband trout numbers would continue to be subject to large fluctuations in flows that: (1) cause fluctuations in water temperature and pH, (2) strand fish, (3) displace fish downstream, (4) reduce fry habitat along channel margins, (5) reduce access to suitable gravels where they are affected by flow fluctuations, and (6) reduce macroinvertebrate food production by reducing the area of the channel suitable for their survival (City of Klamath Falls 1986, Addley et al. 2005, as cited in Hamilton et al. 2011). All of these conditions could result in substantial declines in redband trout abundance in this reach.

Diversion of water at Keno Diversion Dam would continue to alter flows downstream, reducing base flows in the summer when water quality is a concern, and reducing the magnitude and frequency of high flows important for creating and maintaining physical and ecological processes that affect habitat for trout, their macroinvertebrate food, and other aquatic organisms. Reduced flows in the 1.4 mile long Copco 2 Bypass Reach would continue to prevent redband trout from using what would otherwise be complex habitat suitable for spawning and rearing. Productivity of redband trout in the bypass and peaking reaches would continue to be suppressed by Four Facilities effects that limit spawning and rearing habitat in these reaches (Hamilton et al. 2011). Under existing conditions, spawning of redband trout in the Bypass Reach appears limited to an area just downstream from the emergency canal spillway (Hamilton et al. 2011). Patches of gravel that might otherwise be suitable for spawning are rendered inaccessible to redband trout by reductions in instream flows (ODFW 2003, Administrative Law Judge 2006, all as cited in Hamilton et al. 2011).

Reduced redband trout abundance and distribution upstream of Iron Gate Dam attributable to Four Facilities features and operations would continue under the No Action/No Project Alternative. Habitat connectivity and suitability are substantially reduced in some reaches, which also suppresses the full range of life-history options formerly available to them. Other features of the redband trout populations in these reaches would likely be sustained under the No Action/No Project Alternative, such as declines in size (Jacobs et al. 2008, as cited in Hamilton et al. 2011) and condition factor (ODFW 2003, as cited in Hamilton et al. 2011).

The effect of the No Action/No Project Alternative would be no change from existing conditions for redband trout in the short and long term.

Bull Trout The distribution and numbers of bull trout are believed to have declined in the Klamath Basin due to habitat isolation, loss of migratory corridors, poor water quality, and the introduction of nonnative species. The geographic isolation of the Klamath populations places them at greater risk of genetic effects and extirpation (NRC 2004).

The effect of the No Action/No Project Alternative would be no change from existing conditions for bull trout in the short and long term.

Eulachon The southern population of Pacific eulachon consists of populations spawning in rivers south of the Nass River in British Columbia, Canada, to and including the Mad River in California (NOAA Fisheries Service 2009a). On March 18, 2010, NOAA Fisheries Service listed the southern DPS of eulachon as threatened under the ESA (NOAA Fisheries Service 2010b). Historically, the Klamath River was described as the southern limit of the range of eulachon (Gustafson et al. 2010). Moyle (2002) indicates that eulachon have been scarce in the Klamath River since the 1970s, with the exception of three years: they were plentiful in 1988 and moderately abundant again in 1989 and 1998. After 1998, they were thought to be extinct in the Klamath Basin, until a small run was observed in the estuary in 2004. Under the No Action/No Project Alternative,

habitat conditions in the estuary for eulachon would remain the same as they are under existing conditions. However, very little is known about the factors leading to decline of the eulachon.

The effect of the No Action/No Project Alternative would be no change from existing conditions for eulachon in the short and long term.

Longfin Smelt Longfin smelt are a State-listed threatened species throughout their range in California, but the USFWS denied the petition for Federal listing because the population in California (and specifically San Francisco Bay) was not believed to be sufficiently genetically isolated from other populations (USFWS 2009). The importance of ocean rearing is unknown. Little is known about longfin smelt populations in the Klamath River, except that they are presumably small.

The effect of the No Action/No Project Alternative would be no change from existing conditions for longfin smelt in the short and long term.

Introduced Resident Species Introduced resident species occur in Lake Ewauna, Upper Klamath Lake, within reservoirs upstream of Iron Gate Dam, and infrequently downstream from Iron Gate Dam. Under the No Action/No Project Alternative, conditions favorable for introduced species would continue to occur within the Four Facilities reservoirs (Buchanan et al. 2011a). Because these species were introduced and they occur in other nearby water bodies, their abundance is not considered a benefit from a biological perspective.

The effect of the No Action/No Project Alternative would be no change from existing conditions for introduced resident species in the short and long term.

Freshwater mussels The Klamath River appears unusual compared to other Pacific Northwest rivers in that western ridged mussels (*G. angulata*) dominate the freshwater mussel community; of the species found on the mainstem Klamath River, the western ridged mussel seems to be the most abundant and is widely distributed between Iron Gate Dam and the confluence of the Trinity River; (Westover 2010). The floater species (*Anodonta spp*.) are less abundant, with the largest single bed found immediately downstream from Iron Gate Dam (Westover 2010). The western pearlshell (*Margaritifera falcata*) is the least abundant freshwater mussel found in the Klamath River and seems to be mostly found downstream from the confluence of the Salmon River (Westover 2010).

The effect of the No Action/No Project Alternative would be no change from existing conditions for freshwater mussels in the short and long term.

Benthic Macroinvertebrates Under existing conditions, Klamath Hydroelectric Project peaking operations kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for resident trout (Administrative Law Judge 2006). Current peaking operations reduce the production of sessile organisms, like

macroinvertebrates, by 10 to 25 percent (Administrative Law Judge (2006). Macroinvertebrate drift rates, a measure of food availability for trout, in the non-peaking Keno Reach were five to six times greater than in the peaking reach. Fluctuations in the peaking reach are considered to be a contributing factor to the lower macroinvertebrate drift rates (Administrative Law Judge (2006).

The effect of the No Action/No Project Alternative would be no change from existing conditions on macroinvertebrates in the short and long term.

Interim Measures

Implementation of J.C. Boyle Gravel Placement and/or Habitat Enhancement and the Coho Enhancement Fund could result in alterations to habitat availability and habitat quality, and affect aquatic species. Under the-J.C. Boyle Gravel Placement and/or Habitat Enhancement suitable spawning gravel would be placed in the J.C. Boyle Bypass and Peaking Reaches beginning in the fall of 2011 for one year (it is assumed that work would cease in the event of a Negative Determination). This IM would involve placing gravel using a passive approach before high flow periods, or developing other habitat enhancement measures to provide equivalent fishery benefits in the Klamath River upstream of Copco Reservoir. These actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal.

The Coho Enhancement Fund would provide funding for specific projects or actions that would create, maintain, and improve access by coho salmon to important tributary habitats downstream from Iron Gate Dam that are within the potential range of the Upper Klamath coho salmon population. The projects would involve removal of existing fish passage barriers, gravel augmentation, improving/maintaining habitat cover and complexity at coldwater refugia sites, increasing the duration and/or extent of coldwater refugia sites, enhancing habitat in rearing tributaries, restoring connectivity of juvenile rearing habitat in tributaries of the Upper Klamath, Scott, and Shasta Rivers, funding a program to provide flow augmentation in key reaches used for coho spawning and juvenile rearing in the Upper Klamath, Scott, and Shasta Rivers, enhancing habitat in rearing tributaries of the Upper Klamath, Scott, and Shasta Rivers, and protecting summer rearing habitat in tributaries of the Upper Klamath, Scott, and Shasta Rivers (PacifiCorp 2011). **Based on anticipated improvements in habitat availability and habitat quality, implementation of J.C. Boyle Gravel Placement and/or Habitat Enhancement and the Coho Enhancement Fund under the No Action/No Project Alternative would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and benthic macroinvertebrates. These actions would also be beneficial for coho salmon from the Upper Klamath River Population Unit, and less-than-significant for all other population units in the Basin. Effects on bull trout, freshwater mussels, shortnose and Lost River suckers would be less-than-significant. Effects on green sturgeon, eulachon, and Southern Resident Killer Whales would not change from existing conditions.**

Implementation of J.C. Boyle Bypass Barrier Removal could result in alterations to habitat availability, and affect aquatic species. Under this IM, the sidecast rock barrier located approximately three miles upstream of the J.C. Boyle Powerhouse in the J.C. Boyle Bypass Reach would be removed. The objective of this IM is to provide for the safe, timely, and effective upstream passage of Chinook and coho salmon, steelhead, Pacific lamprey, and redband trout. This action would provide improvements in habitat availability for resident fish prior to dam removal, and for resident and anadromous species following dam removal. **Based on anticipated improvements in habitat availability, implementation of J.C. Boyle Bypass Barrier Removal under the No Action/No Project Alternative would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, and redband trout. These actions would also be beneficial for coho salmon from the Upper Klamath River Population Unit, and less-than-significant for all other population units in the Basin. Effects on bull trout, shortnose and Lost River suckers would be less-than-significant. Effects on macroinvertebrates, freshwater mussels, green sturgeon, eulachon, and Southern Resident Killer Whales would not change from existing conditions.**

3.3.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

As described in detail in Section 2.4.3, this alternative includes the removal of the Four Facilities along with the ancillary facilities of each installation in a 20-month period which includes an 8-month period of site preparation and partial drawdown at Copco 1 and a 12-month period for full drawdown and removal of facilities. This includes the entire dam, the powerhouses, spillways, and other infrastructures associated with the power generating facilities, as well as the transfer of the Keno Dam facilities to the Department of the Interior (DOI), and the implementation of the KBRA. Under the Proposed Action, hatchery production would continue for eight years following the removal of Iron Gate Dam. The Proposed Action would result in effects on key ecological attributes that could affect aquatic resources, as summarized below. More detailed technical descriptions of the effects on suspended sediment, bedload sediment, and potential impacts on aquatic species, can be found in Appendices F and G.

Key Ecological Attributes

Suspended Sediment

Suspended sediment effects under Proposed Action are described in detail in Appendix E, and summarized here.

Lower Klamath River: Downstream from Iron Gate Dam Under the Proposed Action, full facility removal would result in the release of 5.3 to 8.6 million yd^3 (1.2 to 2.3 million tons) of sediment stored in the reservoirs into the Klamath River downstream from Iron Gate Dam (Reclamation 2012), resulting in higher SSCs than would normally occur under existing conditions (Figure 3.3-9). Reservoir drawdown (lowering of reservoir water surface elevation) is expected to commence in November 2019 for Copco Reservoir and in December 2019 for J.C. Boyle and Iron Gate Reservoirs. Based on the suspended sediment modeling conducted to analyze each alternative (including facility

removal) (Reclamation 2012), SSCs are expected to exceed 1,000 mg/L for weeks, with the potential for peak concentrations exceeding 5,000 mg/L for hours or days, depending on hydrologic conditions during facility removal. SSC would be highest during the period of greatest reservoir drawdown (January through mid-March 2020), as erodible material behind the dams is mobilized downstream (Reclamation 2012). During normal to dry water years, SSC concentrations would begin to decline in late March 2020 and would continue declining through early summer 2020 (Reclamation 2012). If it is a wet year, it may take longer to drain the reservoirs and the high concentrations may extend until June. The SSCs will be near background conditions for all water year types within the first year following removal. At Iron Gate Dam (Figure 3.3-9), where SSCs are artificially low under current conditions (because of sediment trapping by the dam) SSCs would remain elevated above existing conditions throughout the first 2 years. At Orleans (Figure 3.3-10), where SSCs under existing conditions is higher because of inputs of many tributaries, under a most-likely-to-occur scenario the effects of the Proposed Action would be similar to existing conditions by late April when SSCs from the Proposed Action are predicted to decrease. Under a worst case scenario SSCs are projected to remain somewhat elevated above existing conditions until October.

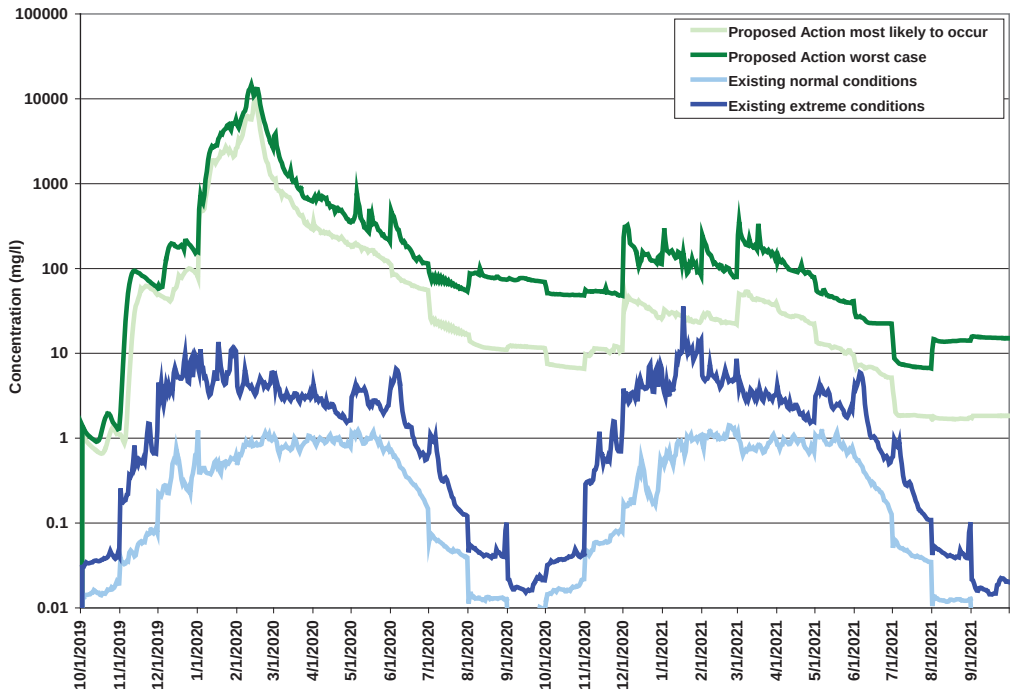

Figure 3.3-9. Comparison of SSCs under Proposed Action and Existing Conditions at Iron Gate Dam, as Predicted Using SRH-1D Model.

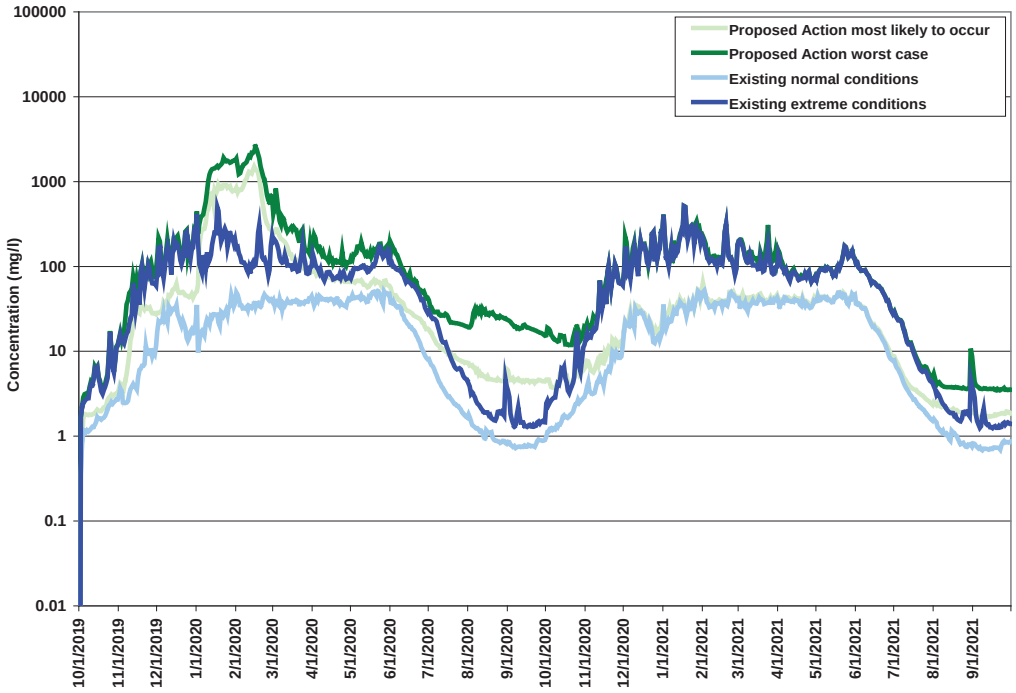

Figure 3.3-10. Comparison of SSCs under Proposed Action and Existing Conditions at Orleans, as Predicted Using SRH-1D Model.

Klamath River Estuary and Pacific Ocean Under the Proposed Action, sediment would be released from Iron Gate Dam, and would decline in concentration in the downstream direction as a result of dilution by input from downstream tributaries. Also, SSCs under existing conditions at Klamath Station are higher than at the upstream sites as a result of sediment input from tributaries. As a result, the difference of SSCs from the Proposed Action relative to existing conditions would be smallest in the Klamath River Estuary (Figure 3.3-11). The SSCs under the most-likely-to-occur scenario would be similar to those that occur under existing extreme conditions, and so resemble those that would be expected to occur about 1 year in 10 on average. Under the worst-case simulation, SSCs concentrations are only marginally higher than those for the existing extreme conditions. Therefore, effects on aquatic species from SSCs within the estuary are not anticipated to be distinguishable from existing conditions.

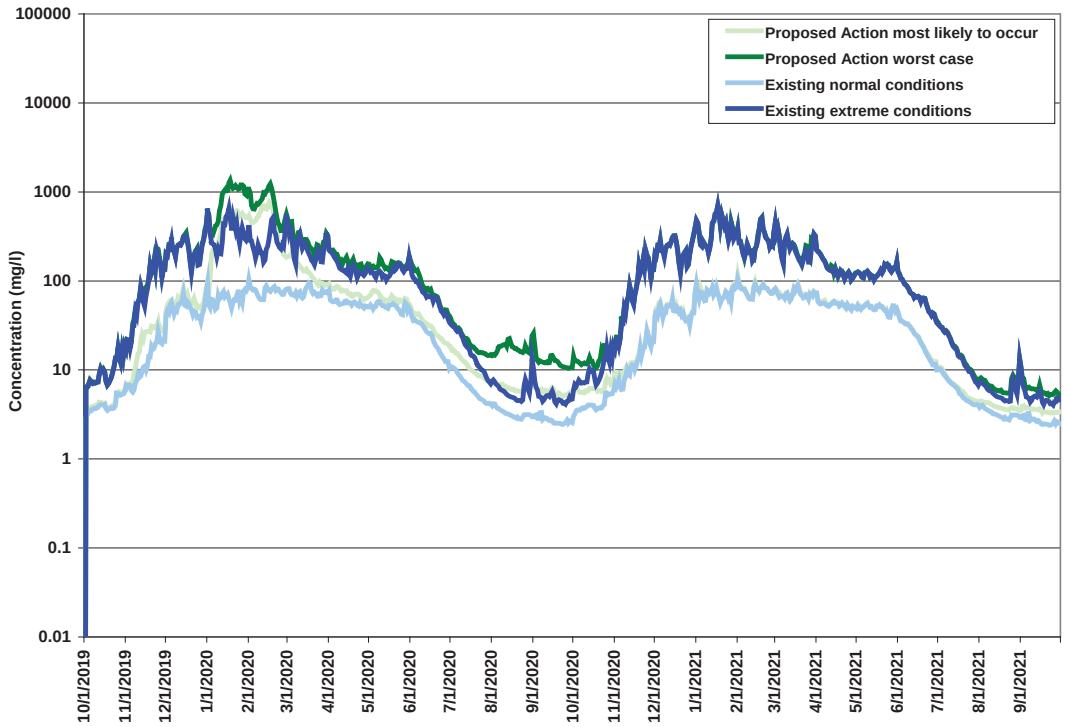

Figure 3.3-11. Comparison of SSCs under Proposed Action and Existing Conditions at Klamath Station, as Predicted Using SRH-1D Model.

Pacific Ocean Nearshore Environment In contrast to the Lower Klamath River, modeled short-term SSCs following dam removal are not available for the nearshore marine environment adjacent to the Klamath River. Substantial dilution of the high (>1,000 mg/L) mainstem river SSCs is expected to occur in the nearshore under the Proposed Action; based on data from 110 coastal watersheds in California, where nearshore SSCs were measured at >100 mg/L during the El Nino winter of 1998 (Mertes and Warrick 2001), peak SSCs leaving the Klamath River Estuary may be diluted by 1 to 2 orders of magnitude from >1,000 mg/L to >10-100 mg/L. Based on the modeled SSCs at Klamath Station presented above, the SSCs in the nearshore ocean would be expected to be similar to what would occur during existing extreme conditions. As described in detail in the subsection of Section 3.2.4.3.2, during several large flood events on the geographically proximal Eel River in the winter of 1997 and 1998, Geyer et al. (2000) found the following: flood conditions were usually accompanied by strong winds from the southern quadrant. The structure of the river plume was strongly influenced by the wind-forcing conditions. During periods of strong southerly (i.e., downwelling favorable) winds, the plume was confined inside the 50-m isobath (i.e., sea floor contour at 50-m below the water surface), within about 7 km of shore. Based upon Eel River plume studies and current knowledge of northern California oceanographic patterns, the fine

sediment discharged to the marine nearshore environment under the Proposed Action would likely be delivered to the ocean in a buoyant river plume that hugs the shoreline as it is transported northward. However, since the flushing of sediments from behind the dams will occur over a number of weeks to months (and perhaps to some degree over 1-2 years), the plume carrying reservoir sediments would likely be influenced by a range of meteorological and ocean conditions (e.g., storm and non-storm periods, differing storm directions). Therefore, some of the time the plume would likely be constrained to shallower nearshore waters, while at other times it would likely extend further offshore and spread more widely. While elevated SSCs (i.e., 10–100 mg/L) created in the nearshore plume would affect physical water quality characteristics specified in the Ocean Plan (i.e., visible floating particulates, natural light attenuation, the deposition rate of inert solids [Table 3.2-7]), the effects are likely to be within the range caused by historical storm events.

River plumes and the associated habitat conditions they create are considered to be areas of high productivity for marine organisms (Grimes and Funucane 1991, Morgan et al. 2005), and create abrupt changes in marine water quality conditions (e.g., water temperature, salinity, sediment) that support salmonids (Schabetsberger et al. 2003, DeRobertis et al. 2005). Due to the relatively small magnitude of SSCs released to the nearshore environment, the anticipated rapid dilution of the sediment plume as it expands in the ocean, and the relatively low rate of deposition of sediments to the marine nearshore bottom substrates, any SSCs elevations associated with the Proposed Action are not anticipated to have effects on species distinguishable from existing conditions.

Bedload Sediment

Bedload sediment effects under Proposed Action are described in detail in Appendix F, and summarized here. As a result of the Proposed Action, the bedload transport processes currently interrupted by the Project that salmon evolved with and depend upon to provide substrate suitable for spawning and early rearing in streams and rivers would be restored.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Dams in the Hydroelectric Reach currently store 13,150,000 yd^3 of sediment (Reclamation 2012). No sediment is stored within the Copco 2 Reservoir, Copco 1 Reservoir stores the greatest amount, and J.C. Boyle Reservoir stores the least. Sediment would continue to accrue from existing conditions through 2020, when the dams would be removed. The SRH-1D model estimated 36 to 57 percent (5.3 to 8.6 million yd^3) of dam-stored sediment would be eroded the first year after dam removal depending on simulation type (wet, median, or dry) (Figure 3.3-12). Of this sediment, about 15 percent would be transported as bedload. Sediment not eroded from the reservoirs during the first year would be stored in gravel bars and terraces. Some of this material would then be released more slowly through surficial and fluvial processes, but a large portion of the sediment left on the terraces is expected to remain indefinitely (Stillwater Sciences 2008).

SRH-1D model results indicate decreases in bed elevation and increases in median substrate size within the reservoirs during drawdown (January 2020 to May 2020)

(Figure 3.3-13). Within the reservoirs, SRH-1D modeling data for the first two years after dam removal show decreases in fine sediment and increases in median substrate size after completion of drawdown that stabilize as the bed returns to pre-dam elevation. The proportion of fine sediment decreases from 50 to 80 percent to near zero within 2 months after drawdown; the proportion of sand initially increases to 30 to 50 percent then decreases to 10 to 25 percent; the proportion of gravel changes (mostly increases) to 20 to 35 percent; and the proportion of cobble increases to 50 to 70 percent, depending on the reservoir and simulation water year type (i.e., wet, median, or dry). These changes would stabilize within six months as the bed within the historical river channel reaches pre-dam elevations (Reclamation 2012). These river sections are expected to revert to and maintain a pool-riffle morphology due to restoration of riverine processes along the Hydroelectric Reach (PacifiCorp 2004a). Still, after dam removal, channels currently inundated by reservoirs would likely vary from narrow, single-threaded channels to wide and sinuous channels with the potential to form complex features, such as meander cut-offs and vegetated islands (Reclamation 2012).

The river reaches upstream of J.C. Boyle Reservoir and from Copco 1 Reservoir to J.C. Boyle Dam show little change in bed composition or median substrate size during drawdown (Figure 3.3-13) (Reclamation 2012). Currently, these reaches are predominantly cobble (90 percent) with small fractions of gravel and sand. Very little temporal change in substrate size would be expected to occur in response to dam removal (Appendix F).

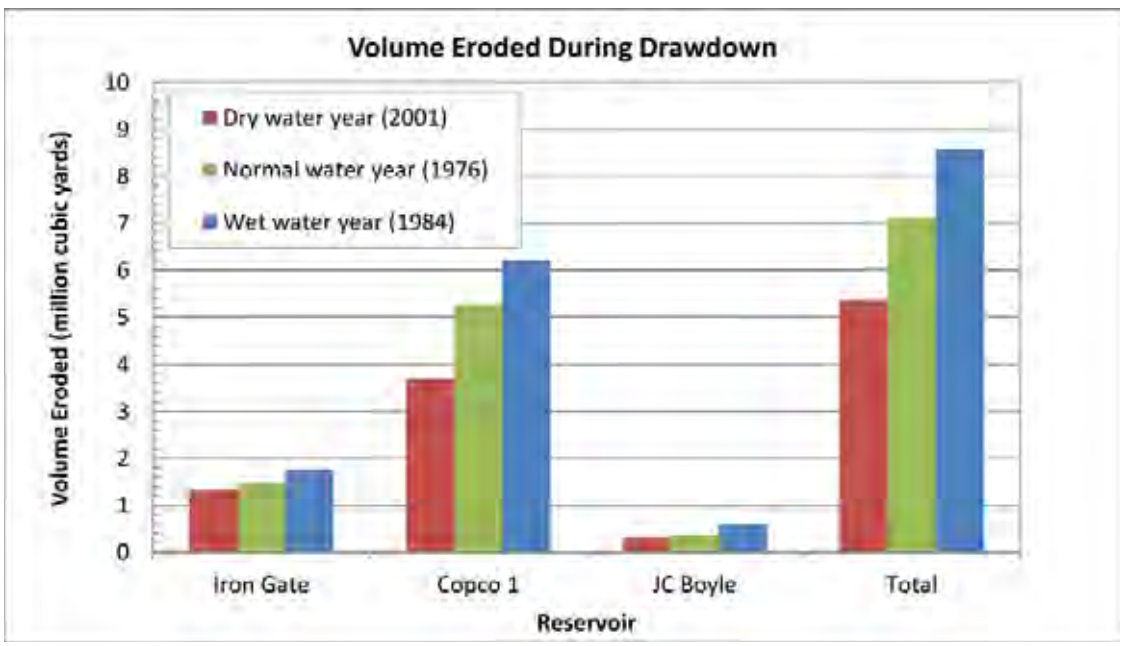

Figure 3.3-12. Sediment Erosion from Dams in the Hydroelectric Reach During 2020 Drawdown Beginning in January (Reclamation 2012).

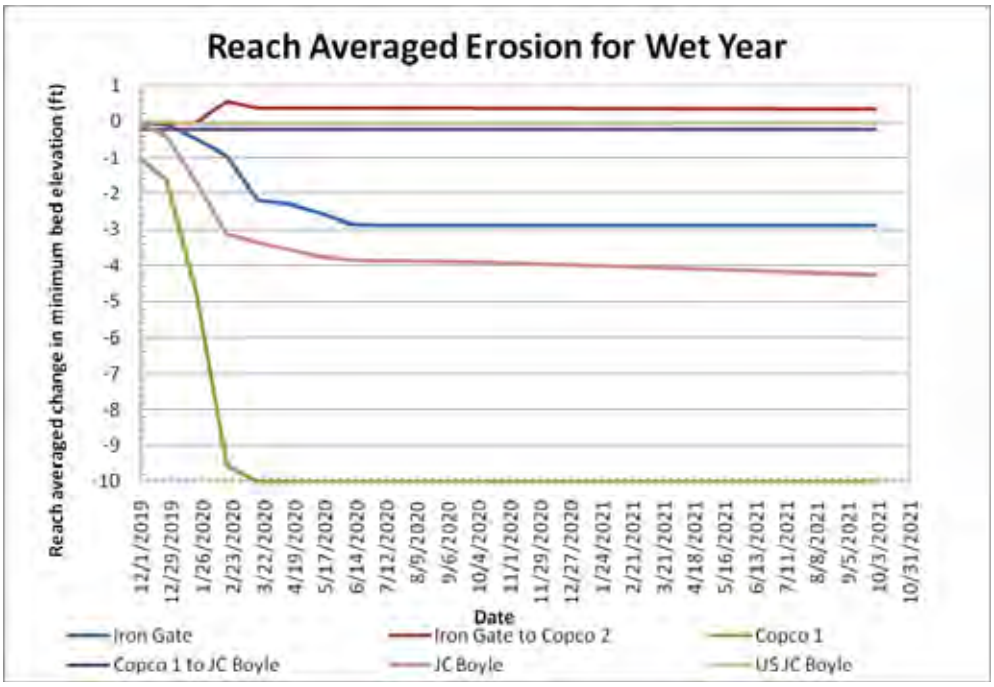

Figure 3.3-13. Reach-Averaged Erosion in the Hydroelectric Reach during Wet Year (Reclamation 2012).

The Copco 2 Dam to Iron Gate Reservoir reach shows decreases in the combined proportion of sand and fine: the dry simulations show decreases to approximately 35 percent two years after drawdown (Figures 3.3-14).

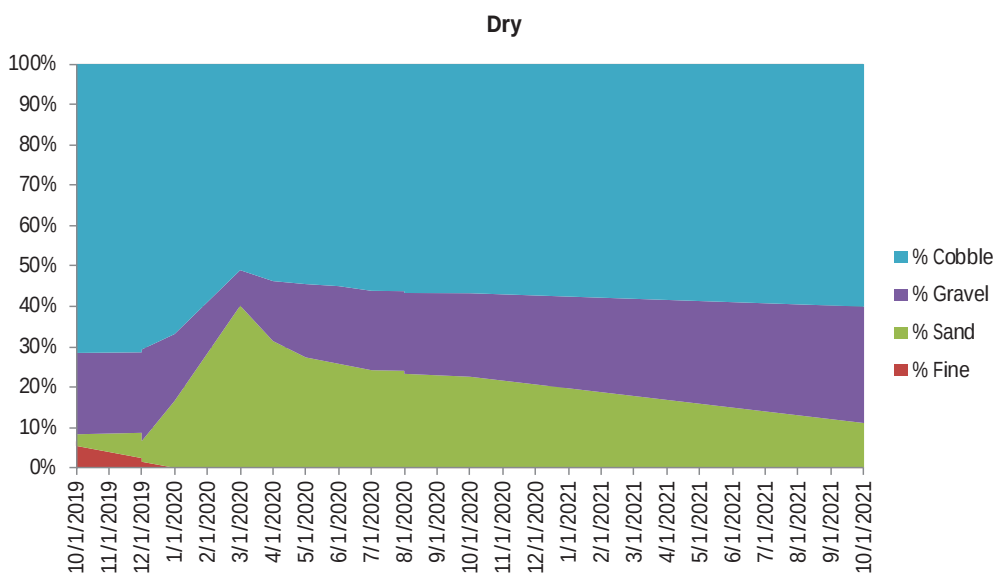

Figure 3.3-14. Simulated Bed Composition from Copco 2 to Iron Gate Reservoirs during Two Successive Dry Water Years during and after Drawdown (Based on simulation results provided by Reclamation, March 2012).

Lower Klamath River: Downstream from Iron Gate Dam Since the construction of the lower four PacifiCorp dams, there has been approximately 3.6 million tons of deposition within these reservoirs. Dam construction has interrupted the transport of sediment, including spawning gravel, below Iron Gate Dam necessary for the long-term maintenance of aquatic habitats (Buer 1981). Under the Proposed Action the streambed downstream from Iron Gate Dam would be affected by dam-released sediment and reconnection of the natural sediment supply from upstream. The sediment stored within the reservoirs has a high water content and 85 percent of the particles are silts and clays (less than 0.063 mm) while 15 percent are sand or coarser (larger than 0.063 mm) (Gathard Engineering Consulting 2006; Stillwater Sciences 2008; Reclamation 2012). As such, most sediment eroded from the reservoirs would be silt and clay (less than 0.063 mm) with smaller fractions of sand (0.063 to 2 mm), gravel (2 to 64 mm), and cobble (64 to 256 mm) (Gathard Engineering Consulting 2006; Stillwater Sciences 2010a; Reclamation 2012). A large portion of the silt and finer substrate would likely be transported as suspended sediment and would travel to the ocean shortly after being eroded and mobilized (Stillwater Sciences 2010a). As described below, coarser (larger than 0.063 mm) sediment, including sand, would travel downstream more slowly, attenuated by channel storage and the frequency and magnitude of mobilization flows.

Short-term (2-year) SRH-1D model simulations estimate up to 1 ft of reach-averaged deposition of fine and coarse sediment between Iron Gate Dam and Bogus Creek (RM 189.8) (0.3 to 1 feet and up to 0.8 ft of deposition between Bogus Creek and Willow Creek (RM 185.2) (0.4 to 0.8 ft). Reaches farther downstream showed no apparent change (<0.5 ft) Figure 3.3-15, Reclamation 2012). In the long-term (from 5 to 50 years), after downstream translation of dam released sediment, bed elevation would adjust to a new equilibrium, which includes sediment supplied by upstream tributaries that was formerly trapped by dams within the Hydroelectric Reach. The average bed elevation increase predicted over the next 50 years is 1.5 ft in the reach from Bogus to Willow Creek and less than 1 foot downstream from there (Reclamation 2012). Reclamation (2011a) expects 2 to 3 feet of aggradation between Iron Gate Dam and Cottonwood Creek over the next 50 years.

Under the Proposed Action, the flow magnitude required to mobilize sediment would likely decrease from existing conditions. Reclamation (2011a) estimated the magnitude and return period of flows required to mobilize sediment downstream from Iron Gate Dam 50 years after dam removal using reach averaged, predicted grain sizes from long-term SRH-1D simulations. The estimates show that under the Proposed Action, sediment mobilization flows from Bogus Creek (RM 190.2) to Willow Creek (RM 185.5) and from Willow Creek to Cottonwood Creek (RM 182.5) would range from 3,000 to 7,000 cfs (1.5 to 2.5 year return period) and 5,000 to 9,000 cfs (1.5 to 3.2 year return period), respectively, lower than Existing Conditions. This would have the effect of increasing bed mobilization at least down to the Shasta River (RM 177) under the Proposed Action.

Downstream from the Shasta River, there would be no significant difference in the flow required to mobilize the bed because the bed elevations of this reach are primarily controlled by relatively immobile large cobbles, boulders, and bedrock. Sediment is expected to quickly move through the reach with or without dam removal. However, there is expected to be higher transport of sand, silt, and clay transport through this reach because of the removal of the Project dams.

The effect of dam-released sediment and sediment resupply would likely extend from Iron Gate Dam to Cottonwood Creek (Reclamation 2012). Estimates of reach-averaged stream power (the ability of the river to move sediment) show a decrease from Iron Gate Dam to Cottonwood Creek, with stream power then increasing again downstream from Cottonwood Creek. The increase suggests that short- or long-term sediment deposition, either from dam release or sediment resupply, is unlikely downstream from Cottonwood Creek. However, while the area of significant sediment release and resupply of gravel and cobble under the Proposed Action is from Iron Gate Dam downstream to Cottonwood Creek, sediment transport rates of sand, silt and clay will increase downstream from Cottonwood Creek as well (Reclamation 2012).

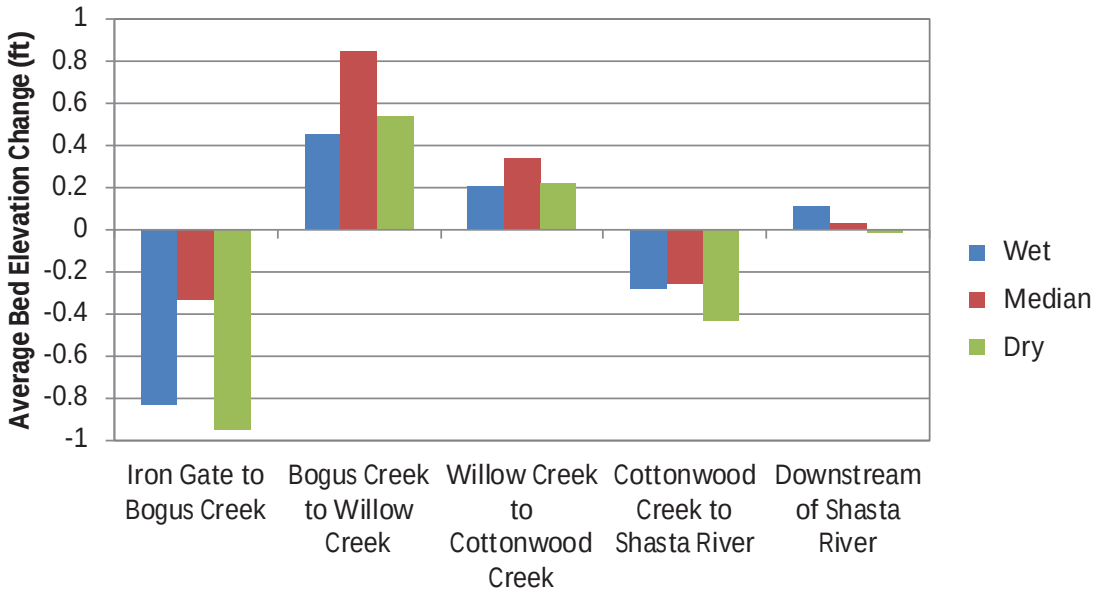

Figure 3.3-15. Reach Averaged Bed Elevation Change for Two Successive Wet, Median, or Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by Reclamation, March 2012).

In the short term (within 2 years), SRH-1D model output indicates dam released sediment and sediment resupply would increase the proportion of sand in the bed and decrease median bed substrate size (Figure 3.3-16 and Figure 3.3-17) (Reclamation 2012). Under wet, median and dry simulations, sand within the bed would increase to 30 to 35 percent by March to June 2020 following drawdown, gradually decreasing to 10 to 20 percent by September 2021, while median substrate size (D50) would fluctuate slightly before finally stabilizing to approximately the initial condition with a D50 of 100 mm (Appendix F). Longer-term (5, 10, 25, and 50 years) simulations show increases in the proportion of sand to 5 to 22 percent and decreases in D50 to approximately 50 to 55 mm (Appendix F) after 5 years that stabilize and continue through to year 50. In general, the effect of the Proposed Action will be a more dynamic and mobile bed downstream from Iron Gate Dam, with increased transport of sediment, and increased sediment supply, including spawning gravel.

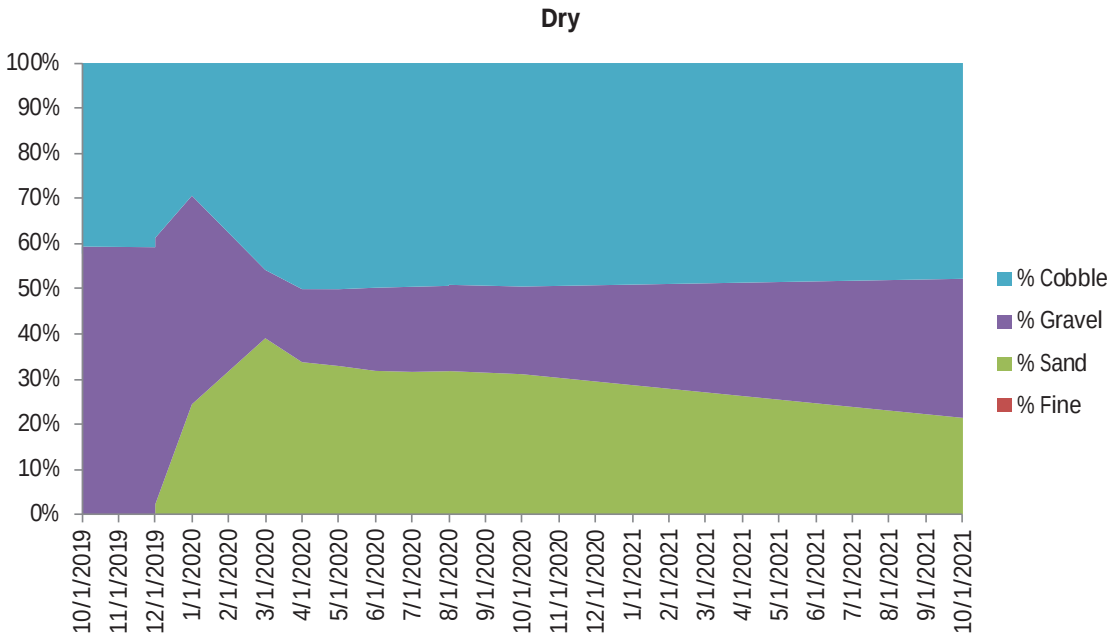

Figure 3.3-16. Simulated Bed Composition from Iron Gate Dam to Bogus Creek during Two Successive Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by Reclamation, March 2012).

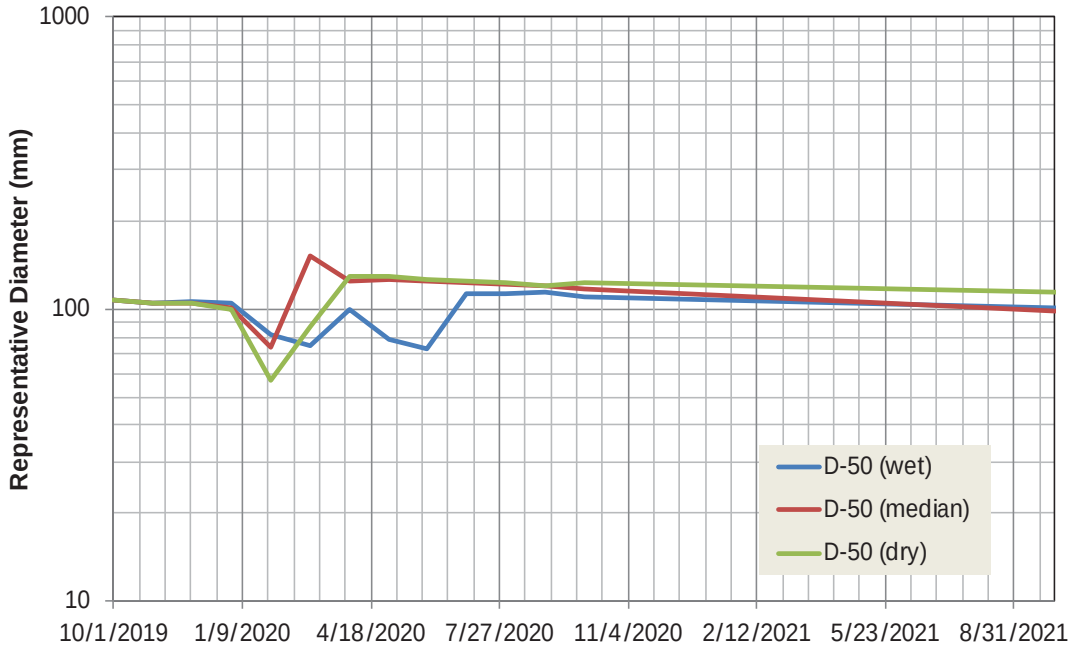

Figure 3.3-17. Simulated D50 (mm) from Iron Gate Dam to Bogus Creek during Successive Wet, Median, and Dry Water Years Following Reservoir Drawdown (Based on simulation results provided by Reclamation, March 2012).

Water Quality

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Dam removal activities under the Proposed Action would not affect water quality in the following areas of the Upper Klamath Basin: Wood, Williamson, and Sprague Rivers, Upper Klamath Lake, and Link River to the upstream end of J.C. Boyle Reservoir.

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, led NOAA Fisheries Service and the DOI to prescribe interim trap-and-haul measures to transport primarily adult fall-run Chinook salmon past Keno Impoundment/Lake Ewauna during periods when conditions would be harmful to salmonids. During most years, the Keno Impoundment/Lake Ewauna reach of the Klamath River (Link River Dam to Keno Dam) exhibits dissolved oxygen concentrations greater than 6 mg/L from mid-November through mid-June. These measurements are generally acceptable for migrating adult anadromous salmonids (USEPA 1986) for these months and are typically above the ODEQ water quality objective for cool water aquatic life (6.5 mg/L minimum, see Table 3.2-3). Under the Proposed Action, interim, seasonal, upstream trap and haul for primarily fall-run adult Chinook salmon around the Keno Impoundment/Lake Ewauna would be necessary when dissolved oxygen and water temperature do not meet the applicable criteria (i.e., typically during July through October), since migrating salmonids would have access to this reach of the Klamath River. As described under the No Action/No Project Alternative (see subsections of Section 3.2.4.3.1, Water Quality, and

Section 3.3.4.3.1, Aquatics), seasonal dissolved oxygen in the Keno Impoundment/Lake Ewauna would also be expected to improve under the Proposed Action following full attainment of the TMDLs, potentially eliminating the need for trap and haul activities.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam As described in the subsection of Section 3.2.4.3.2, Water Quality, the Proposed Action would cause long-term increases in dissolved oxygen in the Hydroelectric Reach . Dissolved oxygen in the current river reaches and the free-flowing river reaches replacing the reservoirs would no longer be affected by hydropower peaking flows or the extreme conditions of super-saturation (i.e., >100% saturation) in surface waters and hypolimnetic oxygen depletion in bottom waters of Copco 1 and Iron Gate Reservoirs during the April/May through October/November period. This would increase the likelihood of consistently supporting beneficial uses during this period.

As described in the subsection of Section 3.2.4.3.2, Water Quality, under the Proposed Action, pH in the Hydroelectric Reach would no longer experience daily variation due to hydropower peaking flows or the high levels (pH > 9) resulting from seasonal algal growth in the surface waters of Copco 1 and Iron Gate Reservoirs. pH in the free-flowing reaches of the river replacing the reservoirs would not exhibit such extremes, instead possessing a more typical riverine signal. While slight increases in pH and daily fluctuation could occur due to increased periphyton growth in the river reaches previously occupied by reservoirs, the increases are expected to consistently meet the Oregon water quality objective to support beneficial uses and would therefore be less than significant (see Section 3.2.4.3.2).

Lower Klamath River: Downstream from Iron Gate Dam Sediment release associated with the Proposed Action could cause short-term increases in oxygen demand and reductions in dissolved oxygen. As described in the subsection of Section 3.2.4.3.2, Water Quality, predicted short-term increases in oxygen demand under the Proposed Action generally result in dissolved oxygen concentrations greater than 5 mg/L. Exceptions to this would occur four to eight weeks following reservoir drawdown (i.e., in February 2020) for median and dry year hydrologic conditions, when dissolved oxygen would drop to levels below 5 mg/L from Iron Gate Dam to near the confluence with the Shasta River (RM 176.7). Recovery to the North Coast Basin Plan water quality objective of 90 percent saturation (i.e., 10–11 mg/L) would occur in the reach from Seiad Valley to the mainstem confluence with Clear Creek, and would therefore not affect dissolved oxygen in the estuary or the nearshore environment.

Facility removal under the Proposed Action could cause long-term overall increases in dissolved oxygen, as well as increased diel variability in dissolved oxygen, in the Lower Klamath River, particularly for the reach immediately downstream from Iron Gate Dam. Effects would diminish with distance downstream from Iron Gate Dam, such that no effects on dissolved oxygen would occur by the confluence with the Trinity River.

Water Temperature

Upper Klamath Basin Upstream of the Influence of J.C. Boyle Reservoir Dam removal activities under the Proposed Action would not affect water temperature in the following areas of the Upper Klamath Basin: Wood, Williamson, and Sprague Rivers, Upper Klamath Lake, and Link River to the upstream end of J.C. Boyle Reservoir. KBRA implementation would have some effects on water temperature in these areas, which are discussed in the subsection of Section 3.2.4.3.2, Water Quality.

Water quality problems (e.g., excessive water temperatures and low dissolved oxygen) in the Keno Impoundment/Lake Ewauna during late spring, summer, and early autumn, led NOAA Fisheries Service and the DOI to prescribe interim trap-and-haul measures to transport primarily adult fall-run Chinook salmon past Keno Impoundment/Lake Ewauna during periods when conditions would be harmful to salmonids. Under the Proposed Action, interim, seasonal, upstream trap and haul for primarily fall-run adult Chinook salmon around the Keno Impoundment/Lake Ewauna would be necessary when dissolved oxygen and water temperature exceed the EPA criteria of 20 ^{o} C (typically during July through October), since migrating salmonids would have access to this reach of the Klamath River. As described for water temperature under the No Action/No Project Alternative (see subsection of Section 3.2.4.3.1, Water Quality, and Section 3.3.4.3.1.1.3, Aquatics), seasonal water temperature in the Upper Klamath Basin are expected to improve following full attainment of the Oregon TMDLs, potentially eliminating the need for trap and haul activities. However, TMDL-related improvements to water temperature in the upper basin would be partially offset by climate change.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Under the Proposed Action, the Klamath River would no longer be dominated by hydropower peaking events and flows in the former Hydroelectric Reach would more closely mimic the natural hydrograph.

In the absence of the reservoirs, hydraulic residence time in this reach would likely decrease from several weeks to less than a day, and water quality would also be improved (Hamilton et al. 2011). Removal of the Project reservoirs will result in a slight increase in flow as the evaporative losses would be reduced. Evaporation from the surface of the reservoirs is currently about 11,000 acre-feet/year and after dam removal the evapotranspiration in the same reaches is expected to be approximately 4,800 acre-feet/year, resulting in a gain in flow to the Klamath River of approximately 6,200 acre-feet/year (Reclamation 2011). The reservoir drawdowns would allow tributaries and springs such as Fall, Shovel, and Spencer Creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). Water quality conditions would also improve further downstream in the Hydroelectric Reach. From Copco 1 to Iron Gate Reservoir, removal of the Four Facilities would result in a 2-10°C decrease in water temperatures during the fall months and a 1-2.5^{o}C increase in water temperatures during spring months (PacifiCorp 2004a, Dunsmoor and

Huntington 2006, NCRWQCB 2010, Perry et al. 2011; see also subsection of Section 3.2.4.3.2). The effects of changes in temperature regimes within this reach will be similar to those discussed in detail below for the reach downstream from Iron Gate Dam.

Removing the dams would allow access to at least 49 tributaries upstream of Iron Gate Dam that could provide hundreds of miles of habitat for anadromous fish (DOI 2007), including groundwater-fed areas resistant to water temperature increases caused by changes in climate (Hamilton et al. 2011). In addition, the mainstem downstream from Iron Gate Dam would reflect natural temperature regimes (Hamilton et al. 2011). The conversion of an additional 22 miles of reservoir habitat to riverine and riparian habitat would improve water quality by restoring the nutrient cycling and aeration processes provided by a natural channel. These improvements resulting from the Proposed Action would likely moderate the anticipated stream temperature increases resulting from climate change.

Lower Klamath River: Downstream from Iron Gate Dam The thermal lag formerly caused by water storage in reservoirs and the associated increased thermal mass would be eliminated in the Lower Klamath River (subsection of Section 3.2.4.3.2). This elimination would cause water temperatures to become more in sync with historical migration and spawning periods for the Klamath River, warming earlier in the spring, and cooling earlier in the fall compared to existing conditions (Hamilton et al. 2011).

Under the Proposed Action, warmer springtime temperatures would result in fry emerging earlier (Sykes et al. 2009), encountering favorable temperatures for growth sooner than under existing conditions (Figure 3.3-18), which could support higher growth rates and encourage earlier emigration downstream, thereby reducing stress and disease (Bartholow et al. 2005; FERC 2007). A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by a vast body of literature relating to increased growth rates and thermal response of outmigrating salmonids (Hoar 1988). In addition, fall-run Chinook salmon spawning in the mainstem during fall would no longer be delayed (reducing prespawn mortality) (Figure 3.3-19), and adult migration would occur in more favorable water temperatures than under existing conditions (Figure 3.3-19). Overall, these changes would result in water temperatures more favorable for salmonids in the mainstem Klamath River downstream from Iron Gate Dam.

The elimination of the thermal lag would also cause water temperatures to have natural diel variations (Figure 3.3-19) similar to what would have occurred historically in the Klamath River. This effect would be most pronounced downstream from Iron Gate Dam, would decline with distance downstream, and by the confluence of the Salmon River (RM 66) would exhibit no difference between the Proposed Action and existing conditions. The highest temperatures experienced by aquatic species would increase during summer (June through August), which could increase physiological stress, reduce growth rates, and increase susceptibility to disease during summer (Figure 3.3-19).

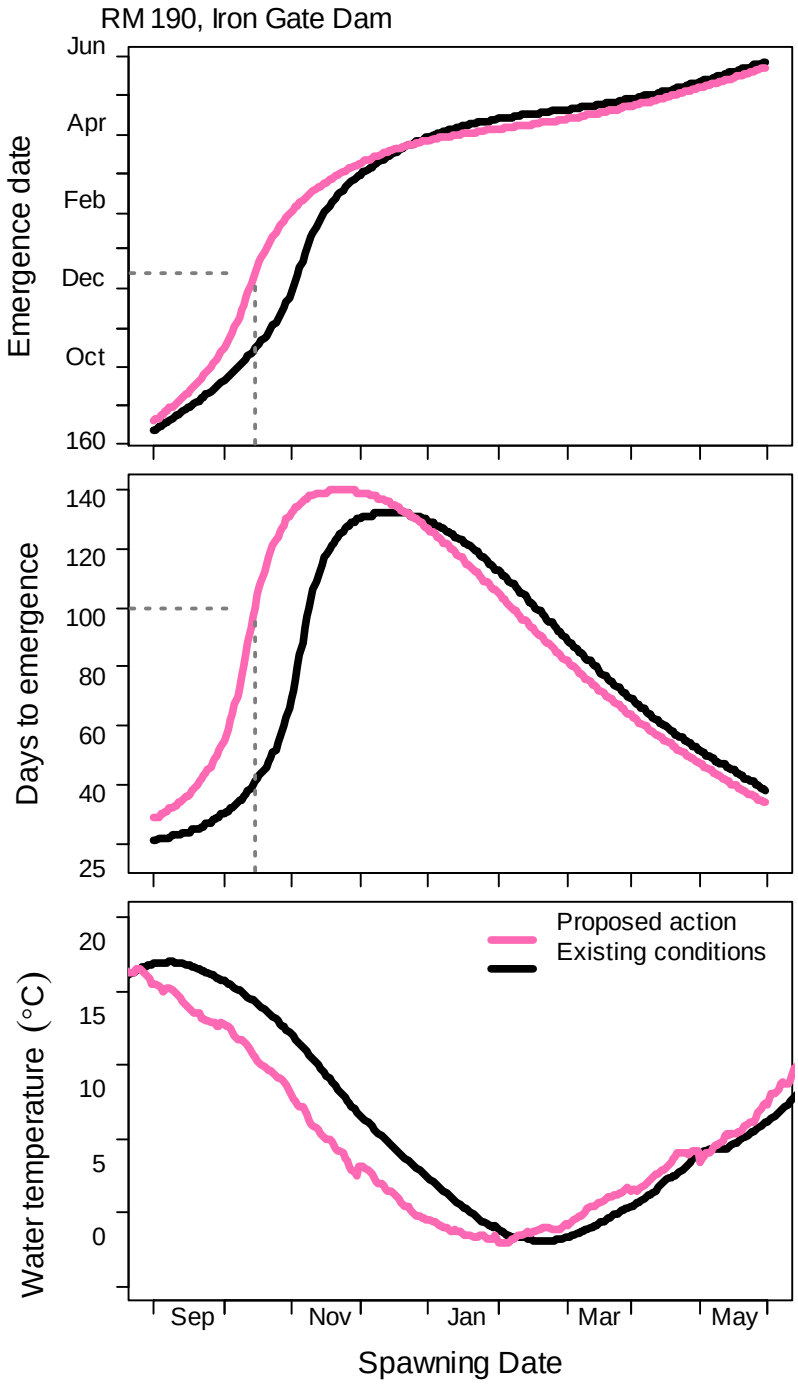

Figure 3.3-18. Time series of average daily mean water temperature (lower panel) forecasted at Iron Gate Dam (RM 190) for the Index Sequential climate scenario spanning years 2020 to 2061, for Proposed Action and Existing Conditions. Days to emergence (middle panel) and date of emergence (upper panel) for fall-run Chinook salmon was estimated as a function of spawning date assuming that emergence would occur at 889 degree days after spawning. (Perry et al. 2011)

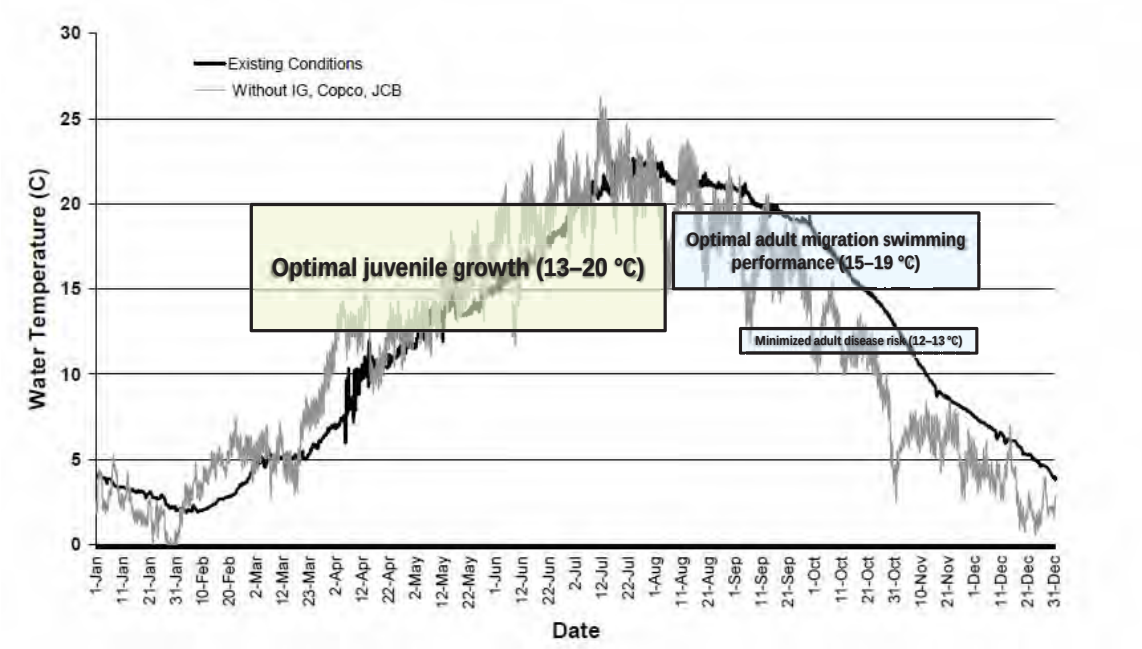

Figure 3.3-19. PacifiCorp (2005) Simulated hourly water temperatures below Iron Gate Dam based on a dry water year (WY 2002) for existing conditions compared to the Proposed Action (without Project dams), and USEPA (2003) water temperature criteria for salmonid growth and migration.

However, the FERC (2007) states that the increase in average and maximum daily temperatures may be compensated for by lower temperatures at night, which NRC (2004) concludes may allow rearing fish to move out of temperature refugia to forage at night, allowing growth to occur even when ambient day time temperatures are above optimal. Foott et al. (2012) observed positive growth and no overt effect of elevated temperature on immune function or fitness in Klamath River juvenile Chinook salmon held over a 23 day period under conditions in the laboratory that simulated fluctuating water temperature profiles similar to what would be observed in the Klamath River under the Proposed Action. Salmonids in the Klamath River have been observed to use cooler hours to migrate between thermal refugia (Belchik 2003), and the decrease in minimum temperatures during the spring, summer, and fall under the Proposed Action would be a benefit for fish (Figure 3.3-19). Increased nighttime cooling of water temperatures is important to salmonids in warm systems, providing regular thermal relief, time for repair of proteins damaged by thermal stress, and significant bioenergetic benefits that help fish persist under marginal conditions (Schrank et al. 2003, NRC 2004). In addition, Dunsmoor and Huntington (2006) suggest that lower nighttime temperatures with dam removal would allow fish to leave thermal refugia in the Klamath River to forage and thereby allow more effective use of the available refugia habitat. Overall, the Proposed Action reductions in minimum daily temperatures below those under existing conditions would benefit salmonids in the Klamath River mainstem, helping them to tolerate the

warmer periods of the year when dwelling in the mainstem, but also allowing feeding excursions when confined to refugia during the warmer times of the day.

Simulations of water temperatures without the reservoirs (as discussed in Hamilton et al. 2011) show that the temperature difference with and without dams would be greatest downstream from Iron Gate Dam, but could extend an additional 120 to 130 miles downstream. Estimated decreases in stream temperature with dam removal relative to current conditions are likely to be smaller with continued climate change; however, temperature conditions would be much improved under the Proposed Action as compared to the No Action/No Project Alternative (See subsection of Section 3.2.4.3.2., Water Quality).

Klamath River Estuary and Pacific Ocean Nearshore Environment The influence of the Proposed Action would likely decrease with distance downstream from Iron Gate Dam (PacifiCorp 2004b), and it is unlikely that facility removal would have detectable effects on temperatures in the Klamath River Estuary and Pacific Ocean nearshore environment.

Fish Disease and Parasites

The Proposed Action would be expected to reduce impacts on salmon from fish disease. The greatest disease related mortality is due to *C. shasta* and *P. minibicornis* in the Lower Klamath River downstream from Iron Gate Dam. Among all of the salmon lifestages, juvenile salmon tend to be most susceptible to *P.minibicornis* and *C. shasta*, particularly during their outmigration in the spring months (Beeman et al. 2008). The main factors contributing to risk of infection by *C. shasta* and *P. minibicornis* include availability of habitat (pools, eddies, and sediment) for the polychaete intermediate host; microhabitat characteristics (static flows and low velocities); polychaete proximity to spawning areas; increased planktonic food sources from Project reservoirs; and water temperatures greater than 15°C (Bartholomew and Foott 2010).

The removal of Iron Gate Dam would reduce the concentration of adults and carcasses that presently occurs downstream. Greater dispersal of spawning adult salmon would reduce their proximity to dense populations of polychaetes. FERC's analysis (FERC 2007) concluded that restoring access to reaches above Iron Gate Dam for anadromous fish would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River. In addition, Bartholomew and Foott (2010) suggested that with dam removal it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall. FERC (FERC 2007) concluded that restoring natural sediment transport processes would likely contribute to the scour of periphyton (attached algae) downstream from the current site of Iron Gate Dam, and deposited gravel and sand would provide a less favorable substrate for periphyton because of its greater mobility during high flow events than the existing armored substrate (see also the subsection of Section 3.4.4.3.2, Periphyton). The reduction in periphyton would provide less favorable habitat for the polychaete

intermediate host of *C. shasta* and *P. minibicornis*, which should reduce the infection rate of juvenile salmonids downstream from Iron Gate Dam (FERC 2007).

Under the Proposed Action, sediment bedload transport rates would increase downstream from the current location of Iron Gate Dam which includes habitats with large populations of polychaetes. Actinospores released from this portion of the Klamath River pass downstream and infect juvenile salmon in the current infectious zone downstream from the Shasta River to Seiad (RM 130) (Bartholomew and Foott 2010). In addition, while the area of significant bedload deposition under the Proposed Action is located upstream of Cottonwood Creek, sediment transport rates will also increase downstream from Cottonwood Creek (Appendix F). This increased movement and transport of sediment (sand, silt, and clay) is anticipated to disrupt polychaete habitat from the current location of Iron Gate Dam to downstream from Shasta River.

The net result of these effects would also depend on temperature. Dam removal would mean cooler temperatures in the late summer and fall, but slightly warmer temperatures during spring and early summer. FERC (2007) concluded that dam removal would enhance water quality and reduce the cumulative water quality and habitat effects that contribute to disease-induced salmon die-offs in the Klamath River downstream from Iron Gate Dam. In turn, this would benefit salmon outmigrants from tributaries downstream from Iron Gate Dam, such as the Shasta and Scott rivers. While Bartholomew and Foott (2010) stated that the effect of cooler temperatures in the early fall on the intermediate host or *C. shasta* is unknown, they also stated that a reduction in temperature could have the result of reducing polychaete reproductive rates (Bartholomew and Foott 2010). Reduced disease in the mainstem is anticipated to increase the likelihood that benefits to outmigrating smolts from restoration in the Shasta and Scott rivers are realized. In addition, with dam removal it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall (Bartholomew and Foott 2010).

The net result of these effects would also depend on smolt behavior. FERC (2007) concluded that more rapid cooling of river temperatures in the fall with the project dams removed may also allow for fall Chinook salmon spawning to occur earlier in the fall. Bartholow et al. (2005) and FERC (2007) also both suggest that earlier warming of the river system could trigger juvenile salmonids to out migrate earlier, This is consistent with findings that accumulated temperature units are more important predictors of migration of juvenile Chinook salmon than flow or photoperiod (Sykes et al. 2009). A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by a vast body of literature relating to increased growth rates and thermal response of emigrating salmonids (Hoar 1988). This, in turn, would likely result in earlier emergence and growth, and encourage earlier emigration. In addition, a slight increase in the rate at which water temperatures increase in the spring would be likely to improve the growth rates of newly emerged fall Chinook salmon fry (FERC 2007). Earlier emigration and improved growth would likely mean most outmigrants would avoid periods of high disease infection of juvenile salmon.

Flows also play an important role in the regulation of disease in the Klamath River. If flows increase during spring, juvenile migration time could be decreased, potentially resulting in reduced disease exposure, especially for fish originating from Lower Klamath River tributaries. The Proposed Action would create a flow regime that more closely mimics natural conditions in the Lower Klamath River by increasing spring flow and by incorporating more variability in daily flows (Hetrick et al. 2009). Implementation of the KBRA will provide flexibility to manage flows that respond to real-time climatic and biological conditions. This would allow for management of out migration flows, as well as enhancing the diversity in flow and water temperature. Because polychaete populations are located outside of the main flow along the margins of the riverbanks (Bartholomew and Foott 2010), variable flows disrupt this habitat. Restoring these dynamic conditions in the Klamath River will create instability and disturbance in microhabitat conditions that are expected to reduce polychaete populations (Stocking and Bartholomew 2007; Bartholomew and Foott 2010) and presumably, reduce infection rates within polychaete populations (Hetrick et al. 2009). The removal of the Four Facilities would also be likely to reduce habitat quality for the polychaete host by reducing reservoir water quality effects and reducing planktonic food sources (Hetrick et al. 2009; Hamilton et al. 2011).

Periphytic algae would also play a role in disease in the Klamath River. Under the Proposed Action additional periphytic growth including *Cladophora* is anticipated within the Hydroelectric Reach, following the initial drawdown period, which could provide habitat for the intermediate host of *C. shasta*. Additional periphytic growth would be a direct result of the conversion of the lacustrine environment in the reservoirs, which fosters growth of phytoplankton algae, to a flowing, riverine habitat that fosters growth of attached aquatic vegetation (including both periphyton and macrophytes), in combination with already ample nutrient concentrations. In the absence of other factors, this could possibly increase the prevalence of the intermediate host for *C. shasta*. However, dam removal would also create other conditions that tend to offset the growth of aquatic vegetation. These conditions include a restoration of bedload sediment transport, a more mobile river bed, increased high flows during spring, more variable flows, and a more normal (and variable) temperature regime with substantially cooler fall water temperatures. FERC (2007) concluded that restoring natural sediment transport processes would likely contribute to the scour of attached vegetation in the Klamath River. Finally, under KBRA, progress toward achievement of TMDL targets, including the reduction of nutrients, would be accelerated compared to existing conditions and would eventually help control growth of periphyton or macrophytes.

There remains some uncertainty of the contribution of nutrients in increasing habitat for the intermediate host for *C. shasta*, the conditions that would offset the growth of aquatic vegetation, and the longitudinal gradations of these conditions. Given the already high concentrations of nutrients, increases in biomass of attached aquatic vegetation would be more attributable to the new habitat area than changes in nutrient concentrations. However, the net long-term effect of the Proposed Action is anticipated to be a slight- to moderate decrease in Cladophora and aquatic vegetation as a result of disruption by the flow and bedload conditions listed above and, ultimately, reductions in nutrients resulting

from the TMDLs or other nutrient management techniques in the Upper Klamath Basin. A decrease in Cladophora and aquatic vegetation would likely decrease habitat for the intermediate host which would reduce the incidence of *C. shasta*. This effect is likely to be reach dependent, with in aquatic vegetation possible in the Hydroelectric Reach. Nevertheless, increased dispersal of spawners and carcasses, transport of bedload, and establishment of variable flows, would likely reduce the severity of exposure to the infection to levels below critical thresholds (Bartholomew and Foott 2010), even if infection itself is not eliminated.

Removal of the Four Facilities would allow anadromous to move upstream in the mainstem Klamath River and tributaries. However, available information indicates that fish passage would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (Administrative Law Judge 2006). *C. shasta* and *P. minibicornis* exist throughout the Klamath River System in both the Upper and Lower Basins, so migration of wild anadromous fish upstream of downstream from Iron Gate Dam would not increase the risk of introducing pathogens to resident trout residing above Iron Gate Dam (Administrative Law Judge 2006). In addition, native Klamath River trout are generally resistant to *C. shasta*. The remaining known pathogens do not impact non-salmonids, with the exception of *F. columnaris* and *Ich*.

Recently several new *C. shasta* genotypes have been discovered in the Klamath River. In this regard, risk is related to host specificity, which appears to exist at least to some degree (Atkinson and Bartholomew 2010). As an example, redband trout are thought to be susceptible to Type 0, which already occurs in the upstream Basin and Chinook salmon are susceptible to Type I, which occurs in the Lower Klamath Basin. Type 0 genotype occurs in low densities and it is not very virulent (infection results in low or no mortality); if Type I genotype were to be reintroduced above Iron Gate Dam, it would affect only Chinook salmon. It is not expected that introduction of *C. shasta* genotypes upstream would be deleterious because fish in the upstream Basin have shown resistance to the downstream genotypes. Redband trout would presumably have been exposed to genotypes of *C. shasta* during the pre-dam period, and their populations were abundant. Because the salmonid species in the Klamath Basin already co-occur with the genotype of *C. shasta* to which they are susceptible, and the salmonid species are less susceptible to other genotypes of *C. shasta*, expanding the distribution of the different genotypes of *C. shasta* would be unlikely to be deleterious to salmonids. Recently discovered *C. shasta* genotypes and research findings in the past several years do not appear to contradict the finding that movement of anadromous salmonids into the Upper Klamath Basin presents a relatively low risk of introducing pathogens to resident fish (Administrative Law Judge 2006, USFWS/NOAA Fisheries Service Issue 2(B)).

Available information also indicates that risks associated with dam removal to anadromous fish upstream of Iron Gate Dam are minimal. For example, steelhead within the Klamath River system are generally resistant to *C. shasta*, (Administrative Law Judge 2006). Since salmon and associated disease pathogens were present historically above Iron Gate Dam, *C. shasta* genotype movement would be a reintroduction of associated risk to these anadromous species.

While it is possible that the current infections nidus (reach with highest infectivity) for *C. shasta* and *P. minibicornis* may be recreated upstream where salmon spawning congregations occur, and there is associated uncertainty (Foott et al. 2011), the likelihood of this happening appears to be remote for the following reasons. Any creation of an infectious zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone in the Klamath River in the reach from the Shasta River downstream to Seiad Valley (FERC (2007; Bartholomew and Foott 2010). Here, flows in that reach that mimic natural conditions, combined with reestablishment of natural sediment transport rates, would restore natural geomorphic channel forming processes (Hetrick et al. 2009) necessary to create diverse habitat and reduce the influence of those synergistic factors that currently create conditions favorable for disease. Under a dams out alternative, those conditions that are believed to result in development of an infectious nidus below Iron Gate Dam, or a could result in development of a potential infectious nidus above Iron Gate Dam, are unlikely to occur.

Further, the likelihood of those synergistic factors in the Williamson River would be reduced as carcasses would likely be more dispersed in the watershed (Foott et al. 2011), and flow variability will act to reduce polychaete habitat stability above the Williamson River mouth. *C. shasta* in the Williamson River is currently maintained by planting of susceptible rainbow trout that become infected, likely produce myxospores, and die within a restricted reach in the lower Williamson River.

In addition, under a scenario of potential dam removal, it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall (Bartholomew and Foott 2010; p. 40), thus missing the time of year when water temperatures in the Williamson River might possibly be conducive to disease. In some years, maximum temperatures in the Williamson River do not exceed the disease threshold of 15 C (Bartholomew and Foott 2010; Hamilton et al. 2010). The risk of a juvenile salmon disease response here would be lower than the current zone but not negligible in all water years (Scott Foott, USFWS, 2012, pers. comm.).

Historically, it appears spawning concentrations of upper basin Chinook salmon took place primarily in the Sprague River (Lane and Lane Associates 1981). There is no information indicating that high densities of polychaetes occur in the Sprague River (Foott et al. 2011). Thus, the synergistic factors that contribute to an infectious nidus for emigrants below Iron Gate Dam and near the Iron Gate Hatchery are unlikely to occur here either. There is some concern regarding a disease zone in the lower Williamson River downstream from the confluence with the Sprague River (Hurst et al. 2012). However, some Chinook emigrants from both these tributaries may very well emerge from groundwater areas early, then rear in Upper Klamath Lake, with growth opportunities that allow them to migrate when they can minimize exposure to *C. shasta*.

The Chinook Salmon Expert Panel convened to attempt to answer specific questions formulated by the project stakeholders to assist with assessing the effects of the Proposed Action compared with existing conditions (Goodman et al. 2011), concluded that the

Proposed Action offers greater potential than the current conditions in reducing disease-related mortality in Klamath River Chinook salmon.

Algal Toxins

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir This region is upstream of any proposed dam removal; therefore, removal of the reservoirs at the Four Facilities under the Proposed Action would not affect fish health as related to algal toxins. Any changes in algal toxin production in this region would be a result of other factors, including TMDL implementation. The effects in this area would be similar to those described for the No Action/No Project Alternative.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Removal of the reservoirs at the Four Facilities under the Proposed Action would eliminate growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* in the Hydroelectric Reach, alleviating high seasonal concentrations of algal toxins and associated bioaccumulation of microcystin in fish tissue for species in this reach. While some microcystin may be transported downstream from large blooms occurring in Upper Klamath Lake, the levels would not be as high as those currently experienced due to the prevalence of seasonal in-reservoir blooms. Overall, bioaccumulation of algal toxins in fish tissue would be expected to decrease in the Hydroelectric Reach and would be beneficial.

Lower Klamath River: Downstream from Iron Gate Dam Removal of the reservoirs at the Four Facilities under the Proposed Action would eliminate growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa*, alleviating the transport of high seasonal concentrations of algal toxins to the Klamath River downstream from Iron Gate Dam. This would also decrease the associated bioaccumulation of microcystin in fish tissue for species downstream from the dam. While some microcystin may be transported downstream from large blooms occurring in Upper Klamath Lake, the levels would not be as high as those currently experienced due to the prevalence of seasonal in-reservoir blooms. Overall, bioaccumulation of algal toxins in fish tissue would be expected to decrease in the Klamath River downstream from Iron Gate Dam and would be beneficial.

Aquatic Habitat

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

Under the Proposed Action access would be restored to an estimated 360 miles of potential anadromous fish habitat upstream of Upper Klamath Lake and Keno Impoundment/Lake Ewauna (Huntington 2006; DOI 2007; NOAA 2007). However, in their analysis the FERC (2007) excluded this 360 miles of anadromous fish habitat based upon poor water quality conditions in these water bodies during summer months. The Chinook Expert Panel (Goodman et al. 2011) also concluded that substantial gains in Chinook salmon abundance for areas upstream Keno Impoundment/ Lake Ewauna would be contingent upon successfully resolving limitations associated with poor water quality problems in Upper Klamath Lake and Keno Impoundment/ Lake Ewauna. The Coho Steelhead Expert Panel (Dunne et al. 2011) stated that poor water quality in Keno

Impoundment/ Lake Ewauna and in Upper Klamath Lake, and the possibility of difficult passage at Keno Dam, could impede steelhead from reaching improved habitat upstream of the Project Reach.

These concerns for Chinook salmon and steelhead migration and spawning overstate the seasonal habitat limitations of Keno Impoundment/ Lake Ewauna and Upper Klamath Lake for two main reasons. First, a recent study examined the response of salmon to Upper Klamath Lake under existing conditions. Iron Gate Hatchery Chinook salmon were tested in the lake and the lower Williamson River to assess whether current conditions would physiologically impair salmon reintroduced into the Upper Klamath Basin. Juvenile Chinook salmon were tested in cages in 2005 and 2006. These juveniles showed normal development as smolts in Upper Klamath Lake and survived well in both locations (Maule et al. 2009). This study strongly suggests that Upper Klamath Lake habitat is suitable to support salmonids for at least the October through May period. Maule et al. (2009) concluded that there was little evidence of physiological impairment or significant vulnerability to *C. shasta* that would preclude this stock from being reintroduced into the Upper Klamath Basin. In addition, the life history of type I fall-run Chinook salmon generally does not include a freshwater phase from June through September. Thus, conditions for juvenile fall-run Chinook emigration through Upper Klamath Lake appear favorable. Due to the timing of the migration period for spring-run Chinook salmon and steelhead, these runs would generally avoid the period of poor water quality in Upper Klamath Lake. Cool groundwater spring inputs in the Williamson River and on the west side of Upper Klamath Lake would likely provide thermal refugia for the year-round life-histories of spring-run Chinook salmon and steelhead. Under a scenario of potential dam removal, Bartholomew and Foott (2010) noted that it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall. These life histories would also likely be able to avoid periods of poor water quality.

Second, water quality issues in Keno Impoundment/Lake Ewauna and Upper Klamath Lake are not year round. Both DOI and NOAA Fisheries Service have long recognized the issue of seasonally poor water quality in Keno Impoundment/ Lake Ewauna. When water quality is poor, which occurs seasonally between June 15 and November 15, both DOI and NOAA Fisheries Service prescribed the transfer of primarily adult Chinook salmon upstream of the Keno between June 15 and November 15 for the purposes of restoration and the safe, effective, and timely passage (DOI 2007; NOAA 2007). In the Klamath Facilities Removal Draft EIS/EIR, accommodation for related short distance, seasonal trap and haul facilities is made under all of the action alternatives other than the No Action/No Project Alternative analyzed below. Migrants of other species, if present, would be transported as well. Thus, under the action alternatives other than No Action/No Project Alternative, all anadromous species and life histories would be able to migrate to and from habitat upstream of Upper Klamath Lake, realize associated benefits provided by these habitats, and complete their life cycles.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Under the Proposed Action, short-term effects would include the release of water stored in the Four Facilities. Based on modeling results, this release is expected to last about 4 months, from January 1 into April 2020, but could vary depending on hydrologic conditions (Reclamation 2012), increasing flows downstream from the dams during the drawdown period. River flows would be expected to remain below the 10-year flood event of 11,000 cfs. Flows would increase not only in the bypass reaches, but also all other mainstem reaches due to changes in operations and the absence of reservoir evaporation. Hydrology in the J.C. Boyle Peaking Reach would follow the natural hydrograph more closely, including increased duration and magnitude of high flows, and cessation of daily extreme flow fluctuations (characteristic of hydroelectric peaking operations). Seasonal high flows will contribute to improving the quality of riparian habitat in the J.C. Boyle Bypass Reach by increasing the sediment deposit within the channel and decreasing reed canary grass (Administrative Law Judge 2006). The more normative flow regime associated with this alternative would provide these seasonal high flows.

These flow increases would provide more habitat than under existing conditions for redband/rainbow trout and other resident riverine species, as well as anadromous fish or lamprey that reestablish in this area. These flows are expected to meet channel maintenance needs to route coarse sediments, build bars, erode banks, flush fine sediments, scour vegetation and undercut and topple large woody riparian vegetation NRC 2008). The removal of project dams would reestablish geomorphic and vegetative processes that form channels that provide fish habitat and spawning gravels in this reach, especially in the former bypassed reaches (FERC 2007). In addition, the impacts associated with daily extreme flow fluctuations resulting from peaking operations, such as stranding, displacement, reduced food production, and increased stress, would no longer occur. The removal of the Four Facilities would eliminate existing habitat for adult shortnose and Lost River suckers, as well as nonnative species occupying the reservoirs. The few shortnose and Lost River suckers that have been observed in these reservoirs are believed to be fish that have moved down from the upstream areas, but are not thought to represent a viable, self-supporting population (Buettner et al. 2006). The Proposed Action would restore 22 miles of riverine habitat (Cunanan 2009) for resident and anadromous fish through removal of reservoirs. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009).

Overall, because the Proposed Action would result in flows more favorable to all life stages, eliminate peaking operations, and remove barriers that have isolated populations; the Proposed Action would result in benefits to salmonid populations and their habitat.

Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed reservoir sediment. No short-term effects are anticipated from these reservoir restoration efforts, and in the long-term aquatic habitat may be improved from restored riparian vegetation.

Lower Klamath River: Downstream from Iron Gate Dam As described above, the Proposed Action would result in elevated flows for about 4 months once drawdown begins, but the flows would be expected to remain below the 5-year flood event. These elevated flow rates could have the beneficial effect of maintaining unsuitable habitat conditions for introduced species in the river downstream from Iron Gate Dam. These increased flows could result in faster transport of outmigrant fish and slower upstream migration of adult fish in the Klamath River during this time.

Over the long term, the Proposed Action would alter the hydrograph so that the duration, timing, and magnitude of flows would be more similar to the unregulated conditions under which the native fish community evolved (Hetrick et al. 2009). While mean annual flows would not substantially change from existing flows due to the lack of active reservoir storage (Stillwater Sciences 2009b; Reclamation 2012), flow variability would increase.

Restoration of the hydrologic function of the river system is paramount to creating habitat diversity and maintaining biophysical attributes of a river system (Stanford et al. 1996; Poff et al. 1997). Although implementation of Alternative 2 or 3 will not fully restore the natural hydrologic regime of the Klamath River, it would result in a flow pattern that mimics pre dam conditions, having greater intra- and inter-annual variability than exists today with the Klamath Dams in place (Hetrick et al. 2009). Implementation of the KBRA will provide flexibility to manage flows that respond to real-time climatic and biological conditions, thereby enhancing the diversity in flow and water temperature. Restoring these dynamic conditions in the Klamath River will create instability and disturbance in microhabitat conditions that we expect will reduce polychaete populations (Stocking and Bartholomew 2007) and presumably, reduce infection rates within polychaete populations (Hetrick et al. 2009).

The Proposed Action would substantially decrease the transit time of water in the Hydroelectric Reach, because it would no longer be detained by the reservoirs, resulting in a shift in the timing of the minimum flows (Balance Hydrologics Inc. 1996; NRC 2004, Fig. 4-2, p. 148, http://www.nap.edu/openbook.php?record_id=10838&page=144). These hydrologic effects would likely be more important in upstream areas (directly downstream from Iron Gate Dam) than downstream areas (downstream from the confluence of the Scott River) due to the substantial flow contribution of tributaries to the Klamath River (Reclamation 2012, Hydrologic modeling, Appendix E). In addition, these hydraulic changes would result in changes to water quality, water temperatures, sediment transport, and riparian habitat, as described in subsequent sections.

Klamath River Estuary and Pacific Ocean Nearshore Environment Modeling results indicate that because of the influence of the tributaries entering the Klamath River downstream from Iron Gate Dam, the flow changes for the Proposed Action would not substantially affect the flows entering the estuary. Section 3.6, Flood Hydrology, provides further information on this effect. Therefore, the Proposed Action would not affect flow-related fisheries habitat in the estuary or the Pacific Ocean.

Aquatic Resources Effects

Critical Habitat

As described below, reservoir drawdown associated with dam removal under the Proposed Action could alter the quality of critical habitat. In addition, the removal of dams and reservoirs could alter the availability and quality of critical habitat.

Coho Salmon Elevated levels of SSCs occurring during 3 to 4 months of drawdown would degrade critical habitat for coho salmon. Bedload movement following dam removal would increase supply of gravel downstream from the dam as far downstream as Cottonwood Creek. This effect would potentially improve critical habitat for coho salmon by reducing median substrate to a size more favorable for spawning (Reclamation 2012).

The Proposed Action would increase the amount of habitat available to coho salmon upstream of currently designated critical habitat and improve water quality in the mainstem Klamath River within current critical habitat. NOAA Fisheries Service may consider whether to designate the newly available habitat as critical habitat as part of its 5-year status review or as a separate reconsideration of the critical habitat designation for the species (J. Simondet, NOAA Fisheries Service, pers. comm., 2011). The Proposed Action would restore access for upper Klamath River Population coho salmon to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall Creeks (Hamilton et al. 2005), including around 76 miles of potential habitat within the Hydroelectric Reach, In addition, coho salmon could find suitable temperatures for holding in pockets within the J.C. Boyle Bypass Reach, although the average and maximum temperatures in this reach are expected to exceed optimal temperatures for coho salmon. Access to this habitat would increase the availability of spawning sites, result in additional food resources, and provide access to areas of better water quality. Water quality conditions would also improve within the mainstem downstream from the J.C. Boyle Powerhouse. As discussed in detail above, the thermal lag formerly caused by water storage in reservoirs and the associated increased thermal mass would be eliminated in the Lower Klamath River. This elimination would cause water temperatures to have more natural diel variation, and would become more in sync with historical migration and spawning periods for Klamath River. Overall, these changes would result in water temperature more favorable for salmonids in the mainstem. Removal of the Four Facilities would also increase dissolved oxygen concentrations, and eliminate reservoir habitat that creates the conditions necessary for the growth of blue green algae and other phytoplankton. These changes would be beneficial for coho salmon critical habitat. **Based on reductions in habitat quality during reservoir drawdowns that would be detrimental to PCEs, the Proposed Action would have a significant effect on coho salmon critical habitat in the short term. Based on benefits to the PCEs, the Proposed Action would have a beneficial effect on critical habitat for coho salmon in the long term.**

Bull Trout Based on the restricted distribution of bull trout, implementation of the Proposed Action would not affect the physical or chemical components of critical habitat. However, the Proposed Action would allow Chinook salmon and steelhead to access

areas they have not been able to access since the completion of the Copco 1 Development in 1918. These species would potentially compete with and prey upon bull trout fry and juveniles; however, bull trout would also be expected to consume the eggs and fry of Chinook salmon and steelhead. These species co-evolved in the watershed together, and it is anticipated that they would be able to co-exist in the future. **The Proposed Action would have a less-than-significant impact on critical habitat for bull trout in the short and long term.**

Southern Resident Killer Whale The Klamath River contributes to critical habitat for Southern Resident Killer Whales through its contribution of Chinook salmon to their food supply. The Proposed Action would not affect the geographic extent of critical habitat for this species, as it is located in the State of Washington. The Proposed Action is expected to increase wild populations of anadromous salmonids, which could increase food supply for Southern Resident Killer Whales. In a compilation of potential adult production from habitats upstream of Iron Gate Dam, estimates ranged from 9,180 to 21,245 (Hamilton et al. 2011). Klamath River salmon are anticipated to provide less than 1 percent of the diet of Southern Resident Killer Whales in most months. The Proposed Action would not be likely to materially affect the food supply of Southern Resident Killer Whales. **Based on small influence of the Klamath River on PCEs of Southern Resident Killer Whale, the Proposed Action would have a less-than-significant impact on critical habitat for Southern Resident Killer Whales in the short and long term.**

Eulachon Under the Proposed Action, PCEs of critical habitat supporting eulachon would be degraded in the short term, including short-term adverse effects of suspended sediment on spawning and egg incubation habitat, and adult and larval migration habitat for southern DPS eulachon. Under the Proposed Action it is anticipated that water quality will improve throughout the Klamath River, including the estuary (WQST 2011) and that habitat restoration effort under KBRA will improve estuary habitat. Critical habitat for the Southern DPS eulachon includes approximately 539 miles of riverine and estuarine habitat in California, Oregon, and Washington, of which the Klamath River Estuary is a small proportion (<2%). **Although the Proposed Action would result in short-term reductions in habitat quality detrimental to PCEs, a very small proportion (< 2%) of eulachon critical habitat would be effected for a short duration, and the Proposed Action would have a less-than significant effect on eulachon critical habitat in the short term. Based on benefits to the PCEs, the Proposed Action would have a beneficial effect on critical habitat for eulachon in the long term.**

Essential Fish Habitat

As described below, reservoir drawdown associated with dam removal under the Proposed Action could alter the quality of EFH. In addition, the removal of dams and reservoirs could alter the availability and quality of EFH.

Chinook and Coho Salmon EFH The short-term release of sediment from the dams under the Proposed Action would be detrimental to Chinook and coho salmon EFH

during the months when SSC concentrations are elevated. In the long term, the Proposed Action would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitats upstream of Iron Gate Dam. EFH quality would be affected by improved water quality, and decreased prevalence of disease, as described above for coho salmon critical habitat. Improved access to habitats (upstream of designated EFH), improved water quality, increased sediment transport, and decreased prevalence of disease, would provide a benefit to EFH for Chinook and coho salmon. **Based on a substantial reduction in EFH quality during reservoir drawdown, the Proposed Action would have a significant effect on EFH for Chinook and coho salmon in the short term. Based on benefits to quality, the Proposed Action would have a beneficial effect on EFH for Chinook and coho salmon in the long term.**

Groundfish EFH EFH for Pacific Coast groundfish includes all waters and substrate within areas with a depth less than or equal to 3,500 m (1,914 fm) shoreward to the mean higher high water level or the upriver extent of saltwater intrusion. Under the Proposed Action, impacts to the nearshore environment are not anticipated to be distinguishable from existing conditions, based on a relatively small magnitude of SSCs released to the nearshore environment, an anticipated rapid dilution of the sediment plume as it expands in the ocean, and a relatively low rate of deposition of sediments to the marine nearshore bottom substrates (subsection of Section 3.3.4.3.2). EFH in the Klamath River Estuary could be affected by elevated suspended sediment from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see ubsection of Section 3.3.4.3.2). However, the area of EFH for groundfish affected by the Proposed Action within the Klamath River Estuary is a very small proportion (<1%) of the total EFH designated for groundfish along the Pacific Coast.

In the long term, SSCs would be similar to that under existing conditions. Natural bedload transport processes would resume, as the dams would no longer trap sediments upstream of Iron Gate Dam. Bedload in the estuary and ocean would not be appreciably affected, because of the small contribution of the area above Iron Gate Dam to the total bedload in the system. With the exception of algal toxins, water quality benefits resulting from dam removal would largely have dissipated upstream of the estuary, and therefore, water quality in the estuary would be expected to remain similar to existing conditions. **Based on small proportion of groundfish EFH affected, and short duration of poor water quality during reservoir drawdown in the near-shore environment and estuary, the Proposed Action would have a less-than-significant effect on EFH for groundfish in the short and long term.**

Pelagic Fish EFH EFH for coastal pelagic species occurs from the shorelines of California, Oregon, and Washington westward to the exclusive economic zone and above the thermocline where sea surface temperatures range from 10 to 26 ºC. The effects of

the Proposed Action on pelagic fish EFH would be the same as those described for groundfish EFH in the estuary and near-shore environment. As described for groundfish, the area for EFH for pelagic fish affected by the Proposed Action within the Klamath River Estuary and near-shore environment is a very small proportion proportion (<1%) of the total EFH designated for pelagic species along the Pacific Coast. **Based on small proportion of Pelagic fish EFH affected, and short duration of poor water quality during reservoir drawdown in the near-shore environment and estuary, the Proposed Action would have a less-than-significant effect on EFH for pelagic fish EFH in the short and long term.**

Species-Specific Impacts

As described below, reservoir drawdown associated with dam removal under the Proposed Action could affect aquatic species. In addition, the removal of dams and reservoirs could alter the availability and quality of habitat, resulting in effects on aquatic species.

Species-specific impacts are based upon effects on key ecological attributes summarized above.

Fall-Run Chinook Salmon Quantitative modeling of fall-run Chinook salmon populations suggests that the Proposed Action would increase population abundance. Modeling of dam removal and existing conditions by Oosterhout (2005) suggests that dam removal would substantially increase numbers of spawners over a 50-year period relative to other management scenarios. Additional population capacity and modeling efforts support this conclusion (Huntington 2006, Dunsmoor and Huntington 2006, Hendrix 2011, Lindley and Davis 2011). Of these, the Hendrix (2011) approach is considered the most intensive and robust conducted to date, because it addressed the Proposed Action, used stock-recruitment data from the Klamath River; explicitly incorporated variability in watershed, and ocean conditions; and presented variance estimates of uncertainty. Hendrix (2011) applied a life-cycle model (EDRRA) to forecast the abundance of Chinook salmon (Type I and Type II life history strategies) for both the Proposed Action and continuation of existing conditions (No Action/No Project Alternative) for the years 2012 to 2061. The EDRRA model includes hatchery releases of Chinook salmon from both Iron Gate and Trinity River hatcheries. All returning hatchery origin Chinook salmon are assumed to return to the hatchery and therefore, do not contribute to naturally spawning populations. Production benefits of Chinook salmon releases from Iron Gate hatchery are assumed to end in 2032, four years following the anticipated end of current mitigation releases (Trinity River Hatchery releases will continue). In addition, the model assumes reintroduction efforts described in the KBRA would fully seed available fry habitats upstream of Iron Gate Dam, including the Upper Klamath Basin upstream of Upper Klamath Lake prior to dam removal. The EDRRA model was not developed to be tributary specific; thus Chinook salmon populations originating from tributary streams cannot be separated from the mainstem, the Upper Klamath Basin or other tributaries. Neither implementation of total maximum daily loads (TMDLs) nor climate change was incorporated into the existing models, including the Chinook salmon life cycle model (EDRRA) developed by Hendrix (2011).

The EDRRA Chinook salmon life cycle model developed by Hendrix (2011) addressed fisheries management of Klamath River Chinook salmon. The Pacific Fishery Management Council (PFMC) was established by the Magnuson Fishery Conservation

and Management Act of 1976 and has regulatory jurisdiction over salmon fishing within the 317,690 square mile exclusive economic zone from 3 miles to 200 miles off the coast of Washington, Oregon and California. Jurisdiction over commercial and recreational salmon fishing regulations in nearshore areas, within 3 miles of shore, lies with the respective States. However, the States generally adopt regulations consistent with those established by the PFMC. The Salmon Fishery Management Plan developed by the PFMC describes the goals and methods for salmon management. Management tools such as season length, quotas, and bag limits vary depending on how many salmon are present. There are two central parts of the Plan: Conservation objectives, which are annual goals for the number of spawners of the major salmon stocks ("spawner escapement goals"), and allocation provisions of the harvest among different groups of fishers (commercial, recreational, tribal, various ports, ocean, and inland). The PFMC must also comply with laws such as the ESA. Since the management of salmon considers many factors that can fluctuate greatly from year to year (population abundance and environmental conditions) it is impossible to predict how future management decisions regarding the specific harvest of Klamath Basin salmon might change as a result of the Proposed Action.

Given these uncertainties in management, the EDRRA Chinook salmon life cycle model assumes that current management rules (fishery control rule) established by the PFMC for management of Klamath River Chinook salmon would remain in place throughout the fifty year period of analysis. As stated in Hendrix (2011) "this rule is based on an optimal (i.e., escapement that produces maximum sustainable yield) escapement target after harvest of 40,700 (PFMC 2005)." The analysis uses the same escapement target for both alternatives (40,700) despite the fact that Basin spawning distribution will be extended by hundreds of miles under the Proposed Action (as described below). Therefore, in the EDRRA model, the population is being managed optimally under the No Action/No Project Alternative, whereas it is being managed sub-optimally under the Proposed Action. The management of natural production could be improved by using a Fishery Control Rule that was tailored to the production potential available under the Proposed Action. Such a management change would likely increase EDRRA model predictions of catches and escapement under the Proposed Action.

Hendrix (2011) results indicated substantial uncertainty in Chinook salmon stock recruitment dynamics, resulting in uncertain escapement and harvest abundance forecasts. Despite the uncertainty, modeling results indicate that the Proposed Action would result in higher relative abundance of Chinook salmon. Median escapements to the Klamath Basin are predicted to be higher with the Proposed Action than under existing conditions. The median values were used because the distributions that describe the uncertainty were not symmetric. As a result, the median was a better metric for describing the central portion of the distribution than the mean value. Harvest is also predicted to be greater with the Proposed Action, and the probability of low escapement leading to fishery closures was less under the Proposed Action. Finally, simulations predicted that there is an approximately 75 percent probability that there would be higher escapement with the Proposed Action, and an approximately 70 percent probability of higher annual harvest.

The high degree of overlap in the 95 percent intervals indicate that the statistical properties of the distributions are similar; that is, the range of predicted values are similar due to the large range of uncertainty in stock production values. Conditions that caused model runs to be lower in the Proposed Action relative to the No Action/No Project Alternative are related to fisheries management and the stock production curves used in Lower and Upper Basins. Due to the Fishery Control Rule, productivity of the stock is optimal in almost all years. This occurs because the fishery management ensures that the spawning stock that produces maximum sustainable yield returns to spawn whenever the escapement in the absence of fishing is greater than maximum sustainable yield. This statement of optimal productivity is not true for the Proposed Action for two reasons: 1) Maximum sustainable yield is greater for the Proposed Action due to additional habitat, which is not incorporated into fishery management; and 2) the target escapement by the fishery is combined for the Lower and Upper Klamath Basin; the escapement is too low for the Lower Klamath Basin and too high for the Upper Basin (or vice versa). Thus there are some years and some model iterations when the combined (suboptimal) production from the Lower Klamath Basin and Upper Klamath Basin is less than the optimal production under the No Action/No Project Alternative. In addition to the quantitative modeling results, FERC (2007) and Hamilton et al. (2011) in synthesizing all available information both concluded that increased habitat access following dam removal would result in an increase in the abundance of fall-run Chinook salmon population in the Klamath River Watershed.

To help determine if the Proposed Action will advance restoration of the salmonid fisheries of the Klamath Basin, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action compared with existing conditions (Goodman et al. 2011). The Panel concluded that the Proposed Action appears to be a major step forward in conserving target fish populations in the Klamath Basin. The Panel predicted that, based on the information provided to them, it was possible that the Proposed Action would provide a substantial increase in the abundance of naturally spawned Klamath River Chinook salmon above that expected under existing conditions in the reach between Iron Gate Dam and Keno Dam. In addition, the Panel concluded that the Proposed Action offers greater potential than the current conditions for Chinook salmon to tolerate climate change and changes in marine survival (Goodman et al. 2011). While the Panel agreed that there was also evidence for dramatic increases in abundance associated with the Proposed Action upstream of Keno Dam, they cautioned that achieving substantial gains in Chinook salmon abundance and distribution in the Klamath Basin is contingent upon successfully resolving key factors (discussed in this report in detail) that will continue to affect population, such as water quality, disease, and instream flows. In addition, they stated the concern that successful implementation of KBRA would be required, and would need appropriate scientific leadership.

The influence of the Proposed Action within specific reaches is described below.

<u>Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir</u> Under the Proposed Action, removal of the Four Facilities would allow fall-run Chinook salmon to

regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River, upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat upstream of Iron Gate Dam (DOI 2007), including access to groundwater areas resistant to climate change (Hamilton et al. 2011).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 25°C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, available information indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009). Summer poor water quality conditions, may necessitate seasonal trap and haul around Keno Impoundment/Lake Ewauna for some life stages of primarily fall-run Chinook salmon until KBRA and TMDL implementation improve water quality. This is consistent with the fishway prescriptions of DOI and U.S. Department of Commerce (DOC) (DOI 2007; NOAA Fisheries Service 2007). For adult fall-run Chinook salmon, seasonal collection and transport mortality when water quality is poor is likely to be minor compared to mortality associated with unaided passage through areas of poor water quality at this time of year. Overall, dam removal and associated KBRA actions would accelerate water quality improvements (Dunne et al. 2011) related to implementation of TMDLs and that would help meet beneficial uses such as anadromous fish (WQST 2011).

<u>Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam</u> The Proposed Action would restore fall-run Chinook salmon access to the Hydroelectric Reach), including around 76 miles of potential habitat within the Hydroelectric Reach, as described in the No Action/No Project Alternative analysis above. Historically Chinook salmon (both fall- and spring-run) spawned and were abundant in tributaries within the Hydroelectric Reach, including Jenny, Fall, and Shovel Creeks (Administrative Law Judge 2006).

Adults could first access this reach in fall 2020 after dam removal. Because of this they would not be exposed to the elevated SSCs that would occur during dam removal. By fall 2020, elevated SSCs from dam removal would have subsided. Most of the sediment stored within the removed reservoirs would likely be eroded within the first six months after dam removal, and, at most, cause minor (less than 0.5 foot) deposition in river reaches between reservoirs, settling into pool and other low-velocity habitats as water velocities decrease.

River channel habitat within the reservoir reaches would be low gradient habitat of critical importance for spawning and rearing for salmon, steelhead, redband trout, and Pacific lamprey. The upstream half of the J.C. Boyle Reservoir is shallow and considered low gradient (FERC 2007, p 3-185). FERC also considered the Copco No. 2 bypassed reach and reaches inundated by Iron Gate and Copco reservoirs to be low gradient. For these reaches, they estimated that the density of Chinook salmon spawners

per mile for mainstem habitat was twice that of high gradient habitat (FERC 2007). These river channels would likely excavate to their pre-dam elevations within six months, and revert to and maintain pool-riffle morphology due to restoration of riverine processes, creating holding and rearing habitat for anadromous salmonids.

Modeling (Reclamation 2011) indicate that after dam removal, spawning gravel in all sections of the Hydroelectric Reach would be within the range usable for fall-run Chinook salmon, but the amount of sand within the bed within former reservoir sections could initially inhibit spawning success. The bed material within the reservoirs and between Iron Gate to Cottonwood Creek is expected to have a high content (30 to 50 percent) of sand immediately following reservoir drawdown until a flushing flow moves the sand sized material out of the reach (Reclamation 2012). The flushing flow is expected to be at least 6,000 cfs and of several days to weeks to return the bed to a bed dominated by cobble and gravel with a sand content less than 20 percent. After the flushing flow, the bed is expected to maintain fractions of sand, gravel, and cobble which would be expected under natural conditions. Based on the historical record a sufficient flushing flow would likely occur within 5 years following dam removal. Riverine sections between reservoirs would be expected to provide the preferred substrate size range for fall-run Chinook salmon, with very little sand, suggesting that high-quality spawning habitat would be created.

Habitat exposed following dam removal is anticipated to be used during the first spawning migration after dam removal (fall 2020). At two dam removal sites in southern Oregon on the Rogue River, fall-run Chinook salmon quickly used spawning habitat that was formerly inaccessible under reservoirs, benefiting from conversion to riverine habitat and associated bedload/gravel movement. At Savage Rapids in 2010 (the first full fall after dam removal), 91 redds from within the bounds of the former reservoir were documented where no redds had existed previously, and more the following year. At the Gold Ray impoundment in 2010 (the fall after dam removal), 37 redds were documented from within the bounds of the former reservoir, with over twice that many the following year (ODFW 2011).

The Proposed Action would establish a flow regime that more closely mimics natural conditions by increasing spring flow and by incorporating more variability in daily flows. The reservoir drawdowns would allow tributaries and springs such as Fall, Shovel, and Spencer Creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). As described in detail in the subsection of Section 3.3.4.3.2, risk of fish disease and parasites for fall-run Chinook salmon will decrease. These changes and removal of the reservoirs would result in more favorable water temperature for salmonids, as well as improve water quality and reduce the incidence of disease and algal toxins.

Lower Klamath River: Downstream from Iron Gate Dam

The Proposed Action would decrease dissolved oxygen and release dam-stored sediment downstream to the Lower Klamath River in the short term, and restore a flow regime that more closely mimics natural conditions the long term. Suspended sediment effects on fall-run Chinook salmon under the Proposed Action are described in detail in Appendix E, and summarized here.

Under the most-likely-to-occur scenario or worst-case scenario, no effect from suspended sediment relative to existing conditions is anticipated for all adult fall-run Chinook salmon migrating or spawning within tributaries to the Klamath River during fall 2019 (around 92 percent of the population), or for juveniles rearing within tributaries (Table 3.3-5). Suspended sediment is anticipated to have sublethal effects on Type I and Type II outmigrants (Table 3.3-5). Effects would be distributed over three year-classes, rather than a single year-class. Therefore, Type-II and Type-III progeny of adults that successfully spawn in tributaries during 2020 will produce smolts that outmigrate to the ocean a year after the spring pulse of suspended sediment in 2020 and should not be noticeably affected by the Proposed Action. Direct mortality from suspended sediment is anticipated to include the following:

- Under the most-likely-to-occur or worst-case scenario complete loss of eggs from the 2019 brood year deposited in the mainstem in fall 2019 is predicted. Based on redd surveys from 1999 through 2009 (Magneson and Wright 2010), an average of around 2,100 redds could be affected. Based on escapement estimates in the Klamath Basin from 2001 through 2009 (CDFG 2010, unpublished data) this would be around 8 percent of all anticipated redds in the Basin in 2019.
- Type III juvenile fall-run Chinook salmon from the 2019 cohort (hatched from eggs laid in 2018) outmigrating to the ocean during spring 2020 would be exposed to high SSCs. However, based on outmigrant trapping in the mainstem Klamath River at Big Bar (Scheiff et al. 2001), Type III age 1 spring outmigrants are very rare, and only 31 were observed at Big Bar in four years of trapping, or around 0.1 percent of trap captures. Under a most-likely-to-occur scenario 0 to 20 percent mortality is predicted, or around 0 to 189 smolts (around 0.02 percent

Table 3.3-5. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Fall-run Chinook Salmon

Scenario	Life History Stage: Fall-run Chinook Salmon			
	Adult migration (July 15–Oct 31 2020)	**Spawning through fry emergence (Oct 15 2019–Feb 28 2020)**	**Age 0+ rearing (March 1–March 31 2020)**	**Outmigration (Type I April 1–August 31 2020) (Type II Sept 1–Nov 30 2020) (Type III Feb 1–April 15 2020)**
Most-likely	**Normal Existing Conditions (50% exceedance probabilities)**			
	No effects	No effects.	Moderate stress for age 0 in upper mainstem.	**Type I:** Major stress for Type I fry (about 60% of production)
				Type II: No effects
				Type III: Major stress for about 2 weeks for Type III outmigrants (<1% of production)
	Proposed Action			
	Same as existing conditions	Up to 100% mortality of the progeny of mainstem spawners (approximately 2,100 redds, or around 8% of production).	No juvenile progeny anticipated rearing in mainstem due to impacts during incubation. Most other juveniles assumed to rear in tributaries prior to outmigration.	**Type I:** Major stress and reduced growth
				Type II: Same as existing conditions
				Type III: Major stress, reduced growth, and up to 20% mortality (0 to 189 smolts, or less than 1% of production)
Worst-case	**Extreme Existing Conditions (10% exceedance probabilities)**			
	No effect	A few days of suspended sediment may reduce size at emergence for progeny from mainstem spawning (about 8% of escapement).	Major stress for age 0 in upper mainstem.	**Type I:** Major stress and reduced growth for the about 60% of fry entering mainstem in April–May
				Type II: Moderate stress for the about 40% of Type II juveniles entering mainstem in Sept–Nov
				Type III: Major stress for the less than 1% of juveniles entering mainstem in Feb–April
	Proposed Action			
	Major stress and impaired homing	Up to 100% mortality of the progeny of mainstem spawners (approximately 2,100 redds, or around 8% of production).	No juvenile progeny anticipated in mainstem due to impacts during incubation. Most other juveniles assumed to rear in tributaries prior to outmigration.	**Type I:** Same as existing conditions **Type II:** Moderate (1 day) to major (about 1 wk) stress **Type III:** Major stress, reduced growth, and up to 71% mortality (Up to 669 smolts, or less than 1% of production)

of the total fall-run Chinook salmon smolt production). Under a worst-case scenario mortality rates of up 71 percent are predicted for the Proposed Action, equating to 669 smolts, or around 0.07 percent of the total fall-run Chinook salmon smolt production. Type I and Type II juvenile outmigrants are expected to experience sublethal effects.

As described in detail in Appendix F, the 2021 cohorts could also be affected by sediment deposits with high levels of sand that would likely remain through fall 2020. In the long term, increased supply of gravel from upstream sources is predicted to increase the amount of fall-run Chinook salmon spawning habitat by decreasing the median substrate size to 40 to 60 mm (Reclamation 2012), within the observed range for Chinook salmon spawning (16 to 70 mm [Kondolf and Wolman 1993]). However, in the short term, high sand composition, may reduce the quality of spawning habitat. These levels of sand may continue to affect the 2020 brood year (2021 cohort) as these levels of sand that could remain through fall 2020 unless it is flushed from the substrate during winter flows. Changes in bedload would be limited to the reach from Iron Gate Dam to Cottonwood Creek, a length of 8 miles, or 4 percent of the channel length of the mainstem Klamath River downstream from Iron Gate Dam. The most severe effects would also be limited to a small proportion of the total channel length (0.5 miles, or less than 1 percent of the channel downstream from Iron Gate Dam), as sediment deposition would lessen downstream from Bogus Creek to Cottonwood Creek. At most, around 8 percent of fall-run Chinook salmon in the Klamath Basin are expected to spawn in the mainstem, with an even smaller percentage expected to spawn within the 8-mile affected reach (Appendix E).

In the long term, decreased substrate size is anticipated to improve spawning gravel quality in the mainstem downstream from Iron Gate Dam. Bedload sediment movement and transport are vital to create and maintain functional aquatic habitat. The river would eventually exhibit enhanced habitat complexity due to a more natural flow and reconnected bedload transport regime that will mean the restoration of spawning gravels and early rearing habitat downstream from Iron Gate Dam. Pools would likely return to their pre-sediment release depth within one year (Reclamation 2012), and the river is predicted to revert to and maintain a pool-riffle morphology providing suitable habitat for fall-run Chinook salmon.

Short-term (< 2 months) reductions in dissolved oxygen are anticipated to occur as a result of high SSCs following dam removal, as described in detail in Section X.X. While predicted short-term increases in oxygen demand under the Proposed Action generally result in dissolved oxygen concentrations above the minimum acceptable level (5 mg/L) for salmonids, exceptions to this would occur four to eight weeks following drawdown of J.C. Boyle and Iron Gate reservoirs (i.e., in February 2020), when dissolved oxygen would remain below 5 mg/L from Iron Gate Dam to near the confluence with the Shasta River (RM 176.7), or for a distance approximately 20–25 km downstream from the dam. Any incubating fall-Chinook salmon eggs in the river during this time are assumed to be already suffering 100% mortality caused by increased SSC during this time, and thus the

decrease in dissolved oxygen is not anticipated to have an additional effect. No other life-stages are anticipated to occur in the mainstem Klamath River during this time, and thus will not be affected.

The Proposed Action would establish a flow regime that more closely mimics natural conditions in the Lower Klamath River. Flows under the Proposed Action are intended to benefit fall-run Chinook salmon, and are anticipated to have positive consequences for Chinook salmon given their life cycle in the Klamath River.

As discussed in detail above in the subsection of Section 3.3.4.3.2, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more synchronized with historical migration and spawning periods (Hamilton et al. 2011). Under the Proposed Action, warmer springtime temperatures would result in fall-run Chinook salmon fry emerging earlier (Sykes et al. 2009), encountering favorable temperatures for growth sooner than under existing conditions (Figure 3.3-19), which could support higher growth rates and encourage earlier emigration downstream, thereby reducing stress and disease (Bartholow et al. 2005; FERC 2007). A predicted earlier outmigration in response to elevated water temperatures in the spring is also supported by a vast body of literature relating to increased growth rates and thermal response of outmigrating salmonids (Hoar 1988). In addition, fall-run Chinook salmon spawning in the mainstem during fall would no longer be delayed (reducing prespawn mortality) (Figure 3.3-18), and adult migration would occur in more favorable water temperatures than under existing conditions (Figure 3.3-19). Overall, these changes would result in water temperatures more favorable for fall-run Chinook salmon in the mainstem Klamath River downstream from Iron Gate Dam.

Incidence of disease are expected to be reduced by enhancing the scour capabilities of flow by uninterrupted sediment transport, a flow regime that more closely mimics natural conditions, thereby disturbing the habitat of the polychaete worm that hosts *C. shasta* (FERC 2007). Reducing polychaete habitat will likely increase abundance of smolts by increasing outmigration survival, particularly for Type I and Type III life-histories (FERC 2007).

<u>Estuary</u>
Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, the Proposed Action would not substantially change or affect estuarine habitat used by fall-run Chinook salmon. Short- and long-term improvements to water quality and reductions in algal toxins would be expected with the establishment of a flow regime that more closely

mimics natural conditions, and would benefit fall-run Chinook salmon. In addition, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Fall-Run Chinook Salmon

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and bedload sediment transport and deposition and affect fall-run Chinook salmon. Fall-run Chinook salmon use the mainstem Klamath River for spawning, rearing, and as a migratory corridor. Direct mortality is predicted for fall-run Chinook salmon redds and some smolts. However, the effect of SSC from the Proposed Action on the fall-run Chinook salmon population, under both most-likely and worst-case scenarios, is expected to be relatively minor because of variable life histories, the large majority of age 0 juveniles that remain in tributaries until later in the spring and summer, and because many of the fry that outmigrate to the mainstem come from tributaries in the mid- or Lower Klamath River, where SSCs resulting from the Proposed Action are expected to be lower due to dilution from tributaries. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for fall-run Chinook salmon in the short term.**

Mitigation Measures AR-1 through AR-4 (see Section 3.3.4.4) could be implemented to reduce the short-term effects of SSCs on fall-run Chinook salmon incubating eggs and smolts. There would still be short-term effects for fall-run Chinook salmon, including some direct mortality, but no one year class would suffer a substantial decrease in abundance. **Based on minimal reduction in the abundance of a year class in the short term, the Proposed Action would be a less-than-significant effect on fall-run Chinook salmon after mitigation.**

Under the Proposed Action, removal of dams could alter habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins, all of which could affect fall-run Chinook salmon in the long term. As stated above, dam removal would also restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create additional spawning and rearing habitat within the Hydroelectric Reach. By providing an unimpeded migration corridor, the Proposed Action would provide the greatest possible benefit related to fish passage, hence, the highest survival and reproductive success. It is anticipated that the Proposed Action would increase the abundance, productivity, population spatial structure, and genetic diversity of fall-run Chinook salmon in the Klamath River watershed. In general, free flowing conditions as per the Proposed Action, would likely provide optimal efficiency, decrease outmigrant delay, and increase concomitant adult escapement (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. In addition, under the Proposed Action diminished disease conditions and improved water quality in the mainstem Klamath River will likely improve the survival of smolts outmigrating from tributaries downstream from Iron Gate Dam (e.g., Scott and Shasta rivers), thus

increasing the likelihood of successful restoration actions in those watersheds. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for fall-run Chinook salmon in the long term**.

Spring-Run Chinook Salmon As discussed above for fall-run Chinook salmon, a Chinook Salmon Expert Panel was convened to attempt to answer specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action compared with existing conditions (Goodman et al. 2011). While noting uncertainties based on existing data, the panel concluded that the prospects for the Proposed Action to provide a substantial positive effect for spring Chinook salmon is more remote than for fall-run Chinook salmon. The primary concern of the panel was that low abundance and productivity (return per spawner) of spring Chinook salmon would limit recolonization of habitats upstream of Iron Gate Dam. However, as described below in this section, this concern would be addressed in that the KBRA includes a reintroduction component to establish populations in the new habitats. KBRA implementation would reintroduce spring-run Chinook salmon upstream of Upper Klamath Lake in Phase 1. The adaptive management approach to reintroduction will include spring-run and fall-run Chinook salmon (Hooton and Smith 2008). Even without supplementation, it is likely that spring-run Chinook salmon recolonization would occur as it did for Chinook salmon following barrier removal at Landsburg Dam in Washington (Kiffney et al. 2009). In addition, KBRA actions would be implemented that are anticipated to improve productivity of existing and potentially newly accessible habitats. The influence of the Proposed Action within specific reaches is described below.

<u>Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir</u>
Under the Proposed Action, dam removal would allow spring-run Chinook salmon to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir (FERC 2007). The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River and upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2010). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007). Warmer winter water temperatures associated with groundwater would also be conducive to the growth of salmonids (Hamilton et al. 2011).

The Proposed Action would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins in this reach. Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 25 °C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, available information indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009). Historically, adult spring-run Chinook salmon migrated upstream of the current location of Iron Gate Dam perhaps as early as February and March (Fortune et al. 1966) and likely held over in large holding pools in the mainstem in tributaries fed by cool water, and in refugia habitat upstream of Upper Klamath Lake (CDFG 1990c; Moyle 2002; Snyder 1931). One benefit of such early migration would be the avoidance of periods of poor water quality. The restored water temperature regime under the Proposed Action may restore upstream migration timing of adult spring-run Chinook salmon because of the shift in water temperatures downstream from Iron Gate dam (Bartholow et al. 2005).

Summer poor water quality conditions, may necessitate seasonal trap and haul around Keno Impoundment/ Lake Ewauna for some life stages of Chinook salmon (primarily fall-run) until KBRA and TMDL implementation improve water quality. This is consistent with the fishway prescriptions of DOI and DOC (DOI 2007; NOAA Fisheries Service 2007). Overall, dam removal and associated KBRA actions would accelerate water quality improvements (Dunne et al. 2011) and TMDL water quality benefits to anadromous fish (WQST 2011).

Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Huntington (2006) cautioned that while access to the Upper Klamath Basin provides considerable promise of increasing spring-run abundance, the existing potential for Chinook salmon production within the Basin upstream of Upper Klamath Lake is clearly much lower than his estimate of historical potential. However, Huntington (2006) did not fully account for the historical (and unknown) production potential of Upper Klamath Lake itself, which could have been considerable, as suggested by a recent experimental reintroduction into Upper Klamath Lake (Maule et al. 2009).

<u>Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam</u>
The Proposed Action would restore spring-run Chinook salmon access to the Hydroelectric Reach), including around 76 miles of potential habitat within the Hydroelectric Reach, as described in the No Action/No Project Alternative analysis above. Chinook salmon (both fall- and spring-run) historically spawned and were abundant in tributaries within the Hydroelectric Reach, including Jenny, Fall, and Shovel creeks (Administrative Law Judge 2006). Adults could first access this reach in spring 2021 after dam removal; thus, short-term gains in flow-related habitat or habitat expansion would be limited to later cohorts. Elevated SSCs and bedload movement from dam removal would have dissipated by this time (see Figure 3.3-5, Figure 3.3-6, and Figure 3.3-7), returning to background levels similar to those under existing conditions and would not be expected to affect spring-run Chinook salmon using this area.

The Proposed Action would eliminate the Four Facilities and would establish a flow regime that more closely mimics natural conditions by increasing spring flow and by incorporating more variability in daily flows. The removal of the reservoirs would allow Fall, Shovel, and Spencer Creeks to flow directly into the mainstem Klamath River, along with Big Springs in the J.C. Boyle Bypass Reach and additional springs, which would provide fish with patches of cooler water as refugia during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). As described in detail in the subsection of Section 3.3.4.3.1, risk of fish disease and parasites for spring-run Chinook salmon will decrease. These changes and removal of the reservoirs would result in more favorable water temperature for salmonids, as well as improve water quality and reduce the incidence of disease and algal toxins.

Lower Klamath River: Downstream from Iron Gate Dam

The Proposed Action would release dam-stored sediment downstream to the Lower Klamath River Reach in the short term, and would establish a flow regime that more closely mimics natural conditions in the long term. Adult spring-run Chinook salmon do not currently occur upstream of the Salmon River, and would not be expected to be able to use the mainstem Klamath River upstream of Iron Gate Dam until conditions in the Hydroelectric Reach are suitable.

Suspended sediment effects on spring-run Chinook salmon under the Proposed Action are described in detail in Appendix E, and summarized here. The distribution of spring-run Chinook salmon in the Salmon River and tributaries downstream limits their exposure to mostly lower concentrations of suspended sediment. Under the most-likely-to-occur scenario or worst-case scenario, no effect from suspended sediment relative to existing conditions is anticipated for all spring-run Chinook salmon spawning and rearing, which occurs primarily within tributaries (Table 3.3-6). Suspended sediment is anticipated to have sublethal effects on adult migration, primarily for those adult returning to the Salmon River (around 5 percent of all spring-run migrants), and sublethal effects on Type I and Type II outmigrants (Table 3.3-6). Direct mortality from suspended sediment is anticipated to include the following:

- Type III juvenile spring-run Chinook salmon from the 2019 cohort (hatched from eggs laid in 2018) outmigrating to the ocean from the Salmon River during spring 2020 would be exposed to high SSCs. However, based on outmigrant trapping in the Salmon River, Type III age 1 spring outmigrants are very rare, and only 30 were observed in five years of trapping. Assuming a larger number of Type III smolts outmigrate from the Salmon River and are undetected (assume an average of around 78 Type III smolts per year), under a most-likely-to-occur scenario 0 to 20 percent mortality is predicted or 16 smolts at most (less than 1 percent of the total spring-run Chinook salmon smolt production). Under a worst-case scenario mortality rates of 20 to 36 percent are predicted, or around 28 smolts at worst (<1 percent of all production). Type I and Type II juvenile outmigrants are expected to experience sublethal effects.

Table 3.3-6. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Spring-run Chinook Salmon

Scenario	Life History Stage: Spring-run Chinook Salmon			
	Adult migration (Apr 1–Jun 30, 2020)	**Spawning through fry emergence (Sept 1 2019–Feb 28, 2020)**	**Fry and juvenile rearing (year-round)**	**Outmigration (Type I: April 1–August 31 2020) (Type II: Sept 1–Nov 30 2020) (Type III: Feb 1–April 15 2020)**
Most likely	**Existing Conditions (normal)**			
	Spring Migration: Moderate stress and Impaired homing for adults returning to Salmon River (average 5% of total run, up to 35% of natural run) **Summer Migration:** No effects	Most spawning takes place in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	**Type I:** Major stress for Type I fry from Salmon River (about 80% of Salmon River production) **Type II:** No effects (about 20% of Salmon R. production) **Type III:** Major stress for Type III juveniles from Salmon River (< 1% of Salmon River production)
	Proposed Action			
	Spring Migration: Major stress and impaired homing **Summer Migration:** Same as existing conditions	Same as existing conditions	Same as existing conditions	**Type I:** Same as existing conditions **Type II:** Same as existing conditions **Type III:** Major stress, reduced growth, and up to 20% mortality. (around 16 smolts, less than 1% of the total smolt population from the Salmon River)
Worst-case	**Existing conditions (extreme)**			
	Spring Migration: Major stress and impaired homing **Summer Migration:** Moderate stress	Most spawning takes place in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	**Type I:** Major stress for Type I fry from Salmon River (about 80% of Salmon River production) **Type II:** Moderate stress for Type II juveniles from Salmon River (about 20% of Salmon River production) **Type III:** Major stress for Type III juveniles from Salmon River (<1% of Salmon River production)
	Proposed Action			
	Spring Migration: Same as existing conditions **Summer Migration:** Impaired homing	Same as existing conditions	Same as existing conditions	**Type I:** Same as existing conditions **Type II:** Same as existing conditions **Type III:** Major stress, reduced or no growth, and up to 36% mortality (up to 28 smolts, less than 1% of the total smolt population from the Salmon River)

Adults could first access the reach upstream of the Iron Gate Dam in Spring 2021 if dam removal is completed by April of that year. As described in detail in Appendix F, short- and long-term changes in bedload would be limited to the reach from Iron Gate Dam to Cottonwood Creek, a length of 8 miles, or 4 percent of the mainstem Klamath River channel downstream from Iron Gate Dam (Appendix F). The most severe effects would also be limited to a small proportion of the total channel length (0.5 miles, or less than 1 percent of the channel downstream from Iron Gate Dam), as sediment deposition would lessen downstream from Bogus Creek to Cottonwood Creek and, thus, would not affect the area currently used by spring-run Chinook salmon. Within one year (i.e., by spring 2021), SSCs would have returned to background levels and the channel would likely have reverted back to its previous pool-riffle morphology (Stillwater Sciences 2008).

The Proposed Action would create a flow regime that more closely mimics natural conditions in the Lower Klamath River by increasing spring flow and by incorporating more variability in daily flows. As discussed in detail above, dam removal would cause water temperatures to warm earlier in the spring and early summer and cool earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. Migrating adults and juveniles rearing or migrating in the mainstem in spring 2020 would be exposed to poor water quality due to the Proposed Action. Because most spawning occurs in the Salmon and Trinity Rivers, magnitude of exposure would be limited by dilution from tributaries entering downstream from Iron Gate Dam.

Incidence of disease are expected to be reduced by enhancing the scour capabilities of flow by uninterrupted sediment transport, a flow regime that more closely mimics natural conditions, thereby disturbing the habitat of the polychaete worm that hosts *C. shasta*. Reducing polychaete habitat would likely increase abundance of smolts by increasing outmigration survival, particularly for Type I and Type III life-histories.

<u>Estuary</u>
Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, the Proposed Action is not expected to substantially change or affect spring-run Chinook salmon estuarine habitat. Short- and long-term improvements to water quality and reductions in algal toxins would be expected with the establishment of a flow regime that more closely mimics natural conditions. This would benefit spring-run Chinook salmon. Flow and water temperature effects would likely not extend downstream to the estuary.

Summary: Spring-Run Chinook Salmon

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and bedload sediment transport and deposition and affect spring-run Chinook salmon. The overall effect of suspended sediment from the Proposed Action on the spring-run Chinook salmon population is not anticipated to differ much from existing conditions and the No Action/No Project Alternative. There is very little difference from existing conditions and the No Action/No Project Alternative for adult migrants, all of which is predicted to be sublethal, and no effects are anticipated for the spawning, incubation, and fry stages because they do not spawn in the mainstem. Type I and II outmigrants are expected to experience very similar conditions under the Proposed Action as under existing conditions and the No Action/No Project Alternative. However, direct mortality is predicted for some Type III smolts (< 1 percent of production). **Based on minimal reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be less-than-significant for spring-run Chinook salmon in the short term.**

Implementation of Mitigation Measures AR-2 (see Section 3.3.4.4) could reduce the short-term effects of SSCs on spring-run Chinook salmon Type III smolts. With implementation of mitigation measures, there would still be short-term effects for spring-run Chinook salmon including some potential direct mortality, but there would not be a substantial reduction in the abundance of a year class. **Based on minimal reduction in the abundance of a year class in the short term, the Proposed Action would be a less-than-significant effect on spring-run Chinook salmon after mitigation.**

Under the Proposed Action, removal of dams could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect spring-run Chinook salmon in the long term. Dam removal would restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin, including additional habitat within the Hydroelectric Reach. Access to additional habitat would provide a long-term benefit to spring-run Chinook salmon populations. The expansion of habitat opportunities would allow maximum expression of life-history variation and the restoration of an additional population of spring-run Chinook salmon population to strengthen resiliency in the Klamath Basin, particularly because passage upstream of Iron Gate Dam would provide access to groundwater thermal refugia during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). By providing an unimpeded migration corridor, the Proposed Action would provide the greatest possible benefit related to fish passage, hence, the highest survival and reproductive success (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. In addition, with large scale hydraulic mining operations now outlawed, spring-run Chinook salmon would no longer be subject to one of their most significant threats in the Klamath River (as discussed above in the subsection of Section 3.3.3.1.1.).

Current improved fisheries management also minimizes overharvest. It is anticipated that as a result of the Proposed Action the spring-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, productivity, population spatial structure, and genetic diversity. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for spring-run Chinook salmon in the long term.**

Coho Salmon A Coho Salmon and Steelhead Expert Panel was convened and charged with answering specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action on coho salmon and steelhead (Dunne et al. 2011). While noting the constraints of the Panel to arrive at conclusions within a short time period and without adequate quantitative or synthesized information, the conclusion of the Panel was that: "Although Current Conditions will likely continue to be detrimental to coho, the difference between the Proposed Action and Current Conditions is expected to be small, especially in the short term (0-10 years after dam removal). Larger (moderate) responses are possible under the Proposed Action if the KBRA is fully and effectively implemented and mortality caused by the pathogen *C. shasta* is reduced. The more likely small response will result from modest increases in habitat area usable by coho with dam removal, small changes in conditions in the mainstem, positive but un-quantified changes in tributary habitats where most coho spawn and rear, and the potential risk for disease and low ocean survival to offset gains in production in the new habitat."

<u>Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir</u>
There is no historical evidence that coho salmon occurred upstream of J.C. Boyle Reservoir. However, in historical interviews Snyder (1931) noted that while, "silver salmon are said to migrate to the headwaters of the Klamath to spawn, the interviews were not conclusive since most people at the time did not distinguish between the various anadromous salmonid species. Overall, historical evidence of coho salmon occurrence upstream of Spencer Creek and J.C. Boyle reservoir is uncertain.

<u>Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam</u>
The Proposed Action would restore access for upper Klamath River Population coho salmon to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall Creeks (Hamilton et al. 2005), including around 76 miles of potential habitat within the Hydroelectric Reach, as described in the No Action/No Project Alternative analysis above. Coho salmon downstream from Iron Gate Dam belonging to the Upper Klamath River Population Unit would migrate above the dam if access was provided by fishways (Administrative Law Judge 2006). Over time, access to habitat above Iron Gate Dam would benefit the Upper Klamath River Population Unit by: a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; b) increase genetic diversity in the coho stocks; c) reduce the species vulnerability to the impacts of degradation; and d) increase the abundance of the coho salmon population (Administrative Law Judge 2006). The NRC of the National Academy of Science reviewed causes of decline and

strategies for recovery of endangered and threatened fishes of the Klamath Basin. The NRC concluded that "removal of Iron Gate Dam... could open new habitat, especially by making available tributaries that are now completely blocked to coho" (NRC 2004). In a recent evaluation of recolonization after access was provided, juvenile coho salmon established a population and outnumbered resident salmonid species by 40 percent within 5 years of colonization (Pess et al. 2011).

Adults could first access this reach in fall 2020 after dam removal. By this time, elevated SSCs from dam removal would likely have dissipated, returning to background levels similar to those of existing conditions. Most sediment released from the reservoirs would likely be eroded within the first six months after dam removal (by May 2020), returning sections of river currently inundated by the Four Facilities and riverine sections between reservoirs to pool-riffle morphology. Within this reach, coho salmon generally spawn in tributaries and not within the mainstem Klamath River, but might rear and migrate through the Hydroelectric Reach. Dam removal would result in the provision of suitable rearing habitat for juveniles and spawning habitat for the few individuals that might spawn in the mainstem Klamath River. Access to the cooler waters associated with spring inputs in the Hydroelectric Reach would benefit coho salmon rearing in the mainstem (Hamilton et al. 2011).

The Proposed Action would also eliminate the Four Facilities and would establish a flow regime that more closely mimics natural conditions by increasing spring flow and by incorporating more variability in daily flows. The reservoir drawdowns would allow tributaries and springs such as Fall, Shovel, and Spencer Creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). As described in detail in the subsection of Section 3.3.4.3.2, risk of fish disease and parasites for coho salmon will decrease. These changes and removal of the reservoirs would result in more favorable water temperature for salmonids, as well as improve water quality and reduce the incidence of disease and algal toxins. All of these changes would benefit coho salmon produced in the Hydroelectric Reach in 2020 and thereafter.

<u>Lower Klamath River: Downstream from Iron Gate Dam</u>
The Proposed Action would release dam-stored sediment downstream to the Lower Klamath River Reach in the short term and would establish a flow regime that more closely mimics natural conditions in the long term. Suspended sediment effects on coho salmon under the Proposed Action are described in detail in Appendix E, and summarized here. There are nine coho salmon population units in the Klamath River watershed (see the subsection of Section 3.3.3.1.4). Only negligible effects from suspended sediment would be expected on the three population units in the Trinity River, and on the Lower Klamath River Population Unit relative to existing conditions. Effects on the Salmon River Population Unit are anticipated to remain sublethal even under a worst-case scenario (Table 3.3-7). Effects on the upper Klamath River, mid-Klamath

Table 3.3-7. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Coho Salmon

Scenario	Life History Stage: Coho Salmon				
	Adult migration (Sept 1, 2019–Jan 1, 2020)	**Spawning through fry emergence (Nov 1, 2019–Mar 14, 2020)**	**Age 0+ rearing during summer (Mar 15–Nov 14, 2020)**	**Age 1+ rearing during winter (Nov 15, 2019–Feb 14, 2020)**	**Outmigration Early spring outmigration: (Feb 15–March 31, 2020) Late spring outmigration: (April 1– June 30, 2020)**
Most Likely	**Existing Conditions (normal)**				
	Stressful SSCs for about 5 days; deleterious effects on adults unlikely	Low survival (<20%)	**Age 0+ summer:** Major stress for age 0+ from 2020 cohort in mainstem (<50% of fry)	**Age 1+ winter:** Moderate stress for age 1+ juveniles from 2019 cohort in mainstem (assume <1% of juveniles)	**Early spring outmigration:** Major stress mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring) **Late spring outmigration:** Major stress for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during late spring (approximately 56% of run)
	Proposed Action				
	Major stress and impaired homing	Up to 100% mortality of progeny of mainstem spawners (about 13 redds, or 0.7–26% of Upper Klamath River Population Unit natural escapement)	**Age 0+ summer:** Reduced growth	**Age 1+ winter:** Major stress, reduced growth, and up to 20% mortality	**Early spring outmigration:** Major stress, reduced growth, and up to 20% mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (~44 percent of run outmigrate in early spring). (2,668 smolts, 3% of total production in basin) **Late spring outmigration:** Major stress and reduced growth

Table 3.3-7. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Coho Salmon

Scenario	Life History Stage: Coho Salmon				
	Adult migration (Sept 1, 2019–Jan 1, 2020)	**Spawning through fry emergence (Nov 1, 2019–Mar 14, 2020)**	**Age 0+ rearing during summer (Mar 15–Nov 14, 2020)**	**Age 1+ rearing during winter (Nov 15, 2019–Feb 14, 2020)**	**Outmigration Early spring outmigration: (Feb 15–March 31, 2020) Late spring outmigration: (April 1– June 30, 2020)**
Worst-case	**Existing Conditions (extreme)**				
	Major stress and impaired homing	Up to 100% mortality of progeny of mainstem spawners (about13 redds, or 0.7–26% of Upper Klamath River Population Unit natural escapement)	**Age 0+ summer:** Major stress and reduced growth for fish rearing in mainstem (< 50% of fry)	**Age 1+ winter:** Major stress and reduced growth for fish rearing in mainstem (assume <1% of juveniles)	**Early spring outmigration:** Major stress and reduced growth for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring) **Late spring outmigration:** Major stress for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during late spring (approximately 56% of run)
	Proposed Action				
	Same as existing conditions	Same as existing conditions	**Age 0+ summer:** No growth	**Age 1+ winter:** Major stress, reduced growth and up to 52% mortality	**Early spring outmigration:** Major stress, reduced growth, and up to 49% mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of run outmigrate in early spring) (6,536 smolts, 8% of total production in basin) **Late spring outmigration:** Major stress and reduced growth

River, Shasta, and Scott population units under the most-likely-to-occur or worst-case scenario are anticipated to be sublethal on most life-stages (Table 3.3-7), with the following exceptions:

- Under the most-likely-to-occur or worst-case scenario, coho salmon from the Upper Klamath River Population Unit that spawn in the mainstem, as well as their progeny, would suffer up to 100 percent mortality; however, even under existing conditions and the No Action/No Project Alternative, 80–100 percent mortality is expected due to the effects of suspended sediment on these life stages (in addition to other sources of mortality). Based on spawning surveys conducted from 2001 to 2005 (Magneson and Gough 2006), from 6 to 13 redds could be affected in 2019 during the Proposed Action, many of which are thought to be hatchery returning fish (NOAA Fisheries Service 2010a). Based on the range of escapement estimates of Ackerman et al. (2006), 13 redds (the highest number observed) could represent anywhere from 0.7 to 26 percent of the naturally returning spawning in the Upper Klamath River Population Unit, and much less than 1 percent of the natural and hatchery returns combined.
- Coho salmon smolts outmigrating from tributaries in the Upper or Mid-Klamath River, Shasta, or Scott populations during early spring (around 46 percent of outmigrating smolts compared to those that outmigrate in late spring) are predicted to experience 20 percent mortality under a most-likely-to-occur scenario, or around 49 percent mortality under a worst-case scenario. Anticipated total mortality varies by population, and is detailed in Appendix E.

All population units would be expected to recover from these losses within one or two generations, given the benefits to the population. Although no single year-class is expected to be completely lost, mortality of a portion of the smolt outmigration from the upper Klamath River, mid-Klamath River, Shasta River, and Scott River population units may affect the strength of the 2018 year class, requiring two or three generations to recover from losses.

The Proposed Action would also result in the release of bedload sediment, as described in detail in Appendix F. Effects associated with release of coarse sediment are expected to affect the same individuals described for suspended sediment above. For example, bedload sediment is predicted to bury redds constructed in fall 2019, which are the same redds expected to suffer from suspended sediment (~13 redds, or 0.7–26 percent of Upper Klamath River Population unit natural escapement). In addition, bedload sediment could result in the deposition that could aggrade pools or overwhelm other habitat features that coho salmon use for adult holding or juvenile rearing. However, the effect on habitat is anticipated to be short term, and pools would likely return to their pre-sediment release depth within one year (Reclamation 2012). If the magnitude and duration of flows in spring 2020 are sufficiently high to effectively mobilize the bed, coho salmon spawning

habitat in the mainstem downstream from Iron Gate Dam could improve over existing conditions. Within six months the river is predicted to revert to and maintain a pool-riffle morphology, providing a benefit to coho salmon.

As discussed in detail above in the subsection of Section 3.3.4.3.2, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. Cooler water temperatures during fall would benefit upstream migrant adults and juveniles during fall upstream migration and juvenile redistribution to overwintering habitats by providing a broader window of suitable habitat. Spring outmigrants may also move out earlier, potentially reducing their susceptibility to parasites. As with SSCs, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to poor water quality due to the Proposed Action, but these effects would be short term.

Incidence of disease are expected to be reduced by enhancing the scour capabilities of flow by uninterrupted sediment transport, a flow regime that more closely mimics natural conditions, thereby disturbing the habitat of the polychaete worm that hosts *C. shasta*. Reducing polychaete habitat would likely increase abundance of smolts by increasing outmigration survival.

Estuary

Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, the Proposed Action is not expected to substantially change or affect coho salmon estuarine habitat. Flow and water temperature effects would likely not extend downstream to the estuary.

Summary: Coho Salmon

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and bedload sediment transport and deposition and affect coho salmon. In general, the wide distribution and use of tributaries by both juvenile and adult coho salmon will likely protect the population from the worst effects of the Proposed Action. However, direct mortality is anticipated for redds and smolts from the upper Klamath River, mid-Klamath River, Shasta River, and Scott River population units. No mortality is anticipated for the Salmon River, Trinity River, and Lower Klamath River populations under the most likely or worst-case scenarios. All population units would be expected to recover from these losses within one or two generations, given the benefits described below. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for the coho salmon**

from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units in the short term. Based on no reduction in the abundance of a year class, the effect of the Proposed Action would be less-than-significant for the coho salmon from the three Trinity River population units, Salmon River and the Lower Klamath River Population Unit in the short term.

Implementation of Mitigation Measures AR-1 through AR-4 (see Section 3.3.4.4) could reduce the short-term effects of SSCs on coho salmon adults, incubating eggs, and smolts. With implementation of mitigation measures there would still be short term effects for coho salmon including direct mortality to as high as 18 percent of the smolts from some population units under a worst-case scenario (see Section 3.3.4.4). **Based on substantial reduction in the abundance of a year class in the short term, the Proposed Action would have a significant effect on coho salmon from the Upper Klamath River, Mid-Klamath River, Shasta River, and Scott River population units after mitigation in the short term.**

Under the Proposed Action, removal of dams could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect coho salmon in the long term. Substantial declines in abundance resulting from effects of the Proposed Action are not anticipated for more than one year class (i.e. one generation), although complete recovery of that year class may require two to three generations. Dam removal would restore connectivity to habitat on the mainstem Klamath River up to and including Spencer Creek and would create additional habitat within the Hydroelectric Reach. As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. It is anticipated that as a result of the Proposed Action, the Upper Klamath River, Mid-Klamath River, Shasta River, Scott River, Salmon River, and Lower Klamath River coho salmon population units would have an increase in abundance, productivity, population spatial structure, and genetic diversity. In general, free flowing conditions as per the Proposed Action, would likely provide optimal efficiency, decrease outmigrant delay, and increase concomitant adult escapement (Buchanan et al. 2011b). It is anticipated that as a result of the Proposed Action, the three Trinity River population units would have increased productivity. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for the coho salmon from the Upper Klamath River, Mid-Klamath River, Lower Klamath River, Shasta River, Scott River, and Salmon River population units in the long term**. **Based on improved habitat quality, the effect of the Proposed Action on coho salmon from the three Trinity River population units would be less-than-significant for the long term.**

Steelhead A Coho Salmon and Steelhead Expert Panel was convened and charged with answering specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action on coho salmon and steelhead

(Dunne et al. 2011). The conclusion of the Panel was that the Proposed Action could result in increased spatial distribution and abundance of steelhead. This assessment is based on the observations that steelhead would be able to access a substantial extent of new habitat, steelhead are relatively tolerant to warmer water (compared to coho salmon), they are similar to other species (resident redband/rainbow trout) that are currently thriving in upstream habitats, and that while steelhead are currently at lower abundances than historical values, they are not yet rare. The influence of the Proposed Action within specific reaches is described below.

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir
Under the Proposed Action, dam removal would allow steelhead to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. This would expand the population's distribution to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising 360 miles of additional potentially productive habitat (Huntington 2006; DOI 2007; NOAA Fisheries Service 2007).

The Proposed Action would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins and disease in the Upper Klamath River. Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
The Proposed Action would restore steelhead access to the Hydroelectric Reach, including an estimated 80 miles of habitat within the Hydroelectric Reach, as described in the No Action/No Project Alternative analysis above. Adults could first access this reach in fall 2020 (winter steelhead) or winter 2021 (summer steelhead) after dam removal (summer steelhead spawning typically does not begin until December). Elevated SSCs resulting from dam removal would likely have returned to background levels similar to existing conditions. Steelhead could use this reach as a migration corridor, as most sediment released from the reservoirs would likely be eroded within the first 6 months after dam removal (by May 2020) and would not impede upstream movement. Reaches currently inundated by reservoirs and reaches between reservoirs would likely return to a pool-riffle morphology, which would benefit rearing steelhead.

The Proposed Action would also eliminate the reservoirs and establish a flow regime that more closely mimics natural conditions by increasing spring flow and by incorporating more variability in daily flows. The reservoir drawdowns would allow tributaries and springs such as Fall, Shovel, and Spencer Creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). The action would also be likely to nearly eliminate blue-green algae blooms and their associated toxins, improving water quality. These changes would benefit steelhead.

Lower Klamath River: Downstream from Iron Gate Dam

The Proposed Action would release dam-stored sediment downstream to the Lower Klamath River in the short term, and restore a flow regime that more closely mimics natural conditions in the long term. Suspended sediment effects on steelhead under the Proposed Action are described in detail in Appendix E, and summarized here.

Under the most-likely-to-occur scenario or worst-case scenario, no effect from suspended sediment relative to existing conditions is anticipated for the half-pounder life history, all spawning (which occurs primarily in tributaries), and age 0 rearing (Table 3.3-8). Sublethal effects are anticipated for all other life stages (Table 3.3-8), with the following exceptions:

- Under the most-likely-to-occur scenario, up to 36 percent mortality is predicted for the winter run steelhead (up to 1,008 adults, or up to 14 percent of the total winter run escapement). On average around 20 percent of winter steelhead migrate prior to initiation of reservoir drawdown on December 15th. In addition, steelhead are highly mobile species that have been known to stray to avoid habitat degradation (Bisson et al. 2005), and regularly occur in environments with high SSC, and therefore the predictions described here are likely more dire than would occur. It is likely that at least some would enter tributaries if conditions within the mainstem were adverse.
- Under the most-likely-to-occur scenario, up to 52 percent mortality is predicted for age 1 juveniles in the mainstem (up to 8,200 juveniles or around 14 percent of total basin-wide age 1 production).
- Under the most-likely-to-occur scenario, up to 52 percent mortality is predicted for age 2 juveniles in the mainstem (up to 6,893 juveniles or around 13 percent of total basin-wide age 2 production).
- Under the worst-case scenario, 0 to 20 percent mortality is predicted for the summer run steelhead (from 0 to 130 adults, or from 0 to 9 percent of the basin-wide escapement).
- Under the worst-case scenario, 71 percent mortality is predicted for the winter run steelhead (up to 1,988 adults, or up to 28 percent of the basin-wide escapement). On average around 20 percent of winter steelhead migrate prior to initiation of reservoir drawdown on December 15th. In addition, steelhead are highly migratory species that stray to avoid habitat degradation (Bisson et al. 2005), and regularly occur in environments with high SSC, and therefore the predictions described here are likely more dire than would occur.
- Under the worst-case scenario, up to 71 percent mortality is predicted for age 1 juveniles in the mainstem (up to 11,207 juveniles or around 19 percent of total basin-wide age 1 production).
- Under the worst-case scenario, up to 71 percent mortality is predicted for age 2 juveniles in the mainstem (up to 9,412 juveniles or around 18 percent of total basin-wide age 2 production).

Table 3.3-8. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Summer and Winter Steelhead

Scenario	Life History Stage: Summer and Winter Steelhead					
	Adult migration Summer run: (Mar 1–June 30, 2020) Winter run: (Aug 1 2019–Mar 31, 2020)	**Adult runbacks: (Apr 1–May 30, 2020) Half-pounder residency (Aug 15, 2019–Mar 31, 2020)**	**Spawning through fry emergence (Dec 1, 2019–June 1, 2020)**	**Age 0+ rearing (Mar 15–Nov 14, 2020)**	**Juvenile rearing Age 1+: (year-round 2019 and 2020) Age 2+: (Nov 15, 2019–Mar 31, 2020)**	**Outmigration (Apr 1–Nov 14, 2020)**
	Existing Conditions (normal)					
Most likely	**Summer run:** Major stress, possibly impaired homing for fish spawning in mid- and upper-Klamath tributaries (about 45% of escapement) **Winter run:** Major stress, possibly impaired homing for fish spawning in mid- and upper-Klamath tributaries (about 80% of escapement)	**Adult runbacks:** Major stress depending on time spent in mainstem **Half-pounder residency:** Many will have returned to the ocean or estuary; those remaining may experience major stress in the mainstem, but may avoid suspended sediment by entering nearby tributaries	Most spawning takes place in tributaries; no effects predicted	Major stress for age 0+ juveniles in mainstem (about 60% of juveniles)	**Age 1+ rearing:** Major stress for juveniles in mainstem (about 60% of juveniles) **Age 2+ rearing:** Major stress for juveniles in mainstem (about 60% of juveniles)	Major stress during outmigration, depending on time spent in mainstem; about 57% outmigrate from Trinity River and will have less exposure

Table 3.3-8. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Summer and Winter Steelhead

Scenario	Life History Stage: Summer and Winter Steelhead					
	Adult migration Summer run: (Mar 1–June 30, 2020) Winter run: (Aug 1 2019–Mar 31, 2020)	**Adult runbacks: (Apr 1–May 30, 2020) Half-pounder residency (Aug 15, 2019–Mar 31, 2020)**	**Spawning through fry emergence (Dec 1, 2019–June 1, 2020)**	**Age 0+ rearing (Mar 15–Nov 14, 2020)**	**Juvenile rearing Age 1+: (year-round 2019 and 2020) Age 2+: (Nov 15, 2019–Mar 31, 2020)**	**Outmigration (Apr 1–Nov 14, 2020)**
	Proposed Action					
Most likely	**Summer run:** Same as existing conditions **Winter run:** Major stress, impaired homing, and up to 36% mortality (Up to 1,008 adults, or up to 14% of the total escapement)	**Adult runbacks:** Same as existing conditions **Half-pounder residency:** Same as existing conditions	Same as existing conditions	Major stress resulting in reduced growth	**Age 1+ rearing:** Major stress, reduced growth, and up to 52% mortality. (Up to 8,200 juveniles or around 14% of total age 1 production) **Age 2+ rearing:** Reduced growth and up to 52% mortality (Up to 6,893 juveniles or around 13% of total age 2 production)	Major stress and reduced growth

Table 3.3-8. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Summer and Winter Steelhead

Scenario	Life History Stage: Summer and Winter Steelhead					
	Adult migration Summer run: (Mar 1–June 30, 2020) Winter run: (Aug 1 2019–Mar 31, 2020)	**Adult runbacks: (Apr 1–May 30, 2020) Half-pounder residency (Aug 15, 2019–Mar 31, 2020)**	**Spawning through fry emergence (Dec 1, 2019–June 1, 2020)**	**Age 0+ rearing (Mar 15–Nov 14, 2020)**	**Juvenile rearing Age 1+: (year-round 2019 and 2020) Age 2+: (Nov 15, 2019–Mar 31, 2020)**	**Outmigration (Apr 1–Nov 14, 2020)**
Worst-case	**Existing conditions (extreme)**					
	Summer run: Major stress, impaired homing for fish spawning in mid- and upper-Klamath tributaries (about 53% of run) **Winter run:** Major stress and potential for impaired homing for fish spawning in mid- and upper-Klamath tributaries (about 80% of run)	**Adult runbacks:** Major stress; exposure dependant on time it takes runbacks to return to sea **Half-pounder residency:** Major stress and reduced growth for any in mainstem, but most assumed to remain in tributaries or to have returned to the ocean or estuary. Those remaining may experience major stress and reduced growth in the mainstem, but may avoid suspended sediment by entering nearby tributaries.	Most spawning takes place in tributaries; no effects predicted	Major stress and reduced growth for age 0+ juveniles in mainstem (about 60% of juveniles)	**Age 1+ rearing:** Stress, reduced growth, and up to 20% mortality for juveniles in mainstem (about 60% of juveniles) **Age 2+ rearing:** Major stress and reduced growth for juveniles in mainstem for juveniles in mainstem (about 60% of juveniles)	Major stress resulting in reduced growth, about 57% outmigrate from Trinity River and will have less exposure

Table 3.3-8. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario SSCs Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Summer and Winter Steelhead

Scenario	Life History Stage: Summer and Winter Steelhead					
	Adult migration Summer run: (Mar 1–June 30, 2020) Winter run: (Aug 1 2019–Mar 31, 2020)	**Adult runbacks: (Apr 1–May 30, 2020) Half-pounder residency (Aug 15, 2019–Mar 31, 2020)**	**Spawning through fry emergence (Dec 1, 2019–June 1, 2020)**	**Age 0+ rearing (Mar 15–Nov 14, 2020)**	**Juvenile rearing Age 1+: (year-round 2019 and 2020) Age 2+: (Nov 15, 2019–Mar 31, 2020)**	**Outmigration (Apr 1–Nov 14, 2020)**
	Proposed Action					
Worst-case	**Summer run:** Major stress, impaired homing, and up to 20% mortality (from 0 to 130 adults, or from 0 to 9% of the basin-wide escapement) **Winter run:** Major stress, impaired homing, and up to 71% mortality. The proportion migrating prior to January would not be affected. (Up to 1,988 adults, or up to 28% of the basin-wide escapement).	**Adult runbacks:** Major stress **Half-pounder residency:** Same as existing conditions	Same as existing conditions	Same as existing conditions	**Age 1+ rearing:** Stress, reduced growth, and up to 71% mortality Up to 11,207 juveniles or around 19% of total age 1 production) **Age 2+ rearing:** Stress, reduced growth and up to 71% mortality (Up to 9,412 juveniles or around 18% of total age 2 production).	Same as existing conditions

As described in detail in Appendix F, dam-released sediment associated with the Proposed Action might aggrade pools or overwhelm other habitat features used for adult holding or juvenile rearing above Cottonwood Creek. The effect would be short term (< one years), as pools would likely return to their pre-sediment release depth (Reclamation 2012). Within six months the river would revert to and maintain a pool-riffle morphology. In the long term, under this alternative bedload sediment transport would restore vital aquatic habitat.

The Proposed Action would establish a flow regime that more closely mimics natural conditions in the Lower Klamath River. As discussed in detail above, dam removal would cause water temperatures to warm earlier in the spring and early summer and cool earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods. These changes would result in water temperature more favorable for salmonids occurring in the mainstem. Migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to low dissolved oxygen due to the Proposed Action, but these effects would be short term. All of these long-term changes would benefit steelhead using the Lower Klamath River Reach.

Estuary

Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, the Proposed Action is not expected to substantially change or affect steelhead estuarine habitat. Flow and water temperature effects would likely not extend downstream to the estuary.

Summary: Steelhead

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and bedload sediment transport and deposition and affect steelhead. In general, the effects of suspended sediment resulting from the Proposed Action on steelhead are likely to be much higher than under existing conditions and the No Action/No Project Alternative, particularly for the portion of the population that spawns in tributaries upstream of the Trinity River. For that portion of the population, effects are anticipated on adults, run-backs, half-pounders, any juveniles rearing in the mainstem, and outmigrating smolts. However, the broad spatial distribution of steelhead in the Klamath Basin and their flexible life history suggests that some will avoid the most serious effects of the Proposed Action by (1) remaining in tributaries for extended rearing, (2) rearing farther downstream where SSC should be lower due to dilution (e.g., the progeny of the adults that spawn in the Trinity River Basin or tributaries downstream from the Trinity River), and/or (3) moving out of the mainstem into tributaries and off-channel habitats during winter. In addition, the life-history variability observed in steelhead means that, although numerous year classes will be affected, not all individuals in any given year

class will be exposed to the effects of the Proposed Action. In addition, some portion of the progeny of those adults that spawn successfully would rear in tributaries long enough to not only avoid the most serious impacts of the Proposed Action in 2020, but may also not return to spawn for up to two years, when any suspended sediment resulting from the Proposed Action should be greatly reduced. The high incidence of repeat spawning among summer-run steelhead (ranging from 40 to 64 percent, Hopelain 1998) should also increase that population's resilience (including all year classes) to effects of the Proposed Action. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for summer and winter steelhead in the short term.**

Implementation of Mitigation Measures AR-2 and AR-3 (see Section 3.3.4.4.2 and 3.3.4.4.3) could be implemented to reduce the short-term effects of SSCs on steelhead adults and outmigrating juveniles. With implementation of mitigation measures there would still be short-term effects on summer and winter steelhead, including sublethal and lethal effects. **Based on substantial reduction in the abundance of a year class in the short term, the Proposed Action would be a significant effect on summer and winter steelhead in the short term after mitigation.**

Under the Proposed Action, removal of dams could result in alterations in habitat availability, flow regime, water quality, temperature variation, and algal toxins which could affect steelhead in the long term. Dam removal would restore connectivity to hundreds of miles of historical habitat in the Upper Klamath Basin and would create additional habitat within the Hydroelectric Reach. FERC (FERC 2007) concluded that implementing fish passage would help to reduce adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that access to additional habitat in the upper Klamath River watershed would benefit steelhead runs. In general, dam removal with KBRA would likely result in the restoration of more reproducing populations, increased abundance, higher genetic diversity, and the opportunity for variable life histories and use of new habitats (Hamilton et al. 2011). In general, free flowing conditions as per the Proposed Action, would likely provide optimal efficiency, decrease outmigrant delay, and increase concomitant adult escapement (Buchanan et al. 2011b). By providing an unimpeded migration corridor, the Proposed Action would provide the greatest possible benefit related to fish passage, hence, the highest survival and reproductive success (Buchanan et al. 2011b). As discussed in detail above, dam removal would also cause water temperatures to become warmer earlier in the spring and early summer and cooler earlier in the late summer and fall, and have diurnal variations more in sync with historical migration and spawning periods (Hamilton et al. 2011). These changes would result in water temperature more favorable for salmonids in the mainstem. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for summer and winter steelhead in the long term**.

Pacific Lamprey Access to habitat would benefit Pacific lamprey by increasing their viability through: a) extending the range and distribution of the species; b) providing additional spawning and rearing habitat; c) increasing the generic diversity of the species;

and d) increasing the abundance of the Pacific lamprey population (Administrative Law Judge 2006). The FERC (2007) concluded that "Removal of Iron Gate dam provides the greatest potential to expand the range of Pacific lamprey, a species of cultural importance to the tribes, to potential habitat upstream of Iron Gate dam." A Lamprey Expert Panel (Panel) was convened and charged with answering specific questions that had been formulated by the project stakeholders to assist with assessing the effects of the Proposed Action on lamprey (Close et al. 2010). The conclusion was that the Proposed Action could increase Pacific lamprey habitat by up to 14 percent. The increase could potentially be more if habitat in the Upper Klamath Basin is accessible and suitable. The panel also concluded there might be a total increase of production of outmigrant lamprey (and hence harvest potential) in the range of 1 to 10 percent relative to the No Action Alternative. The Panel expects that adult Pacific lamprey would recolonize newly accessible habitat after dam removal, but natural colonization of all habitat available to them may take decades. Larval rearing capacity downstream from Iron Gate Dam is expected to increase after dam removal because a large amount of fine sediment—a major component of larval rearing habitat—would be released through dam removal. The available burrowing habitat for larvae would subsequently decrease over time, but would likely remain higher than under current conditions because sediment input and transport processes would be restored and KBRA measures would increase sediment transport (Close et al. 2010). In addition, the return to a temperature regime and flows that more closely mimic natural patterns would likely benefit Pacific lamprey, which evolved under those conditions. The influence of the Proposed Action within specific reaches is described below.

<u>Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir</u>
Pacific lamprey occurred historically at least to Spencer Creek (Hamilton et al. 2005), although there is some uncertainty in this regard (Administrative Law Judge (2006). It is anticipated that Pacific lamprey below Iron Gate dam would migrate above the dam if access was provided (Administrative Law Judge (2006).

<u>Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam</u>
The Proposed Action would provide Pacific lamprey with access to the Hydroelectric Reach and to the mainstem Klamath River and its tributaries upstream at least as far as Spencer Creek, including Jenny, Shovel, and Fall creeks (Hamilton et al. 2011). Most sediment released from the reservoirs would likely be eroded within the first six months after dam removal (by May 2020), returning sections of river currently inundated by reservoirs and riverine sections between reservoirs to a pool-riffle morphology. After erosion of dam-stored sediment, the Hydroelectric Reach would likely contain gravel suitable for lamprey spawning and rearing.

The Proposed Action would also eliminate the reservoirs and establish a flow regime that more closely mimics natural conditions. Drawing down the reservoirs would allow tributaries and springs such as Fall, Shovel, and Spencer Creeks and Big Springs to flow directly into the mainstem Klamath River. These changes would result in more favorable water temperatures for native fishes, and improved water quality. These changes would provide a long-term benefit to Pacific lamprey that occur within the Hydroelectric Reach.

Lower Klamath River: Downstream from Iron Gate Dam

The Proposed Action would release dam-stored sediment and reduce dissolved oxygen downstream to the Lower Klamath River in the short term, and restore a flow regime that more closely mimics natural conditions in the long term. Suspended sediment effects on Pacific lamprey under the Proposed Action are described in detail in Appendix E, and summarized here.

Under the most-likely-to-occur scenario or worst-case scenario, sublethal effects from suspended sediment relative to existing conditions is anticipated for outmigrants, and for Pacific lamprey migrating to or from the Trinity River or tributaries further downstream (Table 3.3-9). High rates of mortality are predicted for adults and ammocoetes in the mainstem Klamath River during winter and spring 2020. However, there is little to no literature on the effects of suspended sediment on lamprey. This analysis used the effects of suspended sediment on salmonids to predict effects on lamprey, with the assumption that effects on lamprey are equivalent or less severe than on salmonids. In general, most life stages of Pacific lamprey appear more resilient to poor water quality conditions (such as suspended sediment) than salmonids (Zaroban et al. 1999), so this is likely a conservative assessment of potential effects.

The Proposed Action would affect spawning and incubation in the area between Iron Gate Dam and Cottonwood Creek by burying gravel in dam-released sediment and increasing the proportion of sand in the bed, thereby decreasing ammocoete survival. The bed material within the reservoirs and between Iron Gate to Cottonwood Creek is expected to have a high content (30 to 50 percent) of sand immediately following reservoir drawdown until a flushing flow moves the sand sized material out of the reach (Reclamation 2012). The flushing flow is expected to be at least 6,000 cfs and of several days to weeks to return the bed to a bed dominated by cobble and gravel with a sand content less than 20 percent. After the flushing flow, the bed is expected to maintain fractions of sand, gravel, and cobble which would be expected under natural conditions, and suitable for Pacific lamprey. Based on the historical record a sufficient flushing flow would likely occur within 5 years following dam removal.

The Proposed Action would establish a flow regime that more closely mimics natural conditions in the Lower Klamath River Reach. Dam removal would cause water temperatures to have natural diurnal variations. These changes would result in water temperatures that are more similar to those that Pacific lamprey evolved with and would improve water quality. These long-term changes would likely provide a benefit to Pacific lamprey using the Lower Klamath River.

Estuary

Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be

Table 3.3-9. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Pacific Lamprey

Scenario	Life History Stage: Pacific Lamprey		
	Adult Migration and Spawning (all of 2020)	**Ammocoete Rearing (all of 2020)**	**Outmigration Spring (May 1–June 30, 2020) Fall/winter (Sept 1–Dec 31, 2020)**
Most Likely	**Existing Conditions (normal)**		
	Major stress and impaired homing; later-returning adults and those returning to lower tributaries would have less exposure	**Ammocoete rearing*:*** Major stress of ammocoetes in mainstem for multiple year classes of ammocoetes in mainstem; majority rear in tributaries and would have lower exposure	**Spring outmigration:** Major stress
			Fall and winter outmigration: Moderate stress and reduced feeding
	Proposed Action		
	Major stress and up to 36% mortality; later-returning adults and those returning to lower tributaries would have less exposure	**Ammocoete rearing*:*** Major stress, reduced growth, and up to 52% mortality	**Spring outmigration:** Same as existing conditions
			Fall and winter outmigration: Same as existing conditions
Worst-case	**Existing Conditions (extreme)**		
	Major stress and impaired homing; later-returning adults and those returning to lower tributaries would have less exposure	**Ammocoete rearing*:*** Major stress and reduced growth	**Spring outmigration*:*** Moderate to major stress and reduced growth
			Fall and winter outmigration*:* Major stress
	Proposed Action		
	Major stress, reduced growth, and up to 71% mortality	**Ammocoete rearing*:*** Major stress, reduced growth, and up to 71% mortality for multiple year classes of ammocoetes in mainstem; majority rear in tributaries and would not suffer mortality	**Spring outmigration*:*** Same as existing conditions
			Fall and winter outmigration*:* Same as existing conditions

higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, the Proposed Action is not expected to substantially change or affect Pacific lamprey estuarine habitat. Flow and water temperature effects would likely not extend downstream to the estuary.

Summary: Pacific Lamprey

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and bedload sediment transport and deposition and affect Pacific lamprey. The Proposed Action would have short-term effects related to SSCs, bedload sediment transport and deposition, and water quality (particularly dissolved oxygen). Overall, because multiple year classes of lamprey rear in the mainstem Klamath River at any given time, and since adults will migrate upstream over the entire year, including January 2020 when effects from the Proposed Action will be most pronounced, effects on Pacific lamprey adults and ammocoetes could be much higher in the mainstem Klamath River than under existing conditions and the No Action/No Project Alternative. However, because of their wide spatial distribution and varied life history, most of the population would likely avoid the most severe suspended sediment pulses resulting from the Proposed Action. In addition, Pacific lamprey are considered to have low fidelity to their natal streams (FERC 2006), and may not enter the mainstem Klamath River if environmental conditions are unfavorable in 2020. Migration into the Trinity River and other Lower Klamath River tributaries may also increase during 2020 because of poor water quality. Low fidelity also increases the potential that lamprey can recolonize mainstem habitat if ammocoetes rearing there suffer high mortality. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for Pacific lamprey in the short term.**

Implementation of Mitigation Measures AR-2 and AR-5 (see Sections 3.3.4.4.2 and 3.3.4.4.5) could be implemented to reduce the short-term effects of dissolved oxygen and SSCs on lamprey ammocoetes. With implementation of mitigation measures there could still be short-term effects for lamprey including sublethal and lethal effects. **Based on substantial reduction in the abundance of a year class in the short term, the Proposed Action would be a significant effect on Pacific lamprey in the short term after mitigation.**

Under the Proposed Action, removal of dams could result in alterations in habitat availability, flow regime, water quality, and temperature variation which could affect Pacific lamprey in the long term. The Proposed Action would provide access to habitat upstream of Iron Gate Dam at least as far as Spencer Creek. It is anticipated that as a result of the Proposed Action the Pacific lamprey population within the Klamath River watershed would have an increase in abundance, productivity, population spatial structure, and genetic diversity. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for Pacific lamprey in the long term**.

Green Sturgeon Listed Southern Green Sturgeon may enter the Klamath River estuary to forage during the summer months. They would not be present when the most severe

effects of dam removal are occurring, and are not expected to be affected by the Proposed Action. The remainder of this section focuses on the effects of the Proposed Action on the Northern Green Sturgeon DPS. Northern Green Sturgeon do not occur upstream of Ishi Pishi Falls and would not be affected by Proposed Action effects that do not extend downstream past these falls.

Lower Klamath River: Downstream from Iron Gate Dam

The Proposed Action would release dam-stored sediment downstream to the Lower Klamath River in the short term, and restore a flow regime that more closely mimics natural seasonal flow patterns in the long term. Suspended sediment effects on green sturgeon under the Proposed Action are described in detail in Appendix E, and summarized here.

Under the most-likely-to-occur scenario or worst-case scenario no effect relative to existing conditions is predicted for adults (Table 3.3-10), mostly because green sturgeon distribution within the mainstem Klamath River is primarily limited to areas downstream from Orleans, where the effects of SSC resulting from the Proposed Action are more diluted from tributary accretion. Up to 100 percent mortality is predicted for incubating eggs and larval life stages, and up to 20 percent mortality is predicted for rearing juveniles under a most-likely-to-occur scenario, or up to 40 percent mortality of juveniles under a worst-case scenario. However, around 30 percent of juveniles rear in the Trinity River and would not be exposed to SSC from the Proposed Action.

Bedload sediment effects related to dam-released sediment would not extend as far downstream to Ishi Pishi Falls and would not affect green sturgeon.

The Proposed Action would establish a flow regime that more closely mimics natural conditions in the Lower Klamath River and would improve water quality and reduce instances of algal toxins. These long-term effects would benefit green sturgeon using the Lower Klamath River reach.

Estuary

Under the Proposed Action, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see Section 3.2.4.3.2.2). However, the Proposed Action is not expected to substantially change or affect estuarine habitat. Flow and water temperature effects resulting from the Proposed Action would likely not extend downstream to the estuary.

Table 3.3-10. Proposed Action, Most-Likely Scenario SSCs Compared with Normal Existing Conditions (50% Exceedance Probabilities) and Proposed Action, Worst-Case Scenario Compared with Extreme Existing Conditions (10% Exceedance Probabilities) for Green Sturgeon. Based on salmonid literature; effects likely overestimated

Scenario	Life History Stage: Green Sturgeon			
	Adult migration	**Post-spawning holding**	**Spawning through hatching/larvae**	**Juvenile Rearing (year-round) and Outmigration**
Most Likely	**Existing conditions (normal)**			
	Moderate to major stress; 75% of adults not expected to migrate in 2020	No effects	Up to 68% mortality; about 30% that spawn in Trinity River would be unaffected (based on salmonid literature; effects likely overestimated)	Major stress; about 30% of juveniles rear in Trinity River and would be unaffected (based on salmonid literature; effects likely overestimated)
	Proposed Action			
	Major stress	Same as existing conditions	76% mortality for all mainstem production	Reduced growth and up to 20% mortality
Worst-case	**Existing conditions (extreme)**			
	Major stress	Short period (<1 week) of relatively low SSCs, not expected to result in deleterious effects	84% mortality for all mainstem production	Major stress and reduced or no growth (based on salmonid literature; effects likely overestimated)
	Proposed Action			
	Same as existing conditions; about 25% of adults expected to be exposed in 2020	Same as existing conditions; about 75% of adults hold in mainstem after spawning; remainder return to ocean	95% mortality for all mainstem production ; about 30% that spawn in Trinity River would be unaffected	Reduced growth and up to 36% mortality; about 30% of juveniles rear in Trinity River and would be unaffected

Summary: Green Sturgeon

Reservoir drawdown associated with dam removal under the Proposed Action could alter SSCs and affect green sturgeon. Overall the effects of the Proposed Action are most likely to include physiological stress, inhibited growth, and high mortality for some portion of the age-0 2020 cohort and age 1 2019 cohort. To summarize, green sturgeon in the Klamath Basin have the following traits likely to enhance the species' resilience to impacts of the Proposed Action:

- Most of the population (subadult and adult) would be in the ocean during the year of the Proposed Action (2020) and would be unaffected (Appendix E).
- The approximately 30 percent of the population that spawn and rear in the Trinity River would be unaffected.
- Much of the spawning and rearing of green sturgeon occurs downstream from the Trinity River, where sediment concentrations would be similar to existing conditions and the No Action/No Project Alternative.

Green sturgeon are long-lived (>40 years) and are able to spawn multiple times (~8 times) (Klimley et al. 2007), so effects on two year classes may have little influence on the population as a whole.

Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for green sturgeon in the short term.

Implementation of Mitigation Measure AR-3 (see Section 3.3.4.4.3) could be implemented to reduce the short-term effects of SSCs on green sturgeon adults post-spawning. With implementation of mitigation measures there would still be short-term effects for green sturgeon including sublethal and sublethal effects. **Based on substantial reduction in the abundance of a year class in the short term, the Proposed Action would be a significant effect on green sturgeon in the short term after mitigation.**

Under the Proposed Action, removal of dams could result in alterations in flow regime, water quality, temperature variation, and algal toxins which could affect green sturgeon in the long term. It is anticipated that as a result of the Proposed Action, the green sturgeon population within the Klamath River watershed would have an increased productivity. **Based on improvements in habitat quality within part of their range, the effect of the Proposed Action would be less-than-significant for green sturgeon in the long term.**

Lost River and Shortnose Sucker A Resident Fish Expert Panel (Panel) was convened to compare the potential effects of the Proposed Action and existing conditions on resident fish, including sucker populations (Buchanan et al. 2011a). The Panel concluded that under the Proposed Action, specifically with implementation of KBRA, restoration strategies used to recover suckers including lake level management, water quality improvement, and habitat restoration (wetlands and spawning and rearing habitat) are

expected to increase spawning success, and larval, juvenile, and adult survival leading to larger populations and more frequent recruitment.

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir
Under the Proposed Action, water elevations in Upper Klamath Lake would be higher, which would benefit Lost River and shortnose suckers, but the difference in habitat value would not be substantive. The KBRA is expected to provide benefits to sucker populations through the following measures: nutrient reduction, reconnecting former wetlands to Agency Lake, reconstructing quality rearing habitat for early life stages, and restoring shoreline spring spawning habitat restoration, among others.

Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
Lost River and shortnose suckers are found within reservoirs in Hydroelectric Reach. The Proposed Action would eliminate reservoir habitat, and as dams within the Hydroelectric Reach were removed, sediment would move downstream. Under the Proposed Action adult Lost River and shortnose suckers in reservoirs downstream from Keno Dam would be captured and relocated to Upper Klamath Lake (Buchanan et al. 2011a). Those not relocated to the Upper Klamath Basin would likely be lost; however, since little or no reproduction occurs downstream from Keno Dam (Buettner et al. 2006), there is no potential for interaction with upstream populations, and they are not considered to substantially contribute to the achievement of conservation goals or recovery (Hamilton et al. 2011). Lost River and shortnose suckers are listed as fully protected species under California Fish and Game code; thus, any take of these species is prohibited. However, if there is an Affirmative Determination by the Secretary, and a concurrence by the State of California, CDFG will provide draft legislation to the other KHSA/KBRA parties which would authorize limited take of these fully protected species.

Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006). Generally, with the exception of *F. columnaris* and Ich, pathogens associated with anadromous fish do not impact non-salmonids (e.g. suckers) (Administrative Law Judge 2006). In the most recent review of effects of interactions between reintroduced anadromous fish and federally listed suckers, the USFWS concludes that indirect effects of removal of the lower four dams is “not likely to adversely affect” listed fish because the effects are insignificant (Roninger 2012).

Summary: Lost River and Shortnose Suckers
Reservoir removal associated with dam removal under the Proposed Action could alter habitat availability and affect Lost River and shortnose suckers. **Based on reduction in abundance within reservoirs, the effect of the Proposed Action would be significant for Lost River and shortnose sucker populations in the short term.**

Implementation of Mitigation Measure AR-6 (see Section 3.3.4.4.6) could be implemented to reduce the impact to individuals within reservoirs by rescuing fish prior to reservoir drawdown. **Based on small numbers of individuals affected after**

mitigation, and on anticipated legislation allowing take, the effect of the Proposed Action would be less-than-significant for Lost River and shortnose sucker populations in the short term after mitigation.

Restoration action associated with KBRA implementation under the Proposed Action could alter habitat availability and suitability and affect Lost River and shortnose suckers. In the long term, restoration actions under KBRA are anticipated to improve conditions for sucker populations within Klamath Lake. **Based on improved habitat quality, the effect of the Proposed Action would be beneficial for Lost River and shortnose sucker populations in the long term.**

Redband Trout A Resident Fish Expert Panel (Panel) was convened to compare the potential effects of the Proposed Action and existing conditions on resident fish, including redband trout (Buchanan et al. 2011a). The Panel concluded that the habitat improvements associated with KBRA implementation, including water quality and quantity and riparian corridor improvements and protection, are anticipated to increase trout productivity in headwater and lower tributary areas of the Upper Klamath Lake Basin. The Panel predicted that following the Proposed Action, the abundance of redband trout in the free-flowing reach between Keno Dam and Iron Gate Dam could increase significantly. In addition, they expect the existing trout and colonizing anadromous steelhead to co-exist, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food. The influence of the Proposed Action within specific reaches is described below.

<u>Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir</u>
Under the Proposed Action, redband trout would be able to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than

under existing conditions. Establishment of a flow regime that more closely mimics natural conditions downstream from Keno Dam would eliminate the stranding of redband trout caused by flow reductions at Klamath Hydroelectric Project facilities.

Redband trout could be affected by increased predation from reintroduced salmonids, but this loss might be offset by an increase in available food sources (e.g., eggs, fry, and juveniles of reintroduced salmonids) (Hamilton et al. 2011). Furthermore, anadromous steelhead trout and resident rainbow/redband trout co-existed and intermingled prior to the construction of Copco 1 Dam in 1917. There are many examples from nearby river systems in the Pacific Northwest showing that wild anadromous salmon and resident rainbow/redband trout can co-exist and maintain abundant populations without negative consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (Administrative Law Judge 2006).

Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
Under existing conditions, redband trout are found within the Hydroelectric Reach, but are impaired from migrating between tributaries and the reservoirs to complete their life cycle because of poorly functioning fishways at J.C. Boyle Dam (DOI 2007; NOAA Fisheries Service 2007). Under the Proposed Action, redband trout would be able to migrate more successfully than under existing conditions (Hamilton et al. 2011). In addition, approximately 4 mi (6.4 km) of habitat has been adversely affected by the dewatered (100 cfs) flows in the bypass reach, and 17 mi (27.4 km) of habitat has been adversely affected by the daily fluctuating flows in the peaking reach (Administrative Law Judge 2006). In addition, the Administrative Law Judge (2006) finding regarding project flow operations stated, "Current Project operations, particularly sediment blockage at the J.C. Boyle Dam, the flow regime, and peaking operations, negatively affect the redband trout fishery."

Under this alternative, the establishment of a flow regime that more closely mimics natural conditions and eliminates peaking and associated negative aquatic impacts would benefit the redband trout populations downstream from J.C. Boyle. Redband trout throughout this reach of the mainstem, except upstream of J.C. Boyle Reservoir, would be affected by high SSCs for a period of three to four months during reservoir drawdown associated with the Proposed Action. Redband trout in riverine reaches between the reservoirs in the Hydroelectric Reach would be vulnerable to sublethal and lethal effects of sediment released during dam removal and bedload deposition (Newcombe and Jensen 1996, Buchanan et al. 2011a); however, a large proportion of the adult population should be already spawning in Spencer or Shovel creeks during the dam removal. Juvenile redband trout outmigrating from Spencer Creek would be expected to recolonize the mainstem by late spring or summer when water conditions become suitable. Those in the affected area could move to tributaries for refuge.

The Proposed Action would eliminate reservoir habitat, returning sections of river currently inundated by reservoirs and riverine sections between reservoirs to a pool-riffle morphology. Modeling data indicate that after dam removal, spawning gravel in all sections of the Hydroelectric Reach would be within the range usable for salmonids, but the amount of sand within the bed within former reservoir sections might inhibit spawning success. Riverine sections between reservoirs would be expected to provide the gravel with very little sand, suggesting high-quality spawning habitat. The initial movement of coarse and fine sediment after drawdown would likely create unfavorable conditions for redband trout within the mainstem Klamath River, but these conditions would be short term. Buchanan et al. (2011a) estimate that 43 miles of additional riverine habitat would be available to resident redband trout as a result of the Proposed Action. The adfluvial life-history strategy would no longer be possible within this reach. Migratory opportunities would increase for these fish, allowing them to access areas with suitable habitat when conditions become unfavorable in one area of their range. The Proposed Action would also increase the number of thermal refugia available to redband trout as they would have access to more tributaries, as well as to the cool areas near the mouths of tributaries and the many springs in this reach.

Summary: Redband Trout

The Proposed Action would have short-term effects related to SSCs and bedload movement that could affect redband trout. **Based on a small proportion of the population with a potential to be exposed to short-term effects, the effect of the Proposed Action would be less-than-significant for redband trout in the short term.**

Dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action would be beneficial for redband trout in the long term.**

Bull Trout

Upper Klamath River Upstream of the Influence of J.C. Boyle Reservoir

To evaluate the effects of the Proposed Action on bull trout, a four member expert panel (Buchanan et al. 2011a) was convened and tasked with reviewing all available information on bull trout in the upper Klamath River, and information on potential effects of the Proposed Action. The panel concluded that the Proposed Action provides promise for preventing extinction of bull trout and for increasing overall population abundance and distribution (Buchanan et al. 2011a).

Buchanan et al. (2011a) observed that the proposed KBRA actions would enhance resident populations of headwater bull trout, and implementation of KBRA could have a significant contribution toward recovery of these populations. Passage from Sun Creek to the Wood River may be improved by KBRA actions allowing for fluvial life history forms of bull trout in the Wood River system. The cold waters of the Wood River may successfully provide habitat for reintroductions of anadromous salmon and steelhead.

Rearing anadromous juveniles could provide an increased prey base for fluvial bull trout and produce predator/prey interactions ecologically similar to historical conditions (Buchanan et al. 1997).

Summary: Bull Trout

Dam removal associated with the Proposed Action could alter habitat availability for anadromous fish, which could affect bull trout. **Based on the restricted distribution of bull trout, the Proposed Action would have a less-than-significant impact on bull trout in the short and long term**.

Eulachon

Lower Klamath River: Downstream from Iron Gate Dam and Estuary

The Proposed Action would release dam-stored sediment downstream to the Lower Klamath River and estuary. Adults entering the Klamath River in the winter and spring of 2020 may be exposed to high SSC for a portion of their migration period. Although no analysis of the effects of SCC on eulachon is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely or worst-case scenario mortality would be

higher under the Proposed Action than under existing conditions. Mortality is also predicted to be higher for spawning, incubation, and larval life stages under the Proposed Action than under existing condition. However, there are two key factors that reduce the likelihood that substantial numbers of individuals would be exposed. First, eulachon are in very low abundance in the Klamath River, and thus there is a very low probability that many individuals will be in the Klamath River during implementation of the Proposed Action. Second, eulachon have a relatively long period of the year when they could potentially spawn in the Klamath River (January through April; Larson and Belchik 1998), and a relatively short duration of occurrence within freshwater (around one month), increasing the probability that most of the population would migrate and spawn either before or after the largest pulses of SCC (predicted to be over 1,000 mg/L for the month of January under a worst case scenario; Figure 3.3-10).

Summary: Eulachon
The Proposed Action would have short-term effects related to SSCs and bedload movement. **Based on no substantial reduction in the abundance of a year class, the Proposed Action would be a less-than-significant effect on eulachon in the short term. Based on short duration of poor water quality in the estuary during reservoir drawdown in the estuary, the Proposed Action would have a less-than-significant effect on eulachon in the long term.**

Longfin Smelt The Proposed Action would release dam-stored sediment downstream to the Klamath River Estuary. Longfin smelt entering the Klamath River in the winter and spring of 2020 may be exposed to high SSC for a portion of their migration period. Although no analysis of the effects of SCC on longfin smelt is available, based on application of the Newcombe and Jensen (1996) approach using studies of the effects on other estuary species, it is predicted that under a most-likely or worst-case scenario mortality would be higher under the Proposed Action than under existing conditions. However, as described for eulachon above, the protracted migration season for longfin smelt (throughout the year), and relatively short duration of occurrence in the estuary (<2 months), increase the probability that most of the population would migrate and spawn either before or after the largest pulses of SCC (predicted to be two weeks in duration or less).

The Proposed Action would have short-term effects related to SSCs and bedload movement. **Based on no substantial reduction in the abundance of a year class, the Proposed Action would be a less-than-significant effect on longfin smelt in the short term. Based on short duration of poor water quality during reservoir drawdown, the Proposed Action would have a less-than-significant effect on longfin smelt in the long term.**

Introduced Resident Species
Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir
Introduced resident species occur in Lake Ewauna and Upper Klamath Lake, but the Proposed Action would not affect populations in this area.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
The Proposed Action would eliminate reservoir habitat upstream of Iron Gate Dam, and thus the abundance of these species would decline substantially or be reduced to nothing, as their preferred reservoir habitat would be eliminated (Buchanan et al. 2011a).

Lower Klamath River: Downstream from Iron Gate Dam
A few introduced resident species occur in the Lower Klamath River, but habitat conditions there are generally not suitable for these species. Under the Proposed Action, conditions would be expected to become less suitable.

Summary: Introduced Resident Species
The Proposed Action would eliminate habitat for introduced resident species in the Hydroelectric Reach. **Because these species were introduced and they occur in other nearby water bodies, their loss would not be considered significant from a biological perspective, and would benefit native species. Their loss would, however, decrease opportunities for recreational fishing for these species, as discussed in Section 3.20, Recreation.**

Interactions Among Species The Proposed Action would restore access for anadromous salmon and steelhead to habitat upstream of Iron Gate Dam, as described in detail above. Restoration of access would result in anadromous salmon and steelhead potentially interacting with resident redband trout and bull trout. These species evolved together in the Upper Klamath Basin of the Klamath River, and co-existed prior to the construction of dams (Goodman et al. 2011).

Bull trout currently exist with redband trout in the upper basin and Proposed Action habitat benefits that would result in redband population increases would also benefit bull trout populations. In the 2007 USFWS Biological Opinion (USFWS 2007c) on relicensing of the Hydropower Project, the Service issued take for bull trout and determined that the level of anticipated take associated with reintroduction of anadromous salmonids is not likely to result in jeopardy to bull trout destruction or adverse modification of critical habitat for bull trout. In the most recent review of effects of interactions between reintroduced anadromous fish and federally listed bull trout, the USFWS concludes that indirect effects of removal of the lower four dams is “not likely to adversely affect” listed fish because the effects are insignificant (Roninger 2012).

Anadromous salmonids currently co-exist with resident rainbow trout and resident cutthroat trout downstream from Iron Gate Dam, without any obvious ecosystem detriment. While there is little information on the nature of any competitive interactions between steelhead and resident trout in the Klamath Basin, research does suggest that in some circumstances, resident trout may have a competitive edge over steelhead trout (Administrative Law Judge 2006). Conversely, a recent study showed that hatchery salmon supplementation negatively impacted resident trout abundance and salmonid biomass in a Washington watershed (Pearsons and Temple 2010). However, competition between steelhead and currently present indigenous species such as redband trout are not assumed to be a major limiting factor since these species historically co-evolved (Hooton

and Smith 2008). There are many examples from nearby river systems in the Pacific Northwest that show wild anadromous steelhead trout and resident rainbow/redband trout can co-exist and maintain abundant populations without adverse consequences. The Deschutes River in Oregon, the Yakima River in Washington, and the river systems in Idaho are examples (Administrative Law Judge 2006). As noted by Buchanan et al. (2011a), existing trout and colonizing anadromous steelhead are expected to co-exist, as they do in other watersheds, although there may be shifts in abundance related to competition for space and food.

Freshwater Mussels

Suspended Sediment Concentrations

Due to the limited data available regarding overall abundance, distribution, life history, and population recruitment of freshwater mussels within the mainstem Klamath River, the overall effects that would be associated with predicted short- and long-term exposure to elevated SSCs on freshwater mussel populations as a result of the Proposed Action are difficult to determine.

Under the Proposed Action, SSCs would be expected to be higher than under existing conditions and would likely exceed 600 mg/L, the minimum SSCs level that would be considered detrimental to freshwater mussels, for 2 to 4 months after facility removal, depending on hydrologic conditions and location on the river. The SSCs in excess of 600 mg/L for 2 to 3 months would occur as far downstream as Klamath Station (at RM 5.0; see Figure 3.3-14); however, the highest levels, well in excess of 1,000 mg/L, would occur between Seiad Valley and Iron Gate Dam. Over time, as sediment stored behind the dams was diminished, the expected increase in SSCs over background levels would also diminish. Under existing conditions, SSCs could spike to levels exceeding 600 mg/L upstream of Orleans, although these spikes generally occur for a few days as opposed to several months, which is what would be expected under the Proposed Action. SSCs in excess of 600 mg/L for more than 4- to 5-day periods within the mainstem Klamath River would cause major physiological stress to freshwater mussels and might result in substantial mortality. The most significant impacts would occur downstream from Iron Gate Reservoir, especially to those individual freshwater mussels or freshwater mussel beds upstream of Orleans and closest to Iron Gate Dam.

Because freshwater mussels found within the Klamath River are so long lived (from 10 to more than 100 years, depending on the species) and sexual maturity might not be reached until 4 years of age or more, even relatively short term (e.g., for more than 5 consecutive days) SSCs in excess of 600 mg/L, would be expected to be detrimental for freshwater mussel populations within the mainstem Klamath River. However, it is anticipated that mainstem Klamath freshwater mussel populations would rebound, recolonizing through the transport of larvae (glochidia) by host fish from downstream populations less affected by excessive SSCs or from populations within tributaries, such as the Salmon or Scott Rivers, or from populations on the Klamath River upstream of Iron Gate Reservoir. This process is expected to take many years, however.

Changes in Bed Elevation

Silt and fine material make up the largest proportion of the volume of sediment stored behind the dams and would be transported downstream primarily as suspended sediment. Courser material (larger than 0.063 mm) would also be transported downstream and would likely be deposited in the river channel, changing riverbed elevations from the existing condition 8 miles between Iron Gate Dam and Cottonwood Creek. The 182 miles of mainstem downstream from Cottonwood Creek are not predicted to have any substantial aggradation.

Of the freshwater mussel species found on the mainstem Klamath River, the western ridged mussel (*G. angulata*) seems to be the most abundant and is widely distributed between Iron Gate Dam and the confluence of the Trinity River (Westover 2010). The Klamath River differs from other Pacific Northwest rivers in that this species dominates its mussel community (Westover 2010). *G. angulata* populations are currently sparsely distributed and it has been extirpated from a portion of its range; it is believed to have had a much wider distribution historically (Westover 2010). The floater species (*Anodonta spp*.) are less abundant, with the largest single bed found immediately downstream from Iron Gate Dam (Westover 2010). The western pearlshell (*Margaritifera falcata*) is the least abundant freshwater mussel found in the Klamath River and seems to be mostly found downstream from the confluence of the Salmon River (Westover 2010). It is not known how well any of these species could tolerate deposition of sediment and whether they could move upward through deposited material to the surface to breathe and feed. It seems reasonable to presume that some percentage of Klamath River freshwater mussels buried under 0.5 to 3.0 feet of new sediment would not survive. Because of the relatively small area affected, these changes in bed elevation are not expected to substantially affect the overall population of freshwater mussels. It is anticipated that Klamath freshwater mussel populations would rebound eventually, recolonizing through the transport of larvae (*glochidia*) by host fish from downstream populations less affected by bed elevation changes or from populations within tributaries, such as the Trinity, Salmon or Scott Rivers, or from populations on the Klamath River upstream of Iron Gate Reservoir. However, due to the extended time it takes for freshwater mussels to reach sexual maturity (4 years or more, depending on the species), the reestablishment of freshwater mussel populations within affected reaches might be slow and might not be readily noticeable for some time, possibly a decade or more. The seven to eight species of fingernail clams and peaclams, including the montane peaclam, found in the Hydroelectric Reach and from Iron Gate Dam to Shasta River, are expected to be similarly affected.

Changes in Bed Substrate

Draining the Four Facilities under the Proposed Action would result in the erosion of accumulated sediments, changing substrate characteristics within the Klamath River, especially within the current reservoir reaches. The reformation of river channels in the reservoir reaches is expected to occur within 6 months (see Figure 3.3-9). The reformation of river channels between Iron Gate Dam and the upstream reaches of J.C. Boyle Reservoir would benefit freshwater mussels by providing more suitable substrates (i.e., large gravel, cobble, and boulder) than currently exists, especially

within the current reservoir reaches. In addition, the Proposed Action would also open access to river reaches upstream of Iron Gate Dam to migratory fish species, which might serve as host fish for parasitic freshwater mussel larvae (glochidia). As a result, suitable habitats upstream of Iron Gate Dam might be colonized or recolonized by freshwater mussel species, transported as glochidia from downstream reaches by migratory fish species, which are currently blocked by Iron Gate Dam. An increased distribution of anadromous salmonids resulting from dam removal would be expected to benefit *M. falcata* by increasing its distribution as well. However, due to the long time it might take for freshwater mussels to reach sexual maturity, the recolonization and/or growth of existing freshwater mussel populations upstream of Iron Gate Dam might be slow and might not readily noticeable for some time.

Summary: Freshwater Mussels
The Proposed Action would have short-term effects related to SSCs and bedload movement. **Based on substantial reduction in the abundance of multiple year classes in the short term and the slow recovery time of freshwater mussels, the effect of the Proposed Action would be significant for mussels in the short term.**

Implementation of Mitigation Measure AR-7 (see Section 3.3.4.4.7) could be implemented to reduce the short- and long-term impacts of the Proposed Action on freshwater mussels. With implementation of mitigation measures there would still be impacts to a portion of the freshwater mussel population, and there could still be a substantial reduction in the abundance of at least one year class. **Based on substantial reduction in year classes, the Proposed Action would have a significant effect on freshwater mussels after mitigation in the short term.**

Dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. **Based on increased habitat availability and habitat quality in the long term, the effect of the Proposed Action would be beneficial for mussels in the long term.**

Benthic Macroinvertebrates
Peaking Effects
Under the Proposed Action, Klamath Hydroelectric Project peaking operations would no longer kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for resident trout (Administrative Law Judge 2006).

Suspended Sediment Concentrations
Under the Proposed Action, increased SSCs would be expected to affect filter-feeding BMI populations in much the same fashion as described for freshwater mussels. Excessive levels of SSCs for durations longer than normally occur under existing conditions are expected to cause physiological stress, reduced growth, and potential mortality to filter-feeding BMIs. The scraper-grazers feeding guild among the BMIs are also expected to be deleteriously affected, but due to their increased mobility, would be affected less than the filter-feeders. This could affect BMI as far downstream as the

Orleans. The high concentrations of suspended sediment released during winter are not predicted to have a severe effect on macroinvertebrates during their winter dormancy period. During spring and summer SSC will be lower, but would be expected to impact macroinvertebrates during the peak of their feeding and reproductive period. Recolonization of affected BMI populations would occur relatively quickly due to the shortened life cycle of BMIs and rapid dispersal through drift and/or the flying stages of many BMI adults. In addition, recolonization is expected to occur rapidly through drift or dispersal of adult life stages from established BMI populations within the many tributary rivers and streams of the Klamath River.

Changes in Bed Elevation

Under the Proposed Action, changes in bed elevation would affect BMIs in much the same fashion as described for freshwater mussels. Higher levels of sediment deposition than would normally occur under existing conditions would be expected to cause physiological stress, reduced growth, and potentially mortality to BMIs. As with the freshwater mussels, the most substantial impacts on BMIs would occur between Cottonwood Creek and Iron Gate Dam (approximately 8 RMs), with the greatest impacts occurring between Willow Creek and Iron Gate Dam. Recolonization of affected BMI populations would occur relatively quickly due to the shortened life cycle and greater dispersal capabilities of BMIs compared to freshwater mussels.

Changes in Bed Substrate

The reformation of river channels in the reservoir reaches upstream of Iron Gate Dam under the Proposed Action would benefit BMIs by providing more suitable substrates than currently exist. As a result, suitable habitats formed upstream of Iron Gate Dam might be opened to additional colonization by BMIs through rapid dispersal by drift from upstream populations within current riverine reaches and/or dispersion of adult life stages. In addition, recolonization would occur rapidly from established BMI populations within the many tributary rivers and streams of the Klamath River.

Summary: Benthic Macroinvertebrates

The Proposed Action would have short-term effects related to SSCs and bedload movement. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Proposed Action would be significant for macroinvertebrates downstream from Iron Gate Dam in the short term.**

While a large proportion of macroinvertebrate populations in the Hydroelectric Reach and in the mainstem Klamath River downstream from Iron Gate Dam would be affected in the short term by the Proposed Action, their populations would be expected to recover quickly because of the many sources for recolonization and their rapid dispersion through drift or aerial movement of adults. Habitat quality would also be improved in the Hydroelectric Reach by the ending of deleterious Klamath Hydroelectric Project peaking operations (Administrative Law Judge 2006).

Dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would

rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. **Based on increased habitat availability and improved habitat quality, the effect of the Proposed Action on macroinvertebrates would be beneficial in the long term.**

Deconstruction

As described below, disturbance to the river channel during construction could affect aquatic species.

The Proposed Action would require relocation of the City of Yreka's water supply pipeline in Iron Gate Reservoir, demolition of the dams and their associated structures, power generation facilities, transmission lines, installation of cofferdams, road upgrading, hauling, reservoir restoration, and other activities (as described in Section 2.4.3.1). These actions would include the use of heavy equipment, and blasting as necessary, and as such, have the potential to disturb aquatic species. Activities at the J.C. Boyle, Copco 1, and Copco 2 Dams would affect the riverine and introduced resident species in the Hydroelectric Reach.

At Iron Gate Dam, anadromous species could also be affected. These effects could include shockwaves associated with breaking down the dam structure using explosives or heavy equipment, potential crushing of aquatic species from operation of heavy equipment in the river, sedimentation, and release of oil, gasoline, or other toxic substances from construction sites. Demolition of the dams and their associated structures, power generation facilities, installation of cofferdams, and other activities are scheduled to occur at Iron Gate Dam between January 10 and June 26, with cofferdam installation scheduled to occur between 2 January 2020 and 6 February 2020. Therefore, this activity would occur during the first month of reservoir drawdown and the peak of SSC associated with reservoir drawdown. As discussed above, any aquatic species within the vicinity of Iron Gate Dam tailrace during this time would also be subject to SSC during the reservoir drawdown that are estimated to range from 80 to >10,000 mg/L during the January 10 through June 26, 2020, period. These SSCs corresponds to Newcombe and Jensen (1996) severity ratings of from 8 to 12, which equate to sub-lethal and lethal effects aquatic species. It is anticipated that this release of sediment would result in the displacement of any individuals that are rearing in the mainstem into tributaries or further downstream prior to deconstruction or cofferdam activities. Therefore, impacts associated with deconstruction would generally be of small magnitude, short duration, and low intensity when compared to those that would occur as a result of the changes in habitat structure and release of sediments stored behind the dams if they were removed.

To minimize these potential construction impacts, construction areas would be isolated from the active river where possible, and water would be routed around the construction area, allowing the flow to move down the other portion of the river, while the isolated portion of the dam is removed. After a work area is isolated, fish rescues to remove any native fish trapped in the work area would be conducted. Fish would be relocated to an area of suitable habitat within the Klamath River. Implementation of soil erosion and sedimentation control and stormwater pollution prevention would minimize soil erosion

and water quality effects on anadromous fish downstream from the work area, during and after construction. **Because best management practices for construction incorporated into the Proposed Action will prevent substantial effects, construction activities associated with the Proposed Action would be less–than-significant.**

Coastal Zone Consistency Determination

The following section provides an analysis of the effects of the Proposed Action on each of the relevant policies of the California Coastal Management Program as outlined in the California Coastal Act of 1976. The deconstruction activities of the Proposed Action would begin approximately 190 miles from the mouth of the Klamath River. Therefore, this analysis focuses on impacts that would be evident many RMs downstream in the estuary and near shore. The policies identified as applicable are Article 4 Marine Environment Section 30231 and Section 30236 (see *italicized* text below). Articles 2, Article 3, Article 5, Article 6, and Article 7 are not applicable due to the distance of deconstruction activities from the near shore environment and will not be further addressed in this analysis. Also this is a phased Coastal Zone Management Act (CZMA) analysis. Additional implementation specific analysis will be completed as needed if the Secretary makes an Affirmative Determination.

Section 30231 The biological productivity and the quality of coastal waters, streams, wetlands, estuaries and lakes appropriate to maintain optimum populations of marine organisms and for the protection of human health shall be maintained and, where feasible restored through, among other means, minimizing adverse effects of waste water discharges and entrainment, controlling runoff, preventing depletion of ground water supplies and substantial interference with surface water flow; encouraging waste water reclamation, maintaining natural vegetation buffer areas that protect riparian habitats, and minimizing alterations of natural streams.

As described above, the Proposed Action would result in substantial short-term increases in suspended sediment during 2020 while the reservoirs are drawndown in preparation for facility removal. The effect of these short-term increases would be significant for some species within the Klamath River. However, as described above, aquatic species within the river would benefit from increased habitat availability and improved habitat suitability in the long term. In addition, under a worst-case scenario, SSCs resulting from the Proposed Action would be elevated within the estuary and nearshore environment for approximately three months (January, February, and March) in 2020. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2.). After this time, SSCs would return to levels similar to existing conditions. Based on the short duration of poor water quality during reservoir drawdown in the estuary and near-shore environment, the Proposed Action would not be deleterious in the short term, and would not likely affect the estuary and near-shore environment in the long term.

For all species analyzed, when the short-term deleterious effects occurring during reservoir drawdown in 2020 are weighed against the long-term benefits to the Klamath River, the systemic restoration espoused in the Proposed Action improves biological productivity and the quality of waters, streams, wetlands, estuaries, and lakes. Therefore the Proposed Action is consistent with the California Coast Act Policy 30231.

Section 30236 Channelizations, dams or other substantial alterations of rivers and streams shall incorporate the best mitigation measures feasible and be limited to (1) necessary water supply projects, (2) flood control projects where no other method for protecting existing structure in the flood plain is feasible and where such protections is necessary for public safety or to protect existing development, or (3) developments where the primary function is the improvement of fish and wildlife habitat.

The primary function of the Proposed Action is to improve fish and wildlife habitat and water quality. For this reason, the Proposed Action deconstruction schedule was crafted with careful attention to the timing necessary to limit the impact of sediment release on aquatic resources and water quality. The timing in the Proposed Action is designed to limit the effects on water quality to one single large increase in suspended sediment and one single reduced dissolved oxygen event occurring within the winter and early spring of 2020. By limiting the duration of elevated suspended sediment and reduced dissolved oxygen, the Proposed Action avoids multiple years of effects to aquatic species and minimizes impacts to the sensitive juvenile rearing and smolt life stages of migratory fish. In addition to this built-in avoidance and minimization measure, the Proposed Action includes several required best management practices for the deconstruction activities including erosion and stormwater management, dust abatement, and hazardous spill prevention and response measures. To further address the alteration of rivers and streams and the effects of returning some of the natural processes to the Klamath River system, mitigation measures are being considered including AR 1: Protection of Mainstem Spawning, AR2: Protection of Outmigrating Juveniles, AR3: Fall Pulse Flows, AR-4: Hatchery Management, and AR-5 Pacific Lamprey Capture and Relocation.

Given the careful crafting of the Proposed Action, the required Best Management Practices and mitigation measures, and the fact that the primary function of the project is improvement of fish and wildlife habitat, the Proposed Action is consistent with the California Coast Act Policy 30236.

Interim Measures

The Proposed Action includes IMs to be implemented prior to the initiation of dam removal in 2020 (as described in Section 2.4.3). These IM's will cease to be implemented if the Secretary makes a Negative Determination, and would therefore have no long-term effect on aquatic resources. As described below, two of these have the potential to affect aquatic resources, including:

- IM 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement, and
- IM 16: Water Diversions.

Implementation of J.C. Boyle Gravel Placement and/or Habitat Enhancement could result in alterations to habitat availability and habitat quality, and affect aquatic species.

Currently trout spawning gravel in the J.C. Boyle bypass reach is embedded with fine silt. In July 2006, the spawning gravel in the bypass reach below the emergency spillway was fifty ("50") percent embedded with silt and sand (ALJ Decision at 42 Finding of Fact number 14-7). Bedload mobilization is the natural geomorphic process whereby flow moves gravel for deposit on alluvial features and cleanses gravel of sediment. Diversion has reduced the capacity of flow to mobilize the bedload by an estimated eighty-three ("83") percent to ninety-six ("96") percent in the bypass reach (ALJ Decision at 40 Finding of Fact 11-2).

Under this IM, suitable spawning gravel would be placed in the J.C. Boyle Bypass and Peaking reaches following an Affirmative Determination and continuing through 2019. The first year would be before the Secretary makes a determination, and would therefore be included in the No Action/No Project Alternative. The following seven years would be part of the Proposed Action. This measure would use a passive approach to place gravel before high flow periods, or develop for other habitat enhancement that would provide equivalent fishery benefits in the Klamath River upstream of Copco Reservoir. These actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal. The additional gravel could also improve bed mobility in this reach following dam removal. Seasonal high flows, in combination with a gravel augmentation program, will likely create a more dynamic channel with a wider range of sediment deposits. This sediment will be deposited higher on the channel margin which will serve as an ecological benefit (ALJ Decision at 38 Finding of Fact 10-5). Also additional gravel may contribute to increased periphyton scour and less favorable habitat for the polychaete intermediate host of *C. shasta* and *P. minibicornis*. This could reduce the potential for infection of juvenile salmonids in the Hydroelectric Reach following dam removal (see also the subsection of Section 3.4.4.3.2, Algae). **Based on anticipated improvements in habitat availability and habitat quality, implementation of J.C. Boyle Gravel Placement and/or Habitat Enhancement under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and benthic macroinvertebrates. These actions would also be beneficial for coho salmon from the Upper Klamath River Population Unit, and less-than-significant for all other population units in the Basin. Effects on bull trout, freshwater mussels, shortnose and Lost River suckers would be less-than-significant. Effects on green sturgeon, eulachon, and Southern Resident Killer Whales would not change from existing conditions.**

Implementation of IM 16 (Water Diversions) could result in alterations to habitat availability and habitat quality, and affect aquatic species. Under this IM, PacifiCorp would seek to eliminate three screened diversions (the Lower Shovel Creek Diversion [7.5 cfs], Upper Shovel Creek Diversion [2.5 cfs], and Negro Creek Diversion [5 cfs]) from Shovel and Negro Creeks and would seek to modify its water rights to move the

points of diversion from Shovel and Negro creeks to the mainstem Klamath River. Based upon available information, the upstream most diversion on Shovel Creek is approximately one mile upstream of the confluence with the Klamath River. If this were successful the screened diversions would be removed prior to dam removal in 2020. The intent of this measure is to provide additional water to Shovel and Negro creeks, thus increasing the quality and amount of suitable habitat for aquatic species within these tributaries, while not diminishing PacifiCorp's water rights. These actions would provide improvements in the quality and amount of suitable habitat for resident and anadromous aquatic species following dam removal. **Based on anticipated improvements in habitat availability and habitat quality with increased flow, implementation of IM 16 (Water Diversions) under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and benthic macroinvertebrates. These actions would also be beneficial for coho salmon from the Upper Klamath River Population Unit, and less-than-significant for all other population units in the Basin. Effects on bull trout, freshwater mussels, shortnose and Lost River suckers would be less-than-significant. Effects on green sturgeon, eulachon, and Southern Resident Killer Whales would not change from existing conditions.**

Keno Transfer

Implementation of the Keno Transfer could cause adverse aquatic resource effects. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on aquatic resources compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measure

Decommissioning the East and Westside Facilities could cause adverse aquatic resource effects. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would no longer divert water flows at Link River Dam into the two canals. Risk of entrainment into these facilities would also be eliminated. Following decommissioning of the facilities, there would be no change in outflow from Upper Klamath Lake or inflow into Lake Ewauna. **Implementation of the East and Westside Facility Decommissioning action would be beneficial for suckers and redband, and no change from existing conditions for other aquatic species.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

The Proposed Action could require the relocation of the City of Yreka Water Supply Pipeline. The existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the dam to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge

across the river near its current location. Standard construction Best Management Practices would reduce the likelihood and extent of aquatic impacts. **Therefore, the relocation of the City of Yreka Water Supply Pipeline would have less-than-significant impacts to aquatic resources.**

KBRA – Programmatic Measures

The KBRA, which is a connected action to the Proposed Action, encompasses several programs that could affect aquatic resources, including:

- Phases I and 2 Fisheries Restoration Plan
- Fisheries Monitoring Plan
- Fisheries Reintroduction and Management Plan - Phase I
- Water Diversion Limitations
- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Klamath Tribes Interim Fishing Site
- Upper Klamath Lake and Keno Nutrient Reduction

With implementation of the KBRA, ongoing habitat restoration would be better funded, better coordinated and monitored to ensure effective implementation. The actions that would be taken under the KBRA would generally benefit aquatic resources by reducing the impacts of past and ongoing disturbance on aquatic habitats. Any undesirable impacts associated with the actions would be short term in nature and could be largely avoided by employing Best Management Practices for construction activities in and near water. Individual components of the KBRA are described below.

Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plan

Implementation of Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plan could result in alterations to water quantity, water quality, habitat availability and habitat quality, and affect aquatic species. The Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plans are designed to improve habitat for aquatic species and measure the efficacy of restoration actions. These plans prioritize restoration needs within the Basin and establish a monitoring and adaptive management program to evaluate and optimize the success of restoration actions.

Measures that are ongoing in the Basin or that have been identified for inclusion in the plans include floodplain rehabilitation, large woody debris emplacement, fish passage improvement, livestock exclusion fencing, riparian vegetation management, purchase of conservation easements, road decommissioning, and treatment of fine sediment sources. Restoration actions will occur within the mainstem Klamath River, as well as within critical tributaries known to support salmonid rearing, such as Scott and Shasta rivers. These activities were chosen to benefit native fish populations as well as the health of the aquatic and riparian ecosystems of the Klamath Basin. Fish passage improvements would be designed to increase access to historical habitat. Many of these activities would

be constructed to reduce fine sediment supply to streams within the project area, improving spawning habitat and productive macroinvertebrate habitat.

Purchase of conservation easements or land could provide long-term protection to areas beneficial to the riverine ecosystem as a whole or specific areas of importance to fish species such as endangered suckers. It could also protect areas where restoration actions have been used to improve or restore habitats.

Some restoration activities under the Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plan could have short-term negative impacts, generally associated with construction and active management phases. Generally, these impacts would be localized and could be avoided through implementation of best management practices, such as control and containment of sediment and toxic discharge, isolation of work areas from the active channel of streams or rivers where possible, and rescuing fish where mortality may result from an action. The long-term water quality improvements generated by implementation of Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plan would contribute to the long-term improvements anticipated from hydroelectric facility removal. **Based on anticipated improvements in water quantity, water quality, habitat availability and habitat quality, implementation of Phases I and 2 Fisheries Restoration Plans and Fisheries Monitoring Plan under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, benthic macroinvertebrates, and shortnose and Lost River suckers. These actions would also be beneficial for coho salmon, except those in the Trinity River population units, where they would be less-than-significant. Effects on green sturgeon, bull trout, eulachon, Southern Resident Killer Whales, and freshwater mussels would not change from existing conditions.**

Phase I Fisheries Reintroduction and Management Plan

Implementation of Phase I of the Fisheries Reintroduction and Management Plan could result in alterations to habitat availability (fish access), and could affect aquatic species. The Phase I Fisheries Reintroduction and Management Plan is intended to support the reintroduction and management of fish in the Upper Klamath Basin during and after implementation of the KHSA. As specified in the KHSA, the plan would include provisions for the continued operation of a fish hatchery at Fall Creek or in the Iron Gate Dam area and the construction of fish collection facilities to support primarily the transport of fall-run Chinook salmon around Keno Impoundment/ Lake Ewauna, when needed, on an interim seasonal basis.

The initial use of the hatchery facility at Iron Gate Dam or on Fall Creek would provide conservation of native salmon stocks during the impact period of dam removal. The development of guidelines for the use of the conservation hatchery at Iron Gate Dam or on Fall Creek outlined in the Phase I Fisheries Reintroduction and Management Plan would be to support the establishment of naturally producing populations in the Klamath Basin following implementation of the KHSA. Additionally, it is anticipated that a

smaller production facility would be constructed in the Upper Klamath Basin to provide necessary research stock and locally reared fish for the reintroduction.

As specified in the KHSA, volitional upstream and downstream passage facilities (screens and ladders) would be developed for passage around Keno Impoundment/ Lake Ewauna and will provide for volitional passage during the majority of the year. In addition, the development of fish collection facilities upstream and downstream from Keno Impoundment/Lake Ewauna would be required to provide effective migration for fall-run Chinook salmon when water quality is poor during the period from June 15 to November 15. During the limited period of use, fish collection and release facilities would be operated to minimize any delay and stress and provide for adequate acclimation. For adult fall-run Chinook salmon, fish transport would be an effective fish passage method because transport would be for a short distance on a seasonal, interim basis[7]. For adult fall-run Chinook salmon, seasonal collection and transport mortality when water quality is poor would be minor compared to mortality associated with unaided passage through areas of poor water quality at this time of year.

In some instances, the collection and transport of fall-run Chinook salmon around Keno Impoundment/Lake Ewauna could result in limited, seasonal mortality as follows:

1. Some juvenile federally listed suckers would likely be collected incidentally and may suffer related stress and mortality. However, regardless of any remediation at an upstream collection facility, nearly all these downstream migrant suckers would eventually die in the absence of lacustrine habitat below Keno Impoundment/Lake Ewauna. There is little to no evidence of recruitment of suckers in downstream reservoirs currently and this habitat does not contribute significantly to the recovery of the species. Suckers may be collected and returned to habitat above Keno Impoundment/Lake Ewauna.
2. Some redband trout may be collected incidentally resulting in displacement and incidental collection-related stress and mortality. Redband trout may be collected and returned to habitat above Keno Impoundment/Lake Ewauna.
3. For fall-run Chinook salmon emigrants, the seasonally poor quality conditions are not expected to overlap with the peak migration period, thus the majority of juvenile Chinook salmon would not be affected. For those fall-run Chinook salmon emigrants collected and transported during poor water quality conditions, transport related mortality would be minor compared to the mortality associated with unaided passage through areas of poor water quality at this time of year.

[7] This seasonal, transport on an interim basis is not to be confused with permanent, year round trap and haul, which does not provide equal benefits for the Klamath River when compared with the Services' fishway prescriptions (U.S. Department of the Interior (2007) The Department of the Interior's Filing of Modified Terms, Conditions, and Prescriptions (Klamath Hydroelectric Project, No. 2082). Sacramento, California: 650 p.; NOAA Fisheries Service (2007). NOAA Fisheries Service Modified Prescriptions for Fishways and Alternatives Analysis for the Klamath Hydroelectric Project (FERC Project No. 2082): 151 p.).

4. For steelhead trout and spring-run Chinook salmon, migration would likely occur primarily when water quality was adequate, thus, collection and transport of these fish would not be necessary or minimal. However, all anadromous salmonids would be collected and transported when water quality is poor during the period from June 15 through November 15. Transport related mortality would be minor compared to the mortality associated with unaided passage through areas of poor water quality at this time of year.

Limited, seasonal transport of fall-run Chinook salmon would provide a net benefit by allowing them migration to and from additional (historical) spawning habitat, by providing more effective migration, and by reducing the density of spawners below Keno Dam in certain poor water quality situations. The majority of fish transported would likely be fall-run Chinook salmon. However, the Phase I Fisheries Reintroduction and Management Plan may include seasonal, interim transport for a minor component of the spring-run Chinook, and steelhead migrants. Thus, these fish would also receive benefits from this program. Increased anadromous fish abundance, especially Chinook salmon, would result in more prey availability for Southern Resident Killer Whales when the whales are near the Oregon and California coasts.

Other reintroduction activities under the Phase I Fisheries Reintroduction and Management Plan could have short-term impacts, generally associated with construction and active management phases. Generally, these impacts would be localized and could be avoided or minimized through implementation of best management practices, such as control and containment of sediment and toxic discharge, isolation of work areas from the active channel of streams or rivers where possible, and rescuing fish where mortality may result from an action. The habitat improvements generated by implementation of the Phase I Fisheries Reintroduction and Management Plan would contribute to the long-term improvements anticipated from hydroelectric facility removal. **Based on access to additional, historical habitat and the anticipated improvements in fish health, implementation of the Phase I Fisheries Reintroduction and Management Plan under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, Southern Resident Killer Whales, and benthic macroinvertebrates. These actions would also be beneficial for coho salmon, except those Trinity River population units, through continued support from the fish hatchery. The Trinity River population units, would experience no change from existing conditions in the long term. Effects on green sturgeon, bull trout, eulachon, and freshwater mussels would be no change from existing conditions. These actions would be less than significant for redband trout as well as for shortnose and Lost River suckers.**

Water Diversion Limitations Implementation of Water Diversion Limitations could result in reducing uncertainties associated with maintaining adequate ecological flows for aquatic species and their habitats, especially in low-flow years, and could alter water quality, and water temperatures in certain seasons and affect aquatic species. *This component of the KBRA would establish limits on specific diversions within*

Reclamation's Klamath Project to protect flows in the mainstem and ensure that adequate water supply is available for allocation to the wildlife refuges.

A plan would be developed for monitoring groundwater in order to restrict pumping to no more than 6 percent of the output of springs listed in the KBRA Section 15.2.4.A.i. This measure would protect an important resource that provides suitable habitat conditions that may be critical to the survival of some species. This reliable source of cool inflow from springs provides benefit to aquatic species by influencing temperature, dissolved oxygen, algal growth, and the dilution of contaminants or natural toxins, such as those produced by *M. aeruginosa*.

The long-term water quality and quantity improvements generated by implementation of diversion limitations would contribute to the long-term improvements anticipated from hydroelectric facility removal. **Based on anticipated improvements in water quantity and water quality, implementation of Water Diversion Limitations under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and shortnose and Lost River suckers. These actions would also be beneficial for coho salmon, except those in the Trinity River population units, where they would be no change from existing conditions. Effects on green sturgeon, bull trout, eulachon, Southern Resident Killer Whales, freshwater mussels, and BMIs would be no change from existing conditions.**

On-Project Plan Implementation of the On-Project Plan could result in alterations to water quantity and water quality and affect aquatic species. *The On-Project Plan would include a groundwater monitoring plan that limits pumping so that flows from springs in the watershed upstream of Copco 1 Dam would not be reduced by more than 6 percent, protecting these important habitats that provide suitable habitat conditions and often support rare or unique species. It would also provide a plan to implement the water diversion limitations described above. This measure would help protect flows in the mainstem with the benefits described above. The long-term water quality and quantity improvements generated by implementation of the On-Project Plan would contribute to the long-term improvements anticipated from hydroelectric facility removal. Based on anticipated improvements in water quantity and water quality, implementation of Water Diversion Limitations under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and shortnose and Lost River suckers. These actions would also be beneficial for coho salmon, except those in the Trinity River population units, where they would be no change from existing conditions. Effects on green sturgeon, bull trout, eulachon, Southern Resident Killer Whales, freshwater mussels, and BMIs would be no change from existing conditions.*

Water Use Retirement Program

The Water Use Retirement Program could alter water quantity and water quality, and affect aquatic species. This component of the KBRA would increase inflow to Upper Klamath Lake by 30,000 acre-feet per year on average. A variety of mechanisms may be used to achieve this objective, including acquisition of water rights, forbearance

agreements, water leasing, changes in agricultural cropping patterns, land fallowing, and juniper removal. The additional water provided would increase flows in tributaries to Upper Klamath Lake improving habitat for redband trout, shortnose and Lost River suckers, and bull trout. Anadromous salmon and steelhead that would have access to these tributaries as a result of the Proposed Action would also be expected to benefit.

This additional water could be used for a variety of purposes downstream from Upper Klamath Lake, including augmenting the base flow or high flow components of the annual hydrograph. Maintaining base flows, particularly during extreme droughts, is critical for fish spawning, rearing, passage, and preventing excessively warm water temperatures for all life stages. High flows are critical for shaping stream and river channels, creating diverse habitats, and connecting these habitats to riparian zones, terraces, and flood plains that provide nutrients to the riverine ecosystem and shelter for fish and other aquatic organisms when conditions in the river are unsuitable. Periodic springtime high flow events also have the potential of scouring the channel of fine-grained sediments and cladaphora which harbor intermediate hosts for organisms that produce high mortality in juvenile salmon. High flows mobilize the streambed, which removes fine sediments and organic material that can reduce spawning success and macroinvertebrate production, as well as reduce interstitial habitat used as cover by small fish. They are also important drivers of riparian ecosystem functions, such as dispersing and germinating seeds of riparian plants, and creating new areas for vegetation colonization through erosion. Riparian ecosystems are important for filtering fine sediment from hillslope runoff, buffering streams from contaminants, providing shade and temperature regulation, bank stability, and nutrients to the stream. Augmenting low flows in some years may be critical due to temperature, water quality, or disease concerns.

The additional water flows generated by implementation of the Water Use Retirement Program would contribute to the long-term improvements anticipated from hydroelectric facility removal. **Based on anticipated improvements in water quantity, and water and stream channel quality, implementation of Water Use Retirement Program under the Proposed Action would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and shortnose and Lost River suckers. These actions would also be beneficial for coho salmon, except those in the Trinity River population units, where there would be no change from existing conditions. Effects on green sturgeon, bull trout, eulachon, Southern Resident Killer Whales, freshwater mussels, and BMIs would be no change from existing conditions.**

Fish Entrainment Reduction

Implementation of the Fish Entrainment Reduction could result in alterations to potential alterations to mortality risk and affect aquatic species. This KBRA action would involve designing and installing fish screens at Project Diversions, including the Lost River Diversion Channel and associated diversion points, North Canal, Ady Canal, and other Reclamation and Reclamation contractor diversions. This action would reduce mortality caused by entrainment of fish at these diversions, to the benefit of endangered shortnose

and Lost River suckers, as well as to redband trout. Steelhead and fall- and spring-run Chinook salmon would also benefit from this action once they recolonize areas upstream of Keno Dam. The reductions in entrainment mortality generated by implementation of the Water Use Retirement Program would contribute to the long-term improvements in anadromous species health anticipated from hydroelectric facility removal. **Based on anticipated reductions in entrainment mortality, implementation of Fish Entrainment Reduction under the Proposed Action would be beneficial for shortnose and Lost River suckers, redband trout, fall-run Chinook salmon, spring-run Chinook salmon, steelhead, and Pacific lamprey. These actions would also be beneficial for coho salmon from the Upper Klamath River population unit, and would be no change from existing conditions for all other coho salmon population units. Effects on green sturgeon, bull trout, eulachon, Southern Resident Killer Whales, freshwater mussels, and BMIs would be no change from existing conditions.**

Klamath Tribes Interim Fishing Site

Implementation of the Klamath Tribes Interim Fishing Site could result in alterations to managed harvest mortality of fish species that are culturally important to the Klamath Tribes, including Chinook and coho salmon, steelhead, and Pacific lamprey. The harvest, which would take place between Iron Gate Dam and Interstate 5, would be coordinated with harvest by other tribes and the commercial fishery to remain within the predicted sustainable limits for the fishery. The coordinated harvest at the Klamath Tribes Interim Fishing Site would not be expected to contribute to any changes generated by the hydroelectric facility removal action. **Based on anticipated fisheries management coordination as part of the implementation of Klamath Tribes Interim Fishing Site under the Proposed Action, this action would result in no change from existing conditions for aquatic species.**

Upper Klamath Lake and Keno Nutrient Reduction Implementation of the Interim Flow and Lake Level Program could result in decreases in summer water temperature and nutrient inputs to Upper Klamath Lake. *KBRA (Appendix C-2, line 11) includes a program to study and reduce nutrient concentrations in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake in order to reduce dissolved oxygen problems and algal problems in both water bodies. Restoration actions to control nutrients have not been developed, and there are many diverse possibilities that could require construction of treatment wetlands, construction of facilities, or chemical treatments of bottom sediment, among other possibilities. A nutrient reduction program in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake would be designed to improve water quality (increasing dissolved oxygen and reducing algal concentration) and to provide fish passage through the Keno Impoundment/Lake Ewauna in summer and fall months; however, implementation of this nutrient reduction program will require future environmental compliance investigations and a determination on significance cannot be made at this time.*

The specific locations in which some of these KBRA actions would be undertaken are unknown at this time, but they would be implemented at different locations and times

than KHSA actions. Many of these actions would require additional environmental documentation and permitting before being implemented, and are covered programmatically in this document. Generally, the KBRA actions described above would be expected to result in a net benefit for fisheries resources and the aquatic environment. Any potential deleterious effects identified could be avoided or mitigated through careful planning and management.

3.3.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams Alternative

The Partial Facilities Removal of Four Dams Alternative would include removal of enough of J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams to allow free-flowing river conditions and volitional fish passage at all times. Under this alternative, portions of each dam would remain in place along with ancillary buildings and structures such as powerhouses, foundations, tunnels, and pipes, all of which would be outside of the 100 year flood-prone width. Under this alternative, partial removal of the embankment/earth-filled dam and concrete dam structures would allow release of dam-stored sediment. The retention of these structures would not be expected to result in any difference in the physical or biological effects of dam removal from those described for the Proposed Action. This alternative would include the transfer of the Keno Facility to the DOI and implementation of the KBRA. Under this alternative, hatchery production would continue for eight years following the removal of Iron Gate Dam.

Key Ecological Attributes

Aquatic ecological attributes under the Partial Facilities Removal of Four Dams Alternative would have indistinguishable effects on aquatic species from the Proposed Action.

Species-Specific Impacts

Reservoir drawdown associated with dam removal under this alternative could affect aquatic species. In addition, the removal of dams and reservoirs could alter the availability and quality of habitat, resulting in effects on aquatic species. The impacts were considered for each of the following species and groups: fall-run Chinook salmon, spring-run Chinook salmon, coho salmon, steelhead, lamprey, green sturgeon, Lost River and shortnose suckers, redband trout, bull trout, eulachon, longfin smelt, introduced resident species, freshwater mussels and benthic macroinvertebrates. The effects of this Partial Facilities Removal of Four Dams Alternative on aquatic species would be indistinguishable from those described for the Proposed Action.

Interim Measures

Implementation of IMs 7 (J.C. Boyle Gravel Placement and/or Habitat Enhancement) and 16 (Water Diversions) could result in alterations to habitat availability and habitat quality, and affect aquatic species. These IM's will cease to be implemented if the Secretary makes a Negative Determination, and would therefore have no long-term effect on aquatic resources. These IMs would increase spawning gravel or habitat upstream of Copco Reservoir and would increase flows in Shovel and Negro Creeks. As described under the Proposed Action, these actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal. **Based on anticipated improvements in habitat availability and habitat**

quality, implementation of IMs 7 and 16 under the Partial Facilities Removal would be beneficial for fall-run Chinook salmon, spring-run Chinook salmon, steelhead, Pacific lamprey, redband trout, and benthic macroinvertebrates. These actions would also be beneficial for coho salmon from the Upper Klamath River Population Unit, and less-than-significant for all other population units in the Basin. Effects on bull trout, freshwater mussels, shortnose and Lost River suckers would be less-than-significant. Effects on green sturgeon, eulachon, and Southern Resident Killer Whales would not change from existing conditions.

Keno Transfer

Implementation of the Keno Transfer could cause adverse aquatic resource effects. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on aquatic resources compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measure

Decommissioning the East and Westside Facilities could cause adverse aquatic resource effects. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would no longer divert water flows at Link River Dam into the two canals. Risk of entrainment into these facilities would also be eliminated. Following decommissioning of the facilities, there would be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. **Implementation of the East and Westside Facility Decommissioning action would be beneficial for suckers and redband, and no change from existing conditions for other aquatic species.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

The Proposed Action would require the relocation of the City of Yreka Water Supply Pipeline. Under the Partial Facilities Removal Alternative, the relocation of the City of Yreka Water Supply Pipeline would have the same impacts as under the Proposed Action.

KBRA – Programmatic Measures

The KBRA would be implemented under the Partial Facilities Removal of Four Dams Alternative and would have indistinguishable effects on aquatic species from those of the Proposed Action.

3.3.4.3.4 Alternative 4: Fish Passage at Four Dams Alternative

The Fish Passage at Four Dams Alternative would provide upstream and downstream fish passage at the Four Facilities, but would not include implementation of the KBRA. The ongoing restoration actions, described in the No Action/No Project Alternative, would continue. The alternative would incorporate the prescriptions from the DOI and DOC imposed during the FERC relicensing process, including fishway installation for both

upstream and downstream migrations at all four facilities and barriers to prevent juvenile salmonid entrainment into turbines. In addition to the fishways, there are a series flow-related measures, including a condition that requires at least 40 percent of the inflow to the J.C. Boyle Reservoir to be released downstream. This alternative would limit generation of peaking power at J.C. Boyle Powerplant to one day per week as water supplies allow, and would include recreation flows one day a week.

Pursuant to FERC's Licensing Regulations, the Department of the Interior filed its comments regarding the impacts of facilities and operations of the Klamath Hydroelectric Project (FERC No. 2082) on public resources and recommended various terms and conditions to be incorporated into any new license to address these impacts. In addition, the Secretaries of Interior and Commerce filed fishway prescriptions under Section 18 of the Federal Power Act (FPA) to provide safe, timely, and effective fish passage, and, in doing so, specifically address the loss of fish habitat after the project was constructed.

Pursuant to the regulations of FERC (18 CFR 385.604), many of the Parties to the FERC licensing proceeding undertook confidential settlement discussions to resolve disputed issues in the licensing proceeding, resulting in the KHSA. Section 3.2.1 of the KHSA provides that the Secretary of the Interior is to undertake NEPA analysis and other appropriate actions to determine whether to proceed with Facilities Removal. Chapter 1 of this EIS/EIR states the purpose of the proposed Federal action "is to advance restoration of the salmonid fisheries in the Klamath Basin that is in the public interest, and is consistent with the KHSA and KBRA and their objectives." Consistency with the KHSA and KBRA and their objectives thus underlies the alternatives and analyses presented in this document. At time of document preparation, FERC has not taken final action on PacifiCorp's application for license. Therefore, the Department of the Interior's position in that proceeding has not changed, including the various impacts of PacifiCorp's dams on public resources and the need for and benefits of the fishways prescribed by the Secretaries. Fishways installed as part of fish passage alternatives in this EIS/EIR would need to comply with the Section 18 prescriptions for the construction, operation, and maintenance of upstream and downstream passage (DOI 2007). General prescriptions cover anadromous (fall- and spring-run Chinook salmon, coho salmon, steelhead, and Pacific lamprey) and resident (rainbow and redband trout, shortnose and Lost River suckers) fish passage at all Klamath Hydroelectric Project dams, and include implementing operation and maintenance plans and prescribing attraction flows for upstream migrants (DOI 2007). Specific provisions apply to individual dams and include performance standards for upstream and downstream passage facilities.

DOI and NOAA Fisheries Service passage prescriptions for Keno Dam include the collection of adult Chinook salmon for transport past Lake Ewauna during summer months when water quality is poor (DOI 2007). If dissolved oxygen concentrations are less than 6 mg/L and water temperatures are higher than 20°C, as measured at Miller Island (RM 246), trap and haul would occur from June 15 through November 15 until restoration efforts improve water quality to conditions suitable for anadromous fish (DOI 2007). Conditions in the reach from Keno Dam to Link River Dam are expected to

eventually improve through implementation of TMDL water quality measures and imposition of State water quality certification conditions to allow year-round volitional passage.

Under the Fish Passage at Four Dams Alternative, Iron Gate Hatchery will continue to operate to meet mitigation requirements.

Key Ecological Attributes

Suspended Sediment

Under the Fish Passage at Four Dams Alternative, SSCs would be the same as under existing conditions. Therefore, this alternative would have no effects associated with suspended sediment transport relative to existing conditions for any aquatic species.

Bedload Sediment

Under the Fish Passage at Four Dams Alternative, the dams would not be removed and sediment would continue to be stored behind Klamath Hydroelectric Project dams. As described for the No Action/No Project Alternative, the Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. These periodic inputs of bedload sediments are necessary for the long-term maintenance of aquatic habitats. As a result of the interception of sand, gravel and coarser sediment supply from sources upstream of Iron Gate Dam the channel downstream from Iron Gate Dam would continue to coarsen and decrease in mobility (Reclamation 2012), providing fewer components of habitat, in particular spawning habitat, and decreased quality habitat over time. This effect would gradually decrease in the downstream direction as coarse sediment is resupplied by tributary inputs (Hetrick et al. 2009), and would be substantially reduced at the Cottonwood Creek confluence (PacifiCorp 2004b). As occurs under existing conditions, the coarser bed material is mobilized at higher flows that occur less frequently, resulting in channel features that are unnaturally static and provide lower value aquatic habitat (Buer 1981).

Water Quality

Under the Fish Passage at Four Dams Alternative, water quality would be the same as under the No Action/No Project Alternative. Anadromous fish would be able to move through the Hydroelectric Reach and might be seasonally exposed to poor water quality during upstream and downstream migration. Dissolved oxygen concentrations within reservoirs can be seasonally stressful for anadromous fish from June to September (FERC 2007) and continued high rates of algal photosynthesis in the reservoirs would result in pH values that would not consistently meet applicable ODEQ and California Basin Plan water quality objectives (see Section 3.2.4.3). Implementation of water quality improvement measures under Oregon and California TMDLs (to address water quality impairments within the period of analysis) would improve conditions for migratory fish.

Water Temperature

Under the Fish Passage at Four Dams Alternative, the effects on water temperature are predicted to be similar to those that are predicted for the No Action/No Project Alternative. Under this Alternative, the expected overall higher flow releases would

result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. These effects would be similar to those under the Proposed Action and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, as with the Proposed Action, areas adjacent to the coldwater springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Fish Passage at Four Dams Alternative. Anadromous fish would be able to move through the Hydroelectric Reach and might be seasonally exposed to high temperatures during upstream and downstream migration. Water temperature in the reservoirs can be high from June to September (see Section 3.2.3.2) and surface layers may seasonally exceed thermal tolerances for salmonids or resident fish. However, these potential periods of high water temperature are outside of peak migration.

Since J.C. Boyle Reservoir, with its large thermal mass, would remain in place, effects on diel temperature variation in the Bypass Reach under the Fish Passage at Four Dams Alternative would be similar to those described for the No Action/No Project Alternative (i.e., reduced diel temperature variation). Maximum water temperatures in the Peaking Reach would be slightly cooler and temperatures would be less artificially variable compared to existing conditions, also due to higher overall flows and the lower frequency of peaking operations at the J.C. Boyle Powerhouse. Under existing conditions, there is a delay in the normal progression of water temperatures downstream from Iron Gate Dam (or Phase Shift from historical timing) (Bartholow et al. 2005). Under this alternative, the current phase shift and lack of temporal temperature diversity will persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adults migrating later in the year would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and prespawn mortality (Hetrick et al. 2009).

Fish Disease and Parasites

The incidence of fish disease in salmon would be reduced under the Fish Passage at Four Dams Alternative relative to existing conditions. FERC's (2007) analysis concluded that restoring access to reaches above Iron Gate Dam for anadromous fish would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River. However, concentrations of post spawn salmon carcasses downstream from Iron Gate Dam may still be elevated associated with the continued operation of Iron Gate Hatchery. Provision of fish passage would allow anadromous salmonid migration to move upstream in the mainstem Klamath River and tributaries. Available information indicates that fish passage would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (Administrative Law Judge 2006). *C. shasta and P. minibicornis* exist throughout the Klamath River System in both the Upper and Lower Basins, so migration of wild anadromous fish upstream of downstream from Iron Gate Dam would not increase the risk of introducing pathogens to resident trout residing above Iron Gate Dam (Administrative Law Judge

2006). In addition, native Klamath River trout are generally resistant to *C. shasta*. The remaining known pathogens do not impact non-salmonids, with the exception of *F. columnaris* and *Ich*.

Recently several new *C. shasta* genotypes have been discovered in the Klamath River. In this regard, risk is related to host specificity, which appears to exist at least to some degree (Atkinson and Bartholomew 2010). As an example, redband trout are thought to be susceptible to Type 0, which already occurs in the upstream Basin and Chinook salmon are susceptible to Type I, which occurs in the Lower Klamath Basin. Type 0 genotype occurs in low densities and it is not very virulent (infection results in low or no mortality); if Type I genotype were to be reintroduced above Iron Gate Dam, it would affect only Chinook salmon. It is not expected that introduction of *C. shasta* genotypes upstream would be deleterious because fish in the upstream Basin have shown resistance to the downstream genotypes. Redband trout would presumably have been exposed to genotypes of *C. shasta* during the pre-dam period, and their populations were abundant. Because the salmonid species in the Klamath Basin already co-occur with the genotype of *C. shasta* to which they are susceptible, and the salmonid species are less susceptible to other genotypes of *C. shasta*, expanding the distribution of the different genotypes of *C. shasta* would be unlikely to be deleterious to salmonids. Recently discovered *C. shasta* genotypes and research findings in the past several years do not appear to contradict the finding that movement of anadromous salmonids into the Upper Klamath Basin presents a relatively low risk of introducing pathogens to resident fish (Administrative Law Judge 2006, USFWS/NOAA Fisheries Service Issue 2(B)).

Available information also indicates that risks associated with movement of anadromous fish upstream of Iron Gate Dam are minimal. For example, steelhead within the Klamath River system are generally resistant to *C. shasta*, (Administrative Law Judge 2006). Since salmon and associated disease pathogens were present historically above Iron Gate Dam, *C. shasta* genotype movement would be a reintroduction of associated risk to these anadromous species.

While it is possible that the current infections nidus (reach with highest infectivity) for *C. shasta* and *P. minibicornis* may be recreated upstream where salmon spawning congregations occur, and there is associated uncertainty (Foott et al. 2011), the likelihood of this happening appears to be remote for the following reasons. Any creation of an infectious zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone in the Klamath River in the reach from the Shasta River downstream to Seiad Valley (FERC (2007; Bartholomew and Foott 2010). Here, flows in that reach that mimic natural conditions, combined with reestablishment of natural sediment transport rates, would restore natural geomorphic channel forming processes (Hetrick et al. 2009) necessary to create diverse habitat and reduce the influence of those synergistic factors that currently create conditions favorable for disease. Under a dams out alternative, those conditions that are believed to result in development of an infectious nidus below Iron Gate Dam, or a could result in development of a potential infectious nidus above Iron Gate Dam, are unlikely to occur.

Further, the likelihood of those synergistic factors in the Williamson River would be reduced as carcasses would likely be more dispersed in the watershed (Foott et al. 2011), and flow variability will act to reduce polychaete habitat stability above the Williamson River mouth. *C. shasta* in the Williamson River is currently maintained by planting of susceptible rainbow trout that become infected, likely produce myxospores, and die within a restricted reach in the lower Williamson River.

In addition, under a scenario of dam removal, it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall (Bartholomew and Foott 2010; p. 40), thus missing the time of year when water temperatures in the Williamson River might possibly be conducive to disease. Although their research was focused on dam removal, access to the habitat above Iron Gate Dam through other means, such as fishways under Alternative 4, would likely have a similar outcome. In some years, maximum temperatures in the Williamson River do not exceed the disease threshold of 15 C (Bartholomew and Foott 2010; Hamilton et al. 2010). The risk of a juvenile salmon disease response here would be lower than the current zone but not negligible in all water years (Foott 2012).

Historically, it appears spawning concentrations of upper basin Chinook salmon took place primarily in the Sprague River (Lane and Lane Associates 1981). There is no information indicating that high densities of polychaetes occur in the Sprague River (Foott et al. 2011). Thus, the synergistic factors that contribute to an infectious nidus for emigrants below Iron Gate Dam and near the Iron Gate Hatchery are unlikely to occur here either. There is some concern regarding a disease zone in the lower Williamson River downstream from the confluence with the Sprague River (Hurst et al. 2012). However, some Chinook emigrants from both these tributaries may very well emerge from groundwater areas early, then rear in Upper Klamath Lake, with growth opportunities that allow them to migrate when they can minimize exposure to *C. shasta*.

Algal Toxins

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at Four Dams Alternative, high nutrient inputs supporting the growth of toxin-producing nuisance algal species such as *M. aeruginosa* in Upper Klamath Lake would remain similar to existing conditions for decades into the future. This would result in continued bioaccumulation of microcystin in suckers in Upper Klamath Lake and could be deleterious to fish health. For salmonids in Upper Klamath Lake, impacts would be similar to those currently observed downstream from Iron Gate Dam. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species in Upper Klamath Lake would likely decrease (see the subsection of Section 3.2.4.3.1, Chlorophyll-a and Algal Toxins – Upper Klamath Basin, and Section 3.4.4.3.1, Alternative 1: No Action/No Project Alternative –Phytoplankton, for additional detail regarding TMDLs and algal growth in

Upper Klamath Lake). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in suckers in Upper Klamath Lake would occur.

Hydroelectric Reach: f rom Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Continued impoundment of water at the Four Facilities under the Fish Passage at Four Dams Alternative would support growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* in Copco 1 and Iron Gate Reservoirs, resulting in high seasonal concentrations of algal toxins in the Hydroelectric Reach for decades into the future. This would result in continued bioaccumulation of microcystin in fish tissue for species in the Hydroelectric Reach and could be deleterious to fish health. For salmonids, impacts would be similar to those currently observed downstream from Iron Gate Dam. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species would likely decrease in the Hydroelectric Reach (see the subsection of Section 3.2.4.3.1, Chlorophyll-a and Algal Toxins – Upper Klamath Basin, and Section 3.4.4.3.1, Alternative 1: No Action/No Project Alternative –Phytoplankton, for additional detail regarding TMDLs and algal growth in the Hydroelectric Reach). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in fish in the Hydroelectric Reach would occur.

Lower Klamath River: Downstream from Iron Gate Dam Continued impoundment of water at the Four Facilities under the Fish Passage at Four Dams Alternative would support the seasonal transport of toxin-producing nuisance algae and microcystin to the Klamath River downstream from Iron Gate Dam. This would result in continued bioaccumulation of microcystin in fish and mussel tissue for species in the river and could be deleterious to fish health. For salmonids, impacts would be similar to those currently observed downstream from Iron Gate Dam. Upon full attainment of the TMDLs (implementation mechanism and timing currently unknown), nutrients and toxin-producing nuisance algal species would likely decrease in the Hydroelectric Reach (see (see the subsection of Section 3.2.4.3.1, Chlorophyll-a and Algal Toxins – Upper Klamath Basin, and Section 3.4.4.3.1, Alternative 1: No Action/No Project Alternative – Phytoplankton, for additional detail regarding TMDLs and algal growth in the Klamath River downstream from Iron Gate Dam). Accordingly, with full attainment of the TMDLs, improvements to microcystin tissue levels in fish and mussels in the Klamath River downstream from Iron Gate Dam would occur.

Aquatic Habitat

Under the Fish Passage at Four Dams Alternative access to historical anadromous fish habitat would be restored (with the exception of habitat under the four reservoirs) as discussed in the Aquatic Habitat section for Alternative 2 (subsection of Section 3.3.4.3.2). Hydrology of the Klamath River from Iron Gate Dam to the Klamath River Estuary would generally remain the same as under existing conditions, subject to the influence of climate change (discussed under Section 3.10, Greenhouse Gases/Global Climate Change). Activities currently underway to recover salmonid and sucker populations within the Klamath Basin would continue at their current levels. Fish would be able to migrate past the dams and would regain access to substantial areas of

additional habitat; however, access could be delayed at the ladders and seasonally may be impaired by water temperatures.

Fish migrating through reservoirs would be protected from entrainment at the hydroelectric intake by fish collection and routing facilities as required under the Section 18 prescriptions for FERC relicensing of the Klamath Hydroelectric Project (DOI 2007). Under this alternative, there would be substantial changes to hydroelectric operations. J.C. Boyle Powerhouse would no longer generate in peaking mode, and higher flow releases would be made through the J.C. Boyle Bypass Reach than under existing conditions. Higher base flows would also be provided in the Copco 2 Bypass Reach. Peaking operations would only occur one day a week to coincide with recreation flows, at least 40 percent of flow would go into the Bypass Reach (and not enter the powerhouse), and ramping rates would be slower than they are currently. Seasonal high flows will contribute to improving the quality of riparian habitat in the J.C. Boyle Bypass Reach by increasing the sediment deposit within the channel and decreasing reed canary grass (Administrative Law Judge 2006). The more normative flow regime associated with this alternative would provide these seasonal high flows. These modifications would benefit fish in this reach, including redband trout and anadromous fish.

Aquatic Resources Effects

Critical Habitat

As described below, continued impoundment of water within reservoirs and access to additional habitat under the Fish Passage at Four Dams Alternative could alter currently designated critical habitat.

Coho Salmon Under the Fish Passage at Four Dams Alternative, coho salmon would be able to access habitat in the Hydroelectric Reach by ascending the fishways associated with each of the dams. The upstream boundary of critical habitat for coho salmon in the Klamath Basin is Iron Gate Dam; any newly accessible areas would be outside of their currently designated critical habitat. NOAA Fisheries Service may want to consider including the newly accessible reaches as critical habitat as part of their 5-year status review or in a separate decision (J. Simondet, NOAA Fisheries Service, pers. comm., 2011). Under this alternative, the KBRA would not be implemented. However, ongoing restoration activities will continue. The areas inundated by the reservoirs would not provide suitable spawning or rearing habitat for coho salmon, but they would regain access to the riverine reaches on the mainstem and to the tributaries, although the downstream ends of most of the tributaries would be inundated by the reservoirs. Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows.

Water temperatures would continue to be seasonally affected by the reservoirs. Similar to existing conditions, they would be warmer in the summer and fall when adults are migrating upstream and may pose a degree of seasonal risk to adult migrants downstream from Iron Gate Dam, upon entry into the reservoirs, and in bypass reaches. The incidence of fish disease in salmon would be reduced under the Fish Passage at Four

Dams Alternative relative to existing conditions. FERC's (2007) analysis concluded that restoring access to reaches above Iron Gate Dam for anadromous fish would allow salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River. However, concentrations of post spawn salmon carcasses downstream from Iron Gate Dam may still be elevated associated with the continued operation of Iron Gate Hatchery.

In terms of PCEs of coho salmon critical habitat, this alternative would provide access to additional spawning habitat upstream of currently designated critical habitat, including in Fall, Jenny, Shovel and Spencer Creeks, although the downstream ends of these streams would continue to be inundated by the reservoirs and would not provide suitable spawning or rearing habitat. The food resources in these tributaries would also become available to fry and juvenile coho salmon rearing in those streams. Water quality conditions in the Hydroelectric Reach and downstream from Iron Gate Dam would be expected to improve over time with TMDL implementation, but would not improve as quickly or to the same extent as under the Proposed Action. **Based on the current designation of critical habitat, the effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for coho salmon critical habitat in the short and long term.**

Bull Trout Under the Fish Passage at Four Dams Alternative, the physical and chemical components of critical habitat for bull trout would be improved by the Oregon TMDL processes, but the KBRA would not be implemented. However, ongoing restoration activities will continue to occur. Actions taken as part of the Fish Passage at Four Dams Alternative would not affect the physical or chemical components of critical habitat, but would allow Chinook salmon and steelhead to access areas they have not been able to access since the completion of the Copco 1 Development in 1918. These species could compete with and prey upon bull trout fry and juveniles. However, bull trout would also be expected to consume the eggs and fry of Chinook salmon and steelhead. Because these species co-evolved in the watershed together, it is anticipated that they would be able to co-exist in the future. **Based on the restricted distribution of bull trout, the Fish Passage at Four Dams Alternative would result in no change from existing conditions.**

Southern Resident Killer Whale Klamath River contributes to critical habitat for Southern Resident Killer Whales through its contribution of Chinook salmon to their food supply. Fish Passage at Four Dams Alternative would not affect critical habitat for this species. Implementation of this alternative is expected to increase production of wild Chinook salmon by providing anadromous salmonids with access to habitat upstream of Iron Gate Dam. The Iron Gate Hatchery would continue to operate, ensuring ongoing production of hatchery Chinook salmon and contribution to ocean stocks. Klamath River Chinook salmon likely represent only a very small proportion of the diet of this killer whale population because most of their feeding is on Fraser River and Puget Sound stocks (Hanson et al. 2010); therefore, any increase in salmon production from this alternative would not substantially affect this species. **Based on small influence of the**

Klamath River on PCEs of Southern Resident Killer Whales, the Fish Passage at Four Dams Alternative would result in no change from existing conditions.

Essential Fish Habitat

As described below, continued impoundment of water within reservoirs and access to additional habitat under the Fish Passage at Four Dams Alternative could alter the availability and suitability of EFH.

Chinook and Coho Salmon EFH Implementation of the Fish Passage at Four Dams Alternative would increase habitat for Chinook and coho salmon (upstream of currently designated EFH) by providing access to habitat upstream of Iron Gate Dam. However, under this alternative, EFH for Chinook and coho salmon would be expected to remain similar to its current condition, as described for the No Action/No Project Alternative. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for Chinook and coho salmon EFH in the short and long term.**

Groundfish EFH Implementation of the Fish Passage at Four Dams Alternative would not affect groundfish EFH. SSCs and bedload would remain the same as under existing conditions, as would water quality. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for groundfish EFH in the short and long term.**

Pelagic Fish EFH Implementation of the Fish Passage at Four Dams Alternative would not affect pelagic fish EFH. SSCs and bedload would remain the same, as would water quality. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for pelagic fish EFH in the short and long term.**

Species-Specific Impacts

A described below, fishways at Four Dams could alter the availability of habitat resulting in effects on aquatic species.

Fall-Run Chinook Salmon

Upper Klamath Basin Upstream of J.C. Boyle Reservoir Under the Fish Passage at Four Dams Alternative, fish passage facilities installed at the four dams within the Hydroelectric Reach would allow fall-run Chinook salmon to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to groundwater discharge areas relatively resistant to effects of climate change (Hamilton et al. 2011). Implementation of the Fish Passage at Four Dams Alternative would not result in changes to the suspended sediments or bedload sediment, flow-related habitat, or algal toxins and disease. Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 25°C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, evidence indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009). Poor water quality conditions from Link Dam to Keno Dam during the late summer and fall could be detrimental to fish in this area, particularly anadromous salmonids (FERC 2007). Therefore, the Fish Passage at Four Dams Alternative would include an interim seasonal trap and haul operation that would involve capturing and trucking both upstream and downstream migrant fish (primarily adult fall-run Chinook salmon) around this area when water quality conditions would be prohibitively stressful. This is consistent with the fishway prescriptions of DOI and U.S. Department of Commerce (DOC) (DOI 2007; NOAA Fisheries Service 2007). As adult fall-run Chinook salmon in the Klamath River migrate upstream of August through October, and juveniles migrate to the ocean from spring to early fall, stress-related mortality associated with seasonal, interim trap and haul activities would affect this species to some degree (Buchanan et al. 2011b). The distance that fish would be transported under this alternative would be limited however, and trap and haul would only be used when fish would otherwise be exposed to stressful conditions.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Implementation of the Fish Passage at Four Dams Alternative would restore fall-run Chinook salmon access to the Hydroelectric Reach. Passage through the reach would provide approximately 54 miles of additional habitat along the mainstem and within accessible tributaries, based on access to 58 miles of anadromous fish (steelhead) habitat (Administrative Law Judge 2006)[8], taking into account the restricted distribution of Chinook salmon (DOI 2007), habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this Alternative, the expected overall higher flow releases would result in more reservoir water entering the J. C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Action and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, passage structures would provide access to thermal refugia created by 200 to 250 cfs of spring flow accretion in the J.C. Boyle Bypass Reach (DOI 2007; FERC 2007). Under this alternative, suspended and bedload sediment, water quality, and algal toxins would be the same as under existing conditions.

Under this alternative fish migrating through reservoirs would be seasonally exposed to some degree to stressful water quality conditions including high temperatures in reservoir

[8] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

surface layers with low dissolved oxygen in reservoir surface layers in the summer and fall, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and exposure to microcystin from *M. aeruginosa* blooms (Dunsmoor and Huntington 2006; FERC 2007). These conditions can become stressful in June through September, contributing to lower resistance to disease seasonally. Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (Administrative Law Judge 2006). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (Administrative Law Judge 2006). The fact that anadromous fish currently complete life cycles through eight dams and reservoirs on the Columbia and Snake rivers, and historically completed life cycles through Upper Klamath Lake, provides strong evidence that anadromous salmonids could also migrate through the reservoirs created by Project facilities (Administrative Law Judge 2006).
Lower Klamath River: Downstream from Iron Gate Dam Under the Fish Passage at Four Dams Alternative, suspended sediment would be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for any aquatic species. Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment, but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009; Stillwater Sciences 2010a). Coarsening of the bed could reduce spawning habitat for fall-run Chinook salmon downstream from the dam over time, but this impact would be limited to the area upstream of Cottonwood Creek. Rearing habitat would be expected to remain similar to existing conditions.

Under the Fish Passage at Four Dams Alternative, the Lower Klamath River downstream from Iron Gate Dam reach would continue to have seasonally poor water quality because of the continued presence of the reservoirs with their increased hydraulic residence time and thermal mass (Bartholow 2005). The continuation of warm water releases from Iron Gate Dam will contribute to the delay in adult upstream migration of fall-run Chinook salmon (Dunsmoor and Huntington 2006), and increase the risk of prespawn mortality (Hamilton et al. 2011).

As described above, the incidence of fish disease for fall-run Chinook salmon would be reduced under the Fish Passage at Four Dams Alternative relative to existing conditions. Dissolved oxygen concentrations during August-October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August-September and 90 percent saturation from October-November (see subsection of Section 3.2.4.3.1, Lower Klamath River). In addition, the presence of microcystin, associated with the dense blooms of *M. aeruginosa* in Iron Gate and Copco Reservoirs, would continue to occur downstream from Iron Gate Dam.

<u>Estuary</u>
The Fish Passage at Four Dams Alternative is not expected to substantially change or affect fall-run Chinook salmon estuarine habitat relative to existing conditions.

Summary: Fall-Run Chinook Salmon

Under this alternative, fishways at Four Dams could result in alterations in habitat availability for fall-run Chinook salmon in the long term. Under the Fish Passage at Four Dams Alternative, fall-run Chinook salmon would regain access to mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach, which would benefit the population. Some degree of stress and mortality of adult and juvenile salmon may result from the interim seasonal trap and haul operations (Buchanan et al. 2011b), especially between Link Dam and Keno Dam, and during periods with high water temperatures or poor water quality. Poor water quality, high water temperature, low dissolved oxygen, algal blooms and toxins could reduce survival of fall-run Chinook salmon passing through the four reservoirs. The distance that fish would be transported under this alternative would be limited however, and trap and haul only used when fish would otherwise be exposed to stressful conditions.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. These conditions would continue to have negative short- and long-term impacts on fall-run Chinook salmon populations. Further, under the Fish Passage at Four Dams Alternative, the KBRA would not be implemented, so any potential habitat improvements from KBRA restoration projects would not be realized. However, ongoing restoration activities would continue to occur. Climate change could also increase the frequency and duration of stressful water temperatures for salmonids under the Fish Passage at Four Dams Alternative. It is anticipated that as a result of the Fish Passage at Four Dams Alternative the fall-run Chinook salmon population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. However, smolts produced from tributaries downstream from Iron Gate Dam would experience a continuation of existing deleterious effects. **Based on increased habitat availability, the effect of the Fish Passage at Four Dams Alternative would be beneficial for fall-run Chinook salmon in the short and long term.**

Spring-Run Chinook Salmon

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at Four Dams Alternative, fish passage facilities installed at the four dams within the Hydroelectric Reach would allow spring-run Chinook salmon to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005, Butler et al. 2010). Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical conditions. Huntington (2006) cautioned that while access to the Upper Klamath Basin provides considerable promise of increasing spring-run abundance, the existing potential for Chinook salmon production within the Basin upstream of Upper

Klamath Lake is clearly much lower than his estimate of historical potential. However, Huntington (2006) did not fully account for the historical (and unknown) production potential of Upper Klamath Lake itself, which could have been considerable, as suggested by a recent experimental reintroduction into Upper Klamath Lake (Maule et al. 2009). Overall, the Fish Passage at Four Dams Alternative would provide access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive anadromous fish habitat upstream of Iron Gate Dam (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2010). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007).

The Fish Passage at Four Dams Alternative is not expected to result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins and disease. Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 25 °C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, evidence indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009). Poor water quality conditions, particularly in Lake Ewauna during the late summer and early fall, could be detrimental to fish in this area, particularly anadromous salmonids (FERC 2007). Therefore, an interim seasonal trap and haul operation would be implemented to capture and truck migrant fish around Lake Ewauna during stressful water quality conditions (from June 15 to November 15). As adult spring-run Chinook salmon in the Klamath River migrate upstream from April through June, and most juveniles migrate from April through May or October through November, trap and haul activities would be expected to have only minor effects on this run of Chinook salmon.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam The Fish Passage at Four Dams Alternative would include restoring spring-run Chinook salmon access to the Hydroelectric Reach. Passage through the reach would provide approximately 54 miles of additional habitat along the mainstem and within accessible tributaries, based on access to 58 miles of anadromous fish (steelhead) habitat (Administrative Law Judge 2006),[9] taking into account the more limited distribution of Chinook salmon (DOI 2007), habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). Habitat in the J.C. Boyle

[9] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this Alternative, the expected overall higher flow releases than under current conditions would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Action and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, passage structures would provide fish with some refuge from high temperatures because of access to cooler water from tributaries, in addition to that provided by 200 to 250 cfs of accretion from springs in the J.C. Boyle Bypass Reach (DOI 2007; FERC 2007; Hamilton et al. 2011). Under this alternative, flows and access would also be restored to the 1.4 mile Copco 2 bypass reach. Under this alternative, suspended and bedload sediment, water quality, and the occurrence of fish disease and algal toxins would be the same as under existing conditions.

This alternative would result in continuation of some of the stresses that currently affect Chinook salmon populations. The presence of J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Adult spring-run Chinook salmon in the Klamath River migrate upstream from April through June (and possibly earlier, Fortune et al. 1966), and most juveniles migrate from April through May or in the fall, as flows increase. Therefore water quality in reservoirs is expected to have minor effects on this species.

Lower Klamath River: Downstream from Iron Gate Dam Under the Fish Passage at Four Dams Alternative, suspended sediment would be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for any aquatic species. Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment, but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009; Stillwater Sciences 2010a).

Under the Fish Passage at Four Dams Alternative, the Lower Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Bartholow et al. 2005). Under this alternative, the current phase shift and lack of temporal temperature diversity will persist, including current warm temperatures in late summer and fall (Hamilton et al. 2011). Juveniles and adults migrating would continue to experience warm temperatures in late summer and fall that could be deleterious to health and survival, including increased risk of disease, and high rates of delayed spawning and prespawn mortality (Hetrick et al. 2009).

As described above, the incidence of fish disease for spring-run Chinook salmon would be reduced under the Fish Passage at Four Dams Alternative relative to existing conditions. Dissolved oxygen concentrations during August-October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent

saturation during August-September and 90 percent saturation from October-November (see Section 3.2.4.3.1.4 – Lower Klamath River). In addition, the presence of microcystin, associated with the dense blooms of *M. aeruginosa* in Iron Gate and Copco Reservoirs, would continue to occur downstream from Iron Gate Dam.

Estuary

The Fish Passage at Four Dams Alternative is not expected to substantially change or affect spring-run Chinook salmon estuarine habitat relative to existing conditions.

Summary: Spring-Run Chinook Salmon

Under this alternative, fishways at Four Dams could result in alterations in habitat availability which could affect spring-run Chinook salmon in the long term. Under the Fish Passage at Four Dams Alternative, spring-run Chinook salmon would regain access to mainstem and tributary habitat in the upper Klamath River and Hydroelectric Reach and thermal refugia within the Hydroelectric Reach. The expansion of habitat opportunities will allow maximum expression of life-history variation and the restoration of an additional population of spring-run Chinook salmon population to strengthen resiliency in the Klamath Basin, particularly because passage upstream of Iron Gate Dam will provide access to thermal refugia at groundwater areas (Hamilton et al. 2011). Stress to migrating adults and juveniles associated with potential interim seasonal trap and haul operation and poor reservoir water quality would likely be minor. As described below, predation could result in some mortality of spring-run Chinook salmon juveniles passing through the reservoirs. Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (Administrative Law Judge 2006). In restoration efforts elsewhere in the Pacific Northwest anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (Administrative Law Judge 2006). Cooler water temperatures (similar to existing conditions) during the spring would continue to benefit upstream migrating adult and downstream migrant juvenile spring-run Chinook salmon. Warmer water temperatures in the fall would continue to be detrimental to juveniles and adults migrating at that time. These effects would be most pronounced for fish migrating through areas upstream of the Scott River.

This alternative would result in continuation of some the stresses that currently affect Chinook salmon populations. The presence of J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of disease for salmon to persist. These conditions would continue to have negative short- and long-term impacts on spring-run Chinook salmon populations. Further, under the Fish Passage at Four Dams Alternative, the KBRA would not be implemented, so any potential habitat improvements from KBRA restoration projects would not be realized. However, ongoing restoration activities will continue to occur. Climate change could also increase the frequency and duration of stressful water temperatures for salmonids under the Fish Passage at Four Dams Alternative. It is anticipated that as a result of the Fish Passage at Four Dams Alternative the spring-run Chinook salmon population within the Klamath River

watershed would have an increase in abundance, population spatial structure, and genetic diversity. In addition, with large scale hydraulic mining operations now outlawed, spring-run Chinook salmon would no longer be subject to one of their most significant threats in the Klamath River (as discussed above in the subsection of Section 3.3.3.1.1). Current improved fisheries management also minimizes overharvest. However, smolts produced from the Salmon River and tributaries downstream from Iron Gate Dam would experience a continuation of existing effects. **Based on increased habitat availability the effect of the Fish Passage at Four Dams Alternative would be beneficial for spring-run Chinook salmon in the short- and long term.**

Coho Salmon

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Hamilton et al. (2005) states that historically coho salmon occurred at least as far as Spencer Creek (J.C. Boyle Reservoir). The Fish Passage at Four Dams Alternative may not affect coho salmon in the Upper Klamath Basin upstream of J.C. Boyle Reservoir Reach.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Coho salmon downstream from Iron Gate Dam belonging to the Upper Klamath River Population Unit would migrate above the dam if access was provided by fishways (Administrative Law Judge 2006). Over time, access to habitat above Iron Gate Dam would benefit the Upper Klamath River Population Unit by: a) extending the range and distribution of the species thereby increasing the coho salmon's reproductive potential; b) increase genetic diversity in the coho stocks; c) reduce the species vulnerability to the impacts of degradation; and d) increase the abundance of the coho salmon population (Administrative Law Judge 2006). Implementation of the Fish Passage at Four Dams Alternative would restore Upper Klamath River Population Unit access to the Hydroelectric Reach, thereby expanding their distribution to include historical habitat along the mainstem Klamath River not inundated by reservoirs and all tributaries upstream at least as far as Spencer Creek, including Jenny, Shovel, and Fall creeks (Hamilton et al. 2005). Passage through the reach would provide approximately 54 miles of additional habitat along the mainstem and within accessible tributaries, based on access to 58 miles of anadromous fish (steelhead) habitat (Administrative Law Judge 2006),[10] taking into account the restricted distribution of coho salmon (DOI 2007), habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. Under this alternative, the expected overall higher flow releases would result in more reservoir water entering the J.C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler temperatures in late fall and winter. These effects would be similar to those under the Proposed Action and would move this short reach away from consistently cooler water temperatures during summer and early fall months; however, upstream passage would

[10] This also takes into consideration slight differences in the Administrative Law Judge (2006) definition of the Project Reach from what is used in this report.

provide fish with some refuge from high temperatures because of access to cooler water from tributaries, in addition to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007; FERC 2007; Hamilton et al. 2011).

Under this alternative, suspended and bedload sediment, water quality, and the occurrence of algal toxins would be the same as under existing conditions.

This alternative would result in continuation of some of the stresses that currently affect coho salmon populations. The presence of J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. Although water temperature in the summer above Iron Gate Dam is an issue, the available information shows that water temperature would not preclude coho salmon from successfully utilizing the habitat within the Project area (Administrative Law Judge 2006). Adult coho salmon enter the Klamath River between late September and mid-December, with peak upstream migration occurring between late October and mid-November, and fry outmigrate to the ocean beginning in late February, with most outmigration occurring in April and May, as such, poor water quality in reservoirs would have minor effect on this species.

Lower Klamath River: Downstream from Iron Gate Dam Under the Fish Passage at Four Dams Alternative, suspended sediment would be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for any aquatic species. Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment, but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009; Stillwater Sciences 2010a). Most spawning and rearing takes place within tributaries. But for the few coho salmon from the Upper Klamath River Population Unit that spawn in the mainstem, coarsening of the bed could reduce spawning habitat for coho salmon between Iron Gate Dam and Cottonwood Creek over time. Rearing habitat would be expected to remain similar to existing conditions.

Under the Fish Passage at Four Dams Alternative, the Lower Klamath River downstream from Iron Gate Dam would continue to have seasonally poor water quality because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Bartholow et al. 2005).

As described above, the incidence of fish disease for coho salmon would be reduced under the Fish Passage at Four Dams Alternative relative to existing conditions. Dissolved oxygen concentrations during August-October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August-September and 90 percent saturation from October-November (see the subsection of Section 3.2.4.3.1, Lower Klamath River). In addition, the presence of microcystin,

associated with the dense blooms of *M. aeruginosa* in Iron Gate and Copco Reservoirs, would continue to occur downstream from Iron Gate Dam.

Estuary

The Fish Passage at Four Dams Alternative is not expected to substantially change or affect coho salmon estuarine habitat relative to existing conditions.

Summary: Coho Salmon

Under this alternative, fishways at Four Dams could result in alterations in habitat availability which could affect coho salmon in the long term. Under the Fish Passage at Four Dams Alternative, coho salmon would regain access to mainstem and tributary habitat in the Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach. Stress to migrating adults and juveniles associated with poor reservoir water quality and predation (as described below) would occur, but would likely be minor. Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (Administrative Law Judge 2006). In restoration efforts elsewhere in the Pacific Northwest, coho salmon and other anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (Administrative Law Judge 2006).

The presence of dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures, allowing some conditions favorable for the transmission of fish disease to persist. These conditions would continue to have negative short- and long-term impacts on coho salmon populations. Further, under the Fish Passage at Four Dams Alternative, the KBRA would not be implemented, so any potential habitat improvements from KBRA restoration projects would not be realized. However, ongoing restoration activities will continue to occur. Climate change could also increase the frequency and duration of stressful water temperatures for salmonids under the Fish Passage at Four Dams Alternative. It is anticipated that as a result of the Fish Passage at Four Dams Alternative the Upper Klamath River Population Unit would have an increase in abundance, population spatial structure, and genetic diversity. It is also anticipated that as a result of the Fish Passage at Four Dams Alternative the Mid-Klamath River, Shasta River, Scott River, Salmon River population units would experience a continuation of existing effects, and the three Trinity River population units, and the Lower Klamath River population units would not be affected. **Based on increased habitat availability the effect of the Fish Passage at Four Dams Alternative would be beneficial for coho salmon from the Upper Klamath River population unit in the short- and long term. Based on the continuation of existing conditions for populations downstream from Iron Gate Dam, this alternative would be no change from existing conditions for the coho salmon from the Mid-Klamath River, Shasta River, Scott River, and Salmon River, three Trinity River population units, and the Lower Klamath River population units in the short- and long term.**

Steelhead

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at Four Dams Alternative, steelhead would regain access to the Upper Klamath Basin upstream of J.C. Boyle Reservoir. This would expand the population's distribution to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005,). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising 360 miles of additional potentially productive habitat (Huntington 2006; DOI 2007; NOAA Fisheries Service 2007). This alternative would not result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins. Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006). Poor water quality (e.g., severe hypoxia, temperatures exceeding 25°C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011).

Poor water quality conditions, particularly in Lake Ewauna during the late spring and early summer could be detrimental to fish in this area, particularly anadromous salmonids (FERC 2007). Therefore, the Fish Passage at Four Dams Alternative includes interim seasonal trap and haul to capture and transport migrant fish (primarily adult fall-run Chinook salmon) around the Keno Impoundment/Lake Ewauna when water quality conditions would be prohibitively stressful.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Fish Passage at Four Dams would provide steelhead with access to the Hydroelectric Reach, which would expand the population's distribution to include historical habitat in the mainstem Klamath River and its tributaries, including Jenny, Spencer, Shovel, and Fall creeks (Hamilton et al. 2005). Passage through the reach would provide approximately 59 miles of additional habitat along the mainstem and within accessible tributaries (Administrative Law Judge 2006), taking into account habitat in the bypass reaches, and the continuation of around 22 miles of spawning and rearing habitat inundated by Klamath Hydroelectric Project reservoirs (Cunanan 2009). Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows, consistent with mandatory conditions (DOI 2007). Under this Alternative, the expected overall higher flow releases would result in more reservoir water entering the J. C. Boyle Bypass Reach and correspondingly warmer water temperatures during summer and early fall, and cooler water temperatures in late fall and winter. These effects would be similar to those under the Proposed Action and would move this short reach away from consistently cooler water temperatures during summer and early fall months.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, fluctuations in dissolved oxygen, pH, ammonia associated with algal blooms, and microcystin from *M. aeruginosa* blooms would continue to be stressful to fish from

June through September (Dunsmoor and Huntington 2006; FERC 2007). Winter steelhead enter and migrate from August to March; thus, poor water quality could have an effect on these fish as they move through reservoirs. Steelhead spawn in tributaries, and juveniles typically outmigrate from April through November, but the peak occurs from April through June, so most individuals would be likely to avoid poor reservoir water quality.

Lower Klamath River: Downstream from Iron Gate Dam Under the Fish Passage at Four Dams Alternative, suspended sediment dynamics would be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for any aquatic species. Klamath Hydroelectric Project dams would continue to trap fine and coarse sediment. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment, but the effect would gradually decrease in the downstream direction as coarse sediment would be resupplied by tributary inputs (Hetrick et al. 2009; Stillwater Sciences 2010a). Current summer steelhead distribution extends from the mouth of the Klamath River upstream to Empire Creek, while winter steelhead are distributed throughout the Lower Klamath River up to Iron Gate Dam (Stillwater Sciences 2010b). Summer and winter steelhead do not spawn in the mainstem Klamath River, nor are they expected to in the future, so spawning habitat would not be affected by alterations to bedload composition downstream from Iron Gate Dam under the Fish Passage at Four Dams Alternative. Changes to bedload sediment would not be expected to affect juvenile rearing and migration.

Under the Fish Passage at Four Dams Alternative, the Lower Klamath River downstream from Iron Gate Dam Reach would continue to have seasonally poor water quality because of the continued presence of the reservoirs, with their increased hydraulic residence time and thermal mass (Bartholow et al. 2005). Dissolved oxygen concentrations during August-October immediately downstream from Iron Gate Dam would continue to be low (less than 85 percent saturation during August-September and 90 percent saturation from October-November (see the subsection of Section 3.2.4.3.1, Lower Klamath River). In addition, the presence of microcystin, associated with the dense blooms of *M. aeruginosa* in Iron Gate and Copco Reservoirs, would continue to occur downstream from Iron Gate Dam.

<u>Estuary</u>
The Fish Passage at Four Dams Alternative is not expected to substantially change or affect steelhead estuarine habitat relative to existing conditions.

<u>Summary: Steelhead</u>
Under this alternative, fishways at Four Dams could result in alterations in habitat availability which could affect steelhead in the long term. Under the Fish Passage at Four Dams Alternative, steelhead would regain access to mainstem and tributary habitat in the Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach. Stress to migrating adults and juveniles associated with seasonally poor reservoir water quality would likely be minor. Survival during migration through reservoirs could be negatively affected at some level by predation.

This alternative would result in continuation of some the stresses that currently affect steelhead populations. The presence of dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality, and high late summer and early fall water temperatures. These conditions would continue to have negative short- and long-term impacts on steelhead populations. Further, under the Fish Passage at Four Dams Alternative, the KBRA would not be implemented, so any potential habitat improvements from KBRA restoration projects would not be realized. However, ongoing restoration activities will continue to occur. Climate change could also increase the frequency and duration of stressful water temperatures for salmonids under the Fish Passage at Four Dams Alternative. FERC (FERC 2007) concluded that implementing fish passage would help to reduce adverse effects to steelhead associated with lost access to upstream spawning habitats. Hamilton et al. (2011) also concluded that access to additional habitat in the Upper Klamath River watershed would benefit steelhead runs. It is anticipated that as a result of the Fish Passage at Four Dams Alternative the summer and winter steelhead within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity. **Based on increased habitat availability, the Fish Passage at Four Dams Alternative would be beneficial for summer and winter steelhead in the short- and long term**.

Pacific Lamprey

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Pacific lamprey occurred historically at least to Spencer Creek (Hamilton et al. 2005) although there is some uncertainty in this regard (Administrative Law Judge 2006). Pacific lamprey below Iron Gate dam would migrate above the dam if access was provided through fishways (Administrative Law Judge (2006). They may not have historically occurred upstream of J.C. Boyle Reservoir (Administrative Law Judge 2006), and may not occupy this reach after implementation of this alternative.

Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam The Fish Passage at Four Dams Alternative would provide Pacific lamprey with access to habitat upstream of Iron Gate Dam, which would benefit lamprey by providing them with additional spawning and rearing habitat (Administrative Law Judge 2006). Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows. In addition, passage would provide fish with some refuge from high temperatures by allowing cooler tributaries to flow directly into the mainstem Klamath River, adding to the 200 to 250 cfs provided by coldwater springs in the J.C. Boyle Bypass Reach (DOI 2007; FERC 2007; Hamilton et al. 2011). Under this alternative, suspended and bedload sediment, water quality, water temperature, and the occurrence of algal toxins would continue to be the same as under existing conditions.

Poor water quality conditions in reservoirs, such as high temperatures with low dissolved oxygen, changes in dissolved oxygen, pH, and ammonia associated with algal blooms, and microcystin from *M. aeruginosa* blooms would continue to be stressful from June to September (Dunsmoor and Huntington 2006; FERC 2007). Pacific lamprey adults migrate from winter through spring, while juveniles (age 2 to age 10) outmigrate year-

round, with peaks during late spring and fall. Seasonally poor reservoir quality would likely not affect migrating adults, but could affect juveniles. Juveniles would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch (FERC 2007). Volitional passage for Pacific lamprey has been designed and is in place in other river systems (Administrative Law Judge 2006).

Lower Klamath River: Downstream from Iron Gate Dam Under the Fish Passage at Four Dams Alternative, Klamath Hydroelectric Project Dams would continue to trap fine and coarse sediment. Suspended sediment would be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for any aquatic species. The channel directly downstream from Iron Gate Dam would continue to be starved of fine sediment. Coarsening of the bed could reduce spawning habitat for lamprey downstream from the dam over time, but this impact would be limited to the area upstream of Cottonwood Creek, as coarse sediment was resupplied by tributary inputs (Hetrick et al. 2009; Stillwater Sciences 2010a).

Under the Fish Passage at Four Dams Alternative, the Lower Klamath River downstream from Iron Gate Dam reach would continue to have seasonally poor water quality. Water quality would continue to be influenced by reservoirs, with increased hydraulic residence time and thermal mass (Bartholow et al. 2005). Finally, the KBRA would not be implemented, so any potential habitat improvements from KBRA restoration projects would not be realized. However, ongoing restoration activities will continue to occur.

Estuary

The Fish Passage at Four Dams Alternative is not expected to substantially change or affect Pacific Lamprey estuarine habitat relative to existing conditions.

Summary: Pacific Lamprey

Under this alternative, fishways could result in alterations in habitat availability which could affect Pacific lamprey in the long term. Under the Fish Passage at Four Dams Alternative, lamprey would regain access to mainstem and tributary habitat in the Hydroelectric Reach, and thermal refugia within the Hydroelectric Reach. Seasonally poor reservoir quality would likely not affect migrating adults, but could affect juveniles. Juveniles would also be exposed to predation from nonnative resident fish.

This alternative would result in continuation of some the stresses that currently affect lamprey populations. The presence of dams under the Fish Passage at Four Dams Alternative would continue to cause seasonally poor water quality and high late summer and early fall water temperatures. Climate change could also increase the frequency and duration of stressful water temperatures for lamprey under the Fish Passage at Four Dams Alternative. It is anticipated that as a result of the Fish Passage at Four Dams Alternative the Pacific lamprey population within the Klamath River watershed would have an increase in abundance, population spatial structure, and genetic diversity (Administrative Law Judge 2006). However, lamprey downstream from Iron Gate Dam would experience a continuation of existing effects. **Based**

on increased habitat availability, the Fish Passage at Four Dams Alternative would be beneficial for Pacific lamprey in the short- and long term.

Green Sturgeon

Under this alternative, fishways at Four Dams could result in alterations in habitat availability which could affect green sturgeon in the long term. Under the Fish Passage at Four Dams Alternative, conditions in the area occupied by green sturgeon are unlikely to change relative to existing conditions as green sturgeon occur downstream from Ishi Pishi Falls, and the effects of this alternative are not anticipated to extend that far downstream.

It is anticipated that as a result of the Fish Passage at Four Dams Alternative the green sturgeon population within the Klamath River watershed would experience a continuation of existing effects. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for green sturgeon in the short- and long term.**

Shortnose and Lost River Sucker

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir The KBRA would not be implemented under this alternative. However, ongoing restoration activities will continue to occur.

Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
Construction of fishways could affect shortnose and Lost River Sucker populations by continuing poor water quality and high rates of predation. Shortnose and Lost River suckers would continue to be subject to seasonally poor water quality and high rates of predation within reservoirs. But with little or no successful reproduction (Buettner et al. 2006), populations downstream from Keno Dam contribute minimally to conservation goals and insignificantly to recovery (Hamilton et al. 2011). Fish passage was not prescribed for sucker species at Iron Gate, J.C. Boyle, Copco 1, or Copco 2 Dams.

Under the Fish Passage at Four Dams Alternative, existing efforts to restore habitat for shortnose and Lost River sucker and improve water quality conditions would continue. These actions would be expected to improve conditions for these species over time and their populations would be expected to increase. **The effect of the Fish Passage at Four Dams Alternative would be less-than-significant for Lost River and shortnose sucker populations in the short and long term.**

Redband Trout

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at Four Dams Alternative, redband trout would be able to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than under existing conditions. Fish passage facilities would improve connectivity to Spencer Creek, which provides important spawning habitat and temperature refugia for redband trout (DOI 2007; Buchanan et al. 2011a). Upstream fish passage would also restore connectivity of resident redband populations in the mainstem Klamath River to those in Lake Ewauna, the Link River, and Upper Klamath Lake (DOI 2007). The Fish

Passage at Four Dams Alternative is not expected to result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins and disease.

Redband could be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease, as described for the Proposed Action above.

Hydroelectric Reach: from Upstream End of J.C. Boyle Reservoir to Iron Gate Dam
Fish passage resulting from the Fish Passage at Four Dams Alternative would allow redband trout to express the seasonal movements and migration patterns that were historically in place, restore population connectivity and genetic diversity, and allow greater utilization of existing habitat and refugia. Effective fishways at J.C. Boyle would greatly improve connectivity to Spencer Creek. Fish passage at Copco 1 and Copco 2 Dams would restore connectivity throughout the Hydroelectric Reach to Shovel Creek, which provides spawning habitat and temperature refugia (DOI 2007). Passage at Iron Gate Dam would restore connectivity between populations in the mainstem Klamath River and those in the Copco 2 bypass channel and in Slide, Scotch, Camp, Jenny, Salt, and Fall Creeks, which also provide spawning habitat and temperature refugia (DOI 2007). The current fish screen and ladder at the J.C. Boyle Dam do not meet current State and Federal fish passage criteria and the ladder impairs upstream migration (Administrative Law Judge 2006). Improvements in efficiency to the fishway at J.C. Boyle Dam would result in significant trout population migration above the dam over time (Administrative Law Judge 2006). Habitat in the J.C. Boyle bypass and peaking reaches and the Copco 2 Bypass Reach would be improved through reduced (but not eliminated) peaking operations and increasing base flows.

Populations of nonnative species within the reservoirs of the Hydroelectric Reach would continue to prey on smaller redband trout rearing in those reservoirs at some level. Water quality would continue to be seasonally poor, although TMDL implementation would improve water quality conditions from existing conditions throughout the Basin through time, benefiting this species. Climate change would result in warmer conditions, which would reduce the suitability of habitat.

<u>Summary: Redband Trout</u>
Under this alternative, fishways at Four Dams and changes in operations could result in alterations in habitat availability and suitability which could affect redband trout in the long term. The Fish Passage at Four Dams Alternative would improve habitat connectivity throughout the Hydroelectric Reach and to the upper Klamath River in the long term, increasing access to spawning habitat and temperature refugia. Redband trout would still be subject to seasonally poor water quality, and some level of predation within the reservoirs, but increases in connectivity and reduced effects of hydropower peaking operations would likely provide a benefit to redband trout populations. **Based on increased habitat connectivity, the effect of the Fish Passage at Four Dams Alternative would be beneficial for redband trout in the short- and long term.**

Bull Trout

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Effects to bull trout under this alternative are the same as those discussed in the subsection of Section 3.3.4.3.2, Alternative 2, Species Specific Impacts.

Fishways at Four Dams could alter habitat access for anadromous fish, which could affect bull trout. **Based on the restricted distribution of bull trout, the Fish Passage at Four Dams Alternative would have a less-than-significant impact on bull trout in the short- and long term.**

Eulachon Under the Fish Passage at Four Dams Alternative, the extent and quality of eulachon habitat would be expected to remain similar to that under existing conditions. Because eulachon occur far downstream in the river, mixing and inflows from intervening tributaries would reduce seasonally poor water quality conditions originating in the dams. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for eulachon in the short and long term.**

Longfin Smelt Under the Fish Passage at Four Dams Alternative, the extent and quality of longfin smelt habitat would be expected to remain similar to that under existing conditions. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for longfin smelt in the short and long term.**

Introduced Resident Species *The Fish Passage at Four Dams Alternative would not affect introduced resident species upstream of J.C. Boyle Reservoir.* Under the Fish Passage at Four Dams Alternative, dams in the Hydroelectric Reach would not be removed, allowing reservoir habitat to remain similar to existing conditions. Connectivity between the reservoirs could increase available habitat area for these species if they are able to migrate through passage facilities. Over time the total volume of habitat would diminish, as sediment accumulates in the reservoirs. TMDL implementation would be expected to improve water quality conditions over time, but climate change would cause temperatures to increase. These species are adapted to warm-water conditions, and are not expected to be affected by these changes. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for introduced resident species population.**

Interactions Among Species The Fish Passage at Four Dams Alternative would restore access for anadromous salmon, lamprey, and steelhead to habitat upstream of Iron Gate Dam, as described in detail above. Restoration of access will result in anadromous salmon and steelhead potentially interacting with resident redband trout and bull trout. Juvenile salmonids and lamprey traveling through the four hydroelectric reservoirs would be exposed to some level of predation by introduced resident fish including largemouth bass, catfish, and yellow perch, resulting in mortality rates that would depend largely on their size (larger migrants would do better) (Administrative Law Judge 2006). Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (Administrative Law Judge 2006). In restoration efforts elsewhere in the Pacific Northwest, anadromous

juveniles successfully pass through reservoirs under similarly difficult circumstances (Administrative Law Judge 2006). Other interactions among species under the Fish Passage at Four Dams Alternative would be the same as described for the Proposed Action.

Freshwater Mussels *Under the Fish Passage at Four Dams Alternative, suspended sediment would be the same as under existing conditions*, thus having no suspended sediment effects relative to existing conditions for any aquatic species. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for mussels in the short and long term.**

Benthic Macroinvertebrates Under the Fish Passage at Four Dams Alternative, Klamath Hydroelectric Project peaking operations (although reduced in frequency) in the hydroelectric reach would continue (although less frequently) to kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for resident trout (Administrative Law Judge 2006). Suspended sediment would also be the same as under existing conditions, thus having no suspended sediment effects relative to existing conditions for benthic macroinvertebrates.

Under the Fish Passage at Four Dams Alternative, habitat conditions would be the same as under existing conditions. **The effect of the Fish Passage at Four Dams Alternative would be no change from existing conditions for macroinvertebrates in the short and long term.**

Trap and Haul – Programmatic Measure

Implementation of trap and haul measures could affect aquatic species. Trap and haul measures would pass upstream and downstream migrating fish around Keno Impoundment and Link River during periods of seasonally poor water quality. The measures would provide effective migration for primarily fall-run Chinook salmon when water quality is poor during the period from June 15 to November 15. During the limited period of use, fish collection and release facilities would be operated to minimize any delay and stress and provide for adequate acclimation. For adult fall-run Chinook salmon, fish transport would be an effective fish passage method because transport would be for a short distance on a seasonal, interim basis.[11] For adult fall-run Chinook salmon, seasonal collection and transport mortality when water quality is poor is likely to be minor compared to mortality associated with unaided passage through areas of poor water quality at this time of year.

In some instances, the collection and transport of fall-run Chinook salmon around Keno Impoundment/Lake Ewauna could result in limited, seasonal mortality as follows:

[11] This seasonal, transport on an interim basis is not to be confused with permanent, year round trap and haul which does not provide equal benefits for the Klamath River when compared with the Services' fishway prescriptions (U.S. Department of the Interior (2007) The Department of the Interior's Filing of Modified Terms, Conditions, and Prescriptions (Klamath Hydroelectric Project, No. 2082). Sacramento, California: 650 p.; NOAA Fisheries Service (2007). NOAA Fisheries Service Modified Prescriptions for Fishways and Alternatives Analysis for the Klamath Hydroelectric Project (FERC Project No. 2082): 151 p.).

1. Some juvenile federally listed suckers would likely be collected incidentally and may suffer related stress and mortality. However, regardless of any remediation at an upstream collection facility, nearly all these downstream migrant suckers would eventually die in the absence of lacustrine habitat below Keno Impoundment/Lake Ewauna. There is little to no evidence of recruitment of suckers in downstream reservoirs currently and this habitat does not contribute significantly to the recovery of the species. Suckers may be collected and returned to habitat above Keno Impoundment/Lake Ewauna.
2. Some redband trout may be collected incidentally resulting in displacement and incidental collection-related stress and mortality. Redband trout may be collected and returned to habitat above Keno Impoundment/Lake Ewauna.
3. For fall-run Chinook salmon emigrants, the seasonally poor quality conditions are not expected to overlap with the peak migration period, thus the majority of juvenile Chinook salmon would not be affected. For those fall-run Chinook salmon emigrants collected and transported when water quality is poor, transport related mortality would be minor compared to the mortality associated with unaided passage through areas of poor water quality at this time of year.
4. For steelhead trout and spring-run Chinook salmon, migration would primarily be expected to occur when water quality was adequate, thus, collection and transport of these fish would not be necessary or minimal. However, all anadromous salmonids would be collected and transported when water quality is poor during the period from June 15 through November 15. Transport related mortality would be minor compared to the mortality associated with unaided passage through areas of poor water quality at this time of year.

Limited, seasonal transport of fall-run Chinook salmon would provide a net benefit by allowing them migration to and from additional (historical) spawning habitat, by providing more effective migration, and by reducing the density of spawners below Keno Dam in certain poor water quality situations.

In the short term, constructing fish handling facilities could have localized construction-related impacts; however, they could be avoided or minimized through implementation of best management practices, such as control and containment of sediment and toxic discharge, isolation of work areas from the active channel of streams or rivers where possible, and rescuing fish where mortality may result from an action. In the long term, trap and haul would benefit fish because of the access to additional habitat and avoidance of areas with seasonally poor water quality. **Based on access to additional, historical habitat and the anticipated improvements in fish health, implementation of trap and haul measures in the Fish Passage at Four Dams Alternative would be beneficial for fall-run Chinook salmon.**

3.3.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative proposes to remove the two largest dams in the Hydroelectric Reach (Copco 1 and Iron Gate Dams) and install fishways for volitional fish passage on the remaining installations (J.C. Boyle and Copco 2). The prescriptions and conditions would still apply to the remaining dams, including flow requirements, the specific provisions and performance standards for both upstream and downstream fish passage facilities at the remaining dams, and the interim seasonal trap and haul trap actions at Keno Dam as described above under the Fish Passage at Four Dams Alternative. Because the four dams would not be removed as required under the KHSA, the KBRA would not be implemented. The ongoing restoration actions described in the No Action/No Project Alternative would continue. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, peaking power would not be generated due to limits on flow regulation at J.C. Boyle and Copco 2 Reservoirs. Similar to the Fish Passage at Four Dams Alternative, 40 percent of the inflow to J.C. Boyle Reservoir would be passed through to the Bypass Reach, except in periods when inflow to J.C. Boyle Reservoir falls below 470 cfs, at which point outflow to the Bypass Reach is required to equal reservoir inflow.

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, Iron Gate Hatchery would be operated to meet existing mitigation requirements until Iron Gate Dam is removed, after which time the disposition of the hatchery would be determined by the DFG in consultation with NOAA Fisheries Service, the USFWS and other Klamath River fish managers, in response to fish population monitoring trends. Funding for continued hatchery operations would need to be identified.

Key Ecological Attributes

Suspended Sediment

Under this alternative, SSCs have not been modeled, but would be very similar to those described with the removal of all four facilities under the Proposed Action (see Section 3.3.4.3.2.1.1), because most stored sediment affecting downstream resources is stored in Copco 1 and Iron Gate Reservoirs. Therefore, this alternative would have very similar effects on aquatic species associated with suspended sediment transport as the Proposed Action.

Bedload Sediment

Under this alternative, J.C. Boyle Dam would continue to store sediment, but the storage capacity of Copco 2 Dam would likely be filled by the release of sediments during the Copco 1 Dam removal, and then bedload would likely pass through Copco 2. This scenario has not been modeled, but the effects of bedload sediment movement under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to, but of slightly lesser magnitude, than under the Proposed Action.

Water Quality

Under this alternative, the effects on water quality would have results intermediate between the Proposed Action and Fish Passage at Four Dams Alternatives. As Copco 1 and Iron Gate Reservoirs are the largest of the four reservoirs, they have the greatest impact on water quality (FERC 2007), and their removal would result in water quality conditions similar to those of the Proposed Action. Because of their small size and short residence times, the retention of J.C. Boyle and Copco 2 Dams would not result in the same poor water quality conditions that occur under current conditions.

Since Alternative 5 would include no peaking power generation or release of flow for recreation at J.C. Boyle, water temperature effects in the J.C. Boyle Bypass Reach would be similar to those under the Fish Passage at Four Dams Alternative because the Fish Passage at Four Dams Alternative also keeps J.C. Boyle Reservoir in place and includes significantly increased flow releases over the No Action/No Project Alternative, approaching the flow conditions for this alternative (i.e., no peaking power generation or release of recreation flows). Thus, the effects would be continued low diel temperature variation and overall warmer water temperatures in the Bypass Reach during summer and early fall, and cooler temperatures in late fall and winter. In the Peaking Reach, water temperature effects would be the same as under the Proposed Action (i.e., slightly lower maximum water temperatures and less artificial diel temperature variation during summer and early fall) since no peaking flows would occur and the effect of J.C. Boyle thermal mass on water temperatures does not extend this far downstream.

In the Hydroelectric Reach, the effects of removing Iron Gate and Copco 1 Reservoirs and converting the reservoir areas to a free-flowing river under this alternative would be similar to effects for the lower Klamath River immediately downstream from Iron Gate Dam under the Proposed Action (i.e., long-term increases in spring water temperatures and decreases in late summer/fall water temperatures) (see Section 3.2.4.3.5).

Fish Disease and Parasites

Under this alternative, there would be fewer deleterious effects in terms of fish disease as compared to existing conditions. Although it would not result in the same level of reduction in fish disease as the Proposed Action, removal of Iron Gate and Copco 1 Dams would result in water quality improvements and would reduce favorable habitat for polychaete worms downstream from Iron Gate Dam. The removal of the two dams would likely increase the availability of nutrients and physical habitat (i.e., periphyton mats) favorable to the polychaete host for *C. shasta* and *P. minibicornis* in the Hydroelectric Reach and downstream from Iron Gate Dam, although to a slightly lesser extent than under the Proposed Action because J.C. Boyle Dam would not be removed. Flow variability and scouring in the Hydroelectric Reach and downstream from Iron Gate Dam will be increased as described for the Proposed Action, with the exception of downstream from J.C. Boyle Dam where peaking flows will be eliminated. Removal of the two dams would likely result in more favorable water temperature for salmonids than under existing conditions as well as improve water quality and reduce instances of algal toxins (see Section 3.2.4.3.5).

Under this alternative, spawning fish would be expected to disperse more fully throughout the watershed than under existing conditions. Fish passage upstream by anadromous salmonids would increase under this alternative, which could reduce the concentration of salmon using the area immediately downstream from Iron Gate Dam for spawning, potentially reducing the transfer of myxospores from fish to the polychaete hosts. FERC's analysis concluded that restoring access to reaches above Iron Gate Dam for anadromous fish would allow adult fall-run Chinook salmon to distribute over a greater length of the river, reducing crowding and the concentration of disease pathogens that currently occur in the reach between Iron Gate Dam and the Shasta River (FERC 2007).

Provision of fish passage would allow anadromous salmonid migration to move upstream in the mainstem Klamath River and tributaries. Available information indicates that fish passage would not increase the risk of disease for resident species that occur upstream of Iron Gate Dam (Administrative Law Judge 2006). *C. shasta and P. minibicornis* exist throughout the Klamath River System in both the Upper and Lower Basins, so migration of wild anadromous fish upstream of downstream from Iron Gate Dam would not increase the risk of introducing pathogens to resident trout residing above Iron Gate Dam (Administrative Law Judge 2006). In addition, native Klamath River trout are generally resistant to *C. shasta*. The remaining known pathogens do not impact non-salmonids, with the exception of *F. columnaris* and *Ich*.

Recently several new *C. shasta* genotypes have been discovered in the Klamath River. In this regard, risk is related to host specificity, which appears to exist at least to some degree (Atkinson and Bartholomew 2010). As an example, redband trout are thought to be susceptible to Type 0, which already occurs in the upstream Basin and Chinook salmon are susceptible to Type I, which occurs in the Lower Klamath Basin. Type 0 genotype occurs in low densities and it is not very virulent (infection results in low or no mortality); if Type I genotype were to be reintroduced above Iron Gate Dam, it would affect only Chinook salmon. It is not expected that introduction of *C. shasta* genotypes upstream would be deleterious because fish in the upstream Basin have shown resistance to the downstream genotypes. Redband trout would presumably have been exposed to genotypes of *C. shasta* during the pre-dam period, and their populations were abundant. Because the salmonid species in the Klamath Basin already co-occur with the genotype of *C. shasta* to which they are susceptible, and the salmonid species are less susceptible to other genotypes of *C. shasta*, expanding the distribution of the different genotypes of *C. shasta* would be unlikely to be deleterious to salmonids. Recently discovered *C. shasta* genotypes and research findings in the past several years do not appear to contradict the finding that movement of anadromous salmonids into the Upper Klamath Basin presents a relatively low risk of introducing pathogens to resident fish (Administrative Law Judge 2006, USFWS/NOAA Fisheries Service Issue 2(B)).

Available information also indicates that risks associated with movement of anadromous fish upstream of Iron Gate Dam are minimal. For example, steelhead within the Klamath River system are generally resistant to *C. shasta*, (Administrative Law Judge 2006).

Since salmon and associated disease pathogens were present historically above Iron Gate Dam, *C. shasta* genotype movement would be a reintroduction of associated risk to these anadromous species.

While it is possible that the current infections nidus (reach with highest infectivity) for *C. shasta* and *P. minibicornis* may be recreated upstream where salmon spawning congregations occur, and there is associated uncertainty (Foott et al. 2011), the likelihood of this happening appears to be remote for the following reasons. Any creation of an infectious zone (or zones) would be the result of the synergistic effect of numerous factors, such as those that occur within the current disease zone in the Klamath River in the reach from the Shasta River downstream to Seiad Valley (FERC (2007; Bartholomew and Foott 2010). Here, flows in that reach that mimic natural conditions, combined with reestablishment of natural sediment transport rates, would restore natural geomorphic channel forming processes (Hetrick et al. 2009) necessary to create diverse habitat and reduce the influence of those synergistic factors that currently create conditions favorable for disease. Under a dams out alternative, those conditions that are believed to result in development of an infectious nidus below Iron Gate Dam, or a could result in development of a potential infectious nidus above Iron Gate Dam, are unlikely to occur.

Further, the likelihood of those synergistic factors in the Williamson River would be reduced as carcasses would likely be more dispersed in the watershed (Foott et al. 2011), and flow variability will act to reduce polychaete habitat stability above the Williamson River mouth. *C. shasta* in the Williamson River is currently maintained by planting of susceptible rainbow trout that become infected, likely produce myxospores, and die within a restricted reach in the lower Williamson River.

In addition, under a scenario of potential dam removal, it is likely that a greater diversity of salmon life histories will evolve, with some of those types more likely to avoid parasite exposure by migrating earlier or over wintering in tributaries and migrating in the fall (Bartholomew and Foott 2010; p. 40), thus missing the time of year when water temperatures in the Williamson River might possibly be conducive to disease. Although their research was focused on dam removal, access to the habitat above Iron Gate Dam through other means, such as fishways under Alternative 4, would likely have a similar outcome. In some years, maximum temperatures in the Williamson River do not exceed the disease threshold of 15 C (Bartholomew and Foott 2010; Hamilton et al. 2010). The risk of a juvenile salmon disease response here would be lower than the current zone but not negligible in all water years (Foott 2012).

Historically, it appears spawning concentrations of upper basin Chinook salmon took place primarily in the Sprague River (Lane and Lane Associates 1981). There is no information indicating that high densities of polychaetes occur in the Sprague River (Foott et al. 2011). Thus, the synergistic factors that contribute to an infectious nidus for emigrants below Iron Gate Dam and near the Iron Gate Hatchery are unlikely to occur here either. There is some concern regarding a disease zone in the lower Williamson River downstream from the confluence with the Sprague River (Hurst et al. 2012). However, some Chinook emigrants from both these tributaries may very well emerge

from groundwater areas early, then rear in Upper Klamath Lake, with growth opportunities that allow them to migrate when they can minimize exposure to *C. shasta*.

Algal Toxins

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir This region is upstream of any proposed dam removal; therefore, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would not affect fish health as related to algal toxins. Any changes in algal toxin production in this region would be a result of other factors, including TMDL implementation. The effects in this area would be similar to those described for the No Action/No Project Alternative.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would eliminate growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa* in the Hydroelectric Reach, alleviating high seasonal concentrations of algal toxins and associated bioaccumulation of microcystin in fish tissue for species in this reach. While some microcystin may be transported downstream from large blooms occurring in Upper Klamath Lake, the levels would not be as high as those currently experienced due to the prevalence of seasonal in-reservoir blooms. Overall, bioaccumulation of algal toxins in fish tissue would be expected to decrease in the Hydroelectric Reach and would be beneficial.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would eliminate growth conditions for toxin-producing nuisance algal species such as *M. aeruginosa*, alleviating the transport of high seasonal concentrations of algal toxins to the Klamath River downstream from Iron Gate Dam. This would also decrease the associated bioaccumulation of microcystin in fish and mussel tissue for species downstream from the dam. While some microcystin may be transported downstream from large blooms occurring in Upper Klamath Lake, the levels would not be as high as those currently experienced due to the prevalence of seasonal in-reservoir blooms. Overall, bioaccumulation of algal toxins in fish and mussel tissue would be expected to decrease in the Klamath River downstream from Iron Gate Dam and would be beneficial.

Aquatic Habitat

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, flow increases would provide more habitat than under existing conditions for redband/rainbow trout and other resident riverine species, as well as any anadromous fish or lamprey that reestablish in the Hydroelectric Reach, but habitat gains would be less than under the Proposed Action. The removal of the two dams would eliminate existing habitat in Copco 1 and Iron Gate Reservoirs for adult shortnose and Lost River suckers, as well as nonnative species, while habitat within J.C. Boyle Reservoir would remain. This alternative would restore around 19 miles of riverine habitat (Cunanan 2009) for resident and anadromous fish through removal of reservoirs. The current reservoirs

inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009).

The alternative would incorporate barriers to prevent juvenile salmonid entrainment into turbines. There would also be substantial changes to hydroelectric operations. J.C. Boyle would no longer generate in peaking mode, and higher flow releases would be made through the J.C. Boyle Bypass Reach than under existing conditions. Higher base flows would also be provided in the Copco 2 Bypass Reach, and ramping rates would be slower than they are currently. These modifications would benefit fish in this reach, including redband trout and anadromous fish. Seasonal high flows will contribute to improving the quality of riparian habitat in the J.C. Boyle bypass reach by increasing the sediment deposit within the channel and decreasing reed canary grass (Administrative Law Judge 2006). The more normative flow regime associated with this alternative would provide these seasonal high flows. As described for the Proposed Action, under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, flow-related habitat changes for species downstream from Iron Gate Dam would increase over existing and historical conditions (Hetrick et al. 2009).

Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed reservoir sediment. No short-term effects are anticipated from these reservoir restoration efforts; however, aquatic habitat would likely be improved from restored riparian vegetation in the long term.

Aquatic Resources Effects

Critical Habitat

As described below, reservoir drawdown associated with dam removal under this alternative could alter the quality of critical habitat. In addition, the removal of two dams and two reservoirs could alter the availability and quality of critical habitat.

Coho Salmon The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would increase the amount of habitat available to coho salmon (currently upstream of designated critical habitat) and the quality of the existing critical habitat by improving water quality in the mainstem Klamath River. NOAA Fisheries Service may consider whether to designate the newly available habitat as critical habitat as part of its 5 year status review or as a separate reconsideration of the critical habitat designation for the species (J. Simondet, NOAA Fisheries Service, pers. comm., 2011). The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative on critical habitat for coho salmon would be similar to those for the Proposed Action, but somewhat reduced by the ongoing presence of Copco 2 and J.C. Boyle Reservoirs. The same habitat expansion expected under the Proposed Action would occur, with the exception of habitat under Copco 2 and J.C. Boyle Reservoirs and the downstream portion of Spencer Creek, which would continue to be inundated by J.C. Boyle Reservoir. Fish passage would be provided past the two remaining dams.

Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through elimination of peaking operations and higher baseflows.

Copco 1 and Iron Gate Reservoirs also cause the majority of the water temperature and water quality issues in the Hydroelectric Reach, so water quality conditions would be improved relative to existing conditions within the Hydroelectric Reach and to areas downstream from Iron Gate Dam as well.

Although upstream of current designated critical habitat, implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would expand the geographic extent of habitat available to coho salmon. Water quality within currently designated critical habitat is anticipated to improve relative to existing conditions. **Based on reduced habitat quality during reservoir drawdown affecting PCEs, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a significant effect on coho salmon critical habitat in the short term. Based on benefits to the PCEs downstream from Iron Gate Dam, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a beneficial effect on critical habitat for coho salmon in the long term.**

Bull Trout The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be expected to have a similar effect on critical habitat for bull trout as the Fish Passage at Four Dams Alternative. **Based on the restricted distribution of bull trout, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant impact on critical habitat for bull trout in the short- and long term.**

Southern Resident Killer Whales The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be expected to have a similar impact on critical habitat for Southern Resident Killer Whales as the Proposed Action. Chinook salmon would be provided access to areas upstream of Iron Gate Dam and into the upper watershed, boosting natural production. Water quality issues would be improved both in the Hydroelectric Reach and in the Lower Klamath River. Fish parasitism would likely decrease as conditions became less favorable for the polychaetes host of *C. shasta* and *P. minibicornis*. However, because Chinook salmon from the Klamath River make up a very small proportion of the Southern Resident Killer Whale diet, this benefit to Southern Resident Killer Whales is expected to be small. **Based on small influence of the Klamath River on PCEs of Southern Resident Killer Whales, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant impact on critical habitat for Southern Resident Killer Whales in the short- and long term.**

Essential Fish Habitat *As described below, reservoir drawdown associated with dam removal under this alternative could alter the quality of EFH. In addition, the removal of two dams and two reservoirs could alter the availability and quality of EFH.*

Chinook and Coho Salmon EFH The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative on EFH for Chinook and coho salmon would be similar to those for the Proposed Action, but would be somewhat reduced by the ongoing presence of Copco 2 and J.C. Boyle Reservoirs. Water quality in the mainstem Klamath River is expected to be improved. Most of the habitat expansion expected (upstream of currently designated EFH) under the Proposed Action would occur, with the exception of habitat under Copco 2 and J.C. Boyle Reservoirs and the downstream portion of Spencer Creek, which would continue to be inundated by J.C. Boyle Reservoir. Fish passage would be improved over existing conditions by providing passage past the remaining two dams.

Copco 1 and Iron Gate reservoirs also cause the majority of the water temperature and water quality issues in the Hydroelectric Reach, so these conditions would be improved relative to existing conditions. These water quality improvements would accrue to areas downstream from Iron Gate Dam as well.

Based on a substantial reduction in EFH quality during reservoir drawdown, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a significant effect on EFH for Chinook and coho salmon in the short term. Based on benefits to the habitat quality, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a beneficial effect on EFH for Chinook and coho salmon in the long term.

Groundfish EFH The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to those of the Proposed Action Alternative, with similar effects on SSCs, bedload and water quality.

Based on short duration of poor water quality during reservoir drawdown in the estuary, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant effect on EFH for groundfish in the short- and long term.

Pelagic Fish EFH The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative on pelagic fish EFH would be similar to those described for the Proposed Action.

Based on short duration of poor water quality during reservoir drawdown in the estuary, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant effect on EFH for pelagic fish in the short- and long term.

Species-Specific Impacts

As described below, reservoir drawdown associated with dam removal under this alternative could affect aquatic species. In addition, the removal of two dams and two reservoirs could alter the availability and quality of habitat, resulting in effects on aquatic species.

Fall-Run Chinook Salmon

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, dam removal and the addition of fish passage facilities at J.C. Boyle and Copco 1 Dams would allow fall-run Chinook salmon to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds miles of additional potentially productive habitat (DOI 2007), including access to groundwater discharge areas resistant to effects of climate change (Hamilton et al. 2011). Poor water quality (e.g., severe hypoxia, temperatures exceeding 25 °C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010). However, evidence indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009).

Dispersal of spawners and carcasses under this alternative would diminish disease conditions. Flow variability would not be as great as under the Proposed Action; therefore, although removal of the two reservoirs would reduce the amount of lentic habitat available, some low-velocity habitats favorable to polychaetes might persist. Removal of the two dams would likely result in more favorable water temperature for salmonids than under existing conditions as well as improve water quality and reduce instances of algal toxins.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam

Implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would restore fall-run Chinook salmon access to the Hydroelectric Reach. Suspended and bedload sediment effects would be similar to those described for the Proposed Action.

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would include removal of Copco 1 and Iron Gate Reservoirs, with continued power generation at J.C. Boyle and Copco 2 hydroelectric plants. Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through elimination of peaking operations and higher baseflows. The reservoir drawdowns would allow tributaries and springs such as Fall and Shovel creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). Spencer Creek would continue to flow into J.C. Boyle Reservoir at its upstream end. Anadromous fish provided access to these reaches would have access to the tributaries as well. The potential habitat under the two remaining reservoirs for the

production of anadromous salmonids, redband trout, and Pacific lamprey would however not be reached under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative.

Lower Klamath River: Downstream from Iron Gate Dam

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in the release of sediment stored within Copco 1 and Iron Gate Reservoirs downstream to the Lower Klamath River. Of the reservoirs in the Hydroelectric Reach, J.C. Boyle Reservoir stores the least amount of sediment, less than 10 percent of the total amount. As such, suspended and bedload sediment conditions and effects on fall-run Chinook salmon in the Lower Klamath River reach would be similar to those described for the Proposed Action, but would be of slightly lesser magnitude.

The removal of two dams and restoration of free flowing sections of river would likely result in more favorable water temperatures for salmonids than under existing conditions. As it would be under the Proposed Action, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to reduced water quality from increased suspended sediment concentrations, but these effects would be short term. Flow variability likely would not be as great as under the Proposed Action, but would still likely reduce habitat conditions favorable for polychaetes and algal toxins.

Disease conditions would be reduced under this alternative. Dispersal of spawners and carcasses would diminish myxospore proximity to the intermediate host. A more mobile bed relative to current conditions would disrupt habitat for the intermediate host.

Estuary

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect fall-run Chinook salmon estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Fall-Run Chinook Salmon

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and affect fall-run Chinook salmon. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for fall-run Chinook salmon in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect fall-run Chinook salmon. As stated above, dam removal would also restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create

additional spawning and rearing habitat within the Hydroelectric Reach. **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for fall-run Chinook salmon in the long term.**

Spring-Run Chinook Salmon

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, dam removal and the addition of fish passage facilities at J.C. Boyle and Copco 1 Dams would allow spring-run Chinook salmon to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. The access would expand the spring-run Chinook salmon's current habitat to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood Rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007), including access to important thermal refugia within areas influenced by groundwater exchange that are more resistant to climate change (Hamilton et al. 2011). Some of these areas, such as the lower Williamson River, have habitat that would provide substantial holding areas for spring-run Chinook salmon (Hamilton et al. 2010). Other holding areas with suitable temperatures upstream of J.C. Boyle Reservoir include groundwater influenced areas on the west side of Upper Klamath Lake, and the Wood River (Gannett et al. 2007).

As described for the Proposed Action, this alternative is not expected to result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins. Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006).

Poor water quality (e.g., severe hypoxia, temperatures exceeding 25 °C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, evidence indicates that Upper Klamath Lake habitat is presently suitable to support Chinook salmon for at least the October through May period (Maule et al. 2009). Historically, adult spring-run Chinook salmon migrated upstream of the current location of Iron Gate Dam perhaps as early as February and March (Klamath Republican articles in Fortune et al. 1966) and likely held over in large holding pools in the mainstem in tributaries fed by cool water, and in refugia habitat upstream of Upper Klamath Lake (CDFG 1990c; Moyle 2002; Snyder 1931). One benefit of such early migration would be the avoidance of periods of poor water quality. The restored water temperature regime under the Proposed Action may restore upstream migration timing of adult spring-run Chinook salmon because of the shift in water temperatures downstream from Iron Gate dam (Bartholow et al. 2005).

Huntington (2006) reasoned that spring-run Chinook salmon likely accounted for the majority of the Upper Klamath Basin's actual salmon production under historical

conditions. Huntington (2006) cautioned that while access to the Upper Klamath Basin provides considerable promise of increasing spring-run abundance, the existing potential for Chinook salmon production within the Basin upstream of Upper Klamath Lake is clearly much lower than his estimate of historical potential. However, Huntington (2006) did not fully account for the historical (and unknown) production potential of Upper Klamath Lake itself, which could have been considerable, as suggested by a recent experimental reintroduction into Upper Klamath Lake (Maule et al. 2009).

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would restore spring-run Chinook salmon access to the Hydroelectric Reach. Suspended and bedload sediment effects would be similar to those described for the Proposed Action.

Habitat in the J.C. Boyle bypass and peaking reaches and the Copco 2 Bypass Reach would be improved through eliminating peaking operations and increasing base flows. The reservoir drawdowns would allow tributaries and springs such as Fall and Shovel creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). Spencer Creek would continue to flow into J.C. Boyle Reservoir at its upstream end. Anadromous fish provided access to these reaches would have access to the tributaries as well.

Removal of the two dams would likely result in more favorable water temperature for salmonids than under existing conditions as well as improve water quality and reduce instances of algal toxins. As with conditions for fall-run Chinook salmon, disease conditions would be reduced under this alternative.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in the release of sediment stored within Copco 1 and Iron Gate reservoirs downstream to the Lower Klamath River. Of the reservoirs in the Hydroelectric Reach, J.C. Boyle stores the least amount of sediment, less than 10 percent of the total amount. As such, suspended and bedload sediment conditions and effects on spring-run Chinook salmon in the Lower Klamath River reach would be similar to those described for the Proposed Action, but of slightly lesser magnitude.

The removal of two dams and restoration of free flowing sections of river would likely result in more favorable water temperatures for salmonids than under existing conditions. As it would be under the Proposed Action, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to reduced water quality, but these effects would be short term. Flow variability likely would not be as great as under the Proposed Action, but would still likely reduce habitat conditions favorable for polychaetes and algal toxins.

Estuary

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, habitat in the estuary could be affected by elevated turbidity from sediment releases during dam removal for about 3 months. After this time, SSCs would return to levels similar to existing conditions. SSCs in the estuary would be less than 40 percent of the peak concentrations that are anticipated to occur immediately downstream from Iron Gate Dam. These peaks would still be substantial, and would be higher than the extreme values estimated by the sediment transport model for existing conditions (see the subsection of Section 3.2.4.3.2). However, this alternative not expected to substantially change or affect spring-run Chinook salmon estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Spring-Run Chinook Salmon

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and affect spring-run Chinook salmon. **Based on minimal reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for spring-run Chinook salmon in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect spring-run Chinook salmon. **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for spring-run Chinook salmon in the long term.**

Coho Salmon

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir As described for the Proposed Action, coho salmon did not historically occur upstream of J.C. Boyle Reservoir, and are not anticipated to occupy this reach after implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative access would be restored for the upper Klamath River Population coho salmon to the Hydroelectric Reach, expanding their distribution to include historical habitat along the mainstem Klamath River and all tributaries upstream at least as far as Spencer Creek; including in Jenny, Shovel, and Fall Creeks (Hamilton et al. 2005), including around 76 miles of potential habitat within the Hydroelectric Reach, as described in the No Action/No Project Alternative analysis above. The NRC of the National Academy of Science reviewed causes of decline and strategies for recovery of endangered and threatened fishes of the Klamath Basin. The NRC concluded that "removal of Iron Gate Dam... could open new habitat, especially by making available

tributaries that are now completely blocked to coho" (NRC 2004). Spencer Creek flows into the upstream end of J.C. Boyle Reservoir and would still be partially inundated under this alternative, but suitable habitat in the Spencer Creek would be accessible to coho salmon. Suspended and bedload sediment effects would be similar to those described for the Proposed Action. Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through eliminating peaking operations and increasing base flows.

Removal of the two dams would likely result in more favorable water temperature for salmonids than under existing conditions as well as improve water quality and reduce instances of algal toxins. As described for fall-run and spring-run Chinook salmon above, disease conditions would be reduced under this alternative.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in the release of sediment stored within Copco 1 and Iron Gate Reservoirs downstream to the Lower Klamath River. Suspended and bedload sediment conditions and effects on coho salmon in the Lower Klamath River reach would be similar to those described for the Proposed Action, but of slightly lesser magnitude.

The removal of two Dams and restoration of free flowing sections of river would likely result in more favorable water temperatures for salmonids than under current conditions. As it would be under the Proposed Action, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to reduced water quality, from increased SSCs, but these effects would be short term. Flow variability likely would not be as great as under the Proposed Action, but would still likely reduce habitat conditions favorable for polychaetes and algal toxins.

Estuary

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect coho salmon estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Coho Salmon

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and affect coho salmon. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for the coho salmon from the Upper Klamath River, Mid-Klamath River, Shasta River, Scott River, and Salmon River population units in the short term. Based on indistinguishable effects predicted to occur during reservoir drawdown, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for the coho salmon from the three Trinity River population units, and the Lower Klamath River Population Unit in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect coho salmon. Dam removal would restore connectivity to habitat on the mainstem Klamath River up to and including Spencer Creek and would create additional habitat within the Hydroelectric Reach. It is anticipated that as a result of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative the upper Klamath River, mid-Klamath River, Lower Klamath River, Shasta River, Scott River, and Salmon River coho salmon population units would have an increase in abundance, productivity, population spatial structure, and genetic diversity. It is anticipated that as a result of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative the three Trinity River population units would have increased productivity. **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for the coho salmon from the Upper Klamath River, Mid-Klamath River, Lower Klamath River, Shasta River, Scott River, and Salmon River population units in the long term**. **Based on improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for the coho salmon from the three Trinity River population units in the long term.**

Steelhead

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at Two Dams Alternative, dam removal and the addition of fish passage facilities at J.C. Boyle and Copco 1 would allow steelhead to regain access to the upper Klamath River upstream of J.C. Boyle Reservoir. This would expand the population's distribution to include historical habitat along the mainstem Klamath River upstream to the Sprague, Williamson, and Wood rivers (Hamilton et al. 2005). This would be a potential increase in access to 49 significant tributaries in the Upper Klamath Basin, comprising hundreds of miles of additional potentially productive habitat (DOI 2007). As described for the Proposed Action, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to result in changes to suspended or bedload sediment, flow-related habitat, or algal toxins. Facilitating the movement of anadromous fish presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006). Poor water quality (e.g., severe hypoxia, temperatures exceeding 25 °C, high pH) in the reach from Keno Dam to Link Dam might impede volitional fish passage at any time from late June through mid-November (Sullivan et al. 2009; USGS 2010; both as cited in Hamilton et al. 2011). However, evidence indicates that Upper Klamath Lake habitat is presently suitable to support salmonids for at least the October through May period (Maule et al. 2009).

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1

and Iron Gate Alternative would restore steelhead access to the Hydroelectric Reach. Suspended and bedload sediment effects would be similar to those described for the Proposed Action.

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would include removal of Copco 1 and Iron Gate reservoirs, with continued power generation at J.C. Boyle and Copco 2 hydroelectric plants. Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through eliminating peaking operations and increasing base flows. The reservoir drawdowns would allow tributaries and springs such as Fall and Shovel creeks and Big Springs to flow directly into the mainstem Klamath River, creating patches of cooler water that could be used as temperature refugia by fish during summer and fall, as well as providing slightly warmer winter water temperatures conducive to the growth of salmonids (Hamilton et al. 2011). Spencer Creek would continue to flow into J.C. Boyle Reservoir at its upstream end. Anadromous fish provided access to these reaches would have access to the tributaries as well.

Removal of the two dams would likely result in more favorable water temperature for salmonids, as well as improved water quality and reduced instances of algal toxins.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in the release of sediment stored within Copco 1 and Iron Gate reservoirs downstream to the Lower Klamath River. Of the reservoirs in the Hydroelectric Reach, J.C. Boyle Reservoir stores the least amount of sediment, less than 10 percent of the total amount. As such, suspended and bedload sediment conditions and effects on steelhead in the Lower Klamath River reach would be similar to those described for the Proposed Action, but of slightly lesser magnitude.

The removal of two dams and restoration of free flowing sections of river would likely result in more favorable water temperatures for salmonids than under current condition. As it would be under the Proposed Action, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to reduced water quality from increased SSCs, but these effects would be short term. Flow variability likely would not be as great as under the Proposed Action, but would still likely reduce habitat conditions favorable for algal toxins.

Estuary

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect steelhead estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Steelhead

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and affect

steelhead. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for summer and winter steelhead in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, and temperature variation, which could affect steelhead. Implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create additional spawning and rearing habitat within the Hydroelectric Reach, as described for the Proposed Action. **As described for the Proposed Action, based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for summer and winter steelhead in the long term**.

Pacific Lamprey

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Pacific lamprey occurred historically at least to Spencer Creek (Hamilton et al. 2005) although there is some uncertainty in this regard (Administrative Law Judge 2006). Pacific lamprey below Iron Gate dam would migrate above the dam if access was provided through fishways (Administrative Law Judge (2006).

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam_Pacific lamprey below Iron Gate Dam would migrate above the dam if access was provided (Administrative Law Judge 2006). Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, dam removal and the addition of fish passage facilities at J.C. Boyle and Copco 1 Dams would provide Pacific lamprey access to the Hydroelectric Reach, which would expand the population's current range to include habitat within the mainstem Klamath River and its tributaries upstream at least as far as Spencer Creek, including Jenny, Shovel, and Fall Creeks (Hamilton et al. 2005). Spencer Creek flows into the upstream end of J.C. Boyle Reservoir and would still be potentially accessible to lamprey. Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through eliminating peaking operations and increasing base flows. Suspended and bedload sediment effects would be similar to those described for the Proposed Action.

The reservoir drawdowns would allow tributaries and springs such as Fall and Shovel Creeks and Big Springs to flow directly into the mainstem Klamath River. Removal of the two dams would likely result in more favorable water temperature for lamprey and other native fishes, and would improve water quality.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would release sediment stored within Copco 1 and Iron Gate Reservoirs downstream to the Lower

Klamath River. Of the reservoirs in the Hydroelectric Reach, J.C. Boyle Reservoir stores the least amount of sediment—less than 10 percent of the total. As such, suspended and bedload sediment conditions and effects on Pacific lamprey in the Lower Klamath River reach would be similar to those described for the Proposed Action, but of slightly lesser magnitude.

The removal of two dams and restoration of free flowing sections of river would likely result in water temperature more favorable for Pacific lamprey occurring in the mainstem, as well as improve water quality. As it would be under the Proposed Action, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to reduced water quality from increased SSCs, but these effects would be short term.

Estuary

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect Pacific lamprey estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Pacific Lamprey

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and Pacific lamprey. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for Pacific lamprey in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, temperature variation, fish disease incidence, and algal toxins which could affect Pacific lamprey. Dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for Pacific lamprey in the long term**.

Green Sturgeon

Upper Klamath River Green sturgeon did not historically occur upstream of Iron Gate Dam (Hamilton et al. 2005) and are not anticipated to occupy this reach after implementation of this alternative. The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would not affect green sturgeon upstream of Iron Gate Dam.

Lower Klamath River: Downstream from Iron Gate Dam The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in the release of sediment stored within Copco 1 and Iron Gate reservoirs downstream to the Lower Klamath River. Of the reservoirs in the Hydroelectric Reach, J.C. Boyle stores the least amount of sediment, less than 10 percent of the total amount. As such, suspended and bedload sediment conditions and effects on green sturgeon in the Lower Klamath River reach would be similar to those described for the Proposed Action, but of slightly lesser magnitude.

Bedload sediment effects related to dam-released sediment or sediment resupply would likely extend as far as the Cottonwood Creek. Current green sturgeon distribution extends from the mouth of the Klamath River upstream to the Ishi Pishi Falls (Moyle 2002; FERC 2007), with some observed migrating into the Salmon River. Short- and long-term changes to bedload sediment under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative are not expected to affect green sturgeon.

The removal of two dams and restoration of free flowing sections of river would likely result in water temperature more favorable for green sturgeon occurring in the mainstem, as well as improve water quality and reduce instances of algal toxins. As with SSCs, migrating adults and juveniles rearing or migrating in the mainstem after dam removal would be exposed to poor water quality due to dam removal, but these effects would be short term.

Estuary

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect estuarine habitat. Sediment, flow, and water temperature effects would likely not extend downstream to the estuary.

Summary: Green Sturgeon

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and affect green sturgeon. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for green sturgeon in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in flow regime, water quality, temperature variation, and algal toxins which could affect green sturgeon. **Based on small improvements in habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for green sturgeon in the long term.**

Shortnose and Lost River Sucker

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Shortnose and Lost River suckers upstream of Keno Dam would not be affected by the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative. Effects on populations downstream from Keno Dam are detailed below in the description of the Hydroelectric Reach. The KBRA would not be implemented under this alternative. However, ongoing restoration activities will continue to occur.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam Federally endangered shortnose and Lost River suckers are found within reservoirs in Hydroelectric Reach, but in lower abundance than in reservoirs and lakes upstream. As described for the Proposed Action, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would reduce reservoir habitat as dams within the Hydroelectric Reach were removed and sediment was allowed to move downstream. Adult Lost River and shortnose suckers in Iron Gate and Copco 1 reservoirs would be captured and relocated to Upper Klamath Lake (Buchanan et al.2011a). Those not relocated to the Upper Klamath Basin would likely be lost, but with little or no successful reproduction (Buettner et al. 2006), the populations downstream from Keno Dam contribute minimally to conservation goals and insignificantly to recovery (Hamilton et al. 2011). Lost River and shortnose suckers are listed as fully protected species under California Fish and Game; thus any take of these species is prohibited. However, if there is an Affirmative Determination by the Secretary, and a concurrence by the State of California, CDFG will provide draft legislation to the other KHSA/KBRA parties which would authorize limited take of these fully protected species.

Facilitating the movement of anadromous fish via prescribed fishways presents a relatively low risk of introducing pathogens to resident fish above Iron Gate Dam (Administrative Law Judge 2006). Generally, with the exception of *F. columnaris* and Ich, pathogens associated with anadromous fish do not impact non-salmonids (e.g. suckers) (Administrative Law Judge 2006).

Based on the low occurrence of suckers within Iron Gate and Copco 1 reservoirs, only a small reduction in abundance could occur, and therefore the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for Lost River and shortnose sucker populations in the short- and long term.

Redband Trout

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, dam removal and the addition of fish passage facilities at J.C. Boyle and Copco 1 dams would allow redband trout to migrate more successfully from the Hydroelectric Reach to the Upper Klamath Basin (Hamilton et al. 2011) than under existing conditions.

Under this alternative, a flow regime that more closely mimics natural conditions would not be established downstream from Keno Dam; therefore, the increases in stream habitat upstream of J.C. Boyle Dam might not be realized under this alternative.

Redband could be affected by the reintroduction of anadromous fish, including the potential for competition, predation, and exposure to disease, as described for the Proposed Action above.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam As described for the Proposed Action, dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would allow redband trout to migrate between tributaries and reservoirs to complete their lifecycle, and would restore around 19 miles of reservoir habitat to riverine habitat (Cunanan 2009). Habitat in the J.C. Boyle Bypass and Peaking Reaches and the Copco 2 Bypass Reach would be improved through eliminating peaking operations and increasing base flows. The current reservoirs inundate sections of the river that had high sinuosity and complex channels that historically provided excellent salmonid spawning and rearing habitats (Hetrick et al. 2009). Under this alternative this habitat would be restored. Suspended and bedload sediment effects would be similar to those described for the Proposed Action. However, sediment would continue to be trapped in J.C. Boyle, and spawning habitat would not likely improve for redband trout in the mainstem.

Summary: Redband Trout

As described for the Proposed Action, reservoir drawdown associated with dam removal under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and affect redband trout. **Based on a small proportion of the population with a potential to be exposed to short-term effects, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less-than-significant for redband trout in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability and flow regime, which could affect redband trout. As described for the Proposed Action, dam removal would restore connectivity among the Lower Klamath Basin, the Hydroelectric Reach and its tributaries, and the Upper Klamath Basin, and would rehabilitate and increase availability of riverine habitat within the Hydroelectric Reach. **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for redband trout in the long term.**

Bull Trout

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir As described for the Proposed Action, under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative bull trout upstream of J.C. Boyle Reservoir

could be affected by increased predation from reintroduced salmonids, but this loss might be offset by an increase in available food sources (e.g., eggs, fry, and juveniles of reintroduced salmonids) (Buchanan et al. 1997).

Based on the restricted distribution of bull trout, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less than significant impact on bull trout in the short and long term.

Eulachon

Lower Klamath River: Downstream from Iron Gate Dam Under this alternative, suspended sediment conditions and effects on eulachon in the Lower Klamath River would be similar to those described for the Proposed Action, but of slightly lesser magnitude. Short-term decreases in water quality might also be associated with this alternative and would affect adults and larvae in the mainstem Klamath River. As with SSCs, these effects could be muted by tributary inputs.

Estuary Based on the lower magnitude of SCC, the Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect estuarine habitat.

Based on no substantial reduction in the abundance of a year class, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be a less-than-significant effect on eulachon in the short term. Based on short duration of poor water quality during reservoir drawdown in the estuary, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant effect on eulachon in the long term.

Longfin Smelt The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would release dam-stored sediment downstream to the Lower Klamath River, but would not be expected to reach the area potentially used by longfin smelt. Longfin smelt using the Lower Klamath River after January 2020 could be exposed to high SSCs for a portion of their migration period. SSCs would likely decrease in the downstream direction from Iron Gate Dam due to dilution from tributaries, so the magnitude of the effect would likely be low. Short-term decreases in water quality could also affect adults and larvae in the mainstem Klamath River. As with SSCs, these effects could be muted by tributary inputs.

Estuary

As described for the Proposed Action, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative is not expected to substantially change or affect estuarine habitat.

Based on short duration of poor water quality during reservoir drawdown in the estuary, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have a less-than-significant effect on longfin smelt in the short- and long term.

Introduced Resident Species

Upper Klamath River: Upstream of the Influence of J.C. Boyle Reservoir
Introduced resident species upstream of J.C. Boyle Reservoir would not be affected by the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative.

Hydroelectric Reach: From Upstream End of J.C. Boyle Reservoir to Iron Gate Dam As described for the Proposed Action, implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would eliminate reservoir habitat associated with the two largest reservoirs Copco 1 and Iron Gate Dam, but would retain the habitat associated with the smaller J.C. Boyle and Copco 2 reservoirs. This would be detrimental to nonnative fishes upstream of Iron Gate Dam. Abundance of these species would decline substantially as the majority of their preferred reservoir habitat would be eliminated (Buchanan et al.2011a).

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would reduce habitat for introduced resident species in the Hydroelectric Reach. **Because these species were introduced and they occur in other nearby water bodies, their loss would not be considered important from a biological perspective, and would benefit native species. This impact would be less than significant from a biological perspective. Their loss would, however, decrease opportunities for recreational fishing for these species, as discussed in Section 3.20, Recreation.**

Interactions Among Species

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would restore access for anadromous salmon, lamprey, and steelhead to habitat upstream of Iron Gate Dam, as described in detail above. Restoration of access would result in anadromous salmon and steelhead potentially interacting with resident redband trout and bull trout. Juvenile salmonids and lamprey would be subject to some level of predation by introduced resident species including largemouth bass, catfish, and yellow perch in J.C. Boyle and Copco 2 Reservoirs, resulting in mortality rates that would depend largely on their size (larger migrants will do better) (Administrative Law Judge 2006), as described for the Fish Passage at Four Dams Alternative. Based on the reservoir dynamics and the predator population that currently occurs, predation of outmigrating salmonids above Iron Gate Dam is anticipated to be low (Administrative Law Judge 2006). In restoration efforts elsewhere in the Pacific Northwest, anadromous juveniles successfully pass through reservoirs under similarly difficult circumstances (Administrative Law Judge 2006). The other effects of interactions among these species would be the same as described for the Proposed Action.

Freshwater Mussels

Suspended Sediment Concentrations Most stored sediment that would affect downstream Klamath River resources is stored in Iron Gate Reservoir, and SSCs resulting from implementation of this alternative would be the same as, or very similar to, those levels described previously for the Proposed Action.

Therefore, SSCs resulting from the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would have the same effects on freshwater mussels, as previously described for the Proposed Action.

Changes in Bed Elevation Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, free-flowing river conditions would be restored through most of the mainstem Klamath River. The release of sediment currently stored behind Iron Gate and Copco 1 Dams would occur and changes in streambed elevation downstream from Iron Gate Dam would be similar, but slightly smaller in magnitude than those of the Proposed Action because the J.C. Boyle and Copco 2 Dams would remain in place and the sediment stored behind them would not be removed. Therefore, the effects of this alternative on bedload elevation changes would be similar, but perhaps slightly smaller in magnitude, than those associated with the Proposed Action.

Changes in Bed Substrate

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, changes in bed substrate would be similar as those described for the Proposed Action. Therefore, this alternative would have similar effects on freshwater mussels in the mainstem Klamath River as the Proposed Action.

Based on substantial reduction in the abundance of multiple year classes in the short term and the slow recovery time of freshwater mussels, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for freshwater mussels in the short term.

Based on increase in habitat availability, the effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial to freshwater mussels in the long term.

Benthic Macroinvertebrates

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, Klamath Hydroelectric Project peaking operations would no longer kill, through stranding, large numbers of young fish and aquatic invertebrates that are the primary prey food for resident trout (Administrative Law Judge 2006).

Suspended Sediment Concentrations

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, the release of sediment currently stored behind Iron Gate and Copco 1 Dams would occur. The effects of SSCs on BMIs would be the same as, or very similar to, those described for the Proposed Action.

Changes in Bed Elevation

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, the effects on BMIs resulting from bedload elevation changes are expected to be similar, if not the same as, those associated with the Proposed Action.

Changes in Bed Substrate

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, the effects on BMIs resulting from changes in bed substrate in the mainstem Klamath River would be similar to those described for the Proposed Action.

Summary: Benthic Macroinvertebrates

As described for the Proposed Action, the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative could alter SSCs and bedload sediment transport and deposition and affect benthic macroinvertebrates. **Based on substantial reduction in the abundance of a year class in the short term, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be significant for macroinvertebrates downstream from Iron Gate Dam in the short term.**

As described for the Proposed Action, in the long term, removal of dams under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, could result in alterations in habitat availability, flow regime, water quality, and temperature variation, which could affect macroinvertebrates. While a large proportion of their populations in the Hydroelectric Reach and in the mainstem Klamath River downstream from Iron Gate Dam would be affected, their populations would be expected to recover quickly because of the many sources for recolonization and their rapid dispersion through drift or aerial movement of adults. Habitat quality would also be improved in the Hydroelectric Reach by the ending of deleterious Klamath Hydroelectric Project peaking operations (Administrative Law Judge 2006). **Based on increased habitat availability and improved habitat quality, the effect of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative on macroinvertebrates would be beneficial in the long term.**

Trap and Haul – Programmatic Measure

Implementation of trap and haul measures could affect aquatic species. The trap and haul measures around Keno Impoundment/Lake Ewauna and Link River would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **Based on access to additional, historical habitat and the anticipated improvements in fish health, implementation of trap and haul measures in the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be beneficial for fall-run Chinook salmon.**

3.3.4.4 Mitigation Measures

3.3.4.4.1 AR-1: Protection of Mainstem Spawning

It is anticipated that short-term effects of the Proposed Action (SSCs and bedload movement) will result in up to 100 percent mortality of fall Chinook and coho salmon embryos and pre-emergent alevin within redds that were constructed in the mainstem in the fall of 2019. In addition, any steelhead or Pacific lamprey migrating within the mainstem Klamath River after December 30th could be directly affected. As described in

Appendix E, around 2,100 fall-Chinook salmon redds are predicted to be affected, and around 13 redds from the Upper Klamath River Population Unit for coho salmon.

Deleterious short-term effects of the Proposed Action on mainstem spawning could be reduced by capturing migrating adult fish (Chinook, coho, steelhead, or Pacific lamprey) in the mainstem Klamath River and relocating them to suitable habitat. Capture of adult fish could be accomplished with the use of an Alaskan-style weir and box trap, similar to that currently used at the Willow Creek and Trinity River site. The most suitable location for the trap appears to be directly upstream of the Shasta River, where the mainstem Klamath River is small enough to effectively trap, and would ensure that fish returning to key tributaries downstream from, and including the Shasta River would not be interrupted. The weir would be installed at the beginning of the fall migration and continue past the initial dam drawdown period until high flows require the trap to be dismantled. Captured fish would periodically be transported to receiving tributaries. Fish could be released either in under-seeded tributaries downstream from Iron Gate Dam (e.g., Scott River), or in tributaries upstream of Iron Gate Dam if that were consistent with post-dam removal management goals. The relocated fish would then spawn naturally in the tributary streams and their progeny would not be affected by the SSCs and bedload movement during the dam removal process. In addition, the trap would only be operated periodically, so that some volitional passage upstream of the Shasta River would occur, allowing fish to return to Bogus Creek and the hatchery during 2019.

Additional surveys in the mainstem downstream from Shasta River could be conducted to locate coho salmon spawning in the mainstem. Any identified adult coho, Chinook, steelhead, or Pacific lamprey could be captured using dip-nets, electrofishing, or seines and transported to tributary habitat. Surveys should be conducted in December 2019, immediately prior to the first release of sediment associated with facilities removal. A detailed plan describing capture techniques, release locations, and monitoring methods would be developed by the Dam Removal Entity (DRE) prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

The effectiveness of the measure will depend on how effectively adults can be captured with the weir. Based on operation of similar traps in other rivers, it is anticipated that when operational the trap could capture nearly all upstream migrants. However, it is the intention to allow a portion of the adult to migrate volitionally to access Bogus Creek or the hatchery. Therefore it is assumed some fall Chinook salmon will continue to spawn within the mainstem during 2019. Depending on the condition of captured adults, some may be injured during transport, or may not spawn when released. However, the progeny of these adults is predicted to suffer 100 percent mortality if they spawn in the mainstem, so relocation is considered worth the risk of reduced spawning success. Overall effectiveness of the adult relocation operation would be measured by using radio-tagged individuals to track the -tagged fish to determine spawning success and location.

3.3.4.4.2 AR-2: Protection of Outmigrating Juveniles

It is anticipated that short-term effects of the Proposed Action (SSC) will result in mostly sublethal, and in some cases lethal impacts to a portion of the juvenile Chinook, coho,

steelhead, and Pacific lamprey that are outmigrating from tributary streams to the Klamath River upstream of Orleans during late winter and early spring of 2020 (Appendix E).

Deleterious short-term effects on outmigrating juveniles could be reduced by capturing juveniles outmigrating from tributaries prior to their entry into the mainstem. This measure includes the installation of downstream migrant traps on up to 13 key tributary streams downstream from Iron Gate Dam including Bogus Creek, Dry Creek, Walker Creek, Shasta River, Seiad Creek, Oneil Creek, Scott River, Grider Creek, Tom Martin Creek, Horse Creek, Beaver Creek, Cottonwood Creek, and Humbug Creek. Results of spawning surveys in fall 2019 could be used to focus trapping efforts within these or other tributaries. Trapping on all of these streams is proposed to help preserve the genetic integrity and varied life history tactics that are represented by this group of streams that have a high diversity with respect to size, channel types, water temperature regimes, geographic distribution, and other attributes.

The trapping would involve the standard CDFG/USFWS rotary screw trap/fyke net/pipe trap methods currently in use. However, placement of a second trap downstream from the first would increase the number of captures. Captured fish could then be placed in aerated tank trucks and transported to a release site downstream from the Trinity River or other locations that have suitable water quality.

The procedures of trapping, handling, trucking, and releasing outmigrating salmonids could result in harm or mortality to some individuals, and releasing fish at downstream locations could reduce natal cues and increase stray rates. Therefore fish will be captured and transported only if conditions within the mainstem are as poor as predicted. Due to the uncertainties with suspended sediment modeling, water quality monitoring during spring 2020 would be used to trigger the initiation and cessation of the capture program and inform suitable release locations. Release locations should be varied to prevent predators from congregating at release locations. Alternatively, in a portion of tributaries juveniles could be held in temporary facilities within tributaries and released when SSC in the mainstem were non-stressful. This would prevent any decrease in the natal cue, as well as any potential associated effects of fish transport.

A detailed plan describing trapping techniques, release locations, and monitoring methods would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

The effectiveness of this measure depends on the efficiency of trapping efforts. Trap efficiency varies with species and tributary. Current trapping efforts in the Shasta River and Scott River typically have trap efficiencies between around 5 and 30 percent, averaging around 15 percent (Underwood et al. 2010). It is anticipated that trapping efficiency could be increased over current efforts by more aggressive trapping efforts using either multiple traps and/or increased weir panels. However, not all tributaries with outmigrating juveniles will be trapped, and within trapped tributaries some individuals will avoid traps and migrate to the mainstem (particularly during high flows). Overall, it

is assumed 50 percent of juveniles outmigrating to the mainstem could be captured. Current predictions of mortality estimate a total of 2,668 to 6,536 smolts for an impact of 9 to 22 percent from the upper Klamath River, mid-Klamath River, Scott River, and Shasta River population units depending on a most-likely-to-occur or worst case scenario. Assuming 50 percent capture efficiency this mitigation measure would reduce mortality a total of 1,334 to 3,268 smolts for an impact of 4 to 11 percent depending on a most-likely-to-occur or worst-case scenario. To evaluate the effectiveness of the mitigation measure, the trapping procedures would need to assess trap efficiency that would lead to the development of estimates of stream production and numbers of fish assumed missed by trapping effort.

3.3.4.4.3 AR-3: Fall Flow Pulses

It is anticipated that short-term effects of the Proposed Action (SSCs) will result in sublethal effects for green sturgeon adults remaining in the mainstem Klamath River during fall 2019, mortality for mainstem spawning fall-run Chinook salmon, mortality for migrating adult winter steelhead, and sublethal effects for adult coho salmon remaining in mainstem prior to entering tributaries.

Deleterious short-term effects on adults could be reduced by augmented flows during fall 2019 prior to dam removal. It has been observed that fall pulse flows result in the downstream migration of post-spawned green sturgeon out of the Klamath River (Benson et al. 2007), and increased flows during fall prior to dam removal may increase the rate and proportion of fall-run Chinook salmon, steelhead, and coho salmon spawning in tributaries, and thus reducing the proportion of the population spawning in the mainstem or being exposed to SSCs in the mainstem during migration (Stillwater Sciences 2009a).

Water releases in the fall prior to dam removal should mimic the natural hydrograph that would have existed in the Klamath River during a “wet year” prior to the Reclamation project, consistent with recommendations in NRC (2004). However, if the water year during dam removal is dry, managers will need to balance the benefits of increased flows during fall with the risk of impacts to the Basin if less water is available during the following spring (during smolt outmigration). Increases in fall flows would likely be most successful if conducted synchronously with increased flows in unregulated tributaries, to help create enough of a pulse of water to encourage migration. Doing so will also ensure that adults that are attracted up the mainstem by increasing fall flows are not blocked from accessing their natal streams due to natural low flow conditions.

A detailed plan describing target flows and monitoring methods would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

It is anticipated that this measure will be effective for reducing deleterious short-term effects on adult green sturgeon during fall 2019. Benson et al. (2007) reported that the majority of adult green sturgeon outmigrating during the first major flow event of the fall. Analysis of the mainstem natural spawner fraction versus flow suggests that, generally, increased numbers of naturally produced fall-run Chinook salmon adults spawn in the

mainstem during years when fall flows are low (Stillwater Sciences 2009a). The minimum proportion of fall-Chinook salmon spawning in the mainstem is 5.3 percent, suggesting that if fall-pulse flows are successful at increasing tributary spawning the proportion of fall-run Chinook salmon spawning in the mainstem could be reduced to this level.

Currently on average less than 4 percent of coho salmon migrate into monitored tributaries after December 15th, and in many years no fish are observed migrating after this date (Appendix E). Migration of coho salmon adults into tributaries also appears to be affected by flow, with earlier tributary entrance times observed in Blue Creek, Shasta River, Bogus Creek and other tributaries during years with high flows during fall (Stillwater Sciences 2009a). A fall pulse-flow is anticipated to be effective at ensuring nearly all adult coho salmon migrate into tributaries prior to initiation of reservoir drawdown on December 15. The effectiveness of the measure could be monitored with spawning surveys during 2019. The proportion of steelhead migrating upstream after December 15th is highly variable (USFWS 1998). Although no analysis has been conducted, it is possible that increased fall flows could result in a greater proportion of steelhead migrating upstream and into tributaries prior to dam removal, as is observed in some years (USFWS 1998).

3.3.4.4.4 AR-4: Hatchery Management

It is anticipated that short-term effects of the Proposed Action (SSC) will result in mostly sublethal, and in some cases lethal impacts to a portion of the juvenile Chinook, coho, and steelhead smolts outmigrating from tributary streams to the Klamath River upstream of Orleans during late winter and early spring of 2020 (Appendix E).

Deleterious short-term effects on outmigrating hatchery Chinook and coho salmon smolts could be reduced by adjustments to hatchery management. Hatchery managers could adjust the timing of hatchery releases during spring 2020. Although it would be out of synch with natural life history timing, if smolts are released later in the spring (e.g., mid-May), survival is anticipated to be higher based on current conditions (Beeman et al. 2008), as well as avoiding the peak in spring release of sediment in the year following dam removal.

An alternative to adjusting the hatchery release timing would be to allow the sub-yearling and yearling smolts to imprint at the hatchery and then truck them to release locations downstream where SSC effects may be muted by tributary accretion flow. Trucking could be accomplished during the normal releasing timing period.

The implementation of this mitigation measure is dependent on the hatchery remaining open and having a suitable water supply. A detailed plan describing adjustments to hatchery management would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

It is anticipated that this measure will effectively reduce short-term lethal effects on hatchery released smolts to sublethal effects.

3.3.4.4.5 AR-5: Pacific lamprey Capture and Relocation

Based on predictions of low dissolved oxygen and the analysis of SSC that was conducted (Appendix E), high rates of mortality are predicted in the short term as a result of the Proposed Action. An action to mitigate this deleterious short-term effect would be to salvage and relocate lamprey ammocoetes from preferred habitat areas where dissolved oxygen levels would be particularly low, including pools, alcoves, backwaters, and channel margins that experience low water velocities and sand and silt deposition (Streif 2009) from areas downstream from Iron Gate Dam. The focus of relocation efforts would be within 3 km of Iron Gate Dam, where SSC is predicted to be highest, and dissolved oxygen levels the lowest. However, the density of lamprey within this reach is not known, and reconnaissance surveys should be conducted prior to the implementation of this measure to assess if enough ammocoetes are present to warrant mitigation.

The salvage operation, if implemented, would be conducted by first identifying preferred (and high risk) areas and then utilize a specialized electrofisher to capture ammocoetes. Collection of lamprey ammocoetes has been demonstrated in the Klamath River (Karuk Tribe and USFWS unpublished data). Captured individuals would be transported to suitable locations (with current low occurrences of lamprey) within tributaries upstream or upstream of Keno Dam. A detailed plan describing lamprey capture and relocation would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

It is expected that implementation of this mitigation measure would reduce dissolved oxygen and SSC-related stress or mortality for a proportion of lamprey ammocoetes. An unknown number of lamprey ammocoetes remaining in the mainstem Klamath River downstream from Iron Gate Dam would still experience stress and mortality resulting from elevated SSC and bedload movement. Mitigation effectiveness monitoring would consist of reporting the number of individuals captured, release location, and their condition upon release.

3.3.4.4.6 AR-6: Sucker Rescue and Relocation

It is anticipated that short-term effects of the Proposed Action will result in mostly sublethal, and in some cases lethal impacts to Lost River and shortnose suckers within reservoirs in Hydroelectric Reach. Under this measure adult Lost River and shortnose suckers in reservoirs downstream from Keno Dam could be captured and relocated to Upper Klamath Lake (Buchanan et al. 2011a).

If deemed feasible in 2019 prior to dam removal, Klamath smallscale suckers will be collected directly downstream from J.C. Boyle Dam and terminating approximately 2 miles downstream in the approximate area of the current powerhouse. Fish will be collected using electro- fishing techniques. Salvaged Klamath smallscale sucker will be relocated to Spencer Creek immediately downstream from the Spencer Creek hook up road (upper limits for sucker in Spencer creek). Smallscale suckers will not be relocated upstream of Keno Dam.

Lost River and shortnose suckers can also be captured using electrofishing and trammel nets. It is recommended that these and other approved capture techniques be utilized for this relocation effort. Captured Lost River and shortnose suckers could then be placed in aerated tank trucks and transported to suitable release sites in Upper Klamath Lake. A detailed plan describing sucker rescue and relocation would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

It is expected that implementation of this mitigation measure would reduce the deleterious short-term effects from the Proposed Action. However, it is not known how many suckers inhabit the Hydroelectric Reach reservoirs, therefore it is unknown what proportion of the population would be captured and successfully relocated. Those Lost River and shortnose suckers not relocated to the Upper Klamath Basin would likely be lost, but with little or no successful reproduction (Buettner et al. 2006), and no connection to upstream populations, the individuals downstream from Keno Dam contribute minimally to conservation goals or recovery (Hamilton et al. 2011).

3.3.4.4.7 AR-7: Freshwater Mussel Relocation

Freshwater mussels in the Hydroelectric Reach and in the Lower Klamath River, downstream from Iron Gate Dam, are likely to be deleteriously affected by prolonged SSCs and bedload movement during the later part of reservoir drawdown and subsequent dam removal. Freshwater mussels cannot move to avoid these impacts, and some species are very long lived, and may not reproduce successfully (or at all) each year. An action to mitigate this effect is to relocate freshwater mussels prior to drawdown. Freshwater mussels could be relocated to tributary streams or upstream of the Hydroelectric Reach, then moved back to their approximate location or to other suitable habitat in the river after dam removal has been completed.

Freshwater mussel relocation success depends on a variety of factors including the availability of suitable habitat (for juveniles, adults, reproduction, feeding, growth, and host fish), population density at the relocation site, and handling during relocation (Hamilton et al. 1997; Bolden and Brown 2002). While many (and still unknown) factors influence the survival and reproduction of freshwater mussels in their natural environment, relocation adds an additional stress. Thus, the variables associated with the characteristics of freshwater mussel habitat at the source and destination sites as well as with the relocation methods should be as similar as possible for all life stages (Cope and Waller 1995; Cope et al. 2003). Previous studies indicate varied success of freshwater mussel relocation projects, with most mortality observed within one year (Thomas 2008). Habitat selection is important for success, as changes in habitat (e.g., substrate size) from the original site appear to influence mortality (Cope and Waller 1995; Bolden and Brown 2002). As such, the presence of existing freshwater mussel populations should guide site selection. Cope et al. (2003) found that proper handling and transport and selection of suitable habitat improved survivorship of relocated freshwater mussels.

Luzier and Miller (2009) developed some general guidelines for freshwater mussel relocation projects, including 1) an initial evaluation of freshwater mussel populations to

site evaluation for relocation to determine (among other factors) habitat quality and presence of appropriate fish hosts, 3) careful and quick transport to minimize stress, and 4) monitoring relocated populations to determine initial survival, recruitment, and persistence through the range of environmental conditions at the site. Following these guidelines, prior to drawdown (e.g., fall 2019 or before) surveys would be conducted to evaluate current freshwater mussel species and habitat downstream from Iron Gate Dam and to identify potential sites for relocation. Freshwater mussels would be relocated to suitable habitats and monitored over the duration of high SSCs. After dissipation of effects, original locations could be resurveyed to determine habitat suitability. If suitable, then the relocated freshwater mussels could be returned to their source location. Most relocation projects are conducted during warm periods when reproductive stress is presumably low for most species, and their metabolic rates are sufficient for burrowing in the substrate (Cope and Waller 1995).

If suitable in-stream habitat cannot be found for the time period of increased SSCs, it may be possible to temporarily house relocated freshwater mussels in fish hatchery raceways at facilities near to the removal sites. However, many freshwater mussels need to burrow to reduce the energy needs of holding their valves closed for extended periods. Thus, such artificial holding areas should not be used for long periods. Aquaculture ponds have sometimes been used as well (Cope et al. 2003).

This mitigation measure would benefit from a pilot program prior to initiation, to assess the success and potential levels of mortality associated with relocation. Relocation should also consider the potential for transmission of disease or interbreeding between genetically distinct populations. A detailed plan describing freshwater mussel rescue and relocation would be developed by the DRE prior to 2019.

Effectiveness of Mitigation in Reducing Impacts

With the proposed mitigation, these impacts freshwater mussels would be reduced.

3.3.4.4.8 Summary of Mitigation Measures

The DRE would be responsible for implementation of Mitigation Measures AR-1 through AR-7. Although all proposed mitigation measures would reduce short-term deleterious effects of the Proposed Action, significant effects would continue to occur for some species, as described in detail in the Proposed Action Species-Specific impacts analysis provided in Section 3.3.4.3.2.2.3 and detailed in Tables 3.3-11 through 3.3-18.

Table 3.3-11. Comparison of Short-term SSC Effects from the Proposed Action with and without Mitigation Measures; Most-likely Scenario (i.e., 50% Exceedance Probabilities) for Fall- and Spring-Chinook and Coho Salmon

Species/Run	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Fall Chinook Salmon	**Proposed Action**				
	No effects	Up to 100% mortality of the progeny of mainstem spawners (about 8% of escapement)	No juvenile progeny anticipated rearing in mainstem due to impacts during incubation. Most other juveniles assumed to rear in tributaries prior to outmigration.	N/A	**Type I:** Major stress and reduced growth for Type I fry (about 60% of production) **Type II:** No effects **Type III:** Major stress, reduced growth, and up to 20% mortality for Type III outmigrants (less than 1% of production)
	Proposed Action with Mitigation Measures AR-1, 2, 3, and 4				
	Increased escapement into tributaries due to augmented attraction flows	Reduced effects due to increased hatchery production, trapping and relocation of adult spawners and additional redds being constructed in tributaries	Reduced effects due to mainstem progeny now rearing in hatchery and tributary streams.	N/A	**Type I:** Major stress on smolts not rescued and relocated; Growth-related effects for non-hatchery smolt; reduced effects on hatchery smolts due to delayed release **Type II:** Same as above for naturally spawned progeny. Reduced effects for hatchery-reared fish due to release timing modification. Reduced effects for rescued and relocated smolts. **Type III:** Major stress, reduced growth, and up to 20% mortality for Type III outmigrants. Reduced effects for rescued and relocated smolts.

Table 3.3-11. Comparison of Short-term SSC Effects from the Proposed Action with and without Mitigation Measures; Most-likely Scenario (i.e., 50% Exceedance Probabilities) for Fall- and Spring-Chinook and Coho Salmon

Species/Run	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Spring Chinook Salmon	**Proposed Action**				
	Spring Migration: Major stress, impaired homing for adults returning to Salmon R. (about 5% of run) Summer Migration: No effects	Most spawning takes place in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	Type I: Major stress for Type I fry from Salmon R. (about 80% of Salmon R. production)
					Type II: Major to moderate stress for 1 to 3 days
					Type III: Major stress, reduced growth, but no mortality
	Proposed Action with Mitigation Measures AR- 2 and 3				
	Spring Migration: Same as above Summer Migration: Same as above	Same as above	Same as above	Same as above	Type I: Major stress on smolts not rescued and relocated
					Type II: Same as above for non-rescued and relocated fish.
					Type III: 20-40% mortality (about 31 smolts)

Table 3.3-11. Comparison of Short-term SSC Effects from the Proposed Action with and without Mitigation Measures; Most-likely Scenario (i.e., 50% Exceedance Probabilities) for Fall- and Spring-Chinook and Coho Salmon

Species/Run	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Coho Salmon	**Proposed Action**				
	Major stress and impaired homing	Up to 100% mortality of progeny of mainstem spawners (typically <1% of run)	**Age 0+ summer:** Reduced growth for age 0+ from 2020 cohort in upper mainstem (<50% of fry). No effect on juveniles rearing in tributaries	**Age 1+ winter:** Major stress, reduced growth, and up to 60% mortality for age 1+ juveniles from 2019 cohort in mainstem (assume <1% of juveniles). No effect on juveniles rearing in tributaries	**Early spring outmigration:** Major stress, reduced growth, and up to 20% mortality for smolts coming from tributaries in upper mainstem in early spring (about 44% of production) **Late spring outmigration:** Major stress and reduced growth for smolts coming from tributaries in the upper mainstem in late spring (about 56% of production)
	Proposed Action with Mitigation Measure AR-2 and 3				
	Same as above	Reduced effects due to relocation of adult spawners and additional redds being constructed in tributaries upstream of Hydroelectric Reach	**Age 0+ summer:** Same as above	**Age 1+ winter:** Same as above	**Early spring outmigration:** Major stress, reduced growth, and up to 4% mortality***; Reduced mortality*** **Late spring outmigration:** Major stress and mortality on smolts not rescued and relocated; Growth-related effects

Table 3.3-12. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Most-likely scenario (i.e., 50% Exceedance Probabilities) for Steelhead and Pacific Lamprey

Species/Run	Life History Stage					
	Adult migration	**Runbacks/Half-pounder residency**	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Summer and Winter Steelhead	**Proposed Action**					
	Summer run: Major stress and impaired homing for fish spawning in mid- and upper-Klamath tributaries (about 45% of escapement) Winter run: Major stress, impaired homing, and up to 36% mortality for fish spawning in mid- and upper-Klamath tributaries (about 1,008 adults)	Adult runbacks: Major stress; depending on time spent in mainstem Half-pounder residency: Most assumed to remain in tributaries; major stress for any remaining in mainstem	Most spawning takes place in tributaries; no effects predicted	Major stress resulting in reduced growth and up to 100% mortality for juveniles in that migrate from tributaries to the mainstem	Age 1+ rearing: Major stress, reduced growth, and up to 100% mortality for juveniles in that migrate from tributaries to the mainstem Age 2+ rearing: Reduced growth and up to 60% mortality for juveniles in mainstem	Major stress and reduced growth; about 57% outmigrate from Trinity R. and would have less exposure

Table 3.3-12. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Most-likely scenario (i.e., 50% Exceedance Probabilities) for Steelhead and Pacific Lamprey

Species/Run	Life History Stage					
	Adult migration	**Runbacks/Half-pounder residency**	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
	Proposed Action with Mitigation Measure AR-2					
Summer and Winter Steelhead	Summer run: Same as above Winter run: Same as above	Adult runbacks: Same as above Half-pounder residency: Same as above	Same as above	Reduced effects for those migrating fish that are captured and relocated. Same effects as above for non-relocated fish.	Age 1+ rearing: Reduced effects for those migrating fish that are captured and relocated. Same effects as above for non-relocated fish. Age 2+ rearing: Reduced effects for those migrating fish that are captured and relocated. Same effects as above for non-relocated fish.	Major stress and reduced growth for that portion of the population not captured by the outmigrant rescue program.

Table 3.3-12. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Most-likely scenario (i.e., 50% Exceedance Probabilities) for Steelhead and Pacific Lamprey

Species/Run	Life History Stage					
	Adult migration	**Runbacks/Half-pounder residency**	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Pacific Lamprey	**Proposed Action**					
	Major stress, reduced growth, and up to 36% mortality; later-returning adults and those returning to lower tributaries would have less exposure	N/A	See adult migration	**Ammocoete rearing*:*** Major stress, reduced growth, and up to 52% mortality for multiple year classes of ammocoetes in mainstem; majority rear in tributaries and would not suffer mortality		**Spring outmigration*:*** Major stress **Fall and winter outmigration*:*** Moderate stress
	Proposed Action with Mitigation Measure AR-5					
	Same as above	N/A	Same as above	**Ammocoete rearing*:*** Reduced effects for ammocoetes that are captured and relocated. Major stress, reduced growth, and up to 52% mortality for lamprey not captured and relocated.		**Spring outmigration*:*** Same as above **Fall and winter outmigration*:*** Same as above

Table 3.3-13. Comparison of Short-term SSC Effects from the Proposed Action with and without Mitigation Measures; Most-Likely Scenario (i.e., 50% Exceedance Probabilities) for Green Sturgeon and Suckers

Species/Run	Life History Stage			
	Adult migration	**Adult Post-spawning Holding**	**Spawning through larvae**	**Juvenile Rearing (year-round) and Outmigration**
Green Sturgeon	**Proposed Action**			
	Major stress; 75% of adults not expected to migrate in 2020	No effects	76% mortality for all mainstem production; about 30% that spawn in Trinity R. would be unaffected (based on salmonid literature; effects likely overestimated)	Reduced growth and up to 20% mortality; about 30% of juveniles rear in Trinity R. and would be unaffected (based on salmonid literature; effects likely overestimated)
	Proposed Action with Mitigation Measure AR-4			
	Reduced effects due to fall flow pulse moving adults downstream; 75% of adults not expected to migrate in 2020.	Same as above	Same as above	Same as above
Suckers (spp)	**Proposed Action**			
	NA	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.
	Proposed Action with Mitigation Measure AR-6			
	NA	Beneficial in upper Klamath Lake due to more habitat area. Loss of all adults within the Hydroelectric Reach that were not captured and relocated.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach since larvae and juveniles will not be captured and relocated.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach since larvae and juveniles will not be captured and relocated.

Table 3.3-14. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measure AR-8 for Freshwater Mussels

Species/Run	Adults	Spawning	Larvae
Freshwater mussels	**Proposed Action**		
	Major physiological stress and substantial mortality	Major physiological stress and substantial mortality during the spawning season	Major adult physiological stress and mortality will significantly reduce larval production. No information on effects of SSC on larvae. Larvae produced in downstream reaches or tributaries may contribute to population recovery.
	Proposed Action with Mitigation Measure AR-8		
	Major physiological stress and substantial mortality. Some individuals would be relocated and would assist in reseeding the population.	Major physiological stress and substantial mortality during the spawning season. Relocated individuals may spawn in upstream reaches.	Major adult physiological stress and mortality will significantly reduce larval production. No information on effects of SSC on larvae. Larvae produced by relocated individuals, in downstream reaches, or in tributaries may contribute to population recovery.

Table 3.3-15. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-Case Scenario (10% Exceedance Probabilities) for Fall- and Spring-run Chinook Salmon

Species/Run	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Fall-run Chinook Salmon	**Proposed Action**				
	No effect	Up to 100% mortality of the progeny of mainstem spawners (about 8% of escapement)	No juvenile progeny anticipated rearing in mainstem due to impacts during incubation. Most other juveniles assumed to rear in tributaries prior to outmigration.	N/A	**Type I:** Major stress and reduced growth for the about 40% of fry entering mainstem in April/May
					Type II: Moderate to major stress for the about 60% of Type II juveniles entering mainstem in Sept/Nov
					Type III: Major stress, reduced growth, and up to 71% mortality for about 0.18% of all juveniles entering mainstem in Feb-April
	Proposed Action with Mitigation Measures AR-1, 2, 3, and 4				
	Increased escapement into tributaries due to augmented attraction flows	Reduced effects due to increased hatchery production, relocation of adult spawners and additional redds being constructed in tributaries	Reduced effects due to mainstem progeny now rearing in hatchery and tributary streams	N/A	**Type I:** Major stress on smolts not rescued and relocated; Growth-related effects for non-hatchery smolt; reduced effects on hatchery smolts due to delayed release
					Type II: Same as above for naturally spawned progeny. Reduced effects for hatchery-reared fish due to release timing modification.
					Type III: Major stress, reduced growth, and up to 60% mortality***; Reduced mortality***

Table 3.3-15. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-Case Scenario (10% Exceedance Probabilities) for Fall- and Spring-run Chinook Salmon

Species/Run	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Spring-run Chinook Salmon	**Proposed Action**				
	Spring Migration: Major stress and impaired homing Summer Migration: Impaired homing	Most spawning takes place in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	Juveniles primarily rear in tributaries; no effects predicted	Type I: Major stress for Type I fry from Salmon R. (about 80% of Salmon R. production)
					Type II: Moderate stress for Type II juveniles from Salmon R. (about 20% of Salmon R. production)
					Type III: Major stress for Type III juveniles from Salmon R. (<1% of Salmon R. production)
	Proposed Action with Mitigation Measure s AR- 2				
	Spring Migration: Same as above Summer Migration: Same as above	Same as above	Same as above	Same as above	Type I: Reduced impacts for those fish that are rescued and relocated. Same impacts as above for fish not rescued.
					Type II: Reduced impacts for those fish that are rescued and relocated. Same impacts as above for fish not rescued.
					Type III: Reduced impacts for those fish that are rescued and relocated. Same impacts as above for fish not rescued.

Table 3.3-16. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-Case Scenario (10% Exceedance Probabilities) for Coho Salmon and Steelhead

Species/Run	Life History Stage					
	Adult migration	**Runbacks/Half-pounder residency**	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Coho Salmon	**Proposed Action**					
	Major stress and impaired homing	N/A	Up to 100% mortality of progeny of mainstem spawners (typically <1% of run)	**Age 0+ summer:** No growth for 2020 cohort rearing in upper mainstem (< 50% of fry). No effect on juveniles rearing in tributaries	**Age 1+ winter:** Major stress, reduced growth and up to 52% mortality for 2018 age-1+ cohort in mainstem (assume <1% of juveniles). No effect on juveniles rearing in tributaries	**Early spring outmigration:** Major stress, reduced growth, and up to 49% mortality for smolts coming from Upper Klamath, Mid-Klamath, Shasta River, and Scott River populations during early spring (approximately 44% of the run outmigrates in early spring). (Mortality for approximately 8% of total population)
						Late spring outmigration: Major stress and reduced growth for smolts coming from tributaries in the upper mainstem in late spring (about 56% of production)
	Proposed Action with Mitigation Measures AR-2 and 3					
	Same as above	N/A	Reduced effects due to relocation of adult spawners and additional redds being constructed in tributaries upstream of Hydroelectric Reach	**Age 0+ summer:** Same as above	**Age 1+ winter:** Same as above	**Early spring outmigration:** Major stress, reduced growth, and up to 11% mortality***; Reduced mortality***
						Late spring outmigration: Reduced impacts for those fish that are rescued and relocated.

Table 3.3-16. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-Case Scenario (10% Exceedance Probabilities) for Coho Salmon and Steelhead

Species/Run	Life History Stage					
	Adult migration	**Runbacks/Half-pounder residency**	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Summer and Winter Steelhead	**Proposed Action**					
	Summer run: Major stress, impaired homing, and up to 20% mortality (From 0 to 130 adults, or from 0 to 9 percent of the basin-wide escapement). Winter run: Major stress, impaired homing, and up to 71% mortality. The proportion migrating prior to January would not be affected. (Up to 1,988 adults, or up to 28 percent of the basin-wide escapement).	Adult runbacks: Major stress; exposure dependant on time it takes runbacks to return to sea Half-pounder residency: Major stress and reduced growth for any in mainstem; Most assumed to remain in tributaries;	Most spawning takes place in tributaries; no effects predicted	Major stress and reduced growth for age 0+ juveniles in mainstem (about 60% of juveniles)	Age 1+ rearing: Stress, reduced growth, and up to 71% mortality Up to 11,207 juveniles or around 19% of total age 1 production). Age 2+ rearing: Stress, reduced growth and up to 71% mortality (Up to 9,412 juveniles or around 18% of total age 2 production).	Major stress resulting in reduced growth, about 57% outmigrate from Trinity R. and will have less exposure
	Proposed Action with Mitigation Measures AR-2					
	Summer run: Same as above Winter run: Same as above	Adult runbacks: Same as above Half-pounder residency: Same as above	Same as above	Same as above	Age 1+ rearing: Same as above Age 2+ rearing: Same as above	Major stress and reduced growth for that portion of the population not captured by the outmigrant rescue program.

Table 3.3-17. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-case Scenario (10% Exceedance Probabilities) for Pacific Lamprey, Green Sturgeon, and Suckers

Species	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Pacific Lamprey	**Proposed Action**				
	Major stress, reduced growth, and up to 71% mortality; later-returning adults and those returning to lower tributaries would have less exposure	See adult migration	**Ammocoete rearing*:*** Major stress, reduced growth, and up to 71% mortality for multiple year classes of ammocoetes in mainstem; majority rear in tributaries and would not suffer mortality		**Spring outmigration*:*** Moderate to major stress and reduced growth **Fall and winter outmigration*:*** Major stress
	Proposed Action with Mitigation Measure AR-5				
	Same as above	Same as above	**Ammocoete rearing*:*** Same as above for any ammocoetes not captured and relocated		**Spring outmigration*:*** Same as above **Fall and winter outmigration*:*** Same as above

Table 3.3-17. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-case Scenario (10% Exceedance Probabilities) for Pacific Lamprey, Green Sturgeon, and Suckers

Species	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Green Sturgeon	**Proposed Action**				
	Major stress; about 25% of adults expected to be exposed in 2020	**Adult Post-spawning Holding:** Short period (<1 wk) of relatively low SSCs, not expected to result in deleterious effects; about 75% of adults hold in mainstem after spawning; remainder return to ocean	95% mortality for all mainstem production; about 30% that spawn in Trinity R. would be unaffected (based on salmonid literature; effects likely overestimated)	**Juvenile Rearing (year-round) and Outmigration:** Reduced growth and up to 36% mortality; about 30% of juveniles rear in Trinity R. and would be unaffected	N/A
	Proposed Action with Mitigation Measure AR-3				
	Reduced effects due to fall flow pulse moving adults downstream	**Adult Post-spawning Holding:** Reduced effects due to fall flow pulse moving adults downstream	Same as above	**Juvenile Rearing (year-round) and Outmigration:** Same as above	N/A

Table 3.3-17. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-case Scenario (10% Exceedance Probabilities) for Pacific Lamprey, Green Sturgeon, and Suckers

Species	Life History Stage				
	Adult migration	**Spawning through fry emergence**	**Age 0+ rearing**	**Age 1+ rearing**	**Outmigration**
Suckers (spp)	**Proposed Action**				
	NA	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach.	NA
	Proposed Action with Mitigation Measure AR-6				
	NA	Beneficial in upper Klamath Lake due to more habitat area. Loss of all adults within the Hydroelectric Reach that will not be captured and relocated.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach since larvae and juveniles will not be captured and relocated.	Beneficial in upper Klamath Lake due to more habitat area. Loss of all individuals within the Hydroelectric Reach since larvae and juveniles will not be captured and relocated.	NA

Table 3.3-18. Comparison of Short-term SSC effects from the Proposed Action with and without Mitigation Measures; Worst-Case Scenario (i.e., 10% Exceedance Probabilities) for Freshwater Mussels

Species	Adults	Spawning	Larvae
Freshwater mussels	**Proposed Action**		
	Major physiological stress and substantial mortality	Major physiological stress and substantial mortality during the spawning season	Major adult physiological stress and mortality will significantly reduce larval production. No information on effects of SSC on larvae. Larvae produced in downstream reaches or tributaries may contribute to population recovery.
	Proposed Action with Mitigation Measure AR-8		
	Major physiological stress and substantial mortality. Some individuals would be relocated and would assist in reseeding the population.	Major physiological stress and substantial mortality during the spawning season. Relocated individuals may spawn in upstream reaches.	Major adult physiological stress and mortality will significantly reduce larval production. No information on effects of SSC on larvae. Larvae produced by relocated individuals, in downstream reaches, or in tributaries may contribute to population recovery.

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3.4 Algae

3.4.1 Area of Analysis

This section of the Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) analyzes potential effects of the Proposed Action and alternatives on algal communities in the Klamath Basin, excluding the Lost River watershed, Tule Lake watershed, and most of the Trinity River.

The area of analysis for algae is generally the same as for Aquatic Resources (Section 3.3, Aquatic Resources, Figure 3.3-1). Potential impacts were assessed within and across reaches of the Klamath Basin, as separated by changes in physiography (e.g., Upper and Lower Klamath Basins), the presence of the Four Facilities under analysis, and degree of marine influence. The area of analysis for algae has the following reaches:

1. Upstream of the influence of J.C. Boyle Reservoir, including the following:
    a. Upper Klamath Lake and Agency Lake
    b. Tributaries to Upper Klamath Lake (Sprague, Sycan, Wood and Williamson Rivers)
    c. Reclamation's Klamath Project facilities (e.g., Link River Dam, Keno Impoundment /Lake Ewauna)
2. Hydroelectric Reach: from the upstream end of J.C. Boyle Reservoir to Iron Gate Dam, including all sections categorized as mainstem, bypass, and peaking reaches and including tributaries to the Klamath River (examples include Jenny, Spencer, Slate, Shovel, and Fall creeks).
3. Lower Klamath River: downstream from Iron Gate Dam, including the following:
    a. Major tributaries to the Klamath River (Shasta, Scott, and Salmon Rivers)
    b. Minor tributaries to the Klamath River (examples include Bogus, Beaver, Humbug, and Cottonwood creeks)
4. Klamath Estuary
5. Pacific Ocean marine nearshore environment (see Figure 3.2-1)

3.4.2 Regulatory Framework

Beneficial uses and water quality objectives for Oregon, California, the United States Environmental Protection Agency (USEPA), and the Hoopa Valley, Yurok and Karuk Tribes provide the regulatory framework for algae listed below. These uses and objectives are described in detail in Section 3.2.2. Oregon includes a narrative nuisance algae growth objective in which impairment of beneficial uses by algal growth is not allowed. Additionally, for natural lakes that do not thermally stratify, reservoirs, rivers and estuaries, the numeric average of 0.015 mg/L chlorophyll-*a* identifies Oregon water bodies where phytoplankton may impair the recognized beneficial uses (Table 3.2-3).

California has a narrative biostimulatory water quality objective that limits nutrients to the extent that such growths cause nuisance or adversely affect beneficial uses (Table 3.2-3). Additionally, the algal concentration "targets" for the California Klamath River Total Maximum Daily Loads (TMDLs) were developed from an interpretation of the biostimulatory substances objective, using the California Nutrient Numeric Endpoint guidelines (North Coast Regional Water Quality Control Board [NCRWQCB] 2010). For water column chlorophyll-*a* concentrations (i.e., phytoplankton) the California Klamath River TMDL target is 10 µg/L. For attached benthic algal biomass (i.e., periphyton), the target is 150 mg of chlorophyll-*a*/m^2. The Hoopa Valley Tribe also uses 150 mg/L of chlorophyll-*a* as the water quality objective for nuisance periphyton growth (Table 3.2-6), which is applicable for River Mile (RM) ≈45–46 of the mainstem Klamath River.

3.4.2.1 Federal Authorities and Regulations

- Clean Water Act (Title 33 U.S.C. §1313 [1972])
- Safe Drinking Water Act (Title 42 U.S.C. CHAPTER 6A §300f-j [1973 as amended])
- Coastal Zone Management Act

3.4.2.2 State Authorities and Regulations

- Oregon Administrative Rules for Water Pollution Control (OAR 340-041)
- North Coast Region Basin Plan (as required by Sections 13240–13247 of California Porter-Cologne Water Quality Act)
- California Ocean Plan

3.4.2.3 Tribal Authorities and Regulations

- Hoopa Valley Tribe Water Quality Control Plan

3.4.3 Existing Conditions/Affected Environment

Two algal communities, phytoplankton and periphyton, are predominant in the Klamath Basin. The lakes and reservoirs are dominated by phytoplankton, small algae that float in the water column. Particular phytoplankton species (i.e., blue-green algae or cyanobacteria) frequently reach nuisance levels within the lakes and reservoirs. In addition, there are portions of the riverine reaches (e.g., backwater eddies and near shore shallows) that have become inoculated with phytoplankton from upstream lakes and reservoirs, which can also support nuisance levels of blue-green algae under certain conditions. The riverine portions of the Klamath River are dominated by periphyton (i.e., attached algae) or algae, fungi, and bacteria that attach to the stream bed and/or periphyton mats. Periphyton is generally dominated by diatoms and green algae. Submerged aquatic macrophytes may also be present in quiet backwater areas in the Klamath River; however, no known quantitative or species-specific information has been collected. No surveys have been conducted to determine the relative distribution or biomass of aquatic macrophytes in the Klamath River. This section focuses on the potential impacts of the Proposed Action and the alternatives on the phytoplankton and periphyton communities.

3.4.3.1 Phytoplankton

A number of different groups contribute to the phytoplankton community, including diatoms, green algae, and cyanobacteria (i.e., blue-green algae). The phytoplankton community shifts seasonally in response to changing temperature, light and nutrient levels. Phytoplankton form the base of the food web in the reservoirs. Phytoplankton are consumed by zooplankton, insects and some small fish, which are fed upon by larger fish, birds, mammals, and humans. Diatoms and green algae are generally considered to be beneficial components of the phytoplankton based on their important role in the food web. When phytoplankton communities reach higher levels of biomass in the water column (e.g., greater than 10–15 µg/L), the species composition often shifts from the more beneficial green algal species to blue-green algal species. This happens quickly as biomass in the water column begins to increase exponentially, which results in nuisance conditions including: extreme diurnal dissolved oxygen and pH fluctuations due to the effect of photosynthesis and respiration of the algal biomass, high concentrations of cyanotoxins produced by toxigenic blue-green algal species (see also Section 3.2.3.7), dissolved oxygen crashes due to the decomposition of decaying algal biomass, and in extreme conditions, disruption of food webs. Typically these nuisance conditions are dominated by blue-green algae species, most notably in Upper Klamath Lake, Copco 1 Reservoir, and Iron Gate Reservoir. Nuisance blooms of green algae are less common in the Klamath Basin. Blue-green algae reach very high densities in the summer months. Some blue-green algae, *Anabaena flos-aquae*, and *Microcystis aeruginosa*, produce toxins that are harmful to fish, mammals and humans (see Section 3.2.3.7).

The stable lacustrine[1] environment created at the Four Facilities, particularly in the larger Copco 1 and Iron Gate Reservoirs, coupled with high nutrient availability and high water temperatures in summer to fall, provides ideal conditions for phytoplankton growth, including the growth of blue-green algal species. While blue-green algae can be found in a variety of lake, reservoir, river, and estuarine environments, in particular, these species thrive under warm water temperature, high nutrient, and stable water column conditions (Konopka and Brock 1978, Kann 2006) where they can out-compete other algal species such as diatoms. Huisman et al. (2004) demonstrate that *M. aeruginosa* can dominate the phytoplankton assemblage at low turbulent diffusivity (i.e., calm-stable lacustrine conditions) when their flotation velocity exceeds the rate of turbulent mixing.

In general, blooms of floating, or planktonic, algae (i.e., phytoplankton) can have important implications for water quality in freshwater systems, causing seasonal and daily fluctuations in nutrients, dissolved oxygen, and pH cycles. Within the Klamath Basin, blue-green algal productivity is locally and seasonally associated with extreme daily fluctuations in dissolved oxygen levels (high during the day and low at night), elevated pH, and free ammonia concentrations, which do not meet Oregon water quality standards during the summer months (Section 3.2.2.3). In California, multiple reaches of the Klamath River from the Oregon-California State line to the Klamath Estuary are included on the CWA Section 303(d) list of water bodies with water quality impairments

[1] Pertaining to a lake or other calm water types.

for water temperature, organic enrichment/dissolved oxygen, nutrients, and microcystin concentration (see Table 3.2-8). The factors contributing to ammonia toxicity (i.e., high ammonia concentrations, high pH, and elevated temperatures) have been documented independently, but concurrent measurements of these conditions are not available to demonstrate ammonia toxicity in California (C. Creager, pers. comm., 2011). Organic enrichment and DO dissolved oxygen depressions are particularly of issue during the summer and fall months when water temperatures are relatively high.

Nuisance algal blooms that occur in the Klamath Basin are primarily composed of three species of blue-green algae: *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, and *M. aeruginosa*. Large blooms of *Aphanizomenon flos-aquae and Anabaena flos-aquae* can strongly influence pH, free ammonia, and concentrations as described above. *M. aeruginosa* requires an aquatic source of dissolved inorganic nitrogen because it cannot make use of (fix) nitrogen gas from the atmosphere. However, *Aphanizomenon* and *Anabaena* are nitrogen fixers which allows them to outcompete other algal species when dissolved inorganic nitrogen becomes scarce in a lake or reservoir. The fixed nitrogen can subsequently become a source of nitrogen for additional primary production of phytoplankton in reservoirs (Federal Energy Regulatory Commission [FERC] 2007).

In addition to its role as a nitrogen fixer, *Anabaena flos-aquae* can produce several types of toxins (i.e., anatoxin, microcystins, and saxitoxins; Lopez et al. 2008). Anatoxin is a neurotoxin which can cause irritation, muscle twitching, paralysis, and death. In contrast to *M. aeruginosa*, toxin production by some strains of *Anabaena flos-aquae* appears to be sporadic, and the circumstances under which this occurs are unknown. Anatoxin has been detected during one sampling event, at levels ranging from 20–34 ug/L in September 2005 at Iron Gate Reservoir (T. Mackie, written communication, 2005); however, the extent of anatoxin production by *Anabaena flos-aquae* in the Klamath River cannot be fully evaluated or ruled out based on the limited sampling to date. Although it is widely assumed that the severe blooms of *M. aeruginosa* in the Klamath Basin are responsible for the detected concentrations of microcystin, the relative proportion of microcystin contributions from *M. aeruginosa* vs. *Anabaena flos-aquae* has not been documented.

Studies suggest that the presence of *M. aeruginosa* blooms could result in acute and chronic effects on fish including increased mortality, reduced fertility, reduced feeding, and habitat avoidance (Interagency Ecological Program 2007; Fetcho 2008, 2009; CH2M Hill 2009; Teh et al. 2010), including potential adverse effects to endangered juvenile suckers in Upper Klamath Lake (VanderKooi et al. 2010; see Section 3.3.3.2 Physical Habitat Descriptions - Water Quality - Algal Toxins). The World Health Organization (WHO) guidelines for exposure to microcystin were exceeded in 2007–2008 in Upper Klamath Lake (VanderKooi et al. 2010). More frequent exceedances of algal toxin guidelines have occurred since 2007 in the Middle and Lower Klamath River (Chorus and Bartram 1999; Fetcho 2006, 2007, 2008; Kann 2008; Kann and Corum 2009), the Klamath River from Copco 1 Reservoir (RM 203.1) to the confluence with the Trinity River (RM 40.0) being listed as impaired for toxicity due to the presence of microcystin in the reservoirs (Section 3.2.2.3).

3.4.3.2 Periphyton

Periphyton are generally dominated by diatoms and green algae. Blue-green algae can also occur in the periphyton community, but they are typically a small component of the community and do not reach nuisance levels. Like phytoplankton in lakes and reservoirs, periphyton are important components in the base of the food web in riverine systems. Periphyton can also play an important role in riverine water quality, affecting nutrient cycling and resulting in diel (24-hour cycle) fluctuations in dissolved oxygen and pH (Anderson and Carpenter 1998, Kuwabara 1992, Tanner and Anderson 1996). Excessive swings in dissolved oxygen and pH can be stressful to aquatic biota, such that too much periphyton can adversely affect designated beneficial uses related to fish and other aquatic organisms (see Section 3.2.2.1, Table 3.2-2). In the Upper Klamath Basin, excessive periphyton growth in the Sprague River has been reported to negatively affect summertime dissolved oxygen in this tributary to Upper Klamath Lake (Oregon Department of Environmental Quality [ODEQ] 2002; see also Appendix C, Section C.4.1.1). Monitoring at multiple locations along the mainstem Lower Klamath River indicates that dissolved oxygen and pH patterns over a 24-hour period are driven primarily by photosynthesis and respiration of periphyton (Ward and Armstrong 2010). The repeatable and consistent diel cycling of dissolved oxygen is characteristic of a stream metabolism dominated by benthic photosynthesis and respiration (Odum 1956). However, planktonic algae transported through the system likely exert some influence on the dissolved oxygen signal in the Klamath River, as does demand from organic matter (Pogue and Anderson 1995) exported from the reservoirs. The exact amount of this influence has not been quantified for the Lower Klamath River downstream from the reservoirs.

Periphytic algae documented within the Klamath Basin include nuisance filamentous green algae species such as *Cladophora* (FERC 2007), which can form dense mats in some places in the Lower Klamath River. These mats tend to be patchy and occur in lower velocity areas. They are not a dominant feature of the river, but in some locations are an important habitat for the polychaete worm that is the intermediate host of the important fish parasites *Ceratomyxa shasta* and *Parvicapsula minibicornis.* The factors influencing periphyton abundance and community composition are complex and include abiotic factors such as nutrients, substrate, flow velocity, shading, light availability, and water temperature (Biggs 2000), as well as ecological factors such as macroinvertebrate grazing that interact with abiotic factors (Power et al. 2008). However, data regarding the distribution, community composition, and biomass of periphyton in the Klamath River is limited.

3.4.3.3 Upper Klamath Basin Upstream of the Influence of J.C. Boyle Reservoir

3.4.3.3.1 Phytoplankton

Multiple peer-reviewed sediment core studies indicate that Upper Klamath Lake was historically a biologically productive lake (i.e., the lake produced abundant fish and algae blooms) as indicated by high nutrient concentrations (particularly phosphorus) in the sediments and algal cell remains, including remains of blue-green algae species (Eilers et al. 2001, Eilers et al. 2004, Bradbury et al. 2004, Colman et al. 2004). Results from

these studies describe a progression from naturally eutrophic conditions in Upper Klamath Lake prior to Euro-American settlement to anthropogenically-exacerbated hypereutrophic[2] conditions in the lake following Euro-American settlement (see also Appendix C, Section C.3).

Interpretation of sediment cores collected by Eilers et al. (2004) suggests that Upper Klamath Lake water quality has changed substantially over the past 100 years as consumptive water use practices (e.g., irrigation, municipal uses, wetland diking and draining for conversion of wetlands to agricultural land) and accompanying changes in land use practices throughout the upper Klamath and Lost River watersheds have increased (Walker 2001). Specifically, it appears that mobilization of phosphorus (e.g., from agriculture and other nonpoint sources) has pushed the lake from a naturally eutrophic state into its current hypereutrophic[3] state, allowing algal blooms to reach or approach their theoretical maximum (Walker 2001).

Evaluation of temporal and spatial patterns of algal community composition in Upper Klamath Lake reveals annual shifts between blue-green algae and diatom-dominated communities. Phytoplankton biovolumes in Upper Klamath Lake are dominated by beneficial diatoms in the spring (Kann 1997, ODEQ 2002, Sullivan et al. 2009), while summer and fall (June–October) algal blooms in Upper Klamath Lake are strongly dominated by noxious blue-green algal species (primarily *Aphanizomenon flos-aquae* but also including *Anabaena flos-aquae*, and *M. aeruginosa*) (Eilers et al. 2004, FERC 2007). *M. aeruginosa* is believed to be responsible for the production of microcystin toxin in the lake, which at times has exceeded the World Health Organization (WHO) limit for drinking water (1 μg/L) and the Oregon Department of Public Health guidelines for issuing public health advisories (Section 3.2.3.7). Health advisories are generally issued for recreational contact with water. Additional microcystin data collection in Upper Klamath Lake is ongoing (Vanderkooi et al. 2010, see Section 3.3, Aquatic Resources for more detail).

Downstream from the Link River to Keno Dam, temporal and spatial patterns of algal community composition are driven by blooms originating in Upper Klamath Lake. In 2008, a total of 141 algae species were identified in this reach, with most of these algae (98.8 percent) belonging to one of four algal groups: blue-green, cryptophytes, diatoms, and green (Sullivan et al. 2009). *Aphanizomenon flos-aquae* possessed the highest average density (61 percent) when present. As in Upper Klamath Lake, algal group composition in this reach is dominated by diatoms in the spring (56 percent of the total algal biovolume at mainstem sites), while in summer and fall blue-green algae represent

[2] Hypereutrophic: a state of water quality characterized by excessive concentrations of nutrients such as nitrogen and phosphorous and resulting in extremely high productivity. Such waters are often shallow, with intense algal blooms and periods of oxygen deficiency and high pH.

the dominant species (76–80 percent of the total algae biovolume) (Sullivan et al. 2009). High mean algal abundances have been documented in the Klamath River at the Keno Bridge (Highway 66), Link River, and Upper Klamath Lake (at Freemont St. Bridge) (Raymond 2005, Sullivan et al. 2009). The prevalence of beneficial diatoms increases relative to noxious blue-green algal species (including nitrogen-fixing and bloom-forming blue-green algae) in the river downstream from Keno Dam (Kann and Asarian 2006). However, farther downstream within the Copco/Iron Gate Reservoir complex, diatoms decrease again in abundance relative to blue-green algae as described further in Section 3.4.3.4.

The reach from Link River to Keno Dam has extremely poor water quality, especially during summer months, with water temperatures exceeding 25ºC, pH approaching 10 units, dense algal blooms, and dissolved oxygen concentrations below 4 mg/L (National Research Council 2004, Deas and Vaughn 2006, Kann and Smith 1999). Decomposition of the algae and organic matter transported from Upper Klamath Lake to this reach is largely responsible for the low dissolved oxygen concentrations measured during summer and early fall (see Section 3.2.3.5 and Appendix C, Section C.4.1.3 for more detail). The large-scale settling of algal-derived (organic) suspended materials in the Keno Impoundment/Lake Ewauna is one of the primary physical mechanisms responsible for the removal of dense seasonal blue-green algal blooms that originate in Upper Klamath Lake and are transported into the upper reaches of the Klamath River. Further breakdown and loss occurs as algal cells are exposed to turbulent mixing in the river from Keno Dam to J.C. Boyle Reservoir (see also Section 3.2.3.3 and Appendix C, C.2.1.3).

3.4.3.3.2 Periphyton

Periphyton are abundant in portions of the upper Klamath River. In the Klamath Basin, one periphyton species that can reach nuisance levels is *Cladophora*, which are common in nutrient enriched waters (Dodds 1991, FERC 2007), particularly with abundant inorganic nitrogen. Periphyton are of particular concern in the Sprague River, tributary to Upper Klamath Lake, where the dominance of these species results in dramatic diurnal fluctuations in dissolved oxygen and pH (ODEQ 2002). Because *Cladophora* provide an ideal habitat for the polychaete host of both *C. shasta* and *P. minibicornis*, the presence of these species may result in an increased abundance of the polychaete host populations, potentially resulting in increased exposure to and incidence of fish disease (see Section 3.3.3.3).

3.4.3.4 Hydroelectric Reach

3.4.3.4.1 Phytoplankton

Excluding patterns of seasonal algal growth within the reservoirs, blue-green algae dominance and biovolume in riverine sections of the Hydroelectric Reach generally decrease with distance downstream (Kann and Asarian 2006, Kann and Corum 2009). In addition to the large degree of settling of suspended algal materials in the upstream Keno

Impoundment/Lake Ewauna and turbulent break-down of algal cells in the river reach from Keno Dam to J.C. Boyle Reservoir (see previous section), dilution from groundwater springs in the J.C. Boyle Bypass Reach can further decrease concentrations of algal cells and associated toxins (i.e., microcystin) in the Upper Klamath River (see also Section 3.2.3.3 and Appendix C, C.2.1.4).

However, the decreasing riverine trend is interrupted by large summer and fall blooms of blue-green algae in Copco 1 and Iron Gate Reservoirs (Kann and Asarian 2006; Raymond 2009; Asarian et al. 2009, Kann and Asarian 2011). In these two reservoirs, a bloom of diatoms generally occurs in spring to early summer, followed by a period of low chlorophyll-*a* concentrations (FERC 2007; Raymond 2008, 2009, 2010) (see also Appendix C, Section C.6.1). Large algae blooms occur again in the reservoirs in mid-summer to fall months, dominated by *Aphanizomenon flos-aquae* and *M. aeruginosa* (Asarian and Kann 2011; Kann 2006; FERC 2007; Raymond 2008, 2009, 2010). During these blooms, *M. aeruginosa* typically constitutes a higher proportion of the overall biomass than it does when it occurs upstream in Upper Klamath Lake and the Keno Impoundment/Lake Ewauna (Kann and Asarian 2006) (see Section 3.4.3.3).

Copco 1 and Iron Gate Reservoirs provide ideal habitat conditions during late summers for the proliferation of large blooms of toxigenic *M. aeruginosa*, which subsequently become the source of *M. aeruginosa* in the Lower Klamath River. This pattern is robust and repeatable in most years. Figure 3.4-1, modified from Kann and Asarian (2007), illustrates the pattern in 2005. At the river station just upstream of Copco 1 Reservoir ("KRAC" in Figure 3.4-1), *M. aeruginosa* was never detected during multiple summer samplings, despite the fact that other, nitrogen-fixing cyanobacteria such as *Aphanazominon flos-aquae* were detected at KRAC during the same period (Kann and Asarian 2007). During the same period, blooms of *M. aeruginosa* within the reservoirs (Copco Reservoir stations CR02 and CR01, and Iron Gate Reservoir stations IR03 and IR01) were pronounced. Among all reservoir samplings in 2005, *M. aeruginosa* comprised 20–60% of sample biovolume and during some periods it was 60–100% of sample biovolume, particularly in Iron Gate Reservoir. Significant export of the *M. aeruginosa* bloom to downstream reaches is evident by the relatively high biovolume observed at the station downstream from Iron Gate Dam (KRBI). Nearly identical patterns were documented for other years, such as 2006 (Kann and Corum 2007), and 2008 (Kann and Corum 2009), and aggregated over longer time period such as 2001–2004 (Kann 2006) and from 2005–2011 (Asarian and Kann 2011), demonstrating the repeatable nature of this phenomenon.

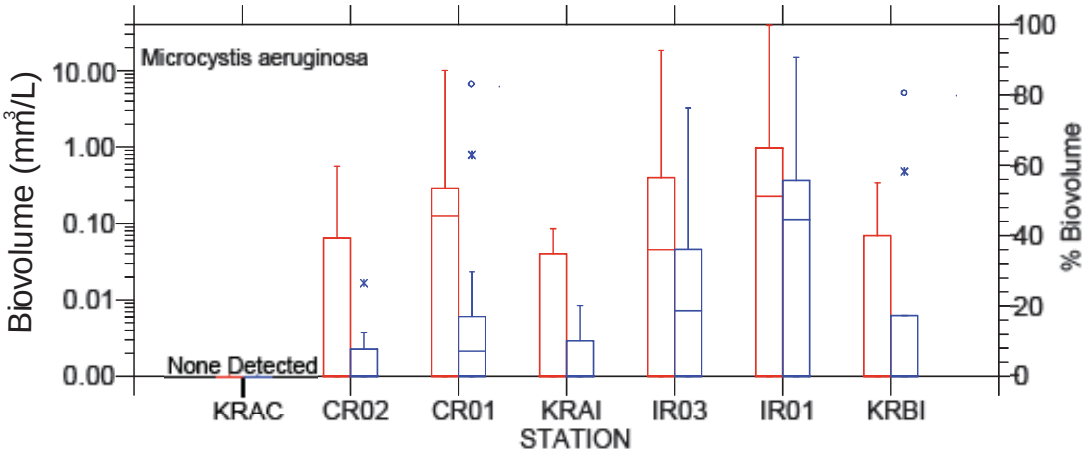

Figure 3.4-1. Biovolume (in red) and percent biovolume (in blue) of Microcystis aeruginosa above, within, and downstream from Copco 1 and Iron Gate Reservoirs during 2005. Station definitions: KRAC, Klamath River above Copco Reservoir; CR01, Copco Reservoir Station 1; CR02, Copco Reservoir Station 2; KRAI, Klamath River above Iron Gate Reservoir; IR03, Iron Gate Reservoir Station 3; IR01, Iron Gate Reservoir Station 1; KRBI, Klamath River below Iron Gate Reservoir. Source: modified from Kann and Asarian (2007).

Of note is that the phytoplankton composition of the river site just upstream of Copco 1 Reservoir does not merely reflect downstream transport of intact algal blooms from Upper Klamath Lake. As described above, seasonal phytoplankton blooms dominated by *Aphanizomenon flos-aquae* occur annually in Upper Klamath Lake and are transported into the Keno Impoundment/Lake Ewauna where they largely settle out of the water column (see Section 3.2.3.3 and Appendix C, Section C.2.1.3), although some colonies are occasionally detected at the inflow to Copco Reservoir (KRAC) (Kann and Asarian 2007). Although *M. aeruginosa* also occurs in Upper Klamath Lake, but generally at relatively low proportions, it rarely survives the journey through Keno Impoundment/ Lake Ewauna and into Copco and Iron Gate Reservoirs, as evidenced by only a few detections at the KRAC site (Asarian and Kann 2011).

The documented presence of algal toxins in water and fish tissue in the reach from upstream of J.C. Boyle Reservoir to Iron Gate Reservoir corresponds with spatial and temporal patterns in the distribution of blue-green algal blooms within the reach. Recent data indicate that while microcystin toxins occur in Upper Klamath Lake, their concentrations decrease downstream to undetectable or very low levels in the Klamath River directly upstream of J.C. Boyle Reservoir. This pattern reverses, however, as water is impounded in Copco 1 and Iron Gate Reservoirs, creating ideal growing conditions for blue-green algae, and producing high microcystin concentrations from July through October (Kann and Corum 2006, 2009). Since 2005, high levels of microcystin have prompted the posting of public health advisories around the Copco and Iron Gate

Reservoirs, and during certain years, along reaches of the Klamath River downstream from Iron Gate Dam during late summer months (see Appendix C, Section C.6.1.4 for more detail). In 2010, the Klamath Hydroelectric Project reservoirs and the entire river downstream from Iron Gate Dam (including the estuary) were posted to protect public health due to elevated cyanobacteria cell counts and cyanotoxin concentrations. High cell counts and toxin concentrations in the water column can result in bioaccumulation of microcystin in muscle and/or liver tissues of resident (i.e., yellow perch) and anadromous fish (i.e., juvenile hatchery Chinook, adult Chinook salmon, steelhead) and in freshwater mussels (Kann 2008, Kann and Corum 2009, Kann et al. 2011). Section 3.3.3.3 Algal Toxins presents a discussion of algal toxins in fish and mussel tissue.

3.4.3.4.2 Periphyton

Nuisance blooms of periphyton have not been documented in the riverine portions of this reach. In the J.C. Boyle Peaking Reach, it has been noted that periphyton tends to be absent from the margins of the river that are alternately dried and wetted during peaking operations (E. Asarian, pers. comm., 2011).

3.4.3.5 Klamath River Downstream from Iron Gate Dam

3.4.3.5.1 Phytoplankton

Although both *Aphanizomenon flos-aquae* and *M. aeruginosa* have been observed just downstream from Iron Gate Dam, and as far downstream as the Klamath Estuary, this reach of the river is more suitable for the growth of periphytic algae, and does not provide optimal habitat for phytoplankton species that typically thrive in reservoir and lake environments. As discussed above, data collected in 2005 and 2007–2010, suggest that the phytoplankton composition of river sites immediately downstream from Copco 1 and Iron Gate Reservoirs can become dominated by blue-green algae on a seasonal basis, when large blooms occurring in the upstream reservoirs are transported downstream. Further downstream in the, *Aphanizomenon flos-aquae* and *M. aeruginosa* are generally documented at lower abundances Lower Klamath River (Kann and Asarian 2006, Raymond 2008). In general, turbulent mixing, increased velocity, and tributary dilution result in the gradual removal of suspended algal materials and chlorophyll-*a* from the water column as the river travels downstream (Armstrong and Ward 2008, Ward and Armstrong 2010) (see also discussion in Appendix C.2.2.1 and C.6.2.1). Occasionally (e.g., 2007), *M. aeruginosa* transported downstream from Copco 1 and Iron Gate Reservoirs can become trapped and accumulate in quiescent pools along the margins of the Lower Klamath River (Kann and Corum 2006), resulting in localized cell abundances greater than those measured immediately downstream from Iron Gate Dam (Kann and Corum 2009, Raymond 2008, Fetcho 2008). At times, accumulations of blue-green algae, including *M. aeruginosa*, along shorelines and in protected coves and backwaters in the Lower Klamath River can result in exceedances to the SWRCB/OEHHA Public Health Threshold (40,000 cells/mL) and WHO guidelines for *M. aeruginosa* cell density (20,000 cells/mL). These thresholds and guidelines are issued for safe recreational water contact (not drinking water).

Despite these localized accumulations of blue-green algae along shorelines and in backwaters, data collected during June through November from 2005–2009 indicate that

the majority of *M. aeruginosa* cell density measurements at river sites in the Lower Klamath River are less than the SWRCB/OEHHA Public Health Threshold of 40,000 cells/mL, while the vast majority of *M. aeruginosa* cell densities in Copco 1 and Iron Gate Reservoir sites are greater than the SWRCB/OEHHA threshold (Appendix C, Figure C-30; see also Kann et al. 2010, Kann and Bowman 2012). A similar pattern exists with respect to the lower WHO guidelines for *M. aeruginosa* cell density (20,000 cells/mL) during June through November 2005–2009 (i.e., the majority of river station measurements are less than the WHO guidelines, while the majority of reservoir station measurements during late summer and fall are greater than the WHO guidelines). There is no documentation of river occurrences of blue-green algae prior to the larger reservoir blooms, although sampling of blue-green algae (and algal toxins) does not occur in the Lower Klamath River until after large-scale summer and fall blooms in Copco 1 and Iron Gate Reservoirs have been observed.

Algal toxins are a critical concern in the Klamath River downstream from Iron Gate Dam because they can remain viable along the low-velocity margins of the river where little mixing occurs (Kann and Corum 2009). Concentrations of microcystin toxin in the Klamath River downstream from the Hydroelectric Reach are typically 1 to 3 orders of magnitude lower than observed in Copco 1 and Iron Gate Dam reservoirs (Appendix C, Figure C-32; see also Raymond 2008, Kann et al. 2010, Kann and Bowman 2012); however, the SWRCB/OEHHA Public Health Threshold (8 ug/L) and WHO guidelines for exposure to microcystin (i.e., < 4 µg/L) have been exceeded downstream from Iron Gate Dam on numerous occasions (Kann 2004, Kann and Corum 2009, Kann et al. 2010, Fetcho 2011, Kann and Bowman 2012), including late-summer/early-fall *M. aeruginosa* blooms in September 2007, 2009, and 2010 from Iron Gate Dam (RM 190.1) to the mouth of the Klamath River (RM 0.0). Overall, the 2005–2009 dataset indicates that while Lower Klamath River exceedances do occur, they are far less in number than exceedances in Copco 1 and Iron Gate Reservoirs (Appendix C, Figure C-32; see also Raymond 2008, Kann et al. 2010, Kann and Bowman 2012). Data from 2007 also indicate that microcystin can bioaccumulate in juvenile salmonids reared in Iron Gate hatchery (Kann 2008; see Section 3.3.3.3 Algal Toxins for a discussion of algal toxins as related to fish health).

Overall, the literature and studies to date overwhelmingly support the conclusion that algal blooms in Copco 1and Iron Gate Reservoirs are the primary source of *M. aeruginosa* and microcystin toxin that are detected seasonally in the river downstream from the Hydroelectric Reach. The relatively high turbulence and velocity of the Lower Klamath River makes it poor habitat for these algal species to thrive in most reaches. Some colonies of *M. aeruginosa* do appear to accumulate and may actually persist in the localized quiescent waters and pools of the lower river, but there is no evidence to indicate that these algal colonies would accumulate or propagate in these types of areas without Copco 1 and Iron Gate Reservoirs as an upstream source. That the reservoirs themselves receive excessive nutrients and potentially a small amount of viable algal cells transported from Upper Klamath Lake and/or the Keno Impoundment/Lake Ewauna, while well documented, does not diminish the fundamental role of Copco 1 and

Iron Gate reservoirs in fostering excessive growth of *M. aeruginosa*, the production of high concentrations of microcystin, and the downstream transport of both to the Lower Klamath River

3.4.3.5.2 Periphyton

Sampling of periphyton in the Klamath River downstream from Iron Gate Dam revealed a shift in community composition, where nitrogen-fixing species are not present directly downstream from Iron Gate Dam but begin to appear by Seiad Valley and then make up an increasing percent of periphyton biomass at sites further downstream. Nitrogen-fixing species are dominant at sites between Orleans and Turwar (Asarian et al. 2010; E. Asarian, pers. comm., 2011). The increased prevalence of nitrogen-fixing periphyton coincides with very low levels of inorganic nitrogen (ammonia and nitrate) concentrations in water samples.

In a single survey downstream from Iron Gate Dam, Eilers (2005) documented relatively high periphyton coverage (near 80 percent) on stream rocks and periphyton chlorophyll-*a* content (near 50 micrograms per square centimeter [$\mu g/cm^2$]) immediately downstream from Iron Gate Dam (RM 189.7), and relatively low periphyton coverage (near 10 percent) on stream rocks several miles downstream near the Collier Rest Area at the I-5 bridge (RM 178). Downstream from the Collier Rest Area, both periphyton coverage and chlorophyll content increased gradually to peak levels near the confluence with the Salmon River (RM 67). While periphyton biomass was generally found to be low to moderate during the survey (with the exception of the site immediately downstream from Iron Gate Dam), it is believed that increased discharge (i.e., a doubling of flow from approximately 600 cfs around August 15 to approximately 1,200 cfs near the end of August, and decreasing to approximately 800 cfs by September 1, the start of the survey) may have dislodged filamentous algae that had proliferated under the previous lower flow regime (Eilers 2005, FERC 2007). *Cladophora* dominated the Shasta River (tributary) site, where it made up one half of the periphyton community by biovolume; however, these species were not documented at any of the other tributary or mainstem Klamath River sites surveyed (Eilers 2005). As discussed previously, *Cladophora* provide suitable habitat for the polychaete worm that is the intermediate host for fish parasites. However, data regarding *Cladophora* biomass are limited, making it difficult to determine the primary factors that control the biomass and distribution of these species (E. Asarian, pers. comm., 2011). Periphyton studies are ongoing under KHSA Interim Measure 15 to better document periphyton biomass in this reach of the Klamath River.

3.4.3.6 Klamath Estuary

The algal community in the Klamath Estuary is dominated by phytoplankton, but has more periphyton in the upstream areas where the estuary has more riverine characteristics. The presence of brackish water influences the types of algae present in different areas of the estuary. Like the Lower Klamath River, the Klamath Estuary has an algal community composed primarily of diatoms and blue-green algae (Fetcho 2007, 2008, 2009). Phytoplankton densities are generally lower in this area than those measured concurrently in the Lower Klamath River. On one occasion, in September 2007, estuary concentrations of *M. aeruginosa* twice exceeded the Yurok Tribe posting

action level (40,000 cells/mL). On a separate occasion, in September 2005, concentrations exceeded the WHO guidelines for low risk recreational use (20,000 cells/mL) (Fetcho 2006, 2008). These instances of elevated levels of *M. aeruginosa* corresponded with elevated levels measured at upstream locations in the Lower Klamath River.

Although periphyton data for the estuary are unavailable, in part due to the difficulty of sampling in deeper areas, abundant periphyton cover has been documented in the south slough (Hiner 2006).

3.4.3.7 Marine Nearshore Environment

The algal community of the near shore Pacific Ocean is dominated by marine algae, including attached red and brown seaweeds, as well as many marine planktonic species. The freshwater algae discussed above are not expected to thrive in this turbulent, saline environment, but may be carried into the ocean with the current and survive for limited periods. Toxins can also be washed into the ocean, but are expected to be rapidly diluted. There have been no reports of problems relating to freshwater algal toxins in the Pacific Ocean near the mouth of the Klamath River; however, algal toxins have been reported as the cause for numerous sea otter deaths in the area of Monterey Bay, California (Miller et al. 2010).

3.4.4 Environmental Consequences

3.4.4.1 Environmental Effects Determination Methods

Existing information regarding blue-green algal blooms in the Klamath Basin suggests that several critical factors affect the frequency and toxicity of such blooms in Upper Klamath Lake and the Klamath Hydroelectric Project reservoirs: water temperature, light levels (FERC 2007), flow rates (Kann 2006), nutrient availability/ratios (Chorus and Bartram 1999, Fetcho 2008, Moisander et al. 2009) and wind-induced turbulence and mixing. In this nutrient-rich system, elevated temperatures and increased light levels that occur during the summer and early fall result in seasonal blue-green algal blooms in Upper Klamath Lake and the Klamath River, and especially the reservoir reaches. In addition to Upper Klamath Lake and Copco 1 and Iron Gate Reservoirs, riverine reaches in close proximity to the reservoirs generally experience high abundance of *M. aeruginosa* (Kann 2006, Kann and Corum 2009), and with the highest cell densities and microcystin toxin concentrations occurring within and directly below the reservoirs (Kann and Corum 2009). This information indicates that the reservoirs provide ideal conditions (see Section 3.4.3.1) for proliferation of blue-green algal species, and likely also serve as a source of algal cells and their toxins to downstream areas. While blue-green algae can occur in riverine and estuarine environments (Christian et al. 1986, Lehman et al. 2005, Lehman et al. 2008), the rate of turbulent mixing in the water column relative to algal flotation velocity is a critical factor controlling the size of blue-green algal blooms (Huisman et al. 2004).

The assessment of the effects of the Proposed Action and alternatives on toxic algal blooms in the area of analysis is based on the expected effects of the alternatives on water temperature, hydrodynamic conditions (water movement potential nutrient availability. Existing model output and empirical data describing the expected effects of dam removal on water quality (see Section 3.2.4.1) provide the basis for the anticipated effects on water temperature, suspended sediment concentrations, and nutrients. In combination with existing literature regarding the biology and ecology of blue-green algal species, the water temperature and nutrient information is used to determine whether the Proposed Action and the alternatives would alter the spatial extent of optimal habitat for blue-green algae or periphyton in the area of analysis.

The following specific metrics are evaluated:

- The extent to which monthly mean and maximum water temperatures would be within the range of 18 to 25 °C or exceed 28 °C;
- Total suspended sediment and nutrient concentrations; and,
- The presence or absence of lacustrine (i.e., lake-like) conditions.

The water temperature thresholds are selected based on information regarding required temperatures for growth and toxicity of blue-green algae provided in the Blue-Green Algae Work Group assessment (SWRCB et al. 2010) and Van Der Westhuizen and Eloff (1985). Suspended sediment and nutrient concentrations data are based on output from the SRH-1D model and the California Klamath River TMDLs model, respectively (see Section 3.2.4.1 and Appendix D for descriptions of these numeric models). Mass balance nutrient budgets presented in Asarian et al. (2010) are also used to evaluate the potential effects of the Proposed Project on periphyton growth. Benthic chlorophyll-*a* data for evaluation of potential changes in periphyton biomass are obtained from the Nutrient Numeric Endpoint Analysis conducted for development of the California Klamath River TMDLs (see NCRWQCB 2010, Appendix 2). Anticipated changes in water quality (i.e., water temperature, suspended sediment concentrations, and nutrients) during the growth season (i.e., summer and early fall) in the reservoirs at the Four Facilities and at various in-river locations throughout the project area are also used to evaluate Project-induced changes on other algal groups such as diatoms and periphyton.

3.4.4.2 Significance Criteria

For purposes of the EIS/EIR, impacts would be significant if they were to result in the following:

- An increase in the spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton blooms, including blue-green algae.
- An increase in the spatial extent, temporal duration, or biomass of nuisance periphyton (i.e., *Cladophora*) growth.

3.4.4.3 Effects Determinations

3.4.4.3.1 Alternative 1: No Action/No Project Alternative

Phytoplankton

Continued impoundment of water in the reservoirs at the Four Facilities could support the long-term growth of seasonal nuisance and/or noxious phytoplankton blooms in the reservoirs and subsequent transport to downstream reaches of the Klamath River. Under the No Action/No Project Alternative, none of the actions under consideration would be implemented. The Klamath Hydroelectric Project would continue current operations under the terms of an annual license until a long-term license is finalized. Annual licenses would not include the actions associated with the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA). Some KBRA actions have already been initiated and would continue under the No Action/No Project Alternative. These include the Williamson River Delta Project, the Agency Lake and Barnes Ranch Project, fish habitat restoration work, and ongoing climate change assessments. Implementation of several Oregon and California TMDLs (Section 3.2.2.4) within the period of analysis is a reasonably foreseeable action associated with water quality under the No Action/No Project Alternative as the TMDLs are an unrelated regulatory action. Because changes to hydroelectric operations resulting from the relicensing process cannot be definitively predicted, it is assumed for the purposes of this analysis that operation of the reservoirs would continue as in recent years, providing peaking power generation during the summer as demand requires and conditions allow. However, increased water temperatures and nutrient loading associated with climate change could increase the spatial extent, temporal duration, toxicity, or concentration of blue-green algal blooms.

Continued impoundment of water at the Four Facilities could support long-term growth of nuisance and/or noxious phytoplankton such as *M. aeruginosa* in the Hydroelectric Reach. Under existing conditions, nuisance phytoplankton blooms occur during summer and fall in Copco 1 and Iron Gate Reservoirs, with the most intense blooms generally occurring in the late summer (Section 3.4.3.4). High seasonal levels of algal toxins (microcystin) in the Project reservoirs are caused by these intense blue-green algae blooms (Sections 3.2.3.7 and 3.4.3.4.1).

TMDLs for the Upper Klamath Lake drainage, the Upper Klamath River and Lost River in Oregon, the Lower Lost River in California, and the Klamath River in California include allocations and/or targets for nutrients and/or chlorophyll-*a* (Section 3.2.2.4); full and successful implementation of these TMDLs would result in a decreased spatial extent, duration, and concentration of phytoplankton blooms in the Upper and Lower Klamath Basin (see also analysis for chlorophyll-*a* under the No Action/No Project Alternative, Section 3.2.4.3.1.6). As discussed in Section 3.2, Water Quality, the timeframes for achieving water quality objectives with respect to the TMDLs will depend on the measures taken to improve water quality conditions. It is anticipated that full implementation would require decades to achieve.

Climate change is projected to result in increased water temperatures due to median annual increases in air temperatures of 3°C and decreases in snowpack (Snyder et al. 2004). The projected decreases in snowpack are associated with increased air temperatures and higher levels of rainfall relative to snowfall. Water temperature increases are generally expected to be more dramatic in the Lower Klamath Basin than in the Upper Basin over the next 50 years due to the cooling influence of ground water in the Upper Basin during the summer months (Hamilton et al. 2010). Between J.C. Boyle Reservoir and Iron Gate Dam, the benefits of substantial groundwater resources would not be realized because they are inundated by reservoirs or occur in bypass reaches (Hamilton et al. 2010). Higher intensity rainfall events are also expected to occur. Runoff from such events could increase the frequency with which the river exhibited high suspended sediment concentrations, which could increase the delivery of nutrients, such as phosphorous, to the reservoir system (Stillwater Sciences 2009). Increased summer temperatures and nutrient inputs would likely result in an increase in the magnitude, duration, and spatial extent of summer blooms of toxic blue-green algae.

Additionally, research conducted in the San Francisco Bay-Delta system indicates that increased temperatures could result in elevated toxicity of *M. aeruginosa* (i.e., increased microcystin concentrations produced by a bloom) (Mioni and Payton 2010). Under the No Action/No Project Alternative, an increase in the toxicity of seasonal phytoplankton blooms due to climate change, if it occurred, would be a significant impact. The anticipated effects of climate change would also occur over a timescale of decades and may offset improvements expected from successful TMDL implementation throughout the Upper and Lower Klamath Basin, particularly in the case of potential elevated toxicity of *M. aeruginosa*. However, overall, the benefits of nutrient reductions under the TMDLs are anticipated to be of greater relative importance than climate change with respect to phytoplankton blooms under the No Action/No Project Alternative. **Existing seasonal nuisance and/or noxious phytoplankton blooms in the Upper and Lower Klamath Basin are adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease these blooms. Continued impoundment of water at the Four Facilities would result in no change from existing conditions.**

Periphyton

Continued impoundment of water at the Four Facilities could support the growth of nuisance periphyton such as Cladophora downstream from Iron Gate Dam. Under existing conditions, periphyton coverage is relatively high immediately downstream from Iron Gate Dam, with coverage decreasing further downstream near the I-5 Bridge (RM 178), and increasing again to peak levels near the mouth of the Salmon River (RM 67) (Section 3.4.3.5). Because *Cladophora* provide suitable habitat for the polychaete worm that is the intermediate host for fish parasites, the presence of large seasonal periphyton mats immediately downstream from the Hydroelectric Reach have been linked to the potential for increased exposure to and incidence of fish disease.

As described above for phytoplankton (i.e., blue-green algae), full and successful implementation of Oregon and California TMDLs would decrease nutrients in the

Klamath River and would result in decreased spatial extent, temporal duration, and/or biomass of periphyton mats. As discussed in Section 3.2, Water Quality, the timeframes for achieving water quality objectives with respect to the TMDLs will depend on the measures taken to improve water quality conditions. It is anticipated that full implementation would require decades to achieve.

Conversely, increases in water temperature with climate change are likely to result in increased growth of periphyton in the Klamath River. Increased temperature through climate change may exacerbate biostimulatory conditions through increased periphyton metabolic and growth rates. As with phytoplankton, the benefits of nutrient reductions under the TMDLs are anticipated to be of greater relative importance than climate change with respect to periphyton spatial extent, bloom duration, and biomass under the No Action/No Project Alternative. **Existing seasonal nuisance periphyton growth in the Upper and Lower Klamath Basin is potentially adverse. Full attainment of the Oregon and California TMDLs (implementation mechanism and timing unknown) would significantly decrease periphyton growth. Continued impoundment of water at the Four Facilities would result in no change from existing conditions.**

The implications of potential changes in periphyton biomass and community composition for dissolved oxygen and the spread of fish disease are described in Water Quality Section 3.2.4.3 and Aquatics Section 3.3.3.3, respectively.

3.4.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Under the Proposed Action, the four major dams in the Klamath Hydroelectric Project (J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams) would be removed along with the ancillary facilities of each installation. This includes the entire dam, the powerhouses, spillways, and other infrastructure associated with the power generating facilities, as well as the transfer of the Keno Dam facilities to the United States Department of the Interior (DOI) and the implementation of the KBRA.

Upper Klamath Basin Upstream of the influence of J.C. Boyle Reservoir

Phytoplankton

The Proposed Action could decrease the long-term spatial extent, temporal duration, toxicity, or concentration of nuisance and/or noxious phytoplankton in the area of analysis. Dam removal activities would not affect the Klamath River upstream of J.C. Boyle Reservoir. Effects of KBRA in this reach are discussed in Section 3.4.4.3.2.9 Alternative 2: Full Removal of Four Dams – KBRA – Programmatic Measures. **There would be no change from existing conditions for nuisance and/or noxious phytoplankton.**

Periphyton

The Proposed Action could decrease the long-term spatial extent, temporal duration, or biomass of nuisance periphyton in the area of analysis. Dam removal activities would not affect the Klamath River upstream of J.C. Boyle Reservoir. Effects of KBRA in this reach are discussed in Section 3.4.4.3.2.9 KBRA – Programmatic Measures. **There would be no change from existing conditions for nuisance periphyton.**

Hydroelectric Reach

Phytoplankton

Sediment release associated with the Proposed Action could cause short-term increases in sediment-associated nutrients downstream from J.C. Boyle Dam that could stimulate nuisance and/or noxious phytoplankton growth in the Hydroelectric Reach. Under the Proposed Action, the short-term increase in nutrients in the Hydroelectric Reach would be a less-than-significant impact due to the timing of reservoir drawdown (i.e., in the wintertime when rates of primary productivity and microbially mediated nutrient cycling are relatively low) and light limitation from high concentrations of suspended sediments in the water (see corresponding discussion in Section 3.2.4.3.2.3). The minimum bioavailability of nutrients in sediments mobilized during dam removal would be unlikely to affect phytoplankton in the short term. Further, by mid-to late- spring when phytoplankton would begin to bloom again, reservoir drawdown would be nearly complete and little to no quiescent habitat would remain in the Hydroelectric Reach. Thus, phytoplankton blooms, and in particular nuisance and/or noxious phytoplankton blooms, would be very limited if not absent from the Hydroelectric Reach. **There would be no effect of short-term (<2 years following dam removal) increased nutrients due to sediment releases in the Hydroelectric Reach.**

Under the Proposed Action, removal of the reservoirs at the Four Facilities would eliminate lacustrine habitat behind the dams and could decrease the long-term spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms. This change, particularly within the larger Copco 1 and Iron Gate Reservoirs, would decrease or eliminate the system's support for excessive growth of blue-green algae over the long term by eliminating large areas of quiescent habitat where these algal species currently thrive. This dramatic decrease in the amount of optimal habitat available for nuisance and/or noxious phytoplankton species would occur even if relatively high nutrient concentrations were to remain in the Klamath River system. This would substantially reduce seasonal phytoplankton bloom occurrence and the associated production of algal toxins in these reservoirs that are potentially harmful to animals and humans. This would be a major benefit of the Proposed Action. The Proposed Action would provide a substantial long-term benefit with regard to phytoplankton in the Hydroelectric Reach. **Under the Proposed Action, long-term reductions in the growth of nuisance and/or noxious phytoplankton due to the elimination of the reservoirs in the Hydroelectric Reach would be beneficial.**

Periphyton

Sediment release associated with the Proposed Action could cause short-term increases in sediment-associated nutrients downstream from J.C. Boyle Dam that could stimulate nuisance periphyton growth in the Hydroelectric Reach. While quiescent habitat for phytoplankton would be eliminated in the short term by reservoir drawdown and dam removal (see above), periphyton growth in the riverine reaches of the Hydroelectric Reach could occur during the initial summer and fall months following drawdown. However, although increased short-term (<2 years following dam removal) nutrient availability may occur under the Proposed Action, it is unlikely to result in substantial

increases in periphyton growth because the effects of increased nutrients in the Hydroelectric Reach would be minimized by the timing of reservoir drawdown (i.e., in the wintertime when rates of primary productivity and microbially mediated nutrient cycling are relatively low) and light limitation from high concentrations of suspended sediments in the water (see also Section 3.2.4.3.2.3.). Additionally, higher flows during drawdown and late spring storm events would result in greater bed turnover (see Section 3.3.4.3, Bedload Sediment) and scouring, which would greatly limit, if not eliminate, short-term establishment of periphyton in the Hydroelectric Reach. **Thus, there would be no effect of short-term increased nutrients on periphyton blooms in the Hydroelectric Reach.**

Under the Proposed Action, conversion of the reservoir areas to a free-flowing river and the elimination of hydropower peaking operations could cause long-term slight increases in nutrients and increases in low-gradient channel margin habitat available for nuisance periphyton in the Hydroelectric Reach downstream from J.C. Boyle Dam. Periphyton growth in low-gradient channel margin areas in the Hydroelectric Reach could increase on a seasonal basis following dam removal. While nutrient increases in this reach would be less than significant following full attainment of the Oregon and California TMDLs (Section 3.2.4.3.2.3), removal of the reservoirs and elimination of hydropower peaking operations in the J.C. Boyle Peaking Reach would immediately provide additional low-gradient habitat suitable for periphyton. The particular periphyton species that may become abundant in these areas are unknown (E. Asarian, pers. comm., 2011). Thus, the difference between the long-term significance calls for nutrients and periphyton in the Hydroelectric Reach is due to the increase in habitat availability for periphyton, rather than the relatively small increase in already elevated nutrient concentrations, which, as noted in Section 3.2.4.3.2.3, would be less than significant. The increase in nutrient inputs from the Upper Klamath Basin are expected to decrease over time with implementation of the Oregon and California TMDLs and KBRA projects, minimizing future potential for heavy colonization of periphyton mats. Potential increases in periphyton growth in the Hydroelectric Reach could also be disrupted by more frequent river bed turnover (see Section 3.3.3.6.2.1.2) and increased flow variability during storm flow under the Proposed Action, which may result in increased scouring of periphyton during late spring storm events and a lower overall biomass later in the growth season. However, the overall effect of the Proposed Action would likely be to increase periphyton in the re-exposed margins of low gradient river channels in the Hydroelectric Reach until full attainment of the Oregon and California TMDLs can be achieved. **Under the Proposed Action, long-term increases in nuisance periphyton growth due to increases in available habitat along channel margin areas of the Hydroelectric Reach downstream from J.C. Boyle Dam would be a significant impact.**

The above "significant impact" determination represents a conservative assessment of the effects of the Proposed Action on periphyton growth. The response of periphyton in the river is subject to many competing processes that could either accelerate or hinder improvements. Improvements (i.e., reductions in biomass) are expected from several processes such as scour, long term nutrient reductions stemming from TMDL or KBRA-

related actions (see WQST [2011] and below subsection on KBRA under Alternative 2 – Proposed Action), and in-stream retention processes, whereas improvements could be hindered by processes such as reduced nutrient retention from the reservoirs or climate change. Additional research prior to the facilities removal would help resolve these uncertainties. Monitoring could also be conducted after dam removal which would help identify the actual changes in the periphyton community resulting from dam removal. The implications of potential changes in periphyton biomass and community composition for dissolved oxygen and the spread of fish disease are described in Sections 3.2.4.3.2.4 and 3.3.3.3, respectively.

Under the Proposed Action, construction/deconstruction activities would include the demolition of various recreation facilities. The existing recreational facilities located along the banks of the reservoirs will be removed once the reservoirs are drawn down. Facilities such as campgrounds and boat ramps, currently located on the reservoir banks will need to be relocated down slope to be near the new river channel once the reservoir is removed. Impacts specific to the deconstruction of the Recreation Facilities are discussed in Section 3.20, Recreation. Once the reservoirs are drawn down, the existing recreational facilities would be well above the new river channel. The removal of the facilities is not expected to impact algae biomass or lifecycles. The potential for impacts during the facilities removal will minimized or eliminated through the implementation of BMPs for construction activities (Appendix B). Implementation of BMPs would ensure that impacts are constrained to the individual sites and their immediate area, and not transferred downstream in the Klamath River. **There would be no effect on algae (phytoplankton or periphyton) levels in the Hydroelectric Reach or the Klamath River downstream from Iron Gate Dam as a result of the removal of the recreational facilities.**

Implementation of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could result in increased bedload mobility and increased scour of nuisance periphyton in the Hydroelectric Reach. The Proposed Action includes seven years of gravel placement; the first year would be before the Secretary makes a determination, and would therefore be included in the No Action/No Project Alternative (Note: since there is no nuisance periphyton growth in the Hydroelectric Reach under current conditions [see Algae Section 3.4.3.4.2], IM 7 would not affect periphyton under the No Action/No Project Alternative). The following seven years would be part of the Proposed Action prior to dam removal. Under this IM, suitable spawning gravel would be placed in the J.C. Boyle Bypass and Peaking reaches using a passive approach before high flow periods, or to provide for other habitat enhancement in the Klamath River upstream of Copco 1 Reservoir. These actions would provide improvements in habitat quality for resident fish prior to dam removal, and for resident and anadromous species following dam removal (see also Aquatics Section 3.3.3.6.2.3). Increased mobility of streambed material due to pre-dam removal gravel augmentation may also result in increased scouring of periphyton and a lower overall biomass in this reach following dam removal, although the effects may be small. Work on IM 7 began in fall 2010 with the contracting,

planning, and permitting phase. **Under the Proposed Action, the effect of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, on nuisance periphyton growth in the Hydroelectric Reach would be beneficial.**

Klamath River Downstream from Iron Gate Dam

Phytoplankton

Under the Proposed Action, removal of the reservoirs would eliminate lacustrine habitat behind the dams and could substantially reduce or eliminate the long-term transport of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins into the Klamath River downstream from Iron Gate Dam. Existing data indicate that large seasonal blue-green algae blooms (i.e., *M. aeruginosa*) and associated algal toxins (i.e., microcystin) in Copco 1 and Iron Gate Reservoirs and the Klamath River downstream from Iron Gate Dam are not the result of algal transport from Upper Klamath Lake; rather, these blooms occur in the two largest Project reservoirs and are transported to Klamath River sites downstream from Iron Gate Dam (see Figure 3.4-1). The following physical mechanisms are responsible for the removal of large seasonal blue-green algal blooms that originate in Upper Klamath Lake and are transported into the upper reaches of the Klamath River:

1. Large-scale settling in the Keno Impoundment/Lake Ewauna (see Section 3.2.3.3 and Appendix C, Section C.2.1.3);
2. Turbulent mixing and associated algal cell breakdown in the river from Keno Dam to J.C. Boyle Reservoir (see Section 3.2.3.3 and Appendix C, C.2.1.3); and,
3. Dilution from springs in the J.C. Boyle Bypass Reach (see Section 3.2.3.3 and Appendix C, C.2.1.4).

Further, under current conditions, microcystin toxin rarely persists through steps 1 to 3, occurring at low (very infrequently) to non-detectable (primarily) concentrations at the Klamath River station just upstream of Copco 1 Reservoir ("KRAC") (see also Figure 3.4-1). The aforementioned removal mechanisms for algal cells (and microcystin) would still occur under the Proposed Action, and additional removal could occur in the Hydroelectric Reach due to turbulence and relatively high velocities in the free-flowing river reaches that were previously occupied by Copco 1 and Iron Gate Reservoirs. The primary lacustrine habitat for supporting seasonal nuisance and/or noxious phytoplankton blooms in the Hydroelectric Reach would be eliminated and there is little reason to suspect that large blooms of *M. aeruginosa* from Upper Klamath Lake would be successfully transported into the Klamath River downstream from Iron Gate Dam. Therefore, the overall occurrence of nuisance and/or noxious phytoplankton and associated toxins in the Klamath River downstream from Iron Gate Dam would be substantially reduced or eliminated.

Increases in nutrient availability associated with delivery and deposition of sediments from the upper watershed could occur over the long term as a result of dam removal (Reclamation 2012; Section 3.3.4.3). However, possible summer through fall increases in nutrient concentrations, particularly directly downstream from Iron Gate Dam, following dam removal (see Section 3.2.4.3.2.3 Nutrients – Lower Klamath Basin) would

not substantially contribute to blue-green algal blooms downstream from the dam due to the lack of the suitable hydrodynamic conditions required for extensive planktonic algal growth in the Klamath River. While some phytoplankton growth could occur along shorelines and protected coves and backwaters in the lower Klamath River Lower Klamath River during low-flow periods, *M. aeruginosa* cell density and microcystin concentrations are not expected to exceed current levels, which are typically 1 to 3 orders of magnitude lower relative to those measured in Copco 1 and Iron Gate Reservoirs (Appendix C, Figure C-32; see also Kann et al. 2010).

This analysis suggests that the Proposed Action would have a positive effect on aquatic resources in the Klamath River downstream from Iron Gate Dam in the long term based on reductions in downstream transport and concentrations of phytoplankton and microcystin toxins to this area. **Under the Proposed Action, long-term reductions in the growth of nuisance and/or noxious phytoplankton in the reservoirs in the Hydroelectric Reach would reduce or eliminate the transport of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins (i.e., microcystin) into the Klamath River downstream from Iron Gate Dam and would be beneficial.**

Periphyton

Under the Proposed Action, dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels and biomass of nuisance periphyton in the Klamath River downstream from Iron Gate Dam. Periphyton growth could continue to be relatively high downstream from Iron Gate Dam on a seasonal basis following dam removal because of continuing nutrient inputs from the Upper Klamath Basin, as described for the J.C. Boyle to Iron Gate Dam reach. However, despite the overall increases in absolute nutrient concentrations anticipated under the Proposed Action (see Section 3.2.4.3.2.3 Nutrients – Lower Klamath Basin), the relatively greater in Total Nitrogen (TN) may not result in significant biostimulatory effects on periphyton growth because it will be accompanied by only a relatively minor increase in Total Phosphorus (TP). Existing data regarding TN:TP ratios in the Klamath River suggest the potential for N-limitation (TN:TP <10), with some periods of co-limitation by N and P (see also Section 3.2.3.4 and Appendix C, Section C.3.2.1). However, concentrations of both nutrients are high enough in the river from Iron Gate Dam (RM 190.1) to approximately Seiad Valley (RM 129.4) (and potentially further downstream) that algal growth is nutrient saturated, and nutrients are not likely to be limiting primary productivity (i.e., periphyton growth) in this portion of the Klamath River (FERC 2007, Hoopa Valley Tribe Environmental Protection Agency 2008, Asarian et al. 2010). In addition, N-fixing species currently dominate the periphyton communities in the lower reaches of the Klamath River where inorganic nitrogen concentrations are low (Asarian et al. 2010). Since these species can fix their own nitrogen from the atmosphere, increases in TN due to dam removal may alter the composition of the periphyton community but it may not significantly increase algal biomass in these reaches because it will be accompanied by only relatively minor increases in TP. In addition, overall TN and TP increases could be less than those predicted by existing models due to implementation of TMDLs and general nutrient reductions in the Klamath Basin.

This potential outcome is supported by results from the Nutrient Numeric Endpoint Benthic Biomass Predictor for the "natural conditions" (i.e., point sources eliminated, large reductions in nutrient input from Upper Klamath Lake and Straits Drain, and dams out) scenario. The model predicts that periphyton growth in the Klamath River downstream from Iron Gate Dam can achieve the proposed 150 mg chlorophyll-*a*/m^2 maximum benthic target when nutrient concentrations approach TMDL compliance targets (NCRWQCB 2010, Appendix 2).

In addition to the effects of changes in nutrient concentrations, periphyton community composition and biomass may be affected by light levels and substrate stability. Potential increases in periphyton growth could be counteracted by more frequent river bed turnover (see Section 3.3.3.6.2.1.2 Bedload Sediment and 3.3.3.6.2.1.5 Fish Disease and Parasites) and increased flow variability during storm flow, which could result in increased scouring of periphyton during late spring storm events, following dam removal (FERC 2007, NCRWQCB 2010, Appendix 2). The magnitude of the effect of bed turnover and scouring on periphyton would decrease with distance downstream, with increased scour occurring from Iron Gate Dam to approximately the Shasta River (RM 177). As described for the Hydroelectric Reach, TMDL model results suggest that increased scouring may somewhat limit long-term periphyton biomass following dam removal (NCRWQCB 2010, Appendix 2). Overall, these processes would reduce periphyton growth downstream from Iron Gate Dam.

Because of these many competing factors, some that may favor enhanced periphyton growth downstream from Iron Gate Dam (i.e., increased nutrients transport and recycling), and some that counteract this response (increased uptake and retention of nutrients by periphyton in the Hydroelectric Reach, increased frequency and intensity of scouring events, decreasing nutrient concentrations due to TMDL implementation and KBRA nutrient reduction programs [see KBRA discussion below]), it is likely that increases in periphyton growth below Iron Gate Dam would be less than significant. **Under the Proposed Action, long-term increases in nuisance periphyton in the Klamath River downstream from Iron Gate Dam would be a less than significant impact.**

Klamath Estuary

Phytoplankton

Under the Proposed Action, removal of the reservoirs would eliminate lacustrine habitat behind the dams and could substantially reduce or eliminate the long-term transport of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins into the Klamath Estuary. Information regarding current conditions of algal biomass, population dynamics, and the likelihood of nutrient limitation on algal growth in the Klamath Estuary is limited (Fetcho 2006, 2007, 2008). Consequently, it is difficult to determine the potential long-term effects that the Proposed Action would have on algae in the estuary. Existing information indicates that instances of elevated levels of *M. aeruginosa* in the Klamath Estuary correspond with elevated levels measured at upstream locations in the Lower Klamath River (Section 3.4.3.6). Since removal of the

Four Facilities would reduce or eliminate elevated *M. aeruginosa* levels in the Lower Klamath River (see prior section), levels in the Klamath Estuary are also likely to be reduced or eliminated.

As discussed for the Klamath River downstream from Iron Gate Dam, increases in nutrient transport from the upper watershed could occur over the long term as a result of dam removal (Reclamation 2012; Section 3.3.4.3). However, possible summer through fall increases in nutrient concentrations, particularly directly downstream from Iron Gate Dam, following dam removal (see Section 3.2.4.3.2.3 Nutrients – Lower Klamath Basin) would not contribute significantly to blue-green algal blooms downstream from the dam due to the lack of the suitable hydrodynamic conditions required for extensive planktonic algal growth following implementation of the Proposed Action. Thus, while some phytoplankton growth could occur in the Klamath Estuary during summer and fall low-flow periods, *M. aeruginosa* cell density and microcystin concentrations would not be expected to exceed current levels, which are typically 1 to 3 orders of magnitude lower relative to those measured in Copco 1 and Iron Gate Reservoirs (Appendix C, Figure C-32; see also Kann et al. 2010). **Under the Proposed Action, long-term reductions in the growth of nuisance and/or noxious phytoplankton in the Hydroelectric Reach would reduce or eliminate the transport of algal cells and their associated toxins into the Klamath Estuary and would be beneficial.**

Periphyton

Under the Proposed Action, dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels and periphyton biomass in the Klamath Estuary. As discussed for the Lower Klamath River downstream from Iron Gate Dam, periphyton growth under the Proposed Action could be affected by increased nutrient availability following dam removal. However, the long-term increase in nutrients in the Klamath Estuary would be relatively small due to the effects of tributary dilution and nutrient retention in the 190 miles between Iron Gate Dam and the Estuary (Asarian et al. 2010). In addition, N-fixing species dominate the periphyton communities in the lower reaches of the Klamath River where inorganic nitrogen concentrations are low and these species can fix their own nitrogen from the atmosphere (Asarian et al. 2010). Thus, increases in total nitrogen (TN) due to dam removal are not likely to significantly increase periphyton biomass in the Klamath Estuary (see also Section 3.2.4.3.2.3 Nutrients – Lower Klamath Basin). Moreover, the biological significance of potential increases in periphyton biomass in the Klamath estuary is unknown due to uncertainty regarding the magnitude of increase in biomass required to generate a significant reduction in habitat quality for aquatic resources (NCRWQCB 2010, Appendix 2). **Under the Proposed Action, long-term increases in the growth of nuisance periphyton in the Klamath Estuary would be a less than significant impact.**

Marine Nearshore Environment

The marine nearshore environment is not a suitable habitat for the freshwater phytoplankton species of concern (i.e., *Aphanizomenon flos-aquae*, *Anabaena flos-aquae*, *M. aeruginosa*) or the freshwater periphyton species of concern (i.e., *Cladophora*) therefore effects on these species under the Proposed Action are not considered further.

Keno Transfer

Implementation of the Keno Transfer could cause adverse effects to algae. The Keno Transfer would be a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in new impacts on algae compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measure

Decommissioning the East and Westside Facilities could cause adverse effects to algae. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate water diversions at Link River Dam into the two canals, back in to Link River. Following decommissioning of the facilities there would be no change in algae conditions in the Klamath River. **Therefore, implementation of the East and Westside Facility Decommissioning action would result in no change from existing conditions.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

Under the Proposed Action, relocation of the City of Yreka Water Supply Pipeline required as part of the removal of Iron Gate Dam would not affect algae. The water supply pipeline for City of Yreka would have to be relocated from its present location under Iron Gate Reservoir. Once the reservoir is drawn down, the existing pipeline would be exposed to higher velocity water flow, debris during flood events, and other potentially damaging situations that it is currently not exposed to at the bottom of the reservoir. To address this, the pipeline would be suspended from a pipe bridge across the Klamath River. Potential impacts to algae from the installation of the pipe bridge would be minimized or eliminated through the implementation of Best Management Practices (BMPs) for construction activities (Appendix B). Implementation of BMPs would ensure that impacts are constrained to the individual sites and their immediate area, and not transferred downstream in the Klamath River. **There would be no effect on algae (phytoplankton or periphyton) levels in the Hydroelectric Reach or the Klamath River downstream from Iron Gate Dam as a result of the City of Yreka Water Supply Pipeline relocation.**

KBRA – Programmatic Measures

The KBRA, which is a connected action of the Proposed Action, encompasses several programs that could affect nuisance and/or noxious phytoplankton and periphyton blooms in the Klamath Basin through improvements to water quality, including:

- Phases I and II Fisheries Restoration Plans
- Wood River Wetland Restoration
- Water Use Retirement Program
- Interim Flow and Lake Level Program
- Upper Klamath Lake and Keno Nutrient Reduction

Beneficial effects of these projects on nutrients in the Klamath Basin would also be beneficial for nuisance and/or noxious phytoplankton and periphyton blooms.

Implementation of restoration actions, programs, and/or plans presented in the KBRA would accelerate restoration actions currently underway throughout the Klamath Basin (with the exception of the Trinity Basin) including KHSA implementation (i.e., dam removal) and reduce nuisance and/or noxious phytoplankton blooms through their beneficial effects on flow and water quality. Specific projects are addressed below.

Phase I Fisheries Restoration Plan

Implementation of the Phase I Fisheries Restoration Plan could result in a long-term reduction in nutrients and associated decreases in nuisance and/or noxious phytoplankton and periphyton blooms. Several ongoing resource management actions related to nutrient reductions may be amplified under the Phase I Plan (Section 3.2.4.3.2.10). Ongoing actions and types of new programs that could be implemented are described at a programmatic level for water quality. Anticipated benefits with respect to phytoplankton and periphyton are the same as those described for any Phase I project that would decrease nutrient levels in the Klamath Basin (Section 3.2.4.3.2.10).

The improvements in nuisance and/or noxious phytoplankton and periphyton blooms generated by implementation of the Phase I Fisheries Restoration Plan would contribute to the long-term water quality improvements in the Klamath Basin, supplementing those anticipated from hydroelectric facility removal. **Resource management actions implemented under the KBRA Phase I Fisheries Restoration Plan would accelerate long-term decreases in nutrients and would reduce the prevalence of nuisance and/or noxious phytoplankton and periphyton blooms in the Klamath Basin and would be beneficial.**

Phase II Fisheries Restoration Plan

Implementation of the Phase II Fisheries Restoration Plan under the KBRA (KBRA Section 10.2) would include a continuation of the same types of resource management actions as under Phase I along with provisions for adaptive management of these actions and would therefore have the same impacts as Phase I. Anticipated benefits with respect to phytoplankton and periphyton are the same as those described for any Phase II project that would decrease nutrient levels in the Klamath Basin (Section 3.2.4.3.2.10). The improvements in nuisance and/or noxious phytoplankton and periphyton blooms generated by implementation of the Phase II Fisheries Restoration Plan would contribute to the long-term water quality improvements in the Klamath Basin, supplementing those anticipated from hydroelectric facility removal. **Resource management actions implemented under the KBRA Phase II Fisheries Restoration Plan would accelerate long-term decreases in nutrients and would reduce the prevalence of nuisance and/or noxious phytoplankton and periphyton blooms in the Klamath Basin and would be beneficial.**

Wood River Wetland Restoration

Implementation of Wood River Wetland Restoration could result in reduced nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms. This project may decrease overall nutrient inputs to Upper Klamath Lake by inundating wetland (peat) soils and creating anaerobic conditions that support nutrient retention, particularly in the case of phosphorus (Snyder and Morace 1997). Specific options still need to be developed and studied as part of a separate project-level National Environmental Policy Act (NEPA) evaluation and Federal Endangered Species Act (ESA) consultation. The improvements in nuisance and/or noxious phytoplankton blooms generated by implementation of the Wood River Wetland Restoration Project would contribute to the long-term water quality improvements in the Klamath Basin, supplementing those anticipated in the Klamath Basin from hydroelectric facility removal. **Under the KBRA, the Wood River Wetland Restoration Project would accelerate ongoing long-term improvements in nutrients and would reduce the prevalence of nuisance and/or noxious phytoplankton blooms in Agency Lake and would be beneficial.**

Water Use Retirement Program

Implementation of the Water Use Retirement Program could result in decreases in nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms. Anticipated benefits with respect to phytoplankton are the same as those described for this project under water quality, because it would decrease nutrient levels (i.e., decrease irrigation and fallowing of crop land and would decrease fertilizer [nutrient] inputs) in Upper Klamath Lake (see Section 3.2.4.3.2.10). The decreases in nutrient inputs to Upper Klamath Lake generated by implementation of the Water Use Retirement Program would contribute to the long-term water quality improvements in the Klamath Basin, supplementing those anticipated from hydroelectric facility removal. **The KBRA Water Use Retirement Program would decrease long-term nutrients and would reduce the prevalence of nuisance and/or noxious phytoplankton blooms in Upper Klamath Lake and would be beneficial.**

Interim Flow and Lake Level Program

Implementation of the Interim Flow and Lake Level Program could result in decreases in nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms. Anticipated benefits with respect to phytoplankton are the same as those described for this project under water quality, because the project would decrease nutrient levels in the Upper Klamath Lake (see Section 3.2.4.3.2.10). The decreases in nutrient inputs to Upper Klamath Lake generated by implementation of the Interim Flow and Lake Level Program would contribute to the long-term water quality improvements in the Klamath Basin, supplementing those anticipated from hydroelectric facility removal. **The KBRA Interim Flow and Lake Level Program would decrease long-term nutrients and would reduce the prevalence of nuisance and/or noxious phytoplankton blooms in Upper Klamath Lake and would be beneficial.**

Upper Klamath Lake and Keno Nutrient Reduction

Implementation of the Upper Klamath Lake and Keno Nutrient Reduction Program could result in decreases in nutrient inputs to Upper Klamath Lake and Keno Impoundment/Lake Ewauna and associated decreases in nuisance and/or noxious phytoplankton blooms. KBRA (Appendix C-2, line 11) includes a program to study and reduce nutrient concentrations in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake in order to reduce dissolved oxygen and nuisance algal problems in both water bodies. Restoration actions to control nutrients have not been developed, and there are many possible actions that could require construction of treatment wetlands, construction of facilities, or chemical treatments of bottom sediment, among other possibilities. A nutrient reduction program in the Keno Impoundment/Lake Ewauna and Upper Klamath Lake would be designed to improve water quality (increasing seasonally low dissolved oxygen and reducing seasonal algal blooms) and fish passage through the Keno Impoundment/Lake Ewauna in summer and fall months, however implementation of this nutrient reduction program will require future environmental compliance investigations and a determination on significance cannot be made at this time.

3.4.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

This alternative proposes to remove enough of the material from each dam to allow the river to retain a free-flowing condition and volitional fish passage under all river stages and flow conditions. Some portion of each dam and much of the appurtenant infrastructure could remain, such as the dam foundations, power houses, buildings, tunnels, and pipes. All tunnel openings would be sealed with concrete, remaining buildings would be fenced, and all hazardous materials would be removed from the site. This alternative would include the transfer of the Keno Facility to the DOI and implementation of the KBRA. **The Partial Facilities Removal of Four Dams Alternative effects on algae would be the same as those described for the Proposed Action.**

3.4.4.3.4 Alternative 4: Fish Passage at Four Dams

This alternative would provide upstream and downstream fish passage at the Four Facilities, but would not include implementation of the KBRA. The ongoing restoration actions, described in the No Action/No Project Alternative, would continue. The alternative would incorporate the prescriptions from the Departments of the Interior and Commerce imposed during the FERC relicensing process, including fishway installation for both upstream and downstream migrations at all facilities and barriers to prevent juvenile salmonid entrainment into turbines. In addition to the fishways, there are a series of flow-related measures, including a condition that requires at least 40 percent of the inflow to the J.C. Boyle Reservoir to be released downstream. This alternative would limit generation of peaking power at J.C. Boyle Power Plant to one day per week as water supplies allow, and would include recreation flows one day a week. The flow requirements would reduce the overall power generation.

The Fish Passage at Four Dams Alternative effects on phytoplankton would be similar to those described for the No Action/No Project Alternative. Nuisance blooms of periphyton do not currently occur in the Hydroelectric Reach

(Section 3.4.3.4.2). Under Alternative 4, increases in J.C. Boyle Dam flow releases and associated increases in summer and early fall water temperatures in the Bypass Reach (Section 3.2.4.3.4), as well as decreases in peaking flows and less flow and water temperature variation in the Peaking Reach, could result in small amounts of periphyton colonization in the Klamath River downstream from J.C. Boyle Dam and upstream of Copco 1 Dam. Slight overall decreases in water temperature in the Peaking Reach are not expected to have an effect on periphyton. However, it is assumed that the periphyton biomass increases would be less-than-significant because the generally high gradient and velocity in this reach of the Klamath River do not currently support excessive periphyton mats. As described under the No Action/No Project Alternative, full and successful implementation of Oregon and California TMDLs would decrease nutrients in the Klamath River and would further minimize colonization of periphyton mats in free-flowing river portions of the Hydroelectric Reach (i.e., downstream from J.C. Boyle Dam and upstream of Copco 1 Reservoir). Since Copco 1 and Iron Gate Reservoirs would remain in place under this alternative, there would be no effect on periphyton in the stretches of river covered by reservoirs. **Overall, small potential increases in periphyton establishment in the Klamath River downstream from J.C. Boyle Reservoir under the Fish Passage at Four Dams Alternative would be less than significant.**

3.4.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Phytoplankton

Removal of Copco 1 and Iron Gate Dams would eliminate lacustrine habitat in the two largest reservoirs in the Hydroelectric Reach and could decrease or eliminate the long-term spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms in the Hydroelectric Reach and subsequent transport to the Klamath River from downstream from Iron Gate Dam to the Klamath Estuary. Dam removal activities under Alternative 5 would not affect the Klamath River upstream of J.C. Boyle Reservoir. The removal of quiescent reservoir habitat in Copco 1 and Iron Gate Reservoirs would decrease or eliminate conditions in the Hydroelectric Reach that support excessive growth of blue-green algae. This change in optimal habitat would occur even if relatively high nutrient concentrations were to remain in the Klamath River system. The reduction in growth of nuisance and/or noxious phytoplankton in the Hydroelectric Reach would reduce the transport of algal cells and their associated toxins to the Klamath River downstream from Iron Gate Dam and the Klamath Estuary. This would substantially reduce the production of toxins from these reservoirs that are harmful to animals and humans. **Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, long-term reductions in the growth of nuisance and/or noxious phytoplankton due to the elimination of the two largest reservoirs in the Hydroelectric Reach would decrease or eliminate levels of nuisance and/or noxious phytoplankton and concentrations of algal toxins from the Hydroelectric Reach to the Klamath Estuary, and would be beneficial.**

Periphyton

Removal of Copco 1 and Iron Gate Dams and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels and periphyton biomass in the Hydroelectric Reach, the Klamath River downstream from Iron Gate Dam, and the Klamath Estuary. Dam removal activities under Alternative 5 would not affect the Klamath River upstream of J.C. Boyle Reservoir. With the exception of the short reach from J.C. Boyle Dam to the upstream end of Copco 1 Reservoir, the effects of removing the two largest dams in the Hydroelectric Reach, Copco 1 and Iron Gate Dams, on nutrients and available habitat for periphytic algal growth under this alternative would be similar to removing all four dams under the Proposed Action (Section 3.2.4.3.5.3). Long-term increases in periphyton growth in the Klamath River downstream from Iron Gate Dam and in the Klamath Estuary could also occur and would be the same as those described under the Proposed Action. **Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, long-term increases in the growth of nuisance periphyton in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir would be a significant impact[3]. Long-term increases in the growth of nuisance periphyton in the Klamath River downstream from Iron Gate Dam, and the Klamath Estuary would be a less than significant impact.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

Removal of Iron Gate Dam would require relocation of the City of Yreka Water Supply Pipeline. Under Alternative 5, Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate, the water supply pipeline for City of Yreka would have to be relocated from its present location under Iron Gate Reservoir. Once the reservoir is drawn down, the existing pipeline would be exposed to higher velocity water flow, debris during flood events, and other potentially damaging situations that it is currently not exposed to at the bottom of the reservoir. To address this, the pipeline would be suspended from a pipe bridge across the Klamath River. **There would be no impact to algae in the Hydroelectric Reach or the Klamath River downstream from Iron Gate Dam as a result of the City of Yreka Water Supply Pipeline relocation.**

3.4.4.4 Mitigation Measures

3.4.4.4.1 Mitigation Measure by Consequences Summary

The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects (i.e., dam removal during the winter would minimize the potential for large blooms of nuisance and/or noxious phytoplankton to be transported downstream [see Section 3.4.4.3.2 Klamath River Downstream from Iron Gate Dam] and would correspond to normal high-flow conditions with scour, light

[3] This revision reflects an editorial clarification. As indicated by the analysis under the Proposed Action, the determination for Alternative 5 in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir should also have been a significant effect.

limitation, and high flow velocity that would inhibit periphyton growth). **No mitigation measures are proposed beyond those described for water quality protection in Section 3.2, Water Quality.**

3.4.4.5 Summary of Impacts on Algae

Table 3.4-1 summarizes the impacts of the Proposed Action and alternatives on algae.

Table 3.4-1 Summary of Algae Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation [1]	Significance After Mitigation Pursuant to CEQA
Upper Klamath Basin Upstream of the Influence of J.C. Boyle Reservoir				
Dam removal activities would not affect phytoplankton in the Klamath River upstream of J.C. Boyle Reservoir	2, 3, 5	NCFEC	None	NCFEC
Dam removal activities would not affect periphyton in the Klamath River upstream of J.C. Boyle Reservoir	2, 3, 5	NCFEC	None	NCFEC
Hydroelectric Reach				
Continued impoundment of water in the reservoirs could support the long-term growth of seasonal nuisance and/or noxious phytoplankton such as *M. aeruginosa* in the Hydroelectric Reach.	1, 4	NCFEC	None	NCFEC
Sediment release associated with dam removal could cause short-term increases in sediment-associated nutrients downstream from J.C. Boyle Dam that could stimulate nuisance and/or noxious phytoplankton growth in the Hydroelectric Reach.	2, 3	NCFEC	None	NCFEC
Removal of the reservoirs would eliminate lacustrine habitat behind the dams and could decrease or eliminate the long-term spatial extent, temporal duration, or concentration of nuisance and/or noxious phytoplankton blooms.	2, 3, 5	B	None	B
Sediment release associated with the Proposed Action could cause short-term increases in sediment-associated nutrients downstream from J.C. Boyle Dam that could stimulate nuisance periphyton growth in the Hydroelectric Reach.	2, 3	NCFEC	None	NCFEC
Dam removal and the elimination or reduction of hydropower peaking operations could result in long-term increases in nuisance periphyton growth due to increases in available habitat along low-gradient channel margin areas downstream from J.C. Boyle	2, 3, 5 [2]	S	None	S

Table 3.4-1 Summary of Algae Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation [(1)]	Significance After Mitigation Pursuant to CEQA
Dam.				
Increased water temperatures and decreased peaking flows could result in long-term small amounts of nuisance periphyton colonization in the Klamath River downstream from J.C. Boyle Reservoir and upstream of Copco 1 Reservoir.	4	LTS	None	LTS
Implementation of IM 7, J.C. Boyle Gravel Placement and/or Habitat Enhancement, could result in increased bedload mobility and the potential for increased scour of nuisance periphyton in the Hydroelectric Reach.	2 ,3	B	None	B
Klamath River Downstream from Iron Gate Dam				
Continued impoundment of water in the reservoirs could support long-term growth of nuisance and/or noxious phytoplankton such as *M. aeruginosa* in the Hydroelectric Reach and subsequent transport into the Klamath River downstream from Iron Gate Dam.	1, 4	NCFEC	None	NCFEC
Continued impoundment of water at the Four Facilities could support long-term growth of nuisance periphyton such as *Cladophora spp.* downstream from Iron Gate Dam.	1, 4	NCFEC	None	NCFEC
Removal of the reservoirs would eliminate lacustrine habitat behind the dams and could substantially reduce or eliminate the long-term transport of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins into the Klamath River downstream from Iron Gate Dam.	2, 3, 5	B	None	B
Dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels and biomass of nuisance periphyton in the Klamath River downstream from Iron Gate Dam.	2, 3, 5	LTS	None	LTT

Table 3.4-1 Summary of Algae Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation [1]	Significance After Mitigation Pursuant to CEQA
Klamath Estuary				
Continued impoundment of water in the reservoirs could support long-term growth of nuisance and/or noxious phytoplankton such as *M. aeruginosa* in the Hydroelectric Reach and subsequent transport into the Klamath Estuary.	1, 4	NCFEC	None	NCFEC
Removal of the reservoirs would eliminate lacustrine habitat behind the dams and could substantially reduce or eliminate the long-term transport of nuisance and/or noxious phytoplankton blooms and concentrations of algal toxins into the Klamath Estuary.	2, 3, 5	B	None	B
Dam removal and conversion of the reservoir areas to a free-flowing river could cause long-term increases in nutrient levels and periphyton biomass in the Klamath Estuary.	2, 3, 5	LTS	None	LTS
Keno Transfer				
Implementation of the Keno Transfer could cause adverse algae effects.	2, 3	NCFEC	None	NCFEC
***East and Westside Facilities* - Programmatic Measure**				
Decommissioning the East and Westside Facilities could cause adverse effects to algae.	2, 3	NCFEC	None	NCFEC
***City of Yreka Water Supply Pipeline Relocation* - Programmatic Measure**				
Under the Proposed Action, relocation of the City of Yreka Water Supply Pipeline required as part of the removal of Iron Gate Dam would not affect algae.	2, 3, 5	NCFEC	None	NCFEC

Table 3.4-1 Summary of Algae Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation [(1)]	Significance After Mitigation Pursuant to CEQA
***KBRA* – Programmatic Measures**				
Implementation of restoration actions, programs, and/or plans presented in the KBRA would accelerate restoration actions currently underway throughout the Klamath Basin (with the exception of the Trinity Basin) including KHSA implementation (i.e., dam removal) and reduce nuisance and/or noxious phytoplankton blooms through their beneficial effects on flow and water quality.	2, 3	B	None	B
Implementation of the Phase I Fisheries Restoration Plan could result in a long-term reduction in nutrients and associated decreases in nuisance and/or noxious phytoplankton and periphyton blooms.	2, 3	B	None	B
Implementation of the Phase II Fisheries Restoration Plan under the KBRA (KBRA Section 10.2) would include a continuation of the same types of resource management actions as under Phase I along with provisions for adaptive management of these actions and would therefore have the same impacts as Phase I.	2, 3	B	None	B
Implementation of Wood River Wetland Restoration could result in reduced nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms.	2, 3	B	None	B
Implementation of the Water Use Retirement Program could result in decreases in nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms.	2, 3	B	None	B

Table 3.4-1 Summary of Algae Impacts

Potential Impact	Alternative(s)	Significance Pursuant to CEQA	Proposed Mitigation [(1)]	Significance After Mitigation Pursuant to CEQA
Implementation of the Interim Flow and Lake Level Program could result in decreases in nutrient inputs to Upper Klamath Lake and associated decreases in nuisance and/or noxious phytoplankton blooms.	2, 3	B	None	B
Implementation of the Upper Klamath Lake and Keno Nutrient Reduction Program could result in decreases in nutrient inputs to Upper Klamath Lake and Keno Impoundment/Lake Ewauna and associated decreases in nuisance and/or noxious phytoplankton blooms.	2,3	B	None	B

[1] The timing of reservoir drawdown under the Proposed Action was optimally developed to minimize environmental effects (Section 3.4.4.4.1).
[2] This revision reflects an editorial clarification. As indicated by the analysis under the Proposed Action, the determination for Alternative 5 in the Hydroelectric Reach from Copco 1 Reservoir to Iron Gate Reservoir should also have been a significant effect

Key:
NCFEC = No change from existing conditions; B = Beneficial; LTS = Less than significant; S = Significant

3.4.5 References

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3.5 Terrestrial Resources

3.5.1 Area of Analysis

The Klamath Hydroelectric Settlement Agreement (KHSA) area of analysis or "project area" for terrestrial resources impacts includes vegetation communities and habitats of the Klamath River watershed currently influenced by the presence of the Four Facilities. Both the riparian vegetation communities downstream from these dams and the associated reservoirs upstream are influenced by the presence of the dams and have the potential to be affected by their removal. Thus, the project area extends along the Klamath River from Keno Dam to the Pacific Ocean and includes the river channel and riparian zone. Upland habitats occurring in construction areas are also included in the project area. This would include areas potentially affected by changes in land use and water supply patterns caused by the KHSA. In addition, the area of analysis includes areas where Klamath Basin Restoration Agreement (KBRA) actions would occur, particularly the Lower Klamath, Tule Lake, and Upper Klamath National Wildlife Refuges (NWR) in the Klamath Basin National Wildlife Refuge System (Figure 3.5-1). Most KBRA actions would occur within the Upper Klamath Basin, but some would also occur in the Lower Klamath Basin (excluding the Trinity River watershed), and are included in the area of analysis.

3.5.2 Regulatory Framework

Terrestrial resources within the area of analysis are regulated by several Federal, State, and local laws and policies, which are listed below.

3.5.2.1 Federal Authorities and Regulations

- Endangered Species Act (ESA) (7 USC § 136; 16 USC § 1531 et seq.)
- Fish and Wildlife Coordination Act (16 USC § 661 et seq.)
- Migratory Bird Treaty Act (16 USC § 703 et seq.)
- Clean Water Act (CWA) (33 USC § 1251 et seq.)
- Executive Order 11990- Protection of Wetlands (42 FR 26961)
- Executive Order 11988- Floodplain Management (42 FR 26951)
- Bald and Golden Eagle Protection Act (16 CFR 668)
- National Wildlife Refuge Administration Act, as amended by the National Wildlife Refuge System Improvement Act of 1997 (16 USC § 668dd et seq.)
- United States Fish and Wildlife Service (USFWS) Biological Opinion
- Northwest Forest Plan[1]
- Noxious Weed Act (7 USC § 2801 et seq.) and Executive Order 13112 Invasive Species (64 FR 6183)

[1] The Northwest Forest Plan, Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, was signed April 14, 1994. The BLM Klamath Falls Resource Area incorporates direction from the Northwest Forest Plan ROD into the 1995 Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary.

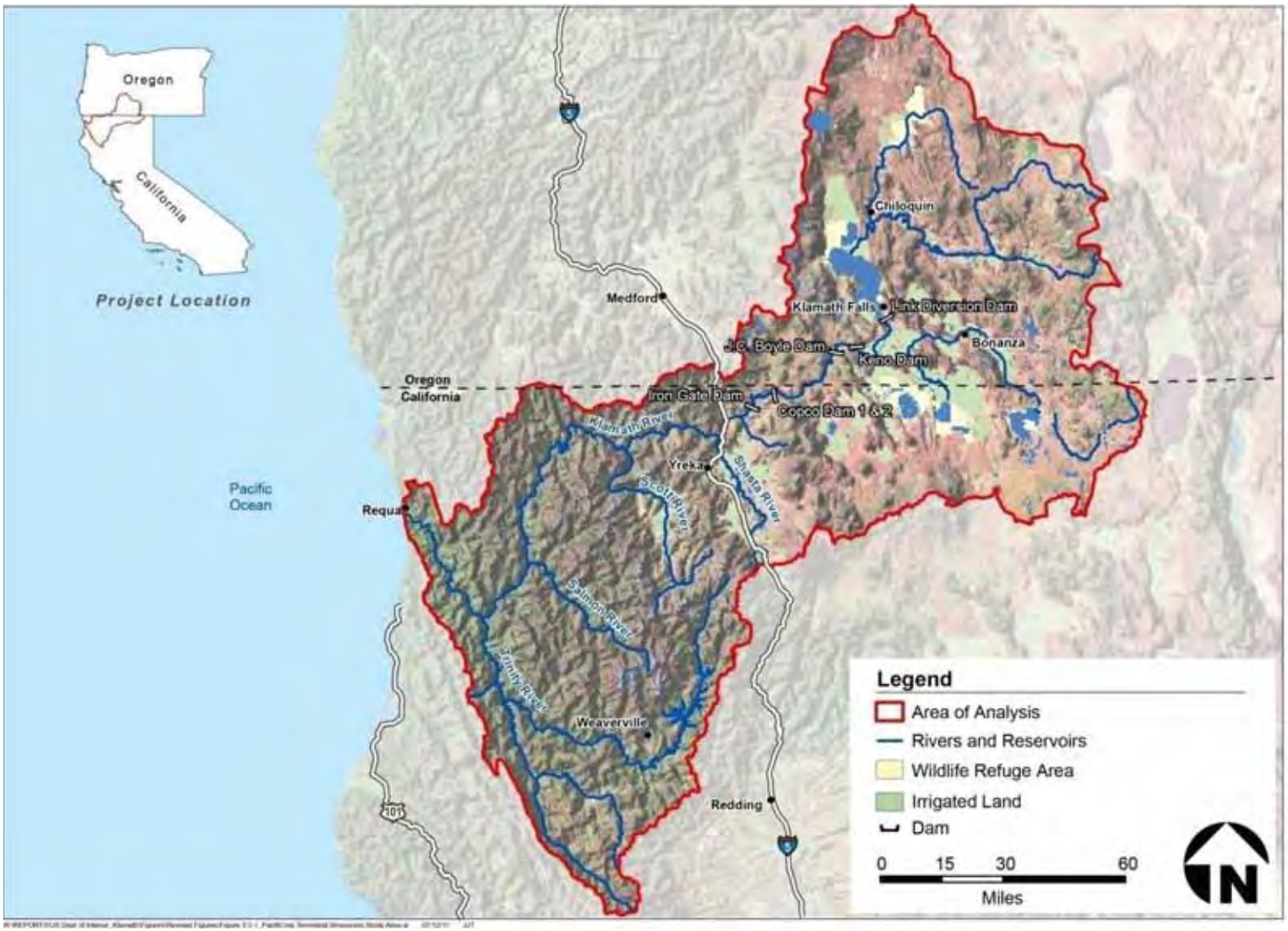

Figure 3.5-1. PacifiCorp Terrestrial Resources Study Area.

3.5.2.2 State Authorities and Regulations

- California Endangered Species Act (ESA) (California Fish and Game Code [FGC] Section 2050 et seq.)
- Migratory Bird Protection (FGC Sections 3500 - 3705)
- Streambed Alterations (FGC Section 1600)
- Exotic Species Introductions (California Food and Agriculture Code Section 403)
- Oregon Endangered Species Act (ESA) (Oregon Revised Statutes [ORS] 496 et seq.)
- Oregon Removal-Fill Law (ORS 196 et seq.)
- Oregon Noxious Weed Control Law (ORS 561)

3.5.2.3 Local Authorities and Regulations

- Siskiyou County General Plan (1973)
- Humboldt County General Plan (1984)
- Del Norte County General Plan (2003)
- Klamath County Comprehensive Plan (2010)

3.5.3 Existing Conditions/Affected Environment

The project area is within the Klamath Ecological Province and the Klamath Bioregion, characterized by forested mountains and a fairly wet climate that supports large river systems. Vegetation communities include wetter forests near the coast, including white fir and Douglas fir, transitioning to drier mixed conifer-pine and mixed conifer-fir in the mountain ranges of Siskiyou County. Sagebrush and interior valley vegetation communities also exist within lower elevation areas. In Oregon, the project area is within the East Slope Cascades and the West Slope Cascades eco-regions. In California, the project area is within the Southern Cascades and the Modoc Plateau physiographic provinces and is also within the Cascade-North Sierra floristic region of the California floristic province (Federal Energy Regulatory Commission [FERC] 2007).

The Klamath-Siskiyou mountain ranges are recognized for their biological diversity, with more than 3,000 known plant species, including 30 temperate conifer tree species, more than any other ecosystem in the world (California Department of Fish and Game [CDFG] 2006). The Klamath River Canyon is a mosaic of pine, oak, juniper, and mixed conifer forest communities, with ponderosa pine and Oregon white oak being the dominant tree species. Riparian habitats are dominated by oak, birch, and white alder (FERC 2007).

3.5.3.1 Vegetation Communities and Habitat Types

The majority of the information in this section was obtained from the PacifiCorp Final Technical Report (FTR) on terrestrial resources prepared for the Klamath Hydroelectric Project (PacifiCorp 2004a). The “primary study area” for the terrestrial resources technical report included the Klamath River from the Link River Dam to the Shasta River and the area within 0.25 mile of all PacifiCorp facilities, reservoirs, and river reaches. PacifiCorp also identified a “secondary study area” that included the area between the canyon rims from J.C. Boyle Dam to the eastern end of Copco Reservoir and all PacifiCorp-owned lands near the PacifiCorp facilities (Figure 3.5-2).

"Study area" in this section refers to the area covered by the terrestrial resources FTR, whereas "project area" refers to the area of analysis defined in Section 3.5.1. The terrestrial resources FTR study area does not include the Klamath River downstream from Shasta River, and information on vegetation communities is not available to the level of detail presented in the terrestrial FTR for the downstream reaches of the Klamath River.

Unless specified, information on terrestrial resources in the Lower Klamath River was obtained from the following sources:

- Draft Hydrology, Hydraulics, and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration (Greimann et al. 2010), which discusses the general physical characteristics of the Klamath River reaches;
- *Green Diamond Resource Company Aquatic Habitat Conservation Plan and Candidate Conservation Agreement with Assurances* (Green Diamond Resource Company 2006), which provides information on habitat and occurrence of southern torrent salamander and tailed frog in the tributaries of the Lower Klamath River;
- *Mid-Klamath Subbasin Fisheries Resource Recovery Plan* (Karuk Tribe of California 2003), which covers the Klamath River between Iron Gate Dam and the Trinity River;
- *The Lower Klamath River Sub-Basin Watershed Restoration Plan* (Yurok Tribal Watershed Restoration Program 2000), which covers the Klamath River between the Trinity River and the Pacific Ocean; and
- *Klamath River Estuary Wetlands Restoration Prioritization Plan* (Yurok Tribe Environmental Program 2009), which covers the Klamath River Estuary.

The study area for the PacifiCorp FTR includes 11 river reaches of the Klamath River upstream of the Shasta River, as listed in Table 3.5-1.

Table 3.5-1. River Reaches in the PacifiCorp Study (2004a)

River Reach	River Mile
Link River	253.3 to 254.8
Keno Impoundment	233.3 to 253.3
Keno Canyon	228.2 to 233.3
J.C. Boyle Reservoir	224.6 to 228.2
J.C. Boyle Bypass	220.2 to 224.6
J.C. Boyle Peaking Reach	203.9 to 220.2
Copco 1 Reservoir	198.7 to 203.9
Fall Creek	0 to 1.5*
Copco 2 Bypass	196.8 to 198.7
Iron Gate Reservoir	188.9 to 196.8
Iron Gate-Shasta	176.8 to 188.9

Source: PacifiCorp 2004a
Notes:
*River Mile of Fall Creek

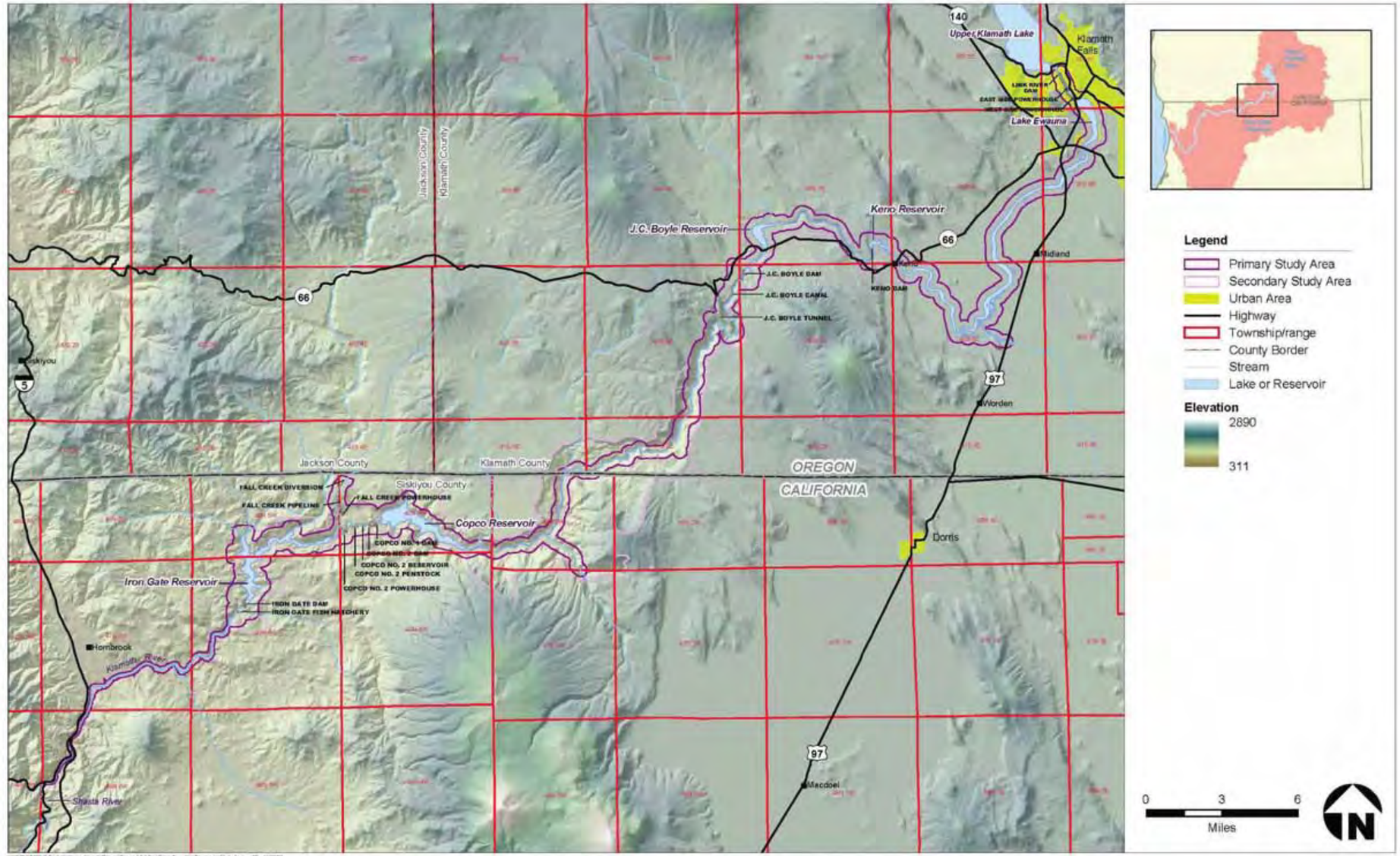

Figure 3.5-2. PacifiCorp Terrestrial Resources Study Area (PacifiCorp 2004a).

Eight vegetation cover types were mapped by PacifiCorp (2004a), with each cover type further sub-classified. Appendix G includes a series of 18 vegetation maps covering the PacifiCorp study reaches. These figures and a description of each cover type are included in Appendix G. Table 3.5-2 lists the major cover types and their relative distribution and acreage among the river reaches and Table 3.5-3 lists the sub-classifications of each cover type. PacifiCorp considered Copco 1 and Copco 2 as one reservoir during their study, and collectively referred to them as Copco reservoir (PacifiCorp 2004a). The methods used by PacifiCorp to map vegetation communities in the study area are summarized in Appendix H.

As shown in Table 3.5-2, upland tree habitat occupies 54 percent of the study area and is the most abundant cover type in all locations except at Keno Impoundment and along the Klamath River, from the Iron Gate development to the Shasta River, where aquatic and wetland cover types dominate at Keno Impoundment and upland herbaceous cover types dominate at Klamath River from Iron Gate Dam to Shasta River. Upland shrub habitat occupies 9.5 percent of the study area and is particularly abundant near the Copco 2 bypass reach. Upland herbaceous habitat occupies 9.2 percent of the study area and is common along the Klamath River between the Iron Gate development and the Shasta River (25.5 percent) and at the Iron Gate (21 percent) and Copco Reservoirs (16 percent).

Barren habitat, consisting of rock talus (rubble at the bottom of a slope or cliff) or exposed rock, occupies 1.7 percent of the study area. Agricultural and developed habitat (excluding general grazing allotment areas) occupies 11 percent of the study area, primarily along Link River, at Keno Impoundment, and along the Klamath River from Iron Gate development to the Shasta River. Developed and agricultural lands dominate the area near Keno Impoundment (48 percent), and consist primarily of pasture or irrigated hayfields.

Wetland and riparian vegetation in the project area is influenced by water flow and level in the river and reservoirs and sediment flow and deposition through the system. Wetland habitat consists of palustrine aquatic bed, palustrine emergent, palustrine forested, and palustrine shrub-scrub wetlands. PacifiCorp (2004a) describes these wetland habitat types as follows:

- Palustrine Aquatic Bed: Dominant species are pondweeds (*Potamogeton* spp.) and coontail (*Ceratophyllum demersum*). Occurs primarily at J.C. Boyle Reservoir (37.6 acres).

- Palustrine Emergent: Dense herbaceous layer, often with a weedy zone immediately upslope of the bulrush (*Scirpus* spp.) zone. Occurs at J.C. Boyle Reservoir (63.2 acres), Copco Reservoir (18.9 acres), and Iron Gate Reservoir (11.2 acres).

- Palustrine Forested: Dense tree cover includes the primarily hydrophilic tree species coyote willow (*Salix exigua*) and shining willow (*Salix lucida*). Occurs at Copco Reservoir (57.1 acres) and Iron Gate Reservoir (38.8 acres).

Table 3.5-2. Distribution of Vegetation Cover Types Mapped in 2002 in the PacifiCorp Study Area (2004a)

Vegetation Cover Type	Iron Gate-Shasta	Iron Gate Reservoir	Copco 2 Bypass	Fall Creek	Copco Reservoir	J.C. Boyle Peaking Reach	J.C. Boyle Bypass	J.C. Boyle Reservoir	Keno Canyon	Keno Impound-ment	Link River	Grand Total
Upland Tree												
Subtotal	135.1	3,472.5	714.4	692.1	3,159.0	15,400.9	1,465.2	1,136.8	1,599.4	304.6	237.3	28,316.9
Percent of Reach	9.7%	52.7%	59.4%	74.6%	51.2%	75.3%	70.6%	59.1%	78.0%	3.2%	42.2%	53.6%
Upland Shrub												
Subtotal	205.8	478.4	251.7	102.6	791.2	1,851.2	285.9	120.0	259.3	607.5	88.7	5,042.2
Percent of Reach	14.8%	7.3%	20.9%	11.1%	12.8%	9.1%	13.8%	6.2%	12.6%	6.4%	15.8%	9.5%
Upland Herbaceous												
Subtotal	353.5	1,383.8	80.4	28.7	962.5	1,675.8	109.6	171.6	24.7	46.8	3.4	4,840.6
Percent of Reach	25.5%	21.0%	6.7%	3.1%	15.6%	8.2%	5.3%	8.9%	1.2%	0.5%	0.6%	9.2%
Wetland												
Palustrine Aquatic Bed		0.9		0.6		0.1		37.6		254.1		293.3
Palustrine Emergent	0.4	11.2	1.4	8.0	18.9	89.8	8.3	63.2	5.1	1,589.4	0.2	1,795.9
Palustrine Forested		38.8	3.1	2.2	57.1		5.0			9.5	2.9	118.6
Palustrine Scrub-Shrub	0.2	9.2		2.7	3.2		0.8	4.2		7.8	2.5	30.6
Subtotal	0.6	60.1	4.5	13.5	79.2	89.9	14.1	105.1	5.1	1,860.8	5.6	2,238.5
Percent of Reach	0.0%	0.9%	0.4%	1.5%	1.3%	0.4%	0.7%	5.5%	0.2%	19.5%	1.0%	4.2%
Aquatic												
Subtotal	218.5	964.9	10.0	0.9	999.6	277.1	45.5	299.4	92.3	2,136.6	32.3	5077.1
Percent of Reach	15.8%	14.7%	0.8%	0.1%	16.2%	1.4%	2.2%	15.6%	4.5%	22.4%	5.7%	9.6%
Riparian												
Subtotal	151.1	41.8	23.1	39.9	25.6	228.3	32.1	0.8	20.3	0.8	33.9	597.5
Percent of Reach	10.9%	0.6%	1.9%	4.3%	0.4%	1.2%	1.6%	0.0%	1.0%	0.0%	6.0%	1.1%
Barren												
Subtotal	17.4	63.1	82.6	38.3	61.4	545.0	96.0	10.2	12.3	0.0	0.0	926.2
Percent of Reach	1.3%	1.0%	6.9%	4.1%	1.0%	2.7%	4.6%	0.5%	0.6%	0.0%	0.0%	1.7%
Agricultural/ Developed												
Subtotal	304.4	120.3	35.5	11.7	96.3	379.6	28.0	80.7	37.2	4,575.8	161.0	5,830.5
Percent of Reach	22.0%	1.8%	3.0%	1.3%	1.6%	1.8%	1.3%	4.2%	1.8%	48.0%	28.6%	11.0%
Total Acres	**1,386.4**	**6,585.1**	**1,202.2**	**927.7**	**6,174.7**	**20,447.8**	**2,076.1**	**1,924.5**	**2,050.6**	**9,532.9**	**562.1**	**52,869.5**
Percent of Total	**2.6%**	**12.5%**	**2.3%**	**1.8%**	**11.7%**	**38.7%**	**3.9%**	**3.6%**	**3.9%**	**18.0%**	**1.1%**	**100.0%**

Table 3.5-3. Sub-Classification of Vegetation Cover Types Mapped in 2002 in the PacifiCorp Study Area (2004a)

Upland Tree Habitats	**Wetland Habitats**	**Barren Habitat**
Montane Hardwood Oak	Palustrine Emergent	Rock Talus
Montane Hardwood Oak-Conifer	Palustrine Scrub-Shrub	Exposed Rock
Montane Hardwood Oak-Juniper	Palustrine Forested	
Juniper	Palustrine Aquatic Bed	**Agricultural/Developed**
Mixed Conifer		
Lodgepole Pine	**Riparian Habitats**	
Ponderosa Pine	Riparian Grassland	
	Riparian Shrub	
Upland Shrub Habitats	Riparian Deciduous	
Mixed Chaparral	Riparian Mixed Deciduous-Coniferous	
Rabbitbrush		
Sagebrush	**Aquatic Habitat**	
	Riverine and Lacustrine Unconsolidated Bottom	
Upland Herbaceous Habitats	Riverine and Lacustrine Unconsolidated Shore	
Annual Grassland		
Perennial Grassland		

- Palustrine Scrub-Shrub: Open canopy with moderate shrub layer. Coyote willow and arroyo willow (*Salix lasiolepis*) are the primary hydrophilic shrubs. Occurs at J.C. Boyle Reservoir (4.2 acres), Copco Reservoir (3.2 acres), and Iron Gate Reservoir (9.2 acres).

Wetland habitat occupies only 4.2 percent of the study area. Wetland habitat occurs primarily at the Keno Impoundment (19.5 percent of wetland habitat in the study area), the J.C. Boyle Reservoir (5.5 percent of wetland habitat), and Copco Reservoir (1.3 percent of wetland habitat). Iron Gate Reservoir contains 60 acres of wetland habitat, or only 0.9 percent of total wetland habitat. Aquatic habitat (open water habitat largely devoid of vegetation) occupies 9.6 percent of the study area, with the highest percentage (22.4 percent or 2,136.6 acres) occurring at the Keno Impoundment.

Riparian habitat occurs along the river and reservoir shorelines in some areas and consists of deciduous, shrub, and grassland vegetation. Riparian habitat occupies only 1.1 percent of the study area. Along the river reaches, reed canarygrass is a common riparian plant species in high flow areas. Reed canarygrass may outcompete other riparian species due to its ability to better use abundant nutrients and withstand frequently fluctuating peaking flows. Along the banks above high flow areas, most river reaches have even distribution of coyote willow/reed canarygrass/colonial bentgrass, perennial ryegrass, and Oregon ash/colonial bentgrass/woolly sedge (PacifiCorp 2004a).

Wetland and riparian vegetation occurs to varying degrees along the project reservoirs and river reaches. Vegetation maps prepared by PacifiCorp (2004a) are provided in Appendix G. The majority of wetland and riparian habitat is limited to small patches in protected locations and near inlets/tributaries. However, several large wetland and riparian habitats are associated with the Keno Impoundment and J.C. Boyle Reservoir. Both the Copco Reservoir and Iron Gate Reservoir have steep slopes that generally lack extensive, near-shore riparian and wetland habitat. Emergent vegetation within the wetland and riparian communities of the reservoirs includes sedge, rush, bentgrass, bulrush, and cattail. Coyote willow is the dominant shrub layer of the wetlands at reservoirs in the project area (PacifiCorp 2004a).

Wetland and riparian habitats currently existing along the shorelines of the project reservoirs are anthropogenic, formed when the natural hydrology of the Klamath River was altered and the reservoirs were created. Riparian corridors typically exist as narrow, fragmented bands with habitat extending from water channels only as far as can be supported by a river's hydrology and elevated water table. However, project reservoirs have shoreline elevations that include expanses of flat, formerly upland areas, which now support wider fragmented patches of wetland and riparian habitat. Although altered from the natural state of the historic Klamath River, the existing wetland and riparian habitats provide important functions, including nursery areas for fish and other aquatic wildlife and food, cover, foraging, and nesting habitat for birds and other terrestrial wildlife.

Figures 3.5-3, 3.5-4, and 3.5-5 show the historic vegetation types for areas currently inundated by J.C. Boyle, Copco, and Iron Gate reservoirs, respectively (PacifiCorp

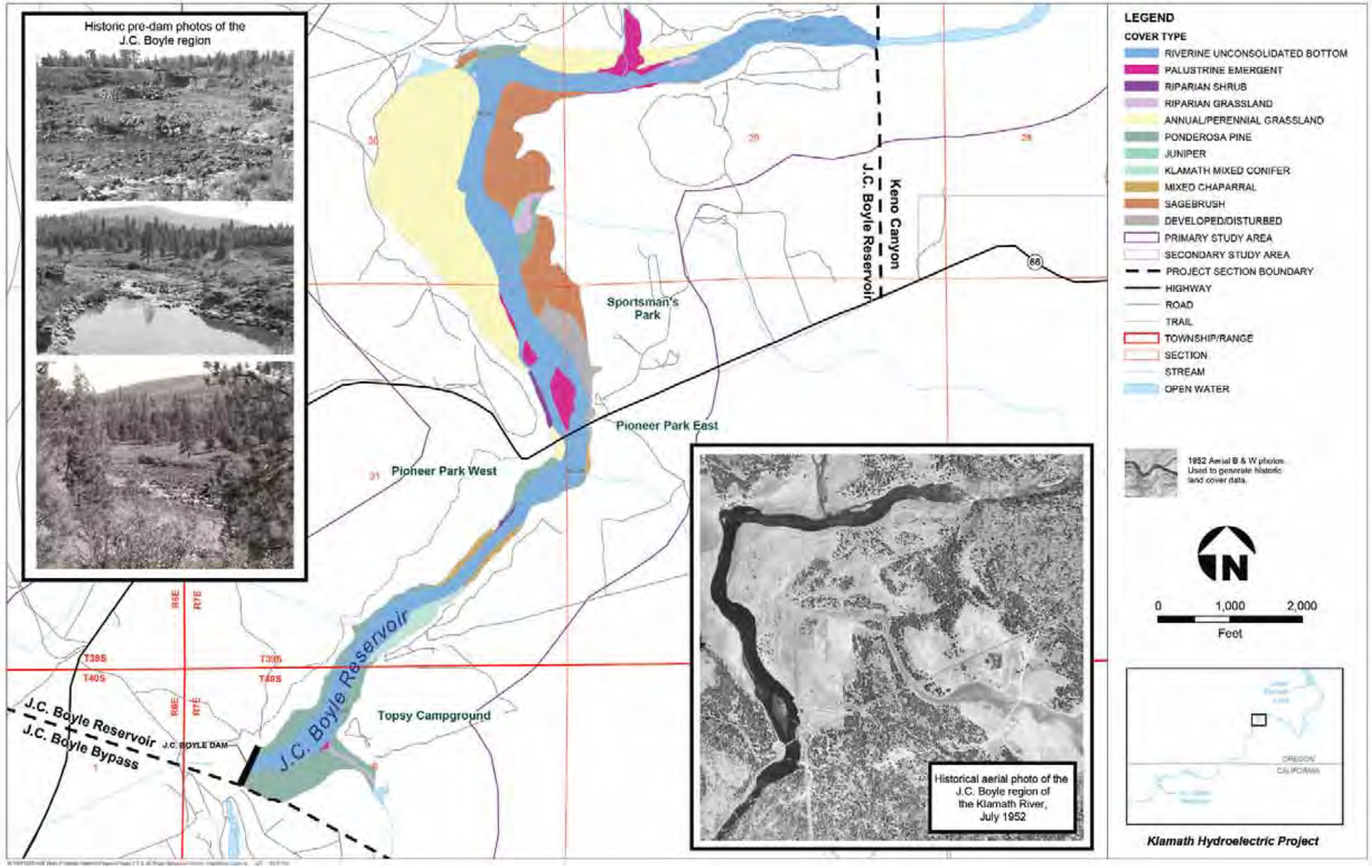

Figure 3.5-3. J.C. Boyle Reservoir Historic Vegetation Types.

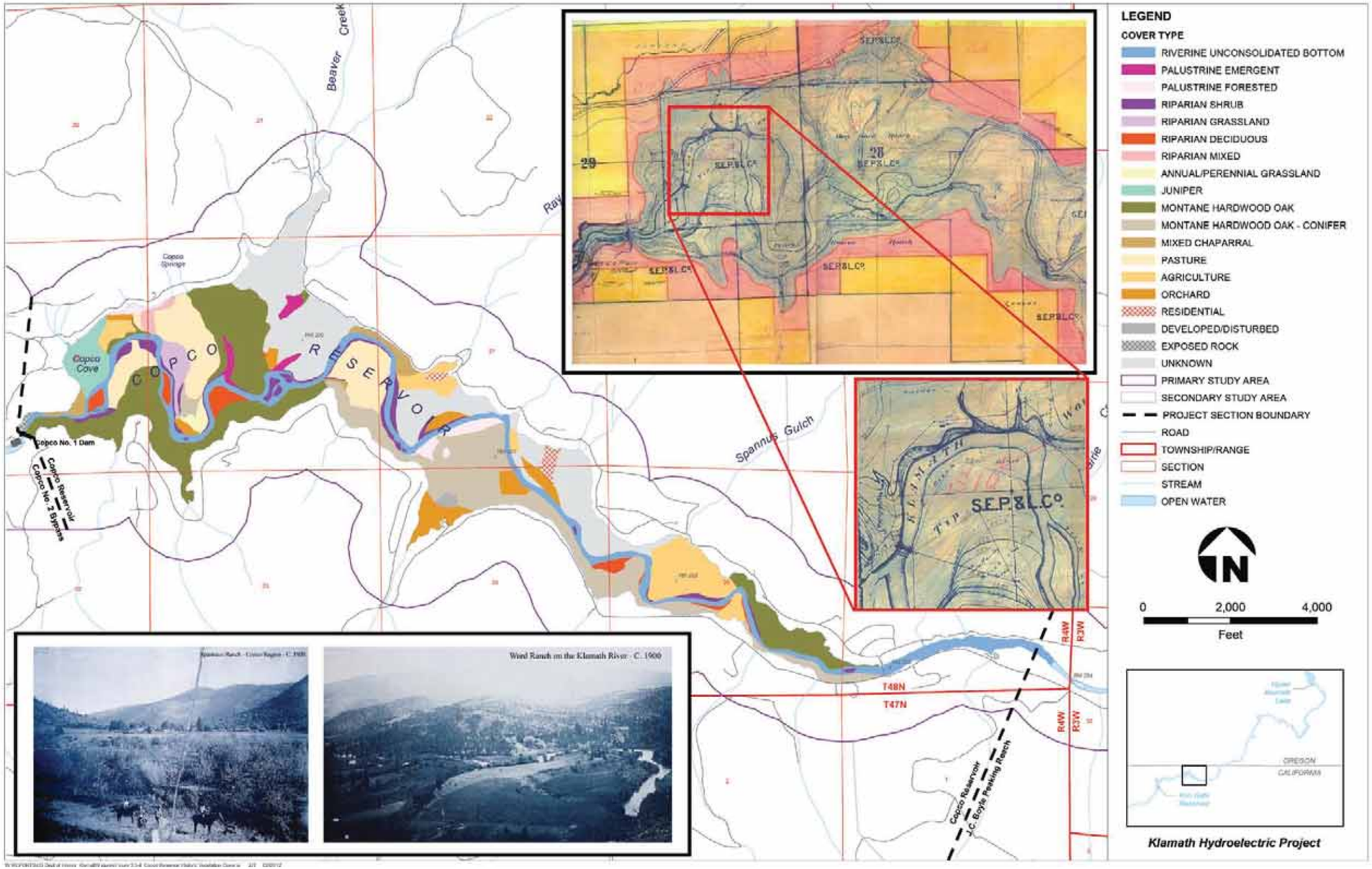

Figure 3.5-4. Copco Reservoir Historic Vegetation Types.

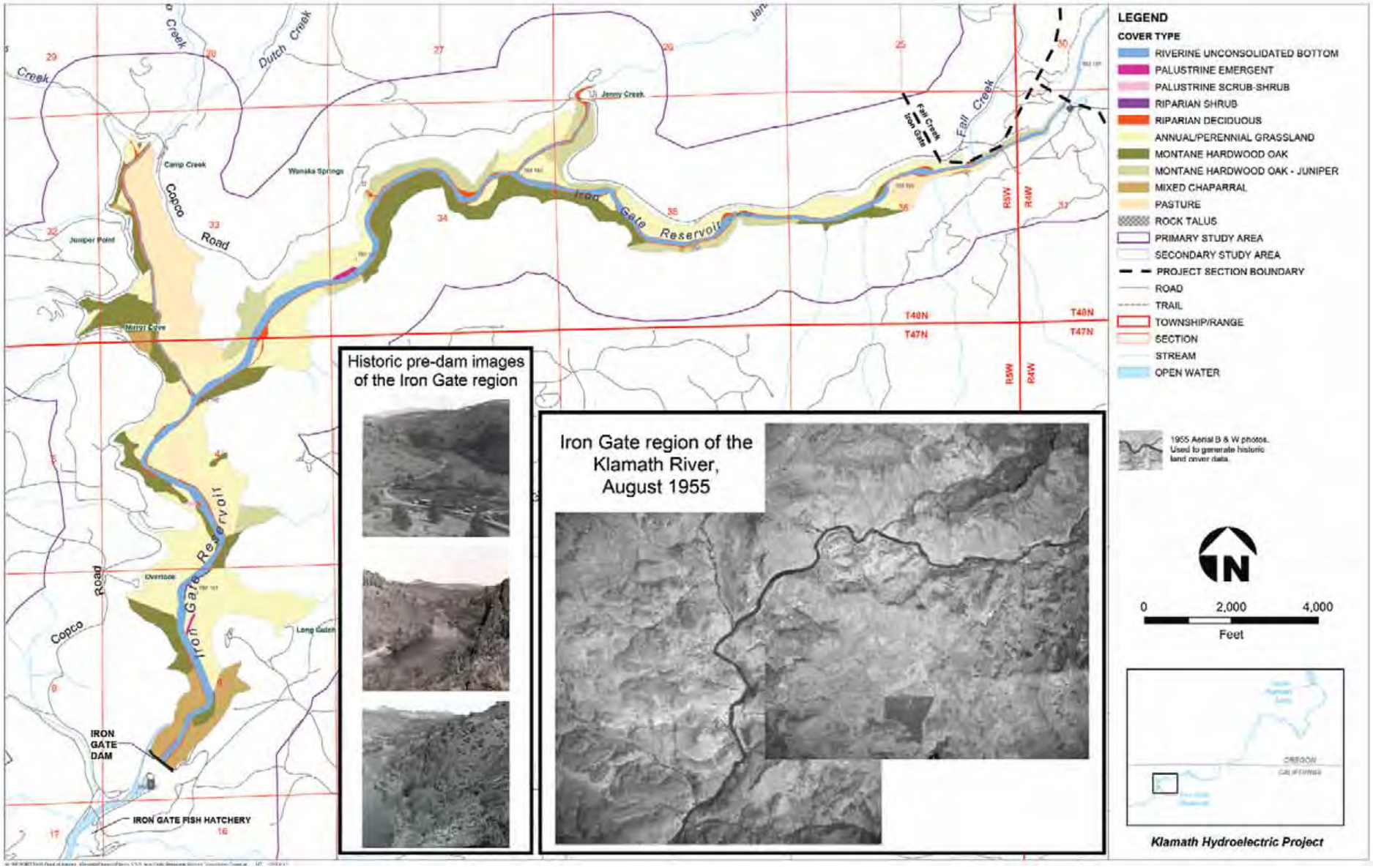

Figure 3.5-5. Iron Gate Reservoir Historic Vegetation Types.

2004a). Assessment of the aerial and oblique photography before dam construction indicated that in general, the distribution of wetland (shown as Palustrine Emergent) and riparian habitat in these areas consisted of long, thin bands running along the historic Klamath River channel. In comparison, somewhat wider, but more widely scattered patches of these vegetation types currently exist along the project reservoir shorelines (PacifiCorp 2004a).

A comparison of historic vegetation communities at J.C. Boyle Reservoir indicates that there is more wetland and riparian habitat surrounding the reservoir than historically occurred. Historically, low-lying uplands located southeast of the Klamath River were composed of sagebrush and grassland (see Figure 3.5-3). These areas are now dominated by a large contiguous patch of palustrine emergent wetland near the Sportsmen's Park that has formed from the raised water level (PacifiCorp 2004a).

At Copco 1 Reservoir, topography limited the establishment of wetland and riparian areas following reservoir inundation. The area where Copco 1 Reservoir is currently located historically consisted of a wide floodplain confined by steep slopes, with a wide, dense riparian forest located along several river bends (see Figure 3.5-4). Currently, the reservoir shoreline extends up these steep slopes, and few areas are available for wetland and riparian habitat establishment due to the steep topography (PacifiCorp 2004a).

At Iron Gate Reservoir, the large wetland and riparian habitat areas that currently exist near the mouths of Jenny, Scotch, and Camp creeks were historically at elevations above the Klamath River and supported primarily upland vegetation including grasslands (see Figure 3.5-5). Creation of the Iron Gate Reservoir raised the water level and created a flat bench for wetland and riparian vegetation (PacifiCorp 2004a).

Based on mapping shown in Figure 3.5-3, Figure 3.5-4, and Figure 3.5-5, an estimated 34.9 total acres of wetland habitats and 101.3 acres of riparian habitats historically occurred along the Klamath River at the current location of the reservoirs prior to construction of the dams. As shown in Table 3.5-2, there are currently a total of 244.4 acres of wetland habitats and 68.2 acres of riparian habitat at the reservoirs based on PacifiCorp mapping (2004a).

3.5.3.1.1 Noxious Weeds and Invasive Plant Species

During biological surveys conducted in 2002, 2003, and 2004, 17 species of noxious weeds were identified within the study area. The noxious weed inventory fieldwork emphasized areas around PacifiCorp facilities, roads, transmission lines, and at reservoirs, riverine shorelines, and riparian areas from the Link River to the mouth of the Shasta River. In addition, data from resource agencies on noxious weeds was obtained to supplement surveys for a 0.25-mile wide (0.4-km-wide) buffer around PacifiCorp structures, reservoirs, and river reaches (PacifiCorp 2004a).

During the surveys, the following 17 noxious weed species were found in the study area:

- Bull thistle (*Cirsium vulgare*)
- Canada thistle (*Cirsium arvense*)
- Cheatgrass (Bromus tectorum)
- Diffuse knapweed (*Centaurea diffusa*)
- Dalmatian toadflax (*Linaria dalmatica*)
- Dyer's woad (Isatis tinctoria)
- Hoary Cress (*Cardaria draba*)
- Mediterranean sage (*Salvia aethiopsis*)
- Medusahead (Taeniatherum caput-medusae)
- Perennial pepperweed (*Lepidium latifolium*)
- Puncture vine (Tribulus terrestris)
- Russian knapweed (*Acroptilon repens*)
- Scotch thistle (Onopordum acanthium)
- Scotch broom (Cytisus scoparius)
- Spiny cocklebur (*Xanthium spinosum*)
- St. John's wort (Hypericum perforatum)
- Yellow starthistle (*Centaurea solstitialis*)

In addition to the species listed above, reed canarygrass is an invasive plant species found throughout the project area.

In addition to these species, other invasive species occur throughout the project area, including the middle and Lower Klamath River reaches. These species include reed canarygrass, Japanese and Himalayan knotweed, and Himalayan blackberry (Hamilton 2011). In addition, poison hemlock (*Conium maculatum*) is a common noxious weed present along the shores of Keno Impoundment (Larson 2011).

During the PacifiCorp vegetation surveys, cheatgrass, yellow starthistle, and medusahead were the most widespread noxious weed species across all 11 of the study area sections. Bull thistle and Canada thistle were also pervasive in the study area (PacifiCorp 2004a). Noxious weeds occurred in 62 percent of the sampled riparian/wetland sites. Many of the weed species occur in uplands or near the riparian/upland interface. In general, noxious weeds were found to be abundant where ground disturbance had occurred. The spread of these weeds likely occurs as a result of vehicles or machinery spreading weed seeds and propagules in areas where bare soil is exposed. Ground disturbance has resulted from various land uses and maintenance activities in the study area, including maintenance of power plants, transmission lines, flowlines, recreation sites, and roads. The abundance of weeds at Keno Impoundment may be the result of agricultural development and livestock grazing. In addition, residential and commercial developments contribute to the spread of these invasive plants (PacifiCorp 2004a).

In addition to the surveys conducted by PacifiCorp (2004a), vegetation surveys were conducted around the perimeter of J.C. Boyle, Copco, and Iron Gate Reservoirs in

November 2009 and July 2010 (U.S. Department of the Interior [DOI] 2011a). These surveys confirmed the presence of yellow starthistle and medusahead at Copco and Iron Gate Reservoirs, but did not find these species at J.C. Boyle Reservoir. However, large stands of reed canarygrass were documented along the eastern shoreline of the northern section of the J.C. Boyle Reservoir.

Upper Klamath River

The Upper Klamath River includes the areas upstream of J.C. Boyle Reservoir. Findings of vegetation and wildlife surveys conducted for the PacifiCorp study (2004a) in the Link River Reach, Keno Impoundment, and Keno Canyon Reach are summarized below. As described in Section 3.5.1, the area of analysis for this Environmental Impact Statement/Environmental Impact Report (EIS/EIR) also includes areas of the Upper Klamath Basin where KBRA actions would occur, particularly those areas associated with the NWRs. Lower Klamath, Tule Lake, and Upper Klamath NWRs would be most directly affected by the KBRA (USFWS 2010). These NWRs are managed to provide habitat and food for waterfowl. As such, they consist largely of seasonal and permanently flooded marshes with emergent and submergent wetland vegetation. In addition, a large amount of croplands surrounding these wetlands provide food for wintering waterfowl.

Link River Reach

The Link River is the headwaters reach of the Klamath River just above Lake Ewauna near the city of Klamath Falls. The Link River Dam and its reservoir (Upper Klamath Lake) are not part of the project area for the Klamath Hydroelectric Settlement Agreement, but are part of the area that would be affected by the KBRA.

In addition to being affected by river hydrology and seepage from canals and penstocks, user-created trails and encampments and maintenance activities have adversely affected riparian vegetation along the Link River reach through ground disturbance that precludes vegetation growth. The riparian vegetation along the right bank is structurally diverse and relatively continuous, while the vegetation on the left bank is more disturbed and patchy. Vegetation in the reach has an abundance of introduced woody species, including apple, plum, and elm (PacifiCorp 2004a).

Keno Impoundment

Keno Impoundment is not part of the project area for the Klamath Hydroelectric Settlement Agreement, but is part of the area that would be affected by the KBRA. Keno Impoundment has a surface area of 2,475 acres. As with the other project reservoirs, wetlands at the Keno Impoundment are influenced by the hydrology of the reservoir. However, the water level at the Keno Impoundment fluctuates less than at the other reservoirs, and the wetlands occur in naturally low-lying areas that probably supported significant wetlands before formation of the Keno Impoundment (PacifiCorp 2004a).

The wetland vegetation at Keno Impoundment is more diverse than at any other project reservoir, with the most abundant wetland vegetation types dominated by hardstem bulrush and broadfruited bur-reed. Applegate's milk-vetch (*Astragalus applegatei*), a

federally endangered and Oregon endangered species, was documented during surveys at Keno Impoundment (PacifiCorp 2004a). See Table 3.5-4 in Section 3.5.3.4 for a discussion of special-status species that occur in the project area. The coyote willow vegetation type, which is dominated by coyote willow in the shrub layer, is not common at the Keno Impoundment, but occurs in dense, small stands in low-lying pastures protected by levees. The tops of the levees are dominated by noxious weed species, such as poison hemlock and Canada thistle (PacifiCorp 2004a). The noxious weed, perennial pepperweed (*Lepidium latifolium*), also occurs in wetlands along the Keno Impoundment and is likely to be present on private lands (Larson 2011).

Keno Canyon Reach

The Keno Canyon reach has steep slopes with a narrow shoreline. The reach experiences low flows in the growing season, resulting in the growth of intact, undisturbed riparian grass vegetation dominated by reed canarygrass. Willow reproduction in the Keno Canyon reach is lacking, and existing willow trees are in a state of decay with large horizontal branches broken because of rot or chewing by beavers (PacifiCorp 2004a). There is a mostly intact transition from the riparian zone to the upland zone that consists primarily of shrub vegetation on the canyon slopes. Some riparian areas are disturbed from recreational use by fishermen.

J.C. Boyle Reservoir

The water level in J.C. Boyle Reservoir is controlled at the J.C. Boyle powerhouse and by inflows from upstream irrigation. As a result, there are wide mudflats exposed on a daily basis in some portions of the reservoir, and there is no woody riparian/wetland vegetation immediately along the shoreline. In spite of water fluctuations, the wetland vegetation at the reservoir is diverse and largely undisturbed, with patches of dense emergent marsh in low-gradient areas. Areas that are fenced and protected, such as at the mouth of Spencer Creek, support high quality woody and herbaceous riparian and wetland vegetation. In contrast, wetlands along the northwest shoreline are highly disturbed by cattle grazing (PacifiCorp 2004a).

J.C. Boyle Bypass and Peaking Reaches

The J.C. Boyle bypass reach generally has a stable water level with low flows, supporting reed canarygrass as well as sedges and willows. A canal with long steep slopes covered by boulders runs along the bypass reach. At the end of the canal is a spillway below which vegetation is lacking due to scour from periodic high flows (PacifiCorp 2004a). In both the J.C. Boyle bypass and peaking reaches, Oregon oak and Oregon ash are dominant tree species, with arroyo willow and coyote willow also common (PacifiCorp 2004a).

Approximately two-thirds of the riparian habitat in the J.C. Boyle bypass reach is riparian grassland, which is predominately reed canarygrass (Administrative Law Judge 2006). The current low-flow situation and the lack of natural flow variability and scouring from intermittent high flows likely contribute to the prevalence of reed canarygrass in this area. Project operations have adversely affected riparian resources in both the J.C. Boyle

bypass and peaking reaches by supporting the perpetuation of reed canarygrass and by affecting the structure, size, and nature of depositional features (Administrative Law Judge 2006).

The J.C. Boyle peaking reach has a generally lower gradient and supports large stands of shrub and tree-dominated riparian vegetation. Wetland habitat occurs on wide benches above the banks that are used for hay production and pasture. Some parts of this reach are accessible to cattle grazing. Many of these wide terraces along this reach are used as large irrigated pastures. Irrigation has created vertical and horizontal discontinuity in the riparian vegetation along the river and reduced cover of native herbaceous and woody riparian vegetation. As a result, exotic and non-native invasive species such as Himalayan blackberry, whitetop, and non-native pasture grasses, have become established (PacifiCorp 2004a).

Copco 1 and Copco 2 Reservoirs

PacifiCorp considered Copco 1 and Copco 2 as one reservoir during their study, and collectively referred to them as Copco Reservoir (PacifiCorp 2004a). Along the shorelines of Copco Reservoir, wetlands are highly disturbed in many areas by a variety of land uses, including livestock grazing and recreational fishing. At the shoreline, the low herbaceous vegetation is heavily grazed and has an abundant “weedy” component of yellow starthistle and medusahead in many locations. Willow habitat is limited to areas where the steep banks of the reservoir shorelines are eroding to form benches upon which coyote willow has become established (FERC 2007).

During invasive plants surveys conducted in November 2009 and July 2010, yellow starthistle was only observed growing on the northern side of the reservoir, where it occurs in dense stands in some areas (Reclamation 2011).

Copco 2 Bypass Reach

In the Copco 2 Bypass Reach, a dense riparian community of white alder dominates, likely prohibiting shade-intolerant coyote willow and reed canarygrass in this reach. Low river flows and water levels in this reach have provided substrate for the establishment of riparian and wetland vegetation consisting of native and non-native hydrophilic herbaceous species that form a relatively sparse herb layer under the dense white alder canopy (PacifiCorp 2004a).

Iron Gate Reservoir

Wetland and riparian areas along the shorelines of Iron Gate Reservoir are highly disturbed by livestock grazing. The reservoir has moderately steep slopes. Along the larger tributaries of Jenny, Scotch, Dutch, and Beaver Creeks, some tree-dominated riparian habitat occurs, and consists of Oregon ash, Oregon oak, and white alder. Shining willow also occurs at Iron Gate Reservoir.

During invasive plant surveys conducted in November 2009 and July 2010, yellow starthistle was documented as prolific in the dry upland slopes and near roadsides around Iron Gate Reservoir (Reclamation 2011).

Fall Creek Reach

Fall Creek is a tributary to the Klamath River just upstream ofIron Gate Reservoir. In the Fall Creek Reach, there is a unique abundance of conifers in the riparian zone, and coyote willow is absent. Four riparian/wetland vegetation types occurring along Fall Creek include Oregon ash/western birch, Oregon ash/Douglas' spiraea, white alder, and ponderosa pine/Douglas fir/western serviceberry, which typically occurs in drier and more upland areas (PacifiCorp 2004a).

Middle Klamath River

The Mid-Klamath subbasin includes the lower Mid-Klamath and the upper Mid-Klamath. The upper Mid-Klamath includes all watersheds from Iron Gate Reservoir downstream to Seiad Creek, excluding the Scott and Shasta Rivers, while the lower Mid-Klamath includes the mainstem of the Klamath River and all watersheds from Grinder Creek downstream to Weitchpec, excluding the Salmon River (Karuk Tribe of California 2003).

The upper Mid-Klamath subbasin has an interior montane climate. Vegetation within the Klamath Range is primarily mixed conifer/hardwood forests while vegetation in the Great Basin consists of chaparral, sagebrush, and juniper woodland. Riparian habitat in the upper Mid-Klamath is affected by a variety of land management practices, including grazing and irrigated agricultural lands, dams and diversions, gravel mining, and roads (Karuk Tribe of California 2003).

The Klamath River from Iron Gate Dam to Shasta River contains the highest percentage (10.9 percent; Table 3.5-2) of riparian habitat in the PacifiCorp (2004a) study area. In most of the reach, the floodplain is mostly restricted to narrow terraces between the in-channel alluvium and steeper slopes or higher elevation surfaces. The narrow terraces typically support coyote willow, shining willow, Oregon ash, and Oregon oak. Cattle grazing in many areas have degraded these stands, as well as some of the coyote willow stands growing on in-channel bars. Even so, woody riparian vegetation is more abundant in this reach than in any other reach of the study area, although tree-dominated stands are typically much smaller in area than in other reaches, due to recreation development on the larger floodplain surfaces between Iron Gate Dam and Cottonwood Creek. Reed canarygrass is not common along the river downstream from Iron Gate Dam for unknown reasons (PacifiCorp 2004a).

Langley Falls is along the middle Klamath River at Gottsville, where several tributaries enter from the north and form a large alluvial fan complex that constricts the river. At the lower end of the Middle Klamath River, Seiad Valley lies where large alluvial fans from Seiad Creek, Little Grider Creek and Grider Creek form a wider alluvial valley with large unvegetated gravel bars (Reclamation 2012).

The lower Mid-Klamath subbasin has a coastal–influenced, Pacific-maritime climate, grading to interior climates of the Klamath Range. The Klamath River and tributaries in this portion of the project area generally have steep slopes and are vegetated with mixed hardwood/conifer forests with mixed conifer evergreen and true fir forests upslope. Riparian habitat in the lower Mid-Klamath has been altered primarily by timber harvest,

gravel mining, roads, and fire suppression (Karuk Tribe of California 2003). Several reaches of the middle Klamath River in this area have been extensively mined. Unvegetated gravel bars are common. Major tributaries include the Salmon River, Trinity River, Bluff Creek, Camp Creek and Ukonom Creek (Reclamation 2012). The middle Klamath River runs through both the Klamath National Forest and the Six Rivers National Forest.

Lower Klamath River and Klamath River Estuary

The Lower Klamath subbasin extends from the confluence of the Klamath and Trinity Rivers to the Pacific Ocean. The coast redwood groves are unique to this part of the project area. Vegetation types are similar to that of the lower Mid-Klamath subbasin, with mixed hardwood/conifer forests dominant. However, based on habitat surveys conducted in 1996 and 1997, conifers comprise less than one third of the riparian canopy in Lower Klamath tributaries. Riparian areas are dominated by deciduous trees including red alder, which are less able to stabilize streambanks than coniferous trees. Red alder is the most common hardwood in riparian zones, and tanoak is the most common mid to upper slope hardwood, with Pacific madrone occurring as a minor stand component on drier sites (Green Diamond Resource Company 2006). Grazing, timber harvest, and roads have degraded riparian habitat in the Lower Klamath (Yurok Tribal Watershed Restoration Program 2000).

The Klamath River estuary lies where the Klamath River enters the Pacific Ocean. A mile-long spit extends from the south shore of the estuary. The estuary is shallow and is about 2,500 feet long and up to 1,000 feet wide. The river channel in the estuary changes positions often as a result of large flood events, during which most fine-grained sediments are flushed to the ocean (DOI 2010).

The estuary consists of several wetland complexes, which have been altered to varying degrees from their historical condition. Large wetlands have been converted into grass pastures for cattle or sown for hay, and hydrology has been altered for the construction of roads including U.S. Highway 101. In addition, many tributaries to the estuary have been straightened and lack connection to the floodplain (Yurok Tribe Environmental Program 2009). The lower channel of the estuary was extensively cleared of snags and large woody debris at the turn of the 20th century for commercial gillnetting and navigational purposes (Green Diamond Resource Company 2006).

Freshwater emergent wetland vegetation dominates the estuary. The estuary also supports a number of salt-tolerant species. Invasive species, including reed canarygrass *(Philaris urundinacea)*, Himalayan blackberry *(Rubus procerns)*, and common reed *(Phragmites australis*) also occur, particularly in areas of disturbed soil. Beaver activity in the estuary helps to create and maintain wetland conditions through the building and maintenance of beaver dams (Yurok Tribe Environmental Program 2009).

3.5.3.2 Culturally Significant Species

Many plants, especially wetland plants, in the project area are culturally important to Indian Tribes in the Klamath River region for food and basketry (Larson and Brush

2010). Among these plants are ipos (roots of *Carum oregonum*), desert parsley (*Lomatium canbyi*), camas bulbs, cattail roots, and wocas (yellow pond lily seeds). Wild celery, wild parsley, and wild rhubarb were gathered along with hazelnuts, acorns, and pine nuts and the fruits of chokecherries, serviceberries, Klamath plums, elderberries, blackberries, gooseberries, wild grapes, and huckleberries (FERC 2007).

All of the tribes in the Klamath basin collect materials from along the Klamath River for making baskets that are used in various ceremonies. Willows *(Salix spp.)* and ferns *(Pteridophyta)* are both common species used in making basketry and regalia, and are important medicinal plants used in healing and ceremony (Yurok Tribe Environmental Program 2009). Tribes commonly collect young willow shoots from gravel bars within riparian areas. Other plant materials used in basket-making include pine, redwood and spruce roots, and grapevine (FERC 2007).

3.5.3.3 Wildlife

The project area supports a large number and diversity of wildlife species. During PacifiCorp surveys conducted in 2002 and 2003, 225 vertebrate wildlife species were detected or confirmed from other sources as occurring in the study area, including five amphibians, 16 reptiles, 174 birds, and 30 mammal species (PacifiCorp 2004a).

3.5.3.3.1 Amphibians

Amphibians and some reptiles are reliant on aquatic, wetland, and riparian habitat. PacifiCorp conducted an inventory of amphibians and reptiles in 2002 and 2003 to document species occurrence and identify important habitats and sites for amphibians and reptiles within the same study area that was used for the community mapping (PacifiCorp 2004a). The focus of the study included aquatic, wetland, and riparian habitats at the reservoirs and within a 0.25 mile buffer around river reaches from Link River to Shasta River. During the surveys, biologists searched suitable aquatic and riparian habitat for adults, larvae, and egg masses, turning rocks, litter, and other cover objects and using nets to catch individuals (PacifiCorp 2004a). Amphibian and reptile surveys were also conducted in suitable upland areas and complemented surveys conducted during previous investigations. Riverine surveys for amphibians found only two amphibian species, Pacific giant salamander and Pacific chorus frog. No amphibians were found during upland surveys. Based on the 2002 and 2003 surveys as well as previous investigations, five amphibian species are known to occur in the Klamath River study area: long-toed salamander, bullfrog, Pacific chorus frog, western toad, and Pacific giant salamander. These species are generally restricted to ponds or other still-water habitat, except for the Pacific giant salamander, which is a stream-dwelling species, and the western toad, which can breed in streams and standing water. Results of the PacifiCorp study indicate that reservoirs in the study area appear to provide only marginal breeding habitat for native pond-breeding amphibians. Fluctuating water levels and predation by yellow perch and bullfrog may limit the suitability of these habitats for amphibian breeding. Existing land uses, including roads, cattle grazing, and recreational activities also affect habitat quality in the study area (PacifiCorp 2004a).

In addition to the species listed in PacifiCorp (2004a), other amphibian species are also known to occur in the Klamath Basin. Western toad and foothill yellow-legged frog were reported in some of the tributaries of the Lower Klamath subbasin during trapping studies conducted in 1991 (USFWS 1992). In addition to the species listed in these previous reports, other amphibians are also known to occur in the Klamath Basin. Foothill yellow-legged frog is known by CDFG to breed in the mainstem of the Lower Klamath River (CDFG unpublished data). The northern red-legged frog is known by CDFG to breed in still water and low-velocity habitats, such as wetlands, ponds, and disconnected side channel habitats in coastal areas of the Lower Klamath River (CDFG unpublished data). The foothill yellow-legged frog and northern red-legged frog are both California Species of Special Concern. In addition, Green Diamond Resource Company conducted presence/absence surveys for tailed frogs and southern torrent salamanders (both California species of concern) in tributary streams of the Lower Klamath River and found these two amphibian species to be widespread in the tributaries (Green Diamond Resource Company 2006). However, due to lack of suitable habitat for these species, neither tailed frog nor southern torrent salamander would be expected to occur in the mainstem of the Lower Klamath River.

3.5.3.3.2 Reptiles

Based on surveys conducted in 2002 and 2003 as well as previous surveys in the study area, reptile species diversity and relative abundance is considered high in the study area, particularly in the Klamath River Canyon, along the J.C. Boyle canal, and near Keno Impoundment. In total, 16 reptile species were documented in the study area. Of these, the western fence lizard was the most abundant reptile species and was found in a variety of habitats. Other reptile species found during the surveys included gopher snake, northern sagebrush lizard, western rattlesnake, southern alligator lizard, yellow-bellied racer, common garter snake, western terrestrial garter snake, and western pond turtle. The remaining seven (7) species documented in the study area were recorded as incidental observations or from other investigators and include common kingsnake, striped whipsnake, sharptail snake, ringneck snake, western skink, rubber boa, and California mountain kingsnake (PacifiCorp 2004a).

Surveys for snake hibernacula, or over-wintering locations, were conducted at six specific areas. Although no snake hibernacula locations were confirmed through 2003 surveys, several locations with suitable habitat were identified (PacifiCorp 2004a).

3.5.3.3.3 Birds

A portion of the project area is in the Upper Klamath Basin along the Pacific Flyway, a major north-south route of travel for migratory birds in the Americas. The Upper Klamath Basin supports the largest concentration of migratory waterfowl in North America, with up to 2 million migratory birds during peak fall migration and about half that number in peak spring migration (Jarvis 2002). Migratory birds travel along the Pacific Flyway in spring and in fall, following food sources, heading to breeding grounds, or travelling to overwintering sites. Fall migration peaks in September and October and spring migration peaks in March and April in the Upper Klamath Basin (Jarvis 2002).

During these months, the wetlands of the Basin support nearly 80 percent of the Pacific Flyway's migratory waterfowl along with thousands of shorebirds and other waterbirds (Point Reyes Bird Observatory 2010).

Large numbers of water-related birds also use the Upper Klamath Basin for breeding. Several bird species have basin-wide populations of greater than 5,000 individuals during the summer months, and 11 other species exceed 1,000 individuals (Shuford et al. 2004). The wetlands support large breeding colonies of American white pelicans, double-crested cormorants, eared, Western, and Clark's grebes, great egret, white-faced ibis, ring-billed gull, California gull, and Caspian, Forster's, and black terns. A large number of these species also use the Upper Klamath Basin for staging prior to breeding in California's Central Valley. The Upper Klamath Basin also supports a high number of nesting bald eagles.

Overwintering birds that occur in the Upper Klamath Basin include tundra swans, snow geese, sandhill cranes, and a large number of waterfowl, other water birds, and raptors. In addition, the Upper Klamath Basin supports the largest wintering population of bald eagles in the coterminous United States (Shuford et al. 2004). Waterfowl are important prey for bald eagles in the Upper Klamath Basin (Manning and Edge 2002).

PacifiCorp conducted avian surveys in 2002 and 2003, consisting of avian point counts and area searches, protocol surveys for northern spotted owl and northern goshawk, and reservoir surveys. In addition, five Rapid Ornithological Inventories were conducted in 2002 by ornithologists from the Klamath Bird Observatory to document avian use and occurrence in riparian habitat during the fall migration. The Rapid Ornithological Inventories included mist-netting and banding along with area searches and nocturnal call-and-response owl surveys conducted during an intensive 3-day survey period in several river reaches. During these surveys, 174 bird species were detected with a total of more than 20,000 individual detections. Over 11,000 of these detections were recorded as occurring on reservoirs, with the highest number of birds found at Keno and Iron Gate Reservoirs. The importance of reservoir habitat was evidenced by the fact that approximately 67 percent of all birds documented by PacifiCorp during its field surveys were waterfowl and other water-related birds. The field surveys documented 47 species of water birds, including 20 species of waterfowl and 19 species of open-water, marsh, and wading birds other than waterfowl (PacifiCorp 2004a).

Seven common bird species were found in all 11 PacifiCorp study area sections. These include the western wood pewee, song sparrow, Brewer's blackbird, yellow warbler (a California species of special concern), brown-headed cowbird, black-headed grosbeak, and mourning dove. Each of these species is associated with riparian and/or wetland habitat (PacifiCorp 2004a). In addition, PacifiCorp documented 19 species of birds of prey, including six species of hawk, two eagle species, three falcon species, seven owl species, and one species of vulture; eight species of woodpeckers, including acorn woodpecker, white-headed woodpecker, Lewis' woodpecker, red-shafted flicker, red-breasted sapsucker, downy woodpecker, hairy woodpecker, and

pileated woodpecker; and five game bird species, including wild turkey, blue grouse, California quail, mountain quail, and mourning dove (PacifiCorp 2004a).

3.5.3.3.4 National Wildlife Refuges (NWRs)

Key wetland sites that support large numbers of birds in the Upper Klamath Basin include Clear Lake NWR, Klamath Marsh NWR, Lower Klamath NWR, Sycan Marsh, Tule Lake NWR, and Upper Klamath Lake (Shuford et al. 2004). These large wetland complexes support the vast majority of birds in the Basin (Jarvis 2002). Of the six refuges within the Upper Klamath Basin NWR System, Lower Klamath, Tule Lake, and Upper Klamath NWRs would be most directly affected by the KBRA (USFWS 2010). For this reason, the affected environment/existing conditions of three NWRs are described in the following paragraphs. Lower Klamath NWR and Tule Lake NWR are shown in Figure 2-13; Upper Klamath NWR is shown in Figure 2-15.

Lower Klamath NWR

Lower Klamath NWR represents the remnants of historic 80,000 acre Lower Klamath Lake and is divided into a number of management units ranging from 63 acres to over 4,000 acres. Basic wetland habitat types consist of seasonal and permanently flooded marshes and winter irrigated grain fields. Seasonally flooded wetlands are critical to meeting the migratory waterfowl goals of the refuge and for providing brood areas for early nesting waterfowl species. Permanent wetlands are flooded year-round and are crucial to meeting the refuge goals of waterfowl production and habitat for fall and spring migrant waterfowl. In addition, permanently flooded wetlands provide key breeding habitat for colonial nesting waterbirds such as several heron and egret species. The emergent vegetation provides nesting substrate for many species of waterfowl, wading birds, and passerine birds and acts as cover for resting waterfowl during periods of inclement weather. The submergent plant community supports a diverse and productive invertebrate community. An additional use of permanently flooded wetlands is by molting waterfowl in July-September (USFWS 2010, Yarris et al. 1994).

In addition to wetland habitats, Lower Klamath NWR also contains approximately 9,000 acres of agricultural lands including grain fields that are extremely attractive to fall migrant and wintering waterfowl and large numbers of wintering raptors, with bald eagles being the most conspicuous. Hayfields attract large populations of spring migrant geese which helps alleviate potential damage to private farmlands off the refuge.

Lower Klamath NWR receives most of its water from two sources: 1) D Plant, which pumps water from Tule Lake through the Sheepy Ridge tunnel and 2) the Ady Canal, which supplies water directly diverted from the Klamath River. Deliveries to the refuge in recent years (since about 2004) have been limited (USFWS 2010).

Tule Lake NWR

Tule Lake NWR is comprised of approximately 17,000 acres of croplands and 13,000 acres of wetlands contained within Sumps 1(A) and 1(B). Most of the area is comprised of open water dominated by submergent plant communities with extensive periodic blooms of filamentous green algae. High fish densities in Sumps 1(A) and 1(B) make

them extremely important foraging areas for fish-eating birds such as white pelicans, western and Clark's grebes, and double crested cormorants. Large areas of submerged aquatic vegetation are very important to migrating diving ducks, especially canvasback, ruddy ducks and lesser scaup (USFWS 2010).

In addition, Tule Lake NWR agricultural programs require growers to leave a proportion of small grain crops (typically 25-33 percent) standing for wildlife consumption. The high energy content of agricultural crops provides an important energy source for migrating waterfowl as they travel northward and southward in the Pacific Flyway (USFWS 2010).

Tule Lake NWR Sumps 1(A) and 1(B) primarily receive agricultural return flows during the spring/summer irrigation season and runoff during winter and spring precipitation events. Excess water in Sumps 1(A) and 1(B) is removed via a tunnel (D-Plant) through Sheepy Ridge to Lower Klamath NWR.

Upper Klamath NWR

Upper Klamath NWR is in Klamath County, Oregon, approximately 35 miles north of the California border and consists of 14,966 acres divided into two units; Hank's Marsh (approximately 1,191 acres) at the south end of Upper Klamath Lake, and Upper Klamath Marsh at the north end. Both Upper Klamath Marsh and Hank's Marsh represent relatively undisturbed remnant wetlands. Additional acreage of water storage within the Upper Klamath NWR include Agency Lake (approximately 9,000 acres) connected to the northern part of Upper Klamath Lake, and Barnes Ranch (approximately 2,000 acres) located northwest of Agency Lake. Because emergent wetlands of Upper Klamath NWR are not separated from the open waters of the lake by perimeter levees, water elevations in the lake have a direct effect on wetland water levels (USFWS 2010).

3.5.3.3.5 Mammals

During the PacifiCorp study, surveys for mammals included small mammal trapping, canal wildlife surveys, winter bait station and track surveys, and bat roost surveys. Common mammals that were found throughout the study area include black-tailed jackrabbit, mule deer, and California ground squirrel. Small mammals commonly found during trapping included deer mouse, bushy-tailed woodrat, least chipmunk, and montane vole. Medium-sized mammals detected in the study area included bobcat, striped skunk, gray fox, yellow-bellied marmot, and coyote. Large mammals included deer, elk, mountain lion, and black bear. Five aquatic and/or riparian-associated fur-bearing mammals were detected: raccoon, beaver, muskrat, mink, and river otter (PacifiCorp 2004a).

3.5.3.4 Special-Status Species

During the PacifiCorp (2004a) study, focused surveys for special-status species were conducted. Appendix G includes a series of 5 maps that show the occurrences of special-status plant species and three maps that show the occurrence of special-status wildlife species observed during the PacifiCorp study (PacifiCorp 2004a). These maps

are assumed to reflect current conditions, as recent comprehensive wildlife surveys have not been conducted. The methods used during these surveys are also summarized in Appendix H.

Fourteen special-status plants and 47 special-status wildlife species were detected in the PacifiCorp study area. Plant species include one federally endangered and Oregon endangered plant, Applegate's milk-vetch, and five Federal plant species of concern. Wildlife species include one Federal threatened species, the northern spotted owl, 15 Federal species of concern, two Oregon threatened species and one California threatened species, three California endangered wildlife species, and four fully protected bird species, golden eagle, bald eagle, peregrine falcon, and greater sandhill crane; Table 3.5-4 lists these species.

In addition to those species identified by PacifiCorp as having the potential to occur, new species lists were obtained for this Klamath Facilities Removal EIS/EIR from USFWS, Oregon Department of Fish and Wildlife (ODFW), Oregon Biodiversity Information Center (ORBIC), and CDFG's California Natural Diversity Database (CNDDB). The USFWS list included species listed by the National Marine Fisheries Service. The ORBIC database search included a 0.25 mile buffer around the Klamath River and the Keno Impoundment and J.C. Boyle Reservoir within Oregon. The CNDDB search included a total of 27 U.S. Geological Survey (USGS) 7.5-minute topographic quadrangles within which the project area is within California. A list of these quadrangles is provided in Appendix I.

Any new species that appeared on lists provided by the resource agencies (in addition to those found during the PacifiCorp study) were compiled into a comprehensive list of special-status species with some potential to occur in the project area (Appendix I). This list includes 242 special-status species: 2 invertebrates, 14 amphibians, 5 reptiles, 70 birds, 24 mammals, 115 plants, 3 bryophytes, and 9 lichens. Non-terrestrial species (fish, sea turtles, sea birds [albatross], marine invertebrates [abalone], and marine mammals) were not included here but are addressed in the Biological Assessment prepared for the project under Section 7 of the Federal ESA.

No additional plant or wildlife surveys beyond those conducted by PacifiCorp (2004b) were conducted for this EIS/EIR.

Table 3.5-4 identifies all the special-status plant species with documented occurrences in the project area based on the results of the PacifiCorp study and the ORBIC, and CNDDB searches. A total of 78 special-status species have been documented as occurring in the project area, including: 1 invertebrate, 3 amphibians, 5 reptiles, 47 birds, 5 mammals, and 17 plants, based on information from PacifiCorp surveys plus occurrences documented on ORBIC and CNDDB and information provided by the USFWS.

Special-status wildlife species were found to occur in each of the 11 PacifiCorp study area sections and in every delineated habitat type except rock talus. The largest number of special-status plants and wildlife species was found in the J.C. Boyle peaking reach.

Keno Impoundment, which has the highest amount of wetland and riparian habitat of the study area sections as well as limited water level fluctuations, was found to support a relatively high abundance of special-status wildlife across species groups, including the largest number of western pond turtles. Keno Impoundment also supports special-status plants including Applegate's milk-vetch (PacifiCorp 2004a; USFWS 2009).

3.5.3.4.1 Amphibians

Western toad was the only special-status amphibian species detected in the study area during PacifiCorp surveys; tailed frog and southern torrent salamander have also been documented in the study area during other investigations (Table 3.5-4). During PacifiCorp surveys, western toad breeding sites were confirmed in 2002 along the north shore of Iron Gate Reservoir and in the J.C. Boyle peaking reach along Way Creek. Adult toads were also reported from near the Copco 1 village. There are likely other breeding sites either along the reservoir shorelines or in small, isolated ponds throughout the study area (PacifiCorp 2004a). Tailed frog and southern torrent salamander were found to be widespread in the tributaries of the Lower Klamath River (Green Diamond Resources Company 2006), but due to lack of suitable habitat for these species, neither tailed frog nor southern torrent salamander would be expected to occur in the mainstem of the Lower Klamath River.

No Oregon spotted frogs were detected during 2003 surveys, or during surveys conducted in 1994 at locations of historic occurrence based on the Oregon Natural Heritage Program database. The presence of non-native bullfrog throughout the study area may indicate that predation has led to the extirpation of Oregon spotted frogs from the study area. Habitat degradation and poor water quality are other likely reasons why the Oregon spotted frog does not occur in the study area (PacifiCorp 2004a).

There is one historical record of foothill yellow-legged frog near the site of the J.C. Boyle Dam. There were no foothill yellow-legged frog detections during focused surveys in 2003, and it is likely that this species has been extirpated from the study area. This species is affected by loss of river habitat, predation by bullfrog and other aquatic predators, and desiccation or scour of egg masses resulting from flow alterations (PacifiCorp 2004a).

3.5.3.4.2 Reptiles

Four special-status reptile species were documented during PacifiCorp surveys: western pond turtle, northern sagebrush lizard, California mountain kingsnake, and common kingsnake. One additional species, sharptail snake, is known to occur based on previous studies (Table 3.5-4). Focused surveys for western pond turtle in 2002 resulted in 501 western pond turtle detections recorded during turtle surveys and 47 incidental observations in the study area, including 18 turtles in the beaver dam pond/wetland between Fall Creek and Iron Gate Reservoir, and 24 turtle observations along the Keno Impoundment shoreline during other wildlife surveys. A total of 276 turtles were documented in Keno Impoundment, 23 in J.C. Boyle Reservoir, 12 in Copco Reservoir, and 17 in Iron Gate Reservoir.

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Invertebrates				
Siskiyou (= Chace) sideband	*Monadenia chaceana*	S/M-B, ONHP List 1	Lower reaches of major drainages, in talus and rock slides, under rocks and woody debris in moist conifer forests, in caves, and in shrubby areas in riparian corridors. Rocks and large woody debris serve as refugia during the summer and late winter seasons.	Not documented during PacifiCorp surveys. Historic occurrence 0.25 miles below Copco Dam in lava rockslide (CNDDB 2010).
Amphibians				
Tailed frog	*Ascaphus truei*	CSSC	Perennial, cold, fast-flowing mountain streams with dense vegetation cover, or streams in steep-walled valleys in non-forested areas.	Widespread in tributary streams in the Lower Klamath River (Green Diamond Resource Company 2006).
Western toad	*Bufo boreas*	BLM, SV, ONHP List 4	Breeds from February to early May in ponds, the edges of shallow lakes, and in slow-moving streams. Adults are common near marshes and small lakes but may also be found in dry forests, shrubby areas, and meadows.	Documented during PacifiCorp surveys along J.C. Boyle peaking reach, along the north shore of Iron Gate Reservoir, and along Klamath River near river mile 185 (between the confluence of Bogus and Cottonwood Creeks). One occurrence near Frain Ranch, Klamath River Canyon (ORBIC 2010).
Northern red-legged frog	*Rana aurora*	CSSC USFS:S	Breeds in quiet low-velocity habitats, such as wetlands, ponds, and disconnected side channel habitats in coastal areas of the Lower Klamath River. Usually breeds January through March (Lannoo 2005).	Documented by CDFG as breeding in coastal areas of the Lower Klamath River.
Foothill yellow-legged frog	*Rana boylii*	BLM, CSSC	Streams and rivers with cobble-size or larger substrate. Breeds generally between late April and June (Lannoo 2005).	Known to CDFG to breed in the Lower Klamath River Mainstem and major tributaries.
Southern torrent salamander	*Rhyacotriton variegatus*	FSC, CSSC	Uppermost portions of cold, well shaded permanent streams with a loose gravel substrate, springs, headwater seeps, waterfalls, and moss covered rock rubble with flowing water.	Widespread in tributary streams in the Lower Klamath River (Green Diamond Resource Company 2006).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Reptiles				
Western pond turtle	*Actinemys marmorata*	FSC, BLM, SC, ONHP List 2, CSSC	Prefers quiet water in small lakes, marshes, and sluggish streams and rivers; requires basking sites.	Documented during PacifiCorp surveys at Keno, J.C. Boyle, Copco, and Iron Gate Reservoirs, along J.C. Boyle bypass reach, along J.C. Boyle peaking reach in California, and along Klamath River from Iron Gate Dam to Shasta River. Also documented at Iron Gate Reservoir and along Klamath River (ORBIC, CNDDB 2010).
Northern sagebrush lizard	*Sceloporus graciosus graciosus*	FSC, BLM, SV, ONHP List 4	Inhabits sagebrush, chaparral, juniper woodlands, and dry conifer forests.	Documented during PacifiCorp surveys in the rocky riparian shrub habitat of Keno reach, along J.C. Boyle peaking reach, near J.C. Boyle powerhouse intake canal, and near the edge of a forested wetland along Iron Gate Reservoir.
Sharptail snake	*Contia tenuis*	BLM	Inhabits moist sites in chaparral, conifer forests, and deciduous forests, but primarily occurs in oaks and other deciduous tree woodlands, particularly in the forest edges.	Known to occur along upper J.C. Boyle peaking reach west of Frain Ranch in Douglas-fir habitat but not detected by PacifiCorp during its surveys.
California mountain kingsnake	*Lampropeltis zonata*	FSC, BLM, SV, ONHP List 4	Inhabits thick vegetation along watercourses, farmland, chaparral, deciduous, and mixed-coniferous forests; specifically associated with moist river valleys and dense riparian vegetation.	Documented during PacifiCorp surveys along Copco Road and in close proximity to J.C. Boyle powerhouse intake canal. Also known to occur along J.C. Boyle peaking reach. Documented in Klamath River Canyon and at J.C. Boyle Dam (ORBIC 2010).
Common kingsnake	*Lampropeltis getula*	FSC, BLM, SV, ONHP List 4	Occurs in pine forests, oak woodlands, and chaparral in, under, or near rotting logs and usually near streams; associated with well-illuminated rocky riparian habitat with mixed deciduous and coniferous trees.	Documented during PacifiCorp surveys along J.C. Boyle peaking reach in oak/woodland and mixed conifer woodland and along Copco Road.
Birds				
Common loon	*Gavia immer*	FSC, CSSC	May over-winter on project reservoirs or occur in aquatic habitat associated with large bodies of water like the project reservoirs while migrating from sub-arctic freshwater breeding grounds to coastal and near-shore pelagic marine	Documented during PacifiCorp surveys at Iron Gate Reservoir.

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
			habitat along the Pacific coast.	
American white pelican	*Pelecanus erythrorhynchos*	BLM, SV, ONHP List 2, CSSC	Nests at lakes and marshes and uses almost any lake outside of the breeding season; have a restricted range in southern Oregon and along the California border, where they are found to be associated with only a few large bodies of inland water.	Documented during PacifiCorp surveys on all project reservoirs, with the highest number occurring on Keno Impoundment, and along Link River, Keno reach, J.C. Boyle bypass reach, and on Klamath River between Iron Gate Dam and Shasta River.
Double-crested cormorant	*Phalacrocorax auritus*	Nesting colonies are afforded special protection by CDFG.	Colonial nester on coastal cliffs, rocks, offshore islands, and along lake margins.	Documented during PacifiCorp surveys at Keno and J.C. Boyle Dams. Documented nesting colonies near mouth of Klamath River (CNDDB 2010).
Black-crowned night heron	*Nycticorax nycticorax*	FSC	Found in riparian habitats and in wetland sites.	Documented during PacifiCorp surveys primarily along Keno reach, but also along Link River, at Keno Impoundment, and along Klamath River from Iron Gate Dam to Shasta River. Communal roost used by night herons and other heron species in a group of willow trees near the East Side powerhouse adjacent to Link River.
Snowy egret	*Egretta thula*	BLM, SV, ONHP List 2	Inhabits emergent wetlands associated with freshwater marshes and along the periphery of large water bodies. The northern limit of the species range includes southern Oregon.	Documented during PacifiCorp surveys near Link River Dam, at Keno Dam, and along Keno reach.
Great egret	*Casmerodius albius*	BLM	Nests in willows and other trees; forages in shallow water, wetlands, and fields. Range includes Klamath basin and eastern Siskiyou County. Known to occur in the study area.	Documented during PacifiCorps surveys at J.C. Boyle and Keno Impoundments, Keno Canyon reach, J.C. Boyle bypass and peaking reaches, and Link River.
Great blue heron	*Ardea herodias*	Breeding colonies are afforded special-	Forages mostly in slow-moving or calm salt, fresh, or brackish water in a variety of habitats, including rocky shores, coastal lagoons, saltwater and freshwater marshes, mudflats, bays,	Documented during PacifiCorps surveys at all reservoirs and most study area reaches; colony documented at Copco Reservoir. Several rookeries documented along the Klamath River (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
		status protection by CDFG	estuaries, along the margins of rivers, lakes, and irrigation canals, and in flooded fields. Nesting colonies are typically found in groves of large trees, often in mixed colonies with other herons, egrets, and cormorants.	
White-faced ibis	*Plegadis chihi*	FSC, BLM, ONHP List 4, CSSC	Breeds in freshwater marshes and lakes, and estuaries, and nests near the water on mats of vegetation and twigs; usually occurs in isolated con-specific flocks. Does not typically overwinter in Oregon but is a fairly common visitor in the Klamath Wildlife Area during the spring and summer.	Documented during PacifiCorp surveys along Link River and at Keno Impoundment and J.C. Boyle Reservoir.
Bufflehead	*Bucephala albeola*	BLM, SU, ONHP List 4	Typically breeds around isolated mountain lakes; nesting habitat includes mixed conifer forest and ponderosa pine forests with sparse to moderate tree canopy closure close to lakes and ponds. Nests in cavities, including artificial nest boxes. May be found in open water and riverine habitat throughout southern Oregon after the breeding season.	Documented during PacifiCorp surveys primarily from January until April along the Link River, at Keno Impoundment and Copco and Iron Gate Reservoirs.
Barrow's goldeneye	*Bucephala islandica*	SU, ONHP List 4, CSSC	Tends to breed along high-elevation mountain lakes and winter in coastal areas. Potential nesting habitat includes forests with sparse to moderate tree canopy closure next to rivers and reservoirs.	Documented during PacifiCorp surveys along Keno Impoundment, in an inundated drainage ditch off of Copco Reservoir, and on Iron Gate Reservoir. Common winter migrant on the Link River and Keno Impoundment (R. Larson, USFWS).
Osprey	*Pandion haliaetus*	CSSC	Nests in all forested vegetation types with large trees near water, as well as on platforms erected in less optimal habitat.	A minimum of 16 active osprey nests, both artificial nesting platforms and natural sites, are found along the shores of the project reservoirs and river reaches. Documented during PacifiCorp surveys along the Keno reach, along the J.C. Boyle bypass reach, along the J.C. Boyle peaking reach, at J.C. Boyle, Copco, and Iron Gate Reservoirs, along Fall Creek, and along Klamath River from Iron Gate Dam

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
				to Shasta River. Several occurrences along Lower Klamath River (CNDDB 2010).
Northern harrier	*Circus cyaneus*	CSSC	Nests and forages in grasslands and emergent wetlands. Permanent residents in the project vicinity and common at the Klamath Wildlife Area.	Documented during PacifiCorp surveys in the low-lying marshland and agricultural fields east of Keno Impoundment and along Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Golden eagle	*Aquila chrysaetos*	CSSC, BCC, FP	Breeds in open mountain and hill habitats, nests in coniferous and deciduous trees and on cliff ledges, forages in grasslands and open conifer forests and woodlands with sparse to open tree canopy closure. Eagles typically use two to three nests during a lifetime.	Historical records exist of several golden eagle nests on cliffs from J.C. Boyle bypass reach to Iron Gate Reservoir. Documented during PacifiCorp surveys at J.C. Boyle powerhouse, along the lower section of J.C. Boyle peaking reach, along Copco and Iron Gate Reservoirs, and Copco bypass reach.
Bald eagle	*Haliaeetus leucocephalus*	FD, BCC, OT, ONHP List 4, CE, FP	Nests in large conifers within several miles of water; forages in rivers and lakes for fish and waterfowl; requires large snags for perching and conifers for night roosts.	Documented during PacifiCorp surveys at all project reservoirs and in all project reaches throughout the project vicinity. Also documented on Upper Klamath River, on the Klamath River near OR-CA border (ORBIC 2010), and along Lower Klamath River (CNDDB 2010).
Cooper's hawk	*Accipiter cooperii*	CSSC	Inhabits riparian deciduous forest, montane hardwood oak woodland, montane hardwood oak-juniper, montane hardwood oak-conifer, juniper woodland, mixed conifer forest, ponderosa pine forest, and lodgepole pine with any level of tree canopy closure.	Documented during PacifiCorp surveys along J.C. Boyle bypass and peaking reaches, and along Klamath River from the Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Northern goshawk	*Accipiter gentilis*	FSC, BLM, BCC, SC, ONHP List 4, CSSC	Inhabits forested communities with at least 60 percent canopy cover and trees greater than 6 inches in diameter, except oak woodland, oak-conifer woodland, and oak-juniper woodland; forages over large home ranges.	Documented during PacifiCorp surveys flying over J.C. Boyle peaking reach. Documented near tributaries of Lower Klamath River (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Sharp-shinned hawk	*Accipiter striatus*	CSSC	Inhabits riparian deciduous forest, montane hardwood oak woodland, montane hardwood oak juniper, montane hardwood oak-conifer, juniper woodland, mixed conifer forest, ponderosa pine forest, and lodgepole pine with any level of tree canopy closure and tree diameters ranging from 6 to 24 inches.	Documented during PacifiCorp surveys in oak habitat along J.C. Boyle bypass and peaking reaches, and along Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Swainson's hawk	*Buteo swainsoni*	FSC, BLM, SV, ONHP List 4, , CT	Dwells in open country and typically inhabits sagebrush, annual grassland, juniper woodland, montane hardwood oak-juniper, and riparian deciduous forest with sparse to open tree canopy closure. The species' range generally lies east of the project vicinity and includes the plains of the Great Basin in southeast Oregon and eastern northern California.	Documented during PacifiCorp surveys flying over agricultural fields southeast of Keno Impoundment. Not listed on CNDDB for project area (CNDDB 2010).
Merlin	*Falco columbarius*	BLM, ONHP List 2, CSSC	Uses a variety of forested and open habitats. Ranges throughout North America and travels great distances during migration from breeding grounds in northern Canada and Alaska to wintering habitat through the contiguous United States south to Central America.	Documented during PacifiCorp surveys at J.C. Boyle Reservoir and along J.C. Boyle peaking reach. Not listed on CNDDB for project area (CNDDB 2010).
Prairie falcon	*Falco mexicanus*	CSSC	Uses cliffs for nesting and plateau grasslands for foraging.	Documented during PacifiCorp surveys near Keno campground and boat ramp, above J.C. Boyle bypass reach, near Copco Reservoir, and flying over Klamath Wildlife Refuge. Several occurrences listed as sensitive (CNDDB 2010).
American peregrine falcon	*Falco peregrinus anatum*	FD, BLM, BCC, OE, ONHP List 2, FP	Breeds at suitable nest sites on cliffs and rocky outcroppings. Uses a variety of habitats, including open grassland areas, forest stands, and reservoirs throughout the project vicinity.	The project vicinity is in a management area designated for peregrine falcon recovery. Known to occur along Keno Impoundment and the J.C. Boyle bypass reach but not documented during PacifiCorp surveys. Several occurrences listed as sensitive (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Mountain quail	*Oreortyx pictus*	FSC, BLM, SU, ONHP List 4	Inhabits open forests, chaparral, and juniper woodlands with dense undergrowth offering suitable refuge; breeds in higher elevation areas; migrates on foot up to 40 miles to lower elevation winter grounds.	Documented during PacifiCorp surveys at J.C. Boyle reservoir, along the J.C. Boyle bypass reach and peaking reaches, along Fall Creek, and along Klamath River from the Iron Gate Dam to Shasta River.
Greater sandhill crane	*Grus canadensis tabida*	FSC, BLM, SV, ONHP List 4, CT, FP	Nests in marshes and wet meadows, and occasionally in pastures and irrigated hayfields. A primary requirement for suitable nesting habitat is the presence of surrounding water or undisturbed habitat.	Documented during PacifiCorp surveys east of Keno Impoundment and along J.C. Boyle reservoir. PacifiCorp located an active nest with two eggs in it in the emergent wetland bordering J.C. Boyle Reservoir. Several occurrences in the Lower Klamath Lake NWR (CNDDB 2010).
Caspian tern	*Sterna caspia*	BCC	Nests in tightly packed colonies on undisturbed islands, levees, and shores along inland water bodies during the summer breeding season. Forages over water.	Documented during PacifiCorp surveys on all project reservoirs as well as along Link River, Keno and J.C. Boyle bypass reaches, and along the Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Forster's tern	*Sterna forsteri*	BLM, ONHP List 4	Breeds at lakes and marshes and on mud or sand flats near water; forages over water.	Documented during PacifiCorp surveys along Link River, along Keno and J.C. Boyle bypass and peaking reaches, and at all project reservoirs. Not listed on CNDDB for project area (CNDDB 2010).
Black tern	*Chlidonias niger*	FSC, BLM, ONHP List 4, CSSC	Nests in emergent vegetation along the shoreline periphery of freshwater lakes, wetlands, and marshes along rivers and ponds; forages in wet meadows, pastures, agricultural fields, and water.	Documented during PacifiCorp surveys at Keno and J.C. Boyle Reservoirs. Not listed on CNDDB for project area (CNDDB 2010).
Marbled murrelet	*Brachyramphus marmoratus*	FT, OT, ONHP List 2, CE	Spends most of the time in the marine environment foraging in nearshore areas. Uses old-growth forests (coast Redwood forests in California) for nesting.	Known to occur within National Forest lands and Green Diamond Resource Company managed lands near the coast. Critical habitat has been designated near the mouth of the Klamath River.
Flammulated owl	*Otus flammeolus*	BLM, BCC, SC, ONHP List 4	Nests in abandoned woodpecker nest cavities in open forests with a ponderosa pine component.	Documented during PacifiCorp surveys along J.C. Boyle bypass and peaking reaches.

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Great gray owl	*Strix nebulosa*	BLM, S/M-C, SV, ONHP List 4, CE	Inhabits mixed conifer, ponderosa pine, and riparian mixed forest stands with trees greater than 11 inches in diameter providing at least 60 percent canopy cover within at least 984 feet of a natural or manmade opening greater than 10 acres. Breeds in tree cavities, typically near suitable open grassland foraging habitat.	Documented during PacifiCorp surveys east of Fall Creek near Jenny Creek. Not listed on CNDDB for project area (CNDDB 2010).
Northern Spotted Owl	*Strix occidentalis caurina*	FT, OT, ONHP List 1	Inhabits ponderosa pine forest, mixed conifer forest, and conifer forest with trees greater than 11 inches in diameter. Prefers old-growth forests with multi-layered tree canopies. Critical habitat occurs within the project area upstream of Copco Reservoir and south of the Klamath River and along portions of the Lower Klamath River.	Documented during PacifiCorp surveys near J.C. Boyle Reservoir and along J.C. Boyle peaking reach. Several occurrences within the project area (CNDDB 2010). Known to occur within National Forest lands and Green Diamond Resource Company managed lands near the coast. Critical habitat has been designated near the mouth of the Klamath River.
Vaux's swift	*Chaetura vauxi*	CSSC	Found in mixed conifer, ponderosa pine, lodgepole pine, riparian deciduous, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak-juniper forests with trees greater than 11 inches in diameter.	Documented during PacifiCorp surveys at J.C. Boyle, Copco, and Iron Gate Reservoirs, along the J.C. Boyle bypass and peaking reaches, along Fall Creek, and along Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Black swift	*Cypseloides niger*	SP, ONHP List 2, CSSC	Suitable nesting habitat is limited to cliffs near water courses. Breeding sites are widely distributed in Oregon and California; none known in Klamath or northern Siskiyou Counties.	Not documented during PacifiCorp surveys. Documented along Klamath River near Orleans (CNDDB 2010).
Pilelated woodpecker	*Drycopus pileatus*	BLM, SV ONHP List 4	Occurs in all forest and woodland cover types with moderate to dense tree canopy closure. Requires large snags 25 inches or more in diameter for excavating suitable nest cavities.	Documented during PacifiCorp surveys along Keno reach, at J.C. Boyle Reservoir, along J.C. Boyle bypass and peaking reaches, and along Fall Creek.

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Acorn woodpecker	*Melanerpes formicivorus*	FSC, BLM, ONHP List 4	Nests in cavities in snags of deciduous tree species, particularly oak snags at least 17 inches in diameter.	Several nesting colonies documented during PacifiCorp surveys in oak, oak-juniper, and oak/conifer habitats, primarily at Copco Reservoir. Also documented during PacifiCorp surveys at J.C. Boyle and Iron Gate Reservoirs, along J.C. Boyle peaking reach, along Copco bypass reach, along Fall Creek, and along Klamath River from Iron Gate Dam to Shasta River.
Lewis' woodpecker	*Melanerpes lewis*	FSC, BLM, BCC, SC, ONHP List 2	Associated with oak woodlands and mixed oak conifer habitat, but also can be found in a variety of open forest stands including ponderosa pine and cottonwood-dominated riparian areas.	Documented during PacifiCorp surveys in upland habitats along J.C. Boyle peaking reach, in riparian habitats at Iron Gate Reservoir, and along Klamath River from Iron Gate Dam to Shasta River. Documented in Klamath River Canyon (ORBIC 2010).
White-headed woodpecker	*Picoides albolarvatus*	FSC, BLM, BCC, SC, ONHP List 2	Nests in cavities typically in ponderosa pine at least 18 inches in diameter. Occurs in lodgepole pine, ponderosa pine, and Klamath mixed conifer forests with trees greater than 11 inches in diameter.	Documented during PacifiCorp surveys along J.C. Boyle bypass reach. Not listed on CNDDB for project area (CNDDB 2010).
Williamson's sapsucker	*Sphyrapiicus thyroideus*	BLM, SU	Associated with higher-elevation coniferous forest types including ponderosa pine, lodgepole pine, and Douglas-fir.	Known to occur in the general project vicinity but not documented during PacifiCorp surveys.
Olive-sided flycatcher	*Contopus cooperi*	FSC, BLM, BCC, SV, ONHP List 4	Typically found in coniferous forests with tall trees providing suitable perch sites.	Documented during PacifiCorp surveys along Link River, at Keno, J.C. Boyle and Iron Gate Reservoirs, and along Keno and J.C. Boyle peaking reaches. Not listed on CNDDB for project area (CNDDB 2010).
Willow flycatcher	*Empidonax traillii*	FSC, BLM, BCC, SV, ONHP List 4, CE	Associated with dense riparian willow thickets.	Documented during PacifiCorp surveys in some of the more dense willow patches along Link River, at J.C. Boyle, Copco, and Iron Gate Reservoirs, along the J.C. Boyle peaking reach, and along Klamath River from Iron Gate Dam to Shasta River. Also documented at Iron Gate Reservoir at Jenny Creek (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Black phoebe	*Sayornis nigricans*	BLM	Nests on cliffs or rock outcrops near water. Forage in riparian areas with thick vegetation and some nearby vertical surface. The Klamath study area exists along the northern limit of the species range.	Documented during PacifiCorp surveys along the Iron Gate-Shasta reach. Also regularly seen along the Miller Island section of the Keno Impoundment (R. Larson, USFWS).
Purple martin	*Progne subis*	FSC, BLM, SC, ONHP List 2, CSSC	Riparian and wetland forests, as well as Klamath mixed conifer forest, ponderosa pine forest, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak-juniper with sparse to moderate tree canopy closure (<60 percent). Range is patchy and may include portions of the study area.	Documented during PacifiCorp surveys above the upper falls at Fall Creek.
Black-capped chickadee	*Parus atricapillus*	CSSC	Nests in a variety of woodland habitats wherever suitable, small nest cavities can be found.	Documented during PacifiCorp surveys along Link River and at Copco and Iron Gate Reservoirs.
Pygmy nuthatch	*Sitta pygmea*	BLM, SV	Typically found in ponderosa pine forests with less than 70 percent canopy closure.	Documented during PacifiCorp surveys at Keno Impoundment and J.C. Boyle Reservoir.
Blue-gray gnatcatcher	*Polioptila caerulea*	BLM	Mixed chaparral, montane hardwood oak woodland, montane hardwood oak-juniper. Range overlaps the study area. The species is specifically known to breed in the chaparral of the Klamath basin.	Documented during PacifiCorp surveys at Iron Gate reservoir.
Western bluebird	*Sialia mexicana*	BLM, SV, ONHP List 4	Found in a variety of open habitats; may be limited by the availability of suitable nesting cavities. Nests in open clearings adjacent to woodlands or in human-made structures providing suitable nest sites.	Documented during PacifiCorp surveys along Copco bypass reach, along Fall Creek, and at Iron Gate Reservoir.

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Yellow warbler	*Dendroica petechia*	CSSC	Found in riparian deciduous forest, riparian shrub, scrub-shrub wetland, and forested wetland. Breeds in riparian habitat throughout North America and winters south from Mexico through South America.	Documented during PacifiCorp surveys throughout the project vicinity at all project reservoirs and in all project reaches. Not listed on CNDDB for project area (CNDDB 2010).
Yellow-breasted chat	*Icteria virens*	FSC, BLM, ONHP List 4, CSSC	Found in the brushy understory of deciduous and mixed woodlands; breeds in brushy vegetation, typically willow thickets, along rivers and streams.	Documented during PacifiCorp surveys primarily in wetland and riparian habitats along J.C. Boyle peaking reach, at Copco Reservoir, along Fall Creek, and along Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Mammals				
Townsend's western big-eared bat	*Corynorhinus townsendii townsendii*	FSC, BLM, SC, ONHP List 2, CSSC	Generally found in open forests and a variety of habitats; the availability of suitable roost sites (rock crevices, cliff ledges, and human-made structures) limits distribution and occurrence.	Known from J.C. Boyle peaking reach but not documented during PacifiCorp surveys. One occurrence in project area listed as sensitive by ORBIC (2010). Not listed on CNDDB for project area (CNDDB 2010).
Yuma myotis bat	*Myotis yumanensis*	FSC, BLM, ONHP List 4	Generally found in open forests and a variety of habitats; the availability of suitable roost sites (rock crevices, cliff ledges, and human-made structures) limits distribution and occurrence.	Documented during PacifiCorp surveys roosting in J.C. Boyle forebay spillway house, in transformer bays at Copco No. 1 powerhouse, and in rafters at Iron Gate south gatehouse. Also known from J.C. Boyle peaking reach. One occurrence outside project area (CNDDB 2010).
Western gray squirrel	*Sciurus griseus*	BLM, SU, ONHP List 4	Found in a variety of forested habitat types including mixed conifer forest, ponderosa pine forest, lodgepole pine, montane hardwood oak woodland, montane hardwood oak-conifer, and montane hardwood oak juniper with trees greater than 6 inches in diameter.	Documented during PacifiCorp surveys at J.C. Boyle and Copco Reservoirs, along J.C. Boyle peaking reach, and along Copco bypass reach.
Ringtail	*Bassariscus astutus*	BLM, SU, ONHP List 4	Uses a mixture of forest and shrublands or other habitats that provide vertical structure near rocky or riparian areas. Range overlaps the study area. The species is known to occur in the study area.	Not documented during PacifiCorp surveys. Documented in Klamath River Canyon (ORBIC 2010). Not listed on CNDDB for project area (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Fisher	*Martes pennanti*	FC, BLM, SC, ONHP List 2, CSSC	Mature, closed canopy forests with some deciduous trees; intermediate to large tree stages of conifer forests and riparian deciduous forests both with high tree canopy closure. Habitats in the study area include lodgepole pine, Klamath mixed conifer forest, ponderosa pine forest, riparian deciduous forest, montane hardwood oak-conifer with trees >11 inches dbh. Range overlaps the study area.	Not documented during PacifiCorp surveys. Documented along Lower Klamath River (CNDDB 2010). Has been documented in the Upper Klamath Basin within the last two years (Collom 2011).
Plants				
Applegate's milk-vetch	*Astragalus applegatei*	FE, OE, ONHP List 1	Occurs in flat-lying, seasonally moist, strongly alkaline soils.	Documented during PacifiCorp surveys at Keno Impoundment. 450 plants were found in 2009 on the west side of the Keno Impoundment near the PacifiCorp wareyard and 10,000 plants occur in a number of sites near the west side of Keno Impoundment on Collins Products property (R. Larson, USFWS).
Greene's mariposa-lily	*Calochortus greenei*	FSC, BLM, OC, ONHP List 1, CNPS List 1B	Occurs primarily in annual grassland, wedgeleaf ceanothus chaparral, and oak and oak-juniper woodlands.	Documented during PacifiCorp surveys at Iron Gate Reservoir. Yellow starthistle, medusahead, and annual bromes form the dominant herb layer cover at nearly all of the sites where Greene's mariposa lily was observed. Also known to occur at Copco Reservoir and along J.C. Boyle peaking reach. Several occurrences on CNDDB along Klamath River (2010).
Bristly sedge	*Carex comosa*	ONHP List 2	Marshes, lake shores, and wet meadows.	Not documented during PacifiCorp surveys. Documented along east shore of J.C. Boyle Reservoir (ORBIC 2010).
Brown fox sedge	*Carex vulpinoidea*	CNPS List 2	Near water on moist open ground in swamps, prairie swales, lowland forests, wet ditches, ravines, and along the edges of marshes, springs, lakes, and ponds.	Not documented during PacifiCorp surveys. Documented on north shore of Iron Gate Reservoir, 0.1 mile downstream from mouth of Fall Creek (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Mountain lady's slipper	*Cypripedium montanum*	BLM, S/M-D, ONHP List 4, CNPS List 4	Occurs in dry, open conifer forests, but more often in moist riparian habitats.	Documented during PacifiCorp surveys on a shaded and mesic, forested slope above Frain Creek, a small tributary to the Klamath River at Frain Ranch along J.C. Boyle peaking reach. Not listed on CNDDB for project area (CNDDB 2010).
Del Norte buckwheat	*Eriogonum nudum* var. *paralinum*	CNPS List 2	Coastal bluff scrub, coastal prairie.	Not documented during PacifiCorp surveys. Documented on sand bar at mouth of Klamath River (CNDDB 2010).
Bolander's sunflower	*Helianthus bolanderi*	BLM, ONHP List 3	Occurs in yellow pine forest, foothill oak woodland, chaparral, and occasionally in serpentine substrates or wet habitats.	Documented during PacifiCorp surveys in highly disturbed and degraded sites filled with annual bromes and starthistle along the lower reach of Hayden Creek, a tributary to the Klamath River along J.C. Boyle peaking reach, and south of Iron Gate Reservoir.
Salt heliotrope	*Heliotropium curvasassavicum*	BLM, ONHP List 2	Occurs in seasonally flooded, low-lying, non-porous areas on the east side of the Cascades.	Documented during PacifiCorp surveys at the upper end of Keno Impoundment.
Bellinger's meadow-foam	*Limnanthes floccosa ssp. Bellingerana*	FSC, BLM, OC, ONHP List 1, CNPS List 1B	Occurs in rocky, seasonally wet meadows, or along the margins of damp rocky meadows often partially shaded by adjacent trees and shrubs.	Not documented during PacifiCorp surveys. Known to occur along J.C. Boyle peaking reach. Not listed on CNDDB for project area (CNDDB 2010).
Detling's silverpuffs	*Microseris laciniata* ssp. *Detlingii*	CNPS List 2	Chaparral and grassy openings among Oregon white oak trees.	Not documented during PacifiCorp surveys. Documented west of Iron Gate Reservoir, 1.2 miles north of Klamath River bridge at Iron Gate Dam (CNDDB 2010).
Egg Lake monkeyflower	*Mimulus pygmaeus*	FSC, CNPS List 4	Occurs in damp areas or vernally moist conditions in meadows and open woods.	Documented during PacifiCorp surveys on the southwest end of J.C. Boyle Reservoir in damp mudflats adjacent to shallow and narrow tributaries to the Reservoir and under the transmission line just southwest of J.C. Boyle Dam. Not listed on CNDDB for project area (CNDDB 2010).
Wolf's evening-primrose	*Oenothera wolfii*	CNPS List 1B	Coastal bluff scrub, coastal dunes, coastal prairie, lower montane coniferous forest.	Not documented during PacifiCorp surveys. Documented along Lower Klamath River (CNDDB 2010).

Table 3.5-4. Special-Status Species Known to Occur in the Project Area

Common Name	Scientific Name	Status	Habitat	Occurrence in Project Area*
Red-root yampah	*Perideridia erythrorhiza*	FSC, BLM, OC, ONHP List 1	Occurs in moist prairies, pastureland, seasonally wet meadows, and oak or pine woodlands, often in dark wetland soils and clay depressions.	Not documented during PacifiCorp surveys. Known to occur along Keno reach, at J.C. Boyle Reservoir, and along J.C. Boyle peaking reach.
Columbia yellow cress	*Rorippa columbiae*	FSC, BLM, OC, ONHP List 1, CNPS List 1B	Occurs in cobbly, gravelly silt associated with seasonal creek drainages in ponderosa pine/juniper woodland, on the shores of alkaline lakes, along roadside ditches, in meadows, and seeps.	Documented during PacifiCorp surveys at Keno Impoundment. One occurrence at Klamath River near Orleans (CNDDB 2010).
Fleshy sage	*Salvia dorrii var. incana*	CNPS List 3	Occurs in silty to rocky soils in great basin scrub, pinyon, and juniper woodland.	Documented during PacifiCorp surveys on weathered bedrock outcrops overlain with thin, loose, and rocky substrate at Iron Gate Reservoir and along Klamath River from Iron Gate Dam to Shasta River. Not listed on CNDDB for project area (CNDDB 2010).
Pendulous bulrush	*Scirpus pendulus*	BLM, ONHP List 2, CNPS List 2	Occurs along streambanks and in wet meadows.	Documented during PacifiCorp surveys along Fall Creek and J.C. Boyle peaking reach. Documented outside project area (CNDDB 2010).
Short-podded thelypody	*Thelypodium brachycarpum*	FSC, BLM, ONHP List 2, CNPS List 4	Occurs in meadows and open flats.	Documented during PacifiCorp's field surveys in low-lying saltgrass grassland at Keno Impoundment. Large populations occur along both sides of the Keno Impoundment at Miller Island and on Collins Products property on the west side of Keno Impoundment (R. Larson, USFWS). Not listed on CNDDB for project area (CNDDB 2010).

Notes:
*Information on occurrence in the project area is based on PacifiCorp surveys (PacifiCorp 2004a) and information obtained from Oregon Biodiversity Information Center (ORBIC) and California Natural Diversity Database (CNDDB) databases (2010).
Key:
BCC: Birds of Conservation Concern (USFWS Division of Migratory Bird Management 2008a)
BLM: Bureau of Land Management sensitive species - species that could easily become endangered or extinct.
CDFG: California Department of Fish and Game
CE: California Endangered

CNPS List 1A: California Native Plant Society (CNPS)- Presumed extinct in California.
CNPS List 1B:rare, threatened, or endangered in California and elsewhere.
CNPS List 2: rare, threatened, or endangered in California, but more common elsewhere.
CNPS List 3: on the review list - more information needed
CNPS List 4: on the watch list - limited distribution
CSSC: California Department of Fish and Game Species of Special Concern - not listed under the Federal or California Endangered Species Act but are believed to: 1) be declining at a rate that could result in listing, or 2) historically occurring in low numbers and having current known threats to their persistence
CT: California Threatened
FC: Federal Candidate Species
FD: Federal Delisted
FE: Federal Endangered
FP: Fully protected under the California Fish and Game Code
FSC: Federal Species of Concern
FT: Federal Threatened
OC: Candidate listing by Oregon Department of Agriculture (ODA) or Oregon Department of Fish and Wildlife (ODFW)
OE: Listed as endangered by ODA or ODFW
ONHP List 1: Oregon Natural Heritage Program (ONHP) threatened with extinction or presumed to be extinct throughout their entire range
ONHP List 2: threatened with extirpation or presumed to be extirpated from theStateof Oregon
ONHP List 3: more information is needed before status can be determined, but may be threatened or endangered in Oregon or throughout their range
OHNP List 4: of conservation concern but not currently threatened or endangered
OT: Listed as threatened by ODA or ODFW
SC: Sensitive Critical - listed by ODFW as threatened or endangered is pending, or listing as threatened or endangered may be appropriate if immediate conservation actions are not taken.
SP: Sensitive Peripheral or Naturally Rare - listed by ODFW with populations on the edge of the range or historically low because of naturally occurring limiting factors
SU: Sensitive Undetermined Status - listed by ODFW for which status is unclear
SV: Sensitive Vulnerable - listed by ODFW as threatened or endangered is not imminent and can be avoided through continued or expanded use of adequate protective measures and monitoring. In some cases the populations are sustainable and protective measures
S/M-B = Survey and Manage Species, as designated in the Northwest Forest Plan; category B- pre-disturbance surveys not practical and not applicable (USFS and BLM 2011a). However, Attachment 4 of USFS and BLM 2011b indicates that for the Siskiyou (= Chace) sideband, “equivalent-effort, pre-disturbance surveys are required”.
S/M-C: Survey and Manage Species, as designated in the Northwest Forest Plan; category C - pre-disturbance surveys practical
S/M-D: Survey and Manage Species, as designated in the Northwest Forest Plan; category D - pre-disturbance surveys not practical or not necessary
USFWS: United States Fish and Wildlife Service

Several river reaches were also found to support pond turtles, including Fall Creek, the J.C. Boyle Peaking reach, and the Iron Gate-Shasta River reach. The turtle nesting habitat suitability mapping conducted in 2002 indicates that out of the 198 miles (319 km) of river and reservoir shoreline in the study area, approximately 42 miles (68 km) (21 percent) were characterized as having suitable nesting and basking habitat. An additional 60 miles (97 km) (30 percent) have suitable basking habitat structure (logs, large rocks, or patches of persistent emergent vegetation), but do not have the high quality potential nesting habitat either because of steep slopes, developed shorelines, or shorelines with dense understory vegetation (PacifiCorp 2004a).

Habitat for western pond turtle is affected by fluctuating water levels at reservoirs and along river reaches, particularly Iron Gate Reservoir and the J.C. Boyle peaking reach. Lower water levels can reduce the amount of aquatic habitat and make bordering emergent wetlands less accessible due to increased distance from water for hatchling turtles (PacifiCorp 2004a).

In addition, dense emergent vegetation may reduce turtle access to upland habitat, although typically small breaks are present. Developed areas and recreation sites may restrict shoreline habitat for turtles and affect their movement into nesting and overwintering sites. Turtles are known to be sensitive to human activity at distances of 328 feet; thus, human disturbance along roads, vegetation management, recreational activities, and other human activities are likely to affect turtles in the study area (PacifiCorp 2004a).

Northern sagebrush lizard was found during PacifiCorp surveys in or near forest habitat at locations including Iron Gate Reservoir, Keno Canyon reach, and J.C. Boyle peaking reach. California mountain kingsnake was recorded along Copco Road and along the J.C. Boyle canal near riparian woodlands. Common kingsnake was found on Copco Road, at the Iron Gate Reservoir, on a road in the Iron Gate-Shasta River reach, and near the Fall Creek reach within oak/woodland or chaparral habitat. No sharptail snakes were detected in the study area during 2002 surveys; however, the species was detected in the upper J.C. Boyle peaking reach during Bureau of Land Management (BLM) surveys in the spring of 2001 (PacifiCorp 2004a).

3.5.3.4.3 Birds

Birds represent the largest group of special-status species detected in the study area with 46 of the 69 species with potential to occur detected during PacifiCorp surveys or listed by ORBIC or CNDDB as occurring in the project area (Table 3.5-4). Among these, there are 14 water birds, 1 quail, 11 raptors, 3 owls, 2 swifts, and 15 passerines.

Most detections of special-status birds during PacifiCorp surveys were recorded in wetland, riparian, or aquatic habitat. During reservoir surveys, large numbers of American white pelicans were found on all reservoirs: 191 birds on Keno Impoundment, 71 birds on J.C. Boyle Reservoir, 55 birds on Copco Reservoir, and 107 birds on Iron

Gate Reservoir. In addition, a great blue heron colony, which is afforded special protection by CDFG, was documented at Copco Reservoir during supplemental surveys in that area (PacifiCorp 2004b).

Bald eagles were also found at all reservoirs, with the highest number (12) found at Copco Reservoir (PacifiCorp 2004a). A known bald eagle nesting site is south of Copco Dam (USFWS 2007). Bald eagles also utilize the middle and Lower Klamath River for foraging and nesting.

Golden eagles have historically nested on cliffs from J.C. Boyle bypass reach to Iron Gate Reservoir. During PacifiCorp surveys, golden eagles were found in several locations, including Copco and Iron Gate Reservoirs and J.C. Boyle powerhouse (PacifiCorp 2004a).

The only federally listed bird species detected during PacifiCorp surveys was the northern spotted owl, a Federal threatened species found near J.C. Boyle Reservoir and along J.C. Boyle peaking reach. A nest site is also known to occur near the Copco Reservoir. All known nest sites are more than one mile away from the dams and associated facilities (Roberts 2011). The majority of habitat surrounding Project features between Iron Gate Dam and J.C. Boyle Reservoir are considered unsuitable, with only two areas containing suitable nesting and roosting habitat (1) southeast of Copco 1 Reservoir (more than one mile away from project facilities) and (2) patchy areas surrounding J.C. Boyle Dam (about 0.9 mile away from project facilities) (Oakley Consulting 2011 and E. Willy, Biologist, USFWS Fish and Wildlife, pers. comm.; both as cited in Reclamation 2012b). No additional suitable habitat is expected to grow by 2019 (Roberts 2011).

Critical habitat for northern spotted owl is located north of the Klamath Hydroelectric Project boundary in the Jenny Creek watershed, upstream of the Copco Reservoir, and along portions of the Lower Klamath River. Northern spotted owls are also documented to occur on National Forest lands and along the Lower Klamath River on lands managed by Green Diamond Resources Company, and a Habitat Conservation Plan for the northern spotted owl is currently in development. Potentially suitable spotted owl habitat in the project area includes all forested communities and oak woodlands adjacent to mixed conifer stands with high canopy cover and large diameter trees (USFWS 2008b).

The marbled murrelet, a Federal threatened bird species, is known to occur on National Forest lands along the coast as well as on lands managed by Green Diamond Resources Company. This species does not occur inland near the PacifiCorp dams and associated facilities.

Four fully protected bird species, bald eagle, golden eagle, American peregrine falcon, and greater sandhill crane, are known to occur in the project area. Bald and golden eagles are discussed above. American peregrine falcons are known to occur along the river including the J.C. Boyle bypass reach. Greater sandhill cranes have been documented nesting at J.C. Boyle Reservoir.

3.5.3.4.4 Mammals

Two special-status mammals, western gray squirrel and Yuma myotis bat, were detected during PacifiCorp surveys (Table 3.5-4). Three other species, Townsend's western big-eared bat, ringtail, and Pacific fisher, have documented occurrences on ORBIC or CNDDB within the project area.

Yuma myotis was detected at the J.C. Boyle forebay spillway house, the Copco 1 powerhouse, and the Iron Gate south gatehouse (PacifiCorp 2004a). Although the presence of the seven other special-status bat species with potential to occur in the project area was not detected during bat roost surveys at PacifiCorp facilities, it is likely that one or more of these other special-status bat species occur in the roosting colonies (Leppig 2010).

3.5.3.4.5 Terrestrial Invertebrates

PacifiCorp did not conduct surveys for terrestrial invertebrates; however, special-status invertebrate species may occur within the project area (Larson 2011). One species that may occur based on known occurrences near the project area is the Siskiyou (Chace) sideband (*Monadenia chaceana*). Although USFWS has determined that the Siskiyou sideband does not warrant Federal listing (USFWS 2011), it is a special-status species under the Northwest Forest Plan (Regional Ecosystem Office [REO] 2011).

3.5.3.4.6 Plants

Ten special-status plant species were documented during PacifiCorp surveys. Of these, seven species are associated with wetland and/or riparian habitats. Seven additional species are known to occur in the project area based on previous investigations or occurrences listed on ORBIC or CNDDB (Table 3.5-4). Four of these additional species are associated with wetland and/or riparian habitats.

One federally listed species, Applegate's milk-vetch, was detected at the Keno Impoundment during PacifiCorp surveys. Applegate's milk-vetch, a Federal and Oregon endangered species, was found growing in an area of dense, undisturbed salt grass within 45 to 100 feet (17 to 30 m) of Keno Impoundment. The plant was observed along the reservoir in an area of approximately 250 feet (76 m) in length at a height or elevation above the reservoir water surface of less than 2 feet (0.6 m) (PacifiCorp 2004a). Additional surveys have identified Applegate's milk-vetch at several sites along the Keno Impoundment totaling over 10,000 plants. Three sites occur in areas within 100 meters of the Keno Impoundment in areas dominated by rabbitbrush (USFWS 2009).

Two other Federal endangered plants potentially occur in the project area. These are Yreka phlox (*Phlox hirsuta*) and Gentner's fritillary (*Fritillaria gentneri*). Ultramafic soils upon which the phlox is found occur within two miles of Copco Reservoir. The habitat for the fritillary that consists of mixed hardwood-conifer vegetation dominated by Oregon oak is present in the reach along Copco and Iron Gate Reservoirs (Larson 2011).

No rare or threatened natural communities were identified during the PacifiCorp study or documented on database searches by ORBIC or CNDDB.

3.5.3.5 Wildlife Corridors and Habitat Connectivity

Riparian corridors enable movement of both aquatic and terrestrial wildlife. Project reservoirs and waterways create substantial breaks in the connectivity of riparian habitat. Large mammals such as elk and deer are likely able to traverse these waterways, while they may create a barrier to movement by small mammals, reptiles, and amphibians. In addition, canals, roads, powerhouses, and other facilities often block movement of amphibians and reptiles (PacifiCorp 2004a).

Birds are highly mobile; however, the presence of transmission power lines has the potential to cause bird mortality from collisions, particularly when transmission lines cross flight paths that birds use during seasonal migration or daily movements between foraging and roosting areas. PacifiCorp determined that there are four segments of project transmission lines near areas of high waterfowl and wading bird use: one at Link River, one near the upstream end of Iron Gate Reservoir, and two segments of line that cross Iron Gate Reservoir. However, because these lines do not pass between the reservoirs/rivers and major wetlands or cropland that would attract foraging birds, the probability of collision is reduced, and there has been no evidence of avian collisions occurring on PacifiCorp lines (PacifiCorp 2004a).

3.5.4 Environmental Consequences

3.5.4.1 Environmental Effects Determination Methods

Evaluating potential impacts on terrestrial resources first entailed identification of the affected terrestrial resources within the analysis area. These include existing terrestrial vegetation communities and their value as habitat for wildlife; terrestrial special-status wildlife and plant species; use and dependence of terrestrial species on riparian, wetland, and aquatic reservoir habitat; and terrestrial wildlife corridors.

Habitats that are most likely to be most affected by the project alternatives are the riparian zones, wetlands, and aquatic habitats. Upland habitats would also be affected by KBRA actions. These habitats are important to many terrestrial wildlife species by providing food, water, cover, and breeding sites. Riparian and wetland communities have been greatly reduced in size within the Klamath Basin, with a wetland loses up to 90 percent by some estimations (Larson and Brush 2010). Thus, such habitats within the project area very important to the many species they support. Special-status species are vulnerable to any habitat loss or degradation. The ability to move to other habitat through wildlife corridors is vital to many terrestrial species. Modification of existing terrestrial habitat in the project area, especially limited riparian and wetland habitat, would have the potential to cause adverse effects.

The evaluation of the project alternatives considered short-term construction effects as well as permanent effects on terrestrial resources. Outputs of sediment transport and hydrologic models were used to identify predicted modifications of terrestrial vegetation communities and how that would affect wildlife habitat, including riparian areas, wetlands, and at reservoirs.

3.5.4.2 Significance Criteria

For the purposes of this EIS/EIR, impacts would be significant if they would result in the following:

- A substantial adverse effect, either directly or through habitat modifications, on any special-status terrestrial species identified in local or regional plans, policies, or regulations, or by the CDFG, USFWS, BLM, or USFS;
- A substantial adverse effect on any riparian habitat;
- A substantial adverse effect on federally protected wetlands as defined by Section 404 of the Clean Water Act through direct removal, filling, hydrological interruption, or other means;
- A substantial adverse effect on species considered significant to Indian Tribes;
- A substantial interference with the movement of any native resident or migratory wildlife species or with established native resident or migratory wildlife corridors; or
- A substantial adverse effect on natural communities through the introduction or spread of invasive plants.

3.5.4.3 Effects Determinations

3.5.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, the Four Facilities would remain in place. There would be no change to current sedimentation or scour rates in downstream river reaches.

As no construction would occur, there would be no impacts related to temporary loss of riparian habitat or direct mortality or disturbance of wildlife. No long-term habitat loss or gain would occur under the No Action/No Project Alternative. Existing habitat provided by the reservoirs would remain, which would benefit many species of birds, including waterfowl and bald eagles, bats, and other wildlife and plants that are supported by the aquatic habitat the reservoirs provide.

Populations of special-status plant and animal species, locally rare populations, and rare or threatened natural communities would continue to be influenced by various stressors in the Klamath Basin, including habitat degradation from surrounding land uses and invasive species. There would be no substantial changes to these stressors under the No Action/No Project Alternative. Under the No Action/No Project Alternative, existing wildlife corridors would remain. The reservoirs and other facilities would continue to present a barrier to movement of some terrestrial wildlife species.

The KBRA would not be implemented under the No Action/No Project Alternative; however, some Ongoing Restoration Actions would occur, including the Agency Lake and Barnes Ranches project which would breach existing dikes to convert the current 63,770 acre feet of pumped storage to passive storage in Upper Klamath Lake. This would provide benefits to waterfowl and their habitat in Upper Klamath Lake NWR through the re-establishment of a natural system of passive water storage. However, since the KBRA would not be fully implemented under the No Action/No Project

Alternative, there would continue to be uncertainty regarding water deliveries to the NWRs, and subsequent impacts on terrestrial resources within the Lower Klamath NWR, Tule Lake NWR, and Upper Klamath NWR. Specifically, there would be continued impacts on wetland habitat, waterfowl, and nongame waterbirds that utilize the NWRs based on predicted water deliveries without implementation of the KBRA.

Adverse impacts on terrestrial resources under the No Action/No Project Alternative would be associated with the continuance of various stressors within the area of analysis, including habitat degradation, invasive species, barriers to movement of some terrestrial wildlife species, and uncertainties in water deliveries to the NWRs. **There would be no change from existing conditions for these threats under the No Action/No Project Alternative.**

3.5.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

The Proposed Action would include the complete removal of power generation facilities, bypass canals, pipelines, unnecessary transmission lines, dams, and dam foundations associated with the Four Facilities. The Proposed Action also includes implementation of the KBRA.

This alternative would result in changes to the amount and distribution of habitat types and consequently to the species that depend on them, as described below. In addition, removal of the Four Facilities under the Proposed Action would enable salmon and other fish species to migrate upstream to reaches of the Klamath River which are currently inaccessible to them. These salmon would provide nutrient-rich food for terrestrial species, including bald eagles, osprey, and many other species of birds and mammals. These consumers would subsequently deposit these marine-derived nutrients into terrestrial habitats, increasing productivity of riparian vegetation and benefiting terrestrial ecosystems as a whole (Hilderbrand et al. 2004, Merz and Moyle 2006, Moore et al. 2011).

To facilitate dam removal, PacifiCorp reservoirs would be drawn down. Accumulated sediment behind the dams would be flushed downstream with river flows, particularly natural seasonal high flows, during dam removal. The drawdown of the reservoirs and dam demolition would begin in November 2019. It is assumed that blasting would be required to remove each of the dams. Blasting would occur between January and July 2020 and would be conducted twice a day (early morning and late afternoon) for up to six days per week during the dam removal period. As described in Section 3.23, Noise and Vibration, blasting would introduce noise levels up to a maximum of 94 A-weighted decibels (dBA) at a distance of 50 feet, while maximum levels for typical construction equipment would range from 75 dBA (pickup truck) to 90 dBA (mounted impact hammer/hoe ram) at 50 feet.

Drawdown of all reservoirs would occur at a rate that would minimize riverbank erosion, while maintaining regulatory discharge rates from the reservoirs (Greimann et al. 2010). This rate would be adjusted depending on the water year, such that flow rates downstream from the dams would not increase significantly above regulatory rates.

Following drawdown of the reservoirs, existing upland vegetation is expected to remain unchanged and contribute to successional processes on newly exposed areas. Wetland-dependent vegetation currently along the margins of the reservoirs is expected to die out and transition to upland communities. Wetland species that occur near confluences may remain unchanged if the hydrology is unaltered, and could expand down to the river channel at reconnected tributaries. Passive restoration of wetland vegetation in areas along the restored river channel is considered feasible, since relatively high densities of viable wetland vegetation seed are present in reservoir sediments based on seedbank analysis (Reclamation 2011).

In contrast, active restoration would be needed for upland and riparian areas. In accordance with the Reservoir Area Management Plan (Reclamation 2011), the reservoir areas will be re-seeded with various herbaceous species (primarily grasses) following drawdown in the spring. Seeding is expected to occur via aerial application of hydromulch, as access to newly drawn down reservoir areas would be limited. Hydroseeding would occur prior to full drawdown, likely in stages as areas are exposed, and ultimately covering the entire area of exposed sediment following drawdown. It would be necessary to hydroseed before the reservoir sediment desiccates so that there is residual soil moisture for seed germination. Following hydroseeding, grasses would quickly germinate and grow on the exposed reservoir surfaces to stabilize the surface of the sediment, minimizing erosion. Invasive plant species would be controlled with the use of herbicides such as glyphosate that have low soil mobility and low toxicity to fish and aquatic organisms (DOI 2011a).

Riparian restoration activities would include planting of various woody species along the channel margins to stabilize the river banks and provide habitat for fish and other species. Pole plantings would be installed in the riparian/wetland zone once the reservoirs have been completely drawn down, the new river channel is established, and banks are stabilized so that labor crews can access riparian zones. Pole planting would occur in the spring the year after drawdown, ideal timing for establishment of woody species in riparian zones (Reclamation 2011).

Following reservoir drawdown and prior to restoration activities, additional fencing may be necessary at the reservoir sites to keep livestock out and protect restoration areas, including Parcel B lands. If needed, any new fencing would be “wildlife-friendly” to enable elk and deer to jump over without getting entangled in barbed wire. The amount and location of additional fencing would be determined once the Definite Plan is available.

In addition to restoration of reservoir areas, many of the developed recreation sites around the reservoirs would be removed and restored following dam removal. This would include regrading, seeding, and planting of parking lots (Reclamation 2011).

Due to the likelihood for invasive or weedy species to colonize newly exposed areas, and the known presence and proximity of large stands of upland invasive species near the reservoir shorelines, active control measures would be required to ensure native species

are established. A Habitat Rehabilitation Plan (HRP) and construction specifications would be developed once the Definite Plan is available and would be submitted to the resource agencies for review and approval as part of required permit application packages prior to construction.

The HRP would include details for the installation of native plants and hydroseeding in appropriate areas to re-vegetate all areas disturbed during construction, including reservoir areas, demolition and disposal sites, staging, access and haul roads, and turn-arounds. Long-term maintenance and monitoring to control invasive species would be included. Performance standards to be met to ensure successful re-vegetation of disturbed areas will be developed as described in **Mitigation Measure *TER-1*** in Section 3.5.4.4.

In addition, to minimize the introduction of invasive plant species into construction areas, construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts and dispose of them in an appropriate disposal facility.

Construction Impacts on Wetland and Riparian Vegetation Communities
Construction of the Proposed Action could result in the loss of wetland and riparian vegetation communities. Disturbances associated with construction areas and haul roads where clearing, grading, and staging of equipment would occur would have impacts on sensitive habitats, including wetlands and riparian habitats along reservoirs and river reaches. Culturally important species such as willows occur in these riparian areas. Heavy machinery traversing wetland and riparian areas could change local topography and destroy wetland and riparian vegetation, and could introduce hazardous materials that would adversely affect water quality in wetland and riparian areas.

Once the Definite Plan is prepared and construction areas are delineated, measures would be implemented prior to and during construction to avoid and mitigate impacts to sensitive vegetation communities such as wetlands. During construction for the Proposed Action, wetlands within 50 feet of any ground disturbance and construction-related activities (including staging and access roads) would be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles. If new temporary access roads are required, grading would be conducted such that existing hydrology would be maintained. In addition, best management practices (BMPs) would be implemented to address potential water quality impacts on wetlands. These construction BMPs are discussed further in Section 3.2, Water Quality. The following pollution and erosion control measures would be incorporated into the Proposed Action to prevent pollution caused by construction operations and to reduce contaminated stormwater runoff:

- Oil-absorbing floating booms would be kept onsite and the contractor would respond immediately to aquatic spills during construction.
- Vehicles and equipment would be kept in good repair, without leaks of hydraulic or lubricating fluids. If such leaks or drips do occur, they would be cleaned up

immediately. Equipment maintenance and/or repair would be confined to one location at each project construction site. Runoff in this area would be controlled to prevent contamination of soils and water.
- Dust control measures would be implemented, including wetting disturbed soils.
- A stormwater pollution prevention plan would be implemented to control the release of stormwater from construction areas. The plan would also prevent construction materials (fuels, oils, and lubricants) from spilling or otherwise entering waterways or water bodies.

Incorporation of these elements into the Proposed Action would avoid or reduce temporary impacts on wetland and riparian vegetation communities including culturally important species that occur there to less than significant.

Construction Impacts on Wildlife

Construction activities could result in direct mortality or harm to special-status invertebrate, amphibian, and reptile species during construction. Construction would require heavy machinery to move through construction areas, staging areas, and haul roads where special-status invertebrate, amphibian, and reptile species could occur. Contact with construction vehicles could result in direct mortality or injury to special-status invertebrate, amphibian, and reptile species including Siskiyou (Chace) sideband, western toad, western pond turtle, California mountain kingsnake, and common kingsnake.

To avoid or reduce the potential for mortality and disturbance of special-status species within construction areas for the Proposed Action, the following elements would be incorporated:

- Biological Resources Awareness Training. Before any ground-disturbing work (including vegetation clearing and grading) occurs in the construction area, a qualified biologist would conduct a mandatory biological resources awareness training for all construction personnel and the construction foreman. This training would inform the crews about special-status species that could occur on site. The training would consist of a brief discussion of the biology and life history of the special-status species; how to identify each species, including all life stages; the habitat requirements of these species; their status; measures being taken for the protection of these species and their habitats; and actions to be taken if a species is found within the project area during construction activities. Species identification cards would be issued to shift supervisors; these cards would have photos, descriptions, and actions to be taken upon sighting of special-status species during construction. Upon completion of the training, all employees would sign an acknowledgment form stating that they attended the training and understand all protection measures. An updated training would be given to new personnel and in the event that a change in special-status species occurs.
- Protocol-level Wildlife Surveys. Prior to construction, a biologist approved by the resource agencies (USFWS, ODFW, and/or CDFG) would conduct protocol surveys to ensure no special-status animals are present within the area in which any

construction activity would occur. For invertebrate species such as the Siskiyou (Chace) sideband, surveys for suitable habitat within construction areas would be conducted to determine the likelihood of presence, and if so, surveys for the species itself would be conducted consistent with the 2011 Survey & Manage settlement agreement memorandum (USFS and BLM 2011b). If special-status species are present (except for birds), they would be captured and relocated to a suitable area in consultation with the resource agencies.

- Exclusion Measures for Special-Status Wildlife. Construction areas, including staging areas and access routes, would be fenced with orange plastic snow fencing to demarcate work areas. The approved biologist would confirm the location of the fenced area prior to habitat clearing, and the fencing would be maintained throughout the construction period. Additional exclusion fencing or other appropriate measures would be implemented in consultation with the resource agencies to prevent use of construction areas by special-status species during construction.
  - To prevent entrapment of wildlife that do enter construction areas during activities, all excavated, steep-walled holes or trenches in excess of two feet deep would be inspected by a biologist or construction personnel approved by the resource agencies at the start and end of each working day. If no animals are present during the evening inspection, plywood or similar materials would be used to immediately cover the trench, or it would be provided with one or more escape ramps set at no greater than 1,000 foot intervals and constructed of earth fill or wooden planks. Trenches and pipes would be inspected for entrapped wildlife each morning prior to onset of activity. Before such holes or trenches are filled, they would be thoroughly inspected for entrapped animals. Any animals so discovered would be allowed to escape voluntarily, without harassment, before activities resume, or removed from the trench or hole by a qualified biologist approved by the resource agencies and the animals would be allowed to escape unimpeded. A biologist approved by the resource agencies would be responsible for overseeing compliance with protective measures during clearing and construction activities within designated areas throughout the construction activities.
- General Requirements for Construction Personnel include the following:
  - The contractor would clearly delineate the construction limits and prohibit any construction-related traffic outside these boundaries.
  - Construction crews would be required to maintain a 20 miles per hour (mph) speed limit on all unpaved roads to reduce the chance of wildlife being harmed if struck by construction equipment.
  - All food-related trash items such as wrappers, cans, bottles, and food scraps generated during construction, subsequent facility operation, or permitted operations and maintenance activities of existing facilities would be disposed of in closed containers only and removed at least once a week from the site. The identified sites for trash collection would be fenced to minimize access from wildlife.
  - No deliberate feeding of wildlife would be allowed.
  - No pets would be allowed on the project site.
  - No firearms would be allowed on the project site.

- If vehicle or equipment maintenance is necessary, it would be performed in the designated staging areas.
- Any worker who inadvertently injures or kills a federally or State listed species, bald eagle, or golden eagle, or finds one dead, injured, or entrapped would immediately report the incident to the construction foreman or biological monitor. The construction foreman or monitor would notify the resource agencies within 24 hours of the incident.

These elements of the Proposed Action would avoid or reduce mortality and harm to special-status invertebrate, amphibian, and reptile species during construction. **Therefore, impacts on special-status invertebrate, amphibian and reptile species during construction would be less than significant.**

Construction activities could result in adverse impacts on birds, including special-status bird species, during construction. Potential impacts on migratory birds, including several special-status species, could occur through nest abandonment due to noise and human activity during construction periods.

It is anticipated that dam demolition activities (including blasting) would begin in January 2020 and mobilization of construction equipment would begin in the late fall of 2019. Construction activities that could result in noise and disturbance impacts on birds would include dam demolition, clearing of access and haul roads, upload staging and disposal sites, and restoration activities. While it would not be possible to exclude all birds from these construction areas throughout the construction period, the Proposed Action incorporates specific construction measures to avoid or reduce impacts on birds, as described below. These measures were developed in coordination with USFWS (Strassburger 2011).

It is important to note that analysis of effects to northern spotted owl and other federally listed species that could be affected by the Proposed Action were evaluated in a Biological Assessment (BA) under Section 7 of the Federal ESA. Avoidance measures and project design standards were detailed in the description of the Proposed Action in the BA (Reclamation 2012b).

Northern Spotted Owl

Based on the analysis conducted in support of the Biological Assessment, no current activity centers are located within the disturbance distance of the anticipated construction activities analyzed (Reclamation 2012b). Suitable habitat which has the potential to support future nesting spotted owl pairs is present within the disturbance distance of the following Proposed Action activities:

1. Copco No 1 Reservoir
    - Improving and use of haul routes at Copco No. 1 Reservoir

- J.C. Boyle
  - Improving and use of haul routes for dam demobilization and reservoir revegetation monitoring and maintenance
  - Removal of the concrete stoplogs and spillway gates
  - Mobilization; excavation of dam embankment; removal of spillway gates and crest structure, fish ladder, steel pipes, canal intake screen structure, left concrete gravity section, power canal (flume), shotcrete slope protection, forbay spillway control structure, tunnel inlet portal structure, surge tank, penstocks (including supports and anchors), tunnel portals, powerhouse gantry crane and substructure, tailrace flume walls, switchyard, warehouse, and support buildings; backfill tailrace channel area and canal spillway scour area; and demobilization
  - Modification or removal of 2.2-mile-long power canal (or flume)
  - Removal of the 64-kV transmission lines

The Proposed Action incorporates specific minimization measures that would avoid or reduce impacts on northern spotted owls during construction. The northern spotted owl typically nests from February through September in the project area. Suitable northern spotted owl nesting and roosting habitat does not occur within one mile of the dams, and none is expected to grow by 2019 (Roberts 2011). In addition, since mobilization of construction equipment would begin in November 2019, noise and human presence would likely discourage northern spotted owls from initiating nesting near construction areas. Therefore, impacts on this species from the Proposed Action would be limited to disturbance during aerial hydroseeding that would occur during restoration activities. All landings, staging areas and flight paths would avoid suitable northern spotted owl nesting or roosting habitat by 0.25 mile. The following minimization measures for the northern spotted owl were proposed in the Biological Assessment (Reclamation 2012b). Final versions of the measures are anticipated in the Biological Opinion and would be implemented as part of the Proposed Action:

- Measure NSO 1: Prior to initiating any construction activities, potential impacts of ground-disturbing construction activities will be evaluated for northern spotted owl and its habitat, and construction plans will be modified as appropriate, with an overall goal of preventing or minimizing impacts. Locations of the individual components of the Proposed Action, noise disturbances, and habitat geographic information system (GIS) layers will be reevaluated using the best available data at the time of construction to determine whether or not additional measures are needed.
- Measure NSO 2: Protocol-level surveys will be conducted within suitable nesting and roosting habitat (assessed by using best available GIS information, aerial photos, and consultation with the USFWS) that occur within the northern spotted owl disturbance distance of the construction activity. If no nesting is observed, no seasonal restriction would be required. If nesting is observed, a California seasonal restriction (February 1–September 15) or Oregon seasonal restriction (March 1–September 30) will be followed or

activity will be delayed as late as possible into the late breeding season for California (July 10–September 15) or Oregon (August 11–September 30) to minimize the disturbance to young prior to fledging.

- Measure NSO 3: To prevent direct injury of young resulting from aircraft, no helicopter flights will occur within or at an elevation lower than 0.8 km (0.5 mi) of suitable nesting and roosting habitat during the entire breeding season unless protocol level surveys identify no activity centers.
- Measure NSO 4: No component of suitable nesting, roosting, foraging, or dispersal habitat will be modified or removed during the removal of transmission lines or installation or removal of fencing.

As part of Measure NSO 2 described above, prior to construction, a biologist approved by the resource agencies (USFWS, ODFW, and/or CDFG) would conduct protocol surveys endorsed by USFWS for northern spotted owls in all areas supporting suitable nesting and roosting habitat that may be affected by construction, including along access roads and haul routes. If, during preconstruction surveys, an active nest of northern spotted owl is identified, a restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed from construction. This would include evaluation of noise levels at the nesting site.

Bald Eagle

Bald eagles are protected under the Bald and Golden Eagle Protection Act and are fully protected under California law. The Proposed Action incorporates specific elements that would avoid or reduce impacts on bald eagles during construction [2]. Bald eagle nesting trees are known to exist within or near to construction areas for the Proposed Action, and bald eagles often use the same nests in multiple years. Prior to construction, all necessary permits in compliance with the Bald and Golden Eagle Protection Act would be obtained. Measures incorporated into the Proposed Action to reduce impacts on bald eagles (and golden eagles) from loss of nesting habitat will include the following:

- Complete a two-year survey for eagle use patterns prior to construction activities. Surveys will be conducted by a qualified avian biologist and will include any facilities to be removed or modified to determine bird use patterns. Surveys will be conducted during the time of year most likely to detect eagle usage.

- Prior to construction, conduct at least one focused survey for bald eagle nests within 2 miles of construction areas, including along access roads and haul routes, during the early bald eagle breeding season (January 15 through February 28). Three additional surveys would be conducted; two between March 1 and April 1, and one after April 1. Additional survey visits would be conducted to determine if eagles are nesting within 2 miles of the construction area. Before commencing

[2] The discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate the development of compliance documentation for the Bald and Golden Eagle Protection Act. These BMPs are also described in Appendix B.

construction activities during the early breeding season, at least one survey would be conducted within two weeks prior to beginning operations.

- Wherever possible, clearing, cutting, and grubbing activities shall be conducted outside the eagle breeding period (January 15 through August 15).
- If active nests are present within 2 miles of construction areas, a 0.5-mile restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed. If active bald eagle nests are present within 0.5 miles of construction areas, construction activities would be halted until approval is obtained from the resource agencies to resume. If a nest is not within line of site of the project, meaning that trees or topographic features physically block the eagle's view of construction activities, the buffer could be reduced to 0.25 miles.

Golden Eagle

Golden eagles are protected under the Bald and Golden Eagle Protection Act and are fully protected under California law. The Proposed Action incorporates specific elements that would avoid impacts on golden eagles[3]. Golden eagles are known to have historically nested in cliffs within the project area. Golden eagles are also known to nest within pine, juniper and oak trees.

Measures incorporated into the Proposed Action to reduce impacts on golden eagles during construction will include the following:

- Complete a two-year survey for eagle use patterns prior to construction activities. Surveys will be conducted by a qualified avian biologist and will include any facilities to be removed or modified to determine bird use patterns. Surveys will be conducted during the time of year most likely to detect eagle usage.
- Prior to construction, at least one protocol survey for golden eagle nests would be conducted within 5 miles of construction areas, including along access roads and haul routes, during the breeding season (January through July). Before commencing construction activities during the early breeding season, at least one focused survey would be conducted within two weeks prior to beginning operations. Additional survey visits would be conducted to determine if eagles are nesting within 2 miles of the construction area.
- Wherever possible, clearing, cutting, and grubbing activities shall be conducted outside the eagle breeding period (January through July).
- If active nests are present within 2 miles of construction areas, a 1-mile restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed. If active golden eagle nests are present within 1 mile of

[3] Please note that the discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate compliance with the Bald and Golden Eagle Protection Act. These BMPs are repeated in Appendix B.

> construction areas, construction activities would be halted until approval is obtained from the resource agencies to resume. If an active nest is not within line of site of the project, meaning that trees or topographic features physically block the eagle's view of construction activities, the buffer could be reduced to 0.5 miles.

It is noted that USFWS is not currently issuing permits authorizing take for golden eagles under the Bald and Golden Eagle Protection Act.

Osprey

The Proposed Action incorporates specific elements that would avoid or reduce impacts on ospreys during construction. Known osprey nests are located within or near to construction areas for the Proposed Action. Some osprey nests are located on transmission line poles or other man-made platforms that would be removed during construction for the Proposed Action, or are located within areas where construction noise or human presence would cause disturbance to the birds. To avoid nesting disturbance, the nests located within or near to construction areas would be removed prior to the breeding season and replaced with nesting platforms following construction on a 1:1 basis. In addition, a search for osprey nests within 0.25 mile of construction areas, including along access roads and haul routes, would be conducted prior to beginning operations and during the breeding season, which begins in February. If active nests are present, a 0.75-mile restriction buffer would be established and delineated on maps and resource agencies would be consulted to obtain concurrence prior to conducting construction activities.

Willow Flycatcher

The Proposed Action incorporates specific elements that would avoid or reduce impacts on willow flycatcher during construction. Prior to construction during the nesting season of June 1-August 31, a focused survey for willow flycatcher would be conducted within construction areas, including along access roads and haul routes. The survey would follow the established protocol described in Bombay et al. (2003). If active willow flycatcher nests are detected, a 0.5-mile restriction buffer would be established and delineated on maps and resource agencies would be consulted to obtain concurrence prior to conducting construction activities.

Peregrine Falcon

Peregrine falcons, a fully protected species, are known to occur along the J.C. Boyle bypass reach, and have the potential to occur elsewhere in the project area. Specific elements described below (see Other Migratory Birds) would be incorporated during construction, including nesting surveys, to avoid or reduce impacts on peregrine falcons. If nesting peregrine falcons are detected, a restriction buffer would be established prior to conducting construction activities.

Greater Sandhill Crane

Greater sandhill cranes, a fully protected species, are known to occur in the project area, and have been documented nesting along the J.C. Boyle Reservoir. Specific elements

described below (see Other Migratory Birds) would be incorporated during construction, including nesting surveys, to avoid or reduce impacts on greater sandhill cranes. If nesting sandhill cranes are detected, a restriction buffer would be established prior to conducting construction activities.

Other Migratory Birds

The Proposed Action incorporates the following specific elements that would avoid or reduce impacts on migratory birds from removal, destruction, or disturbance of active nests during construction:

- Removal or trimming of any trees or other vegetation for construction would be conducted outside of the nesting season (March 20 through August 20). This would include removal or trimming of trees along access roads and haul routes and within disposal sites.

- Where clearing, trimming, and grubbing work cannot occur outside the migratory bird nesting season, a qualified avian biologist will survey construction areas to determine if any migratory birds are present and nesting in those areas.

- For all raptors (other than eagles), inactive nests will be removed before nesting seasons begin, to the greatest extent practicable. For those nests where access is difficult, traffic cones or other deterrents will be placed in the nest platform to prevent nesting in the year of construction. All deterrents will be removed as soon as possible after construction crews have passed to a point beyond the disturbance buffer for that species. See **Mitigation Measure *TER-2*** (Section 3.5.4.4, Table 3.5-6).

- If an active nest is located, a restriction buffer in accordance with **Mitigation Measure *TER-2*** (Section 3.5.4.4, Table 3.5-6) would be established and the resource agencies would be consulted to obtain concurrence prior to conducting construction activities.

Incorporation of these elements into the Proposed Action and implementation of **Mitigation Measures *TER-2*** and ***TER-3*** would avoid or reduce impacts on birds during construction.[4] **Therefore, impacts on birds, including special-status bird species, during construction would be less than significant.**

Construction Impacts on Plants

Construction activities could result in the loss of special-status plants during construction. Special-status plants occurring in construction areas could be destroyed by heavy equipment. Prior to the implementation of construction activities, a botanist approved by the resource agencies would conduct protocol-level surveys within

[4] The discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate the development of compliance documentation for the Bald and Golden Eagle Protection Act. These BMPs are also described in Appendix B.

construction areas for special-status plants during the peak blooming season prior to start of construction. If any special-status plants occur within the construction areas, locations of these plants would be clearly marked and/or fenced to avoid impacts from construction equipment and vehicles where possible.

In addition, to avoid or reduce impacts on special-status plants from the introduction of invasive plant species, construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts and dispose of them in an appropriate disposal facility. The HRP would include details for the installation of native plants to re-vegetate all areas disturbed during construction. Long-term maintenance and monitoring to control invasive species would be included.

It is important to note that analysis of effects to Applegate's milk-vetch (*Astragalus applegatei*) and other federally listed plant species that could be affected by the Proposed Action are evaluated in a BA under Section 7 of the Federal ESA. Determination of impact significance for federally listed plant species in this EIS/EIR is consistent with the findings of the BA.

Following any positive Secretarial Determination and during development of the Definite Plan, additional measures would be included as needed for "Survey and Manage" species to comply with the requirements of the applicable Land and Resource Management Plan for any activities on National Forest System lands.

Incorporation of these elements into the Proposed Action and implementation of **Mitigation Measures *TER-1*** and ***TER-4*** would avoid or reduce impacts on special-status plants during construction.[5] **Therefore, impacts on special-status plants during construction would be less than significant.**

Construction activities could result in adverse impacts on wildlife from riparian habitat loss. Impacts from temporary loss of riparian habitat would affect wildlife that use this habitat, particularly several common amphibian species, such as Pacific giant salamander and several bird species, including several species of special-status riparian birds such as willow flycatcher, yellow warbler, and yellow-breasted chat. In addition, western pond turtle, a special-status reptile, could be affected by the loss of this habitat. As discussed below, there would be gains in riparian habitat at the reservoirs following dam removal and restoration. In addition, localized disturbance of riparian habitat downstream due to sedimentation is expected to be short-term, with colonization of riparian plant seedlings and subsequent re-vegetation of riparian areas within three years following implementation of the Proposed Action. **Therefore, impacts on wildlife using riparian habitat would be less than significant.**

[5] The discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate the development of compliance documentation for the Bald and Golden Eagle Protection Act. These BMPs are also described in Appendix B.

Short-term Impacts of High Suspended Sediment Concentrations (SSC) on Special-Status Amphibians and Reptiles

The Proposed Action would result in the release of sediment from behind the dams, causing increased suspended sediment concentrations (SSC) within the mainstem of the Klamath River downstream from the dams. According to the EIS/EIR in Section 3.2.4.3.2, the Proposed Action would result in a large increase in SSC (>1,000 mg/L) between early January to February 2020 when Iron Gate and J.C. Boyle begin drawdown and Copco 1 enters phase 2 of drawdown. SSC remain very high (>1,000 mg/L) for approximately 3 months from January through April 2020 (see Figure 3.2-11 and Table 3.2-11). SSC are expected to be higher in reaches of the Klamath River located closer to the point of origin of the sediment (i.e., the former site of the dam) and to decline in a downstream direction due to dilution from tributaries (Stillwater Sciences 2009). Elevated SSC has the potential to adversely affect or cause mortality to sensitive life stages of amphibians and reptiles occurring in the Lower Klamath River mainstem.

According to Stillwater (2009) high SSC from dam removal could result in a worst-case scenario of 100% mortality of all amphibian eggs deposited in the Lower Klamath River mainstem. However, Stillwater (2009) did not undertake a detailed species-specific analysis of the timing of the increased SSC and the life history attributes and habitat utilization of the potentially affected amphibians and reptiles.

Increased SSC from dam removal has the potential to decrease food availability by effecting the growth and survival of food sources such as algae, diatom, and macroinvertebrate populations. This indirect impact of increased SSC would likely have some effect on all reptile and amphibian species utilizing the Lower Klamath River mainstem. However, this indirect impact is not considered a substantial adverse effect due to the timing of this impact and the life history attributes of affected species, particularly the seasonality of their habitat utilization. The potential impacts of high SSC on specific special-status amphibian and reptile species are discussed below.

Tailed Frog and Southern Torrent Salamander

Both the tailed frog and southern torrent salamander utilize high-gradient headwater stream habitat and have been documented in tributaries in the lower Klamath River. These species would not typically be expected to occur in the Lower Klamath River mainstem. The high short-term high SSC from dam removal would only affect the Klamath River mainstem. Sediment released from behind the dams would be transported downstream within the Lower Klamath River mainstem and tributary streams would not experience elevated SSC.

Under the Proposed Action, the short-term impact of increased SSC on the tailed frog and southern torrent salamander in the Lower Klamath River would be less than significant.

Northern Red-Legged Frog

The northern red-legged frog, breeds in still or low-velocity ponds, pools, side-channels and wetlands in the coastal areas of the Lower Klamath Basin, generally within 20 kilometers of the river mouth. Northern red-legged frogs lay their eggs on aquatic or submersed herbaceous emergent vegetation. Because their egg-laying habitat requires still water or very low flow, their breeding sites would typically be more up-slope and disconnected from the Lower Klamath River mainstem. These breeding sites would typically only be connected with the Lower Klamath River mainstem during extreme high-flow events, in which case egg masses would likely experience high rates of mortality. Adult northern red-legged frogs are mostly terrestrial and spend substantial time foraging in upland habitats. Thus, short-term high SSC in the Lower Klamath River mainstem are not expected to result in substantial negative effects on eggs, tadpoles, or adult northern red-legged frogs.

Under the Proposed Action, the short-term impact of increased SSC on the northern red-legged frog in the Lower Klamath River would be less than significant.

Foothill Yellow-Legged Frog

The foothill yellow-legged frog is known to breed in the mainstem of the Lower Klamath River as well as its major tributaries. According to Lannoo (2005), the foothill yellow-legged frog typically breeds between late April and June. In California, egg masses have been found between April 22-July 6, with an average of May 3 (Lannoo 2005). In the Trinity River, a major tributary to the Lower Klamath River, Ashton et al. (1998) found foothill yellow-legged frogs lay eggs throughout a three month period of April to June. As discussed in the EIS/EIR within Section 3.2.4.3.2, the Proposed Action would result in the highest SSC during the period of approximately January to April. The early period (late April) of the foothill yellow-legged frog breeding season potentially overlaps with the end period of high SSC from the Proposed Action. Thus, high SSC could have a short-term negative effect on this species by resulting in mortality in mainstem Klamath River egg masses laid earliest in the breeding season during the spring of 2020. This impact would decrease with distance downstream from Iron Gate Dam. SSC at Iron Gate Dam in excess of 1,000 mg/L would occur on a timescale of weeks to months (see Table 3.2-11 in Section 3.2 Water Quality), as compared to SSC (or Total Suspended Solids [TSS]) greater than 1,000 mg/L that can occur during winter storm events on a timescale of days to weeks under existing conditions in the Klamath River at Iron Gate Dam (see Appendix C, Section C.2.2.2). Predicted SSC would remain greater than or equal to 100 mg/L for 5-7 months following drawdown, and concentrations would remain greater than or equal to 30 mg/L for 6-10 months following drawdown (see Table 3.2-11 in Section 3.2 Water Quality). Model results also indicate that dilution in the Lower Klamath River would decrease SSC to 60-70 percent of their initial value downstream from Seiad Valley (RM 129.4) and to 40 percent of their initial value downstream from Orleans (~RM 59) and consequently impacts from the SSC become progressively smaller as they move downstream (Reclamation 2012). There would be no impact from high SSC on foothill yellow-legged frogs breeding in Klamath River tributaries.

It is uncertain how negatively SSC affects egg mass survival for this species, though it is anticipated that high SSC may result in some mortality for egg masses laid earliest in the breeding season (e.g. April). In his discussion of foothill yellow-legged frog conservation, Lannoo (2005) lists a wide range of environmental impacts that this species is susceptible to, and suspended sediment or turbidity are not one of them. Furthermore, according to Lannoo (2005), egg masses observed in the field frequently have silt accumulation on the outer surface. According to Lannoo (2005), it is unknown if silt accumulation affects egg development, but the silt makes the masses less conspicuous and may reduce predation by visual predators. Adult foothill yellow-legged frogs are much more aquatic than the northern red-legged frogs and spend considerably more time in or adjacent to the stream and river habitats in which they breed. However, being semi-terrestrial, they also inhabit adjacent riparian and wetland habitats and would have the ability to avoid the short-term impacts of high SSC by moving up-slope or up tributary channels. Thus, high adult mortality is not expected from high SSC in the Lower Klamath River mainstem.

Under the Proposed Action, the short-term impact of increased SSC on the foothill yellow-legged frog in the Lower Klamath River would be less than significant.

Western Toad

Western toads lay their eggs in still or barely moving water, typically in ponds, lakes, streams, and ditches (Lannoo 2005). Adults are primarily terrestrial, inhabiting upland areas during the non-breeding season. Although there are detections of western toads along the Klamath River (see Table 3.5-4), they would be unlikely to breed in the mainstem river, outside of the reservoirs. Consequently, aside from the reservoirs, western toad egg masses and tadpoles would typically only occur in off-channel and associated wetlands and ponds near the Klamath River mainstem, but not in the mainstem channel itself. The adults are terrestrial and would only incidentally and sporadically utilize the Klamath River mainstem for habitat. Given the habitat utilization of the western toad, eggs, tadpoles, and adults would have a very low probability of occurring in the Lower Klamath River mainstem, and therefore high SSC would have a low likelihood of substantially affecting this species.

Under the Proposed Action, the short-term impact of increased SSC on the western toad in the Lower Klamath River would be less than significant.

Western Pond Turtle

Western pond turtles in the Lower Klamath River utilize the mainstem channel as well as side-channels, backwaters, and adjacent wetland and riparian habitat. They often move to off-channel habitats, such as oxbows, or uplands during high flow events.

Although the western pond turtle is considered an aquatic species, they are known to spend a considerable portion of their lives in upland habitats. They may travel across terrestrial habitats as much as one kilometer from aquatic habitat and radio-tracking studies have recorded individuals occurring on land for up to seven months out of each year (Bury and Germano 2008). Some animals may be active year-round, while others

may enter terrestrial overwintering sites in October-November and reemerge in March-April (Bury and Germano 2008). Turtles from river and stream habitats often leave the watercourse in late fall and move up to 480 m into upland habitats to overwinter (Bury and Germano 2008).

Since eggs are laid in underground upland nests, their egg life stage would not be affected by high SSC in the river (Stillwater Sciences 2009). Hatchlings in northern California overwinter in their nests and emerge in the spring. This life history trait would also diminish the potentially negative effects of high SSC on emerging juveniles.

The increased SSC could result in impacts on the western pond turtle if it causes turtles to move away from underwater refugia and thus become more vulnerable to predators or if it diminishes foraging opportunities. Increased SSC following dam removal is anticipated to have a short-term, but unsubstantial effect on this species' foraging and habitat utilization because of their ability to forage in, and escape to, adjacent upland habitat if needed and because, as discussed in EIS/EIR Chapter 3.2, high SSC events are natural and commonly-occurring winter-spring events in the Lower Klamath River and this species is adapted to them. Other important habitat features, such as availability of basking sites, are not anticipated to be adversely affected by increased SSC.

Under the Proposed Action, the short-term impact of increased SSC on the western pond turtle in the Lower Klamath River would be less than significant.

Long-Term Habitat Loss and/or Modification

Permanent alteration of existing habitats would have long-term impacts on plants and animals that occur in these habitats, including special-status plants and wildlife species.

Loss of Aquatic Habitat at Reservoirs

Removal of reservoirs could result in impacts on wildlife from the permanent loss of aquatic habitat. Following dam removal, aquatic habitat at reservoirs would become riverine, riparian, and upland habitat depending on future hydrologic and physical (topographic) conditions. Water birds that use the reservoirs seasonally during migration and/or for overwintering would be affected by the loss of this aquatic habitat for nesting, foraging, loafing, and roosting. The loss of aquatic habitat would also reduce foraging opportunities for fish-eating birds including osprey, merganser, cormorant, egret, and heron. Changes in food availability for birds such as dabbling ducks that consume aquatic vegetation and invertebrates would occur. However, these species would utilize the river or other aquatic habitat outside the project area for foraging once the reservoirs are gone. Similarly, foraging habitat for swifts and bats would be reduced; however, swifts and bats would also feed in riverine habitat once the reservoirs are gone.

The loss of aquatic habitat at reservoirs would reduce habitat for western pond turtle. However, turtles would utilize future restored riverine habitat at the former reservoir areas as they do currently along the J.C. Boyle peaking reach, Iron Gate-Shasta River reach, and other areas. There are at least five known bald eagle nests near Copco and J.C. Boyle Reservoirs, and additional nest locations are located between these two areas

and upstream (Larson 2011). Since bald eagles primarily use the Lower Klamath NWR for preying on waterfowl, there would be some anticipated effects on bald eagles from loss of this reservoir habitat. However, bald eagles would utilize riverine habitat or other aquatic habitat outside the project area for foraging. In addition, there may be an increase in foraging opportunities for raptors presented by the return of salmon to the riverine system that replaces the reservoirs.

PacifiCorp estimated that decommissioning and removal of the Four Facilities would result in the loss of a total of about 2,404 reservoir acres (FERC 2007). Compared to the large reservoirs and wetland complexes of Upper Klamath Lake (approximately 77,000 acres), Tule Lake (approximately 13,000 acres), and Lower Klamath Lake (approximately 22,000 acres of which approximately 2,200 acres are permanently flooded), the project reservoirs represent a small amount of the available reservoir habitat in the Klamath Basin when wetland and aquatic habitat at the NWRs is at full capacity. Based on National Wetland Inventory data, there are approximately 380,000 acres of wetlands in the Oregon portion of the Upper Klamath Basin (Larson and Brush 2010).

It is also important to note that under the Proposed Action, much of the aquatic reservoir habitat would be converted to upland and riparian habitat based on future hydrology and with active restoration activities (hydroseeding and planting) described above (Reclamation 2011). Upland vegetation restoration would occur at a total of approximately 1,602 acres following reservoir drawdown: 195 acres at J.C. Boyle Reservoir, 632 acres at Copco 1 Reservoir, and 775 acres at Iron Gate Reservoir. Restoration of wetland/riparian habitat would occur at a total of 272 acres following reservoir drawdown: 52 acres at J.C. Boyle Reservoir, 170 acres at Copco 1 Reservoir, and 50 acres at Iron Gate Reservoir (Reclamation 2011). This is discussed further below under Long-term Impacts on Wetlands.

At Copco 1 and Iron Gate Reservoirs there is approximately 1,400 acres of upland habitat types that are currently inundated by the reservoirs. These habitat types include grassland, juniper, oak woodland, mixed chaparral, pasture, orchard and agriculture (PacifiCorp 2004a). Removing the dams, specifically removal of Iron Gate and Copco 1 Reservoirs, would increase the amount of available acres of habitat within critical deer winter range in the long term, benefiting deer by expanding winter range habitat (Hamilton 2011).

In addition, based on historic maps and aerial photos, PacifiCorp (2004a) estimated historic aquatic habitat types at the reservoirs to be approximately 125 acres at J.C. Boyle Reservoir, 119 acres at Copco 1 Reservoir, and 108 acres at Iron Gate Reservoir (Copco 2 Reservoir was not mapped). Thus, a total of approximately 350 acres of aquatic habitat occurred historically and would be expected to be available for restoration following reservoir drawdown.

Therefore, while unavoidable impacts on wildlife, particularly waterfowl and other waterbirds, from the permanent loss of reservoir habitat would occur under the Proposed Action, these impacts would be less than significant.

Modification of Riparian Habitat

Dam removal could result in long-term impacts on riparian habitat from sedimentation in downstream reaches. After the dams are removed and if sediment is allowed to flush downstream, the steep riverbank slopes along the reservoirs would cause the new river channel to conform to the pre-dam river channel alignment (Gathard Engineering Consultants [GEC] 2006). Riverbank stabilization and re-vegetation of riverbank with native plantings would be conducted at each reservoir after the drawdown is complete. This restoration would occur in areas with slopes less than 20 percent, and would entail transplanting and pole-planting of trees and woody shrubs with interspersed seeding of herbaceous species. In addition to erosion control, restoration would exclude invasive plant species from colonizing un-vegetated areas exposed by reservoir drawdown.

Thus, riparian habitat at reservoirs would increase with restoration following drawdown. PacifiCorp estimated that decommissioning and removal of the Four Facilities would add about 184 acres of riparian vegetation. This estimate was based on the assumption of an average riparian corridor width of 100 feet along the 3.6-mile length of the J.C. Boyle Reservoir, the 4.5-mile length of the Copco Reservoir, the 0.3-mile length of the Copco 2 Reservoir, and the 6.8-mile length of the Iron Gate Reservoir (FERC 2007).

The establishment of woody species along the riparian corridor is expected to take several years, following which there would be benefits to terrestrial wildlife, particularly riparian-associated species. With control and monitoring of invasive plants, there would also be benefits to native plant species.

In downstream reaches of the Klamath River, no adverse erosion of riverbanks would be anticipated based on expected flow rates. However, based on modeling conducted using the DREAM-1 modeling software to simulate downstream sediment deposition following dam removal, sedimentation would be likely to occur, particularly if the number of intense storms or snowmelt were low during the 2019-2020 season and in subsequent years. This sedimentation would be limited to downstream reaches as far as Cottonwood Creek. If rain and snowmelt levels were high, less sedimentation in downstream reaches would occur, as there would be more water in the system to flush out sediment (Stillwater Sciences 2008).

Sediment sampling in the reservoirs has indicated that the majority of accumulated sediment is fine-grained (coarse sand and finer) (DOI 2010). If the sediment is allowed to move downstream naturally, it is likely that some sedimentation would occur in deep pools or channel margins downstream during low-flow periods and cover wetland/ riparian with a veneer of fine material (DOI 2011). This short-term wetland/riparian habitat alteration would be localized and would not be substantial. Additionally, this sediment would be flushed out during subsequent high flow events (see Section 3.11 Geology, Soils and Geologic Hazards). Sedimentation has the potential to create new surfaces for riparian plants to colonize, and result in beneficial effects on riparian habitat (Shafroth et al. 2002). Effects on existing riparian habitat from sedimentation would be short-term in nature, as riparian vegetation would quickly be re-established through colonization by seedlings of willows, cottonwoods, and other riparian species. This

colonization occurs following disturbance during peak flows that creates substrate for seedlings, followed by declining spring and summer flows that occur during seed dispersal. Under this natural process, new riparian vegetation would become established within 3-5 years after disturbance (Riparian Habitat Joint Venture 2009). Based on this assessment, no permanent loss of riparian habitat is anticipated to occur in any river reaches. There would be gains in riparian habitat (approximately 184 acres) at the reservoirs through restoration efforts following dam removal and reservoir drawdown. **Both short- and long-term impacts on riparian habitat would be less than significant.**

Long-term Impacts on Wetlands

Dam removal could result in loss of reservoir wetlands. A substantial amount of the historical wetlands of the Upper Klamath Basin have been lost to agricultural developments and water diversions (Larson and Brush 2010). As a result, there is less wetland habitat for waterfowl than there was prior to development, but abundant food for dabbling ducks and geese that feed on small grains in fields surrounding the wetlands (Jarvis 2002).

Under the Proposed Action, there would be unavoidable impacts on wetland habitat at the J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs (244.4 acres, Table 3.5-2). However, much of these unavoidable impacts would be temporary, as wetlands would be expected to become reestablished in some areas along the new river channel with adequate hydrology, soils, and vegetation. As these areas would be prone to colonization by invasive plant species, management and control of invasives would be needed.

Based on the Reservoir Area Management Plan, restoration of wetland/riparian habitat would occur at a total of 272 acres following reservoir drawdown: 52 acres at J.C. Boyle Reservoir, 170 acres at Copco 1 Reservoir, and 50 acres at Iron Gate Reservoir (Reclamation 2011). These acreages were not based on jurisdiction wetland delineations of existing wetlands at the reservoirs. Rather, restored wetland/riparian acreages were determined using reasonable biological parameters with subsequent comparison to river geomorphic maps of the reservoirs developed from historical photography. Bathymetric data were adjusted for post dam removal desiccation and used to determine slopes. Height above river was determined by subtracting a modeled river elevation from the bathymetric elevations. Potential wetlands were modeled with slopes less than 2 percent and height less than one foot above the river. Bank riparian habitat was modeled using slope less than 5 percent and height above river less than 5 feet. All wetland and riparian area estimates were combined into one estimate of wetland/riparian acreages for planning purposes (Reclamation 2011).

With implementation of the Reservoir Area Management Plan (Reclamation 2011), permanent wetland loss at the reservoirs would be reduced. Table 3.5-5 provides the acreages of historic and existing wetlands and wetland/riparian habitat to be restored at each reservoir.

Table 3.5-5. Estimates of Historic, Existing and Future Wetlands at the Reservoirs

Reservoir	Historic Wetland Habitat (PacifiCorp 2004a)	Existing Wetland Habitat (PacifiCorp 2004a)	Wetland/Riparian Habitat to be Restored** (Reclamation 2011)
J.C. Boyle	12.1	105.1	52
Copco 1*	20.3	79.2	170
Iron Gate	2.5	60.1	50
Total	34.9	244.4	272

Notes:

*PacifiCorp 2004a considered Copco 1 and Copco 2 Reservoirs together

**Acreages were estimated for wetland and riparian habitat together.

Estimates are preliminary and not based on jurisdictional wetland delineations. Acreages will be revised based on jurisdictional wetland delineations to be conducted for the Clean Water Act 404 permit once the Definite Plan is available.

Figure 3.5-6, Figure 3.5-7, and Figure 3.5-8 depict restored wetland and riparian habitat at J.C. Boyle Reservoir, Copco Reservoir, and Iron Gate Reservoir, respectively, following implementation of the Reservoir Area Management Plan (Reclamation 2011). Restored wetland and riparian habitats would be supported by the natural hydrological processes of the river channel and would be similar to those that existed historically, as depicted in Figure 3.5-3, Figure 3.5-4, and Figure 3.5-5. Restored wetlands would also benefit from marine-derived nutrients in salmon and other anadromous fish that would have access to Klamath River reaches within the project area once the dams are removed.

Dam removal would not result in impacts on wetland habitats located in other reaches of the Klamath River, including 14.1 acres along the J.C. Boyle bypass reach, 89.9 acres along the J.C. Boyle peaking reach, 13.5 acres along Fall Creek, and 4.5 acres along the Copco 2 bypass reach. In contrast, wetlands would benefit from increased water availability under the Proposed Action, particularly in areas such as the J.C. Boyle bypass reach where water availability is currently limited.

Impacts on wetlands under the Proposed Action would be a significant impact because of the historical loss of wetlands and the regulatory framework of laws and regulations for wetland protection. **Mitigation Measure *TER-5* would reduce this impact on wetlands to less than significant.** See Section 3.5.4.4.

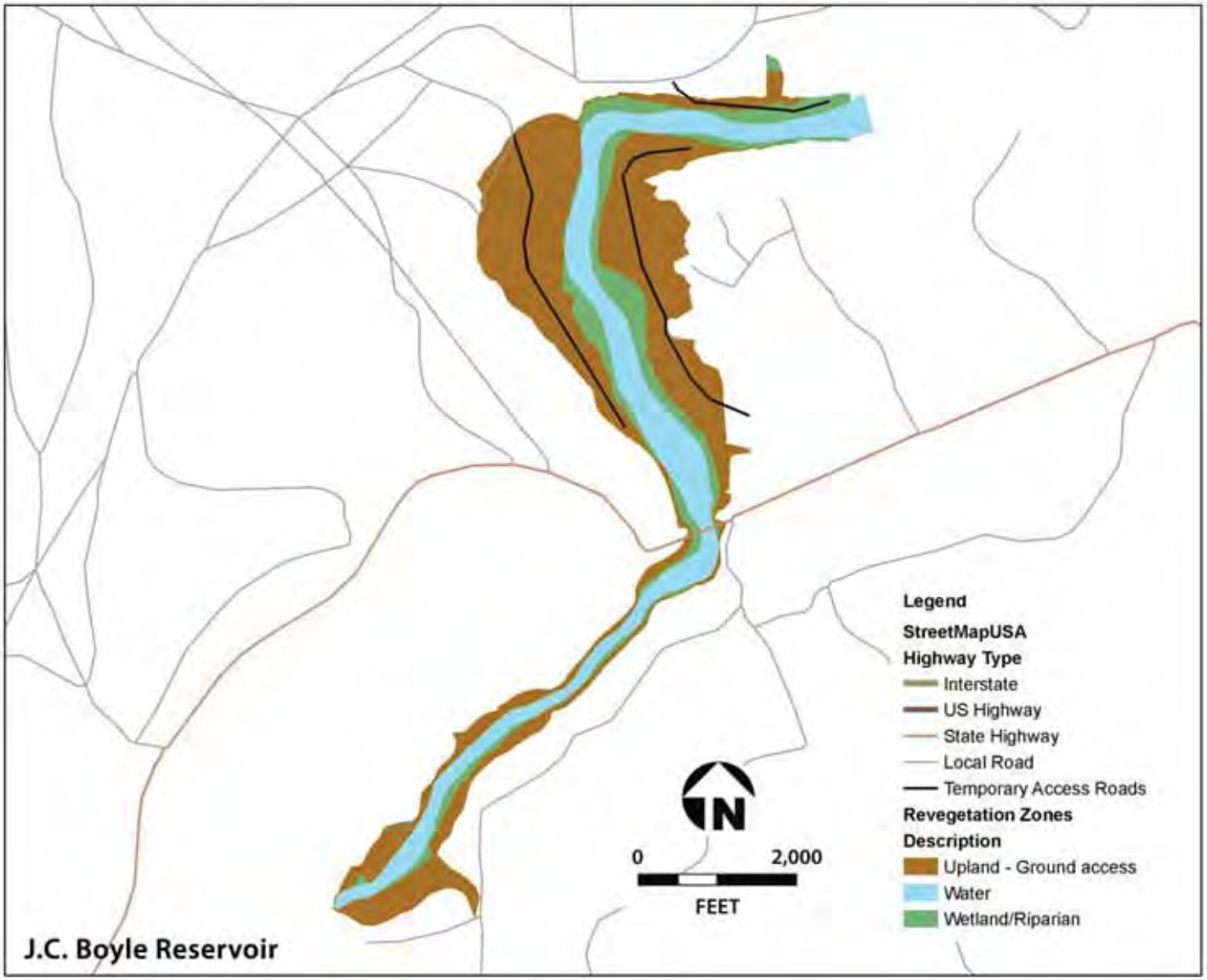

Figure 3.5-6. J.C. Boyle Reservoir Revegetation.

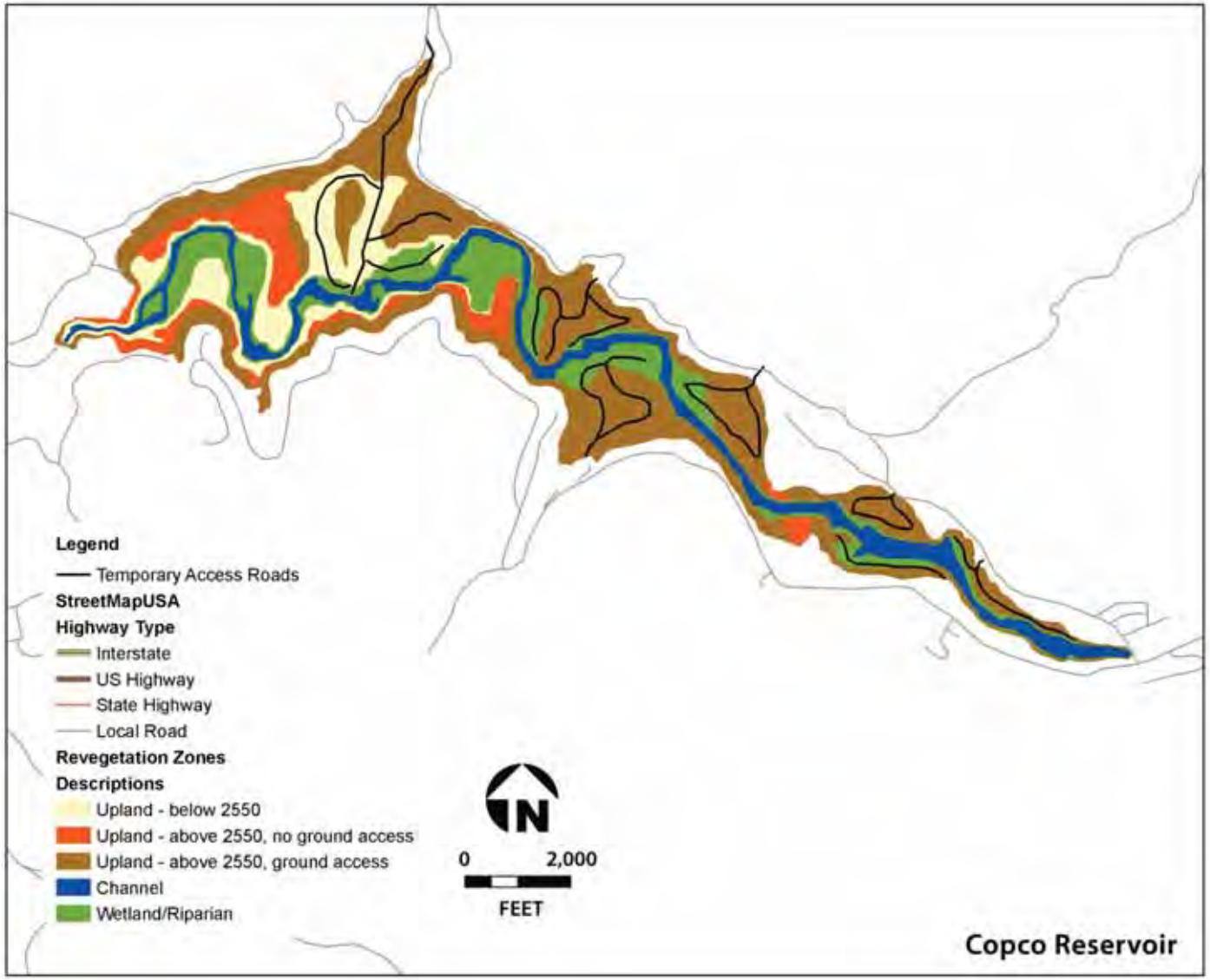

Figure 3.5-7. Copco Reservoir Revegetation.

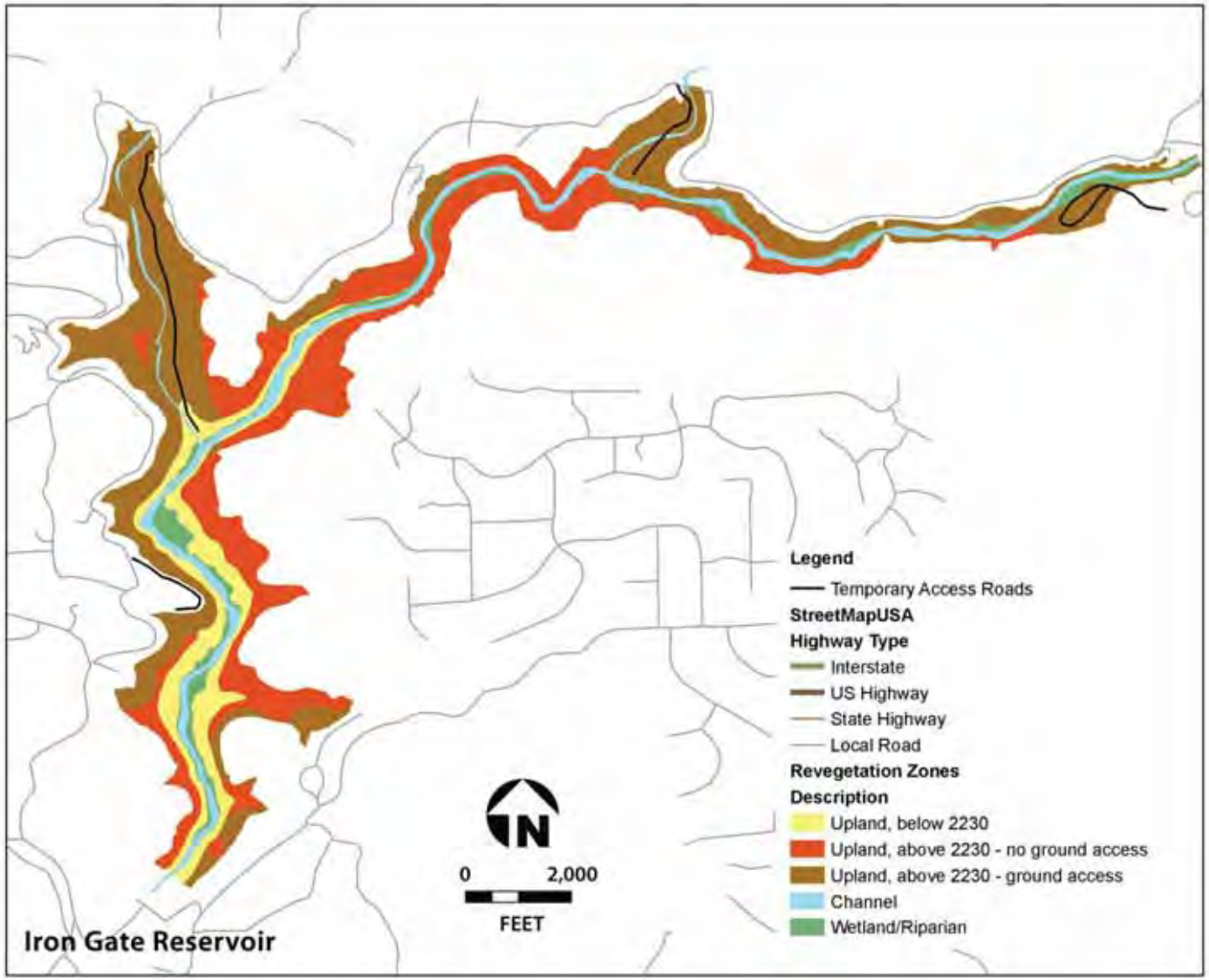

Figure 3.5-8. Iron Gate Reservoir Revegetation.

Long-term Impacts on Wildlife Habitat from Tree and Vegetation Removal

The Proposed Action would result in long-term impacts on wildlife habitat from tree and vegetation removal. During construction, some trees and other vegetation that provides habitat for birds and other wildlife would be removed at construction areas, upland disposal sites, equipment staging areas, and access and haul roads. Following construction, restoration of this habitat would be conducted through the planting of native vegetation in accordance with a HRP approved by the resource agencies. In addition, if known nesting trees or platforms used by osprey or other raptors (except eagles) are removed, they would be replaced on a 1:1 basis as part of the Proposed Action. No known nesting sites for bald or golden eagles or northern spotted owl would be removed under the Proposed Action; no component of suitable northern spotted owl nesting, roosting, foraging, or dispersal habitat would be modified or removed during the removal of transmission lines or installation or removal of fencing. **Therefore, long-term impacts on wildlife habitat from tree and vegetation removal would be less than significant.**

It is important to note that analysis of effects to northern spotted owl and other federally listed species that could be affected by the Proposed Action are evaluated in a BA under Section 7 of the Federal ESA. Determination of impact significance for the northern spotted owl and other federally listed species in this EIS/EIR is consistent with the findings of the BA.

Long-term Impacts on Wildlife Habitat from Reservoir Restoration

As part of the Proposed Action, revegetation and management of noxious and invasive weeds would occur on newly exposed land (e.g., reservoir shoreline). Long-term effects of the revegetation plan are anticipated to benefit bald or golden eagles, osprey, and northern spotted owl by enhancing future nesting, roosting, foraging, or dispersal habitat.

Northern spotted owl forage primarily on small mammals (e.g., mice, voles), golden eagles primarily on birds, reptiles, and insects, and bald eagles and osprey primarily fish, and it is plausible that the risk to these prey species may occur from direct or indirect spraying of herbicides. Herbicides will be used to control weeds through hand treatment; therefore the application is not intended to target plants or trees that currently support suitable habitat. Effects of glysophate and glyphosate-based herbicides with surfactant additives are analyzed below.

- Studies and assessments of glyphosate show ecological risks for focused, short-term eradication efforts are small (Monheit 2003).
- While highly toxic to plants, glyphosate is non-toxic to animals (Williams et al. 2000, as cited in Monheit 2003).
- Glyphosate is poorly absorbed by the digestive track and is excreted essentially unmetabolized (EXTOXNET database, Cornell University, both as cited in Monheit 2003; Williams et al. 2000).

- There is no evidence to support glyphosate is an immunotoxicant, neurotoxicant, or endocrine disruptor (Syracuse Environmental Research Associates [SERA] 2002, as cited in Monheit 2003).
- At typical application rates, none of the acute scenarios studied presented unacceptable risks to wildlife including predatory birds consuming small mammals (Bautista 2007).
- The majority of prey are arboreal and/or nocturnal and are not likely to be directly exposed to herbicides (U.S. Department of Agriculture [USDA], and U.S. Forest Service [USFS] 2010) and if consumption did occur, a Biological Opinion (BO), Concurrence, and Conference Report on the Effects to 23 Species and 4 Critical Habitats from the U.S. Forest Service Pacific Northwest Region Invasive Plant Program (USFWS Reference Number 1-7-05-7-0653, as cited in USDA Forest Service. 2010) states: "The U.S. Forest Service found that the results of exposure scenarios to spotted owls indicate that no herbicide included in the Invasive Plant Program (which includes glyphosate) is likely to adversely affect spotted owls… There was no risk to spotted owls from eating contaminated small mammals because expected doses to predatory birds eating mammals for all herbicides, even with very conservative assumptions, are well below any known no observable adverse effects."

Glyphosate may be formulated with surfactants that increased efficacy. In some cases, toxicity data have indicated that surfactants added to the glyphosate are more toxic than the glyphosate itself. Studies conducted by the USDA Forest Service found no evidence that nonylphenolethoxylate-based surfactants lead to any level of concern for terrestrial wildlife (Bakke 2003, as cited in CINWECC 2004). All herbicide application would adhere to BMPs for herbicide handling as described in Appendix B. **Therefore, long-term impacts on avian habitat would be less than significant.** If another herbicide or herbicide base is chosen, it should meet similar characteristics of low toxicity to small mammals and birds.

Long-term Impacts on Bats from Loss of Roosting Habitat

The Proposed Action would result in long-term impacts on bats from loss of roosting habitat. Impacts on bats would occur from the loss of dam structures and associated facilities used as roosting habitat. Based on surveys conducted by PacifiCorp in 2003, bats roost in all four dams or in their associated facilities and structures (FERC 2007). Multi-species colonies of bats, which have been documented using these structures, are likely to contain one or more special-status bat species, and regardless of listing status, the loss of a bat colony site or adverse effects to an active colony would be a significant impact. **Mitigation Measure *TER-6* would reduce impacts on bats to less than significant.** See Section 3.5.4.4.

Long-term Impacts on Amphibian Habitat

Dam removal could result in long-term impacts on amphibians from habitat degradation due to sedimentation in downstream reaches of the Klamath River. Sediment inputs in downstream reaches could fill riffle substrate in some areas, reducing localized habitat

for the larval phases of amphibian species such as Pacific giant salamander. However, most sediment is expected to be flushed out during subsequent high flow events (Stillwater 2008, Bureau of Reclamation [Reclamation] 2011), and restoring a more natural sediment regime would be expected to benefit amphibian habitat in the long-term. In addition, removal of reservoirs would reduce populations of non-native bullfrogs which prey on native amphibians. **Therefore, long-term impacts on amphibian habitat would be less than significant.**

Long-term Impacts on Special-Status Species at the Reservoirs

The Proposed Action could result in impacts on special-status species from loss of aquatic habitat at reservoirs. Permanent loss of wetland and aquatic habitat at reservoirs would adversely affect special-status species populations that use these habitats. Specifically, western toad and western pond turtle have been documented at the four reservoirs in the project area, and over 25 species of special-status birds use aquatic and wetland habitat and the reservoirs.

Bald Eagles at the Reservoirs

Loss of aquatic habitat following reservoir drawdown would result in impacts on bald eagles that nest at the reservoirs. These eagles could use riverine habitat once the reservoirs are gone, or move to other aquatic habitat such as the large reservoirs of the NWRs. **Therefore, long-term impacts on bald eagles would be less than significant.**

Great Blue Heron Colony at Copco Reservoir

Under the Proposed Action the drawdown and conversion of reservoirs to riverine habitat may adversely affect a great blue heron colony documented at the Copco Reservoir. This colony would use riverine habitat once the reservoirs are gone, or move to other aquatic habitat nearby. **Therefore, long-term impacts on great blue heron would be less than significant.**

Special-Status Plants at the Reservoirs

Wetland habitat at reservoir margins supports several species of special-status plants (Table 3.5-4). Many of these plants, including Applegate's milk-vetch, short-podded thelypodium, Columbia yellow cress, and salt heliotrope, occur at only the Keno Impoundment which would not be drawn down under the Proposed Action. However, there is potential for special-status plants to occur at the reservoirs that would be drawn down, and therefore there would be loss of habitat for these species once the reservoirs are removed. Protocol-level surveys for special-status species would be conducted prior to construction to determine the location of special-status plants. If found, **Mitigation Measure *TER-4*** (Section 3.5.4.4) would be implemented to reduce impacts. **Therefore, long-term impacts on special-status plants would be less than significant.**

Impacts on Culturally Important Species

The Proposed Action could result in impacts on culturally important species. Willows, which are riparian-dependent plants, are culturally important to Indian Tribes who use

them for basket-making. As discussed above, riparian habitat is expected to increase in the long-term at the reservoirs, and any loss of riparian habitat from sedimentation downstream from the dams is anticipated to be short-term in nature. Since willows are one of the first species to re-colonize following disturbance (Riparian Habitat Joint Venture 2009), impacts on these culturally important plants are not anticipated to be significant. No effects on other culturally important plants are anticipated. **Therefore, impacts on culturally important species would be less than significant.**

Effects on Wildlife Corridors

The Proposed Action would result in impacts on wildlife corridors. The Proposed Action would be expected to provide beneficial effects on terrestrial wildlife movement. Removal of PacifiCorp structures and open water reservoirs and restoration of the pre-dam river channel would eliminate areas of wide deep water crossings that are a hindrance to large and small mammal movements from one side of the river to the other. More narrow and shallower water crossing points would be available for both large and small terrestrial species to cross the river. This would provide benefits in increasing the amount of habitat available for these species, making them less vulnerable to disease and other environmental stressors than before dam removal. Increased movement could also increase genetic diversity in previously separate populations. **Therefore, the Proposed Action would result in beneficial effects on wildlife corridors.**

Effects Related to Invasive Plant Species

The Proposed Action could result in native vegetation impacts related to invasive plants. Under the Proposed Action, there would be potential for invasive plant species to quickly re-colonize exposed reservoir bottoms and other disturbed soil areas and out-complete native plants. In addition, invasive plant seeds could be transported to downstream areas following removal of the dams, particularly those plants that disperse by water (Nilsson et al. 2010, Merritt and Wohl 2002, Merritt and Wohl 2006, Merritt et al. 2010). A Reservoir Area Management Plan (Reclamation 2011) would be implemented for restoration of native plants and habitat communities at the reservoirs. In addition, the HRP would be implemented for restoration of native habitats at upland areas disturbed by construction, including disposal sites, access and haul roads, and equipment staging areas. Other specific elements of construction include measures to prevent the introduction of invasive plant species. All construction vehicles and equipment would be cleaned with compressed water or air within a designated containment area to remove pathogens, invasive plant seeds, or plant parts and dispose of them in an appropriate disposal facility. Implementation of the Reservoir Area Management Plan and the HRP would include long-term maintenance and monitoring to control invasive species. See **Mitigation Measure *TER-1*** in Section 3.5.4.4.

It is noted that reed canarygrass, which is found along the margins of some of the reservoirs and in many riparian areas along the Klamath River, is an invasive plant that can colonize quickly and out-compete native plants. After draw down of the reservoirs, it is likely that populations of reed canarygrass along the reservoir margins would die (Larson 2011).

In addition, seasonal high flows under the Proposed Action would contribute to improving the quality of riparian habitat in the J.C. Boyle bypass reach by decreasing the prevalence of reed canarygrass (Administrative Law Judge 2006).

Implementation measures during construction and restoration following construction in accordance with **Mitigation Measure *TER-1*** (Section 3.5.4.4) would avoid or reduce impacts related to invasive plants. **Therefore, impacts related to invasive plants would be less than significant.**

Replacement of the Iron Gate Fish Hatchery Water Supply Pipeline

Under the Proposed Action, the Iron Gate Fish Hatchery would remain in place, but the water supply pipeline from the penstock intake structure to the fish hatchery would be removed with the dam. Under the KHSA, PacifiCorp is responsible for evaluating hatchery production options that do not rely on the current Iron Gate Hatchery water supply. PacifiCorp is also responsible for proposing and implementing a post-Iron Gate Dam Hatchery Mitigation Plan (Hatchery Plan) to provide continued hatchery production for eight years after the removal of Iron Gate Dam; and this Hatchery Plan would be developed with information from PacifiCorp's evaluation. However, PacifiCorp is not required to propose a Hatchery Plan until six months following an Affirmative Secretarial Determination. The Lead Agencies do not currently know what PacifiCorp will propose in the Hatchery Plan and are unlikely to know unless there is an Affirmative Secretarial Determination. An impact analysis of a hatchery production option that does not rely on the current Iron Gate water supply would be purely speculative at this point. Therefore, the potential environmental effects of implementing a hatchery production option that does not rely on the current Iron Gate water supply are not analyzed in this EIS/EIR.

Relocation of Recreation Facilities

The Proposed Action would require the relocation of existing recreation facilities, which would require the construction of new facilities along the river bank. Recreation facilities, such as campgrounds and boat ramps, currently located on the reservoir banks would be relocated down slope to be near the new river bed once the reservoir is removed. Impacts specific to the relocation of the Recreation Facilities are discussed in Section 3.20, Recreation. Temporary construction impacts on terrestrial resources could occur at the existing recreation facility sites from contact between wildlife and equipment and habitat disturbance. Elements incorporated into construction would avoid or reduce these effects, and **Mitigation Measures *TER-1*** through ***TER-4*** (Section 3.5.4.4) would be implemented, as necessary, to avoid or reduce impacts. The relocation would occur on lands that are currently inundated and provide no existing habitat to terrestrial species, and would not impede habitat restoration efforts. **Therefore, impacts on terrestrial resources would be less than significant.**

Keno Transfer

Implementation of the Keno Transfer could cause impacts to terrestrial resources. The Proposed Action includes the Keno Transfer, a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on terrestrial resources compared with existing facility operations. Following transfer of

title, DOI would operate Keno in compliance with applicable laws and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facility Decommissioning – Programmatic Measure

Decommissioning the East and Westside Facilities could cause adverse effects to terrestrial resources. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would stop water flows currently diverted at Link River Dam into the two canals, back in to Link River. The decommissioning action would not be expected to result in the disturbance of any currently undisturbed habitat. **Therefore, implementation of the East and Westside Facility Decommissioning action would result in no change from existing conditions.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

The Proposed Action would require the City of Yreka Water Supply Pipeline to be relocated, which could result in construction impacts on terrestrial resources. The existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. Surveys are still required to determine if the bridge is adequate to support the pipeline and the construction traffic from the decommissioning activities. A detailed discussion of the traffic impacts and road conditions concerns is provided in Section 3.22, Traffic and Transportation, and Mitigation Measure TR-1 addresses these concerns. Construction of a pipe bridge in the existing location or placing the pipeline along an existing road and bridge would have temporary construction impacts on terrestrial resources within construction areas. Elements incorporated into construction and implementation of **Mitigation Measures *TER-1*** through ***TER-4*** (Section 3.5.4.4), as necessary, would avoid or reduce these impacts. Habitat restoration in accordance with **Mitigation Measure *TER-1*** (Section 3.5.4.4) would reduce long-term impacts in construction areas to less than significant. **Therefore, impacts on terrestrial resources would be less than significant.**

KBRA - Programmatic Measures

Implementation of programs under the KBRA would increase the amount of water in the Klamath River and maintain the elevation of Upper Klamath Lake. Water allocations and delivery obligations would also be established for the Lower Klamath NWR and Tule Lake NWR. During implementation of KBRA actions described below, special-status

species and their habitats would be protected through coordination with resource agencies for compliance with the ESA and development of habitat conservation plans by non-Federal parties.

The KBRA has several programs that could result in impacts on terrestrial resources, including:

- Phases I and 2 Fisheries Restoration Plan
- Fish Entrainment Reduction
- Wood River Wetland Restoration
- Water Diversion Limitations
- On-Project Plan
- Water Use Retirement Program (WURP)
- Interim Flow and Lake Level Programs
- Mazama Forest Project

Fisheries Restoration Plan- Phase I and Phase II

Construction activities associated with the Fisheries Restoration Plan- Phase I and Phase II could result in impacts on terrestrial wildlife and/or habitat. The Fisheries Restoration Plan would include measures to restore riparian and floodplain vegetation throughout the Klamath Basin. Actions that could have impacts on terrestrial resources within the project area are described below.

Floodplain Rehabilitation

Floodplain rehabilitation may include activities such as riparian planting and understory thinning to facilitate the development of mature riparian stands. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of, and specific locations where these floodplain rehabilitation actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant. In the long term, terrestrial species that utilize riparian habitat are expected to benefit from floodplain rehabilitation and associated improvements to riparian habitat.**

Wetland and Aquatic Habitat Restoration

These activities may involve hydroseeding for creation of grass banks. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of and specific locations where these habitat restoration actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the

vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts, and in the long term, terrestrial species that utilize wetland and aquatic habitat are expected to benefit from these habitat restoration actions. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.**

Woody Debris Placement

These activities may involve the use of construction equipment to place large wood in the stream channel or along banks. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of, and specific locations where these woody debris placement activities could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.**

Fish Passage Correction

These activities may include culvert upgrades or replacements. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of and specific locations where these fish passage correction actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.**

Cattle Exclusion Fencing

This would entail the construction of fencing along riparian areas. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of and specific locations where these cattle exclusion fencing installation actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in

the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant. In the long term, terrestrial species that utilize riparian habitat are expected to benefit from the establishment of riparian vegetation.**

Mechanical Thinning and Prescribed Burning

The structure and species composition of many forested stands have been altered through fire exclusion and past and on-going timber management. This includes mixed conifer forests, oak woodlands, and aspen. The alteration of these stands has resulted in the degradation of habitat for species associated with these vegetative communities. Additionally, many of these stands exhibit high amounts of surface and ladder fuels, increasing the potential for uncharacteristically severe wildfire. The following best management practices can reduce the effects on plants and wildlife related to vegetation management:

- Small diameter thinning of overstocked upland forests to promote development of structurally diverse stands with desired species composition and variable densities, and to reduce the risk of uncharacteristically severe wildfire.
- Prescribed burning in upland forested habitats to promote the development of understory growth and reduce the amount of small to medium diameter surface fuels.
- In oak stands, small diameter thinning (typically < 9” dbh) of dense oaks to promote the development of large structurally diverse oak trees.
- Removal of encroaching juniper (up to 15” dbh).
- Installing fencing around aspen stands to exclude livestock and allow for the passive restoration of aspen trees combined with planting of native shrubs.

These activities are anticipated to result in benefits to terrestrial wildlife from restoration of upland habitats. However, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of and specific locations where these mechanical thinning and prescribed burning actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However,**

impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.

Road Decommissioning

Construction activities associated with road decommissioning could result in adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of, and specific locations where these road decommissioning actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts, and in the long term, terrestrial species that utilize the restored habitats are expected to benefit from road decommissioning. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.**

Gravel Augmentation

Placement of gravel in the stream using backhoes could result in adverse effects on terrestrial species, including special status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The timing of, and specific locations where these gravel augmentation actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant.**

Each of the actions under the Phase I Fisheries Restoration Plan would require separate project-level evaluations under National Environmental Policy Act (NEPA) and Federal ESA, as appropriate.

Fish Entrainment Reduction

Construction activities associated with Fish Entrainment Reduction could result in impacts on terrestrial wildlife and/or habitat. Fish Entrainment Reduction would entail the installation of fish screens at various water diversion structures for the Klamath Reclamation Project. There could be adverse impacts on riparian vegetation and wildlife habitat within these localized construction areas. During construction, there could be adverse effects on terrestrial species, including special-status amphibians and reptiles, from direct contact with construction equipment and loss of habitat. There could be impacts on special-status bird species such as bald and golden eagle and northern spotted

owl from disturbance during nesting. There could also be impacts on special-status plants if they occur in construction areas. The geographic location and timing of fish screen installation reduces the potential for any negative terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. Implementation of construction-related BMPs would occur during fish screen construction to avoid or reduce these impacts. **However, impacts would be potentially significant. Implementation of Mitigation Measures *TER- 1* through *TER- 4* would reduce these impacts to less than significant. Impacts on terrestrial resources from specific construction activities would be further analyzed as a part of future environmental compliance, as appropriate.**

Wood River Wetland Restoration

Modification of aquatic habitat from the Wood River Wetland Restoration project could result in impacts on terrestrial wildlife and/or habitat. Implementation of this project may reconnect subsided wetlands adjacent to Agency Lake to provide additional water storage. Therefore, this project is anticipated to benefit waterfowl, water birds, and other species that utilize wetlands and aquatic habitat through increased reliability of water to wetland habitat. The geographic location and timing of this project reduce the potential for any negative terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. However, some adverse effects could also occur to some species, depending on whether habitats are managed as marsh or open water. **Impacts on terrestrial wildlife and/or habitat would be less than significant.**

Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Program

The Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs could result in impacts on terrestrial wildlife and/or habitat. In general, additional water supply would be expected to increase the numbers of waterfowl using the National Wildlife Refuges.

Using the Water Resource Integrated Modeling System (WRIMS), the USFWS (2010) conducted an analysis of the effects of the Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs on three NWRs (Lower Klamath NWR, Tule Lake NWR, and Upper Klamath NWR). The following paragraphs provide a summary of the findings of that analysis.

Lower Klamath NWR

<u>Impacts on Water Delivery Needed to Support Wetland Habitat</u>

Lower Klamath NWR water demand was modeled using WRIMS to estimate quantities of water delivered to the refuge under both the No Action/No Project Alternative and the Proposed Action Alternative through both the Ady Canal and D-Plant (USFWS 2010). For each time step in the model, the total refuge demand was approximated based on the area of habitat and the water requirement for that habitat. Modeling results indicate water delivery to Lower Klamath NWR would be greater if KBRA was implemented than under the No Action/No Project Alternative. By estimating the amount of water needed

per wetland habitat type, USFWS (2010) determined that the Refuge would support more wetland habitat if KBRA was implemented than under the No Action/No Project Alternative.

D-Plant pumping is critical to serving the needs of some marsh units at Lower Klamath NWR that cannot be reached from the Ady Canal. Due to recent increases in pumping costs coupled with shortages of agricultural water, D-Plant pumping, especially in the irrigation season, has been declining over time and water from D-Plant often does not arrive at Lower Klamath NWR in a timely manner and in the quantities needed (USFWS 2010). Implementation of the KBRA would allow Lower Klamath NWR water allocation to be delivered through either the D-Plant or the Ady Canal or a combination of both at the times and quantities needed for optimal management of wetland habitats (USFWS 2010).

In addition, there would be less uncertainty regarding water rights if the KBRA was implemented as compared to the No Action/No Project Alternative. Implementation of the KBRA would result in a higher potential for the NWRs to receive more water than under the No Action/No Project Alternative (USFWS 2010).

Impacts on Waterfowl

To determine impacts on migratory waterfowl, the fall carrying capacity for waterfowl on Lower Klamath NWR was approximated based on the assumption that food resources are the major component influencing waterfowl use of the refuge during the peak September and October migratory period. Estimates of food energy produced per acre in each wetland habitat type, the daily energy requirement per bird, the period of use, and the estimated acres flooded was used to determine the carrying capacity of the wetland for foraging dabbling and diving ducks. Results indicate that if the KBRA was implemented, Lower Klamath NWR would support a higher number of fall migratory dabbling and diving ducks, in addition to benefitting molting mallards, than under the No Action/No Project Alternative (USFWS 2010; Yarris et al. 1994).

Impacts on Nongame Waterbirds

An estimate of the numbers of nongame waterbirds (broadly defined as shorebirds, gulls, terns, cranes, rails, herons, grebes, egrets, and ibis) that would be supported with implementation of the KBRA was also conducted based on the approximate number of waterbirds that could be supported in late summer on the Refuge in different water year types. Using this method, the Refuge would support higher numbers of nongame waterbirds if the KBRA was implemented than the No Action/No Project Alternative. Furthermore, because wintering bald eagles in the Klamath Basin forage predominantly on waterfowl, the KBRA would result in higher numbers of wintering bald eagles than the No Action/No Project Alternative (USFWS 2010).

Impacts on Habitat Management

If the KBRA was implemented, lease land farming would continue, and 20 percent of the net lease revenues would be available to the Refuge for habitat enhancement. In contrast, under the No Action/No Project Alternative, all lease revenues would

continue to be under the jurisdiction of Reclamation, some of which may or may not be available for habitat enhancement work on the Refuge (USFWS 2010).

Implementation of the Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs as part of the KBRA would result in beneficial effects on wetland habitat, waterfowl, nongame waterbirds, and habitat management at Lower Klamath NWR. The geographic location of Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs reduce the potential for any terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. **Therefore, there would be beneficial effects on terrestrial resources from implementation of KBRA at Lower Klamath NWR.**

Tule Lake NWR

Impacts on Water Delivery Needed to Support Wetland Habitat

Water for wetland habitats in Sumps 1(A) and 1(B) of the Tule Lake NWR are primarily provided as return flows from private lands. With implementation of the KBRA, there would be greater flexibility in the draining and refill of Sumps 1(A) and 1(B) compared to the No Action/No Project Alternative. This increased ability to manage sumps will mean improved habitat conditions for migratory waterfowl and nesting nongame birds. Thus, KBRA implementation would result in more wetland habitat than the No Action/No Project Alternative (USFWS 2010).

Impacts on Waterfowl

Waterfowl use of the refuge currently depends upon wetland habitats provided in Sumps 1(A) and 1(B) and the “Walking Wetlands” program, which incorporates wetlands into commercial crop rotations, and food provided from Refuge agricultural lands (USFWS 2010). If the KBRA was implemented, there would be less uncertainty in agricultural water deliveries to Refuge wetlands and agricultural lands than under No Action/No Project. There would also be more certainty in water for the “Walking Wetlands” program that provides wetland-related food and habitats for migratory dabbling ducks and geese. Therefore, if KBRA were implemented there would be more wetland habitat and food resources for migratory waterfowl (USFWS 2010). In contrast to the Upper Klamath, due to the change in the water regime with the KBRA, there would be a benefit to molting mallards (Yarris et al. 1994).

Impacts on Nongame Waterbirds

Nongame waterbirds are dependent on wetland habitats on Tule Lake NWR, which are dependent on agricultural return flows. Increased certainty of agricultural water deliveries with implementation of the KBRA would therefore have a beneficial effect on wetland habitats and the nongame waterbirds that depend on them than the No Action/No Project Alternative (USFWS 2010).

Impacts on Habitat Management
With implementation of the KBRA, there would be less uncertainty in the ability to manage Sump 1(B) than under No Acton/No Project. In addition, 20 percent of the net lease revenues to the Refuge would be available for habitat enhancement with KBRA implementation (USFWS 2010).

Implementation of the Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs as part of the KBRA would result in beneficial effects on wetland habitat, waterfowl, nongame waterbirds, and habitat management at Tule Lake NWR. The geographic location of Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs reduce the potential for any terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. **Therefore, there would be beneficial effects on terrestrial resources from implementation of KBRA at Tule Lake NWR.**

Upper Klamath NWR

Impacts on Wetland Habitat from Water Delivery
Based on modeled water elevations for future years, water elevations in Upper Klamath Lake would be low enough to leave refuge wetlands dry during the fall migration period (September-October) in 82 percent of years with implementation of the KBRA as compared to 68 percent of years under the No Action/No Project Alternative (USFWS 2010). Thus implementation of the KBRA could be an adverse impact compared to the No Action/No Project Alternative; however, other measures described below would provide benefits to offset these potential issues..

Impacts on Waterfowl
Male and female mallards molt at slightly different times of the year and mallards of both sexes depend on wetlands to escape predators during molting. Male mallards begin the molt in mid July with females initiating the molt approximately 30 days later. During the 30 day molting period, mallards (and other waterfowl species) lose all wing feathers and are incapable of flight. Dry conditions can have an adverse effect on the survival of individuals. Based on modeled Upper Klamath Lake elevations, under the KBRA Alternative water is present in refuge wetlands in all but 3 percent of future years in July and 38 percent of future years in August. Under the No Action Alternative/No Project Alternative, refuge wetlands become dry more often in July (20 percent of years), and August (59 percent of years). Thus, implementation of the KBRA would have a beneficial effect on molting male mallards in July and August compared to conditions under the No Action/No Project Alternative.

For female mallards, the effect is somewhat reversed, since refuge wetlands would be dry in a higher proportion of years in September with KBRA implementation (82 percent of years) compared to the No Action/No Project Alternative (68 percent of years). It is important to note that breeding mallards are monogamous and females (due to lower survival rates) form a smaller proportion of the population. Thus, the welfare of female mallards is more important to the viability of the species and this represents an adverse

impact of KBRA implementation compared to the No Action/No Project Alternative (USFWS 2010). In addition, due to the large concentration of diving ducks and marine ducks in fall and winter, there may also be concern for effects of the KBRA on diving ducks and marine ducks in the fall and winter.

Impacts on Nongame Waterbirds

With KBRA implementation, water elevations in Upper Klamath Lake would be sufficient to support breeding nongame waterbirds in a higher number of future years than under the No Action/No Project Alternative. The primary breeding period for nongame waterbirds extends from March through July. For successful breeding, refuge wetlands must remain flooded during this time period. With KBRA implementation, water would be present in Refuge wetlands during more of this period than without KBRA implementation (USFWS 2010).

Implementation of the Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs as part of the KBRA would result in beneficial effects on nongame waterbirds at Upper Klamath NWR. The geographic location of Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow and Lake Level Programs reduce the potential for any negative terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. **While there is potential for adverse impacts on wetland habitat and some waterfowl, there would beneficial effects on other waterfowl and nongame waterbirds as compared to the No Action/No Project Alternative. Combined, these impacts would be less than significant.**

Juniper Removal under WURP

The WURP program could include juniper removal in order to increase inflow to Upper Klamath Lake. There could be adverse impacts on certain terrestrial wildlife, including nesting migratory birds, from removal of juniper trees; however, juniper removal would likely benefit other terrestrial wildlife species. The geographic location and timing of these juniper removal actions reduce the potential for any negative terrestrial resource effects generated by this action from contributing to the effects of the hydroelectric facility removal actions analyzed above. Measures implemented during construction as described for the Proposed Action would avoid or reduce this impact; however, this impact would be potentially significant. **Implementation of Mitigation Measure *TER-2* would reduce this impact to less than significant.**

In the long-term, WURP is anticipated to result in long-term benefits to terrestrial wildlife, particularly waterfowl and waterbirds that utilize Upper Klamath Lake.

Mazama Forest Project

The Mazama Forest Project could result in adverse impacts on terrestrial resources. The Mazama Forest Project would transfer 90,000 acres of privately owned timberland back to the Klamath Tribes(Chui 2008; Kerr 2012). With ownership of the lands, the tribe could hunt, harvest timber, or use the land for other purposes. Additionally the Mazama Forest Project would not be

expected to contribute to any terrestrial resource effects generated by the hydroelectric facility removal action. **No changes to existing conditions for terrestrial resources are anticipated.**

3.5.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities Removal of Four Dams Alternative, only the primary structure of the four dams would be removed, while auxiliary dam and hydroelectric features would remain in place. Drawdown of reservoirs would still occur and sediment behind the dams would be flushed downstream by river flows. Following partial facilities removal, riverbank stabilization and replanting activities would be conducted and the KBRA would be fully implemented, as with the Proposed Action.

Temporary Construction Impacts

Temporary construction impacts on terrestrial resources under the Partial Facilities Removal Alternative would be very similar to those described for the Proposed Action. There would be temporary construction impacts that would adversely affect local populations of common plants and wildlife in construction areas. Elements incorporated into construction would avoid or reduce these effects. These effects would be short-term in nature and less than significant for most common species. Temporary construction impacts on special-status species would be similar to those under the Proposed Action. **Mitigation Measures *TER-1*** through ***TER-4*** (Section 3.5.4.4) would be implemented, as necessary, to avoid or reduce impacts as under the Proposed Action. **Therefore, temporary construction impacts on terrestrial resources from the Partial Facilities Removal Alternative would be less than significant.**

Long-Term Impacts

As with the Proposed Action, there would be the same adverse effects related to loss of aquatic and wetland habitat at the reservoirs under the Partial Facilities Removal Alternative. **Mitigation Measure *TER-5*** would reduce impacts from permanent loss of wetlands, if it occurs, to less than significant. **Mitigation Measure *TER-6*** would reduce impacts on bats from the loss of roosting habitat from the removal of structures to less than significant. See Section 3.5.4.4 for a description of Mitigation Measures.

As described above for the Proposed Action, there would also be benefits to wildlife from gains in upland and riparian habitat following establishment of newly planted areas and with control and monitoring of invasive plants. Riparian habitat at the reservoirs would be restored and any riparian habitat destroyed by sedimentation downstream would be expected to re-establish within a few years; therefore, impacts on riparian habitat would be less than significant. Remaining PacifiCorp facilities would still pose a barrier to terrestrial wildlife movement in some places; however, drawdown of the reservoirs would benefit some terrestrial species by eliminating those barriers. Impacts related to invasive plants at the reservoir sites and other construction areas would be reduced to less than significant with implementation of the Reservoir Area Management Plan and HRP (**Mitigation Measure *TER-1***). **Therefore, long-term impacts on terrestrial resources from the Partial Facilities Removal Alternative would be less than significant.**

Keno Transfer
The effects of the Keno Transfer would be the same as those described for the Proposed Action.

East and Westside Facility Decommissioning – Programmatic Measure
The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure
The effects of the City of Yreka Water Supply Pipeline relocation would be the same as those described for the Proposed Action.

KBRA – Programmatic Measures
The Partial Facilities Removal Alternative would include full implementation of the KBRA. Therefore, impacts and benefits related to KBRA actions would be the same as under the Proposed Action, discussed above.

3.5.4.3.4 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, all four dams and hydroelectric facilities would remain in place and fish passage facilities would be constructed around each. Reservoirs would remain in place. The KBRA would not be implemented.

The provisions of the USFWS Biological Opinion (USFWS 2007) for the relicensing of the Klamath Hydroelectric Project may be in effect under the Fish Passage at Four Dams Alternative. These include a number of environmental measures to address impacts on terrestrial resources. One is a vegetation resource management plan for restoration of disturbed sites and riparian habitat restoration, protection of special-status plants, and long-term monitoring. In addition, a wildlife resource management plan would be required to provide: wildlife crossings, deer winter range management, a plan to address avian electrocution hazards, amphibian breeding habitat, bald eagle and osprey habitat, road closures, turtle basking sites, bat roosting structures, surveys for special-status species, and long-term monitoring (USFWS 2007).

Temporary Construction Impacts

Short-term construction activities would occur associated with the installation of fish passage at the four dams. Construction areas would likely be similar to, but smaller than those required for demolition of all four dams under the Proposed Action or the Partial Facilities Removal Alternative. The same or similar elements would be incorporated into construction activities to avoid or reduce impacts on wildlife and plants, including special-status species, and sensitive habitats. **Mitigation Measures *TER-1*** through ***TER-4*** (Section 3.5.4.4) would be implemented, as necessary, to avoid or reduce impacts as under the Proposed Action. **Therefore, temporary construction impacts on terrestrial resources from the Fish Passage at Four Dams Alternative would be less than significant.**

Long-Term Impacts

Under the Fish Passage at Four Dams Alternative, reservoirs would remain in place and there would be no anticipated sedimentation in downstream reaches that would affect riverine areas. As with the No Action/No Project Alternative, the KBRA would not be implemented under the Fish Passage at Four Dams Alternative. Therefore, there would continue to be uncertainty regarding water deliveries to the NWRs, and subsequent impacts on terrestrial resources within the Lower Klamath NWR, Tule Lake NWR, and Upper Klamath NWR.

Although detailed plans are not yet available, construction of the fish passage facilities would not likely result in permanent loss of wetlands. There would also be no anticipated long-term impacts on terrestrial wildlife, including special-status species, from operation of the fish passage facilities. Existing barriers to terrestrial wildlife movement presented by the dams and associated facilities would remain. There would be potential for impacts related to invasive species in areas disturbed by construction, although much less so than under the Proposed Action, the Partial Facilities Removal Alternative, and the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative where reservoirs are drawn down. Implementation of the HRP (**Mitigation Measure *TER-1*** (Section 3.5.4.4) in construction areas would avoid or reduce impacts related to invasive species. **Therefore, long-term impacts on terrestrial resources from the Fish Passage at Four Dams Alternative would be less than significant.**

3.5.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

The Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative includes the removal of two of the Four Facilities (Copco 1 and Iron Gate). Copco 1 Reservoir and Iron Gate Reservoir would be drawn down. This alternative also includes development and/or improvement of fish passage at Copco 2 and J.C. Boyle Dams. Since the J.C. Boyle and Copco 2 Reservoirs store much less sediment than do the Copco 1 and Iron Gate Reservoirs, the amount of sediment released to the river system would be similar under the Fish Passage at Two Dams Alternative as under the Proposed Action.

Temporary Construction Impacts

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative there would be temporary construction impacts similar to those of the Proposed Action at the Copco 1 and Iron Gate facilities. Construction impacts would also occur at Copco 2 and J.C. Boyle with the construction of fish passage facilities there. Construction areas would likely be smaller than those required for demolition of all four dams under the Proposed Action or the Partial Facilities Removal Alternative. The same or similar elements would be incorporated into construction activities to avoid or reduce impacts on wildlife and plants, including special-status species, and sensitive habitats. **Mitigation Measures *TER-1*** through ***TER-4*** (Section 3.5.4.4) would be implemented, as necessary, to avoid or reduce impacts as under the Proposed Action. **Therefore, temporary construction impacts on terrestrial resources from the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less than significant.**

Long-Term Habitat Loss and Modification
Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, two reservoirs would remain in place and two would be drawn down. As with the No Action/No Project Alternative, the KBRA would not be implemented under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative. Therefore, there would continue to be uncertainty regarding water deliveries to the NWRs, and subsequent impacts on terrestrial resources within the Lower Klamath NWR, Tule Lake NWR, and Upper Klamath NWR.

Although detailed plans are not yet available, construction of the fish passage facilities would not likely result in permanent loss of wetlands. **Mitigation Measure *TER-5*** (Section 3.5.4.4) would reduce impacts from permanent loss of wetlands, if it occurs, to less than significant. In addition, permanent loss of wetlands at Copco 1 and Iron Gate Reservoirs would be offset by restoration activities. As described above for the Proposed Action, there would also be benefits to wildlife from gains in upland and riparian habitat at Copco 1 and Iron Gate Reservoirs following establishment of newly planted areas and with control and monitoring of invasive plants.

As with the Proposed Action, there could be sedimentation in downstream reaches that would have impacts on riparian areas, although this is anticipated to be short-term and not considered a significant long-term impact (Stillwater 2008, Reclamation 2012). There would be impacts on terrestrial wildlife, including special-status species, from the loss of aquatic habitat at the Copco 1 and Iron Gate Reservoirs, but these impacts would be less than significant, as described for the Proposed Action. **Mitigation Measure *TER-6*** (Section 3.5.4.4) would reduce impacts on bats from the loss of roosting habitat to less than significant. Some vegetation that provides habitat for terrestrial species would be removed, but elements incorporated into construction and **Mitigation Measure *TER-1*** (Section 3.5.4.4) would avoid or reduce these impacts to less than significant, as with the Proposed Action. Existing barriers to terrestrial wildlife movement presented by the two remaining dams, Copco 2 and J.C. Boyle Dams, would remain. Implementation of the HRP in construction areas would avoid or reduce impacts related to invasive species. **Therefore, long-term impacts on terrestrial resources from the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less than significant.**

3.5.4.4 Mitigation Measures

3.5.4.4.1 Mitigation Measure by Consequence Summary

TER-1: Habitat Rehabilitation Plan
To reestablish native vegetation communities and wildlife habitat in areas disturbed by construction, a HRP will be developed once the Definite Plan is prepared and construction areas are delineated. The HRP will be a stand-alone document separate from the Reservoir Area Management Plan (Reclamation 2011) that describes rehabilitation of the reservoir areas. The HRP will cover all areas disturbed by

construction, including upland sediment disposal sites, access and haul roads, pipeline corridors, and equipment staging areas. Habitat rehabilitation of construction areas will take place in three general phases:

Phase 1: Rehabilitation/re-grading of site to restore pre-disturbance topography. Where present, topsoil and subsoil will be salvaged and replaced. The seedbed will be prepared to optimize plant establishment and physically stabilize the site against erosion during the plant-establishment period. This process will include soil decompaction to prepare site for planting.

Phase 2: Establishment of a certified weed-free erosion-control seed mixture. Immediately following re-grading of a site and seedbed preparation, construction areas will be seeded or hydroseeded (for steep slopes) prior to the rainy season with a fast-growing mixture of perennial species and an annual nurse crop (also certified weed-free). The proposed seed mixture will be from a local, native source where available and would be similar to that used by California Department of Transportation (Caltrans) on nearby rehabilitation sites. The seed mix is subject to approval by the appropriateStateor Federal agency. The standard Caltrans mix for the area includes the following species:

California brome (*Bromus carinatus*)
Squirrel tail (*Elymus elymoides*)
Barley (*Hordeum vulgare*)
Common yarrow (*Achillea millefolium*)
Silver bush lupine (*Lupinus albifrons*)
Antelope bitterbrush (*Purshia tridentata*)
California poppy (*Eschscholzia californica*)

Phase 3: Long-term Habitat Rehabilitation. A reference site of suitable size will be selected for each rehabilitation area to reflect pre-disturbed, native conditions with low to no cover of invasive species. The reference site will be located nearby to and consist of the same vegetation community and similar slope, aspect, and other physical features of the construction area. Rehabilitation of construction areas will be based on the percent of native plant cover, density, and richness found at the reference sites. Construction areas will be re-vegetated with seeding and installation of container plants (for shrubs) of native species. Where possible, seeds of native species will be collected from reference sites. Otherwise, seeds will be obtained from a local native seed supplier. In addition to the use of reference sites, aerial images of the impact sites will be collected prior to disturbance as an additional measure to meet rehabilitation goals.

A Maintenance and Monitoring Plan will be implemented to measure success of long-term rehabilitation as compared to reference sites. Maintenance and monitoring will be

conducted on average bi-weekly during the first six months following seeding, monthly during the next six months, bi-monthly during the next year, quarterly for years 2 and 3 of the 3-year maintenance period.

Maintenance activities will include removal of invasive, noxious, and other undesirable plants listed by the California Invasive Plant Council, California Department of Food and Agriculture, Oregon Invasive Species Council, Oregon Department of Agriculture (ODA), and local resource agency lists. Invasive, noxious, and other undesirable plants will be controlled using mechanical methods such as discing, mowing, and hand-weeding, and chemical herbicides where deemed appropriate in coordination with local resource agencies.

Monitoring will consist of qualitative characterization based upon visual analysis of the rehabilitation area and will focus on soil conditions (moisture and fertility), seed germination, presence of native and invasive/non-native species, and any problems (erosion, disease, pests) and the corrective actions to be taken.

Following the maintenance period, the sites will be monitored annually to ensure that rehabilitation goals are being met. Due to the arid environment and low annual precipitation, plant growth rate is slow in and around the project area and vegetation development is expected to be relatively slow as well. Qualitative and quantitative monitoring will be conducted yearly after the growing season for measures including plant cover and density. Cover, density, and species richness will be calculated for the rehabilitated area and compared to the data collected from the reference sites. Rehabilitation goals will be as follows:

1. Establishment Period: Years 1 and 2

Assessment Schedule and Technique: Qualitative estimate made through visual reconnaissance of the reclaimed area at the end of each growing season.

- Cover of Seeded Plant Species: >75% of cover at reference site.
- Density of Seeded Plant Species: either >5 plants/ft^2 or >25% of the density at reference site.
- Native Species Richness: 5 plant species with >1% cover or >25% of the richness at reference site.
- Control of Invasive, Noxious, and Undesirable Species: 76-90%

Maintenance: Noxious and undesirable weed control and use of engineered best management practices for erosion control.

Compliance: When goals are met, 80% of reclamation bond or retainage is released.

2. Monitoring Period: Years 3 to 5, or until performance criteria are met.

Assessment Schedule and Technique: Qualitative estimate made through visual reconnaissance of the reclaimed area during year 3 and 4, and quantitative measurements made after the 5th growing season using permanently staked transects.

- Cover of Seeded Plant Species: >75% of the amount of cover at reference site.
- Density of Seeded Plant Species: either >5 plants/ft^2 or >50% of the plant density at reference site.
- Native Species Richness: 5 plant species with >1% cover or >50% of the richness at reference site.
- Control of Invasive, Noxious, and Undesirable Species: 90-100%

Maintenance: Noxious and undesirable weed control and use of engineered best management practices for erosion control.

Compliance: When goals are met, 90% of reclamation bond or retainage is released.

TER-2: Nesting Bird Surveys[6]

If, during preconstruction surveys, an active nest of a special-status bird species (e.g., northern spotted owl, osprey, willow flycatcher) or migratory bird is identified, a restriction buffer would be established in consultation with the resource agencies to ensure nests are not disturbed from construction. This may include evaluation of noise levels at the nesting site for special-status species such as northern spotted owl. Once the Definite Plan is prepared and construction areas are delineated, detailed plans for nesting bird surveys and measures to be implemented if active nests are found will be developed in consultation with USFWS, ODFW, and CDFG. See **Mitigation Measure *TER-3*** for mitigation related to bald and golden eagles.

Table 3.5-6 lists the restriction buffers for many common raptor species with potential to occur within or near construction areas. This information was provided by USFWS (Strassburger 2011). *Buffer zones* are defined as seasonal or spatial areas of inactivity in association with individual nests or nesting territories. *Spatial buffers* are defined as radii from known occupied and unoccupied nest sites. *Seasonal buffers* are restrictions on the times when human activities may occur within the spatial buffers (USFWS 2002). All restriction buffers would be established as appropriate and in consultation with USFWS, ODFW, and CDFG.

[6] The discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate the development of compliance documentation for the Bald and Golden Eagle Protection Act. These BMPs are also described in Appendix B.

Table 3.5-6. No Surface-Disturbing Activity Spatial Buffers and Seasonal Timing Restriction Stipulations for Raptor Nests

Species	Spatial Buffer (miles)	Seasonal Timing Restriction
Bald eagle	1.00	Jan 1 – Aug 31
Golden eagle	1.00	Jan 1 – Aug 31
Northern goshawk	0.75	March 1 – Aug 15
Northern harrier	0.75	April 1 – Aug 15
Cooper's hawk	0.75	March 15 – Aug 31
Ferruginous hawk	1.00	March 1 – Aug 1
Red-tailed hawk	0.75	March 15 – Aug 15
Sharp-shinned hawk	0.75	March 15 – Aug 31
Swainson's hawk	0.75	March 1 – Aug 31
Turkey vulture	0.75	May 1 – Aug 15
Peregrine falcon	1.00	Feb 1 – Aug 31
Prairie falcon	0.75	April 1 – Aug 31
Merlin	0.75	April 1 – Aug 31
American kestrel	0.05 (300 feet)	April 1 – Aug 15
Osprey	0.75	April 1 – Aug 31
Burrowing owl	0.25 to 0.75	March 1 – Aug 31
Flammulated owl	0.75	April 1 – Sept 30
Great horned owl	0.75	Dec 1 – Sept 30
Long-eared owl	0.75	Feb 1 – Aug 15
Northern saw-whet owl	0.75	March 1 – Aug 31
Short-eared owl	0.75	March 1 – Aug 1
Northern pygmy-owl	0.75	April 1 – Aug 1
Western screech-owl	0.75	March 1 – Aug 15
Barn owl	0.062 to 0.25	Feb 1 – Sept 15

Source: USFWS 2002

When active raptor nests (with eggs or young) are located within the disturbance buffer for that species, and if construction is scheduled to occur in the vicinity during the nesting period, then additional considerations will include the following:

- Line-of-sight considerations- if the nest is visually obscured from construction activities by substantial vegetation (i.e., a forest or woodlot), or by geographic relief (e.g., a ridgeline), or any other type of visual barrier, then construction may continue. However, the nest will be monitored continuously throughout the nesting season to assure that the birds are not disturbed to a level that jeopardizes or alters the outcome of the nest. Initially, the birds will be monitored for signs of disturbance, and bird behavior will be compared to pre-construction levels.

Monitoring in these cases will include determining and reporting to USFWS the ultimate fate of the nest. Birds nesting in locations that are visually protected from the construction site are not automatically protected from disturbance; their level of response to disturbance will depend on the species, tolerances of individual birds, type of activity, noise level, and distance from the activity. If birds appear to be disturbed by construction, regardless of species, then the USFWS Migratory Bird Program will be contacted to seek solutions to this issue.

TER-3: Impacts to Nesting Habitat of Bald and Golden Eagle and Other Migratory Birds[7]

Mitigation to reduce impacts on Bald and Golden Eagle and Other Migratory Birds from loss of nesting habitat will include the following measures described below. This information was provided by USFWS (Strassburger 2011):

- Complete a two-year survey for bird use patterns prior to construction activities. Surveys will be conducted by a qualified avian biologist and will include any facilities to be removed or modified to determine bird use patterns. Surveys will be conducted during the time of year most likely to detect bird usage;

- Before approval of any site specific implementation plan, develop an Eagle Conservation Plan in coordination with USFWS;

- If deemed necessary and before approval of any site specific implementation plan, a permit from the USFWS will be obtained if project activities are anticipated to result in take under the Bald and Golden Eagle Protection Act.

Mitigation to Avoid Mortality and Disturbance

If surveys indicate part of the construction footprint or facilities slated for removal is utilized by bald or golden eagle or other migratory bird, then these mitigations will be employed to minimize disturbance and mortality to those birds:

- Where ever possible, clearing, cutting, and grubbing activities shall be conducted outside the eagle breeding period (January 15 through August 15);

- Where clearing, cutting, and grubbing work cannot occur outside the migratory bird nesting season (March 20 through August 20), a qualified avian biologist shall survey those areas to determine if any migratory birds are present and nesting in those areas;

[7] The discussion presented in this section includes both BMPs that would be incorporated during construction as well as mitigation measures in order to facilitate the development of compliance documentation for the Bald and Golden Eagle Protection Act. These BMPs are also described in Appendix B.

- If nesting migratory birds/eagles are found, one of the following measures shall be taken to minimize impacts to nesting birds; 1) modification of the project footprint to avoid the nest permanently, 2) protection of the nest until the young have fledged, or 3) implementation of measures included in the Eagle Conservation Plan in coordination with USFWS.

Monitoring Measures to Determine Success and Corrective Action Measures
If project activities are anticipated to result in take under the Bald and Golden Eagle Protection Act, five years of monitoring by qualified avian biologists will be conducted following completion of deconstruction activities. The mitigation will be deemed successful if there is no net loss of eagles within the project area.

If this standard is not met, the Dam Removal Entity will consult with the USFWS and CDFG or ODFW, as appropriate, to ascertain the potential need for further mitigation.

TER-4: Special-Status Plants
Once the Definite Plan is prepared and construction areas are delineated, detailed plans for protocol-level surveys for special-status plants will be developed in consultation with USFWS, ODFW, and CDFG. If, during preconstruction surveys, any special-status plants are found to occur within the construction areas, the size and location of all identified occurrences would be mapped on the final construction plans, and impact acreages would be quantified based on proposed limits of disturbance. Compensation measures are expected to be a combination of the relocation, propagation, and establishment of new populations in conservation areas within the project site at a 1:1 ratio or at a 2:1 ratio in approved off-site habitat preservation areas, as determined in consultation with the resource agencies.

TER-5: Permanent Loss of Wetlands at Reservoirs
Under the Proposed Action, the Partial Facilities Removal Alternative, and the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, there would be loss of wetlands from the drawdown and permanent removal of reservoirs. Based on PacifiCorp surveys (PacifiCorp 2004a), there could be unavoidable impacts on 244.4 acres of wetland habitat at the J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs, much of which would be restored with implementation of the Reservoir Area Management Plan (Table 3.5-5). In compliance with the Clean Water Act, a Section 404 Permit will be required and a Compensatory Wetland Mitigation Plan will be developed and implemented in accordance with the requirements of the United States Army Corps of Engineers (USACE) and the Oregon Department of State Lands (DSL) in compliance with the Oregon Removal-Fill Law.

The Compensatory Wetland Mitigation Plan will be based on Federal and State no-net-loss policies with an emphasis on on-site and in-kind restoration and enhancement of wetlands. The Compensatory Wetland Mitigation Plan may also include creation or other potential mitigation strategies in compliance with the final 404 Permit and Oregon Removal-Fill Permit. Compensation wetlands will be required to meet or exceed the functions and quality of the wetland habitat lost at the reservoirs. A monitoring plan will

be required to assess whether the compensation wetlands are functioning as intended. Based on the final 404 Permit and Oregon Removal-Fill Permit, specific performance standards for hydrologic, floral, and faunal parameters will be proposed to determine success of the Compensatory Wetland Mitigation Plan. The monitoring plan would specify the corrective measures/ modifications to be implemented in the event that monitoring indicates that the performance standards are not being met. Monitoring will occur for at least five years and until success criteria are met, and as required by USACE, Oregon DSL, and the resource agencies in compliance with the final 404 Permit, Oregon Removal-Fill Permit and Federal and State no-net-loss policies.

In addition, a maintenance plan will be required as part of the Compensatory Wetland Mitigation Plan describing the measures to be implemented to assure wetland habitats are maintained in perpetuity. The maintenance plan will address buffering from adjacent uses, fencing, access erosion control, and weed eradication.

TER-6: Impacts on Special-Status Bats from Loss of Roosting Habitat
Mitigation to reduce impacts on special-status bats from loss of roosting habitat will include the following:

- For the two years immediately prior to construction activities, qualified bat biologists will conduct bat surveys at facilities to be removed or modified to determine bat use patterns. Surveys will be conducted during the time of year most likely to detect bat usage.

Mitigation to Avoid Mortality and Disturbance
If surveys indicate a facility is utilized as a bat roost, then one of two mitigations will be employed to minimize disturbance and mortality to roosting bats:

- The facility shall be removed or modified outside the bat roosting and breeding period (November 1 to March 1); or

- Bat exclusion methods to seal-up facility entry sites (e.g., blocking and netting or installing sonic bat deterrence equipment) will occur prior to March 1 of the year the facility will be removed or modified.

Mitigation for Loss of Roosting Habitat
To reduce impacts on bats from the permanent loss of roosting habitat, five free-standing bat roosts will be constructed in consultation with bat specialists and the resource agencies. Experienced contractors will perform the installation of bat roosts. The structure will be placed in full sun at least 30 feet above ground. The structure will be concrete with high thermal mass and will meet the specifications of Bats in American Bridges (Keeley and Tuttle 1999) and California Bat Mitigation Techniques, Solutions, and Effectiveness (H.T. Harvey and Associates 2004).

Monitoring Measures to Determine Success and Corrective Action Measures
Five years of monitoring by qualified bat biologists will be conducted following installation of the bat roosts to determine the pattern and amount of use by bats. The

mitigation will be deemed successful if one or more of the bat roosts, are utilized by at least 600 bats (combined use at all five facilities) as either day or night roosts, or some combination, for at least two years.

If this standard is not met, the Dam Removal Entity will consult with the USFWS and CDFG or ODFW, as appropriate, to ascertain the potential need for further mitigation.

Effectiveness of Mitigation in Reducing Consequence

Proposed mitigation measures would be effective in reducing impacts on terrestrial resources to less than significant. Effectiveness would be evaluated through monitoring incorporated into the mitigation measures. If monitoring results indicate that mitigation measures are not effective in reducing impacts, corrective action would be taken, as described in the mitigation measures.

Agency Responsible for Mitigation Implementation

The Dam Removal Entity will be responsible for implementing the mitigation measures.

Remaining Significant Impacts

With the implementation of mitigation measures, there would be no significant impacts to terrestrial resources.

Mitigation Measures Associated with Other Resource Areas

Several other mitigation measures involve construction work, including mitigation measures H-2 (flood-proof structures), GW-1 (deepen or replace affected wells), WRWS-1 (modify or screen affected water intakes), REC-1 (develop new recreational facilities and access to river), TR-6 (assess and improve roads to carry construction loads), and TR-7 (assess and improve bridges to carry construction loads). During these construction activities, there could be impacts on terrestrial resources, including impacts on special-status species, wetlands, or effects related to the spread of invasive plants. Elements incorporated into construction would avoid or reduce these effects, as described for the Proposed Action. **Mitigation Measures *TER-1*** through ***TER-5*** (Section 3.5.4.4) would be implemented, as necessary, to avoid or reduce impacts. **Therefore, impacts on terrestrial resources from mitigation measures associated with other resource areas would be less than significant.**

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3.6 Flood Hydrology

This section is focused on flooding effects from the Proposed Action and alternatives. The surface water hydrology within the Klamath Basin has a complicated and complex history; however, only elements of the hydrology related to the alternatives' potential flood impacts are described in this section. Other sections of the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) discuss groundwater (Section 3.7), water quality (Section 3.2), and water supply/water rights (Section 3.8).

3.6.1 Area of Analysis

The area of analysis for this section includes the Klamath River and tributaries that define the Klamath Basin, which lies in portions of three Oregon counties (Klamath, Jackson, and Curry) and five California counties (Modoc, Siskiyou, Del Norte, Humboldt, and Trinity). Upper Klamath Lake is in Oregon. The downstream outlet of Upper Klamath Lake is Link River Dam which releases water into the Link River. About one mile below the Link River Dam, the Link River flows into Keno Impoundment/Lake Ewauna. The Keno Impoundment/Lake Ewauna is controlled by the Keno Dam near Keno, Oregon. The Klamath River technically begins at the historic outfall of Lake Ewauna which is above Keno Dam. However, water impounded by Keno Dam, flooded portion of the Klamath River between the outfall of Lake Ewauna and Keno Dam and today forms part of the lake-like waterbody of Keno Impoundment/Lake Ewauna. The Klamath River flows approximately 250 miles from the old outfall of Lake Ewauna, through Keno Dam, through the Klamath Hydroelectric Project into the Pacific Ocean near Klamath, California (see Figure 3.6-1).

The Upper Klamath Basin is upstream of Iron Gate Dam and includes Upper Klamath Lake and its tributaries, Link River, the Keno Impoundment/Lake Ewauna, and the Hydroelectric Reach (from J.C. Boyle Dam to Iron Gate Dam). Several facilities control water management in the Upper Klamath Basin, the Klamath Hydroelectric Project, and Reclamation's Klamath Project via several diversions from the Upper Klamath River (Federal Energy Regulatory Commission [FERC] 2007).

The Lower Klamath Basin includes the areas of the Klamath Basin downstream from Iron Gate Dam to the Pacific Ocean. Tributaries to the Lower Klamath Basin include the Shasta, Scott, Salmon, and Trinity Rivers. The Klamath Estuary, on the northern California coast, completes the system and eventually outlets to the Pacific Ocean (FERC 2007). Section 3.6.3.2 describes basin hydrology in more detail. The areas downstream from J.C. Boyle Reservoir are discussed in more detail because they may experience project-level impacts from the Klamath Hydroelectric Settlement Agreement (KHSA) (or alternatives). Upstream areas are discussed in less detail because these areas are

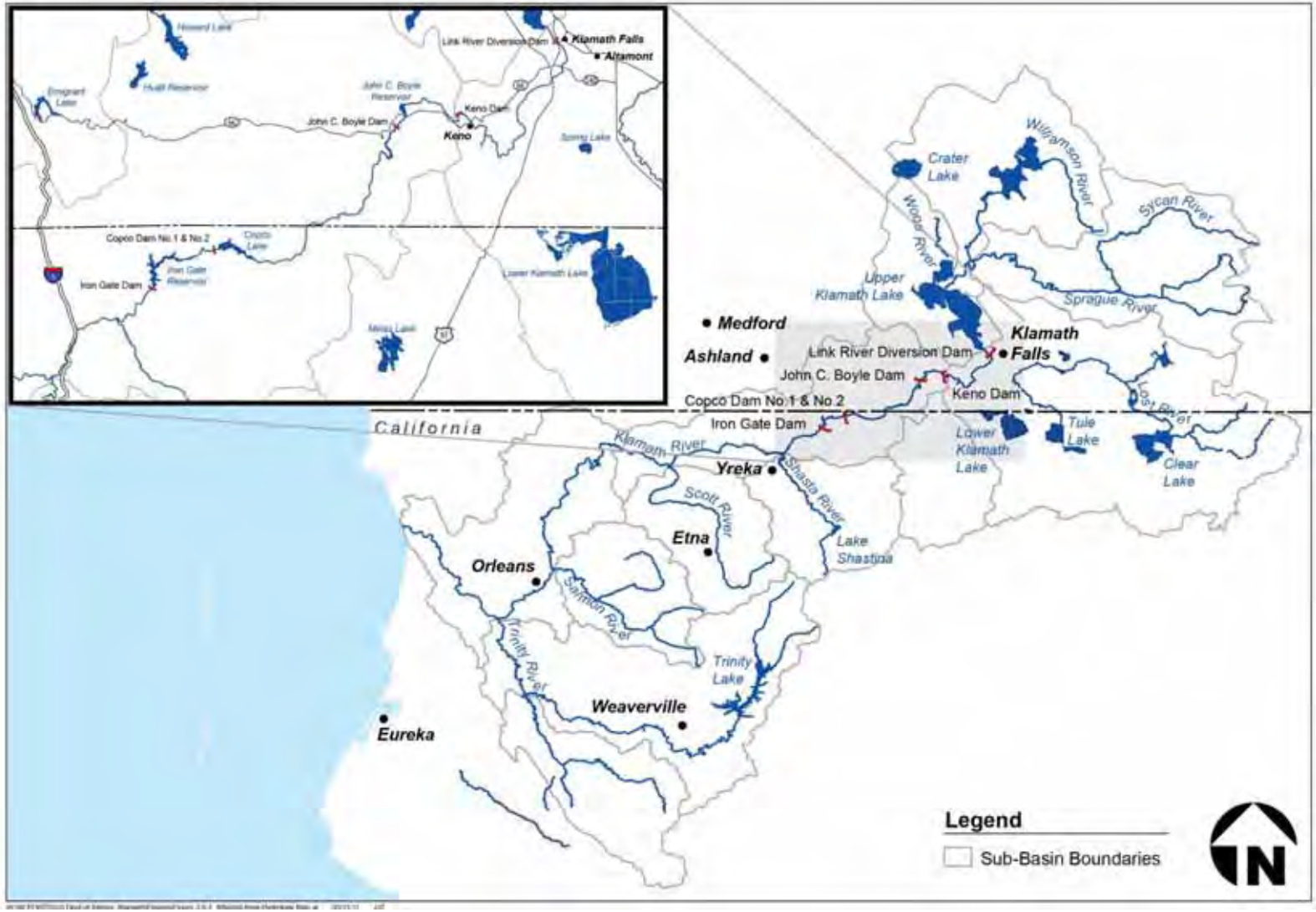


Figure 3.6-1. Flood Hydrology Affected Area.

upstream of the proposed dam removal activities associated with the KHSA. The potential Klamath Basin Restoration Agreement (KBRA) impacts are analyzed at a program level in this EIS/EIR.

3.6.2 Regulatory Framework

Flood hydrology within the area of analysis is regulated by several Federal, State, and local laws and policies, which are listed below.

3.6.2.1 Federal Authorities and Regulations

- National Flood Insurance Program

3.6.2.1.1 National Flood Insurance Program

The National Flood Insurance Program (NFIP) is regulated by the Flood Insurance and Mitigation Administration under the Federal Emergency Management Agency (FEMA). The program was established as part of the National Flood Insurance Act of 1968 and includes three components: Flood Insurance, Floodplain Management and Flood Hazard Mapping (FEMA 2002).

Through the voluntary adoption and enforcement of floodplain management ordinances, U.S. communities participate in the NFIP. The NFIP makes available federally backed flood insurance to homeowners, renters and business owners in participating communities. The NFIP promotes regulations designed to reduce flood risks through sound floodplain management. NFIP maps identify floodplains and assist communities when developing floodplain management programs and identifying areas at risk of flooding.

In 1973, the Flood Disaster Protection Act was passed by Congress. The result of this was the requirement for community participation in the NFIP to receive Federal financial assistance for acquisition or construction of buildings and disaster assistance in floodplains. It also “required Federal agencies and federally insured or regulated lenders to require flood insurance on all grants and loans for acquisition or construction of buildings in designated Special Flood Hazard Areas” within participating communities (FEMA 2002).

Later, in 1994, the two acts were amended with the National Flood Insurance Reform Act, which included a requirement for FEMA to assess its flood hazard map inventory at least once every 5 years. FEMA prepares floodplain maps based on the best available science and technical information available. However, changes to the watershed or the availability of new information may cause the need for a map revision. When a revision is required, the applicable community works with FEMA to develop the map revision through a Letter of Map Amendment (LOMA) or a Letter of Map Revision (LOMR) (FEMA 2002).

In order for communities to participate in the NFIP they must adopt and enforce floodplain management criteria. The local counties in which dam removal would

cause hydrologic effects, Klamath County in Oregon and Siskiyou County in California, participate in the NFIP (FEMA 2002).

3.6.2.2 Affected County Flood Codes and Ordinances

- Klamath County Code (Klamath County Land Development Code Article 59) (Klamath County)
- Siskiyou County Code (Article 54, Chapter 6) (Siskiyou County)
- Siskiyou County Code (Policy 27, Chapter 10) (Siskiyou County)

3.6.2.2.1 Klamath County, Oregon

Article 59 of the Klamath County Land Development Code includes the Flood Hazard Overlay in accordance with the NFIP. It includes provisions for development within and around designated flood hazard areas and defines those areas according to the Flood Insurance Rate Map prepared by FEMA. It also includes provisions for alterations of watercourses and waterway development that preclude any diminishment of the flood carrying capacity of a water course (Klamath County 2010a). The *Klamath County Comprehensive Plan* (2010b) establishes goals and policies for areas subject to natural disasters and hazards; this includes identifying flood prone areas on maps to protect life and property from natural disasters and hazards. The Comprehensive Plan specifies that "the County will continue to participate in the FEMA NFIP."

3.6.2.2.2 Siskiyou County, California

Siskiyou County has policies related to flood hazards within its County General Plan (1997). These policies refer to flood boundaries shown on FEMA flood hazard maps and regulate development within and near flood hazard areas (Siskiyou County 1997). Article 54 of the Siskiyou County Zoning Ordinance (Chapter 6) further defines the regulations within District F (Floodplain Combining Districts) where areas experience inundation by periodic overflow and backwater (Siskiyou County 1986). Chapter 10 of Planning and Zoning Code addresses Flood Damage Prevention and provides for requirements to notify the Federal Insurance Administration of alteration or relocation of watercourses and also addresses other issues related to Flood Damage Prevention. Land Use Policy 27 states the following:

> "No residential or industrial development shall be allowed on water bodies. Exceptions may be considered for water supply, hydroelectric power generation facilities, public works projects necessary to prevent or stabilize earth movement, erosion, and the enhancement of migratory fish and other wildlife, light commercial, open space, non-profit and non-organizational in nature recreational uses, and commercial/recreational uses." (Siskiyou County 1990)

3.6.3 Existing Conditions/Affected Environment

This section describes the hydrologic conditions of surface water and wetlands in the Klamath Basin. Figure 3.6-1 shows the area of analysis. The setting section includes a

description of basin hydrology including precipitation, reservoirs, major rivers and tributaries; lakes; springs and seeps providing measurable flow; historic stream flows; and flood hydrology. Available data of existing average daily and monthly river flows and their relationship to Reclamation's Klamath Project and PacifiCorp's Klamath Hydroelectric Project are also described throughout this section.

3.6.3.1 Historical Hydrologic Conditions

3.6.3.1.1 Pre-Dams and Pre-Klamath Project Hydrology

Several studies have been conducted to determine the natural flow conditions of the Klamath Basin (Bureau of Reclamation [Reclamation] 2005); however, these studies are limited by a lack of data. Prior to development of dams and implementation of Reclamation's Klamath Project, the Upper Klamath Basin contained lakes and large areas of marshes and wetlands. The Upper Klamath Lake was not much larger than its current size; however, Tule Lake and Lower Klamath Lake were much larger. Springs, snowmelt, and groundwater dominated rivers carrying water from the Cascades and other highlands in the Upper Basin contributed greatly to Upper Klamath Lake, the Klamath River, and the wetlands and marshes in that area (Akins 1970). The elevation of Upper Klamath Lake was originally controlled by a natural rock reef dam at the outlet of the lake. Water then flowed 1.3 miles down the Link River to Lake Ewauna. Within this stretch of river, Lake Ewauna developed because of a natural rock reef dam near Keno, Oregon. Originally before the construction of dams and other water control structures, the Klamath River began at the outfall of Lake Ewauna.

During high flow events out of Upper Klamath Lake, some water was captured and would flow down the Lost River Slough and into Tule Lake, another natural sump and wetland area. Water that flowed into the Klamath River reached another split near Keno (Akins 1970).

During flood conditions, water would also back up from the Keno Reef (near Keno, Oregon) and flow into the Klamath Straits and down to Lower Klamath Lake. The Lower Klamath Lake and Tule Lake areas once contained large areas of wetlands and marshes. The Lost River flowed from Clear Lake to Tule Lake. Now, a diversion provides water from the Lost River to the Klamath River (Akins 1970). Figure 3.6-2 shows the historic wetlands and configuration of the Upper Basin.

The presence of both historic Tule and Lower Klamath Lake influenced flows in the Klamath River. Lower Klamath Lake (approximately 30,000 acres of open water and 55,000 surface acres of marsh) was connected to the Klamath River through the Klamath Straits. When the river began to rise in the spring during high water flow events, water overflowed into this lake and marsh and, as the river fell in the fall some of the water flowed back out of the lake (Weddell et al. Undated). Lower Klamath Lake provided some short term storage by reducing the total volume of water leaving the upper watershed as well as delaying the peak flow. Tule Lake received overflow during high flow periods from the Klamath River near Klamath Falls, Oregon. Tule Lake was a terminal lake system; the overflow through the Lost River Slough reduced peak flows in the Klamath River in late winter and spring (Abney 1964).

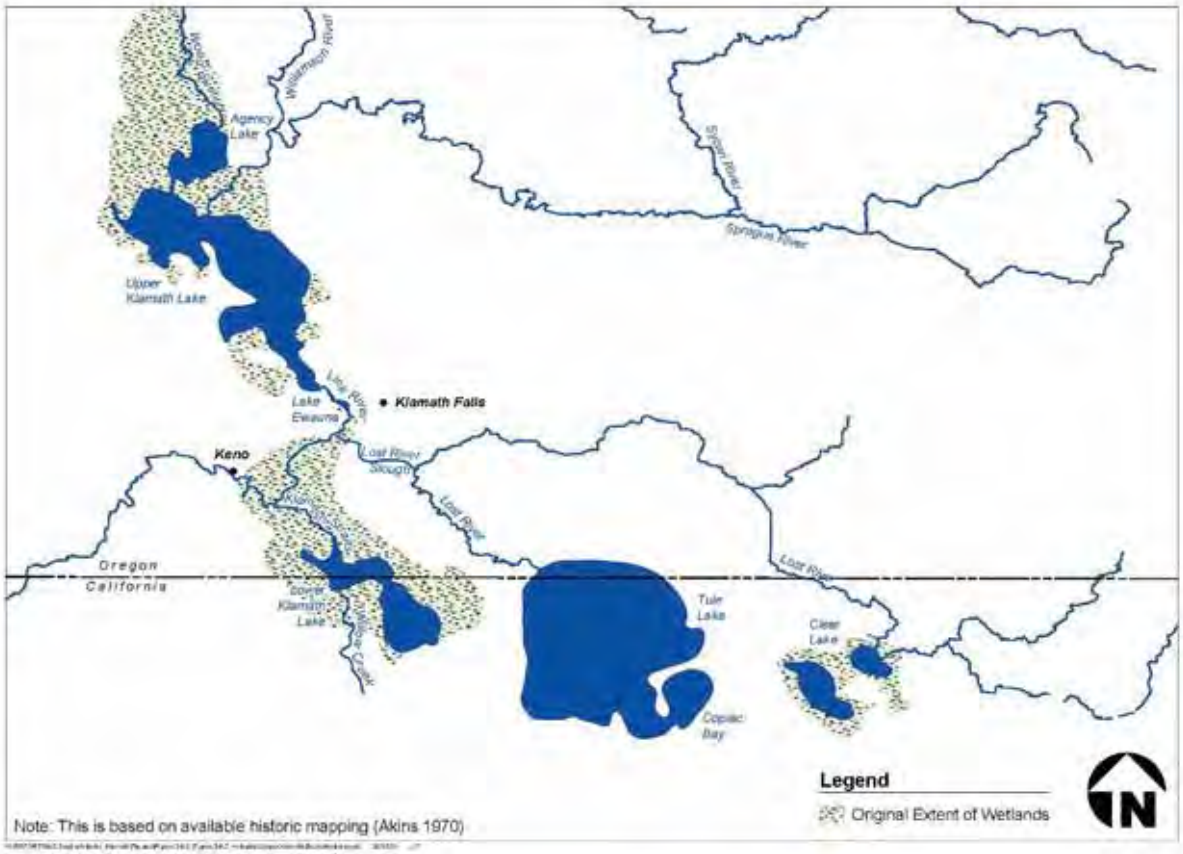


Figure 3.6-2. Historical Upper Klamath Basin Hydrology Before Dams, National Wildlife Refuges, and Reclamation's Klamath Project.

Below the Keno Reef, the Klamath River flowed freely with no dam controls. The J.C. Boyle, Copco and Iron Gate Reservoirs did not exist. Dams along major tributaries entering the river also did not exist and the water flowed to the river, then to the Klamath Estuary and eventually to the Pacific Ocean.

3.6.3.1.2 Historical Uses Affecting River Flows

During the early part of the 19th century, the Klamath Basin was home to seven Indian Tribes (see Section 3.13, Cultural and Historic Resources). These tribes depended on the Klamath River to produce salmon, steelhead, and other fish, which contributed to their survival and culture. During this time period, the river system had no dams, and the wetland areas of the Upper Basin including Upper Klamath Lake, Tule Lake and Lower Klamath Lake had not been altered (FERC 2007).

The discovery of gold in California in 1848 prompted a dramatic influx of European immigrants to California and other areas, including the Klamath Basin. Euroamerican settlement in the Klamath River watershed continued throughout the 19th Century.

Sustained logging enterprises appeared in the 1880s, and the first hydroelectric development in the Klamath Basin was established in 1891 in the Shasta River Canyon below Yreka Creek.

Additional hydrologic changes to the mainstem of the Klamath Basin were triggered by the passage by the U.S. Congress of the Reclamation Act of 1902 and the subsequent authorization of Reclamation's Klamath Project in 1905. The Reclamation Act supported development in the "arid West" by allowing the Federal Government to fund irrigation projects (Department of the Interior [DOI] 2011b). In 1905, the Oregon and California legislatures and the U.S. Congress passed the Cession Act for all necessary legislation to begin Reclamation's Klamath Project (DOI 2011a). Afterwards, Reclamation began building its Klamath Project, which led to the construction of the Link River Dam, several hundreds of miles of irrigation ditches and large canals and pumping plants to divert water from the Klamath River watershed for agricultural use (FERC 2007). This infrastructure supported the agricultural community which was already well established in the Upper Klamath Basin and allowed for reclamation of additional wetlands for agricultural use (FERC 2007).

In 1908, President Roosevelt created the Lower Klamath Lake National Wildlife Refuge (NWR). Later, in 1928, the Tule Lake and Upper Klamath Lake NWRs were also created, and a portion of the water from the Upper Klamath Lake was diverted to these NWRs (FERC 2007). Historic wetland areas were drained to accommodate agricultural development; however, some of the historic wetland areas around Upper Klamath Lake have more recently been returned to Upper Klamath Lake.

Development of hydroelectric plants in the Klamath Basin began as early as 1891 in the Shasta River Canyon to provide electricity for the City of Yreka. In 1895, another facility was constructed on the east side of the Link River supplying power to Klamath Falls, Oregon. Additional power suppliers developed facilities in the area on Fall Creek and the West Side plant on the Link River (FERC 2007). Chapter 1 provides additional historical detail regarding the Klamath Hydroelectric Project.

Concern over the effects of these dams on salmon and suckers grew over the years. The shortnose and Lost River suckers were listed as endangered under the Endangered Species Act in 1988 (FERC 2007). The Southern Oregon/Northern California Coast (SONCC) coho salmon Ecologically Significant Unit were reviewed in 1996 and listed as threatened in 1997. . The listing was reaffirmed in 2005 (National Oceanic and Atmospheric Administration [NOAA] Fisheries Service 2005). Section 3.3, Aquatic Resources, provides background information and an analysis of effects on these endangered species.

3.6.3.2 Basin Hydrology

This section describes reservoirs, rivers, and creeks in the affected environment and lists historic average stream flows. Various springs and seeps occur in the vicinity of Iron Gate, Copco and J.C. Boyle Dams and contribute flows to surface water. Springs around Upper Klamath Lake provide inflow to many of the streams feeding

the lake and also provide stability for area wetlands (Akins 1970). Section 3.7.3.1, describes the locations of springs and seeps in more detail. Some measurable inflows from springs and seeps to various surface waters are described below. Figure 3.6-1 shows the major reservoirs and rivers in the Klamath Basin.

3.6.3.2.1 Precipitation and Runoff

The Upper Klamath Basin receives rain at all elevations and snow at elevations above 4,000 feet during the late fall, winter, and spring. Snow is the primary form of precipitation in the upper watershed. Depending on the elevation and location, the amount of precipitation ranges from approximately 10 to more than 50 inches per year. From 1907 through 1997 the average annual precipitation at Klamath Falls was 13.4 inches and from 1959 to 2009 it was 20 inches at Copco 1 Dam (DOI 2011b). Peak stream flows generally occur during snowmelt runoff around March through May. After the runoff has stopped, flows drop to low levels in the late summer or early fall. Fall storms may increase flows compared with the lower summer flows. Generally, conditions in the Upper Klamath Lake area are drier than the area where the Klamath River reaches the ocean. The reaches downstream from the Klamath River's confluence with the Shasta River receive higher levels of precipitation than other reaches in the Klamath Basin (FERC 2007). Average annual precipitation is 49 inches at Happy Camp from 1914 to 2010 and 80 inches at Klamath between 1948 and 2006 (Desert Research Institute Web Site 2011).

3.6.3.2.2 Upper Klamath Basin

Upper Klamath Lake and Link River Dam

Link River Dam was constructed in 1921 at the natural outlet of Upper Klamath Lake by California Oregon Power Company (now PacifiCorp). The dam, deeded to the United States, is operated and maintained by PacifiCorp to control lake levels and provide water for irrigation. Upper Klamath Lake has an active storage capacity ranging from 502,347 acre feet at the existing reservoir to 597,817 acre feet including areas restored by levee and dike breaches at Tulana Farms and Goose Bay and pumped storage at Agency Lake and Barnes Ranches (Reclamation, 2011, Appendix E). Currently, Reclamation manages Upper Klamath Lake for irrigation delivery and in accordance with United States Fish and Wildlife Service (USFWS) and NOAA Fisheries Service biological opinions based on current and expected hydrologic conditions (Reclamation 2010).

Outlets from Upper Klamath Lake include the Reclamation A Canal, PacifiCorp's East and West Side development canals and the Link River Dam. Water that passes through the East and West Side development canals re-enters the Link River downstream from the dam where it eventually enters Keno Impoundment/Lake Ewauna (FERC 2007).

Reclamation's Klamath Project

Operation of Reclamation's Klamath Project affects Klamath River flows and Upper Klamath Lake water surface elevations. Section 3.8, Water Supply/Water Rights, describes the scope of Reclamation's Klamath Project in more detail, including the water supply diversions and amount of water diverted. As a Federal agency, Reclamation is required to comply with the Endangered Species Act (ESA). To meet ESA requirements,

Reclamation operates the Klamath Project in compliance with the two biological opinions—one issued by U.S. Fish and Wildlife Service in 2008 and one issued by NOAA's Fishery Service in 2010 (USFWS 2008; NOAA Fisheries Service 2010). One component of these biological opinions requires that Reclamation issue an annual operations plan describing how Reclamation's Klamath Project will be operated for a given year based on forecasted inflows to Upper Klamath Lake. The forecast is adjusted each month, using the actual inflows for the year and predicted inflows for the remainder of the water year. The forecast becomes increasingly accurate as time passes because the actual amount of inflow is known, and only the inflow for the remaining portion of the year needs to be predicted.

The biological opinions include requirements for targeted Klamath River flows measured below Iron Gate Dam and water surface elevations in Upper Klamath Lake. Annual operations plans for Reclamation's Klamath Project must plan for flows and water surface elevations that are adequate to meet biological opinion requirements while providing irrigation water according to contracts with the water users. Because the exact amount of water that will be available is only an estimate, the river flows and lake levels are set based on the probability the forecast is correct, or the exceedence level. A 90 percent exceedence means the predicted inflow will actually occur 90 percent of the time. The amount of water that must be released is based on the amount of inflow. As inflow changes, the releases also change. The amount of water that would be released is calculated for each 10 percent increment in exceedance, or probability of occurrence, and releases are adjusted as the forecast changes.

Table 3.6-1 displays flow release requirements in cubic feet per second (cfs) measured below Iron Gate Dam under the biological opinion (NOAA Fisheries Service 2010). Water available in the system is predicted (forecasted) based on watershed modeling that considers "hydrologic and climatological information, including data from tributaries within the PacifiCorp Hydroelectric Project Reach (Keno Dam to Iron Gate Dam)" (NOAA Fisheries Service 2010). Because the forecast is only a prediction, the amount of water actually available may be more or less than forecasted. When additional water is available, due to inaccuracies in the modeling, a team comprised of representatives from NOAA Fisheries Service, NOAA Weather Service, USFWS, United States Geological Survey (USGS), California Department of Fish and Game, the Karuk, Hoopa Valley and Yurok Tribes, PacifiCorp and Reclamation determine the best use of the water (NOAA Fisheries Service 2010). For example, if conditions in the river are good for fish, and Upper Klamath Lake is not full, water can be stored for later release.

The flow requirements included in Table 3.6-1 describe the flow release requirements during the corresponding exceedance level during the time periods indicated. For example, as shown in Table 3.6-1, the required flow under the biological opinion in July, for a 90 percent exceedance, would be 840 cfs. Reclamation is required to release adequate flows from Upper Klamath Lake to allow PacifiCorp to meet these flow requirements at Iron Gate Dam.

Keno Impoundment/Lake Ewauna and Keno Reach

Lake Ewauna existed before the construction of Keno Dam due to a natural blockage or reef (Akins 1970). In 1931, Needle Dam was built on the Klamath River near Keno, Oregon and, in 1967, Keno Dam was built to replace Needle Dam. With construction of Keno Dam, the waterbody of Keno Impoundment/Lake Ewauna became a long and narrow lake that begins where the Link River ends, 1.3 miles downstream from the Link River Dam, and ends at Keno Dam. The Keno Dam is owned and operated by PacifiCorp. The operations are coordinated with the operations of Link River Dam. Before Keno dam, the river meandered through swamps for approximately 20 miles. It took two to four days for water released at Link River Dam to reach Copco 1 dam. With the construction of Keno Dam, and dikes along the shores of Keno Impoundment/Lake Ewauna, this lag time has been reduced to 12 hours. The currently normal water surface elevation is 4,085 feet in Keno Impoundment/Lake Ewauna(USGS 2009a).

Table 3.6-1. Biological Opinion Requirements for Iron Gate Dam Releases (cfs)

Exceedance Level	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	April	May	June	July	Aug. 1-5	Aug. 16-31	Sept.
95%	1,000	1,300	1,260	1,130	1,300	1,275	1,325	1,175	1,025	805	880	1,000	1,000
90%	1,000	1,300	1,300	1,245	1,300	1,410	1,500	1,220	1,080	840	895	1,000	1,000
85%	1,000	1,300	1,300	1,300	1,300	1,450	1,500	1,415	1,160	905	910	1,001	1,000
80%	1,000	1,300	1,300	1,300	1,300	1,683	1,500	1,603	1,320	945	935	1,005	1,006
75%	1,000	1,300	1,300	1,300	1,300	2,050	1,500	1,668	1,455	1,016	975	1,008	1,013
70%	1,000	1,300	1,300	1,300	1,300	2,350	1,500	1,803	1,498	1,029	1,005	1,014	1,024
65%	1,000	1,300	1,300	1,300	1,323	2,629	1,589	1,876	1,520	1,035	1,017	1,017	1,030
60%	1,000	1,300	1,300	1,309	1,880	2,890	2,590	2,029	1,569	1,050	1,024	1,024	1,041
55%	1,000	1,300	1,345	1,656	2,473	3,150	2,723	2,115	1,594	1,056	1,028	1,028	1,048
50%	1,000	1,300	1,410	1,751	2,577	3,177	3,030	2,642	1,639	1,070	1,035	1,035	1,060
45%	1,000	1,300	1,733	2,018	2,728	3,466	3,245	2,815	1,669	1,077	1,038	1,038	1,066
40%	1,000	1,300	1,837	2,242	3,105	3,685	3,485	2,960	1,682	1,082	1,041	1,041	1,071
35%	1,000	1,300	2,079	2,549	3,505	3,767	3,705	3,115	1,699	1,100	1,050	1,050	1,085
30%	1,000	1,434	2,471	2,578	3,632	3,940	3,930	3,225	1,743	1,118	1,053	1,053	1,089
25%	1,000	1,590	2,908	2,627	3,822	3,990	4,065	3,390	2,727	1,137	1,058	1,058	1,097
20%	1,000	1,831	2,997	2,908	3,960	4,160	4,230	3,480	2,850	1,152	1,066	1,066	1,135
15%	1,000	2,040	3,078	3,498	4,210	4,285	4,425	3,615	2,975	1,223	1,093	1,093	1,162
10%	1,000	2,415	3,280	3,835	4,285	4,355	4,585	3,710	3,055	1,370	1,126	1,126	1,246
5%	1,000	2,460	3,385	3,990	4,475	4,460	4,790	3,845	3,185	1,430	1,147	1,147	1,281

Source: NOAA Fisheries Service 2010
Notes:
cfs: cubic feet per second

On an annual basis, the majority of the water entering Keno Impoundment/Lake Ewauna comes from Upper Klamath Lake through the Link River. Several notable Federal and private facilities upstream of Keno Dam transport water to or from the river including: the Lost River Diversion Channel, Klamath Straits Drain, and the Ady Canal. The surface elevation of Keno Impoundment/Lake Ewauna is maintained to facilitate the operations of these facilities. (FERC 2007).

J.C. Boyle Reservoir

J.C. Boyle Reservoir is approximately 5 miles downstream from Keno Dam. PacifiCorp operates J.C. Boyle Reservoir to produce hydroelectric power. Current operations of the reservoir follow Interim Measures from the Interim Conservation Plan effective as of February 2010. Water is spilled from the dam during high flow months of January through May and when inflow "exceeds the capacity of the J.C. Boyle powerhouse and low flow requirements" (FERC 2007).

J.C. Boyle Bypass Reach

The J.C. Boyle Bypass Reach is a 4.3-mile section of the Klamath River between the J.C. Boyle Dam and Powerhouse; it flows at a steep grade. At 0.5 miles downstream from the dam, flows are increased by groundwater entering the bypass reach. There is currently a 100 cfs minimum required release from J.C. Boyle Reservoir into the J.C. Boyle Bypass Reach (NOAA Fisheries Service 2010). The average accretion due to groundwater inflow/spring inflow is an additional 220 to 250 cfs and varies seasonally and from year to year (FERC 2007).

J.C. Boyle Peaking Reach

The J.C. Boyle Peaking Reach is downstream from the J.C. Boyle powerplant, so flows vary based on releases from the plant. Typically, the reach has high flows during the day as a result of powerhouse flows used to provide peak energy demand. The powerhouse flows may be reduced to zero at night when J.C. Boyle Reservoir is refilled. The powerhouse ramps up flow for either a one-unit operation (up to 1,500 cfs) or a two-unit operation (up to 3,000 cfs). Normal daily average flows in the peaking reach during periods with no power generation range from 320 to 350 cfs (80 cfs from the fish ladder, 20 cfs from the juvenile fish bypass system). A minimum monthly flow rate of 302 cfs has been recorded in the month of August based on data from 1959 to 2010 (USGS 2011). Additional water enters the reach from springs.

Commercial whitewater rafting and boating occurs during the same months as peak power demands, May through October. The water supply for this unique rafting opportunity during the summer tourist season is from the peaking operations of J.C. Boyle powerhouse. Under PacifiCorp's current annual FERC license, upramping and downramping occur at a rate of 9 inches per hour for both (FERC 2007). PacifiCorp diverts some water from this reach for irrigation purposes (FERC 2007).

Copco 1 Reservoir

PacifiCorp operates Copco 1 Reservoir for hydroelectric power generation through Copco 1 Dam. With the most active storage volume of all the project reservoirs of

6,235 acre feet for power production, Copco 1 Reservoir has a total storage capacity of 46,867 acre feet (Reclamation 2012b). This reservoir is deeper than both Keno Impoundment/Lake Ewauna and J.C. Boyle Reservoir (FERC 2007).

Copco 2 Reservoir and Bypass Reach

Copco 2 Reservoir, a small impoundment, receives discharge from Copco 1 Reservoir through Copco 1 Dam and provides flow to Copco 2 Powerhouse through a 1.5-mile bypass reach. The maximum hydraulic capacity is 3,200 cfs in the powerhouse flowline controlling flows from Copco 1 Reservoir to Copco 2 Reservoir. Copco 2 Dam controls the flow from the reservoir, and only spills when inflow from the reservoir exceeds storage capacity. Spillage from the dam is rare and typically only happens from November through April. PacifiCorp releases between 5 to 10 cfs at the bypass reach under normal conditions. Copco 2 Powerhouse discharges water to Iron Gate Reservoir (FERC 2007).

Iron Gate Reservoir

Iron Gate Reservoir is downstream from the Copco 2 Dam and also receives water from Jenny and Fall Creeks, which are tributaries to the Klamath River downstream from Copco 2 Dam and Iron Gate Reservoir. PacifiCorp operates Iron Gate Dam and Reservoir as a re-regulating facility for peaking operations at the other three hydroelectric power dams. Iron Gate Reservoir is the deepest of the four reservoirs in the Hydroelectric Reach. The total storage at this reservoir is approximately 58,794 acre feet of which 3,790 acre feet is available for power production (Reclamation 2012b). Iron Gate Powerhouse, at the base of the dam, has a maximum hydraulic capacity of 1,735 cfs. Cool water is diverted from the reservoir to the Iron Gate Fish Hatchery, downstream from the dam (FERC 2007). USGS gage station 11516530 on the Klamath River, downstream from Iron Gate Dam, provides flow monitoring data regarding compliance with NOAA Fisheries Service biological opinions. Bogus Creek and effluent from the hatchery enter the river upstream of the gage and downstream from the dam (USGS 2009b). Table 3.6-1 lists the flow requirements measured downstream from Iron Gate Dam.

Lower River Basin

The Lower Klamath Basin includes the river area downstream from Iron Gate Dam, which includes 190 miles of river flowing to the Klamath Estuary and then to the Pacific Ocean. The major tributaries entering the river include the Shasta, Scott, Salmon and Trinity Rivers. The Klamath Basin is heavily influenced by these four rivers because 44 percent of the average annual runoff is provided by them (FERC 2007). Below are brief descriptions of these four rivers and other reaches along the Lower Klamath River.

Shasta River

The Klamath River receives water from the Shasta River approximately 13.5 miles downstream from Iron Gate Dam. The watershed includes high mountain peaks, forested terrain and agricultural land. Peak flows, near the Shasta River's confluence with the Klamath River, are in the winter with minimum flows during July and August. Dwinnel

Dam, approximately 25 miles upstream of its confluence with the Klamath River, resulted in the creation of Lake Shastina. Additional diversion dams and smaller dams are located between Dwinnel Dam and the Klamath River (FERC 2007).

Scott River

The Klamath River receives water from the Scott River approximately 33.6 miles downstream from the Klamath River's confluence with the Shasta River. The watershed includes the Salmon Mountains, which are heavily forested creating a rain shadow for the rest of the watershed. The valley is comprised of land for grazing and agriculture. Average monthly flows entering the Klamath River from the Scott River are 4 to 5 times higher in the winter and spring months than from the Shasta River; however, minimum flows are similar during August and September (FERC 2007).

Klamath River at Seiad Valley

A USGS flow gage is on the Klamath River at Seiad Valley, downstream from its confluence with the Scott River. During the low flow months of August through November, approximately 75 percent of the water flowing past this gage is attributed to Iron Gate Dam releases. During the high flow months of April through June approximately 50 percent of the water flowing past this gage is attributable to Iron Gate Dam releases (FERC 2007).

Salmon River

Approximately 77 miles from the Klamath River's confluence with the Scott River, the Salmon River enters the Klamath River. The Salmon River flows through the Klamath National Forest and many designated wilderness areas. The region surrounding the Salmon River is forested with some agricultural activity. High monthly average flows (3,375 cfs) occur in January, which is the winter peak for flooding as rain and rain on snow events occur. In April and May, the Salmon River has a high monthly average flow (2,660 and 2,630 cfs, respectively) from snowmelt at higher elevations. The Salmon River has its lowest monthly average flow at about 200 cfs in September, which is later than for other tributaries upstream including the Shasta River where lowest monthly average flow occurs in July (FERC 2007).

Klamath River at Orleans

USGS gage no. 11523000 is at Orleans, downstream from the Klamath's confluence with the Salmon River and other smaller tributaries within the Lower Klamath watershed. This area receives a high amount of precipitation compared to other reaches upstream of the Shasta River; therefore, higher flows than in upstream reaches occur here in the winter and spring months. Iron Gate Dam releases account for approximately 20 percent of the flow during these high flow periods and over 50 percent of the flow during the late summer and fall (FERC 2007).

Trinity River

The Trinity River is the largest tributary to the Klamath River and is downstream from the Klamath River's confluence with the Salmon River and Orleans. It is heavily forested and receives a heavy amount of precipitation. Peak average monthly flows

into the Klamath River occur in February and March at approximately 11,000 cfs and flows decrease to a low of 500 cfs in September (FERC 2007).

Klamath River at Klamath

A USGS gage no. 11530500 is at the mouth of the Klamath River where it meets the estuary within the Lower Klamath watershed. During low flow periods, the releases from Iron Gate Dam account for approximately 40 percent of flow during September to October. However, the area surrounding the Klamath River reach downstream from its confluence with the Trinity River receives a heavy amount of precipitation, and during the winter months approximately 85 percent of the flow comes from other sources than Iron Gate Dam releases (FERC 2007).

Klamath River Estuary

The Klamath River estuary is within the Redwood National Park and spans approximately 4 to 5 miles upstream of the mouth. The tidal influence normally extends approximately 4 miles upstream of the mouth during high tides greater than 6 feet upstream of the U.S. Highway 101 bridge. Past studies have observed the formation of a sill at the river mouth in late summer or early fall causing a standing water backup up to 6 miles upstream. During high tides saltwater was observed in the summer and early fall from the mouth upstream ranging approximately 2.5 to 4 miles depending on the time period samples were taken. The saltwater recedes during low tides (Wallace 1998).

3.6.3.3 Historic Stream Flows

The USGS operates several stream gages on the Klamath River (Table 3.6-2 and Figure 3.6-3). As noted above, summer and early fall periods (July through October) generally have much lower flows than the months of the spring runoff. Tributaries downstream from Iron Gate Dam contribute substantial amounts of flow. Figure 3.6-4 shows historical daily average stream flows at several locations on the river using USGS monitoring data from 1961-2009 (USGS 2011). Flows are substantially higher during wet years; Table 3.6-3 shows historic average monthly flows during wetter years (represented by flows exceeded ten percent of the time) using the same USGS data (USGS 2011).

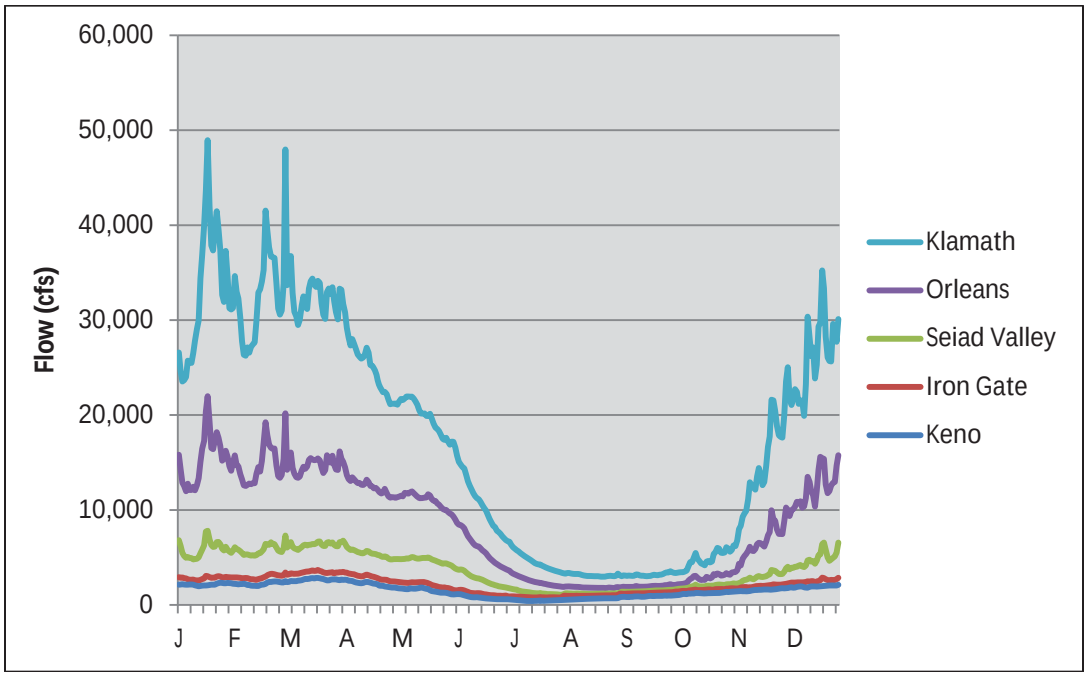
Table 3.6-4 shows the daily average flows at the four dams. The column indicating “% of time equaled or exceeded” indicates the hydrologic conditions, with 99 percent being an extremely dry conditions and 1 percent being an extremely wet conditions. Figures 3.6-5 and 3.6-6 show average daily flows in different conditions downstream from Iron Gate and J.C. Boyle Dams. The gage downstream from J.C. Boyle Dam is also downstream from the return of flow from the J.C. Boyle power plant.

Table 3.6-2. USGS Gages on the Klamath River

USGS Gaging Station	Station Name	Drainage Area (miles^2)	Latitude	Longitude	Gage Elevation (feet)	Period of Record (Water Years)
11509500	Klamath River at Keno, OR	3,920	42°08'00"	121°57'40"	3,961	1905-1913 1930-2009
11510700	Klamath River below John C. Boyle Power Plant near Keno, OR	4,080	42°05'05"	122°04'20"	3,275	1959-2009
11512500	Klamath River below Fall Creek near Copco, CA	4,370	41°58'20"	122°22'05"	2,310	1924-1961
11516530	Klamath River below Iron Gate Dam, CA	4,630	41°55'41"	122°26'35"	2,162	1961-2009
11520500	Klamath River near Seiad Valley, CA	6,940	41°51'14"	123°13'52"	1,320	1913-1925 1952-2009
11523000	Klamath River at Orleans, CA	8,475	41°18'13"	123°32'00"	356	1927-2009
11530500	Klamath River near Klamath, CA	12,100	41°30'40"	123°58'42"	5.6	1911-1927 1932-1994, 1996, 1998-2009

Source: Reclamation 2012b.

Figure 3.6-3. USGS Stream Gage Locations.



Source: USGS 2011

Figure 3.6-4. Daily Average Flows at Five USGS Stream Gages on Klamath River.

Table 3.6-3. Historic Monthly Average Flows (cfs) in Wetter Years (10% Exceedance Level) during Water Years 1961-2009 on the Klamath River

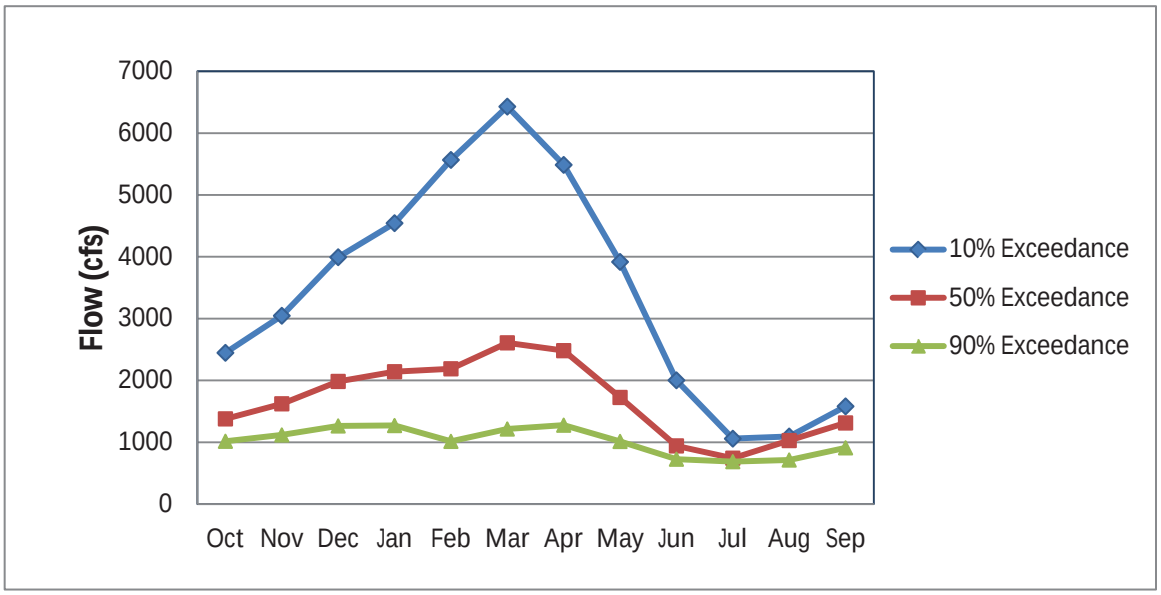
	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May.	Jun.	Jul.	Aug.	Sept.
Keno Dam	2053	2625	3304	3645	4703	5691	4543	3046	1525	755	788	1225
J.C. Boyle Dam	2271	2824	3449	3720	4727	5741	4766	3346	1823	1010	1035	1441
Iron Gate Dam	2447	3047	3994	4544	5567	6429	5487	3918	2003	1059	1094	1582
Seiad Valley	3070	4606	9372	11866	11129	11658	9516	8077	5262	1985	1461	1903
Orleans	4031	11635	28185	33198	23710	25697	20345	18408	11277	4060	2343	2418

Source: USGS 2011

Table 3.6-4. Annual and Seasonal Daily Flows

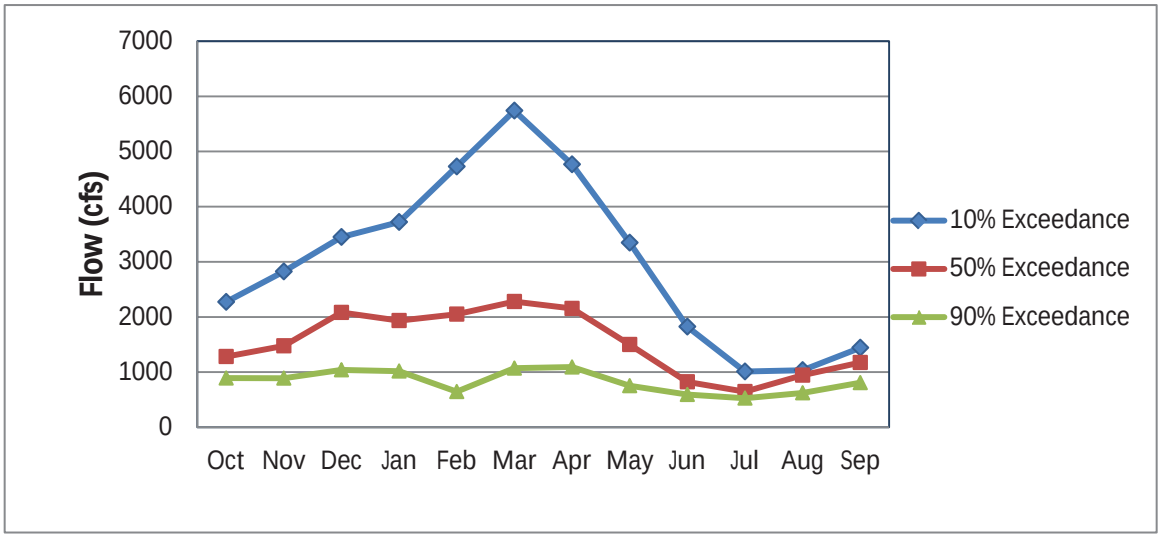
% of time equaled or exceeded	Discharge (cfs)							
	Annual				Seasonal (July 1 – Nov 31)			
	Keno	Boyle	Copco	Iron Gate	Keno	Boyle	Copco	Iron Gate
99	152	331	290	528	147	325	294	441
95	297	522	529	716	292	473	524	701
90	431	635	643	741	417	592	604	725
80	645	802	882	955	621	725	823	846
70	821	962	1,088	1,040	737	856	973	1,000
60	990	1,130	1,269	1,320	901	960	1,150	1,030
50	1,180	1,260	1,483	1,360	1,020	1,060	1,273	1,130
40	1,440	1,480	1,730	1,700	1,180	1,180	1,470	1,320
30	1,800	1,810	2,104	1,977	1,390	1,280	1,670	1,350
20	2,390	2,660	2,640	2,980	1,580	1,490	1,905	1,510
10	3,120	3,200	3,350	3,870	1,960	1,890	2,300	1,840
5	4,320	4,530	4,486	5,500	2,450	2,710	2,720	2,920
1	6,875	7,660	7,295	9,167	3,300	3,970	3,536	4,350

Source: Reclamation 2012b



Source: USGS 2011

Figure 3.6-5. Stream Flows Downstream from Iron Gate Dam in Wet, Average, and Dry Conditions.



Source: USGS 2011

Figure 3.6-6. Stream Flows Downstream from J.C. Boyle Dam in Wet, Average, and Dry Conditions.

Table 3.6-5 shows the flows associated with different flood levels in the basin. Peak flows at Iron Gate Dam are substantially greater than peak flows at J.C. Boyle Dam, because of the tributaries that enter the Klamath River in the Hydroelectric Reach, and peak flows continue to increase substantially as tributaries enter the Klamath River. The 10 year discharge at Seiad Valley, which is downstream from the Scott River, is 56,500 cfs. The 10 year discharge at the mouth is close to 300,000 cfs.

Table 3.6-5. Flood Frequency Analysis on Klamath River for 10-yr to 100-yr Floods based upon Full Period of Record[1] of Each Gage

Gaging Station	Drainage Area (miles^2)	Discharge (cfs)			
		10-yr	25-yr	50-yr	100-yr
Keno	3,920	8,642	10,350	11,200	11,800
Boyle	4,080	9,058	11,050	12,220	13,150
Copco	4,370	10,750	12,720	13,730	14,470
Iron Gate	4,630	15,610	21,460	26,280	31,460
Seiad	6,940	56,540	93,400	131,000	179,300
Orleans	8,470	163,100	230,300	287,000	348,900
Klamath	12,100	298,300	392,900	466,900	543,300

Source: Reclamation 2012b

Notes:

[1] Keno Dam 1905-1913, 1930-2009; J.C. Boyle Dam 1961-2009; Copco 1 Dam 1930-1961; Iron Gate Dam 1961-2009. Data for all gages except Iron Gate Dam was extended using equations to match the period of record for Keno Dam.

Key: cfs: cubic feet per second

3.6.3.4 Flood Hydrology and River Flood Plain

The active storage capacity at Upper Klamath Lake is approximately 597,817 acre-feet and includes areas restored by levee and dike breaches at Agency Lake, Barnes Ranch, Tulana Farms, and Goose Bay (Reclamation, 2011, Appendix E). Active storage at Keno, J.C. Boyle, Copco 1, Copco 2 and Iron Gate reservoirs totals approximately 12,244 acre-feet (FERC 2007). Approximately 98 percent of the active surface water storage along the Klamath River is provided by Upper Klamath Lake behind Link River Dam. Keno, J.C. Boyle, Copco 1, Copco 2 and Iron Gate Dams provide approximately 2 percent of the active storage on the river.

During extremely wet years, increased flows occur in the Klamath River and its tributaries, and surface water elevations rise in Upper Klamath Lake. Agency Lake, Barnes Ranch, and the Nature Conservancy-owned lands provide over 108,000 acre feet of storage area due to the recent breaching of dikes and levees around and near Upper Klamath Lake. During these wet periods, there is little surplus storage at the Four Facilities to help control flooding downstream from Iron Gate Dam. During wet periods, decreased irrigation demands may allow for more water to remain in Upper Klamath Lake for use later in the year. The amount of retained water depends on decisions such as the magnitude of spring flushing flows and fall migration flows. The biological opinions include provisions for average and wet years that increase minimum flow requirements at Iron Gate Dam and surface water elevations in Upper Klamath Lake to more closely mimic natural flow and lake-level conditions during wetter years and provide storage for surplus water. Additional descriptions of area geomorphology are in Section 3.11, Geology, Soils and Geologic Hazards.

Periodically during flood years, the Klamath River overtops its banks and inundates the floodplain. FEMA has prepared flood risk mapping for portions of the Klamath River in Siskiyou, Del Norte and Humboldt Counties and provides access to these maps via their Web mapping service or can be downloaded from their Web site. The revised Flood Insurance Rate Map (FIRM) and Flood Insurance Study for Siskiyou County was released on January 19, 2011, however, this update did not include new flood analysis along the Klamath River. FEMA flood analysis for the river is based on studies and cross sections developed prior to 1985 and later revised in 1987.

3.6.3.5 Risks of Dam Failure

Dams are manmade structures and do exhibit some risks of failure that could result in flooding downstream. According to the Association of State Dam Safety Officials (ASDSO), dams fail due to one of five reasons (ASDSO 2011).

- Overtopping caused by water spilling over the top of dam;
- Structure failure of materials used in dam construction;
- Cracking caused by movements like the natural settling of dam;
- Inadequate maintenance and upkeep; or
- Piping – when seepage through a dam is not properly filtered and soil particles continue to progress and form sink holes in the dam.

In California, weighted point systems are used during inspections to classify both the hazard or damage potential and condition of the dam. Once classified, the frequency of inspection and return period for hydrology studies is selected. The classifications used for damage potential are extreme, high, moderate and low and refer to the possibility of loss of life and property downstream from the dam if it were to fail. The classifications of the condition of the dam are poor, fair, good, and excellent and are determined based on the age, general condition, geologic and seismic setting. Dams may be reclassified after improvements or other changes have occurred (ASDSO 2000).

Siskiyou County is in the process of developing a Multi-Jurisdictional Hazard Mitigation Plan which will address, among other issues, flood and dam failure hazards. Maps are currently available which describe dam inundation areas at J.C. Boyle and Iron Gate dams as well as a domino effect, depicting the inundation area if multiple dams were to fail at the same time (Siskiyou County Web Site 2011). The FERC staff have conducted safety inspections of the dam structures as part of the licensing program over the past 50 years. Every five years J.C. Boyle, Copco 1 and Iron Gate dams are inspected and evaluated by an independent consultant and reports documenting the evaluation are submitted to the FERC for review (FERC 2007).

3.6.4 Environmental Consequences

The flood hydrology section of the EIS/EIR will discuss the changes to river flows that would occur during implementation of the alternatives, including the Proposed Action.

3.6.4.1 Environmental Effects Determination Methods

The No Action/No Project Alternative would include operations similar to current operations. PacifiCorp would operate the Klamath Hydroelectric Project as it did before the Secretarial Determination process. PacifiCorp would continue to coordinate operations with Reclamation and operate the Klamath Hydroelectric Project in compliance with existing NOAA Fisheries Service and USFWS biological opinions issued for Reclamation's Klamath Project. The action alternatives would vary operations by removing facilities or installing fish ladders to provide fish passage.

The assessment of the environmental impacts on flood hydrology that would result from implementation of the alternatives determines whether changes in stream flows could cause flooding or inundation areas in the watershed. The impact assessment is based on the hydrologic modeling completed by the Lead Agencies. The modeling covered the No Action/No Project Alternative and the Proposed Action. The Lead Agencies used a one-dimensional HEC-RAS model that assessed hydrologic conditions for these two alternatives. The Lead Agencies also analyzed modeling output to determine how frequently the current FEMA floodplain is inundated and how the floodplain could change under the Proposed Action. This information was included within the *Draft Hydrology, Hydraulics and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration* (Reclamation

2012b). The model results under the No Action/No Project Alternative and the Proposed Action provide adequate information to estimate the relative effects of the other alternatives not modeled.

The model results included predictions of the river flows that would occur if the Four Facilities were removed. The river flows would be the same for long-term future conditions for the Partial Facilities Removal of Four Dams Alternative as those modeled for the Proposed Action. The Fish Passage at Four Dams Alternative, however, would leave the dams in, but would include fish passage at each facility. Flows downstream from Iron Gate Dam would be the same under the Fish Passage at Four Dams Alternative as the No Action/No Project Alternative; however, flows within the hydroelectric reach would change to account for flows through fish ladders and flows in the bypass reaches. The predicted flows under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to the No Action/No Project Alternative at the two remaining dams and less than modeled flows under the Proposed Action at the removed dams. The flows within the hydroelectric reach for the Fish Passage at Four Dams and the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Dam alternatives are addressed qualitatively because the model does not simulate these flows. The modeling effort provided useful information for assessing the impacts on flood hydrology in the long term, but provides limited information about the construction period. Flood risks associated with dam removal activities are described qualitatively and quantitatively using the HEC-RAS and SRH-1D modeling results completed by DOI, and the analysis includes the measures incorporated to reduce these risks.

3.6.4.2 Significance Criteria

For the purposes of this EIS/EIR, impacts would be significant if they would substantially increase the risks of exposing people or structures to loss, injury or death involving flooding as measured by changes in the FEMA 100-year floodplain.

3.6.4.3 Effects Determinations

3.6.4.3.1 Alternative 1: No Action/No Project

The No Action/No Project Alternative could alter river flows and result in changes to flood risks. Under the No Action/No Project Alternative (a Negative Determination), the Four Facilities would remain in place and operations similar to the current operations would be in effect. The PacifiCorp Klamath Hydroelectric Project and Reclamation's Klamath Project would be operated as they were before the Secretarial Determination process began. PacifiCorp would continue to coordinate operations with Reclamation and operate the Klamath Hydroelectric Project in compliance with existing NOAA Fisheries Service and USFWS biological opinions issued for Reclamation's Klamath Project. PacifiCorp would operate under annual FERC licenses until a long-term license is issued. For the purpose of this EIS/EIR, however, the No Action/No Project Alternative includes operations that would be similar to current operations.

Table 3.6-6 shows modeled average monthly wet year flows at multiple points along the river under the No Action/No Project Alternative. Wet year flows are represented by the modeled 10 percent exceedance (flows are exceeded only ten percent of the time). The

No Action/No Project Alternative flows are based on model results and the affected environment flows (Table 3.6-3) are based on historic monitoring data. The monthly flows described in the two tables (Tables 3.6-6 and 3.6-3) vary because the sources used to develop the data are different, but the flows are generally similar. Peak flows would likely exceed the average monthly flows in Table 3.6-6; however, the peak flows would be similar to those currently experienced because the No Action/No Project Alternative would not change operations.

Table 3.6-6. Modeled Average Monthly Flows (cfs) in Wetter Years (10% Exceedance Level) on the Klamath River under the No Action/No Project Alternative

	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
Keno Dam	1022	1925	2867	3113	3859	4979	4752	3003	2493	894	794	901
J.C. Boyle Dam	1249	2159	3054	3396	4099	5265	5102	3482	2948	1178	1033	1113
Iron Gate Dam	1372	2351	3383	3939	5150	6145	5835	3910	3184	1344	1149	1207
Seiad Valley	1822	3898	7747	9511	10523	10987	9911	8486	6435	2388	1534	1482
Orleans	3283	10977	26536	29451	22477	26116	19837	18272	13067	4540	2415	2115

In addition to the model results described above, the Lead Agencies also modeled flood events that meet criteria for a 100-year flood under the No Action/No Project Alternative condition and the Proposed Action (Appendix J). The “WithDams_100yr” shown on the maps in Appendix J depicts the No Action/No Project Alternative condition (Reclamation, 2011, Appendix G). All of the areas depicted on this map are within Siskiyou County. The FEMA 100-year flood area corresponds fairly closely with the Lead Agencies’ modeling of flood risks both with and without dams which reinforces the fact that the four dams were not constructed for the purpose of flood risk reduction. However, there are some differences between the FEMA and the Lead Agencies’ No Action/No Project Alternative 100-year inundation zones. These differences are attributable to the use of different hydrographic base data for flood events and the use of enhanced elevation data by the Lead Agencies. The Lead Agencies’ analysis is based on LiDAR data with elevation values sufficient to support 2 foot contours along the reach of the Klamath River from Iron Gate to Happy Camp.

Detailed imagery was used to identify structures within the modeled No Action/No Project Alternative 100-year inundation zone. Structures include mobile homes, houses, farm sheds, bridges, and other features large enough to cast a shadow, including hay stacks. Imagery from 2010 and 2009 was used and compared which revealed that many of the structures are mobile homes that move annually or seasonally. Within the FEMA 100-year floodplain, there are 481 structures that include bridges. The Lead Agencies’ modeling of the 100-year flood inundation area under the No Action/No Project Alternative revealed 671 structures to be at risk.

The No Action/No Project Alternative includes operations that are the same as the existing operations; therefore, the No Action/No Project would not cause any changes to flooding from the affected environment. Although the Lead Agencies' mapping of the 100-year inundation area varies compared to FEMA mapping, this difference can be attributed to the use of different base data and the Lead Agencies' use of enhanced elevation data. FEMA is in the process of updating FIRMs using enhanced elevation data, but has not accomplished this near the Klamath River. Under the No Action/No Project Alternative, the Four Facilities would not be removed and the actual 100-year flood inundation area would not change. The risks of dam failure would be same under the No Action/No Project alternative as under the existing conditions. **There would be no change from existing conditions from flood risk.**

Ongoing restoration actions could affect flood hydrology. Under the No Action/No Project Alternative, some restoration actions in the Klamath Basin are currently underway and would be implemented regardless of the Secretarial Determination on the removal of the Four Facilities. Table 3.6-7 lists the restoration actions affecting flood hydrology that would occur under the No Action/No Project Alternative. Several of these projects involve breaching levees and dikes upstream and around Upper Klamath Lake, thereby re-establishing hydrologic connections and providing additional storage that could potentially absorb some flood-related increases in inflows. The hydrologic model used to determine effects to flood hydrology under the No Action/No Project Alternative considered the expanded storage capacity described in Table 3.6-7 specifically related to evaporation and changes to consumptive use (Reclamation 2012b). **Overall, the ongoing restoration actions would cause no change from existing conditions from flood hydrology related to the affected environment.**

Dam failure could inundate areas in the downstream watershed. The Four Facilities, collectively, store over 169,000 acre-feet of water when they are full. The dams are inspected regularly, and the probability for failure has been found to be low. However, if a dam failed, it could inundate a portion of the downstream watershed (Siskiyou County Web Site 2011). The risk of failures may or may not increase as the facilities age (maintenance could reduce failure risk), and PacifiCorp's inspection procedures (described on page 3.6-19) would likely reduce the likelihood of dam failure. **The dam failure risk associated with the Four Facilities would have less-than-significant impacts to flood hydrology.**

3.6.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Drawdown of reservoirs could result in short-term increases in downstream surface water flows and result in changes to flood risks. Reservoir drawdown activities would begin on November 1, 2019 at Copco 1 Dam, and on January 1, 2020 at J.C. Boyle and Iron Gate Dams, at which times hydroelectric power generation would cease. At Copco 2 Dam, reservoir drawdown activities would begin on June 1, 2020 to allow for continued hydroelectric power generation at this site until dam removal must begin. Releases at all of the dams during reservoir drawdown periods would be in accordance with Dam Removal Plans developed by the Lead Agencies and with applicable biological opinions and operation plans. The Dam Removal Entity (DRE) would control the releases that

Table 3.6-7. No Action/No Project Alternative Resource Management Actions Affecting Flood Hydrology on the Klamath River

Component	Implemented Actions	Effects on Flood Hydrology
Williamson River Delta project	Restore wetlands for endangered fish and improve water quality in Upper Klamath Lake. The project involved breaching levees where the river flows into Upper Klamath Lake. Two miles of levees were breached in 2007 restoring approximately 3,500 acres of wetlands. Another 1,400 acres were flooded in 2008. Project would provide 28,800 AF of additional storage in Upper Klamath Lake. No additional levee breaching is proposed under this project	No impact, measures have already been implemented and are described as an existing condition.
Agency Lake and Barnes Ranches	Project to use the diked and drained portions of the ranches as interim pumped storage and ultimately to reconnect to Agency Lake by breaching dikes to add 63,770 AF of additional storage to Upper Klamath Lake. Actions include 1) complete land transfer between Reclamation and USFWS, 2) USFWS to study options to enhance water management flexibility for water storage and fish and wildlife habitat, and 3) complete NEPA analysis and ESA consultation on preferred option. Agency Lake Ranch and Barnes Ranch together comprise approximately 9,796 acres between Agency Lake and the Upper Klamath NWR. Options for water management could include using diked areas for pumped storage or breaching levees to reconnect former wetland areas to Agency Lake. Specific options to be developed and studied under separate NEPA evaluation.	Beneficial effect because more incidental flood protection could be provided.

Key:
AF: acre feet
ESA: Endangered Species Act
NEPA: National Environmental Policy Act
NWR: National Wildlife Refuge
USFWS: United States Fish and Wildlife Service

would vary by reservoir depending on the type of dam, discharge capacity, water year type, and the volume of water and sediment within the reservoir. The resultant reservoir water surface elevation after the initial drawdown would be generally higher in a wetter year than in a drier year at all the dams.

The reservoir drawdown plans were made with consideration for minimizing flood risks downstream. The DRE would carefully control drawdown to maintain flows that would not cause flood risks. Drawing down the reservoirs would increase storage availability in J.C. Boyle, Copco 1, and Iron Gate Reservoirs. If a flood event occurred during drawdown, the DRE would retain flood flows using the newly available storage capacity and continue drawdown after flood risks have ended. Existing conditions do not allow these reservoirs to assist in flood prevention in this manner.

At J.C. Boyle Dam, the DRE would begin reservoir drawdown activities in January while streamflows were still high. Controlled releases would initially be through the gated spillway and power penstock at normal release rates, depending on year type, plus additional flow of up to 100 cfs for reservoir drawdown. These releases would continue

until the reservoir water surface elevation decreased to the lowest level possible for the streamflow occurring at that time. The DRE would then remove the stoplogs from one of two low-level culverts beneath the spillway, temporarily releasing additional water downstream at flows between approximately 1,900 and 2,700 cfs depending upon reservoir level. Penstock releases could be reduced if necessary to limit the total sudden increase in streamflow to between approximately 500 and 1,000 cfs. Once the reservoir water surface is stabilized at a lower level, the DRE would remove the stoplogs from the second low-level culvert, temporarily releasing additional water downstream at flows between approximately 1,000 and 1,900 cfs than the current flows at the time. After this, the reservoir would reach the lowest water surface elevation possible prior to removal of the dam embankment.

While the controlled releases during reservoir drawdown would be higher than simulated No Action/No Project Alternative releases during the same time period, they would not be likely to increase flood risks because they would be within the range of historic flows. A 10-year storm at J.C. Boyle results in an estimated flow of 9,058 cfs (see Table 3.6-5), and the maximum daily winter flow (January through March) is in excess of 8,000 cfs (USGS 2011). The average monthly flow below J.C. Boyle Dam from 1961-2009 was about 2,380 cfs in January, 2,450 cfs in February, and 2,890 cfs in March. Increasing the flow temporarily during reservoir drawdown by up to an additional 1,900 cfs over the No Action/No Project Alternative by removal of the stoplogs from the diversion culverts would not cause flood damage downstream. The concrete spillway crest structure would be removed once the reservoir water surface elevation was drawn down sufficiently, to provide additional flood release capacity and avoid reservoir refill. The embankment dam crest and left abutment wall would be retained for flood protection until removal.

Removal of the J.C. Boyle Dam embankment would begin at the end of May 2020. By then, the minimum reservoir drawdown level would have been achieved and inflow would have decreased to summer levels averaging less than 1,000 cfs. Within four to six weeks, the majority of the embankment would be removed except for a portion of the upstream toe which would serve as an upstream cofferdam. The upstream cofferdam would be armored with rockfill to allow a controlled breach between about water surface elevation 3758 and the channel bottom at elevation 3740, to fully drain the reservoir by July 2020. Reservoir releases would temporarily exceed inflow by up to approximately 5,000 cfs, depending upon the rate of breach development, but would remain below the downstream channel capacity. Although the breach flow would quickly attenuate as it moved downstream due to the very small reservoir volume, the Iron Gate cofferdam would be breached before breaching J.C. Boyle as a precaution.

Although limited drawdown of Copco 1 Reservoir would begin in November 2019 to permit early removal of the spillway gates and crest structure, the primary drawdown and sediment release of Copco 1 Reservoir would begin at the same time as the J.C. Boyle Dam reservoir drawdown in January 2020 and would be affected by the additional upstream releases. Average inflow to Copco 1 Reservoir would be no more than 100 cfs greater than normal streamflow for drawdown between reservoir water surface elevations 2590 feet and 2529 feet over a five to six week period, resulting in a total reservoir

release from the diversion tunnel averaging up to 400 cfs above streamflow. A 10-year storm is estimated to result in flows of approximately 10,750 cfs (see Table 3.6-5), and the average daily flow has exceeded 9,000 cfs (USGS 2011).

The concrete dam would be removed in 8-foot lifts while the reservoir was being drawn down, removing concrete in the dry by blasting as the water surface elevation lowered. The diversion tunnel would pass the entire streamflow for as long as possible, but its discharge capacity would continue to decrease as the reservoir head is reduced. When additional discharge capacity is required, notches would be blasted in the concrete dam near the left abutment to allow for overtopping flows. The extent of notching would be affected by the water year type: wet years would require more notching than normal or dry years. The sudden increase in reservoir releases during notching may be controlled by reducing the diversion tunnel discharge if necessary. Drawdown between reservoir water surface elevations 2529 and 2484 would occur within 30 days. By March 12, 2020, the reservoir would be drained to the normal level of Copco 2 Reservoir (elevation 2484) and a large portion of the concrete dam would have been removed. The final portion of the concrete dam would be removed following drawdown of Copco 2 Reservoir and during the summer low flow period.

Copco 2 Dam does not provide any meaningful storage and the reservoir is very small compared to the other reservoirs, with little or no impounded sediment. Normal streamflow would be diverted downstream from Copco 2 Dam to the bypassed river reach beginning in mid-May 2020 when dam removal would begin. No additional releases would be made from the upstream reservoirs during this time as they would have already been mostly drained. The DRE would use cofferdams to isolate areas of the small concrete dam during demolition and would remove them once they were no longer needed.

Reservoir drawdown at Iron Gate Dam would occur simultaneously with reservoir drawdown at J.C. Boyle and Copco 1 Dams. Normal inflows to the reservoir in January and February 2020 would be increased by up to an estimated 500 cfs due to upstream reservoir drawdown releases. Reservoir drawdown between water surface elevations 2328 and 2202 would occur within a 10½-week period by controlled releases through the modified diversion tunnel, at an average drawdown rate of 3 feet per day. The maximum downstream flow during drawdown of Iron Gate Reservoir could exceed normal streamflow at the site by up to 1,800 cfs. The average monthly flow below Iron Gate Dam from 1961-2009 was about 2,830 cfs in January, 2,940 cfs in February, and 3,430 cfs in March (USGS 2011). A 10-year storm is estimated to discharge approximately 15,610 cfs (see Table 3.6-5), and average daily winter flows have exceeded 10,000 cfs (USGS 2011). Increasing the flow during reservoir drawdown by up to an additional 1,800 cfs would not cause flood damage downstream. The modified diversion tunnel discharge capacity would range between approximately 3,200 and 8,500 cfs during reservoir drawdown. Should a large flood event occur during drawdown, the outlet capacity would be exceeded and the reservoir could partially refill. This would be similar to existing operations during a flood event.

The Dam Removal Plan requires that sufficient freeboard be maintained for the dam embankment at all times to prevent potential flood overtopping and embankment failure. The amount of freeboard would be determined according to water year type and surface water elevation during removal operations. Excavation of the dam embankment would begin in June 2020, during a period of reducing streamflow and with a minimum reservoir release capacity of approximately 7,500 cfs. During this time, the embankment dam crest would be lowered 55 feet from elevation 2348 to elevation 2293. In July, excavation of the dam embankment would continue at an average rate of between 14,000 and 18,000 cubic yards per day, lowering the dam crest from elevation 2293 to elevation 2250, with a minimum reservoir release capacity of approximately 5,800 cfs. The majority of the dam embankment volume would be excavated during the following 8 weeks, while maintaining a portion of the upstream toe at elevation 2205 to serve as an upstream cofferdam. This would provide a minimum flood release capacity in excess of 3,000 cfs in both August and September, which is greater than the maximum historical streamflow during this period and far exceeds the average monthly flow rates for August and September of 980 cfs and 1,250 cfs, respectively (USGS 2011). By late September, the reservoir would be drawn down to the maximum possible extent, minimal streamflow would be occurring, and drawdown releases from upstream reservoirs would have ended. The upstream cofferdam would be armored with rockfill to allow a controlled breach between about water surface elevation 2189 and the channel bottom at elevation 2165, to fully drain the reservoir by September 2020. Reservoir releases would temporarily exceed inflow by up to approximately 5,000 cfs, depending upon the rate of breach development, but would remain below the downstream channel capacity. The breach flow would quickly attenuate as it moved downstream due to the very small reservoir volume. The upstream cofferdam at J.C. Boyle would not be breached until the natural river channel has been restored at the Iron Gate site.

This analysis uses the reservoir drawdown release rates at Iron Gate Dam to determine the level of significance of adverse impacts downstream because Iron Gate Dam has the largest reservoir, provides the highest amount of discharge, and is the most downstream from all of the dams that would be removed. The release rates that would occur during drawdown of the reservoir would be in accordance with the historical flow during an extremely wet year (1 percent exceedance capacity). Figure 3.6-5 shows historic and maximum flows at Iron Gate Dam under wet year, average year and dry year types. While the release rates that would occur during reservoir drawdown would be greater than the flows at the same time under the No Action/No Project Alternative, and in some months, above the historic monthly maximum flow (September), they would be lower than the overall peak flows in each reach. Because the flows would stay below historic peak flows, they would not change the floodplain or flood risks in comparison to the No Action/No Project Alternative. **Therefore, the impact from drawing down the reservoirs on flood risk would be less than significant.**

The release of sediment stored behind the dams and resulting downstream sediment deposition under the Proposed Action could result in changes to flood risks. Approximately 27 to 51 percent of sediment behind J.C. Boyle Dam, 45 to 76 percent of

sediment behind Copco 1 Dam, and 24 to 32 percent of sediment behind Iron Gate Dam would be eroded and flushed down the river during removal activities (Reclamation 2012b). The remaining sediment would be left in place after dam removal above the active channel. The Lead Agencies conducted an analysis of future geomorphology and sediment transport during and after dam removal for dry, median and wet start year scenarios. Most of the erosion would occur during the drawdown period from January 1, 2020, to March 2020 and afterwards the river bed in the reservoir reaches is expected to stabilize. Minor deposition would occur in some of the reaches downstream from dam removal activities, however none is expected downstream from Shasta River (Reclamation 2012b). The Geology and Soils analysis considers the effects of sediment deposition in more detail (see Section 3.11.4.3). Sedimentation would occur downstream from the Four Facilities, but the quantity would vary depending on year type. The magnitude of sediment deposition is relatively small compared to sediment loading from other existing sources along the Klamath River. The only measurable sedimentation will occur in the reach from Bogus Creek to Cottonwood Creek. From Willow Creek to Bogus Creek, there is about 1.5 feet of deposition and from Cottonwood to Willow Creeks there is less than 1 foot of deposition. Downstream from Cottonwood Creek deposition would not be appreciable. Additionally, the sedimentation will occur in primarily pool and not in the riffle and bedrock sections that tend to control surface elevations. Because the sediment deposition would be small in comparison with the No Action/No Project Alternative, it would not affect stream characteristics in a way that would substantively affect flood inundation or flood risks. **Therefore, sediment deposition would have a less than significant effect on flood risk. However, even though its effect was considered less than significant, the increase in bed elevations due to sedimentation was included in the mapping of the 100 year floodplain inundation areas downstream from Iron Gate Dam described in the next section.**

Under the Proposed Action, the 100-year floodplain inundation area downstream from Iron Gate Dam could change between River Mile 190 and 171. Table 3.6-8 describes modeled flows on the Klamath River under the Proposed Action in wet conditions (10 percent exceedance level) at multiple points on the river. These flows include all aspects of the Proposed Action, and the primary difference from the No Action/No Project Alternative is related to implementation of the KBRA. The bold numbers represent flows higher than the wet conditions under the No Action/No Project Alternative described in Table 3.6-6. Flows during wet conditions would be higher under the Proposed Action when compared to the No Action/No Project Alternative at all of these sites during the months of January and February and July to September. The Figures 3.6-7 to 3.6-11 graphically describe the comparisons in flows at 10, 50 and 90 percent flow exceedances between the No Action/No Project Alternative and the Proposed Action.

Table 3.6-8. Flood Flow Exceedance: Modeled Wet Conditions on the Klamath River under the Proposed Action

	Oct.	Nov.	Dec.	Jan.	Feb.	March	April	May	June	July	August	Sept.
Keno Dam	923	929	2,259	**3,258**	**4,349**	4,809	**4,845**	2,917	2,191	**1,465**	**920**	**1,067**
J.C. Boyle Dam	1,160	1,117	2,508	**3,481**	**4,562**	5,189	**5,233**	3,399	2,544	**1,780**	**1,155**	**1,320**
Iron Gate Dam	1,304	1,305	2,908	**4,192**	**5,219**	5,957	**5,960**	**3,966**	2,806	**1,939**	**1,292**	**1,449**
Seiad Valley	1,770	3,196	**8,319**	**11,090**	**10,803**	**11,025**	9,904	**8,509**	6,124	**3,018**	**1,695**	**1,724**
Orleans	3,195	10,153	**27,098**	**30,998**	**22,727**	**26,485**	**19,973**	**18,614**	12,629	**4,993**	**2,574**	**2,306**

Notes:
Bold numbers represent flows that are greater than the No Action/No Project Alternative.

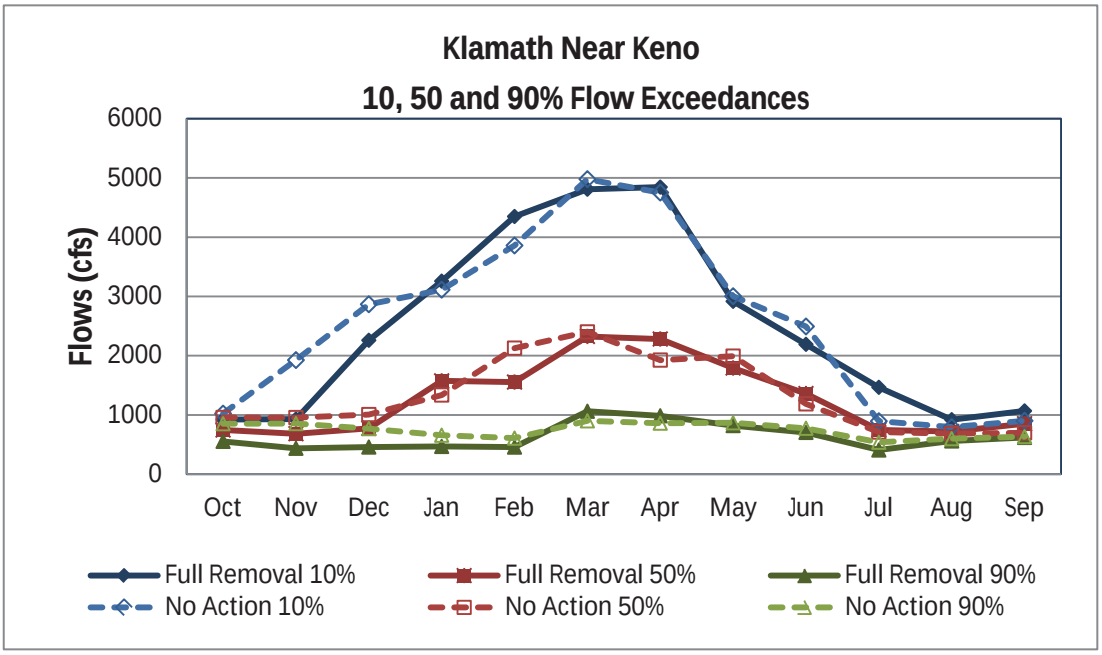


Figure 3.6-7. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Near Keno Dam.

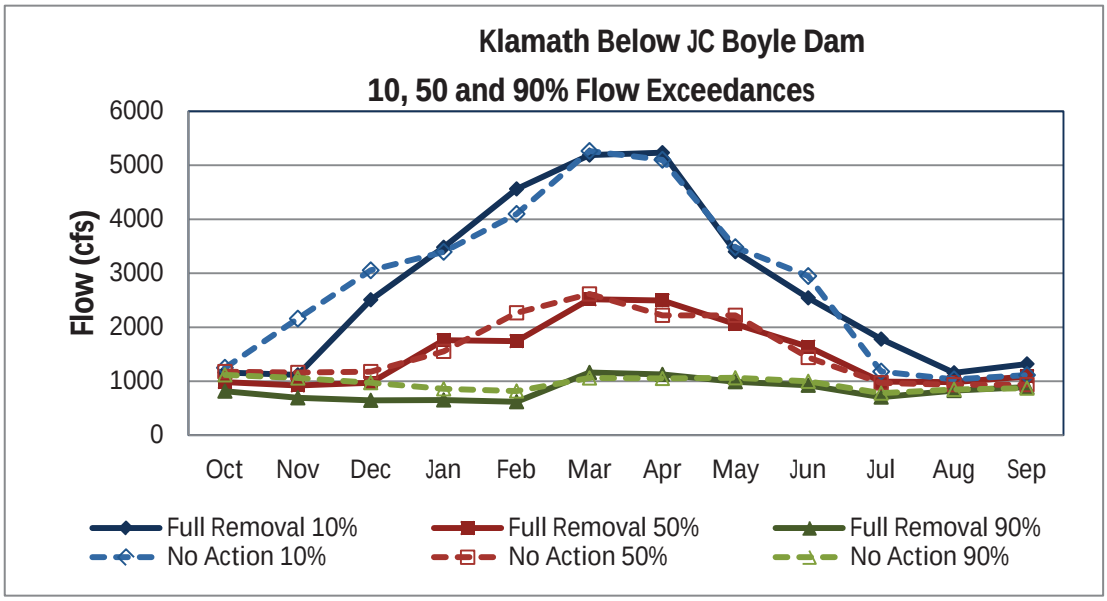


Figure 3.6-8. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Below J.C. Boyle Dam.

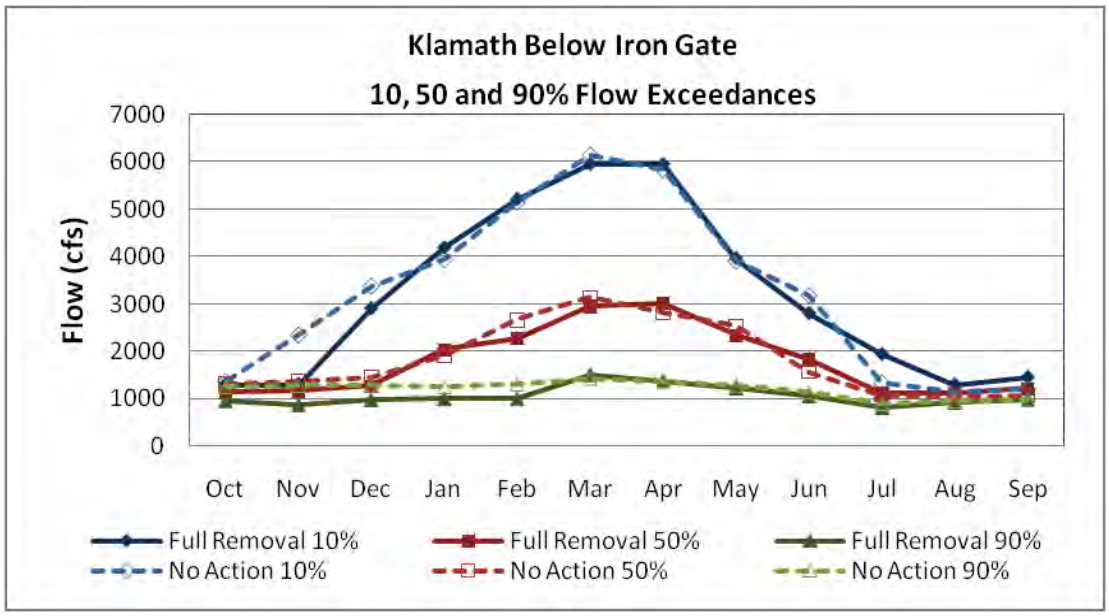


Figure 3.6-9. Modeled Flow Exceedances under the No Action/No Project Alternative and Proposed Action Below Iron Gate Dam.

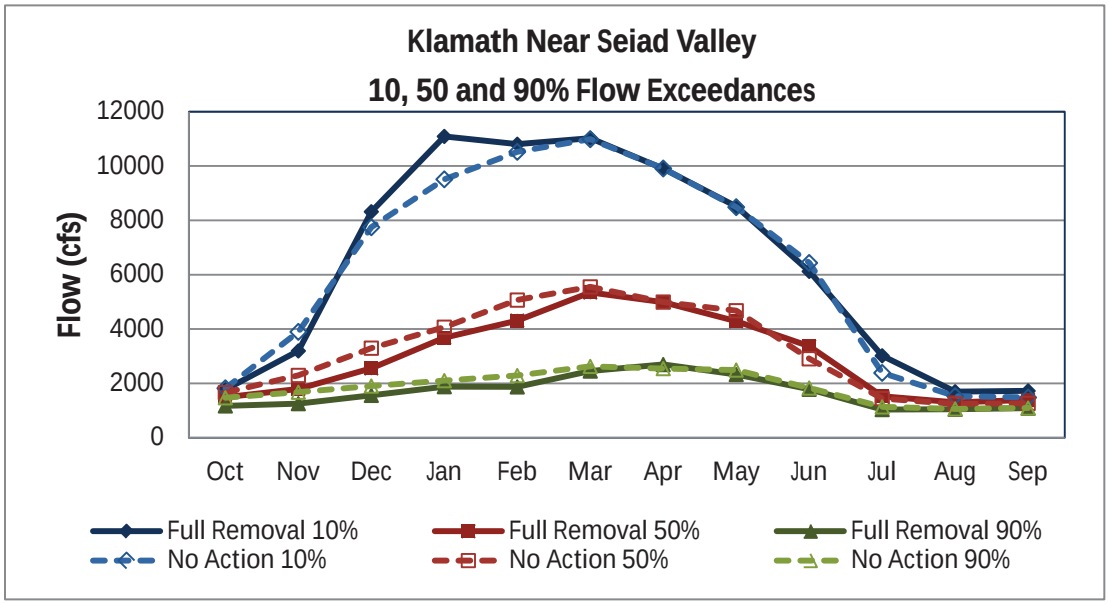


Figure 3.6-10. Modeled Flow Exceedances under the No Action/ No Project Alternative and Proposed Action Near Seiad Valley.

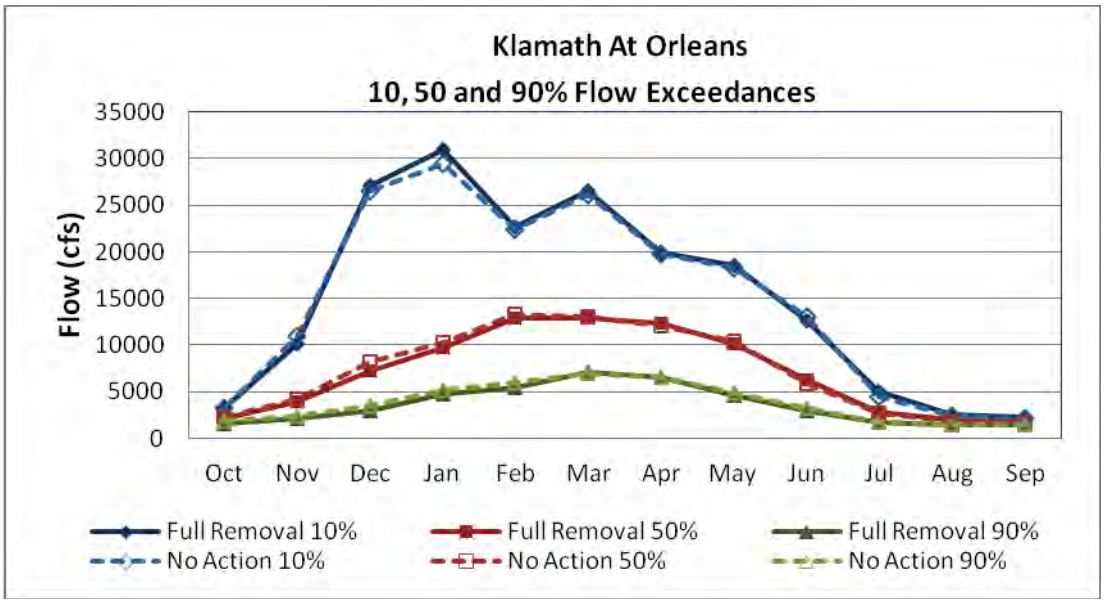


Figure 3.6-11. Modeled Flow Exceedances under the No Action/ No Project Alternative and Proposed Action at Orleans.

J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams provide only incidental flood protection during flood events. Table 3.6-9 shows peak flood flows and shows flood attenuation of less than 7 percent would have been provided by Iron Gate and Copco 1 Dams under the No Action/No Project Alternative for the 100 year flood. (J.C. Boyle and Copco 2 Dams have negligible capacity for flood attenuation.) Under the Proposed Action, the facilities would not be in place to provide this reduction in peak flow.

Table 3.6-9. Flood Attenuation of Iron Gate and Copco 1 Reservoirs

Flood	Peak Flow No Action	Peak Flow Under the Proposed Action	% Reduction With Dams In
Synthetic 100-yr flood	31,460	33,800	6.9
1989	10,200	10,300	1.2
1993	11,100	11,400	2.7
1996	11,200	11,300	1.1
1997	20,500	21,400	4.0
2005	12,400	12,800	3.0

Source: Reclamation 2012b

Appendix J includes model results that show flood maps for the river reaches below Iron Gate Dam to Happy Camp. The series of figures show the 100-year floodplain under the No Action/No Project Alternative and the Proposed Action; the differences between the two floodplains are very minor. The mapping includes the effects of the increase in the 100 year flood peak flow rate and the small amounts of deposition due to the removal of the four facilities.

As described under No Action/No Project Alternative analysis, there are some differences in the current 100 year flood inundation areas between FEMA and the model. These differences are attributable to the use of different base data and the use of enhanced elevation data by the Lead Agencies. FEMA is in the process of updating FIRMs using enhanced elevation data but has not accomplished this near the Klamath River.

DOI determined the existing floodplain by computing the 100 year flood and then mapping the extent of that floodplain on the existing topography. The existing floodplain may be different than that designated by FEMA because it is based upon more current information. DOI also simulated a 100 year floodplain after dam removal. Though FEMA ultimately would determine the 100 year floodplain for the Klamath River after dam removal, for the sake of this NEPA/ CEQA analysis, DOI modeled possible changes to downstream flood risk to evaluate how hydrologic changes associated with dam removal might impact the river and property owners downstream from Iron Gate Dam. Based upon the most current inventory of structures downstream from Iron Gate Dam to Humbug Creek over 24 residences are within the existing 100 year flood plain. Less than 6 residences and other structures such as garages are outside of this flood plain, but may be put into the 100 year floodplain after removal of the dams. Klamath Ranch Resort is just downstream from Iron Gate Dam and includes several structures and associated infrastructure (e.g. septic tanks, utilities, and roads). This is the largest enterprise that

could be affected by a change in the 100 year floodplain, 100 year flood peak flow, and the release of sediment downstream if dams were removed; the final determination of the future 100 year floodplain after dam removal will be made by FEMA. The purpose of the analysis was to estimate the costs to mitigate the increase in flood risk. If dam removal was pursued under the Proposed Action, the Dam Removal Entity would work with property owners to get full descriptions of property, buildings, and infrastructure; assess risks in more detail; and discuss feasible mitigation options as needed.

All the bridges over the Klamath River from Iron Gate to Hambug Creek were evaluated to determine the effects of the increase in the 100 year flood (Reclamation, 2012). All the bridges intended for vehicle traffic have more than 3 ft of freeboard for the 100 year flood under the Proposed Action. CalTrans requires that there is 2 ft of clearance below the low cord for the 50 year flood and that the 100 year flood passes under the low cord. The potential for increasing scour at the bridge piers was also evaluated. In all cases except the Rail Bridge (RM 183.3), the scoured bed elevation will not decrease more than 0.2 ft due to the Future Dams Out alternative. This is not considered a significant change in scour elevation considering the uncertainty associated with scour computations and the conservatism used in scour computations. The largest change to the scour elevation is at the Rail Bridge where it is expected to decrease approximately 1.2 ft. The change in scour elevation is not considered to affect significantly the structural integrity of the piers considering likely presence of bedrock near the riverbed that will limit scour at this location. Further investigations are planned to confirm the geologic conditions at this site. Therefore, no improvements to the existing bridges should be necessary to convey flows under the Proposed Action.

Not all of the structures that could be exposed to increased flooding risks are permanent. However, an increase in risk to one habitable structure or bridge is considered to be significant according to the significance criteria. Mitigation measures H-1 and H-2 are described below.

Modeled flows represent average monthly conditions, but peak flows for fisheries and storms could result in greater flows for a short duration. Table 3.6-9 shows the flood attenuation during a 100-year storm, and the dams provide an even smaller percent attenuation during a peak flow event. During high flow periods, the existing flood control capacity with the four dams would do little to reduce flood damage. Therefore, there would be little change to flood control capacity after the four dams are removed.

While high-flow events would experience only minor changes in magnitude under the Proposed Action, the timing of the storm peak could change. Modeling indicates that during a 100-year storm, the peak flows could reach downstream areas approximately 10 hours sooner under the Proposed Action compared to the No Action/No Project Alternative (Reclamation 2012b). This change could reduce the time that residents have to prepare for floods; however, the change would not substantially increase the risk that residents would be unprepared. The National Weather Service uses weather and watershed models to predict how potential storms and precipitation forecasts could affect the Klamath basin and typically provides flood warnings days in advance. The National

Weather Service is now using newer methods of predicting storms that allow a prediction two days in advance that is as accurate as a one-day prediction was five years ago (Haynes and Soulliard 2010).

When a large flood event is predicted, the National Weather Service provides river stage forecasts for the Klamath River for the USGS gages at Seiad Valley, Orleans and Klamath. They currently do not publish a forecast for river stage at Iron Gate gage. However, they work with PacifiCorp to issue flood warnings to Siskiyou County. After removal of Copco and Iron Gate Dams, it is likely that National Weather Service will publish a forecast at the Iron Gate gage location (Reclamation 2012b). Adding flood forecasting information at this site would improve information disseminated to the residents downstream.

Both Klamath County (Klamath County 2010b) and Siskiyou County participate in the NFIP and rely on existing 100-year flood maps prepared by FEMA to plan for future development or management near flood prone areas. Regulations under the NFIP require participating communities to "inform FEMA of any physical changes that affect 100-year flood elevations…within 6 months of the date that such data are available." This information is submitted in the form of a LOMA-F or LOMR by the community. FEMA will review the submitted data and determine if a map revision is warranted and proceed accordingly (FEMA 2002). Removal of the four dams would change the 100-year flood inundation zone when compared to the current FEMA map. This would require either a LOMA-F or LOMR to be prepared by Klamath and Siskiyou Counties for areas within their jurisdictions. Both counties might require the DRE or other responsible agency to work with them to prepare the application. In Klamath County, the FEMA 100-year flood inundation area would change due to removal of J.C. Boyle Reservoir. **The change to the 100-year floodplain inundation area downstream from Iron Gate Dam would increase the risks of flooding structures; therefore, the impact on flood hydrology would be significant. Mitigation Measures H-1 and H-2 would reduce the impact to flood hydrology to less than significant.**

Removing the Four Facilities could reduce the risks associated with a dam failure. As discussed in the No Action/No Project Alternative, the Four Facilities store over 169,000 acre-feet of water that could inundate a portion of the watershed if the dams fail (Siskiyou County Web Site 2011). The dams are inspected regularly, and the probability for failure has been found to be low. Removing the Four Facilities would eliminate the potential for dam failure and subsequent flood damages. **Therefore, eliminating the dam failure risk associated with the Four Facilities would have a beneficial effect on flood hydrology.**

Under the Proposed Action, recreational facilities currently located on the banks of the existing reservoirs would be removed following drawdown and could change flood hydrology. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities would be removed. These facilities would be well above the new river channel, and deconstruction would not place anything in the channel or otherwise impeded low or high

flows in the Klamath River. **Therefore, there would be no change from existing conditions from flood hydrology from the removal of the recreational facilities.**

Keno Transfer

Implementation of the Keno Transfer could cause changes to operations affecting flows downstream from Keno Dam, which could cause changes to flood risks. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on flood hydrology compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice. **Implementation of the Keno Transfer would have no change from existing conditions from flood risks.**

East and Westside Facilities – Programmatic Measures

Decommissioning the East and Westside Facilities could cause changes in flood risk downstream from the facilities. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals. Following decommissioning of the facilities there would be no change in outflow from Upper Klamath Lake or inflow into Lake Ewauna. **Therefore, implementation of the East and Westside Facility Decommissioning action would result in no change from existing conditions.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The relocation of the City of Yreka Water Supply Pipeline could affect river flows and result in changes to flood risks. The existing water supply pipeline for City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. The pipe bridge would be located above the 100 year flood line as the intention is to prevent the pipeline from being exposed to high velocity flows. Thus, the pipe bridge would not affect flood hydrology. Therefore, there would be no change from existing conditions from flood risk from the relocation of the City of Yreka Water Supply Pipeline.

KBRA – Programmatic Measures

The KBRA, which is a connected action to the Proposed Action, encompasses several programs that could affect flood hydrology, including:

- Phases I and 2 Fisheries Restoration Plan
- Wood River Wetland Restoration
- Future Storage Opportunities
- On-Project Plan
- Water Use Retirement Program
- Emergency Response Plan

- Water Diversion Limitations
- Climate Change Assessment and Adaptive Management
- Interim Flow and Lake Level Program

3.6.4.3.3 Phases 1 and 2 Fisheries Restoration Plans

Implementation of the Fisheries Restoration Plans could change flows downstream from Upper Klamath Lake, which could result in changes to flood risks. Actions within the floodplain and river channel including: floodplain rehabilitation, large woody debris replacement, fish passage correction, cattle exclusion fencing, riparian vegetation planting, and treatment of fine sediment sources could alter river hydraulics. The restoration actions are designed to improve aquatic and riparian habitat and the potential changes in river hydraulics are intended to improve the habitats' ability to support river fisheries. Changes in river hydraulics could generate minor changes in flood risks in and around the specific restoration locations. The timing of and specific locations where these resource management actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. **However, potential changes in river hydraulics are likely to generate a less than significant impact to flood risks.**

Implementation of specific plans and projects outlined in the Fisheries Restoration Plans will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.

3.6.4.3.4 Wood River Wetland Restoration

Implementation of Wood River Wetland Restoration may change flows upstream and downstream from Upper Klamath Lake, which could result in changes to flood risks. A study of future Wood River Wetland area management options would be conducted to provide additional water storage for a total of 16,000 acre-feet of storage capacity in or adjacent to Agency Lake. This additional storage upstream of Upper Klamath Lake is likely to decrease potential flood risks downstream from Upper Klamath Lake by potentially storing excess flows. The improvements in flood risk generated by implementation of the Wood River Wetland Restoration Project would not be expected to contribute to the effects of hydroelectric facility removal analyzed above. **Implementation of the Wood River Wetland Restoration Project is anticipated to have a beneficial effect on flood risks. Implementing Wood River Wetland Restoration will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

3.6.4.3.5 Future Storage Opportunities

Implementation of Future Storage Opportunities by Reclamation may cause changes to flows upstream and down downstream from Upper Klamath Lake, which could result in changes to flood risks. Reclamation plans to identify and study additional off-stream storage opportunities with a 10,000 acre-feet of storage milestone in implementation of KBRA. Offstream storage is likely to decrease potential flood risks by potentially storing excess flows. The improvements in flood risk generated by development of off-stream storage would not be expected to contribute to the effects of hydroelectric facility removal analyzed above. **Implementation of Future Storage Opportunities is**

anticipated to have a beneficial effect on flood risks. Implementing Future Storage Opportunities will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.

3.6.4.3.6 On-Project Plan

Implementation of the On-Project Plan may change flows downstream from Upper Klamath Lake during dry years, which could result in changes to flood risks. The On-Project Plan supports full implementation of Water Diversion Limitations by taking actions to reduce water use for irrigation. These actions include: land fallowing and shifting to dryland crop alternatives, changes in land use and forage availability/types for terrestrial species, efficiency and conservation measures (i.e. drip irrigation), development of groundwater sources, or creation of additional storage. Reductions in water use under the On-Project Plan would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Implementation of the On-Project Plan is likely to generate no change in flood risk when compared to existing conditions as it would be implemented during dry years during the irrigation season when flood risks are low. Implementing the On-Project Plan will require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

3.6.4.3.7 Water Use Retirement Program (WURP)

Implementation of the WURP would change flows upstream of Upper Klamath Lake, which could result in changes to flood risks. The WURP is a voluntary program for the purpose of supporting fish populations restoration by permanently increasing inflow to Upper Klamath Lake by 30,000 acre-feet per year. A variety of management measures and irrigation water use changes would help to accomplish an inflow increase and are described in Section 2.4.3.9. Upper Klamath Lake storage has already increased after breaching of levees and dikes by the Williamson River Delta project which would be large enough to accommodate the inflow increase. Other KBRA measures described below would manage outflow to the Klamath River. Reductions in water use under the WURP would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Implementation of the WURP is expected to generate no change in flood risks when compared to existing conditions because flow changes would be implemented during the irrigation season and not the flood season. Implementing the WURP will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

3.6.4.3.8 Emergency Response Plan

Implementation of an Emergency Response Plan could result in changes to flood risks in the event of failure to a Klamath Reclamation Project facility or dike on Upper Klamath Lake or Lake Ewauna. The purpose of the plan is to prepare water managers for an emergency affecting the storage and delivery of water needed for KBRA implementation. The components of the Emergency Response Plan are described in Section 2.4.3.9 and include potential emergency response measures and processes to implement emergency responses. While use of an Emergency Response Plan could potentially reduce damage to property or loss of life due to a facility or dike failure, the intent of this plan is to allow for continued storage and delivery of water according to KBRA commitments and would

not affect the probability of experiencing a flood. Additionally the Emergency Response Plan would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Therefore, it is anticipated that implementation of the Emergency Response Plan would generate no change in flood risk when compared to existing conditions, although it would likely help to reduce damage to property or loss of life due to a flood event which would be a beneficial effect to flood risks. Implementing the Emergency Response Plan will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

3.6.4.3.9 Climate Change Assessment and Adaptive Management

Implementation of Climate Change Assessment and Adaptive Management may change flows upstream and downstream from Upper Klamath Lake, which could result in changes to flood risks. One of the main purposes of Climate Change Assessment and Adaptive Management is to respond to and protect basin interests from the adverse affects of climate change. Flood risks could be adversely impacted due to climate changes which increase river flows and/or flooding frequency. Klamath Basin Parties including technical experts would be involved in the development of assessment and adaptive management strategies. Assessments and development of adaptive management strategies would be implemented continuously to respond to predicted climate changes. The improvements in flood risk generated by the Climate Change Assessment and Adaptive Management Program would be expected improve the effects of hydroelectric facility removal analyzed above. **While flood risks could be adversely impacted by climate change in general, implementation of Climate Change Assessment and Adaptive Management would help to reduce flood risks in the event of climate changes and be beneficial to flood risks. Implementing Climate Change Assessment and Adaptive Management will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.**

Interim Flow and Lake Level Program

Implementation of Interim Flow and Lake Program during the interim period would change river flows, which could result in changes to flood risks. The goal of the Interim Flow and Lake Level Program is to "further the goals of the Fisheries Program" during the interim period. This would require changes in flows to accommodate fish needs during the irrigation season. Changes in water flows under the Interim Flow and Lake Level Program would not be expected to contribute to any changes in flood risk generated by the hydroelectric facility removal action. **Therefore, implementation of the Interim Flow and Lake Level Program would cause no change in flood risk from existing conditions because flow changes would not be implemented during the flood season.**

3.6.4.3.10 Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities of Four Dams Alternative, impacts would be the same as for the Proposed Action. While this alternative would leave some facilities in place, it would remove enough of the facilities to allow a free-flowing river at all times and would not alter flood effects discussed under the Proposed Action. **The increased flood risks would be less than significant. The change in the 100-year floodplain downstream**

from Iron Gate Dam would increase the risks of flooding structures and would be significant. Mitigation measures H-1 and H-2 would reduce this impact to less than significant. Eliminating the dam failure risk would have a beneficial effect.

Keno Transfer

The flood hydrology impacts of the Keno Transfer under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

East and Westside Facilities – Programmatic Measures

The surface water and hydrology impacts of the decommissioning the East and Westside canals under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The surface water and hydrology impacts of relocating the City of Yreka's Water Supply Pipeline under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action**.**

KBRA – Programmatic Measures

Under this alternative, the KBRA would be fully implemented and the potential effects would be the same as described for the Proposed Action. **Implementation of the KBRA would result in a less than significant impact to flood hydrology.**

3.6.4.3.11 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, flows downstream from Iron Gate Dam would remain the same as for the No Action/No Project Alternative. The risk of dam failure and downstream flooding would be the same as under the No Action/No Project Alternative and existing condition. Within the Hydroelectric Reach, however, flows would change to accommodate the new fish ladders and requirements within the bypass reaches. Flows within the J.C. Boyle Bypass Reach would increase to meet fish needs in this area. Although the flows would increase compared to the No Action/No Project Alternative, the existing channel capacity is adequate to accommodate these increases. Flows downstream from Iron Gate Dam would not change. **Therefore, the effects from Fish Passage at Four Dams Alternative on flood hydrology would be less than significant because the river channel capacity can support flow increases and there would be no increased risks of flooding.**

3.6.4.3.12 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Drawdown of reservoirs could result in short-term increases in downstream surface water flows and result in changes to flood risks. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, short-term drawdown of reservoirs would occur at Copco 1 and Iron Gate dams, with the same effects as for the Proposed Action. No drawdown would occur in Klamath County because J.C. Boyle Reservoir would remain in place. As described in the Proposed Action, **drawdown-**

related impacts to flood risks for the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less than significant because flow changes would be within the historic range.

The release of sediment stored behind Copco 1 and Iron Gate dams and resulting downstream sediment deposition could result in changes to flood risks. Approximately 46 to 81 percent of sediment behind Copco 1 Dam, and 25 to 38 percent of sediment behind Iron Gate Dam would be eroded and flushed down the river during removal activities (Reclamation 2012b). As was described and analyzed above for the Proposed Action, the magnitude of sediment deposition is relatively small compared to sediment loading from other existing sources along the Klamath River. Additionally, the sedimentation would be short term following dam removal. Because the sediment deposition would be short term and small in comparison with the No Action/No Project Alternative, it would not affect stream characteristics in a way that would substantively affect flood inundation or flood risks. **Therefore, sediment deposition would have a less than significant effect on flood risks.**

The 100-year floodplain inundation area downstream from Iron Gate Dam could change between River Mile 190 and 105 (study area). Removing Copco 1 and Iron Gate would result in a change in flows downstream from Iron Gate Dam. These changes would be less than the Proposed Action, but could result in flooding to some structures in the 100-year floodplain. Additionally, flow requirements in the J.C. Boyle Bypass Reach would increase flows, but similar to the Fish Passage at Four Dams Alternative, these changes would be within the historic range of flows in this reach. **The change to the 100-year floodplain inundation area downstream from Iron Gate Dam would increase the risks of flooding structures; therefore, the impact on flood hydrology would be significant. Mitigation measures H-1 and H-2 would reduce the impact to flood hydrology to less than significant.**

Removing Copco 1 and Iron Gate Dams could reduce the risks associated with a dam failure. Copco 1 and Iron Gate Dams together store over 90,000 acre-feet of water when they are full. The dams are inspected regularly, and the probability for failure has been found to be low. However, if a dam failed, it could inundate a portion of the downstream watershed (Siskiyou County Web Site 2011). Removing the dams would eliminate the potential for dam failure and subsequent flood damages. J.C. Boyle Dam would still be in place, and the potential for dam failure would be the same as in the No Action/No Project. The inundation area, however, could change because removal of the downstream facilities would affect flow patterns. **Overall, eliminating the dam failure risk associated with Copco 1 and Iron Gate Dams would have a beneficial effect on flood hydrology.**

Recreational facilities currently located on the banks of Iron Gate and Copco reservoirs would be removed following drawdown and could change flood hydrology. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, recreation facilities would be removed at Iron Gate and Copco reservoirs, with the same effects as for the Proposed Action. **Therefore, there would be no change from existing conditions flood hydrology from the removal of the recreational facilities.**

Construction of a new gage within the 100-year floodplain at Copco 2 Dam or J.C. Boyle Dam to measure flows could affect flood hydrology. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative a new gage would need to be developed at Copco 2 Dam or J.C. Boyle Dam to measure flows required to protect fish habitat downstream. Incorporation of environmental measures in the project would avoid construction-related impacts from construction in the floodplain. **The construction of a new gage would be a less than significant impact.**

Changes in flows in the Hydroelectric Reach including the J.C. Boyle and Copco 2 Bypass Reaches could affect flood hydrology. Similar to the analysis stated under the Fish Passage at Four Dams Alternative, flows would change to accommodate the new fish ladders and requirements within the bypass reaches. As stated under the Fish Passage at Four Dams Alternative, **the effects on flood hydrology would be less than significant because the river channel capacity can support flow increases and there would be no increased risks of flooding.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The surface water and hydrology impacts of relocating the City of Yreka's Water Supply Pipeline under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as for the Proposed Action.

3.6.4.4 Mitigation Measures

3.6.4.4.1 Mitigation Measure by Consequence Summary

Mitigation Measure H-1: Once there is a positive determination, the DRE will inform the National Weather Service (NWS), River Forecast Center, of a planned major hydraulic change (removal of four dams) to the Klamath River that could potentially affect the timing and magnitude of flooding below Iron Gate. The River Forecast Center is the Federal agency that provides official public warning of floods. The NWS currently forecasts flood elevations at the Seiad Valley gage on the Klamath River and at several points downstream, which are all downstream from the Four Facilities. After the removal of the Four Facilities, the Lead Agencies will work with NWS to allow it to forecast floods at Iron Gate gage as well, located just downstream from Iron Gate Dam. Shifting the analysis point upstream will help increase the warning time available to respond to flood conditions.

If there is a positive determination, NWS will begin evaluating the natural stream response of the Klamath River between Upper Klamath Lake and the location of Iron Gate Dam, which includes characterizing the hydrologic response of tributaries entering this river reach and routing water (from upstream sources and tributary inputs) through this reach without dams and reservoirs (the natural channel). In addition, at least two new stream gaging stations will be installed and operated to assist in the calibration of the model. Key locations would likely include a larger tributary that enters the PacifiCorp Hydroelectric Reach (e.g. Jenny Creek) and another gage on the main-stem river (e.g. near the current location of Copco 1 Dam). The gage on the tributary will be installed several years prior to dam removal to ensure that there is adequate time to develop a flood warning at the Iron Gate stream gage. The updates needed are similar to those that

are regularly performed by the NWS when operating the models. Because the dams are not operated for flood control and have limited influence on the peak discharges at Iron Gate Dam, the historical stream gaging information can still provide valuable information in the development of a flood warning model at Iron Gate Gage and therefore, NWS will not be only reliant upon the new stream gaging.

As currently occurs, flood forecasts and flood warnings would be publicly posted by the River Forecast Center for use by Federal, State, county, tribal, and local agencies, as well as the public, so timely decisions regarding evacuation or emergency response could be made.

Prior to dam removal, the DRE will inform FEMA of a planned major hydraulic change to the Klamath River that could affect the 100-year flood plain. The DRE will ensure recent hydrologic/hydraulic modeling, and updates to the land elevation mapping, will be provided to FEMA so they can update their 100-year flood plain maps downstream from Iron Gate Dam (as needed), so flood risks (real-time and long term) can be evaluated and responded to by agencies, the private sector, and the public.

Mitigation Measure H-2: The DRE will work with willing landowners to develop and implement a plan to address any increased flood threat generated by changes to the 100-year flood inundation area as a result of the removal of the Four Facilities for permanent, legally established, permitted, habitable structures in place before dam removal. Such plan could include measures to move, modify, or elevate structures where feasible.

3.6.4.4.2 Effectiveness of Mitigation in Reducing Consequence

These mitigation measures will be effective as they will identify the extent of the increased flood risks and take measures which will reduce the risks for loss, injury or death from flooding.

3.6.4.4.3 Agency Responsible for Mitigation Implementation

The DRE would be responsible for implementing mitigation measures H-1 and H-2.

Mitigation Measures Associated with Other Resource Areas

Implementation of Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. These facilities will not contribute to channelization of the river and thus increase flood risks, or create infrastructure in the flood plain that would be at risk of damage during inundation. **Therefore, there would be no change from existing conditions to Flood Hydrology from the implementation of REC-1.**

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3.7 Ground Water

This section of the Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) describes the changes in ground water levels and availability that would be caused by the Proposed Action and alternatives.

3.7.1 Area of Analysis

This EIS/EIR's area of analysis, or "project area," for ground water as related to the Klamath Hydroelectric Settlement Agreement (KHSA) includes the area within 2.5 miles upstream of J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs. The project area lies within Klamath County, Oregon, and Siskiyou County, California. The project area for the Klamath Basin Restoration Agreement (KBRA) with respect to ground water is the Klamath basin upstream of Copco 1 Dam. This is the area covered by a United States Geological Survey (USGS)-Oregon Water Resources Department (WRD) ground water model designed to determine effects on ground water from pumping water for irrigation purposes. No model exists for areas below Copco 1 Dam. Ground water issues, such as changes in ground water levels or recharge, are described in this section. Issues related to geology are described in Section 3.11, Geology, Soils, and Geologic Hazards.

3.7.2 Regulatory Framework

Ground water resources within the area of analysis are regulated by the State and local laws listed below.

3.7.2.1 State Authorities and Regulations

- California Water Code (CWC §10750, §10753.7, §1702, §1706, §1727, §1736, and §1810) (California, State of)
- California Assembly Bill 3030 (CWC §10750 et seq.)
- California Senate Bill 1938 (Sections 10753.4 and 10795.4 of, to amend and renumber Sections 10753.7, 10753.8, and 10753.9 of, and to add Sections 10753.1 and 10753.7)
- Oregon Revised Statutes (Chapters 536 through 541) (Oregon, State of)
- California Department of Water Resources (DWR) Bulletin 118 (DWR 2003)

3.7.2.2 Local Authorities and Regulations

- Siskiyou County Code (Title 3, Chapter 19) (Siskiyou County)

3.7.3 Existing Conditions/Affected Environment

3.7.3.1 Ground Water Basin Hydrology Description

3.7.3.1.1 Regional Ground Water Conditions

The project area has few wells that completely characterize ground water conditions. Gannett et al. 2007 completed the most recent and comprehensive attempt to estimate the water level gradients and flow patterns within the project area upstream and downstream from the four dam sites. Figures 3.7-1 and 3.7-2 show a generalized ground water flow map for the Upper Klamath Basin and portions of the Lower Klamath Basin. Figure 3.7-2 suggests that the regional ground water flow patterns along the Klamath

River downstream from Keno Dam are generally from the higher elevations (upland areas, mountain ranges, hills, etc.) toward the Klamath River, and from Keno Dam toward Iron Gate Dam (Bureau of Reclamation (Reclamation) 2011a). Figure 3.7-2 shows a very steep ground water head gradient between Keno Dam and the J.C. Boyle Reservoir. That steep head gradient suggests the presence of a ground water barrier and is also roughly correlative with the mapped trace of the Sky Lakes fault zone (Personius, 2003). A ground water barrier at this location implies that the ground water system above Keno Dam is separate from the ground water system below Keno Dam.

The Lead Agencies reviewed the area around the reservoirs on USGS topographic 7½-minute quadrangle maps (Iron Gate and Copco Quadrangles in California; Spencer Creek and Chicken Hills Quadrangles in Oregon) (Reclamation 2012a). Numerous springs, where ground water discharges to the surface, are shown surrounding Iron Gate Reservoir. These springs occur at elevations from less than 50 to more than 300 feet (ft) above the reservoir level (Reclamation 2012a). The maps also show springs around Copco Reservoir. These springs are similarly less than 50 to more than 800 ft above the reservoir level (Reclamation 2012a).

The USGS mapping shows a number of the small drainages that empty into Copco Reservoir have a spring at the headwater of the drainage. The maps show very few springs in the vicinity of J.C. Boyle Reservoir, and those that are shown are only a few tens of feet above the reservoir level (Reclamation 2012a). However, many of the small drainages that empty into J.C. Boyle Reservoir have a spring at the headwater of the drainage (e.g., Spencer Creek (Gannett et al. 2007)). The presence of springs in the area suggests local ground water systems, and possibly a regional ground water system, that are not receiving water directly from the reservoirs (Reclamation 2012a). That is, the water discharging from the springs is not thought to be reservoir water (Reclamation 2012a).

The flows from the springs and the location of the springs could be influenced indirectly by the presence of a reservoir because the reservoir could create higher ground water levels adjacent to the reservoir. These higher ground water levels could cause ground water levels to be increased as compared to the condition where the reservoir was not in place. These increased ground water levels could rise to the ground surface and affect the location of a spring and the volume of water discharging from the spring. The level of hydraulic connection between the reservoirs and the spring systems is not known (Reclamation 2012a).

A spring complex about one mile below J.C. Boyle Dam contributes substantial flow to the river (Gannett et al. 2007). The water discharging at this site may be originating from the local ground water system. The flows could also be influenced by seepage from the reservoir that is flowing around or under the dam and coming to the surface at the spring site. It is likely that the flows from this spring complex are influenced by both the local ground water system as well as leakage from the reservoir (Reclamation 2012a).

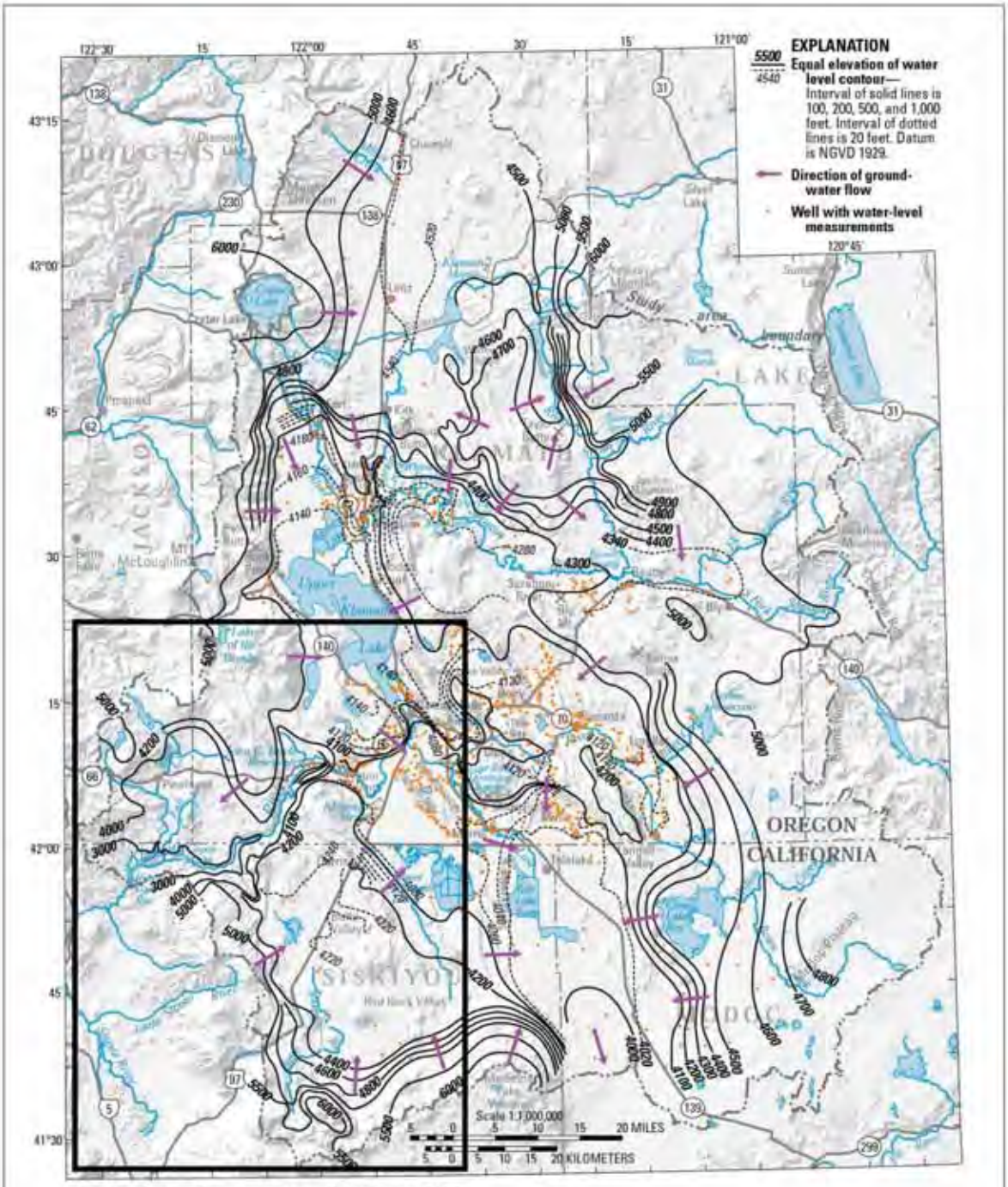

Figure 3.7-1. Generalized Ground Water Potentiometric Surface Contour Map and Ground Water Flow Directions in the Upper Klamath Basin [after Gannett et al. 2007].

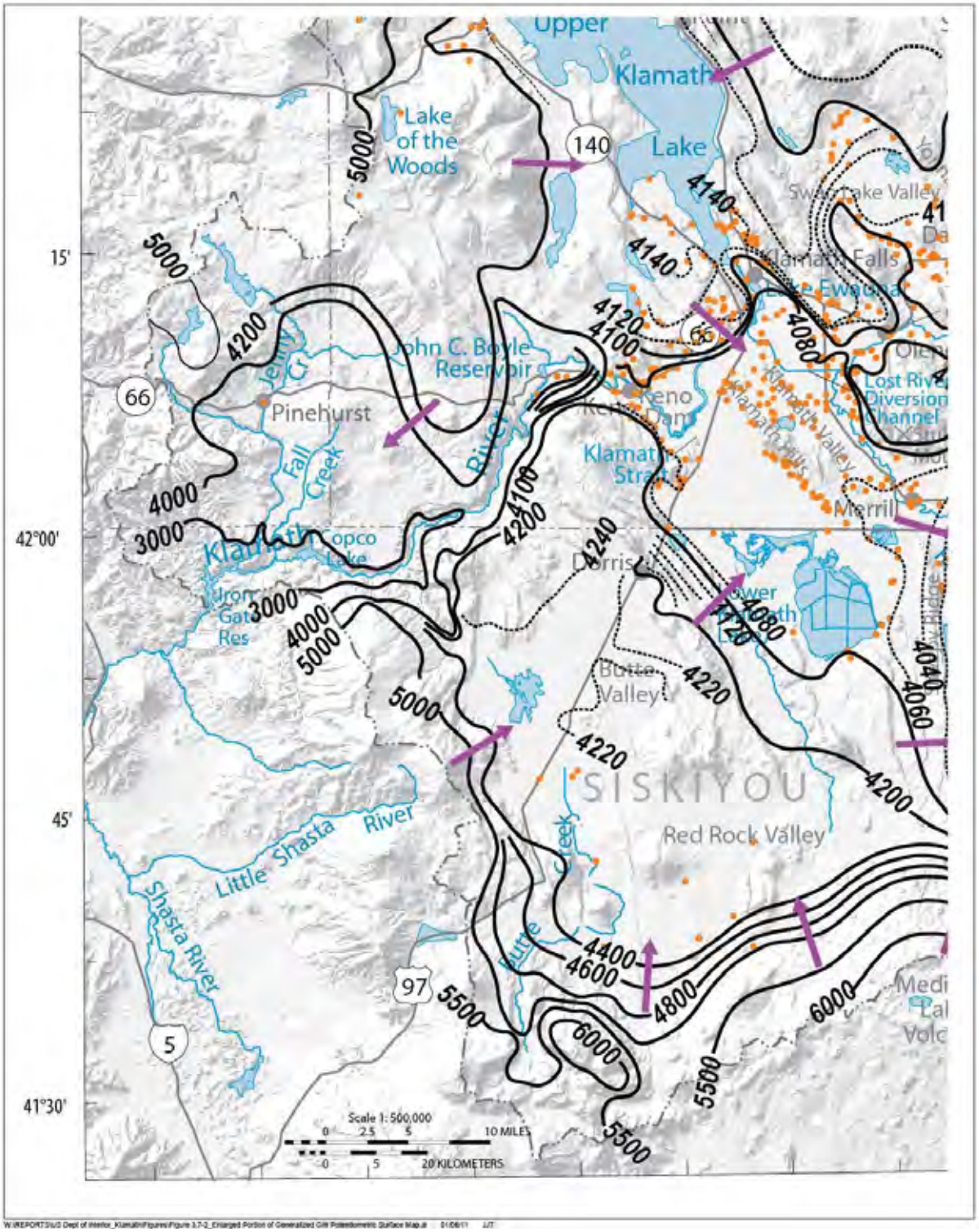

Figure 3.7-2. Enlarged Portion of the Generalized Ground Water Potentiometric Surface Contour Map and Flow Directions for the Areas around J.C. Boyle, Copco, and Iron Gate Reservoirs [after Gannett et al. 2007].

Sources of Ground Water in Project Area

Ground water in the project area is likely fed by the infiltration of precipitation and subsequent percolation through the surface materials to the bedrock units. As Figures 3.7-1 and 3.7-2 show, at a regional scale, ground water flows into the project area near the four dams from upland areas toward the Klamath River and the reservoirs. The figures show an apparent ground water divide in the area just upstream of J.C. Boyle/ Keno Impoundment. These figures also show the regional trends in ground water elevations and flow paths. Where ground water levels are above the river and reservoir elevations, it is generally assumed that ground water levels in the vicinity of the reservoirs are supported by the regional ground water system more so than by reservoir leakage. However wells immediately adjacent (potentially extending up to a mile from the reservoirs under certain conditions) to the reservoirs are more likely influenced by reservoir leakage where such leakage exists.

Ground water in the project area is also maintained by ground water flows from upgradient areas. In the absence of barriers to vertical flow, surface water infiltration is a common source of recharge to ground water systems. Rivers, lakes and other surface water bodies are common sources of site specific infiltration recharge. Aerial precipitation is more of a dispersed, wide extent source of infiltration recharge. Given a regional ground water flow direction toward the river and reservoirs in the project area, reaches are more likely receiving water from the ground water systems than they are losing water to the ground water systems, while reservoirs are more likely to lose water to the ground water (Reclamation 2012a). However, there are conditions where the reservoirs could be gaining water from the ground water system(s) (Reclamation 2012a). The lack of data from ground water wells in the area makes a more specific characterization of ground water sources in the project area difficult.

Ground Water Sinks in Project Area

In areas where surface water levels are lower than the adjacent ground water level, ground water can discharge to the surface water (e.g., rivers, streams, and reservoirs). This would be called a ground water “sink” because ground water flows towards it and is lost from the ground water system. Gannett et al. (2007) estimates that ground water adjacent to the Klamath River discharges to the river in the project area. An average discharge of 190 cfs of ground water for the reach from Keno Dam to downstream from the J.C. Boyle Powerhouse and 92 cfs for the reach from there downstream to Iron Gate Dam is estimated (Gannett et al. 2007). These estimates are calculated for the length of each of these reaches based on gage data and changes in reservoir storage. These estimates may include some ungaged tributary inflows.

Ground water pumping is also a typical process in the project area where water is removed from the ground water system. In the project area, ground water is pumped to the surface for domestic use and irrigation. Most domestic wells around the reservoirs are likely seasonal residences (i.e., owner’s official address is different than the well location address) and are not expected to be a major ground water sink in the project area (Reclamation 2012a). Average well yields in Siskiyou County, California are just over 19 gpm while in Klamath County, Oregon the average yield is just over 22 gpm

(Reclamation 2012a). Based on completion dates on well logs for Siskiyou County, an average of five new wells per year have been installed in the project area since 1963. In Klamath County the average is about three new wells per year since 1976, including the area around Keno and Keno Dam, Oregon (Reclamation 2012a).

A large ground water flow system exists in the Upper Klamath Basin (Gannett et al. 2007). Ground water is recharged in areas in the Cascade Range and upland areas surrounding the basin. Ground water flows from these areas toward the interior of the basin and subbasins (Figure 3.7-1). Many of the streams in the interior of the basin are at least partially fed by ground water discharge (Gannett et al. 2007). Some streams are fed predominately by ground water (i.e., baseflow) at a consistent rate throughout the year. Ground water is used in the Upper Basin to irrigate agricultural land as well as for domestic, industrial, and municipal purposes. Ground water is used as a primary source of irrigation water where surface water is not available and also as a supplemental source when surface supplies are limited (Gannett et al. 2007).

Ground water levels in the Upper Basin vary in response to climatic cycles, ground water pumping, lake levels, and canal operations. Typical annual drawdown and recovery cycles caused by ground water pumping are from one to ten ft. Ground water use in the Upper Basin increased by approximately 50 percent in response to the 2001 biological opinion, primarily in the area surrounding Reclamation's Klamath Project. This pumping increase resulted from changes in surface water management practices . Reclamation's ground water acquisition program in 2001 and National Oceanic and Atmospheric Administration Fisheries Service's (NOAA Fisheries Service) requirement for a 100,000 acre-ft pilot water bank are the primary factors in this increase. The pilot water bank, which operated during the 2003, 2004, and 2005 water years, was required by the 2002 NOAA Fisheries Biological Opinion. The estimated ground water pumping in the area was approximately 28,600 acre-ft in 2001. In 2004, pumping increased to approximately 69,300 acre-ft for water bank operations (Gannett 2012b).

Prior to 2001, ground water levels were affected by typical climate-based fluctuations of approximately five ft resulting from cycles of dry and wet periods. Near centers of ground water pumping for irrigation, water levels also typically varied between one and ten ft from year to year as a result of seasonal pumping. Following the increased pumping that started in 2002, ground water levels have declined more than ten ft in portions of the deep water-bearing zones in the Klamath Valley. Overall, the increase in pumping resulted in ground water levels dropping 10 to 15 ft in portions of this area between 2001 and 2004 (Gannett et al. 2007).

Local Ground Water Conditions

The California DWR *Bulletin 118 – Update 2003, California's Groundwater,* delineates 515 ground water basins and subbasins throughout the State. The area of analysis for the Proposed Action and alternatives does not fall within one of these delineated basins. The area is defined as a "ground water source area" by the California DWR. A "ground water source area" is "rocks that are significant in terms of being a local ground water sources, but do not fit the [typical] category of basin or subbasin" (DWR 2003). The Klamath

River from the Oregon-California Stateline to downstream from Iron Gate Dam is a predominantly non-alluvial river flowing through mountainous terrain. Downstream from the Iron Gate Dam, and for most of the river's length to the Pacific Ocean, the river maintains a relatively steep, high-energy, coarse-grained channel frequently confined by bedrock. Section 3.11, Geology, Soils, and Geologic Hazards, of this document describes project area geology in more detail.

Well information was obtained and reviewed from the databases of both the Oregon WRD and the California DWR to identify well logs for known domestic and irrigation wells within several miles upstream and downstream from the Four Facilities. Roughly 83 percent of the logs (300 out of 360 logs) included sufficient detail to locate the wells relative to the reservoirs. Of the 300 logs for which reasonable coordinate data could be determined, only 63 wells were within 2.5 miles of one or more of the three reservoirs, 25 near Iron Gate, 22 near Copco 1 and 2, and 16 near J.C. Boyle (Reclamation 2012a).

Using the local topography, reservoir bathymetry, and lithologic descriptions on the well logs, representative cross-sections through the reservoirs and adjacent lands were drawn such that each cross-section intersected at least one known well location. The cross-section for J.C. Boyle is presented below, and cross sections for Copco 1 and 2 and Iron Gate are presented in Appendix K. Each cross-section displays the topography, water surface elevation of the reservoir, well log ID, abbreviated well log lithology, and the static water level in the well. The water-bearing units in each well are presented in summary tables for each reservoir.

The following discussions of potential or possible impacts to the local wells from the Proposed Action are predicated on the conceptual model that in order to be impacted, the water-bearing unit that each well is tapping must be hydraulically connected to the reservoir – either by having the water-bearing unit exposed to the surface (i.e., daylight) within the reservoir walls or being hydraulically connected to the reservoir through a series of permeable layers between the reservoir and the water-bearing unit.

The potential for impacts to the wells is further predicated on the relative elevation differences between the static water level in the well(s) and the water surface elevation of the reservoir. Specifically, if the water-bearing unit being tapped by any given well is in hydraulic connection with a reservoir, then the static water level in the well should be similar or close to the water surface elevation in the reservoir. If the static water level is higher or lower than the reservoir level, and the water-bearing unit is not exposed along the reservoir walls, then it is likely that the water-bearing unit is reflecting a regional or local aquifer system influence in addition to, or in place of, the reservoir. If the water-bearing unit itself is entirely above the reservoir water levels, or is substantially deeper (more than three or four intervening impermeable units) than the lowest portion of the reservoir, then it would be unlikely that the water-bearing unit would be in hydraulic connection with the reservoir. It should be noted that the static water level in a well can vary from year to year based on preceding hydrologic conditions (i.e., climatic cycles, wet years vs. dry years).

J.C. Boyle Reservoir

The bedrock surrounding and underlying the J.C. Boyle Reservoir is principally composed of moderately well bedded to massive, moderately well-consolidated volcanic rocks of the High Cascade Geomorphic Province. Lava flows dominate the landscape and geologic strata and form many of the ridges above the reservoir. In the downstream portion of the reservoir (downstream from the Highway 66 bridge) young lava flows line the sides of the reservoir (Reclamation 2012a). Section 3.11, Geology, Soils, and Geologic Hazards, provides additional geologic information.

The Oregon WRD well database identifies 50 wells within 2.5 miles of the J.C. Boyle Reservoir (Oregon WRD 2011). Sixteen of these 50 wells were able to be located geographically based on well addresses recorded on the drill logs or by comparing the well log information to ownership parcel data supplied by Klamath County. Ten of those 16 wells were shallow Oregon Department of Transportation borings near bridge footings. Figure 3.7-3 shows the locations of the wells that could be located. The construction details for these wells are outlined in Appendix K.

Three cross-sections that intersected at least one of the six wells were developed. Figure 3.7-3 shows the locations of these cross-sections. Figures 3.7-4 and 3.7-5 show the cross-sections. The well parameters used to develop the cross-sections are summarized in Table 3.7-1.

The data in Table 3.7-1 suggests that the water-bearing volcanic units are deeper than the bottom elevation of the reservoir (i.e., the pre-reservoir river bed) in wells 10059 and 51633. The static water level for each well is 50 to 100 ft below the bottom of the reservoir. The top of the water bearing layer and the static water level in well 14002 are similar to the elevation of the river bed (Reclamation 2012a). Therefore, the reservoir level is unlikely to affect these wells.

The lateral extent, homogeneity/inhomogeneity, and degree of fracturing, of the volcanic deposits in the region are variable. Some degree of hydraulic connectivity exists between the reservoir and water bearing strata near the reservoir which allows downward migration of reservoir water. There may also be a zone of similar horizontal hydraulic connectivity around the reservoir. The extent and degree of connectivity is uncertain based on the limited well data. Both wells 10059 and 14002 have significant amounts of clay recorded on the logs at depths between the top of their water bearing units and the equivalent depth of the old river bed that probably inhibits or significantly reduces the vertical migration of infiltration water from the reservoir. The extents of these clay units are uncertain (Reclamation 2012a).

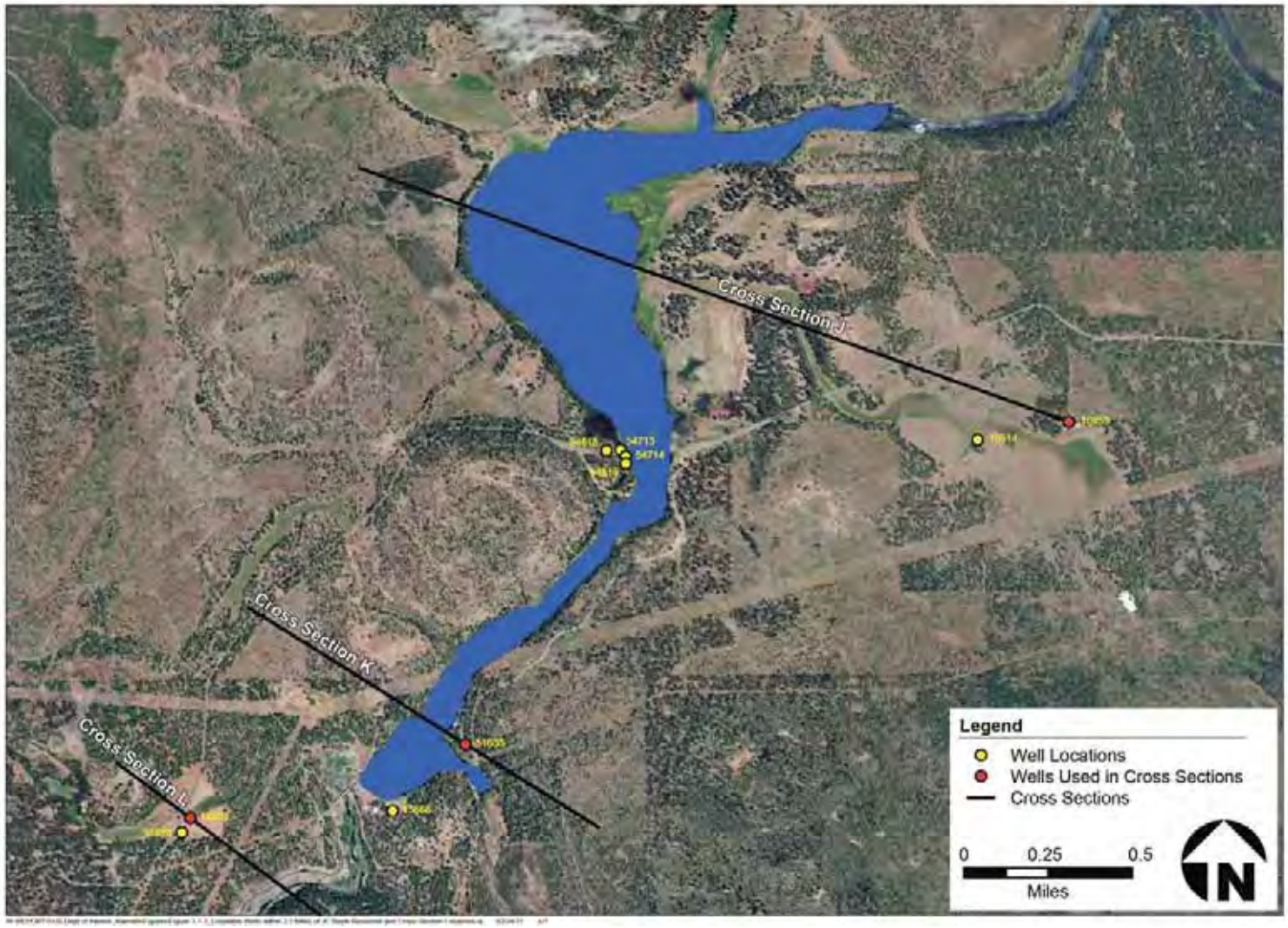

Figure 3.7-3. Locatable Wells within 2.5 Miles of J.C. Boyle Reservoir and Cross-Section Locations.

Table 3.7-1. Well Construction Information for Wells[1] within 2.5 Miles of J.C. Boyle Reservoir[2]

Well ID[3]	Drill Date	Well Diameter (in)	Depth to top of perforated zone or bottom of surface casing in an open well (ft)	Depth to bottom of perforated zone (ft)	Depth of Well (ft)	Depth to 1st Water (ft)	Pumping Rate (gpm)	Depth to Static Water (ft)	Located on Cross-Section	Static Water Elevation (ft)	Water-Bearing Unit and Top Elevation (ft)
10059	6/29/1990	6	159 [4]	Open	281	77	12	222	J	3,686	Brown lava and clay from 203 to 223 ft bgs interspersed with black rock from 212 to 215 ft bgs, and gray rock and clay, and gray rock from 223 to 281 ft bgs with bubbly brown lava from 257 to 280 ft bgs; Elevation 3,705 ft
14002	8/10/1988	6	99 [4]	Open	238	181	25	178	L	3,698	Hard gray volcanic rock from 181 to 238 ft bgs; Elevation 3,695 ft
51633	10/19/2006	6	280 [4]	Open	315	126	55	126	K	3,701	Gray and brown basalt from 126 to 315 ft bgs interspersed with hard gray baslalt, broken and fractured zones, and two ash layers; Elevation 3,700 ft

Source: Reclamation 2012a, DOI 2010.
Notes:
[1]Well list does not include Oregon Department of Transportation boreholes used for bridge footings.
[2]Reservoir stage is 3,787 ft AMSL; river bed elevation at the dam is 3,720 ft AMSL.
[3]All wells listed as domestic supply wells.
[4]Depth to the bottom of the surface casing or sanitary seal in holes/wells that are open
Key:
AMSL: above mean sea level
bgs: below ground surface
in: inches
ft: feet
gpm: gallons per minute

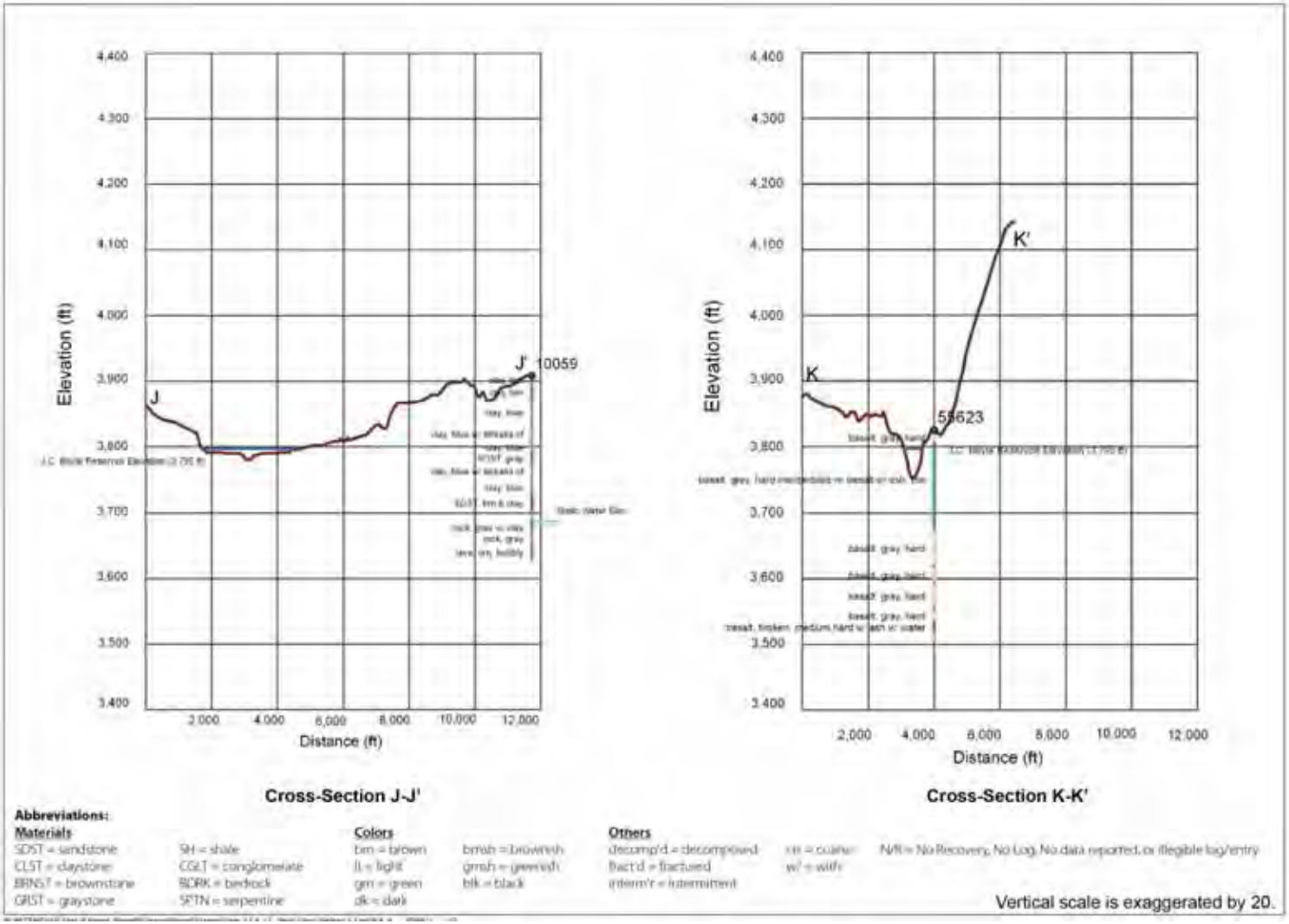

Figure 3.7-4. J.C. Boyle Reservoir Cross-Sections J and K.

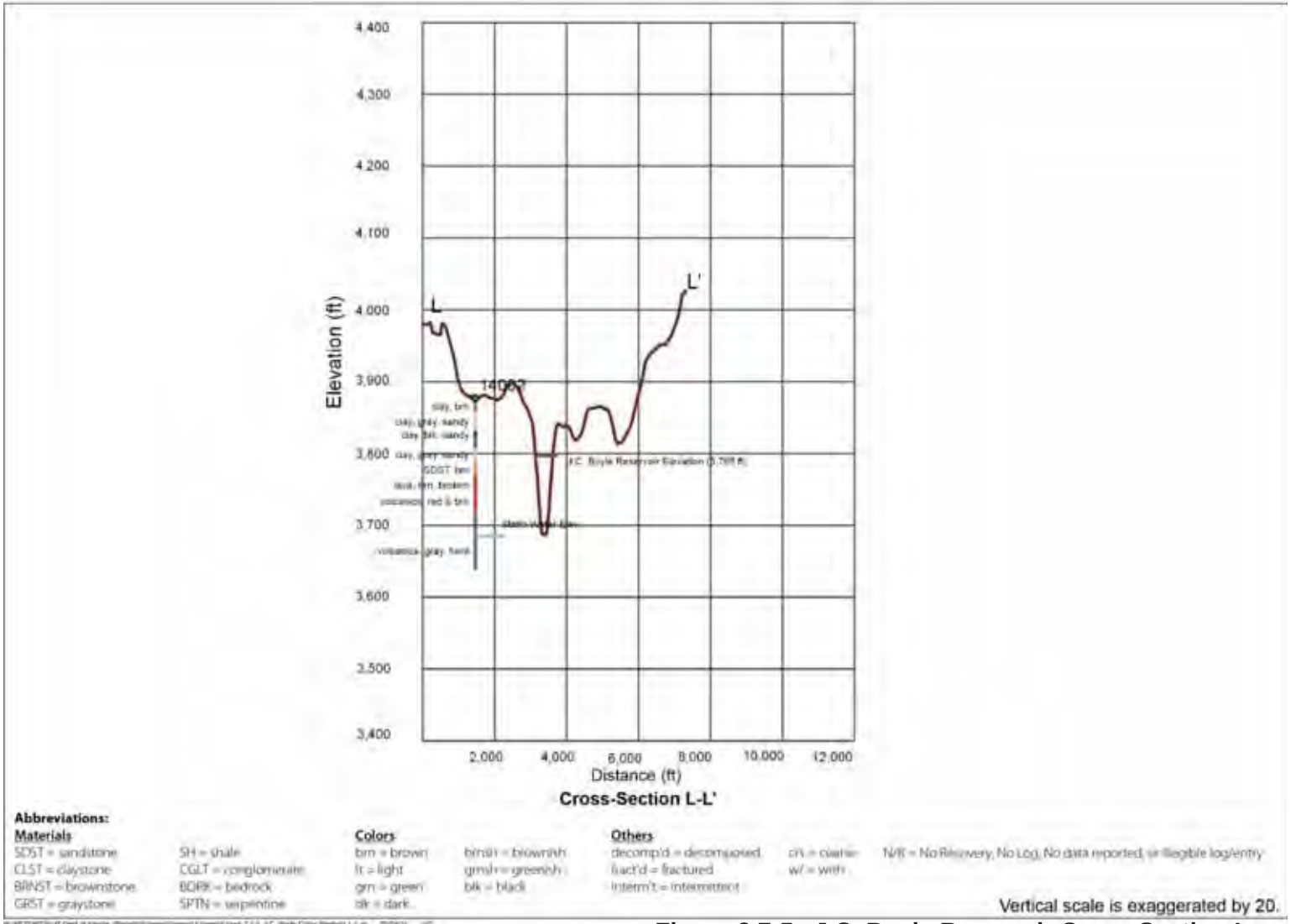

Figure 3.7-5. J.C. Boyle Reservoir Cross-Section L.

Comparison of the elevations of the static water levels in the six wells near J.C. Boyle reservoir shows that two wells downstream from the dam (13628, 14002) have static water levels 20 to 40 ft below the pre-dam river bed elevation (at the dam site); the two wells (10514, 10059) furthest away from the reservoir (4,721 ft and 5,518 ft from the reservoir) have static water level elevations nearly 100 ft below the pre-dam upstream river bed elevation; and the two wells near the shore of the reservoir have static water level elevations 20 to 30 ft below the pre-dam river bed elevation at the dam site. The static water level elevations in the wells furthest from the reservoir are near or below the static water level elevations for the wells closer to the reservoir. No clear determination of any trends in vertical head gradients can be drawn from the data of these six wells (Reclamation 2012a).

Copco 1 and Copco 2 Reservoirs

As described in Section 3.11, Geology, Soils, and Geologic Hazards, Copco Lake including the smaller impoundment at Copco 2 Dam, sits at the divide between the Western Cascade and the High Cascade geomorphic provinces. The Western Cascade is faulted and intruded by basaltic dikes and its composition of lower and higher permeable stratified rocks results in discrete aquifer units. The relationship between ground water flow in and between the High Cascade and Western Cascade is complicated and not well understood but the ground water utilized in the vicinity of Copco Lake is likely contained in the permeable units of the High Cascade or upper water bearing units of the eastern dipping Western Cascade based upon the generally shallow depth of known ground water wells. The Western Cascade strata have the potential to contain geothermal reservoirs where capped by the High Cascade lava flows (Hammond 1983).

The identification of wells in the vicinity of the Copco Reservoirs followed the same method as for the J.C. Boyle Reservoir. The California DWR well database identifies 22 wells within 2.5 miles of the Copco Reservoirs. Figures and tables showing the locations and construction details of the 22 identified wells and the five cross-sections that were developed are provided in Appendix K.

The data for the wells in the cross-sections indicate that the water-bearing units and static water levels are above the bottom of the reservoir. All the wells near the Copco Reservoirs, with the exception of one well, have static water levels that are below the reservoir stage but above the river bed elevation at the dam site. Similarly, all the wells except one have elevations for the top of the water bearing unit below the reservoir stage and above the river bed elevation at the dam site. The two exceptions are two different wells. The top of the water bearing formation was not identified on the log for some wells. In this case, the elevation at which water was first encountered in the drilling is used as a substitute for the top of the water bearing unit.

The average static water level for all wells less than 300 ft from the reservoir is 2,591 ft while the average static water level for all wells greater than 400 ft from the reservoir is 2,680 ft (Reclamation 2012a). These levels suggest that there is downward ground water flow near the reservoir (i.e., ground water is flowing down toward the reservoir). Because

ground water is flowing toward the reservoir, this information suggests that the water level in the reservoir does not have a significant lateral influence on ground water levels in the area around J.C. Boyle reservoir (Reclamation 2012a).

Iron Gate Reservoir

Iron Gate Reservoir overlies the volcanic units of the Western Cascade which like Copco 1 Reservoir have been faulted and intruded by basaltic dikes (Hammond 1983). The relationship between ground water flow in the units of the Western Cascade is complicated and not well understood. Specific ground water well data provides the best understanding of the occurrence of ground water in the vicinity of Iron Gate Reservoir.

The identification of wells in the vicinity of Iron Gate Reservoir followed the same method as for the J.C. Boyle, Copco 1, and Copco 2 Reservoirs. The California DWR well database identifies 25 wells within 2.5 miles of the Iron Gate Reservoir. Figures and tables showing the locations and construction details of the 25 identified wells and the five cross-sections that were developed are provided in Appendix K.

The well data shows that the static water level (when recorded) is above the reservoir stage with only two exceptions (wells 781723, 99834). The static water level for all the wells is also above the elevation of the river bed at the dam site with only one exception (781723). The data in Appendix K shows that the estimated elevation of the top of the water bearing unit (recorded on 13 of the 25 logs) is above the reservoir stage in 10 of the 13 wells. The top of the water bearing unit is between the reservoir stage and the reservoir bottom in two wells. The top of the water bearing unit is below the reservoir bottom in only one well (781723).

Wells further away from Iron Gate Reservoir have higher static water levels and generally higher top of water bearing unit elevations than wells closer to the reservoir. These elevations indicate ground water flow direction is towards the reservoir in agreement with the regional ground water gradients (Gannett et al, 2007). Wells within 2,000 ft of the reservoir have static water levels very close or above to the reservoir stage (one exception, well 334387) indicating a potential flow direction toward the reservoir. The current well dataset cannot determine conclusively whether Iron Gate Reservoir has any vertically downward or horizontal seepage (Reclamation 2012a).

3.7.4 Environmental Consequences

The section analyzes the environmental consequences on ground water from implementation of the Proposed Action or its alternatives. Effects to ground water quality are not expected because ground water discharges to surface water in the majority of the area. Impacts to water quality are discussed in detail in Section 3.2, Water Quality.

3.7.4.1 Environmental Effects Determination Methods

The method for this analysis was to compare the effects of the Proposed Action and alternatives to the existing conditions. This analysis used the ground water information presented in Section 3.7.3 to evaluate potential effects on existing wells and on ground water's influence on surface water resources in the project area.

3.7.4.2 Significance Criteria

For the purposes of this EIS/EIR, impacts would be significant if they would result in the following:

- Lowering of the local ground water table level so the production rate of pre-existing nearby wells would drop to a level that would not support existing land uses or planned uses for which permits have been granted.
- Substantially interfering with ground water levels or ground water recharge so there would be changes to the ground water/surface water interaction that would adversely affect surface water conditions or related resources.

Land subsidence caused by aquifer collapse can be caused by many processes such as the dewatering of fine grained materials (i.e., clays) or collapse of the structure of an aquifer (i.e., through overpumping, dissolution, or piping). Although land subsidence as a result of changes in ground water levels is a common significance criterion, it is not considered in this EIS/EIR given that land subsidence would not be an effect of the Proposed Action or alternatives because water levels would not be lowered in areas of substantial clay deposits and the rock types of the aquifer are not susceptible to collapse in the area of analysis.

3.7.4.3. Effects Determinations

3.7.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, there would be no change in project dam and associated facility operations and no impacts on ground water resources in the vicinity of the reservoirs. Under the No Action/No Project Alternative, J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams and their associated facilities would remain in place and be operated similarly as they have been during historical operations. Therefore, the No Action/No Project Alternative would not change the elevation of surface water in the reservoirs outside of historical ranges. Ground water levels in the vicinity of the reservoirs would be expected to remain consistent with historic values. **Therefore, no changes from existing conditions relative to the elevation of the ground water table in the vicinity of the reservoirs would be expected.**

Under the No Action/No Project Alternative, there could be increased ground water storage. Activities associated with the No Action/No Project Alternative include certain resource management actions that are currently approved and ongoing, and which would continue to be implemented. Actions that could affect ground water resources include Agency Lake and Barnes Ranches. These actions would provide storage to store additional surface water supplies. In some years, when water is available, ground water use could decrease. However, as with historic conditions, ground water use may fluctuate depending on climatic conditions (i.e., there would likely be more ground water pumping during dry years when surface water diversions are less available). Stored surface water may also increase seepage into underlying ground water basins. **This would be a beneficial effect to ground water resources.**

3.7.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

Under the Proposed Action, ground water levels in existing wells adjacent to the reservoirs could decline in response to the drop in surface water elevation when the reservoirs are removed. The water-bearing units from which most of the existing domestic or irrigation wells pumps are: a) below the elevation of the original river channel, b) exposed along reservoir walls, or c) above the reservoir stage. The paucity of data regarding the hydraulic connection between these water bearing units and the reservoirs precludes the articulation of definitive statements so reasonable inferences are offered below.

Some of the water-bearing units tapped by existing domestic or irrigation wells lie above the reservoir water surface elevation and are at elevations similar to those of mapped springs. These springs are likely fed by the same water-bearing units supplying the wells and neither are expected to be significantly impacted by the removal of the reservoirs. Wells that pump from water-bearing units that are directly connected to the reservoirs will likely be affected by reservoir removal and the impacts could be significant. Wells which tap water-bearing units below the bottom of the reservoir are assumed to be maintained by regional ground water flow patterns that will continue to "sink" toward the restored Klamath River and its alluvial floodplain. Consequently, those wells are unlikely to be affected by the removal of the reservoirs. Ultimately however, the potential impacts at specific wells will depend upon local hydrogeologic conditions at the well site as well as the well construction characteristics.

Fish hatchery operations will continue at the Iron Gate Hatchery for eight years following removal of the Iron Gate Dam. After eight years, hatchery production will continue, but may be at an alternate site. Under the KHSA, PacifiCorp is responsible for evaluating hatchery production options that do not rely on the current Iron Gate Hatchery water supply. Such options could include use of ground water, surface water, or water reuse technologies. PacifiCorp is also responsible for proposing and implementing a post-Iron Gate Dam Hatchery Mitigation Plan (Hatchery Plan) to provide continued hatchery production for eight years after the removal of Iron Gate Dam; and this Hatchery Plan would be developed with information from PacifiCorp's evaluation. However, PacifiCorp is not required to propose a Hatchery Plan until six months following an affirmative Secretarial Determination. The Lead Agencies do not currently know what PacifiCorp will propose in the Hatchery Plan and are unlikely to know unless there is an affirmative Secretarial Determination. An impact analysis of a hatchery production option that does not rely on the current Iron Gate water supply would be purely speculative at this point. Therefore, the potential environmental effects of implementing a hatchery production option that does not rely on the current Iron Gate water supply are not analyzed in this EIS/EIR.

There are existing domestic and irrigation ground water wells that could not be located reliably based on the information in the Oregon WRD or California DWR databases. In addition to the non-locatable wells in the databases, there are likely other existing wells in the vicinity of the reservoirs. The real estate information presented in the Dam

Removal Real Estate Evaluation Report prepared by the United States Department of the Interior (DOI) in 2011 lists 1,467 potentially impacted parcels near the Copco and Iron Gate reservoirs. Of those 1,467 parcels, 12% (176 parcels) are listed as improved and 88% (1,291 parcels) are shown as vacant (Bender Rosenthal, Inc. 2011). The extent of improvements on the 12% of parcels is not known. However, it is possible that improvements may have included installation of a ground water well for domestic supplies. The number of improved parcels near the J.C. Boyle reservoir is not known. Therefore, there could be additional domestic or irrigation wells in water-bearing units that intercept the reservoirs. **A decline in ground water levels in existing wells adjacent to the reservoirs in response to the drop in surface water elevation when the reservoirs are removed would be a significant impact, but implementation of mitigation measure GW-1 would reduce this impact to less than significant.**

The Proposed Action could cause a reduction in ground water discharge to the Klamath River. Removing the dam and eliminating the reservoir could result in less percolation of surface water to the underlying ground water aquifer due to removal of the water body. However, as discussed in Section 3.7.3 Affected Environment, the reservoirs generally lie within rock valleys where this recharge is expected to be low. Gannett et. al. 2007 concluded that the Klamath River reaches in the project area are gaining reaches (i.e., ground water discharges to the stream). This assessment, and characteristics of the rock surrounding the reservoirs, suggest that any surface water that may have infiltrated to ground water systems under the reservoir would likely discharge back to the river just downstream from the impoundment.

The Proposed Action would result in the same relative volume of water flowing through the project area in the Klamath River. The timing of river's hydrograph would be modified to improve fish habitat. Under current conditions, water is retained in the reservoirs to maximize hydropower production by filling and keeping the reservoirs as full as possible; however, the stored volume in the reservoirs does not vary substantially from one time period to another to act as a buffer to flows going down the river. Under the Proposed Action, the water in the river would remain in the river through the project area. **The Proposed Action's impacts on ground water recharge and the resulting ground water/surface water interaction would be less than significant.**

Under the Proposed Action, recreational facilities currently located on the banks of the existing reservoirs will be removed following drawdown. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities will be removed. The removal of the recreational facilities would not impact ground water or ground water recharge. **The removal of the recreational facilities would result in no change from existing conditions on ground water resources.**

Keno Transfer

Implementation of the Keno Transfer could cause adverse effects to local ground water. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. There will be no changes in facility operations. This transfer would not result in the

generation of impacts to ground water compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **Therefore, the implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measures

Decommissioning the East and Westside Facilities could have adverse effects to ground water resources. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals. Following decommissioning of the facilities there will be no change in outflow from Upper Klamath Lake or inflow into Lake Ewauna. Ground water recharge in the area is not expected to change. **The decommissioning of the East and Westside facilities would result in no change from existing conditions on ground water resources.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The Proposed Action would require the relocation of the City of Yreka Water Supply Pipeline. The existing water supply pipeline for City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the dam to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. The water supply utilized by the City of Yreka would not change, and none of the construction activities are anticipated to interact with or impact existing ground water supplies or require ground water supplies to complete the construction. **The relocation of the City of Yreka Water Supply Pipeline would result in no change from existing conditions on ground water supplies.**

KBRA – Programmatic Measures

The KBRA, which is an action connected to the Proposed Action, encompasses several programs that could affect ground water, including:

- Water Diversion Limitations
- On-Project Plan
- Water Use Retirement Program
- Interim Flow and Lake Level Program
- Emergency Response Plan

Water Diversion Limitations and the On-Project Plan

The Water Diversion Limitations program could reduce irrigation water in the driest years. The KBRA provides for limitations on specific diversions to Reclamation's Klamath Project through the Water Diversion Limitations program, and a means to address these limitations on the diversion through the On-Project Plan. The Water Diversion Limitations program (KBRA Section 15.1) could reduce the availability of surface water for irrigation on Reclamation's Klamath Project. These limitations are

intended to increase water availability for fisheries purposes at critical times and increase the certainty of water deliveries to Reclamation's Klamath Project. If the Water Diversion Limitations program diversion quantities were compared to historic diversion data, the maximum reduction in surface water diversion to Reclamation's Klamath Project would have been about 100,000 AF in the driest years (Klamath Settlement Parties 2010). For example, if KBRA's Water Diversion Limitations program were in place during 2010, instead of receiving approximately 185,000 AF of water, Klamath Reclamation Project irrigators would have received 330,000 AF, an increase of approximately 145,000 AF (Hicks, J. 2012). KBRA makes this possible through more real-time water management.

Recognizing that Klamath Reclamation Project irrigators are likely to require supplemental water or other actions during dry and other years, the KBRA provides for creation of the On-Project Plan by the Klamath Water and Power Agency (KWAPA). The On-Project Plan is being prepared and is intended to align water supply and demand within Reclamation's Klamath Project (KBRA Section 15.2). Implementation of the On-Project Plan could include water conservation and improved efficiency, increased water storage, ground water management, and demand reduction (e.g. forbearance agreements, change in crop type, and land idling) (KBRA, § 15.2.3., KWAPA, Technical Memorandum 2, § 10.3. [KWAPA 2011a, KWAPA 2011b and KWAPA 2011c]). In the event there is an increased reliance on ground water, as compared to historic levels, because of the Water Diversion Limitations program, such increased use could affect ground water levels in the pumped aquifer and reduce ground water inflow into the Klamath River and its tributaries.

Recognizing the potential for increased reliance on ground water, the KBRA includes provisions that would require monitoring of pumping at existing wells, the monitoring of ground water levels in the pumped aquifer, and the monitoring of springs affected by drops in ground water levels. Additionally, the KBRA specifies the development of an On-Project Plan objective prohibiting adverse effects on ground water levels within Reclamation's Klamath Project boundaries. The KBRA defines adverse effects as the flow of certain springs being reduced by more than six percent from year 2000 flows when the ground water system was in a state of equilibrium (KBRA Section 15.2.4). The KBRA identifies springs to be monitored and protected as those along Upper Klamath Lake, the Wood River subbasin, Spring Creek on the Williamson River, the Klamath River downstream to Copco 1 Dam, Shovel Creek, and Spencer Creek. The KBRA also prohibits the On-Project Plan from using new irrigation wells when an irrigator has a surface water forbearance agreement or similar agreement (KBRA, p. 75, § 15.2.4.D.). Additionally, the KBRA would also provide funding to remedy adverse impacts due to ground water use (KBRA Appendix C-2). As part of this effort to mitigate any effects on ground water, the KBRA requires implementation of the work plan in Appendix E-2 of the KBRA which provides for investigation and monitoring of the ground water resources of the Upper Klamath Basin.

The USGS, in support of this ground water investigation and monitoring effort, developed a ground water model that will be utilized to assess the effects of ground water

use in the basin and identify any adverse changes in ground water levels (Gannett et al., 2012). The work plan would be implemented in three phases. The first phase would be to evaluate all existing and historic stream gaging station and ground water level monitoring sites and data and to also identify the additional sites where streamflow, spring discharge, or ground water level data are required. The second phase would be to establish the additional sites identified in phase one. The third phase would be the collection of data over time, analysis of data, and reporting of findings.

Implementation of the On-Project Plan and Water Diversion Limitations program has the potential to generate localized short-term adverse effects on ground water through the increased use of ground water to replace surface water deliveries. These effects would be reduced through: the implementation of ground water monitoring and pumping restrictions as described in KBRA 15.2.4.A.i, the reduction of ground water pumping in the driest years, increased data collection, new modeling of the maximum potential ground water withdrawals, and increased funding related to mitigating adverse effects on ground water. As a result, implementation of the Water Diversion Limitations program and the On-Project Plan will not exceed the thresholds of significance. Although implementation of the Water Diversion Limitations program would reduce the need for supplemental ground water in the driest years, details of the On-Project Plan are not yet available. So although the Lead Agencies expect implementation of the On-Project Plan to benefit ground water levels, the plan's overall success is too speculative to assess given its current status of development.

The geographic separation between actions proposed under this program and the hydroelectric facility removal actions analyzed above reduce any potential for ground water improvements generated by this program to contribute to ground water effects generated by facility removal. **In the long term, implementation of the On-Project Plan (KBRA Section 15.2) and the Water Diversion Plan (KBRA Section 15.2.4) would be expected to benefit ground water resources by protecting them from overuse (through provisions prohibiting adverse impacts to ground water, where none currently exist), but because such benefits cannot be accurately assessed at this time, the effect on ground water is determined to be less than significant. Implementation of the On-Project Plan and Water Diversion Plan will require future environmental compliance as appropriate.**

Water Use Retirement Program (WURP)

Upland vegetation management under the WURP would increase inflow to Upper Klamath Lake. The WURP is intended to permanently increase the flow of water into Upper Klamath Lake by 30,000 acre-ft per year to support restoration of fish populations (KBRA Section 16.2.2). Actions to increase inflow would include upland vegetation management of high water-use plants (i.e., juniper removal) to increase ground water recharge. The geographic separation between actions proposed under this program and the hydroelectric facility removal actions analyzed above reduce any potential for ground water improvements generated by this program to contribute to ground water effects generated by facility removal. **Implementation of the WURP would benefit**

ground water resources by increasing ground water recharge through upland vegetation management. Implementation of the WURP will require future environmental compliance as appropriate.

Interim Flow and Lake Level Program

The purchase and lease of water under the Interim Flow and Lake Level Program would increase water for fisheries. The Interim Flow and Lake Level Program (KBRA Section 20.4) would be an interim program of water purchase and lease to reduce surface water diversions and further the goals of the fisheries programs during the interim period prior to full implementation of the On-Project Allocation and WURP. Water purchase and lease agreements with a term greater than the interim period defined in KBRA Section 20.4.2 would be subject to a consistency requirement with the On-Project Plan (KBRA Section 20.4.3). Reduced surface water diversions would not be expected to directly result in increased ground water use given provisions developed to prevent adverse impacts to ground water in the KBRA (Section 15.2.4). The geographic separation between actions proposed under this program and the hydroelectric facility removal actions analyzed above eliminate any potential for negative ground water effects generated by this program contributing to ground water effects generated by facility removal. **Implementation of the Interim Flow and Lake Level Program would result in less than significant impacts on ground water resources in the short term, and would be expected to benefit ground water resources in the long term. Implementation of the Interim Flow and Lake Level program will require future environmental compliance as appropriate.**

Emergency Response Plan

Implementation of an Emergency Response Plan could result in changes to ground water following the failure of a Klamath Reclamation Project facility or dike on Upper Klamath Lake or Lake Ewauna. The purpose of the plan is to prepare water managers for an emergency affecting the storage and delivery of water needed for KBRA implementation (KBRA Section 19.3). The components of the Emergency Response Plan are described in the EIS/EIR Section 2.4.3.10 and include potential emergency response measures and processes to implement emergency responses. Implementation of an Emergency Response Plan could potentially reduce emergency ground water use following a facility or dike failure that limited surface water deliveries by shortening the duration of any surface water delivery interruption. The intent of this plan is to allow for continued storage and delivery of water according to KBRA commitments, and would not affect the probability of facility or dike failure. Additionally, given the geographic separation between actions proposed under this program and the hydroelectric facility removal actions analyzed above, the Emergency Response Plan would not be expected to contribute to any changes in ground water generated by the hydroelectric facility removal action. **Therefore, it is anticipated that implementation of the Emergency Response Plan would result in no change from existing conditions on ground water resources. However, implementation of the Emergency Response Plan would likely help to reduce ground water use due to a facility or dike failure which would be a beneficial**

effect to ground water resources. Implementing the Emergency Response Plan will likely require the analysis of changes to flood risks in future environmental compliance investigations as appropriate.

3.7.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams Alternative

The ground water impacts of the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

Keno Transfer

The ground water impacts of the Keno Facility transfer under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

East and Westside Facility Decommissioning – Programmatic Measure

The ground water impacts of the East and Westside Facility Decommissioning under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

The ground water impacts of the City of Yreka Water Supply Pipeline relocation would be the same as the Proposed Action.

KBRA – Programmatic Measures

The ground water impacts of the KBRA under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

3.7.4.3.4 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, surface water elevations in the reservoirs would not change and there would be no changes to the relative elevation of the ground water table. Under the Fish Passage at Four Dams Alternative, the J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams and Reservoirs would remain in place and water levels in the reservoirs would be similar to historical levels. Therefore, the Fish Passage at Four Dams Alternative would not change the elevation of surface water in the reservoirs outside of historical ranges. Therefore, no changes to the relative elevation of the ground water table in the vicinity of the reservoirs would be expected. **There would be no ground water impacts under the Fish Passage at Four Dams Alternative.**

3.7.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Ground water impacts associated with the removal of Copco 1 and Iron Gate would be the same as under the Proposed Action. Ground water impacts at Copco 2 and J.C. Boyle would be the same as those described for the No Action/No Project Alternative.

3.7.4.4 Mitigation Measures

3.7.4.4.1 Mitigation Measure by Consequences Summary

Mitigation Measure GW-1 – This mitigation measure provides for the deepening (or replacement) of an existing affected domestic or irrigation ground water well so the

ground water production rate from the well is returned to conditions prior to implementation of the Proposed Action or its alternatives. This mitigation measure is intended to mitigate for potential impacts from the Proposed Project or its alternatives. Therefore, a preconstruction well survey will be conducted prior to implementation of the Proposed Project or its alternatives. This survey will measure water levels and pumping rates in existing domestic and irrigation wells. This information will form the basis of review for potential claimed damages following construction activities. Well owners not participating in this preconstruction survey will be required to provide adequate documentation showing a decrease in production from the well before and after construction conditions. The review of pre-construction data will be considered with respect to preceding hydrologic conditions (i.e., climatic cycles, wet year vs. dry year). This mitigation measure would also provide an interim supply of potable water for health and safety prior to the completion of the modifications to the affected well.

Effectiveness of Mitigation in Reducing Consequences

Implementation of mitigation measure GW-1 would ensure that affected ground water wells are able to provide water supply benefits similar to those prior to implementation of the Proposed Action or its alternatives.

Agency Responsible for Mitigation Implementation

The Dam Removal Entity would be responsible for implementing mitigation measure GW-1.

Remaining Significant Impacts

Following implementation of mitigation measure GW-1, no significant adverse impacts associated with ground water would be anticipated. If the amount of ground water discharging to the Klamath River was reduced so adverse impacts on fish habitat or habitat for other aquatic species resulted, such impacts would be considered significant. The potential for such impacts and mitigation for them have been addressed in other relevant chapters of this EIS/EIR.

Mitigation Measures Associated with Other Resource Areas

Mitigation measure REC-1 would develop new recreational facilities and access point along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. Water supplies for these facilities would most likely be supplied through wells located on the new recreational sites. These wells would be replacing existing wells and water consumption is unlikely to increase as a result of replacing recreational facilities. **Therefore, impacts to ground water as a result of implementing mitigation measure REC-1 would be less than significant.**

No other mitigation measures associated with other resource areas as described in this EIS/EIR would affect ground water resources.

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3.8 Water Supply/Water Rights

This section describes the impacts on surface water supply availability and water rights compliance that would be associated with implementation of the Proposed Action and alternatives.

3.8.1 Area of Analysis

The area of analysis includes the Klamath Basin in south central Oregon and northwestern California. This discussion divides the Klamath Basin into Upper and Lower Klamath Basins based upon hydrologic sub-basins. The Upper Klamath Basin covers 5.6 million acres, and contains the reaches of the Klamath River upstream of Iron Gate Dam. Along this portion of the Klamath River, six dams exist, of which four are being considered for removal under the Klamath Hydroelectric Settlement Agreement (KHSA). The Upper Klamath Basin also contains Reclamation's Klamath Project, which diverts irrigation water from the Klamath River for agricultural use. Reclamation's Klamath Project also provides water to two National Wildlife Refuges (NWRs). The Upper Klamath Basin is the area that would be most directly affected by implementation of the Proposed Action. The Lower Klamath Basin covers approximately 4.5 million acres and includes seven hydrologic sub-basins. The lower reaches of the Klamath River are included from downstream from Iron Gate Dam to the river's mouth on the California coastline. Downstream from Iron Gate Dam, the Klamath River has no dams on its mainstem. The sections below are generally organized from upstream to downstream.

3.8.2 Regulatory Framework

This section describes the regulatory framework regarding water rights and supply at the Federal and State levels. Section 3.2, Water Quality, discusses the regulations protecting water quality.

3.8.2.1 Federal Water Law

3.8.2.1.1 The Reserved Rights Doctrine

The Reserved Rights Doctrine was first articulated in the 1908 Supreme Court decision in *Winters* v. *United States*. The doctrine provides that when lands are set aside as Indian or other Federal reservations, sufficient water to fulfill the purposes of the reservation is reserved as well. Federal reserved water rights arise expressly or by implication from Federal treaties, statutes, and Executive orders, and vest no later than the date the reservation was established. Unlike State appropriative rights, Federal reserved water rights are for present and future uses and may be exercised at any time and are not lost through non-use. 43 U.S.C. 666, commonly known as the McCarran Amendment (66 Stat. 560; adopted July 10, 1952) waives the sovereign immunity of the United States in suits to determine rights to use the water of a river system or other source. The waiver authorizes States to quantify Federal Indian reserved water rights, and water rights associated with other Federal reservations, in the context of comprehensive State general

stream adjudications. While Federal reserved water rights may be quantified by a State under the McCarran Amendment's narrow waiver of sovereign immunity, they are governed by Federal, not State, law.

3.8.2.2 State Water Law

Two basic State water law doctrines exist in the United States, and States administer water resources within their boundaries in accordance with one or some combination of the doctrines. Under the doctrine of prior appropriation, water rights are based on beneficial use, with the first person putting water to use accruing the highest priority appropriative right to receive water in times of shortage, regardless of the proximity of the place of use to the source of water. Appropriative rights must be used to be retained. Under the riparian doctrine, rights are based on location rather than use, with landowners bordering waterways possessing corresponding rights to use the flow, and with any water shortages shared accordingly among riparian landowners. Riparian rights may be used at any time, and are not lost through non-use.

A number of States, including Oregon, recognize certain riparian rights, but require all water users, including riparian landowners, to obtain water use permits from the State. In California, riparian landowners may use natural flows for beneficial purposes on riparian lands without a permit, but appropriative rights acquired after 1914 may only be acquired by permit.

3.8.2.2.1 Oregon

Oregon enacted a comprehensive water use code in 1909, establishing a process by which all new water uses must be applied for and permitted. If an appropriation of water was initiated prior to enactment of the 1909 water code and not forfeited or abandoned since then, the current property owner may have a vested water right. Such vested water right claims are determined in Oregon in a two-step administrative and judicial process known as a general stream adjudication. The Oregon Water Resources Department (OWRD) initiated an adjudication of all pre-1909 and Federal reserved water right claims for the use of surface water in the Klamath Basin in 1975. The Klamath Basin Adjudication, which is ongoing, is the first adjudication in the State to include Federal water right claims, including claims for and by the Klamath Tribes, for four NWRs, for Reclamation’s Klamath Project, for a National Park, for public water reserves, for the wild and scenic portion of the Klamath River in Oregon, for three other wild and scenic river segments in the Upper Klamath Basin, and for a National Forest. Water right claims have also been filed by numerous private water users, individual Klamath Indian allottees, and non-Indian successors to allottees.

Oregon’s water laws are codified in Oregon Revised Statutes, Chapters 536 through 541.

3.8.2.2.2 California

California enacted a water use law in 1914, establishing a system of permitting and licensing of all new appropriative uses of water. In general, riparian rights continue to have higher priority in California, with riparian landowners retaining a right to use natural flows for beneficial purposes on riparian lands at any time without obtaining a

permit from the State Water Resources Control Board (SWRCB). An adjudication may be initiated to determine relative rights to use water from a specific source, but no such proceeding to determine all rights in the Klamath Basin, including Federal reserved rights, has been initiated to date in California. If the SWRCB determines a stream is fully appropriated, no new permits are issued. The SWRCB has determined the mainstem of the Klamath River, from 100 yards downstream from Iron Gate Dam to the Pacific Ocean, is fully appropriated during the entire calendar year (SWRCB 2010).

California's water rights law is contained in case law, the California Water Code, and the California Code of Regulations, Title 23.

3.8.2.2.3 Upper Klamath Basin Adjudication

If an appropriation of water was initiated prior to the enactment of the 1909 water code and has not been forfeited or abandoned since then, a water user may have a "vested" water right. Federal reserved water rights vest no later than the date of the reservation, and as early as "time immemorial," regardless of whether they have been used. A "time immemorial" water right is one that originated under aboriginal title and was subsequently recognized by Federal law. A claim to a vested water right is determined and made a matter of record through an adjudication proceeding. The OWRD is responsible for gathering information about the use of water and presenting to the circuit court OWRD's findings of fact and order of determination, which states who has the right to use water, the amount and location of water use, period of use, and priority date. If nobody files an exception to OWRD's findings, then they are final. If any exceptions are filed, the circuit court hears the matter de novo (again) or delegates it for rehearing. A water right certificate is issued for each decreed right (State of Oregon 2009).

The Klamath Basin Adjudication is the adjudication process for pre-1909, Federal reserved, and *"Walton"* (non-Indian successor to Indian allottees) water right claims for the use of surface water within the Upper Klamath Basin in Oregon. The Klamath Basin proceeding began in 1975. Claims of water use have been gathered and contests to the claims have been filed on all of those claims. Administrative law judges have been holding hearings and issuing proposed orders determining the claims and contests. The OWRD will review those proposed orders, and any proposed settlements of contests, and submit its Findings and Order of Determination to the Circuit Court in 2012 or 2013 (the last proposed orders are due to be issued in April 2012). Water right claims have been filed by private water users the Klamath Tribes, Klamath allottees, and the United States (for Indian and other Federal reservations of land and the Reclamation's Klamath Project). Once OWRD's findings are submitted to court there will be an opportunity for parties to file exceptions to those findings. The Klamath Circuit Court will resolve the exceptions and issue a decree. As of July 2010, 97 percent of contests and 92 percent of the claims in the Upper Klamath Basin have reached a proposed resolution, either by issuance of an administrative law judge's proposed order or by a proposed settlement of contests (State of Oregon 2010a).

3.8.2.3 Interstate Water Allocation

3.8.2.3.1 Klamath Basin Compact

Allocations of water among States are generally made by compact – a negotiated interstate agreement made with the consent of Congress – or by Federal judicial proceeding. No Federal court proceeding has allocated the waters of the Klamath River between Oregon and California. However, in 1957, the two States ratified and Congress consented to the Klamath Basin Compact, to "facilitate and promote the orderly, integrated and comprehensive development, use, conservation and control" of water resources in the Klamath Basin. Subject to all vested rights, the Compact provides for equitable distribution of water among the two States and the Federal Government, and for preferential rights to the use of water after the effective date of the compact for domestic and irrigation purposes in the Upper Klamath Basin. The Compact recognizes, and protects from any adverse impact, the rights, privileges, and immunities of tribes, as well as the rights, powers and jurisdiction of the United States.

3.8.3 Existing Conditions/Affected Environment

The following section describes the environment and environmental setting for water supply availability and water rights compliance that could be affected by implementing the KHSA (including the Keno Transfer and decommissioning of PacifiCorp's East Side/Westside Facilities) and KBRA. The Klamath Basin water supply is described, including its relationship to Reclamation's Klamath Project and PacifiCorp's Klamath Hydroelectric Project.

The Klamath Basin is divided into two areas, the Upper and Lower Klamath Basins, as described in Section 3.8.1. The Upper Klamath Basin includes six hydrologic sub-basins: Sprague, Williamson, Upper Klamath Lake, Lost, Butte, and Upper Klamath East. The Lower Klamath Basin includes seven hydrologic sub-basins: Upper Klamath West, Shasta, Scott, Salmon, Lower Klamath, Trinity, and South Fork Trinity. Figure 3.8-1 shows the subset of Klamath River hydrologic sub-basins within the affected environment.

Average annual precipitation in Klamath Falls, Oregon is 13.3 inches, occurring primarily as rain during the fall and winter seasons. Precipitation amounts in the (Lower) Klamath Basin in northwest California can be more than seven times that amount. Surface water runoff is closely related to annual precipitation patterns and has historically defined distinct dry and wet cycles. Recent trends include dry periods from 1915 to 1940 and 1975 to 1994 and wet periods from 1885 to 1915 and 1940 to 1975 (Department of the Interior [DOI] 2011). Klamath River runoff patterns have been measured by United States Geological Survey gages dating back as far as 1905 and reflect these climatic cycles.

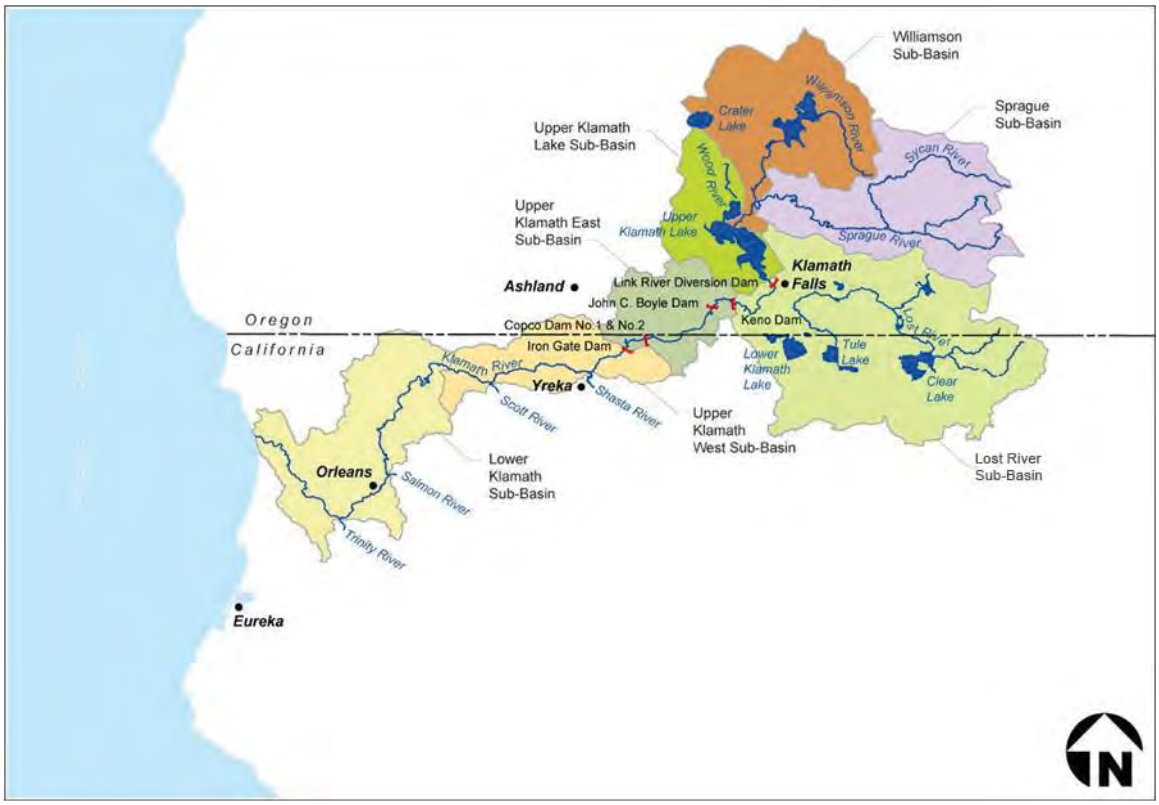

Figure 3.8-1. Area of Analysis.

3.8.3.1 Upper Klamath Basin

Of the Upper Klamath Basin's six hydrologic sub-basins, the Sprague, Williamson, and Wood Rivers provide the majority of the flow volume to the Klamath River via Upper Klamath Lake. Upper Klamath Lake is a controlled, natural lake that serves water users as a large, shallow storage basin and also provides the necessary habitat for several fish species that the Klamath Tribes have relied upon for centuries. Several measures have increased storage in the lake during recent years. In 2007, two miles of levees were breached, restoring approximately 3,500 acres of wetlands in the Williamson River Delta area. Another 1,400 acres were flooded in 2008, which provided 28,800 acre-feet of additional storage in Upper Klamath Lake. Table 3.8-1 shows data for the six hydrologic sub-basins in the Upper Klamath Basin.

Multiple entities rely on the availability of the Upper Klamath Basin's water supply. The Klamath Tribes, upper Klamath irrigators, Reclamation's Klamath Project, Klamath Hydroelectric Project, and six NWRs are all included in the Upper Klamath Basin.

Table 3.8-1. Upper Klamath Basin Hydrologic Sub-Basins

Sub-Basin	Size (acres)	Irrigated Acres	Water Supply Source
Williamson River	928,000	65,100	90% diverted from streams, 10% ground water
Sprague River	1,020,000	61,600	65% diverted from streams, 35% ground water
Upper Klamath Lake	465,300	52,300	Diverted from streams or from Upper Klamath Lake
Lost River (Three sub-basins)			
Upper Lost River Sub-basin	*1,200,000*	*84,500*	50% of water coming from Reclamation's Klamath Project
Middle Lost River Sub-basin	*454,500*	*117,000*	70% of agricultural land is irrigated with Reclamation-supplied water; the rest is obtained from ground water, individual surface water rights, or special Reclamation contracts.
Tule Lake Sub-basin	*296,600*	*64,800*	Ground water provides 40–50% of water for irrigated pastures; most tailwater is reused from Reclamation
Butte Valley	388,100	52,300	Butte Valley sub-basin is an internal drainage basin with an artificial outlet. Ground water flows from west to east out of the sub-basin toward Lower Klamath Lake. Irrigation water is from ground water sources and diverted from surface water.
Upper Klamath River East	419,400	4,000	All irrigation water is diverted from the river or tributary streams; water withdrawals are insignificant along this stretch of the river.

Source: Natural Resource Conservation Service (United States Department of Agriculture 2004)

3.8.3.1.1 The Klamath Tribes

The Klamath Tribes consist of the Klamath and Modoc Tribes and the Yahooskin Band of the Snake Indians. In an 1864 Treaty with the United States, the Tribes ceded over 20 million acres of land in southern Oregon and Northern California to the United States, reserving for themselves an area extending northeast from Upper Klamath Lake, and containing over 2 million acres. Within the boundaries of the Klamath Reservation, the Treaty provided that the Tribes would retain exclusive fishing and gathering rights. Pursuant to the General Allotment Act of 1887, tribal lands within the Reservation were allotted to individual tribal members, and over the next decade, many of the allotted lands passed into non-Indian ownership. By the early 20th century, the Reservation had been reduced to approximately half its original size. In 1954, Congress terminated Federal recognition of the Klamath Tribes and condemned the Tribes' remaining lands. However, the Tribes' fishing and gathering rights, as recognized in the 1864 Treaty, survived termination. The Klamath Termination Act expressly preserved the Tribes' water rights, fishing rights, and other treaty privileges, and the Federal courts have since confirmed the existence, scope and priority of the Klamath Tribes' water rights in the Upper Klamath

Basin. In a series of decisions in *United States v. Adair (Adair)*, the courts held that the Tribes have a water right sufficient to support their treaty fishing, hunting and gathering rights, with a priority date of "time immemorial" - thus senior to all other users in the basin. The courts also recognized a tribal water right for agrarian purposes, with a reservation date (1864) priority. Individual tribal members who received allotments pursuant to the General Allotment Act have a right to use a proportionate share of the tribal water for agrarian purposes, as do their non-Indian successors in interest under certain circumstances. The Klamath Tribes, the United States on behalf of the Tribes, individual Klamath Indian allottees, and non-Indian successors to Indian allottees have numerous claims in Oregon's Klamath Basin Adjudication.

3.8.3.1.2 Upper Klamath Landowners

Individual landowners within the Upper Klamath Basin have water rights for a variety of purposes, including but not limited to irrigation, domestic, livestock, instream use and wildlife purposes. All water right users in the Klamath Basin are subject to the senior Federal reserved instream flow rights of the Klamath Tribes that may reduce the available water to junior water rights users. Private irrigators in the Upper Klamath Basin have filed claims in the adjudication and some have organized themselves into an association to help support its members through the legal process of protecting their water rights. The Upper Klamath Water Users Association was created by a group of off-Project water users and is a non-profit organization protecting the interests of its members within the Klamath and Lost River Drainages. They are considered off-Project water users because they are outside of the Reclamation’s Klamath Project. In addition, there are other irrigators above Klamath Lake who are seeking to protect their water rights.

3.8.3.1.3 Klamath Basin National Wildlife Refuge System

Between 1908 and 1958, six NWRs were established in the Upper Klamath Basin: Klamath Marsh (formerly Klamath Forest) (1958), Upper Klamath (1928), Bear Valley (1978), Lower Klamath (1908), Tule Lake (1928), and Clear Lake (1911). Klamath Marsh NWR is along the Williamson River, and the Upper Klamath NWR is on the northwest and southeast sides of Upper Klamath Lake. The other four are south of Klamath Falls in Oregon and California; two are adjacent to, and two are within, the boundaries of Reclamation’s Klamath Project.

The United States Fish and Wildlife Service (USFWS) manages the NWRs. These areas provide suitable habitat and resources for migratory birds and other fish and wildlife species. The USFWS has claimed vested water rights under the Reclamation’s Klamath Project for two of the refuges, the Lower Klamath and Tule Lake NWRs. USFWS has also claimed Federal reserved water rights for Lower Klamath, Tule Lake, Klamath Marsh and Upper Klamath NWRs and *Walton* rights for Klamath Marsh NWR. Water rights for these four refuges are being quantified in the Klamath Basin Adjudication.

3.8.3.1.4 Reclamation’s Klamath Project

Reclamation’s Klamath Project facilities provide irrigation water to approximately 1,400 farms covering about 235,000 acres (Congressional Research Service 2005) and to the Lower Klamath and Tule Lake NWRs. In 1905, Reclamation filed an application

with the State of Oregon to secure a water supply for the lands within the Project area (Reclamation 2000). There are more than 250 contracts associated with Reclamation's Klamath Project; these contracts are with various irrigation districts and other water users (Reclamation 2000). In most cases, the contracts have no end date, and they specify acres to be covered rather than an amount of water to be provided (Reclamation 2000). Water users formed the Klamath Water Users Association in 1953 to help protect the "on-Project" water interests inside the Reclamation's Klamath Project.

Water is delivered to Reclamation's Klamath Project water users under contractual obligations between the United States and the water districts subject to the availability of water and in accordance with the Project water rights. Reclamation's Klamath Project also provides water to the refuges when available, which is usually after meeting contractual deliveries. Additionally, Reclamation has an obligation to ensure that the refuges receive adequate water to fulfill their Federal reserved water rights, when in priority and when water is available. Beginning in 1995, in compliance with the ESA and tribal trust responsibilities, water was first made available to meet the needs of the ESA listed fishes in Upper Klamath Lake and the Klamath River, then to meet contractual irrigation deliveries and then to the refuges.

The Upper Klamath Lake is one of the main sources of water for Reclamation's Klamath Project. The project's infrastructure and operation turned the Lost River hydrologic basin, once largely a closed basin, into a tributary to Lower Klamath Lake by returning Lost River flows through the Lost River Diversion Channel and Tule Lake to Lower Klamath Lake. The Lost River is another main source of water for Reclamation's Klamath Project, as is the Klamath River from Keno Impoundment/Lake Ewauna. Upper Klamath Lake represents most of its storage, but the lake is shallow, with an average depth of approximately 9 feet when full (Wood et al. 2006). Upper Klamath Lake can only provide small opportunities for carryover storage between years; therefore, Reclamation's Klamath Project operations are dependent on the amount of annual precipitation. Figure 3.8-2 shows a schematic of Reclamation's Klamath Project.

Beginning in April, Reclamation forecasts the available water supply and establishes a general management plan for the coming year. Reclamation's forecast is based upon Natural Resource Conservation Service forecasts, watershed conditions, and projected water use for both irrigation and wildlife use. The annual operations plan estimates water availability and has been provided to the water users' community since 1995 (Reclamation 2000).

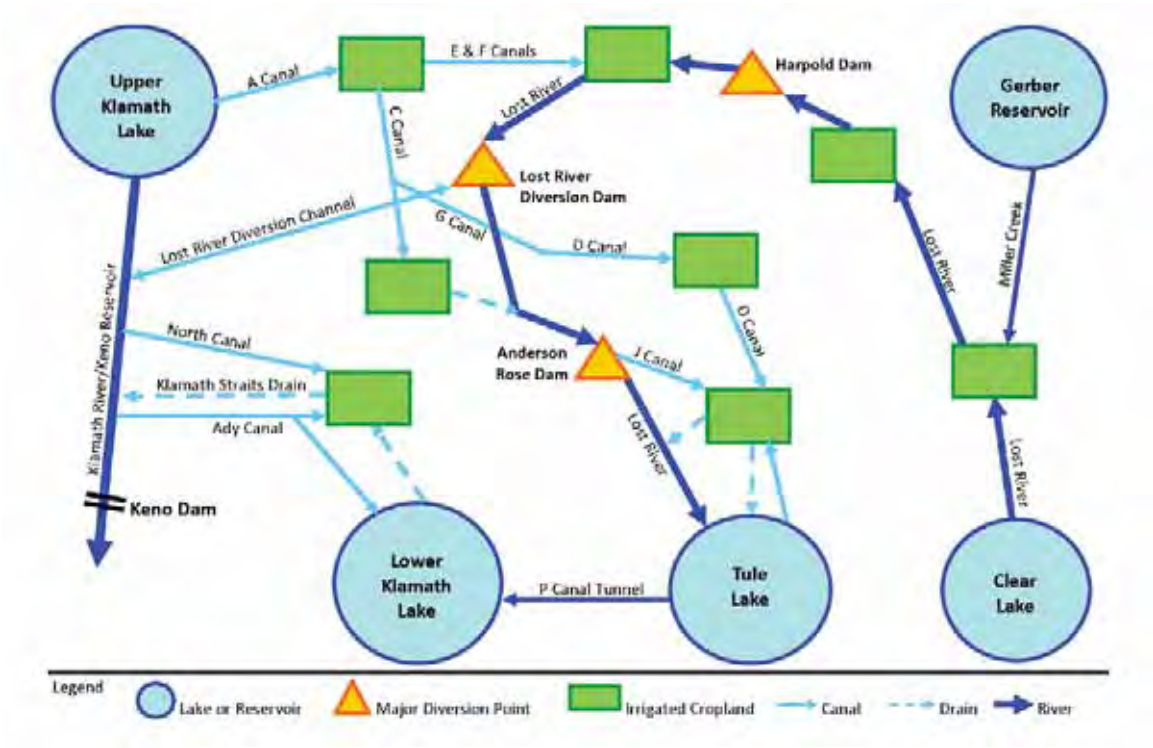

Figure 3.8-2. Schematic of Reclamation's Klamath Project.

3.8.3.1.5 Klamath River Dams

Multiple dams are associated with the Klamath Hydroelectric Project, which is in both Klamath County, Oregon and Siskiyou County, California, and is owned and operated by PacifiCorp. The Klamath Hydroelectric Project includes eight developments, of which seven are on the mainstem of the Klamath River. Reclamation owns the Link River Dam, which controls Upper Klamath Lake. The East and Westside powerhouses, downstream from Link River Dam, represent the upstream boundary of the Klamath Hydroelectric Project; the Iron Gate Development is the downstream boundary.

Flows through the Hydroelectric Reach (from Keno Dam downstream to Iron Gate Dam) are related to flow releases from Upper Klamath Lake, flows diverted to and returned from Reclamation's Klamath Project, relatively small storage capacities of the Klamath Hydroelectric Project developments, and the releases out of Iron Gate Dam (Federal Energy Regulatory Commission [FERC] 2007). Upper Klamath Lake holds 83 percent of the total storage capacity of the reservoirs on the Klamath River (FERC 2007) and approximately 98 percent of active storage (Greimann 2011). Associated reservoirs for J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams contain 14 percent of the total storage capacity and 2 percent of the active storage on the river. However, these dams were not designed for water supply storage purposes and are most often operated as run-of-the-river facilities.

A query on California's Electronic Water Rights Information Management System provided three water right listings upstream of Iron Gate Development, with the Klamath River identified as the water source. These rights are held by PacifiCorp for irrigation and stock watering, for a total of 5,475 acre-feet during April 1 through October 31. Their locations are approximately four miles upstream of the Copco 1 Reservoir. Three additional PacifiCorp water rights list Copco 1 Reservoir as the water source. Each is for 3,200 cfs and they are associated with power generation and impoundment of water for Copco 1 and 2 Powerhouses. PacifiCorp filed Statements of Diversion and Use for pre-1914 claims with the California SWRCB to use water at Iron Gate Dam for hydropower activities as part of their licensing application. The pre-1914 claims are for 1,800 cfs for power generation, 50 cfs for fish propagation facilities, 3,300 cfs to refill regulatory storage space in Iron Gate Reservoir, and 48 cfs for fish culture.

PacifiCorp holds two Oregon water right permits, one associated with the J.C. Boyle Dam hydroelectric generation and the other for irrigation purposes on less than an acre. The irrigation water is drawn from the Link River. (Source: State of Oregon Water Resource Department Water Rights Information System (State of Oregon 2010b)).

3.8.3.1.6 Municipal Water Rights

City of Yreka

The City of Yreka receives its water supply from Fall Creek, a tributary to the Klamath River in the Upper Klamath Basin that is approximately 23 miles northeast of the city. California State Water Rights Permit 15379 allocates the City of Yreka up to 15 cfs or 9.7 million gallons per day (mgd) from this source, although the current demand is less than the permitted amount (City of Yreka 2010). The City of Yreka's diversion was completed in 1969 and the public water systems facilities at Fall Creek include two impoundments; an intake structure with fish screens, a pump, and pre-treatment facility; a cathodic protection field at the Fall Creek Campground and Day Use Boat Ramp; and a 24-inch pipeline that crosses on the eastern upstream end of Iron Gate Reservoir. Water diverted from Fall Creek for the City of Yreka is mainly returned through subsurface drains, infiltration, and irrigation runoff to a tributary of the Shasta River (City of Yreka 2010). The California Department of Fish and Game (CDFG) possesses a 10 cfs non-consumptive water right (SWRCB License 11681) for fish propagation at Fall Creek Hatchery between March 15 and December 15 each year, not to exceed 5,465 acre-feet per year.

3.8.3.2 Lower Klamath Basin

As described above, the Lower Klamath Basin includes seven sub-watersheds downstream from Iron Gate Dam. The area of analysis does not include the Shasta, Scott, Salmon, and Trinity Rivers (see Figure 3.8-1). Generally, the flow rate in the Klamath River increases substantially further downstream within the Lower Klamath Basin, as described in Section 3.6.3.3. The months of July through October generally have much lower flow volumes than the spring runoff months. The long-term average annual flow rate at Iron Gate Dam is just more than 2,000 cfs and approximately 17,600 cfs at the mouth of the Klamath River. Historic stream flows for the Klamath River are discussed in Section 3.6.3.3.

3.8.3.2.1 Klamath River Water Rights

Downstream from the California State line, the mainstem of the Klamath River flows through Siskiyou, Del Norte, and Humboldt Counties to the Pacific Ocean. A query on California's Electronic Water Rights Information Management System provided 38 water right listings with the Klamath River as the water source (Table 3.8-2). Six of these water rights listings are upstream of Iron Gate Dam and 32 of these listings are on the mainstream of the Klamath River downstream from Iron Gate Dam. Appendix L contains the query results and has a map that displays the documented locations.

Table 3.8-2. Summary of Water Rights Listings From California's Electronic Water Rights Information Management System

Type of Water Rights Listings[1]	Number of Claims
Statement of Diversion and Use	
Claimed	16
Inactive	6
Appropriative Water Rights	
State Filing	10
Licensed	4
Permitted	1
Small Domestic Registration	1

Source: California Electronic Water rights information Management System (SWRCB 2010)
Notes:
[1]Status Definitions:
Claimed: Riparian and pre-1914 appropriative rights predate the Water Commission act. Entities that hold these rights are not required to obtain a permit from the SWRCB. These types of rights can only be confirmed by the courts.
Inactive: Unexercised water right.
State filing: To preserve water for future use and development consistent with a coordinated plan such as the State's Water Plan or a County General Plan. The SWRCB holds them in trust for the people of California. Parties who desire to develop water supply projects consistent with the coordinated plan may petition the SWRCB to assign all or part of the State-filed application to them. If approved, this action gives the petitioner a water right priority based on the date that the State-filed the water right application.
Licensed: If a project is determined to be using the allotted water beneficially under the conditions of a permit, a vested water right license is issued.
Permitted: A permit is an authorization that allows for the development of a project to proceed with considerations for the beneficial uses of water, the public interest, reasonableness, and the public trust.
Registered: In lieu of a water right, entities can register to divert and use a small amount of water from a stream for domestic purposes or the use of a small amount of water for livestock. In such cases, the use is registered with the SWRCB and must follow conditions set by the CDFG to protect fish and wildlife.

A total of 22 Statement of Diversion and Use water rights were filed with the SWRCB; 6 of the 22 are currently inactive. Statement of diversion and use water rights include reported riparian water rights as well as pre-1914 appropriative rights.

A total of 15 appropriative water rights have been filed after 1914. Of these 15 appropriative water rights, 10 are State filings only, meaning that those rights have not yet been assigned or developed. State filings are to preserve water for future use and development consistent with a coordinated plan such as the State's Water Plan or a County General Plan. State filings hold water in trust for the people of the State of California based on the date of filing. The State filings on the Klamath River all have priority dates of 1956. A State filing in Siskiyou County that maybe intended for the use of the Shasta Valley Irrigators was submitted in 1956 by the SWRCB to use 60,000 acre-feet from the point of diversion at the current location of Iron Gate Dam. As of December 2010, no diversion infrastructure exists or is planned for construction involving this water right application. None of the alternatives considered in this EIS/EIR would affect these State filings.

There are four appropriative water rights with a licensed status: one with PacifiCorp in 1957, one with Klamath River Country Estates Owners Association Inc., in 1960, and two with individuals in 1964 and 1966. The Klamath Community Services District holds one appropriative permitted water right from 1968, and there is one Small Domestic Registration water right from 2006. There are also multiple claims on a number of the creeks, unnamed springs, and ground water sources scattered within the Lower Klamath Basin. It is expected that each of these water rights listings will have associated intake facilities to draw water from the Klamath River however; the specific type, location, and layout of each of these intake facilities is unknown at this time.

Indian Tribes

Quartz Valley Indian Reservation

The members of the Quartz Valley Community are of upper Klamath (Karuk) and Shasta Indian ancestry. The 174-acre Quartz Valley Indian Reservation is in Siskiyou County near the community of Fort Jones within the Klamath watershed and area of study. Any fishing and concomitant water rights to which the Quartz Valley Indian Reservation may be entitled have not yet been determined.

Karuk Tribe

Congress never formally ratified the treaty negotiated between the United States and the Karuk Tribe in 1851, and no statute or executive order otherwise set aside reservation lands for the Tribe. However, the United States has more recently taken lands into trust for the benefit of the Karuk Tribe, including 652 acres in Siskiyou County and Humboldt County. Most of the Tribe's aboriginal lands along the Klamath River, above the Klamath Trinity Confluence, now form part of the Klamath National Forest. Any fishing and concomitant water rights to which the Karuk Tribe may be entitled have not yet been determined.

Hoopa Valley and Yurok Tribes

The Klamath River Reservation, consisting of a strip of land beginning at the Pacific Ocean and extending one mile in width on each side of the Klamath River for a distance of approximately 20 miles, was established by Executive Order in 1855. The Reservation was established on Yurok ancestral lands. In 1876, a second executive order established the Hoopa Valley Indian Reservation, a 12 mile square area southeast of the Klamath River Reservation, beginning at the confluence of the Klamath and Trinity Rivers, and bisected by the Trinity River. A third executive order in 1891 created an extended Hoopa Valley Reservation, which encompassed the original Hoopa Reservation, the Klamath River Reservation, and a strip down the Klamath River from the Klamath-Trinity confluence connecting the two original reservations. In 1988, Congress passed the Hoopa-Yurok Settlement Act, 25 U.S.C. 1300i et seq, which partitioned the extended reservation between the Hoopa Valley and Yurok Tribes, with the Yurok Reservation comprising the original Klamath River Reservation and the connecting strip, and the Hoopa Reservation comprising the original 12 mile square area. The Federal courts have confirmed that the United States reserved fishing rights for the Hoopa Valley and Yurok Tribes when it set aside reservations along the Klamath and Trinity Rivers. DOI has found that the original orders setting aside the Hoopa Valley and Yurok Reservations also reserved rights for instream flows sufficient to sustain fish within the reservation. Although the State of California has not commenced an adjudication to determine the quantity of water to which the Tribes have a right to support their reserved fishing rights, the recognition of such rights is consistent with the Federal precedent set in United States v. Adair.

Resighini Rancheria

The 239-acre Resighini Rancheria is located near the mouth and on the south bank of the Klamath River, and is surrounded by the Yurok Reservation. The Rancheria Reservation was purchased by the Bureau of Indian Affairs in 1938 under the authority of the Indian Reorganization Act, and proclaimed an Indian reservation by Secretarial Order in 1939. Any fishing and concomitant water rights associated with the Resighini Rancheria have not yet been determined.

3.8.4 Environmental Consequences

The analysis of water rights discusses the changes to river flows and water diversions throughout the affected environment in the Klamath Basin and whether the changes could affect existing water rights or water supplies.

3.8.4.1 Environmental Effects Determination Methods

The impact assessment is based on flow rates and water supply delivery data from the hydrologic modeling completed by the Lead Agencies, along with the methods and assumptions that were utilized in the model. The Lead Agencies applied a one-dimensional HEC-RAS model using historic flow data as input to the model. The modeling provided results for the No Action/No Project Alternative and the Proposed Action. The model's average daily instream flow data helps to describe how the flows would change under different alternatives. The hydrologic modeling addressed flow-related changes associated with the Klamath Basin Restoration Agreement (KBRA);

flow changes downstream from the Four Facilities from KBRA actions are incorporated into the modeling analysis of removal of the Four Facilities. The Lead Agencies used this data to assess whether changes to instream flows as a result of the project would be adequate to meet water right requirements. The Lead Agencies also compared water supply diversions to baseline conditions and water rights to determine impact significance. The Hydrology, Hydraulics, and Sediment Transport Studies include more information on the modeling methods and assumptions (Reclamation 2012).

Specific analysis of changes in river flows and the resulting effect on fisheries are described in Section 3.3, Aquatic Resources. The assessment of the alternatives' effects on Safe Drinking Water Act requirements is presented in Section 3.2, Water Quality. The assessment of the alternatives' effects on Fire Suppression is presented in Section 3.18, Public Health and Safety, Utilities and Public Services, Solid Waste, Power.

3.8.4.2 Significance Criteria

For the purposes of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR), impacts would be significant if they would result in the following:

- Causing injury to existing water rights or adjudication claims.[1]
- Decreasing water supplies beyond what is needed for public health and safety (i.e., needs for drinking water and fire suppression) for the current population.

3.8.4.3 Effects Determinations

3.8.4.3.1 Alternative 1: No Action/No Project

The J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams would not be removed under the No Action/No Project Alternative (with a Negative Determination) and operations similar to current operations would be in effect. The Klamath Hydroelectric Project and Reclamation's Klamath Project would be operated as they were before the Secretarial Determination process began, including operation requirements under the 2010 National Oceanic and Atmospheric Administration (NOAA) Fisheries Service Biological Opinion and 2008 USFWS Biological Opinion on Reclamation's Klamath Project. PacifiCorp would resume the FERC relicensing process and operational measures could change.

Under the No Action/No Project Alternative, continued operation of the Four Facilities could affect water supply operations. Under the No Action/No Project Alternative, water supplies would be similar to existing conditions depending on the water year type. However, the current demand for water exceeds the supply. As a result, low water years can be devastating to the Indian Tribes and other communities dependent on water to support fish for subsistence, religious, sport and commercial harvest, and to agriculture communities dependent on irrigation water for their livelihood. The No Action/No Project Alternative does not include any action to change water supplies from existing conditions. **Therefore, the No Action/No Project Alternative would result in no change from existing adverse conditions.**

[1] An existing water right or adjudication claim is one that was either being used or was part of an existing claim at the time of the Notice of Preparation (NOP).

Under the No Action/No Project Alternative, ongoing restoration actions would continue to be implemented and could affect water supply availability. These actions include the Agency Lake and Barnes Ranches Project, and ongoing fisheries restoration actions.

Reclamation purchased the Agency Lake and Barnes Ranches adjacent to Agency Lake in 1998 and has used portions of the ranches as pumped storage in some years. These ranches have been transferred to the USFWS and are now part of the Upper Klamath NWR. USFWS is studying the possibility of breaching the dikes which would convert the maximum of 24,000 acre-feet of pumped storage to 63,770 acre-feet of dead pool and useable storage in Agency Lake and Upper Klamath Lake. The Agency Lake/Barnes Ranches Project would go through separate National Environmental Policy Act evaluations as plans are developed for future restoration activities. **Future changes would not substantively change the quantity of storage or water supply yield associated with that storage and therefore, there would be no change from existing conditions.**

3.8.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

Removal of recreational facilities currently located on the banks of the existing reservoirs could affect water supply or water rights. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs and currently do not use surface water supplies. Once the reservoirs are drawn down, these facilities would be removed. **The removal of the recreational facilities would result in no change from existing conditions.**

Dam removal could change surface water flows available for diversion downstream from Iron Gate Dam. Modeling efforts rely on historical flow data to create a set of flows under future operational prescriptions. The Lead Agencies compared the modeled flow rate at Iron Gate Dam under the Proposed Action to that of the No Action/No Project Alternative. Figure 3.8-3 shows the exceedance flow results for the No Action/No Project Alternative and the Proposed Action. The results showed either a slightly higher or slightly lower flow rate on the Klamath River downstream from Iron Gate Dam when compared to the No Action/No Project Alternative. Flows under the Proposed Action could change both because of the dam removal activities and the KBRA diversion and instream flow requirements, and these effects are combined in these figures. Figure 3.8-4 shows that these differences would diminish farther downstream from Iron Gate Dam. The modeling results show that at Seiad Valley, approximately 62 miles downstream from the Iron Gate Dam, the flow rates would be nearly identical.

Because the flow rates at Seiad Valley would be nearly identical between the Proposed Action and the No Action/No Project Alternative, the Proposed Action is not likely to affect water supply downstream from Seiad Valley. As shown in Appendix L, approximately 8 of the 32 California water rights are downstream from Seaid Valley. **Under the Proposed Action, impacts on water supply downstream from Seiad Valley would be less than significant.**

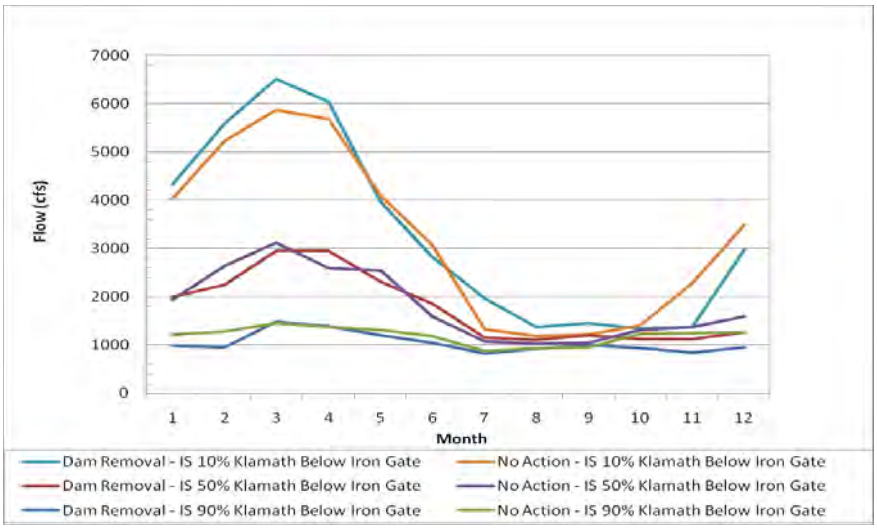

Figure 3.8-3. Flows for different year types under the Proposed Action and No Action Alternatives just downstream from Iron Gate Dam (Reclamation 2012).

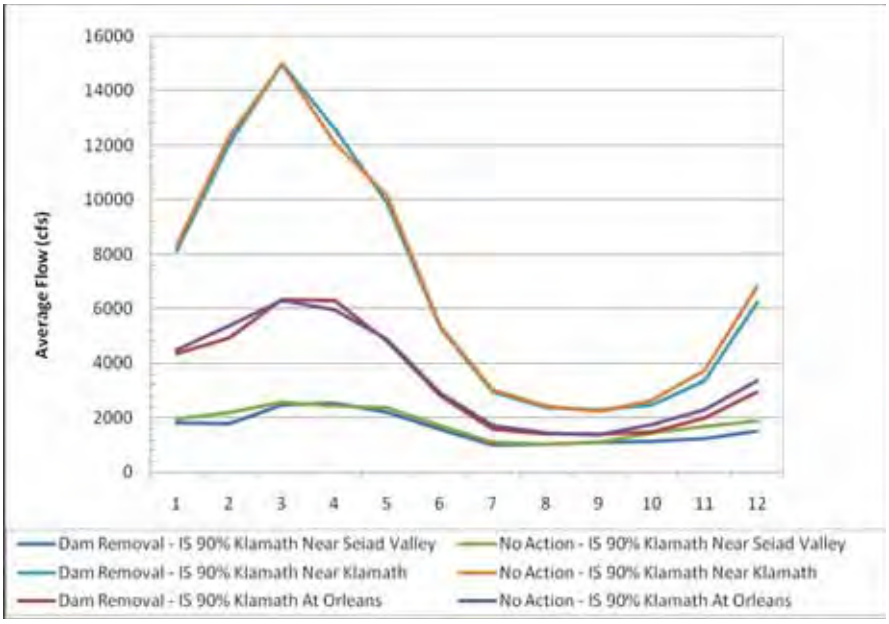

Figure 3.8-4. 90% Exceedance Flows Near Seiad Valley, Orleans, and Klamath for Dam Removal and No Action Alternatives.

Dam removal could cause changes in water supply compared to the No Action/No Project Alternative. Flow rates just downstream from Iron Gate Dam are the lowest within this reach and provide a conservative estimate on available water supply when comparing to the downstream diversion amounts. A query of California's Electronic Water Rights Information Management System provided 38 water right listings with the Klamath River as the water source and identified 24 water right holders. Of these listings, sixteen water rights are for riparian uses (Statement of Diversion and Use permits), of which 6 are inactive. Also there are four appropriative water rights with a licensed status: one with PacifiCorp in 1957, one with Klamath River Country Estates Owners Association Inc., in 1960, and two with individuals in 1964 and 1966. The Klamath Community Services District holds one appropriative permitted water right from 1968, and there is one Small Domestic Registration water right from 2006 (Table 3.8-2 and Appendix L). The listing for PacifiCorp is associated with facilities at Iron Gate Dam including operation of the fish hatchery. As stated in Section 2.4.3.1, an alternate water source would need to be found for operation of the fish hatchery until the restoration and return of native fish at self sustaining population levels is achieved.

The monthly diversion flow rate associated with all of the active and inactive water rights, aside from the four reserved State filings and the PacifiCorp power diversion water right,[2] is approximately 64 cfs (based on water right information in Appendix L). During peak summer months, usage typically doubles. Since usage generally doubles between Iron Gate Dam and Seiad Valley during July and August, the peak short term diversion flow rate that would be diverted is 128 cfs if all users doubled their water diversion rate during the same period. This flow rate represents the peak flow diverted, and would likely be lower during wetter water years. The Proposed Action would change the flows in the river, but the flows would still be substantially greater than the peak diversion. The most conservative comparison is just downstream from Iron Gate Dam, where the flows would be the lowest in the potentially affected reach. Comparing the peak potential diversion with low flow conditions, the diversions would be approximately 16 percent of the Klamath River flows during a dry year[3]. A 90 percent exceedance flow of 824 cfs was used to represent a dry year. The flow rate of 824 cfs was once the seasonal low during the month of July, when irrigation and livestock demands are the greatest. (These low flows were used to develop a conservative impact evaluation, but they are less than what is currently acceptable under the NOAA Fisheries Service biological opinion.)

Because the amount of flow diverted for water right users between Iron Gate Dam and Seiad Valley would be less than 20 percent of the flow in the Klamath River in the upstream portions of this reach during dry year, low flow conditions, water right users are

[2] The four State filings with the SWRCB were not included because the water right is associated with a storage amount to preserve water for future use with no indication of the period of time during which the flow volume will be drawn. The PacifiCorp water right is associated with power generation at Iron Gate Dam and does not result in reduction of flows. For the diversion amount given in cubic feet per year (ID: WR-6), a diversion period of six months was assumed.

[3] The increase during July and August is an average based on reported values on Statement Diversion and Use forms available on California Electronic Water Rights Information Management System for the Klamath River.

not likely to experience decreased supplies because of the changes in flows. **Under the Proposed Action, impacts on downstream Klamath River water right users would be less than significant.**

Release of stored sediment during drawdown of reservoirs could change Klamath River geomorphology and affect water intake pumps downstream from Iron Gate Dam. Reservoir drawdown would release the sediment behind PacifiCorp dams downstream. Reservoir drawdown activities would begin on November 1, 2019 at Copco 1, on January 1, 2020 at J.C. Boyle and Iron Gate Dams, and on June 1, 2020 at Copco 2 Dam. During this period, individual downstream intake facilities could be inundated with sediment deposits, causing operational problems. Reclamation conducted modeling of the reservoir drawdown and erosion of reservoir sediment. The released sediment would likely exceed the carrying capacity of the river during some water year types, and would result in sedimentation and particle settling in slow-moving downstream areas. The fine fraction of the released sediment (silts, clays, and organics) would not be expected to deposit in substantial amounts in the river channel. The majority of this material would be transported to the ocean and would not interact substantially with the river bed. The amount of fine deposition would also decrease with distance from the dam. If drawdown occurred in a dry year, a substantial deposition of sands would be expected in the reach from Iron Gate Dam to as much as eight miles downstream from the dam, around Cottonwood Creek. There are 14 water rights registered on this reach; five are listed as inactive, two are State filings with the SWRCB, and two are associated with PacifiCorp's Iron Gate Dam facility and fish hatchery. The remaining water rights are associated with domestic, irrigation, and/or fire protection use.

The specific layout of these intake facilities is unknown, and they have potential to be affected by sediment deposits. The Lead Agencies have incomplete information on the exact configuration of water diversions in the eight-mile reach of the river that could be affected because this information would be prohibitively expensive to obtain and would not change the significance finding of this impact. These diversions are on private property. The property owners would need to grant access to the Lead Agencies to investigate the diversions, and obtaining permission is time consuming and expensive to implement. Information collection would include extensive data collection efforts regarding the type of diversion facility, elevation, location, screening, and canal or pipeline to the place of use. Some of this information collection would occur in the river, which would increase its expense.

The incomplete information would not change the finding of significance for the water supply impact. The analysis of this impact considered the results of detailed hydraulic, hydrologic, and sediment transport modeling; however, all models have a margin of error. Even small deviations in localized sediment deposition at a site could affect the ability to use diversion facilities. Because of this uncertainty, the Lead Agencies would declare these impacts to be significant and in need of mitigation even if this information was available and indicated that the impact could be minor.

Sediment deposition in the eight miles downstream from Iron Gate Dam could affect diversion facilities that deliver water to users. **Under the Proposed Action, impacts to water intake pumps downstream from Iron Gate Dam would be significant**. **Implementation of mitigation measure WRWS-1 would reduce this impact to a less than significant level.**

Activities associated with Interim Measures (IMs) could result in changes to PacifiCorp's water rights. Prior to dam removal, "Interim Measures" as described in the KHSA (KHSA Section 1.2.4) would be implemented and would control operations of the hydroelectric facilities. IM 16 would eliminate three screened diversions from Shovel and Negro Creeks (the Lower Shovel Creek Diversion [7.5 cfs], Upper Shovel Creek Diversion [2.5 cfs], and Negro Creek Diversion [5 cfs]) and would seek to modify PacifiCorp's water rights to move the points of diversion to the mainstem Klamath River. The intent of this measure is to provide additional water for suitable habitat for aquatic species in Shovel and Negro creeks, while not diminishing PacifiCorp's water rights. While this measure would require a change to PacifiCorp's water rights, it would not affect the exercise of the water right (i.e., the quantity of water diversions) or flow in the Klamath River. **Therefore, the impact on water supply from implementation of the Interim Measures would be less than significant.**

3.8.4.3.3 Keno Transfer

Implementation of the Keno Transfer could cause changes to operations affecting water levels upstream of Keno Dam, which could cause changes to water supply or water rights. The Keno Transfer would be a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on water supply/water rights compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

3.8.4.3.4 East and Westside Facilities – Programmatic Measures

Decommissioning the East and Westside Facilities could cause adverse impacts to water supply and water rights. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA will stop diversions of water flows at Link River Dam into the two canals, back in to Link River. Following decommissioning of the facilities there would be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. Water users currently reliant on a diversion from the West Canal would have their water supply connection extended to either Link River or Upper Klamath Lake. **Therefore, implementation of the East and Westside Facility Decommissioning action would result in no change from existing conditions.**

3.8.4.3.5 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Relocation of the City of Yreka Water Supply Pipeline after drawdown of the Iron Gate Reservoir could affect water supply. The existing water supply pipeline for City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. The water intake for the City of Yreka, on Fall Creek, would be unaffected by the relocation work. The water quantity and quality diverted from Fall Creek would not change. During connection of the new pipeline, the existing pipeline would be disconnected for less than 12 hours during the winter season. The available water in storage would be able to supply the city for up to 72 hours during the winter (Taylor 2010); therefore, the pipeline connection would not interrupt service to the residents of the City of Yreka. **The relocation of the City of Yreka Water Supply Pipeline would result in no change from existing conditions.**

KBRA – Programmatic Measures

The KBRA, which is a connected action to the Proposed Action, encompasses several programs that could affect water rights and water supply, including:

- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- Water Diversion Limitations
- On-Project Plan
- Future Storage Opportunities
- Water Use Retirement Program
- Off-Project Water Settlement
- Off-Project Water Reliance Program
- Emergency Response Plan
- Climate Change Assessment and Adaptive Management
- Interim Flow and Lake Level Program
- Drought Plan

One of the goals of the KBRA includes improving water supply reliability by increasing storage capabilities and management plans, improving availability. There is not a specific KBRA flow regime in the Klamath River or a specific Upper Klamath Lake level regime. KBRA allows for more flexible management based on water availability and real-time consideration of fisheries issues. Figure 3.8-5 presents Reclamation's Klamath Project Simulation Model results predicting the annual flow at Keno Dam and annual agricultural supply. Appendix E-5 of the KBRA presents a range of simulated conditions developed by some parties; however, these conditions would not necessarily be the flows or lake levels that would occur in a given hydrologic condition or year-type. The agricultural supply represents supply to Reclamation's Klamath Project and includes Tule Lake NWR and Lower Klamath NWRs (two NWRs in the area that are the most directly affected by the KBRA). The flows for the No Action/No Project Alternative are governed by operating requirements under the 2010 NOAA Fisheries Service Biological

Opinion and 2008 USFWS Biological Opinion on Reclamation's Klamath Project, while flows for the Proposed Action would change because of the dam removal activities and would be governed by KBRA diversion and instream flow requirements (as well as future biological opinions). Annual flows downstream from Keno Dam would be generally similar between the No Action/No Project Alternative and Proposed Action except for a few dry years when flow would continue to be supplied to Reclamation's Klamath Project[4].

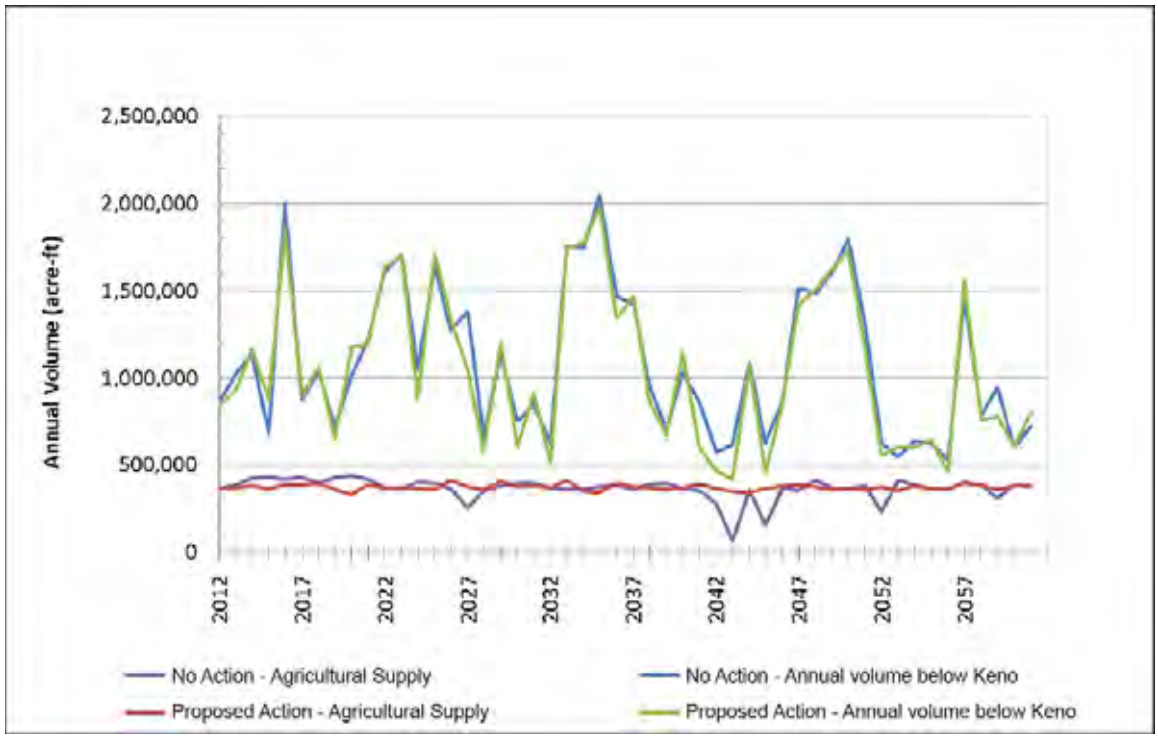

Figure 3.8-5. Annual flows under the No Action/No Project Alternative and Proposed Action (Reclamation 2012).

Fisheries Reintroduction and Management Plan

Implementation of the trap and haul element of the Fisheries Reintroduction and Management Plan could require water rights to divert water for the fish handling facilities. Fish handling facilities to collect fish downstream from Keno Dam and at Link River Dam would require water sources. The facilities would not consumptively use the water; the water would pass through the facilities for release back into the system. Trap and haul is likely to be an exempt use under ORS 537.141(d) and OAR 340-0010(2)(c)(B) if it causes no injury to existing water rights and if it is found to be not

[4] Minimum flows may change in the future. Hydrologic modeling assumed that the Drought Plan would include a minimum flow of 800 cfs (Reclamation 2012). The final Drought Plan or future ESA actions could change the minimum flows; however, these assumptions reflect the best available information at the time of the modeling.

harmful to fish or wildlife after consultation with Oregon Department of Fish and Wildlife (ODFW). Changes in water diversions near Keno and Link River Dams would not contribute to any changes in water supply or water rights associated with removal of the Four Facilities because the actions are in different parts of the watershed. **Because the fish handling facility would not increase consumptive use on the Klamath River system, the impacts of the trap and haul operations on water supply/water rights would be less than significant.**

Wood River Wetland Restoration

Implementation of the Wood River Wetland Restoration Project would result in changes to storage opportunities at Agency Lake, which could affect water supply. A study of Wood River Wetland area management options would investigate providing additional storage for a total of 16,000 acre-feet of storage capacity at or adjacent to Agency Lake. This additional storage would improve water supply reliability and assist with alleviating short-term impacts related to water supply delivery during Water Diversion Limitations (another KBRA program) helping to offset a portion of the deficiencies. Changes in water storage in Upper Klamath Lake would not contribute to any changes in water supply or water rights associated with removal of the Four Facilities because the actions are in different parts of the watershed. **Implementation of the Wood River Wetland Restoration Project would be a less than significant impact to water supply. Implementation of the Wood River Wetland Restoration will require future environmental compliance as appropriate.**

Water Diversion Limitations

Implementation of Water Diversion Limitations to Reclamation's Klamath Project could result in changes to water diversions, which may affect water rights and water supply. Water Diversion Limitations provide specific allocation of water for refuges and limitations on specific diversions for the Reclamation's Klamath Project intended to increase water availability for fisheries purposes. Water Diversion Limitations would be implemented during dry years to increase flows for fisheries by reducing Reclamation's Klamath Project diversion upstream by approximately 100,000 acre-feet. Water diversions could increase by 10,000 acre-feet for irrigation in some years if: 1) dam removal is implemented, 2) 10,000 acre-feet of new storage is created, or 3) Klamath Basin Coordinating Council concurs. Implementation of the diversion limitations would include assurances of increased reliability of diversions. The On-Project Plan, described in more detail below, provides the framework for management of Water Diversion Limitations implementation. While reducing diversions during the driest years would affect water supply for irrigation, it would not affect what is needed for public health and safety. Water may not be available to fulfill some water rights or adjudication claims during dry years; however the On-Project Plan, Drought Plan, and Future Storage Opportunities to be implemented as part of the KBRA would help to offset a portion of these deficiencies. These plans would provide mechanisms for irrigators to plan for water deliveries based on the type of water year. Changes in water diversions to Reclamation's Klamath Project would not contribute to any changes in water supply or water rights associated with removal of the Four Facilities because the actions are in different parts of the watershed. **Implementation of Water Diversion Limitations is anticipated to have less than significant impact on water supply to Reclamation's**

Klamath Project. Implementation of the Water Diversion Limitations will require future environmental compliance as appropriate.

On-Project Plan

Implementation of the On-Project Plan to allow for full implementation of Water Diversion Limitations to Reclamation's Klamath Project would result in changes to water diversions for irrigation in dry years, which could affect water rights or adjudicated rights and water supply to the NWRs. The purpose of the On-Project Plan is to provide additional water supply or reduce the demand for Reclamation's Klamath Project to make up the differences between anticipated demand and actual diversion. These actions include: land fallowing and shifting to dryland crop alternatives, efficiency and conservation measures, development of ground water sources, or creation of additional storage. A specific objective is included in the plan that ground water pumping would not reduce flow greater than 6 percent to springs upstream of Copco Dam; which includes the Klamath, Wood and Williamson Rivers. Implementation of the On-Project Plan would partially offset the expected supply reductions. The improvements in water supply generated by implementation of the On-Project Plan and Water Diversion Limitations would not be expected to contribute to effects of hydroelectric facility removal analyzed above.

Water is delivered to Reclamation's Klamath Project water users under contractual obligations between the United States and the water districts subject to the availability of water and in accordance with the Project water rights. The Project also provides water to the refuges when available, which is usually after meeting contractual deliveries. Additionally, Reclamation has an obligation to ensure that the refuges receive adequate water to fulfill their Federal reserved water rights, when in priority and when water is available. Beginning in 1995, in compliance with the ESA and tribal trust responsibilities, water was first made available to meet the needs of the ESA listed fishes in Upper Klamath Lake and the Klamath River, then to meet contractual irrigation deliveries and then to the refuges. Under the proposed KBRA flows, the refuges would receive a specific annual allocation unless all demands cannot be met. The KBRA provides for sharing of shortage between the Project irrigators and the refuges in drought and severe drought years. Shortages are expected to be offset by measures to be provided through the On Project Plan and other KBRA actions designed to reduce demand, conserve water and increase supply. **Implementation of the On-Project Plan is anticipated to benefit water rights and supply. Implementation of the On-Project Plan will require future environmental compliance as appropriate.**

Future Storage Opportunities

The study of additional off-stream storage opportunities in the Upper Klamath Basin to identify new storage opportunities could affect water supply. Reclamation plans to identify and study additional off-stream storage opportunities. KBRA parties would support ongoing investigations and acquisition of additional storage. Off-stream storage is likely to improve water supply reliability and assist with alleviating short-term impacts related to water supply delivery during droughts. Additionally the development of future storage opportunities would not be expected to contribute to any changes in water supply generated by the hydroelectric facility removal action. **Implementation of Future**

Storage Opportunities would result in no change from existing conditions for water supply. Implementation of the Future Storage Opportunities will require future environmental compliance investigations as appropriate.

Water Use Retirement Program (WURP)

Implementation of the WURP increases instream flow to Upper Klamath Lake which could affect water rights and water supply upstream of Upper Klamath Lake. The WURP is a voluntary program for the purpose of supporting fish populations restoration by permanently increasing inflow to Upper Klamath Lake by 30,000 acre-feet per year. Deliveries to these users would decrease, but it would be a completely voluntary program and would not affect users that do not request participation. A variety of management measures and irrigation water use changes would help to accomplish an inflow increase and are described in Section 2.4.3.10. Some measures include implementing water efficiency projects, increasing natural storage through wetland or improved riparian area performance, and purchase and retirement of water rights from willing sellers. Increases to inflow rates from these measures are for instream flows and are not meant for diversion and use and there would be no additional increases available for downstream diversions. Changes in flows upstream of Upper Klamath Lake would not contribute to any changes in water supply or water rights associated with removal of the Four Facilities because the actions are in different parts of the watershed. **Implementation of the WURP is anticipated to have a less than significant impact to water rights because rights would be voluntarily retired. Implementation of the WURP is expected to have no effect to the water supply for public health and safety because there would be no changes to downstream diversions. Implementing the WURP will likely require future environmental compliance investigations as appropriate.**

Off-Project Water Settlement (OPWAS)

Implementation of OPWAS negotiations could affect water rights and adjudicated rights upstream of Upper Klamath Lake. The intent of OPWAS is to negotiate a settlement of long-standing water disputes between the Upper Klamath Water Users Association, Klamath Tribes, the Bureau of Indian Affairs, and potentially other water users in the Upper Basin. OPWAS includes terms that: 1) resolve the Off-Project Irrigators' contests to claims in Tribal Cases; 2) in the event that not all such contests are resolved, provide reciprocal assurances for maintenance of instream flows and reliable irrigation water deliveries consistent with applicable law; and 3) in all cases provide for a WURP. The effects of these settlement actions could provide an amicable and quicker solution for those who are affected by the ongoing Klamath Basin Adjudication. The negotiated settlements would resolve certain contests to significant major water right claims in the Upper Klamath Basin. The improvements in water supply generated by the settlement of water disputes would not be expected to contribute to effects of hydroelectric facility removal analyzed above. **Implementation of OPWAS would be a beneficial effect to resolve water rights and adjudicated rights and a less than significant impact to unresolved cases due to reciprocal assurances. Implementation of OPWAS will require future environmental compliance as appropriate.**

Off-Project Water Reliance Program

Implementation of Off-Project Water Reliance Program could change water deliveries for irrigation upstream of Upper Klamath Lake to Off-Project water users affecting water supplies. The Off-Project Water Reliance Program would not be implemented until full implementation of the WURP and 30,000 acre-feet of additional flow is added to Upper Klamath Lake and Water Diversion Limitations are fully implemented. The agreement establishes a program consistent with the WURP to avoid or mitigate the immediate effects of unexpected circumstances affecting water availability for irrigation in the Off-Project area. Activities under the Off-Project Water Reliance Program may include: funding water leasing to increase water supply availability for irrigation in the Upper Klamath Basin or mitigating the economic impacts of lost agricultural production by Off-Project irrigators. Changes in irrigation deliveries upstream of Upper Klamath Lake would not contribute to any changes in water supply or water rights associated with removal of the Four Facilities because these facilities are not used as water supply for irrigation. **Implementation of the Off-Project Water Reliance Program to provide additional water availability and help minimize reductions in water supply in the Off-Project Area would help to maintain or improve water supply conditions but may not fully remedy negative water supply effects. This would be a less than significant impact. Implementation of the Off-Project Water Reliance Program will require future environmental compliance as appropriate.**

Emergency Response Plan

Implementation of an Emergency Response Plan could result in a change to water supply deliveries in the event of failure to a facility in Reclamation's Klamath Project or dike on Upper Klamath Lake or Keno Impoundment/Lake Ewauna. The purpose of the plan is to prepare water managers for an emergency affecting the storage and delivery of water necessary to meet the commitments of the KBRA. The components of the Emergency Response Plan are described in Section 2.4.3.10 and includes providing a notice and response in case of a failure of a Klamath Reclamation Project facility, such as a pump or dike. Emergency response actions would include any necessary measures to reduce damage to property or injury to persons and to restore water diversions or releases back to their intended uses as quickly as possible. The Emergency Response Plan would provide a framework for minimizing the effects of an emergency on water supply. **Implementation of an Emergency Response Plan would be a beneficial effect to water supply deliveries during emergency periods because management actions would help to restore supply as quickly as possible. Implementation of the Emergency Response Plan will require future environmental compliance as appropriate.**

Climate Change Assessment and Adaptive Management

Implementation of Climate Change Assessment and Adaptive Management could result in changes to water deliveries depending on climatic changes. One of the main purposes of Climate Change Assessment and Adaptive Management is to respond to and protect basin interests from the adverse affects of climate change. Water deliveries could be affected during periods of water shortages or surplus conditions. Klamath Basin Parties including technical experts would be involved in development of the assessment and adaptive

management strategies. Assessments and development of adaptive management strategies would be implemented continuously to respond to predicted climate changes. Climate change assessments would be conducted to identify indications of effects of climate change, such as a wider range of wet and dry years. Management of water resources would include actions such as improving storage capabilities during the wet years and conservation during dry years. The improvements in water supply generated by development of off-stream storage would not be expected to contribute to effects of hydroelectric facility removal analyzed above. **While water supply could be adversely impacted by climate change, implementation of Climate Change Assessment and Adaptive Management would be a beneficial effect to water supply because it will help to reduce the effects of climate change. Implementation of Climate Change Assessment and Adaptive Management will require future environmental compliance as appropriate.**

Interim Flow and Lake Level Program

Implementation of Interim Flow and Lake Program during the interim period could change water deliveries affecting water supply. The goal of the Interim Flow and Lake Level Program is to "further the goals of the Fisheries Program" during the interim period. This would be accomplished with, among other actions, an interim program of water purchases and leases during the interim period prior to full implementation of the On-Project Plan and WURP. Leases and purchases of water under this interim program shall be from willing sellers and counted towards instream water supply. Additionally, changes in water deliveries during the interim period would not contribute to any changes in water supply or water rights in the vicinity of the Four Facilities. This is due to the fact that there is very limited water supply for irrigation in the Hydroelectric Reach and the Interim Flow and Lake Program are focused on Upper Basin agricultural water supplies. **Therefore, implementation of the Interim Flow and Lake Level Program would cause a less than significant impact to water rights as leases and purchases of water would be from willing sellers. Implementation of the Interim Flow and Lake Level Program is expected to have less than significant impact to the water supply for public health and safety as changes in water supply during the interim period would not contribute to any changes in the vicinity of the Four Facilities. Implementation of the Interim Flow and Lake Level Program will require future environmental compliance as appropriate.**

Drought Plan

Implementation of Drought Plan water and resource management actions could result in changes to water supply deliveries for Klamath Basin interests during drought years. The purpose of the plan is to take management actions so that no Klamath Basin interest shall bear an unreasonable portion of burdens imposed or the risk of loss or injury as a result of drought or extreme drought. Response actions could include releasing stored water, paid forbearance agreements, conservation, ground water substitution, or ground water sharing. The effects of these actions could improve short-term water supply reliability and could have potential short-term ground water elevation effects. Because users would have a choice between irrigating and being compensated for not irrigating, the current priority system in place within Reclamation's Klamath Project might not be

necessary during most year types. The improvements in water supply generated by development of off-stream storage would not be expected to contribute to effects of hydroelectric facility removal analyzed above. **Implementation of a Drought Plan would be a beneficial effect to water supply deliveries during drought periods because management actions would help to offset shortfalls in supply as well as improve the reliability of water supply used for public health and safety. Implementation of the Drought Plan will require future environmental compliance as appropriate.**

Water Rights Assurances Related to Tribal Water Rights

Implementation of KBRA Section 15.3 Water Rights Assurances Related to Tribal Water Rights could affect tribal trust water rights and water supply. In 1908, the U.S. Supreme Court issued its decision in *Winters v. United States*, 207 U.S. 564 (1908). In that decision, the Court found that the agreement creating the Fort Belknap Reservation impliedly reserved water necessary to irrigate its lands and to provide water for other purposes. Under the *Winters* Doctrine, as it has become known, water rights necessary to meet the purposes of Federal reservations, including Indian reservations and Indian allotments held in trust, have been reserved pursuant to Federal law.

Similar to water law concepts in the western United States, *Winters* rights – or Federal reserved water rights – have a priority date no later than the date of the treaty, statute, or executive order that established the Federal reservation. Certain Federal Indian reserved water rights, such as those addressed in the *Adair* litigation with respect to the Klamath Reservation, may have an aboriginal or "time immemorial" priority. Unlike State-based water rights in the West, *Winters* rights cannot be lost for non-use under State-law concepts such as abandonment or forfeiture.

As a general matter, Federal Indian reserved water rights may attach to a variety of water sources, such as rivers, lakes, and springs, "which arise on, border, traverse, underlie, or are encompassed within Indian reservations." COHEN 585 (1982 ed.); *see also* COHEN 1176-77 (2005 ed.) (same). Consistent with U.S. Supreme Court precedent in both *Winters* and *United States v. Winans*, 198 U.S. 371 (1905) (*Winans*), some courts have also recognized that Federal Indian reserved water rights may attach to waters outside of an Indian reservation as necessary to support reserved fishing rights. In the on-going Klamath River adjudication in the State of Oregon, the United States and the Klamath Tribes filed claims to support the fishing rights reserved to the Klamath Tribes in their 1864 Treaty, both in areas within the former Klamath Reservation as well as in areas outside the former Reservation.

To date, only the Federal Indian reserved water rights of the Klamath Tribes, both as part of the *Adair* litigation and now as part of the on-going Klamath River Adjudication in Oregon, have been the subject of a water rights adjudication within the Klamath Basin. No claims were filed by or on behalf of the California tribes as part of the Oregon adjudication, and no adjudication in California has addressed the nature and extent of the *Winters* rights of the California tribes. In other contexts, DOI has opined generally in support of *Winters* rights to support the reserved fishing rights of the Hoopa Valley and

Yurok Tribes, and DOI has also recently implemented a new instream flow regime in the Trinity River based on these rights as well as related statutory directives.

KBRA Section 15.3 and related provisions provide certain assurances related to Reclamation's Klamath Project operations in Oregon and directly tie into claims filed as part of the Oregon adjudication. As noted above and as referenced in these KBRA sections, the only tribal water rights being litigated there involve claims filed by the United States and the Klamath Tribes, not to any other Indian tribe in the Klamath Basin. Under the KBRA, these claims--to Upper Klamath Lake (Case 286 in the Oregon adjudication) and to the Klamath River from the Lake to the Oregon border (Case 282)--will be subordinated in relation to Reclamation's Klamath Project as specified in the KBRA. In particular, Section 15.3.9 (the KBRA "no-call" provision) affects the ability of the United States or other parties to alter Reclamation's Klamath Project's water budget in the future if the Secretary were to make an Affirmative Determination regarding dam removal, the KBRA were implemented, dams were removed, and certain KBRA conditions were met.

As important (and controversial) as this section of the KBRA has been in relation to tribal water rights, it is also important to emphasize what this section does not do. First, no provision of the KBRA waives or releases water, fishing, or any other rights in California held by the United States or any Indian tribe, something reaffirmed by KBRA Section 15.3.2.A. Second, nothing in that section or any other part of the KBRA determines any tribal rights in California. Third, the KBRA does not affect the ability of the California tribes or others to challenge or limit other users in Oregon as may be appropriate. Fourth, nothing in the KBRA or otherwise affects the ability of California tribes to continue exercising whatever rights they have, in the interim or otherwise and with or without an adjudication or negotiated settlement to define their rights with specificity. Fifth, nothing in the KBRA affects the ability of the United States or any other tribe to develop and assert water rights claims in California in the context of a State adjudication or other action. Sixth, DOI has also committed to identify other potential mitigation tools, including additional releases from Trinity Reservoir, as necessary to protect Trinity River-based fishery resources as well (KBRA Section 2.2.12).

Finally, whether or not the KBRA becomes law and gets implemented, the United States will not have unfettered discretion to alter Reclamation's Klamath Project operations in the future. Even in the absence of the KBRA, the Oregon adjudication will ultimately determine both claims related to Reclamation's Klamath Project operations as well as claims filed by the United States and the Klamath Tribes for Upper Klamath Lake and the Klamath River in Oregon. Thus, Reclamation's Klamath Project diversions and associated Klamath River flows from Oregon will be defined either through an adjudicated decree or through a negotiated settlement and not by determinations of DOI and its agencies.

Similar to other water uses, dam removal and associated KBRA activities may result in some short-term adverse effects. Tribal water rights are important to support the continued health of their salmonid fishery. In the short-term, reservoir drawdown

associated with dam removal would result in the release of high suspended sediment concentrations. These suspended sediment concentrations are expected to result in lethal and sub-lethal effects on a specific part of fish populations; in particular, coho salmon smolts and steelhead trout in the mainstem Klamath River would be affected during the peak sediment release from early January through mid-March (See Section 3.3, Aquatic Resources). However, the timing of release was scheduled to coincide with existing periods of naturally high sediment concentrations that fish have adapted to, and at a time that much of the fish population would be in tributaries rather than the mainstem of the river.

Full implementation of the agreements promises, not just dam removal, Project diversion limitations, and habitat restoration activities throughout the Basin, but the KBRA also offers Project drought planning for water-short years, water acquisition, and other actions to protect the Basin fishery during the interim period. This finding is supported by the scientific analysis summarized in the Klamath Dam Removal Overview Report for the Secretary of the Interior (Overview Report) and this Klamath Facilities Removal EIS/EIR. Table 3.8-3 (also Table 5-9 from the Overview Report) summarizes these findings related to long-term benefits for tribal interests.

Table 3.8-3. Common Benefits to all Indian Tribes with Dam Removal and Implementation of the KBRA

Water Resources	
Hydrology	More natural river hydrology. Natural flushing flows would benefit aquatic species and riparian vegetation.
Water Quality	Natural temperature regime and improved water quality would benefit aquatic life.
Toxic Blue Green Algae	Free flowing river segments would deter conditions that lead to toxic algal blooms and reduce human health concerns.
Aesthetics	Improvements in water quality would improve aesthetics and ceremonial opportunities that require a healthy river.
Aquatic Resources	
Traditional Lifestyle	Greater fisheries abundance would bolster opportunities for transmitting traditional knowledge to successive generations, including the important practice of giving fish to elders. Improved social cohesion and function among Indian populations through strengthened sense of tribal identity.
Cultural and Religious Practices	Improved fish abundance would facilitate the tribes' ability to reinstate and continue to practice ceremonies in their historic, complete forms at the appropriate times of the year, thereby improving tribal identity.
Standard of Living	Increased fish abundance would contribute to greater food supply and food security for the Indian population, enhancing standard of living.
Health	Greater opportunity for healthy food consumption associated with increased subsistence fishing opportunities, which would improve overall health conditions.

The six Klamath Basin tribes are sovereign governments individually, and the Yurok, Karuk, and Klamath Tribes signed the KBRA to bring a degree of certainty to their goal

of restoring the Klamath River fisheries. These three tribes have exercised their sovereignty by choosing not to assert certain of their claims for tribal water rights in the Klamath River in return for the assurances and commitments to limit water diversions by the Upper Basin water users. This limitation of the exercise of their water rights will exist in the future so long as the Project users stay within the limits set by the KBRA in Section 15.3 and other beneficial actions for fisheries occur. These provisions include:

- Implementation of the Project water plan that limits diversions to the agreed upon water allocation rule
- Projects that increase the storage capacity of Upper Klamath Lake are completed
- Full funding is authorized to implement the Water User Retirement Program above Upper Klamath Lake
- Drought Plan is adopted
- Fisheries Reintroduction Plan is finalized
- Dams are removed
- Establish a rigorous adaptive management regime in which tribal scientists will play a central role.

Pursuing adjudication of tribal water rights in State courts has considerable costs and risks as does the FERC relicensing process for the four project dams. Without the KBRA and KHSA there would be no funds for habitat remediation, fisheries restoration or dam removal. Restoration activities contained in the KBRA would be consistent with any Federal trust responsibility regarding Klamath River resources, regardless of the potentially affected tribe and even including those tribes who currently oppose the KBRA and its authorizing legislation. The KBRA improves community relationships and attitudes, and shortens the time to improved conditions for the natural resources. For these reasons, the Secretary believes that the KBRA and KHSA may provide a better path forward in the management of water and other natural resources used by the both signatory and non-signatory tribes.

Another relevant concern pertains to a narrow waiver of potential claims against the United States for past water management decisions above the California/Oregon border. This provision is also described in Section 15.3 of the KBRA and is again contingent upon specific restoration actions and water retirement. In this provision, the Tribes essentially state that, in return for the Federal Government's participation in the restoration of the Basin, the Tribes will not assert potential legal claims for past water management decisions in the Upper Basin which *arose before the Agreement*. (There is no agreement regarding claims against the United States which might arise *after* the Agreement.) This promise too, is not effective unless certain conditions are realized:

- The legislation needed to implement the agreement has been passed
- The terms of Section 15.3.4 have been met (see above)

- Funding for the following plans has been *appropriated*: Fisheries Restoration Plan, Fisheries Reintroduction Plan, Fisheries Monitoring Plan, Water Retirement Program, Interim Flow and Lake-level Program, and Regulatory Assurances Program
- The four dams are removed.

Overall, restoration would be consistent with any trust obligation to all Basin tribes, including those who currently oppose the KBRA and its authorizing legislation. Conversely, litigation or adjudication of these and other issues entails considerable risks and costs, takes years if not decades to resolve, and ultimately does not provide the opportunity, both in programs and appropriations, that the KBRA and related activities will if enacted. In fact, the Oregon adjudication originated in the mid-1970s, begun in earnest in the mid-1990s, and has yet to complete the first of two major phases. **Implementation of KBRA Section 15.3 Assurances Related to Tribal Water Rights would be beneficial to water rights and water supply.**

3.8.4.3.6 Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities Removal of Four Dams Alternative the impacts would be the same as those described for the Proposed Action. **Impacts associated with removal of recreation facilities at reservoirs would have no effect to water supply or water rights. Flow changes downstream from Iron Gate Dam and implementation of IMs would have a less than significant impact to water supply and water rights. Sediment release during reservoir drawdown has the potential to significantly affect water intake pumps by sediment deposits. Mitigation measure WRWS-1 would reduce this impact to less than significant.**

Keno Transfer

The effects of the Keno Transfer would be the same as those described for the Proposed Action.

East and Westside Facilities – Programmatic Measures

The effects of the decommissioning of the East and Westside Facilities would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the relocating the City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

KBRA – Programmatic Measures

The KBRA would also be implemented under the Partial Facilities Removal Alternative. Impacts on water supply and water rights would be the same as described for the Proposed Action.

3.8.4.3.7 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, the drawdown and sediment impacts described under the Proposed Action would not occur. Flow rates downstream from Iron Gate Dam and water supply operations would be similar to those under the No Action/No Project Alternative to provide adequate flows for fish. **Under the Fish Passage at Four Dams Alternative, there would be no impact on water rights and water supply.**

Trap and Haul – Programmatic Measures

Implementation of trap and haul measures could require water rights to divert water for the fish handling facilities. Fish handling facilities to collect fish downstream from Keno Dam and at Link River Dam would require water sources. The facilities would not consumptively use the water; the water would pass through the facilities for release back into the system. Trap and haul is likely to be an exempt use under ORS 537.141(d) and OAR 340-0010(2)(c)(B) if it causes no injury to existing water rights and if it is found to be not harmful to fish or wildlife after consultation with ODFW. **Because the fish handling facility would not increase consumptive use on the Klamath River system, the impacts of the trap and haul measures in the Fish Passage at Four Dams Alternative on water supply/water rights would be less than significant.**

3.8.4.3.8 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Under this alternative, only Iron Gate and Copco 1 Dams would be removed and fish passage would be installed at Copco 2 and J.C. Boyle Dams. The impact of sediments deposited downstream would be smaller, because sediment would be retained behind J.C. Boyle and Copco 2 Dams. After the drawdown period, flow rates downstream from Iron Gate Dam would be intermediate between the flows modeled for the No Action/No Project Alternative and the Proposed Action.

Impacts associated with removal of recreation facilities at reservoirs would have no effect to water supply or water rights. Flow changes downstream from Iron Gate Dam would have a less than significant impact to water supply and water rights. Sediment release during reservoir drawdown has the potential to significantly affect water intake pumps by sediment deposits. Mitigation measure WRWS-1 would reduce this impact to less than significant.

Trap and Haul – Programmatic Measure

Implementation of trap and haul measures could require water rights to divert water for fish handling facilities. The trap and haul measures around Keno Impoundment/Lake Ewauna and Link River would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **Because the fish handling facility would not increase consumptive use on the Klamath River system, the impacts of trap and haul measures in the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative on water supply/water rights would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measure

The effects of the relocating the City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

3.8.4.4 Mitigation Measures

3.8.4.4.1 Mitigation Measure by Consequences Summary

Mitigation Measure WRWS-1 - Assess each pump location at legitimate points of diversion. Following dam removal, investigate intake and pump sites at the request of the water user. If effects on water supply intakes occur as a result of dam removal, the Dam Removal Entity (DRE) will complete modifications to intake points as necessary to reduce effects to a less-than-significant level. Modifications will allow the water right holder to divert water on the same pattern (including amounts and timing) as before the project. Before reservoir drawdown, the DRE will notify water right holders about the project and request information about their diversion patterns to obtain a baseline with which to verify that impacts are fully mitigated.

3.8.4.4.2 Effectiveness of Mitigation in Reducing Consequences

Implementation of WRWS-1 will ensure that intake points of diversion affected by sediment deposition downstream from dam removal activities are dealt with individually and on an as-needed basis.

3.8.4.4.3 Agency Responsible for Mitigation Implementation

The DRE will coordinate with affected water users to determine appropriate solutions on a site-by-site basis.

3.8.4.4.4 Remaining Significant Impacts

No remaining significant adverse impacts on water rights and water supply are anticipated.

3.8.4.4.5 Mitigation Measures Associated with Other Resource Areas

Mitigation REC-1 would create a plan to develop new recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoirs are removed. Water supplies for the campgrounds would most likely be supplied through wells placed on the new sites as appropriate. **There would be no impact to water rights or supplies from the implementation of REC-1.**

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3.9 Air Quality

This section discusses potential air quality impacts from the Proposed Action and alternatives. This discussion describes the affected environment/environmental setting, analysis methods, significance criteria, and impacts for each of the alternatives. Appendix M provides a summary of the existing emission sources and monitoring data, detailed emission calculation methodologies, and detailed emission inventories.

3.9.1 Area of Analysis

The area of analysis includes multiple counties in northern California and southern Oregon. Direct air quality impacts from the Proposed Action and alternatives would be limited to Siskiyou County, California and Klamath County, Oregon for dam removal activities, while additional impacts could occur in Jackson County, Oregon and Shasta County, California from haul truck or construction worker travel. The quantitative analysis for the alternatives was limited to these four counties.

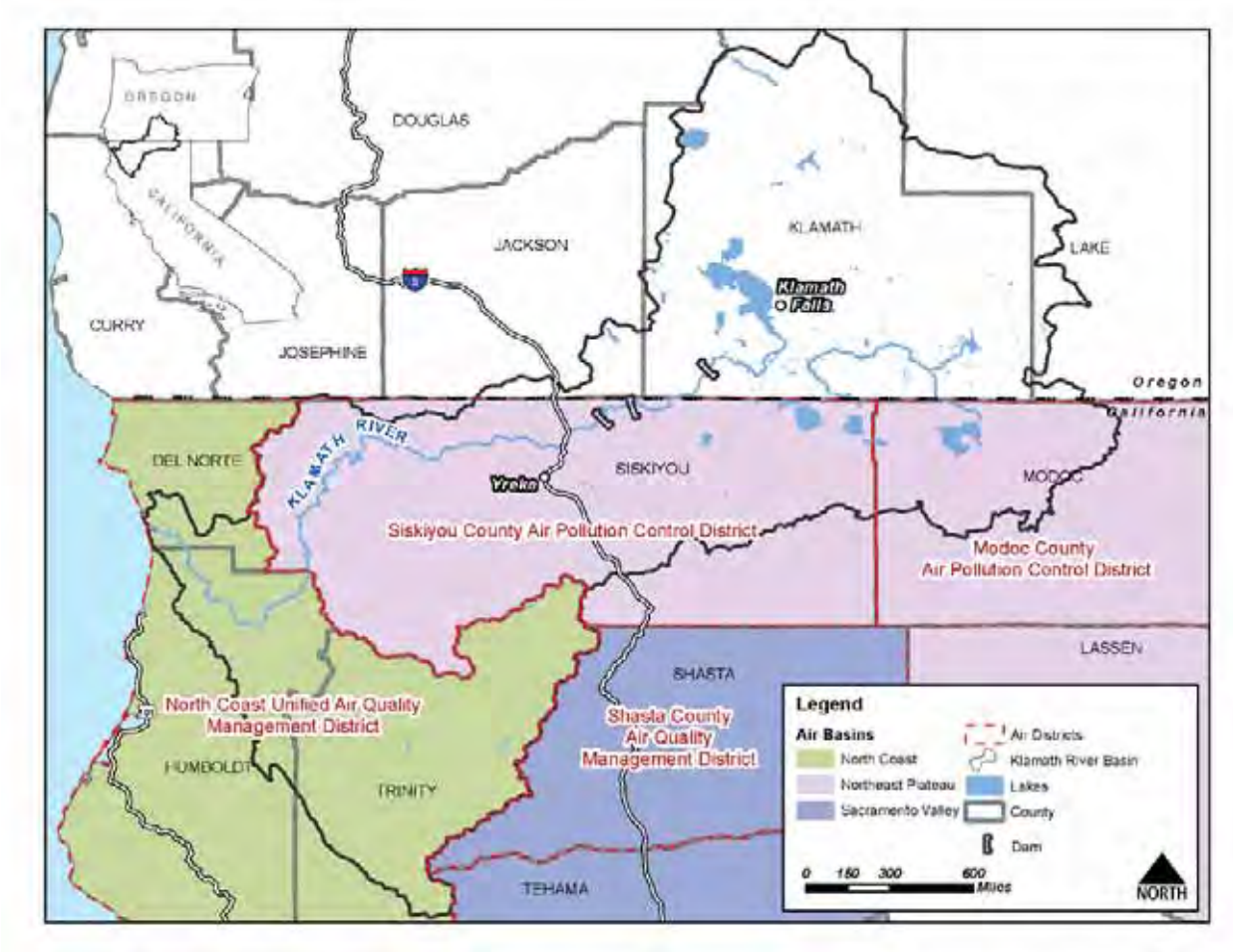
The area of analysis includes the Curry County in Oregon and Del Norte, Humboldt, Modoc and Trinity counties in California for a qualitative analysis of the impacts that would be caused by implementation of programmatic elements of the alternatives.

California is divided into fifteen different air basins based on common geographic and political boundaries. The North Coast, Northeast Plateau, and Sacramento Valley Air Basins cover the portion of the Klamath Basin within California. The geographic scope of the analysis also includes the jurisdictions of the North Coast Unified Air Quality Management District, the Siskiyou County Air Pollution Control District, the Modoc County Air Pollution Control District, and the Shasta County Air Quality Management District. Figure 3.9-1 identifies the air quality area of analysis.

3.9.2 Regulatory Framework

The Klamath Falls, Oregon Nonattainment Area is designated as a nonattainment area for fine particulate matter <2.5 microns ($PM_{2.5}$), while the Klamath Falls Urban Growth Boundary (UGB) is designated as a maintenance area for carbon monoxide (CO) and inhalable particulate matter <10 microns (PM_{10}). Additionally, the Medford-Ashland Air Quality Maintenance Area (AQMA) in Oregon, is designated as a maintenance area for PM_{10} and CO. As a result, the following de minimis thresholds for general conformity apply to these two urban areas:

- $PM_{2.5}$ (nonattainment): 100 tons per year
- Sulfur dioxide (SO_2) (as $PM_{2.5}$ precursor): 100 tons per year
- Nitrogen oxides (NOx) (as $PM_{2.5}$ precursor): 100 tons per year
- CO (maintenance): 100 tons per year
- PM_{10} (maintenance): 100 tons per year



Source: California Air Resource Board (CARB) 2010a.

Figure 3.9-1. Area of Analysis for both the Klamath Hydroelectric Settlement Agreement (KHSA) and the Klamath Basin Restoration Agreement (KBRA).

Air quality management and protection responsibilities are regulated by Federal, State, tribal, and local levels of government, which are listed in Section 3.9.1

3.9.2.1 Federal Authorities and Regulations

- Clean Air Act (40 CFR 50-88)
- General Conformity (40 CFR 93, Subpart B)

3.9.2.2 State Authorities and Regulations

- California Clean Air Act (H&S Code, §39000 et seq.)
- Oregon Administrative Rules (Chapter 340, Divisions 200-268)
- Oregon Revised Statutes (Chapter 468A)

- Medford Maintenance Plan for CO (Oregon Department of Environmental Quality [ODEQ] 2001)
- Klamath Falls PM_{10} Maintenance Plan (ODEQ 2002)
- Medford-Ashland AQMA PM_{10} State Implementation Plan (ODEQ 2004)

3.9.2.3 Local Authorities and Regulations

- Siskiyou County Air Pollution Control District
- Modoc County Air Pollution Control District
- Shasta County Air Quality Management District
- North Coast Unified Air Quality Management District (Del Norte, Humboldt, and Trinity Counties)
- Klamath County Clean Air Ordinance (Ordinance No. 63.05)

3.9.2.4 Tribal Air Quality Management

- Karuk Tribe *Eco-Cultural Resources Management Plan* (2010)
- Yurok Tribe Air Quality Ordinance

3.9.3 Existing Conditions/Affected Environment

Siskiyou County, California is dominated by volcanic peaks (e.g., Mount Shasta) and forested mountains. The county is sparsely populated. Agricultural activities (including rangeland) are primarily in areas that are not wooded. The climate generally features hot summer days with cool nights and mild winters in the low valleys. The mountainous areas have cool summers and severe winters. Various recreational activities and hunting also occur in Siskiyou County.

Klamath County is generally characterized by high desert prairie with a variety of mountain ranges and isolated peaks. As with Siskiyou County, the area is largely rural and agricultural, while recreation and hunting activities dominate.

3.9.3.1 Existing Air Quality Conditions

The air quality conditions for the area are typically the result of existing emission sources in the area and meteorological conditions that affect the dispersion of the emissions once they enter the atmosphere.

3.9.3.1.1 Attainment Designations

Regions are designated as nonattainment, maintenance, or attainment areas with respect to the various National and California ambient air quality standards, based on their compliance with the standards. A nonattainment area is defined as a region that does not meet the Federal or State ambient air quality standards. Maintenance areas are those areas that previously did not meet the air quality standards (i.e., nonattainment), but are now consistently meeting the requirements. If an area consistently meets the air quality

standards, then it is designated as an attainment area. The affected counties in California are all currently designated as a Federal attainment area for all pollutants. The Klamath Falls UGB in Oregon is designated as a maintenance area for CO and PM_{10}; the Medford-Ashland AQMA is designated as a maintenance area for CO and PM_{10}; and the Klamath Falls Nonattainment Area is designated as a nonattainment area for $PM_{2.5}$. Table 3.9-1 presents the attainment designations for each of the Federal criteria air pollutants.

Table 3.9-1. Federal Attainment Status of the Study Area

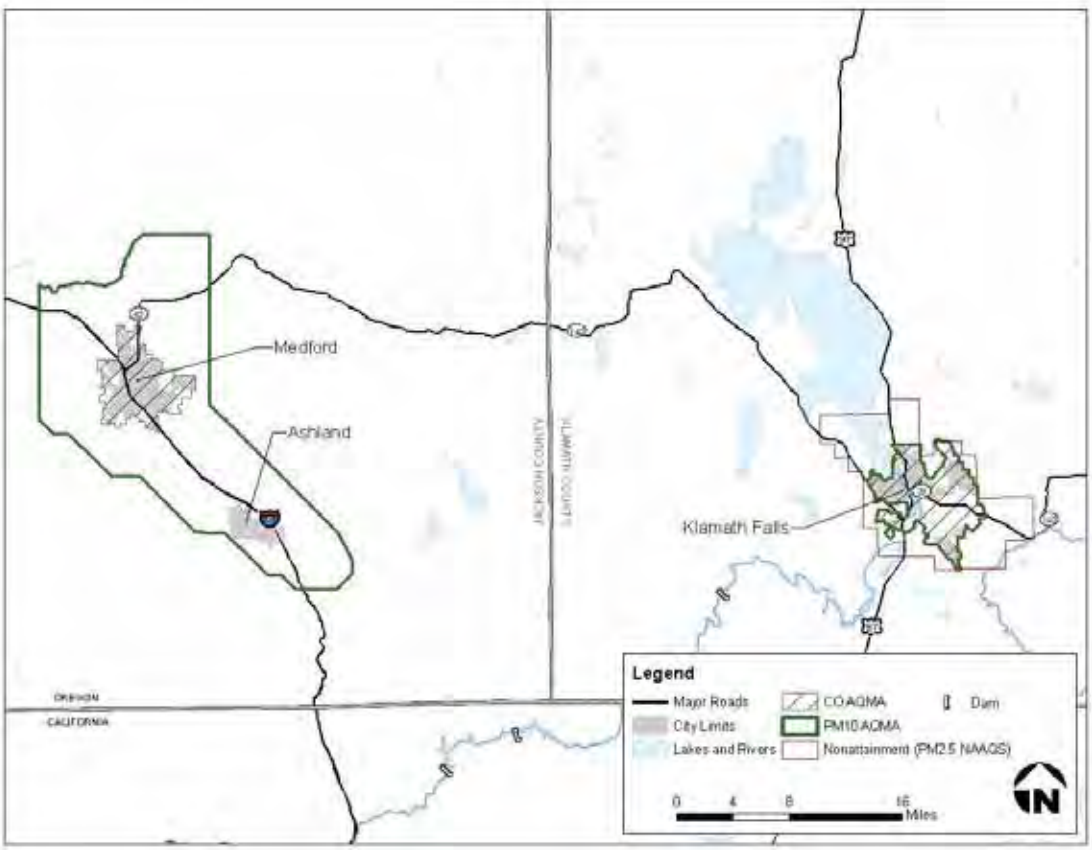
Pollutant	Federal Status
Ozone (O_3)	Attainment
Inhalable particulate matter (PM_{10})	Maintenance (Klamath Falls UGB and Medford-Ashland AQMA) Attainment (all other areas)
Fine particulate matter ($PM_{2.5}$)	Nonattainment (Klamath Falls Nonattainment Area) Attainment (all other areas)
Carbon monoxide (CO)	Maintenance (Klamath Falls UGB and Medford-Ashland AQMA) Attainment (all other areas)
Nitrogen dioxide (NO_2)	Attainment
Sulfur dioxide (SO_2)	Attainment

Source: United States Environmental Protection Agency (USEPA) 2010a; OAR 340-204.
AQMA: Air Quality Maintenance Area
UGB: urban growth boundary

The J.C. Boyle Dam is in Klamath County and not in the Klamath Falls UGB or the Klamath Falls $PM_{2.5}$ Nonattainment Area; therefore, the dam is in an area that is designated an attainment area for all pollutants. The Medford-Ashland AQMA is currently a maintenance area for the PM_{10} and CO National Ambient Air Quality Standards (NAAQS). Although this area is outside of the Klamath Basin, trucks and/or construction workers could travel through this region. Figure 3.9-2 shows the location of particulate matter (PM_{10} and $PM_{2.5}$) nonattainment and maintenance areas for the NAAQS in relation to the Klamath Basin. Figure 3.9-3 shows the Klamath Falls UGB, the Klamath Falls Nonattainment Area, and the Medford-Ashland AQMA.

Source: California Air Resources Board (CARB) 2010a; United States Environmental Protection Agency (USEPA) 2010b.

Figure 3.9-2. Particulate Matter (PM_{10} and $PM_{2.5}$) NAAQS and California Ambient Air Quality Standards (CAAQS) Designations.



Source: Oregon Department of Environmental Quality 2008

Figure 3.9-3. Particulate Matter (PM_{10} and $PM_{2.5}$) and Carbon Monoxide (CO) NAAQS Designations in Oregon.

Siskiyou County is currently a nonattainment-transitional area[1] for the California ozone (O_3) standard, whereas Shasta County is a nonattainment area for the State O_3 California Ambient Air Quality Standard (CAAQS). All other California counties within the Klamath Basin are in attainment of the O_3 CAAQS. Siskiyou County is in attainment of the California PM_{10} standards, but the other California counties in the Klamath Basin are in nonattainment of the PM_{10} CAAQS. All California counties in the project area are in attainment of the $PM_{2.5}$, CO, nitrogen dioxide (NO_2), and SO_2 CAAQS. Table 3.9-2 lists the attainment status for each pollutant with regard to CAAQS. Figure 3.9-2 identifies the attainment status for the PM_{10} CAAQS and Figure 3.9-4 identifies the attainment status for the O_3 CAAQS.

[1] An area classified "nonattainment-transitional" for O_3 has had three or fewer exceedances at each site during the last year. This classification means that the area is close to attaining the standard for the given pollutant.

Table 3.9-2. California Air Quality Attainment Status for the Study Area

Pollutant	California Status
Ozone (O_3)	Nonattainment-Transitional (Siskiyou County) Nonattainment (Shasta County) Attainment (Del Norte, Humboldt, Modoc, and Trinity Counties)
Inhalable particulate matter (PM_{10})	Attainment (Siskiyou County) Nonattainment (Del Norte, Humboldt, Trinity, Shasta, and Modoc Counties)
Fine particulate matter ($PM_{2.5}$)	Attainment/Unclassified (All counties)
Carbon monoxide (CO)	Attainment/Unclassified (All counties)
Nitrogen dioxide (NO_2)	Attainment (All counties)
Sulfur dioxide (SO_2)	Attainment (All counties)

Source: CARB 2010b.

Source: CARB 2010a; United States Environmental Protection Agency (USEPA) 2010b.

Figure 3.9-4. Ozone (O_3) NAAQS and CAAQS Designations.

3.9.4 Environmental Consequences

3.9.4.1 Environmental Effects Determination Methods

This analysis uses estimates of emissions that would occur from the removal of the dams or the installation of fish passage structures. These estimates came from a variety of emissions models and spreadsheet calculations:

- CARB Urban Emissions (URBEMIS) model, Version 9.2.4 (fugitive dust calculations from construction equipment, cut/fill activities, and building demolition)
- CARB EMFAC2007 model (on-road vehicle emissions factor model for California)
- United States Environmental Protection Agency (USEPA) MOBILE6.2[2] (on-road vehicle emissions factor model for Oregon)
- CARB OFFROAD2007 (off-road vehicle emissions factor model for California)
- USEPA NONROAD2008a (off-road vehicle emissions factor model for Oregon)
- Midwest Research Institute (1996), *Improvement of Specific Emission Factors* (paved road dust emissions)
- *Compilation of Air Pollutant Emission Factors (AP-42)* (USEPA 2006)

Appendix M provides detailed information on the emission calculations.

3.9.4.2 Significance Criteria

For the purposes of this analysis, an air quality impact would be significant if one or more of the following criteria are met:

- The effects would cause an air quality standard to be violated
- Activities or emissions would result in a cumulatively considerable net increase of:
    - O_3 in Siskiyou County or Shasta County, California (O_3 nonattainment-transitional and nonattainment areas, respectively)
    - PM_{10} in Del Norte, Humboldt, Trinity, Shasta, and Modoc Counties, California (PM_{10} nonattainment areas)
- Cause release of emissions that exceed 250 pounds per day for NOx, volatile organic compounds (VOC), PM_{10}, $PM_{2.5}$, or sulfur oxides (SOx); or 2,500 pounds per day for CO (Siskiyou County Air Pollution Control District Rule 6.1)
- Expose sensitive receptors to substantial pollutant concentrations (defined by pollutant thresholds)

[2] Although the USEPA recently developed the Motor Vehicle Emission Simulator (MOVES) to replace MOBILE6.2, MOVES has only been approved for use in SIPs and Transportation Conformity (75 FR 9411). Because it has not yet been approved for project-level analyses, MOBILE6.2 was used to estimate emissions from on-road vehicles in Oregon.

- Activities or emissions would be inconsistent with Oregon's Regional Haze Plan (ODEQ 2009)
- Activities or emissions would be inconsistent with California's Regional Haze Plan (CARB 2009)

The Proposed Action would also occur within close proximity (within 100 kilometers[3]) of several mandatory Federal Class I areas, which are areas in which visibility was declared by Congress to be an important value (Clean Air Act, Section 169A). The following Class I areas could be affected by the Proposed Action or its alternatives.

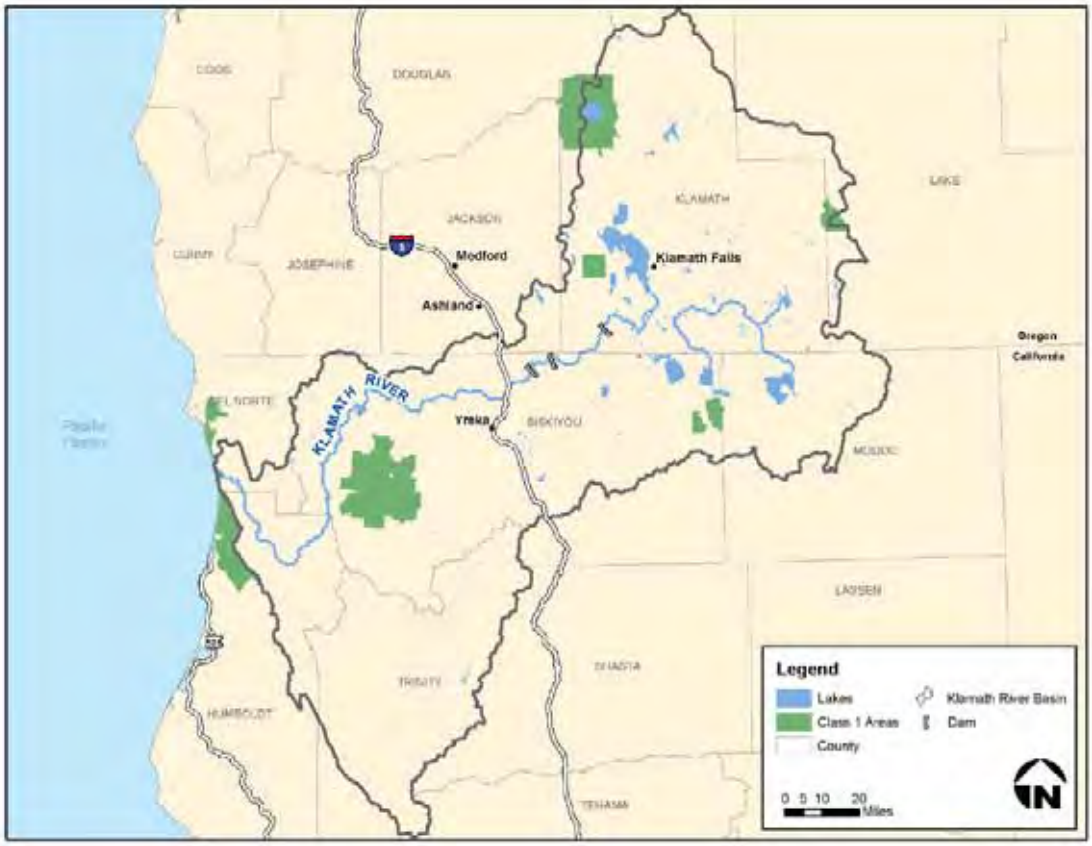
- Crater Lake National Park (Oregon)
- Gearhart Mountain Wilderness (Oregon)
- Lava Beds National Monument (California)
- Marble Mountain Wilderness (California)
- Mountain Lakes Wilderness (Oregon)

Oregon's *Regional Haze Plan* (ODEQ 2009) indicates that the current rules addressing construction-related activities in Oregon are sufficient to prevent visibility impairment in Oregon Class I areas. Several rules that address construction activities include Oregon Administrative Rule (OAR) 340-208-0110, which sets opacity limits for visible emissions from any air contaminant source and OAR 340-208-0210, which addresses fugitive emissions from a variety of sources.

California's *Regional Haze Plan* (CARB 2009) indicates that CARB's In-Use Off-Road Diesel Vehicle Regulation (adopted on July 26, 2007) will reduce particulate matter and NOx emissions by 74 percent and 32 percent, respectively, from current levels. CARB expects this measure to be sufficient to mitigate visibility impacts from construction activities.

Figure 3.9-5 shows the Federal Class I areas that are within the Klamath Basin.

[3] The 100-kilometer distance is based on a memorandum from the USEPA (1979) to Regional Administrators that indicated that "[v]ery large sources…may be expected to affect 'air quality related values' at distances greater than 100 kilometers." Although the distance is related to the Prevention of Significant Deterioration permitting program, the distance is being used as a proxy for activities associated with the Proposed Action.



Source: National Park Service 2010.

Figure 3.9-5. Federal Class I Areas.

3.9.4.3 Effects Determinations

No operational sources are part of the Proposed Action; therefore, this analysis considers only construction-related air quality impacts. Appendix M describes the methods by which construction impacts were estimated.

3.9.4.3.1 Alternative 1: No Action/No Project Alternative

Vehicle exhaust from continued maintenance and operation of the Four Facilities could cause emissions of air pollutants. Under the No Action/No Project Alternative, none of the activities under the Klamath Hydroelectric Settlement Agreement (KHSA) would be completed. Operational emissions that would occur from employees commuting to the Four Facilities, vendor trips, or other emission sources would continue to occur under the No Action/No Project Alternative. **These emissions are expected to be minimal and were not quantified for this analysis.**

Activities associated with Interim Measures (IMs) could result in short-term and temporary increases in criteria pollutants from vehicle exhaust and fugitive dust that

could exceed Siskiyou County's thresholds of significance. Several IMs would be implemented under the No Action/No Project Alternative. Several of these measures could result in increased criteria pollutant emissions:

- IM 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement
- IM 8: J.C. Boyle Bypass Barrier Removal

IM 7 would require PacifiCorp to place suitable gravels in the J.C. Boyle Bypass and Peaking reaches using a passive approach before high flow periods or to provide for other habitat enhancement. The No Action/No Project Alternative includes only one year of this measure. Criteria pollutant emissions could occur from trucks hauling gravel to the J.C. Boyle Bypass and Peaking reaches; however, the number of trucks required to deliver gravel is expected to be minor.

IM 8 requires the removal of the sidecast rock barrier located approximately 3 miles upstream of the J.C. Boyle Powerhouse in the J.C. Boyle Bypass Reach. Potential air quality emissions are expected to be less than those quantified for the removal of Copco 1 from blasting activities.

Based on the limited amount of construction equipment expected to be used simultaneously, peak daily emissions are not expected to exceed the significance criteria described previously. **The impact on air quality from implementation of the IMs would be less than significant.**

Ongoing Restoration Activities

Construction activities from several ongoing restoration actions could cause emissions of air pollutants. Under the No Action/No Project Alternative, several projects would be assumed to proceed over time. These resource management actions could receive additional funding and could be expanded or accelerated through the Klamath Basin Restoration Agreement (KBRA); however, they were started or under consideration before the KBRA was developed and would move forward even without the KBRA. The Fish Habit Restoration activities could result in criteria pollutant emissions. **This project would involve some limited construction activities that could result in short-term temporary air emissions in the upper basin. The effects of these activities would be fully analyzed in separate National Environmental Policy Act evaluations for each project as they are designed.**

3.9.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Vehicle exhaust and fugitive dust emissions from dam removal activities could increase emissions of VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ to levels that could exceed Siskiyou County's thresholds of significance. Emission sources include exhaust emissions from off-road construction equipment, on-road trucks, construction worker employee

commuting vehicles; and fugitive dust emissions from unpaved roads and general earth moving activities. General earth moving activities that could generate fugitive dust include the operation of construction equipment on the site and removal of excavated materials (cut/fill activities). The Iron Gate Fish Hatchery would be operated for eight years after the dam removal, but the hatchery would not be rebuilt or relocated. While additional water may be supplied to the hatchery to support its operation, an increase in emissions would not occur. Operational emissions were therefore not estimated for the hatchery.

Table 3.9-3 summarizes predicted uncontrolled peak daily and annual emission rates for VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ for the Proposed Action. This analysis uses the conservative assumption that the peak day of construction could occur at the same time for each dam; therefore, the peak daily emissions are additive. The analysis assumes that dust control measures like watering and erosion control fabrics would be required by the United States Department of the Interior (DOI). In addition, the calculations assume that all haul roads would be covered in gravel with minimal silt content. As a result, these measures are included as part of the project and are not considered to be mitigation measures.

Cofferdams would be constructed at the Four Facilities during deconstruction activities. Concrete rubble, rock, and earthen materials that would come from the dam removal activities would be used as possible to construct the cofferdams. Since the cofferdams would be constructed from materials salvaged from the dam demolition activities, emissions associated with construction would already be included in the emissions inventory. Additional emissions could occur when the cofferdams are later demolished, but this activity would not cause any changes to the significance determinations.

As Table 3.9-3 shows, total emissions of NOx and PM_{10} exceed the significance criteria for the four sites. The greatest source of NOx emissions from each of the dams would be off-road construction equipment, followed by on-road trucks, and then employee commuting vehicles. The major sources of PM_{10} emissions would be fugitive dust from unpaved roads and then cut/fill activities. Any adverse impacts would be temporary.

Demolition of Copco 1 dam could generate concrete dust, which has a high pH. Dust control measures as described in mitigation measure AQ-4 would be used to control concrete dust to the maximum extent feasible. Management of the high pH content is discussed further in Section 3.5, Terrestrial Resources. **The impact on air quality from emissions of NOx and PM_{10} from the demolition of the Four Facilities would be a significant impact. Implementation of mitigation measures AQ-1 through AQ-4 would reduce emissions of NOx to a less than significant level; however, emissions of PM_{10} would remain significant and unavoidable.**

Table 3.9-3. Uncontrolled Emissions Inventories for the Proposed Action

Location	Peak Daily Emissions (pounds per day)[1]					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Iron Gate	67	272	**348**	2	210	50
Copco 1	27	176	129	1	174	165
Copco 2	22	83	113	1	17	6
J.C. Boyle	15	54	60	5	103	27
Grand Total	131	584	**650**	9	**503**	248
California Total[3]	116	531	**590**	4	**401**	221
Oregon Total	15	54	60	5	103	27
Significance Criterion[4]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Iron Gate	3	11	14	<1	10	2
Copco 1	1	7	5	<1	8	7
Copco 2	1	3	5	<1	<1	<1
J.C. Boyle	1	3	5	<1	3	1
Total (2020)	6	24	28	1	20	11
California Total[3]	5	21	23	<1	18	10
Oregon Total	1	3	5	<1	3	1
De Minimis Threshold[5]	n/a	100	100	100	100	100

Notes:
1 Values shown in **bold** are significant.
2 Where emission factors were only provided for PM_{10}, appropriate PM size profiles were used to estimate $PM_{2.5}$ emissions. Appendix M[3] California total includes emissions for activities at Iron Gate, Copco 1, and Copco 2 Dams.
4 Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
5 General conformity de minimis thresholds from 40 CFR 93.153.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

Activities associated with several IMs could result in short-term and temporary increases in criteria pollutants from vehicle exhaust and fugitive dust that could exceed Siskiyou County's thresholds of significance. Prior to construction, IMs as described in the KHSA (KHSA Section 1.2.4) would be implemented and would control operations of the hydroelectric facilities. Several of the IMs in the Proposed Action could result in increased criteria pollutant emissions:

- IM 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement
- IM 16: Water Diversions

IM 7 would require PacifiCorp to place suitable gravels in the J.C. Boyle bypass and peaking reach using a passive approach before high flow periods or to provide for other

habitat enhancement. The Proposed Action includes seven years of implementing this measure. Criteria pollutant emissions could occur from trucks hauling gravel to the J.C. Boyle bypass and peaking reach; however, the number of trucks required to deliver gravel is expected to be minor.

IM 16 would eliminate three screened diversions from Shovel and Negro Creeks and would also require the installation of screened irrigation pump intakes, as necessary, in the Klamath River. Limited construction equipment and haul trucks would be required to remove the screened diversions or to construct new diversions.

Based on the limited amount of construction equipment expected to be used simultaneously, peak daily emissions are not expected to exceed the significance criteria described previously. **The impact on air quality from implementation of the IMs would be less than significant.**

Restoration actions could result in short-term and temporary increases in criteria pollutant emissions from vehicle exhaust and fugitive dust from the use of helicopters, trucks, and barges. Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed river-side sediment. Upper areas of the reservoir basins would be reseeded from a barge until the reservoir levels become too low to operate and access the barge. Aerial application would be necessary for precision applications of material near sensitive areas and the newly established river channel. Aerial hydroseeding is scheduled to begin on March 15, 2020 and last for 10 days at Iron Gate and 20 days at Copco. Trucks would also be used as necessary to provide seeding. Additional fall seeding may be necessary to supplement areas where spring hydroseeding was unsuccessful.

Annual greenhouse gas (GHG) emissions were estimated using information provided in the *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2012). A combination of techniques was used to estimate emissions from reservoir restoration activities. Emissions from aerial application were estimated using the Federal Aviation Administration's Emissions and Dispersion Modeling System. Emissions from barges were estimated using the following sources:

- *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data* (United States Environmental Protection Agency [USEPA] 2000)
- AP-42, Chapter 3.3: Gasoline and Diesel Industrial Emissions (USEPA 1996)
- Title 17 California Code of Regulations, Section 93115.7: Air Toxic Control Measure for Stationary Compression Ignition Engines – Stationary Prime Diesel-Fueled Compression Ignition Engine (>50 bhp) Emission Standards
- Title 13 California Code of Regulations, Section 2423: Exhaust Emission Standards and Test Procedures—Off-Road Compression-Ignition Engines

Emissions from ground support equipment were estimated using the emission factors for off-road engines identified above and EMFAC for on-road motor vehicle emissions. Table 3.9-4 summarizes emissions from reservoir restoration.

Table 3.9-4. Uncontrolled Emissions from Reservoir Restoration (Reseeding)

Phase	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Ground Equipment	3	8	15	2	<1	<1
Barges	16	54	153	18	3	3
Aerial (Rotary Aircraft)	15	39	3	1	<1	<1
Maximum Daily[1]	19	62	168	20	3	3
Significance Criterion[2]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Total	9	33	33	2	20	11
De Minimis Threshold[3]	n/a	100	100	100	100	100

Notes:
1 Barge and aerial application will not happen simultaneously; therefore, maximum daily emissions summarizes the peak day that consists of ground equipment and barges operating at the same time.
2 Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
3 General conformity de minimis thresholds from 40 CFR 93.153.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-4, emissions would not exceed the significance criteria. **The impact on air quality from reservoir restoration activities would be less than significant.**

Relocation and demolition of various recreation facilities could result in short-term and temporary increases in criteria pollutant emissions from vehicle exhaust and fugitive dust. The demolition of the Four Facilities would change recreational opportunities from lake-based recreation to river-based recreation. This change would require several recreation facilities to be reconstructed or demolished. On- and off-road construction equipment would be used to complete these activities, which would occur after the dam demolition actions. Annual GHG emissions were estimated using information provided in the *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2012) and CalEEMod. Table 3.9-5 summarizes emissions from the relocation and demolition of recreation facilities.

Table 3.9-5. Uncontrolled Emissions from Relocation and Demolition of Recreation Facilities

Location	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
J.C. Boyle	4	32	31	<1	3	1
Copco	2	13	16	<1	2	1
Iron Gate	6	32	38	<1	5	3
Total Emissions	12	77	85	<1	11	5
Significance Criterion[1]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Total	0.1	0.7	0.8	<0.1	0.1	0.1
De Minimis Threshold[2]	n/a	100	100	100	100	100

Notes:
[1] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
[2] General conformity de minimis thresholds from 40 CFR 93.153.
Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-5, emissions would not exceed the significance criteria. **The impact on air quality from the relocation and demolition of the various recreation facilities would be less than significant.**

Vehicle exhaust and fugitive dust emissions from dam removal activities could exceed the de minimis thresholds in 40 CFR 93.153 that would require the development of a general conformity determination. Emissions from trucks and employee commuting could occur within the Klamath Falls UGB, the Klamath Falls Nonattainment Area ($PM_{2.5}$), or the Medford-Ashland AQMA; therefore, emissions that would occur within these areas are subject to the requirements of general conformity. If the total of direct and indirect emissions are below the general conformity de minimis thresholds in 40 CFR 93.153, then no further action is needed and a general conformity determination is not required.

While only emissions that would occur within the designated nonattainment or maintenance areas would be subject to general conformity, it is not possible to separate those emissions from the project total. As a result, total emissions from haul trucks and employee commuting was compared to the general conformity de minimis thresholds as a conservative analysis. Emissions from trucks and employee commuting are less than the general conformity de minimis thresholds identified in Section 3.9.2.1 (see Tables 3.9-3 through 3.9-5) and therefore a conformity determination is not necessary for any of the maintenance or nonattainment areas. **As a result, a general conformity determination is not required.**

Fugitive dust emissions from demolition activities could impair visibility in Federal Class I areas. Demolition activities would be conducted in compliance with Oregon and California regulations related to fugitive dust emissions. In addition, any fugitive dust emissions would be short term and temporary and would not have long-term effects related to visibility. **Impacts related to visibility would be less than significant.**

Keno Transfer

Implementation of the Keno Transfer could have adverse effects on air quality. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on air quality compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance with agreements and historic practice (KHSA Section 7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facility Decommissioning – Programmatic Measures

Decommissioning the East and Westside Facilities could cause adverse air quality effects. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would cease the current diversion of water at Link River Dam into the two canals from the Link River. These construction activities would be conducted in the years prior to 2020 and would not overlap with other construction or demolition activities. Peak daily emissions would likely be minimal and are not expected to exceed the significance criteria. **The impact on air quality from the East and Westside Facilities decommissioning action would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary increases in criteria pollutant emissions from vehicle exhaust and fugitive dust that could exceed Siskiyou County's thresholds of significance. On- and off-road construction equipment would be used to complete the relocation and construction of the City of Yreka Water Supply Pipeline. Construction of the pipeline was assumed to occur in 2020 and would last approximately one month. It was assumed that construction of the 400 foot pipeline would occur over a space of approximately 4 acres. The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model (2009) was used to estimate emissions associated with grubbing/land clearing, grading/excavation, and other phases. Table 3.9-6 summarizes maximum daily emissions that would occur from construction of the pipeline.

Table 3.9-6. Uncontrolled Emissions from Construction of City of Yreka Water Supply Pipeline

Phase	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Grubbing/Land Clearing	2.3	9.3	16.4	--	10.1	2.6
Grading/Excavation	2.8	16.5	18.4	--	10.3	2.7
Drainage/Utilities/Sub-Grade	2.2	11.3	14.4	--	10.2	2.6
Maximum	2.8	16.5	18.4	--	10.3	2.7
Significance Criterion[1]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Total	<0.1	0.1	0.2	--	0.1	<0.1
De Minimis Threshold[2]	n/a	100	100	100	100	100

Notes:
[1] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
[2] General conformity de minimis thresholds from 40 CFR 93.153.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-6, emissions would not exceed the significance criteria. **The impact on air quality from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

KBRA – Programmatic Measures

The KBRA has several programs that could cause temporary increases in air quality pollutant emissions, primarily from construction activities. The following KBRA programs could cause air quality impacts from the use of heavy equipment:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration Project
- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Power for Water Management Program
- Additional Water Conservation and Storage

Construction activities associated with the KBRA programs could result in temporary increases in air quality pollutant emissions from vehicle exhaust and fugitive dust. Potential construction activities include channel construction, mechanical thinning of trees, road decommissioning, fish passage and facilities construction, breaching levees, and fish hauling. Several of these activities would require construction equipment with

the potential to emit air quality pollutants. While the exact geographic location and timing of these programs is not known, it is assumed that some could occur at the same time and in the same area as the hydroelectric facility removal actions analyzed above and could contribute to the severity of the facility removal air quality effects. **Due to the potentially large amount of construction activities that would occur for the various KBRA programs, it is anticipated that the effects from air quality could be significant. Mitigation Measures AQ-1, 2, and 3 would be implemented to reduce the severity of these effects to a less than significant level; however, emissions from any construction actions completed in the same year as hydroelectric facility removal actions may not be reduced to a less than significant level. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

Operational activities associated with the Fisheries Reintroduction and Management Plan could result in temporary increases in air quality pollutant emissions from vehicle exhaust associated with trap-and-haul activities. Potential operational emissions could occur from haul trucks moving fish around Keno Impoundment/Lake Ewauna and Link River. Upstream-migrating fish would be collected downstream from Keno Dam and relocated to Upper Klamath Lake or its tributaries. Downstream-migrating fish would be collected at Link River Dam (and the East Side and Westside canals) and relocated downstream from Keno Dam. Seasonal trap and haul operations would occur during periods of poor water quality in Keno Impoundment/Lake Ewauna. Hauling activities would occur after the peak emission-generating period of facility removal because fish cannot access Keno Dam until after removal of the Four Facilities; however, some construction activities associated with completing removal activities and reservoir restoration may occur at the same time as hauling operations. Construction emissions related to dam removal and hauling operations, taken together, could increase the severity of the air quality effects, but the combined emissions would likely still be less than the peak emissions during dam deconstruction. **Although the exact extent and timing of these hauling activities is not known, it is assumed that air quality impacts would be significant because of the long haul distance that is expected. Mitigation Measures AQ-1, 2, and 3 would be implemented to reduce the severity of these effects to a less than significant level; however, emissions from any construction actions completed in the same year as hydroelectric facility removal actions may not be reduced to a less than significant level. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

3.9.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams Alternative

Under the Partial Facilities Removal Alternative, some of the structures associated with the dams would remain in place. As a result, the area in which removal activities could occur is smaller than under the Proposed Action.

Vehicle exhaust and fugitive dust emissions from dam removal activities could increase emissions of VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ to levels that could exceed Siskiyou County's thresholds of significance. As it would be for the Proposed Action, the major source of NOx emissions associated with the Partial Facilities Removal Alternative

would be off-road construction equipment and other sources of exhaust emissions. The major source of PM_{10} and $PM_{2.5}$ emissions would be fugitive dust that is generated from movement on unpaved roads and surfaces. Secondary formation of $PM_{2.5}$ could also occur from NOx and SOx emissions; however, these pollutants are not emitted in sufficient quantities to affect the Klamath Falls Nonattainment Area.

The Iron Gate Fish Hatchery would be operated for eight years after the dam removal, but the hatchery would not be rebuilt or relocated. While additional water may be supplied to the hatchery to support its operation, an increase in emissions would not occur. Operational emissions were therefore not estimated for the hatchery.

Table 3.9-7 is a summary of predicted uncontrolled peak daily and annual emission rates for VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ for the Partial Facilities Removal Alternative. As Table 3.9-7 shows, total emissions of NOx and PM_{10} would exceed the significance criteria for the four sites.

Demolition of Copco 1 dam could generate concrete dust, which has a high pH. Dust control measures as described in mitigation measure AQ-4 would be used to control concrete dust to the maximum extent feasible. Management of the high pH content is discussed further in Section 3.5, Terrestrial Resources. **The impact on air quality from emissions of NOx and PM_{10} the Four Facilities would be a significant impact. Implementation of mitigation measures AQ-1 through AQ-4 would reduce emissions of NOx to a less than significant level; however, emissions of PM_{10} would remain significant and unavoidable.**

Activities associated with several IMs could result in short-term and temporary increases in criteria pollutants from vehicle exhaust and fugitive dust that could exceed Siskiyou County's thresholds of significance. Air quality impacts associated with implementation of IMs would be the same as those discussed for the Proposed Action. **The impact on air quality from implementation of the IMs would be less than significant.**

Restoration actions could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions from the use of helicopters, trucks, and barges. Air quality impacts associated with the restoration actions would be the same as those discussed for the Proposed Action. **The impact on air quality from reservoir restoration activities would be less than significant.**

Relocation and demolition of various recreation facilities could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions. Air quality impacts associated with the recreation facilities would be the same as those discussed for the Proposed Action. **The impact on air quality from the relocation and demolition of the various recreation facilities would be less than significant.**

Table 3.9-7. Uncontrolled Emissions Inventories for the Partial Facilities Removal Alternative

Location	Peak Daily Emissions (pounds per day)[1]					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Iron Gate	66	270	**344**	2	208	49
Copco 1	27	173	124	1	171	165
Copco 2	21	80	103	1	12	5
J.C. Boyle	14	48	53	5	94	25
Grand Total	128	570	**625**	9	**484**	244
California Total[3]	115	522	**571**	4	**390**	219
Oregon Total	14	48	53	5	94	25
Significance Criterion[4]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Iron Gate	3	11	14	<1	10	2
Copco 1	1	7	5	<1	7	7
Copco 2	1	3	4	<1	<1	<1
J.C. Boyle	1	2	3	<1	2	1
Total (2020)	6	23	26	<1	20	11
California Total	5	21	23	<1	17	10
Oregon Total	1	2	3	<1	2	1
De Minimis Threshold[5]	n/a	100	100	100	100	100

Notes:
1 Values shown in **bold** are significant.
2 Where emission factors were only provided for PM_{10}, appropriate PM size profiles were used to estimate $PM_{2.5}$ emissions. Appendix M includes detailed calculation tables.
3 California total includes emissions for activities at Iron Gate, Copco 1, and Copco 2 Dams.
4 Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
5 General conformity de minimis thresholds from 40 CFR 93.153.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

Vehicle exhaust and fugitive dust emissions from dam removal activities could exceed the de minimis thresholds in 40 CFR 93.153 that would require the development of a general conformity determination. Emissions from trucks and employee commuting could occur within the Klamath Falls UGB, the Klamath Falls Nonattainment Area ($PM_{2.5}$), or the Medford-Ashland AQMA; therefore, emissions that would occur within these areas are subject to the requirements of general conformity. If the total of direct and indirect emissions are below the general conformity de minimis thresholds in 40 CFR 93.153, then no further action is needed and a general conformity determination is not required.

While only emissions that would occur within the designated nonattainment or maintenance areas would be subject to general conformity, it is not possible to separate those emissions from the project total. As a result, total emissions from haul trucks and

employee commuting was compared to the general conformity de minimis thresholds as a conservative analysis. Emissions from trucks and employee commuting are less than the general conformity de minimis thresholds identified in Section 3.9.2.1 (see Tables 3.9-4 through 3.9-7) and therefore a conformity determination is not necessary for any of the maintenance or nonattainment areas. **As a result, a general conformity determination is not required.**

Fugitive dust emissions from demolition activities could impair visibility in Federal Class I areas. Demolition activities would be conducted in compliance with Oregon and California regulations related to fugitive dust emissions. In addition, any fugitive dust emissions would be short term and temporary and would not have long-term effects related to visibility. **Impacts related to visibility would be less than significant.**

Keno Transfer

The effects of the Keno Transfer would be the same as those for the Proposed Action.

East and Westside Facility Decommissioning – Programmatic Measures

The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions that could exceed Siskiyou County's thresholds of significance. Air quality impacts associated with the water supply pipeline construction would be the same as those discussed for the Proposed Action. **The impact on air quality from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

KBRA – Programmatic Measures

The effects of implementing the KBRA would be the same as those described in the Proposed Action.

3.9.4.3.4 Alternative 4: Fish Passage at Four Dams Alternative

The Fish Passage at Four Dams Alternative would not include removal of dams, but would instead include construction of fish passages. Under this alternative, fugitive dust emissions would be caused by movement of construction equipment on the soil and internal haul roads, but not by cut/fill activities, which would not occur.

Vehicle exhaust and fugitive dust emissions from construction of fish passage could increase emissions of VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ to levels that could exceed Siskiyou County's thresholds of significance. Table 3.9-8 is a summary of predicted uncontrolled peak daily and annual emission rates for VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ for the Fish Passage at Four Dams Alternative. As Table 3.9-5 shows, maximum

daily emissions for all pollutants would not exceed the thresholds of significance. **The impact on air quality from emissions of VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ at the Four Facilities would be a less than significant impact.**

Vehicle exhaust and fugitive dust emissions from dam removal activities could exceed the de minimis thresholds in 40 CFR 93.153 that would require the development of a general conformity determination. Emissions from trucks and employee commuting could occur within the Klamath Falls UGB, the Klamath Falls Nonattainment Area ($PM_{2.5}$), or the Medford-Ashland AQMA; therefore, emissions that would occur within these areas are subject to the requirements of general conformity. If the total of direct and indirect emissions are below the general conformity de minimis thresholds in 40 CFR 93.153, then no further action is needed and a general conformity determination is not required.

While only emissions that would occur within the designated nonattainment or maintenance areas would be subject to general conformity, it is not possible to separate those emissions from the project total. As a result, total emissions from haul trucks and employee commuting was compared to the general conformity de minimis thresholds as a conservative analysis. Emissions from trucks and employee commuting are less than the general conformity de minimis thresholds identified in Section 3.9.2.1 (see Table 3.9-8) and therefore a conformity determination is not necessary for any of the maintenance or nonattainment areas. **As a result, a general conformity determination is not required.**

Fugitive dust emissions from construction activities could impair visibility in Federal Class I areas. Construction activities would be conducted in compliance with Oregon and California regulations related to fugitive dust emissions. In addition, any fugitive dust emissions would be short term and temporary and would not have long-term effects related to visibility. **Impacts related to visibility would be less than significant.**

Trap and Haul – Programmatic Measures

Implementation of trap and haul measures could result in temporary increases in air quality pollutant emissions from vehicle exhaust. Potential operational emissions could occur from haul trucks moving fish around Keno Impoundment/Lake Ewauna and Link River. Upstream-migrating fish would be collected downstream from Keno Dam and relocated upstream of Link River Dam. Downstream-migrating fish would be collected at Link River Dam (and the East Side and West Side canals) and relocated downstream from Keno Dam. Seasonal trap and haul operations would occur during periods of poor water quality in Keno Impoundment/Lake Ewauna. **Although the exact extent and timing of these hauling activities is not known, it is assumed that air quality impacts from the trap and haul measures would be significant because of the long haul distance that is expected. Mitigation Measures AQ-1, 2, and 3 would be implemented to reduce the severity of these effects to a less than significant level.**

Table 3.9-8. Uncontrolled Emissions Inventories for the Fish Passage at Four Dams Alternative

Location	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[1]
Iron Gate	11	63	59	<1	8	3
Copco 1	10	58	45	<1	5	2
Copco 2	10	58	50	<1	5	2
J.C. Boyle	9	16	50	4	11	6
Maximum[2]	11	63	59	4	11	6
Significance Criterion[3]	250	2,500	250	250	250	250
	Annual Emissions (tons per year)					
Iron Gate (2023)	2	10	5	<1	2	1
Copco 1 (2025)	1	7	3	<1	2	<1
Copco 2 (2024)	1	4	1	<1	1	<1
J.C. Boyle (2022)	<1	<1	2	<1	1	<1
Total (2022-2025)	4	22	11	<1	6	1
Maximum	2	10	5	<1	2	1
De Minimis Threshold[4]	n/a	100	100	100	100	100

Notes:

[1] Where emission factors were only provided for PM_{10}, appropriate PM size profiles were used to estimate $PM_{2.5}$ emissions. Appendix M includes detailed calculation tables.

[2] Since demolition activities for each dam site occurs during different years and do not overlap, the maximum daily emissions from each dam site are used to evaluate significance.

[3] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.

[4] General conformity de minimis thresholds from 40 CFR 93.153.

Key:

VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

3.9.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative

The Fish Passage at Two Dams Alternative would include removal of Copco 1 and Iron Gate Dams, but would leave Copco 2 and J.C. Boyle Dams in place with newly constructed fish passages. This alternative would essentially be a combination of the Proposed Action (Full Facilities Removal) and the Fish Passage at Four Dams Alternative, with similar emissions sources.

Vehicle exhaust and fugitive dust emissions could increase emissions of VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ to levels that could exceed Siskiyou County's thresholds of significance. Table 3.9-9 is a summary of predicted uncontrolled peak daily and annual emission rates for VOC, NOx, CO, SO_2, PM_{10}, and $PM_{2.5}$ for the Fish Passage at Four Dams Alternative. The Iron Gate Fish Hatchery would be operated for eight years after the dam removal, but the hatchery would not be rebuilt or relocated. While additional

water may be routed to the hatchery to support its operation, an increase in emissions would not occur. Operational emissions were therefore not estimated for the hatchery. As Table 3.9-9 shows, total emissions of NOx and PM_{10} would exceed the significance criterion for the four sites.

Demolition of Copco 1 Dam could generate concrete dust, which has a high pH. Dust control measures as described in mitigation measure AQ-4 would be used to control concrete dust to the maximum extent feasible. Management of the high pH content is discussed further in Section 3.5, Terrestrial Resources. **The impact on air quality from emissions of NOx and PM_{10} from construction work at the Four Facilities would be a significant impact. Implementation of mitigation measures AQ-1 through AQ-4 would reduce emissions to a less than significant level.**

Table 3.9-9. Uncontrolled Emissions Inventories for the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative

Location	Peak Daily Emissions (pounds per day)[1]					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Iron Gate	67	282	**345**	2	209	49
Copco 1	28	179	129	1	173	165
Copco 2	12	61	82	<1	6	4
J.C. Boyle	10	32	63	4	11	7
Grand Total	117	552	**620**	7	**399**	225
California Total[3]	107	521	**557**	3	**388**	218
Oregon Total	10	32	63	4	11	7
Significance Criterion[4]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Iron Gate	3	12	14	<1	10	2
Copco 1	1	7	5	<1	8	7
Copco 2	<1	1	1	<1	<1	<1
J.C. Boyle	<1	1	2	<1	<1	<1
Total (2020)	4	20	22	<1	18	10
California Total	4	19	20	<1	17	10
Oregon Total	<1	1	2	<1	<1	<1
De Minimis Threshold[5]	n/a	100	100	100	100	100

Notes:
1 Values shown in **bold** are significant.
2 Where emission factors were only provided for PM_{10}, appropriate PM size profiles were used to estimate $PM_{2.5}$ emissions. Appendix M includes detailed calculation tables.
3 California total includes emissions for activities at Iron Gate, Copco 1, and Copco 2 Dams.
4 Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
5 General conformity de minimis thresholds from 40 CFR 93.153.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

Restoration actions could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions from the use of helicopters, trucks, and barges. Air quality impacts related to restoration activities would be similar to those described for the Proposed Action but would only occur near the Iron Gate and Copco 1 Dam sites. Table 3.9-10 summarizes emissions from reservoir restoration.

Table 3.9-10. Uncontrolled Emissions from Reservoir Restoration (Reseeding)

Phase	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
Ground Equipment	2	6	12	1	<1	<1
Barges	16	54	153	18	3	3
Aerial (Rotary Aircraft)	15	39	3	1	<1	<1
Maximum Daily[1]	18	60	165	20	3	3
Significance Criterion[2]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Total	7	29	26	1	18	10
De Minimis Threshold[3]	n/a	100	100	100	100	100

Notes:

[1] Barge and aerial application will not happen simultaneously; therefore, maximum daily emissions summarizes the peak day that consists of ground equipment and barges operating at the same time.

[2] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.

[3] General conformity de minimis thresholds from 40 CFR 93.153.

Key:

VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-10, emissions would not exceed the significance criteria. **The impact on air quality from reservoir restoration activities would be less than significant.**

Relocation and demolition of various recreation facilities could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions. Recreation facilities near J.C. Boyle Reservoir would stay intact, and the Copco 2 area does not have any developed recreation facilities. Recreation facilities at Iron Gate and Copco 1 would be removed. Annual GHG emissions were estimated using information provided in the *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2011) and CalEEMod. Table 3.9-11 summarizes emissions from the relocation and demolition of recreation facilities.

Table 3.9-11. Uncontrolled Emissions from Relocation and Demolition of Recreation Facilities

Location	Peak Daily Emissions (pounds per day)					
	VOC	CO	NOx	SO_2	PM_{10}	$PM_{2.5}$[2]
J.C. Boyle	n/a	n/a	n/a	n/a	n/a	n/a
Copco	2	13	16	<1	2	1
Iron Gate	6	32	38	<1	5	3
Total Emissions	8	45	54	<1	7	4
Significance Criterion[1]	250	2,500	250	250	250	250
	Annual Emissions (tons per year) – 2020					
Total	0.1	0.7	0.8	<0.1	0.1	0.1
De Minimis Threshold[2]	n/a	100	100	100	100	100

Notes:
[1] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.
[2] General conformity de minimis thresholds from 40 CFR 93.153.
Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

As shown in Table 3.9-11, emissions would not exceed the significance criteria. **The impact on air quality from the relocation and demolition of the various recreation facilities would be less than significant.**

Vehicle exhaust and fugitive dust emissions from dam removal activities could exceed the de minimis thresholds in 40 CFR 93.153 that would require the development of a general conformity determination. Emissions from trucks and employee commuting could occur within the Klamath Falls UGB, the Klamath Falls Nonattainment Area ($PM_{2.5}$), or the Medford-Ashland AQMA; therefore, emissions that would occur within these areas are subject to the requirements of general conformity. If the total of direct and indirect emissions are below the general conformity de minimis thresholds in 40 CFR 93.153, then no further action is needed and a general conformity determination is not required.

While only emissions that would occur within the designated nonattainment or maintenance areas would be subject to general conformity, it is not possible to separate those emissions from the project total. As a result, total emissions from haul trucks and employee commuting was compared to the general conformity de minimis thresholds as a conservative analysis. Emissions from trucks and employee commuting are less than the general conformity de minimis thresholds identified in Section 3.9.2.1 (see Tables 3.9-9 through 3.9-11) and therefore a conformity determination is not necessary for any of the maintenance or nonattainment areas. **As a result, a general conformity determination is not required.**

Fugitive dust emissions from construction and demolition activities could impair visibility in Federal Class I areas. Construction and demolition activities would be conducted in

compliance with Oregon and California regulations related to fugitive dust emissions. In addition, any fugitive dust emissions would be short term and temporary and would not have long-term effects related to visibility. **Impacts related to visibility would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary increases in vehicle exhaust and fugitive dust emissions. Air quality impacts associated with the City of Yreka water supply pipeline would be the same as those described for the Proposed Action. **The impact on air quality from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

Trap and Haul – Programmatic Measures

Implementation of trap and haul measures could result in temporary increases in air quality pollutant emissions from vehicle exhaust. The trap and haul measures around Keno Impoundment/Lake Ewauna and Link River would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **Although the exact extent and timing of these hauling activities is not known, it is assumed that air quality impacts from the trap and haul measures would be significant because of the long haul distance that is expected. Mitigation Measures AQ-1, 2, and 3 would be implemented to reduce the severity of these effects to a less than significant level.**

3.9.4.4 Mitigation Measures

3.9.4.4.1 Mitigation Measure by Consequence Summary

AQ-1 – Any off-road construction equipment (e.g., loaders, excavators, etc.) must be equipped with engines that meet the model year (MY) 2015 emission standards for off-road compression-ignition (diesel) engines (13 CCR 2420-2425.1). Older model year engines may also be used if they are retrofit with control devices to reduce emissions to the applicable emission standards.

AQ-2 – Any on-road construction equipment (e.g., pick-up trucks at the construction sites) must be equipped with engines that meet the MY 2000 or on-road emission standards.

AQ-3 – Any trucks used to transport materials to or from the construction sites must be equipped with engines that meet the MY 2010 or later emission standards for on-road heavy-duty engines and vehicles (13 CCR 1956.8). Older model engines may also be used if they are retrofit with control devices to reduce emissions to the applicable emission standards.

AQ-4 – Dust control measures will be incorporated to the maximum extent feasible during blasting operations at Copco 1 Dam. The following control measures will be used during blasting activities:

- Conduct blasting on calm days to the extent feasible. Wind direction with respect to nearby residences must be considered.
- Design blast stemming to minimize dust and to control fly rock.
- Install wind fence for control of windblown dust

3.9.4.4.2 Effectiveness of Mitigation in Reducing Consequence

Implementation of the various engine control measures (AQ-1, AQ-2, AQ-3, and AQ-4) would substantially reduce NOx and PM_{10} emissions; however, the extent of the reduction would vary based on the size (horsepower), age, and type of equipment[4]. Controlling emissions from equipment operating on the construction site, including both off-road construction equipment (AQ-1) and on-road pick-up trucks (AQ-2), would reduce NOx and PM_{10} emissions by over 80 percent each. Controlling emissions from on-road heavy-duty diesel trucks could also reduce NOx emissions by approximately 20 percent or more. The effectiveness of AQ-4 cannot be quantified, but the mitigation would minimize PM_{10} and $PM_{2.5}$ emissions that would occur during blasting operations at Copco 1. Table 3.9-12 summarizes the expected emissions after mitigation.

Table 3.9-12. Summary of Mitigated Emissions by Alternative

Alternative[1]	Peak Daily Emissions (pounds/day)					
	VOC	CO	NOx	SOx	PM_{10}	$PM_{2.5}$
Full Facilities Removal	66	405	146	3	**309**	74
Partial Facilities Removal	64	394	137	3	**294**	60
Fish Passage at Two Dams	54	372	156	3	209	44
Significance Criterion[2]	250	2,500	250	250	250	250

Notes:
[1] Alternative 4 (Fish Passage at Four Dams) not shown in Table because mitigation was not required.
[2] Based on Siskiyou County Air Pollution Control District Rule 6.1 permitting thresholds.

Key:
VOC = volatile organic compounds
CO = carbon monoxide
NOx = nitrogen oxides
SO_2 = sulfur dioxide
PM_{10} = inhalable particulate matter
$PM_{2.5}$ = fine particulate matter

[4] The vehicular emission factor models used in this analysis, specifically EMFAC2007 for on-road emissions and OFFROAD2007 for off-road emissions in California, assume a specific fleet mix of vehicles. For example, by default, EMFAC2007 contains emission factors and vehicle activity data for model years 1965 through 2040 for each vehicle class. When the model is run for a specific calendar year, then it makes assumptions about the percentage of vehicles for each model year, fuel type, and vehicle class would be operating. As a result, the default model assumptions would contain a mix of vehicles from model year 1965 to 2020 (year of construction).

3.9.4.4.3 Agency Responsible for Mitigation Implementation

The Dam Removal Entity would be responsible for implementing mitigation measures AQ-1 through AQ-3.

3.9.4.4.4 Remaining Significant Impacts

Following implementation of the mitigation measures specified for a given alternative, PM_{10} emissions would remain significant and unavoidable for the Proposed Action and the Partial Facilities Removal Alternative.

3.9.4.4.5 Mitigation Measures Associated with Other Resource Areas

Transporting fish and mollusks under Mitigation Measures AR-1, 2, 5-7 could cause temporary increases in criteria pollutants. These mitigation measures would involve trap and haul of fish and mollusks to protect them from the reservoir drawdown and dam demolition activities. It is anticipated that as many as 150 truck trips would be required to transport juveniles from areas downstream from Iron Gate Dam to the confluence of the Klamath and Trinity Rivers between February and April 2020. The increase in daily truck trips would be minor (approximately 2 trips per day) and would not contribute substantially to the existing emissions. **The air quality impacts associated with these mitigation measures would be less than significant.**

Construction activities associated with Mitigation Measure TR-1 could cause a temporary increase in vehicle exhaust and fugitive dust emissions. Relocation of Jenny Creek Bridge and culverts near Iron Gate Reservoir would occur before the other construction phases of dam removal. On- and off-road construction equipment would be used to complete the necessary construction, but would be minor compared to the dam demolition emissions. **Air quality impacts associated with Mitigation Measure TR-1 would be less than significant.**

Several other mitigation measures may require construction, including Mitigation Measure H-2 (move or elevate structures with flood risk), GW-1 (deepen or replace wells), REC-1 (replacement of recreational facilities), and WRWS-1 (modify water intakes). These measures could produce temporary impacts on air quality during construction activities within localized areas. These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed Action and action alternatives. The same or similar elements as for the Proposed Action and action alternatives would be incorporated into these construction activities to avoid or reduce impacts on air quality. **Mitigation Measures *AQ-1*** through ***AQ-3*** would be implemented, as necessary, to avoid or reduce impacts as under the Proposed Action. **Therefore, impacts on air quality from the implementation of H02, GW-1, REC-1, and WRWS-1 would be less than significant.**

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3.10 Greenhouse Gases/Global Climate Change

This section discusses potential greenhouse gas (GHG) and global climate change impacts from the Proposed Action and alternatives. The analysis related to climate change was organized into two distinct categories: 1) issues related to how climate change would affect the Proposed Action, and 2) issues related to the quantification of GHG emissions. This section describes the affected environment/environmental setting, analysis methods, significance criteria, and impacts for each of the alternatives. Appendix N provides detailed GHG emission calculations.

3.10.1 Area of Analysis

The area of analysis is the Klamath Basin, which includes multiple counties in northern California and southern Oregon. A quantitative analysis of GHG emissions associated with dam removal consistent with implementation of the Klamath Hydroelectric Settlement Agreement (KHSA) was restricted to Siskiyou and Shasta Counties in California and Klamath and Jackson Counties in Oregon. This area was defined to encompass GHG emissions associated with dam removal activities and construction-related vehicle trips (e.g., trucks and construction worker commuting).

A qualitative analysis of GHG impacts was completed for the aforementioned counties, as well as Del Norte, Humboldt, Modoc, and Trinity Counties in California and Curry County in Oregon. These counties would encompass areas affected hydrologically by implementation of the KHSA and the Klamath Basin Restoration Agreement (KBRA). In other words, regions that could be affected by the effects of climate change, such as increased temperature, changes in precipitation, and reduced snowpack, were evaluated.

Although project-related emissions are restricted to the area of analysis described above, data on the existing GHG emissions are only available at the State-level for California and Oregon (California Air Resources Board [CARB] 2009; Oregon 2010). The climate change analysis is based on global circulation models that typically do not have resolutions finer than the region or State. As a result, it was necessary to use a larger region than that included the area of analysis to establish existing conditions.

3.10.2 Regulatory Framework

Greenhouse gas and global climate change are governed by several Federal and State laws and policies, which are listed below.

3.10.2.1 Federal Authorities and Regulations

- Department of the Interior (DOI) Secretarial Order No. 3289
- Prevention of Significant Deterioration and Title V Greenhouse Gas Tailoring Rule (75 FR 31514)

3.10.2.2 State Authorities and Regulations

- California Executive Order S-3-05
- California Executive Order S-13-8
- California Executive Order S-14-08
- California Executive Order S-21-9
- California Global Warming Solutions Act of 2006 (Assembly Bill [AB] 32)
- California Renewable Energy Resources Act (Senate Bill 2, First Extraordinary Session [SBX1 2])
- California Environmental Quality Act (CEQA) Guidelines (14 CCR §15064)
- Oregon House Bill 3543

3.10.2.2.1 Existing Conditions/Affected Environment

Data generated from global circulation models are used to project changes to climate. Climate change projections are based on varying global circulation models and emissions scenarios documented in reports, as described below. Because each report is based on different models and scenarios, each has varying levels of uncertainty associated with the projected changes. For this analysis, the ranges of projected changes published in each report are presented. In addition, the models used for each report were conducted at different scales (regional, State or local), as indicated in the descriptions below.

- **The United States Global Change Research Program (USGCRP)[1] climate impact analyses (USGCRP 2009):** The foundation for the USGCRP report is a set of 21 Synthesis and Assessment Products, as well as other peer-reviewed scientific assessments, including those of the Intergovernmental Panel on Climate Change (IPCC), the United States Climate Change Science Program, the United States National Assessment of the Consequences of Climate Variability and Change, the Arctic Climate Impact Assessment, the National Research Council's Transportation Research Board report on the Potential Impacts of Climate Change on United States Transportation, and a variety of regional climate impact assessments (USGCRP 2009). The scale of the USGCRP results is for the Northwest.
- **The Oregon Climate Assessment Report by the Oregon Climate Change Research Institute (OCCRI) (OCCRI 2010):** The Oregon Climate Assessment Report draws on research on climate change impacts in the western United States from the Climate Impacts Group at the University of Washington and the California Climate Action Team (OCCRI 2010). The scale for the OCCRI results is for the State of Oregon.

[1] United States Global Change Research Program is a consortium of 13 Federal departments and agencies authorized by Congress in 1989 through the Global Change Research Act (Public Law 101-606). The USGCRP coordinates and integrates Federal research on changes in the global environment and their implications for society.

- **The regional climate change effects synthesized by the Federal Highway Administration (FHWA 2010):** The FHWA report is based on the USGCRP report and the supporting database (CMIP3), as well as publicly available publications and literature on model results. In addition, FHWA high-resolution temperature and precipitation projections for the continental United States developed through statistical downscaling of the results of 16 climate models of the CMIP3 database were provided for low and moderately high emission scenarios for three future projections, including near-term, mid-century, and end-of-century. The scale of the FHWA results is for the Northwest.
- **Impacts to the Klamath Basin prepared by the National Center for Conservation Science and Policy; and the Climate Leadership Initiative (Barr et al. 2010):** For the Klamath Basin by the National Center for Conservation Science and Policy and the Climate Leadership Initiative, three global climate models—CSIRO, MIROC, and HADCM—and a vegetation model (MC1) simulated future temperature, precipitation, vegetation, runoff, and wildfire in the Klamath Basin (Barr et al. 2010). The scale of the results for this report is for the Klamath Basin.
- **Hydrology, Hydraulics and Sediment Transport Studies for the Secretary's Determination on Klamath River Dam Removal and Basin Restoration (Bureau of Reclamation [Reclamation] 2011c):** For the hydrologic, hydraulic, and sediment transport studies conducted by the Reclamation Technical Service Center, five different future climate scenarios were simulated. The scenarios were chosen to bracket the range of results simulated by global circulation models. Four scenarios correspond to combinations of the 25th and 75th quantiles of the precipitation and temperature simulated by the global circulation models for the Upper and Lower Klamath Basins. The fifth is the 50th quantile of the precipitation and temperature. The precipitation and temperature simulated by the global circulation models were downscaled to the Upper and Lower Klamath Basin. See Section 3.6, Flood Hydrology.
- **SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water (Reclamation 2011):** This report was prepared by Reclamation to address the effect of, and risk resulting from, global climate change with respect to the quantity of water resources located in each major Reclamation river basin. Information in the report was derived from available literature and from key findings from peer-reviewed studies. An original assessment was completed for the climate change implications for snowpack and natural hydrology.

3.10.2.2.2 Summary

The projected changes in climate conditions are expected to result in a wide variety of effects in the Pacific Northwest[2] and the Klamath Basin with regard to the Proposed

[2] The Pacific Northwest is defined by the USGCRP as Washington, Oregon, Idaho, and western Montana. Although the USGCRP "Pacific Northwest" region does not include California, it has the climate most representative of the Klamath Basin. The USGCRP region that contains California is the "Southwest" climate region, which includes California, Nevada, Arizona, Utah, and parts of New Mexico, Colorado, and Texas. The Southwest data represents the desert climates, which is not applicable to the Klamath Basin.

Action and the alternatives. The most relevant consequences related to the Proposed Action include changes to stream flow, temperature, precipitation, ground water, vegetation changes, and flow. In general, climate model projections include:

- Increased average ambient air and water temperature
- Increased number of extreme heat days
- Changes to annual and seasonal precipitation, including increased frequency and length of drought, less winter snow and more winter rain, and changes in water quality
- Increased heavy precipitation
- Reduced snow pack and snow melt, resulting in less runoff during the late spring through early autumn
- Vegetation changes
- Ground water hydrology changes
- Changes to annual stream flow

These projected changes are discussed in detail in the following paragraphs. The potential impacts related to the Proposed Action are discussed in Section 3.10.4.3, Effects Determination.

3.10.2.2.3 Increased Temperature

Future regional average annual air temperatures in Oregon are projected to increase by 0.2 to 1°F per decade depending on future GHG emissions, as compared to temperatures in the 20th century (OCCRI 2010). Projected temperature increases for the Pacific Northwest and the Klamath Basin are presented in Table 3.10-1.

Table 3.10-1. Projected Changes in Air Temperature under Existing Conditions

Region	Next Two Decades	Mid-21st Century	End of 21st Century
Pacific Northwest	+3.0 °F	+3.6 to 5.0 °F	+5.1 to 8.3 °F
Klamath Basin[1]	--- (---)	+2.1 to 3.6 °F (+2.7 to 3.0 °F)	+4.6 to 7.2 °F (+5.0 to 6.0 °F)

Source: USGCRP 2009, Barr et al. 2010, Reclamation 2011

Note:

[1] Data in (parentheses) from SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water (Reclamation 2011).

Key:

--- = data not available

Baseline conditions for the Pacific Northwest are based on data from 1961 to 1979 (USGCRP 2009). Baseline conditions for the Klamath Basin are based on data from 1961 to 1990 (Barr et al. 2010). Baseline conditions in the Klamath Basin are also considered to be the 1990s in the SECURE Water Action Section 9503(c) Report (Reclamation 2011).

In addition, the results of the hydraulic, hydrologic and sediment studies conducted to support this document show an average temperature increase of 2.5 to 4.0 °F in the Upper Klamath Basin between 2020 and 2069, as compared to temperatures during the period 1950 –1999 (Reclamation 2012c).

Increased temperature may result in a variety of general consequences for the Pacific Northwest and the Klamath Basin:

- Increased evaporation rates (USGCRP 2009).
- Increased incidence of wildfire (OCCRI 2010).
- Increased occurrence of short-term and long-term drought conditions (USGCRP 2009).
- Changing water quality of natural surficial water bodies, including higher water temperatures, decreased and fluctuating dissolved oxygen content (Barr et. al 2010), and increased cycling of detritus.
- Earlier, longer, and more intense algae blooms (Barr et al. 2010).
- Changes to soil moisture (USGCRP 2009), which may lead to soil subsidence under structures.
- Increased energy demand for cooling, refrigeration and water transport (Barr et al. 2010; USGCRP 2009).
- Buckling of pavement or concrete structures (USGCRP 2009).
- Decreased lifecycle of equipment or increased frequency of equipment failure (USGCRP 2009).
- Increased frequency of freeze-thaw cycles in winter months (USGCRP 2009).
- Changes to salmon populations due to increased water temperatures and other water quality changes (USGCRP 2009).
- Drought stresses and higher temperatures that could decrease tree growth and change habitat in most low- and mid-elevation forests (Barr et al. 2010).
- Warmer winters and longer growing seasons that may increase the frequency and intensity of insect attacks, such as those of the mountain pine beetle (Barr et al. 2010).
- Disruption of the coordination between predator-prey or plant-pollinator life cycles that may lead to declining populations of many native species (Barr et al. 2010).
- Increased water temperature (Barr et al. 2010).

As discussed in Section 3.3, Aquatic Resources, high water temperatures are detrimental to anadromous species when eggs or juveniles are present. High water temperatures have also been associated with fish die offs in the Lower Klamath River downstream from Iron Gate Dam.

3.10.2.2.4 Increased Number of Extreme Heat Days

By mid-century, heat events are projected to increase in the Pacific Northwest (FHWA 2010). By mid-century, the Pacific Northwest could experience an additional one to

three heat waves annually (i.e., three or more days with the daily heat index exceeding 90°F), with other locations experiencing up to one additional heat wave each year under a moderate emission scenario (Salathe et al. 2009).

Increases in the number of extreme heat days may result in declining air quality due to increased ozone concentrations and increased incidence of heat-related illness and death.

3.10.2.2.5 Annual Precipitation

Over the next century, mean precipitation is projected to change gradually from existing precipitation averages. By mid-century (2035-45), the annual precipitation projections in the Klamath Basin exhibit a large range, from an 11 percent reduction to a 24 percent increase overall (Barr et al. 2010). Baseline conditions for the Klamath Basin are based on data from 1961 to 1990 (Barr et al. 2010).

The results of the hydraulic, hydrologic and sediment studies conducted to support this document show a change in total precipitation under the climate change scenarios ranging from 5 percent less to 5 percent greater precipitation between 2020 and 2069, as compared to precipitation during the period 1950–1999 (Reclamation 2012c).

Precipitation changes associated with climate change are complicated by the El Niño Southern Oscillation (ENSO). ENSO produces a cool, dry winter in the Klamath Basin and has cycles of 2–7 years of building and declining precipitation (Independent Science Advisory Board 2007). Climate change could affect the frequency or severity of ENSO events, which would change precipitation patterns in the Klamath Basin (Kiparksy and Gleick 2003). In addition, the Klamath Basin is at the southern edge of a low pressure cell during ENSO events, with the primary effect being a shift of storms southward towards southern California (National Oceanic and Atmospheric Administration Fisheries Service 2008). Climate change could move the low pressure area northward, which could change the types of ENSO effects within the basin from producing a drier winter to producing more intense winter storms.

3.10.2.2.6 Changes to Seasonal Precipitation

While only a slight increase in precipitation (defined as annual total precipitation divided by the number of “wet” days where precipitation exceeds 1 millimeter per day) is projected for the Pacific Northwest (Salathe et al. 2009), changes in seasonal precipitation, including winter rain replacing winter snow, are projected to result in earlier and higher spring stream flows and lower late summer stream flows (USGCRP 2009; Barr et al. 2010). Table 3.10-2 summarizes projected seasonal changes in precipitation for the Pacific Northwest and the Klamath Basin.

Table 3.10-2. Projected Seasonal Changes in Precipitation

Region	Season	Next Two Decades	Mid-21st Century	End of 21st Century
Pacific Northwest	Winter	+3 to +5%	+5 to +7%	+8 to +15%
	Spring	+3%	+3 to +5%	+5 to +7%
	Summer	-6%	-8 to -17%	-11 to -22%
	Fall	+3 to +5%	+5%	+7 to +9%
Klamath Basin[1]	Summer	---	-15 to -23%	-3 to -37%
	Winter	---	+1 to +10%	-5 to +27%
	Annual	---	-9 to +2% (+2.2 to +2.7%)	-11 to+24% (-0.2 to +2.2%)[2]

Source: USGCRP 2009, Barr et al. 2010, Reclamation 2011

Note:

[1] Data in (parentheses) from SECURE Water Act Section 9503(c) – Reclamation Climate Change and Water (Reclamation 2011).

[2] Data based on expected change in the 2070s.

Key:

--- = data not available

Baseline conditions for the Pacific Northwest are based on data from 1961 to 1979 (USGCRP 2009). Baseline conditions for the Klamath Basin are based on data from 1961 to 1990 (Barr et al. 2010).

Summer months in the Klamath Basin are projected to have precipitation decreases ranging from 15 to 23 percent from historic baseline (1961-1990) (Barr et al. 2010). However, less than 12 percent of the average annual precipitation in the Klamath Basin falls from June-August (Western Regional Climate Center 2010), so the effect on average actual summer precipitation would be small (less than 0.2 inches). In the Upper Klamath Basin, dry-season (April to September) and summer (July to September) stream flow have already declined 16 percent and 38 percent, respectively, during the period between 1961-2009 (Mayer and Naman 2011).

Changes to seasonal precipitation may result in a variety of general consequences for the Pacific Northwest and Klamath Basin, which are listed below.

- Shifting stream flow patterns, including higher and earlier peak spring flows and lower late summer flows may alter the timing of fish migration (Barr et al. 2010).
- Decreased summer water supply (OCCRI 2010).
- Increased fine sediment in streams may result in negative impacts on the spawning of native fish that build their nests in the areas of clean rocks and gravel (Barr et al. 2010).
- Cessation of flow from springs fed by ground water may reduce the amount of refuge that these areas provide for fish survival (Barr et al. 2010).
- More variable flow from smaller ground water springs may occur, with potential disappearance in the driest years (Barr et al. 2010).
- Increased frequency and severity of flooding may occur (USGCRP 2009).

- Increased runoff may lead to surface water quality changes, including increased turbidity, increased organic content, color changes, and alkalinity changes (Barr et al. 2010).

3.10.2.2.7 Increase in Heavy Precipitation

Projections show that by mid-century, heavy precipitation, defined as annual total precipitation divided by the number of "wet" days where precipitation exceeds one millimeter per day, would increase slightly in the Pacific Northwest (FHWA 2010). The fraction of precipitation that falls on days where precipitation exceeds the 95th percentile was projected to decrease along the leeward side of the Cascade Mountains (Salathe et al. 2009). The characteristics along the leeward side of the Cascade Mountains are comparable to the Klamath Basin. Diffenbaugh (2005) projected an increase of up to 10 extreme precipitation events per year in the Pacific Northwest (up to a 140 percent increase) under a higher emission scenario with some variation depending on location within the region.

Increases in heavy precipitation may result in a variety of general consequences for the Pacific Northwest:

- Increased fine sediment in streams may result in negative effects on the spawning of native fish that build their nests in the areas of clean rocks and gravel (Barr et al. 2010).
- Increased frequency and severity of flooding may occur (USGCRP 2009).
- Increased runoff may lead to surface water quality changes including increased turbidity, increased organic content, color changes, and alkalinity changes (Barr et al. 2010).

3.10.2.2.8 Reduced Snowpack

By the 2040s, April 1st snowpack is projected to decline by as much as 40 percent in the Cascade Mountains (Payne et al. 2004) and between 37 percent and 65 percent in the Klamath Basin (Hayhoe et al. 2004). Cascade snowpack is projected to be less than half of what it was in the 20th century, with lower elevation snowpack being most vulnerable (OCCRI 2010). Projections show that by mid-century, warm-season runoff will decrease by 30 percent or more on the western slopes of the Cascade Mountains and by 10 percent in the Rocky Mountains (USGCRP 2009). By the end of the century, snowpack is projected to decline by 73 percent to 90 percent (Hayhoe et al. 2004).

The reduction in snowpack and snowmelt is also expected to result in less runoff during the late spring through early autumn. Snowpack decreases are projected to be more substantial in the warmer parts of the Klamath Basin. Projected warming might also change runoff timing, with more rainfall-runoff during the winter and less runoff during the late-spring and summer (Reclamation 2011).

Similarly, the results of the hydraulic, hydrologic and sediment studies conducted to support the Secretarial Determination on the Klamath Dam Removal and Basin Restoration show a more rapid snow melt for all climate change simulations.

Reduced snowpack may result in a variety of general consequences for the Pacific Northwest, including increased incidence of short- and long-term drought and limited inundation periods for side channels, which serve as nurseries for young fish and other aquatic animals (Barr et al. 2010). Summer water supply will also decrease as a result of reduced snowpack (OCCRI 2010).

3.10.2.2.9 Ground Water Hydrology

Projected increases in temperature and changes to seasonal precipitation will impact ground water hydrology. Projected changes in ground water hydrology include alterations of the timing and amount of recharge, increases in evapotranspiration, lowering of heads in boundaries such as streams, lakes, and adjacent aquifers, sea-level rise, and increased pumping demand, which will be exacerbated by population growth (OCCRI 2010). The high Cascade basins that are primarily fed by deep ground water systems could sustain low flow during summer months (OCCRI 2010). Basins in the east of the Cascades are projected to have low summer flow in a distant future as ground water recharge declines over time (OCCRI 2010).

Ground water hydrology changes may result in a variety of general consequences for the Pacific Northwest and Klamath Basin, including the following:

- Decreased stream flows for rivers and streams that are primarily fed by ground water supplies (Barr et al. 2010).
- Decreased availability of ground water for agricultural use and water supply (USGCRP 2009).

Reduced cool water refuge for aquatic animals due to the decline of springs fed by ground water and the cessation and increased variability of flow to smaller springs (Barr et al. 2010).

3.10.2.2.10 Vegetation Changes

Conditions in the Upper Klamath Basin are projected to favor grasslands in areas that are currently suitable for sagebrush and juniper (Barr et al. 2010). In the Lower Klamath Basin, conditions suitable for oaks and madrone may expand while those suitable for maritime conifer forest could decrease (Barr et al. 2010). The percentage of the Klamath Basin burned by wildfire is expected to increase from current levels by 11 percent to 22 percent per year by the end of the 21st century (Barr et al. 2010). In addition, decreased soil moisture and increased evapotranspiration may result in the loss of wetland and riparian habitats (Barr et al. 2010).

Vegetation changes may result in a variety of general consequences for the Pacific Northwest and Klamath Basin, including the following:

- Changes in water quality (e.g., sediment) from burn area runoff (Barr et al. 2010).
- Changes in the tree canopy that affect rainfall interception, evapotranspiration, and infiltration of precipitation, affecting the quantity of runoff (Barr et al. 2010).

- Changes in the shading over surface waters, which may affect surface water temperatures and other water quality characteristics (USGCRP 2009).
- Changes in wood and organic debris recruitment, which may affect water quality and channel morphology and complexity (Barr et al. 2010).
- Reduced ability to respond to flooding due to changes in wetland and riparian zone plant communities and hydraulic roughness (USGCRP 2009).
- Increased stress on species populations due to loss of wetland and riparian habitats (USGCRP 2009).
- Shifting distribution of plant and animal species on land, with some species becoming more or less abundant (OCCRI 2010).
- Rare or endangered species may become less abundant or extinct (OCCRI 2010).
- Insect pests and invasive species may become more abundant (OCCRI 2010).

3.10.2.2.11 Flow

Future annual stream flow effects calculations based on projected precipitation amount and timing changes are particularly difficult to project. Annual stream flows (the volume of flow in a year) were evaluated by comparing future model-estimated flows (based on runoff estimates from the three climate models) against actual stream flow measurements. Annual stream flows at the four stations evaluated (Iron Gate, Sprague River, Shasta River, and Salmon River) were "similar" to past records when comparing the frequency of "particularly" high and low flow events. The three models' results vary regarding projections of higher or lower annual flows—two models projecting lower flows and one projecting higher annual flows as compared to current flows (Barr et al. 2010).

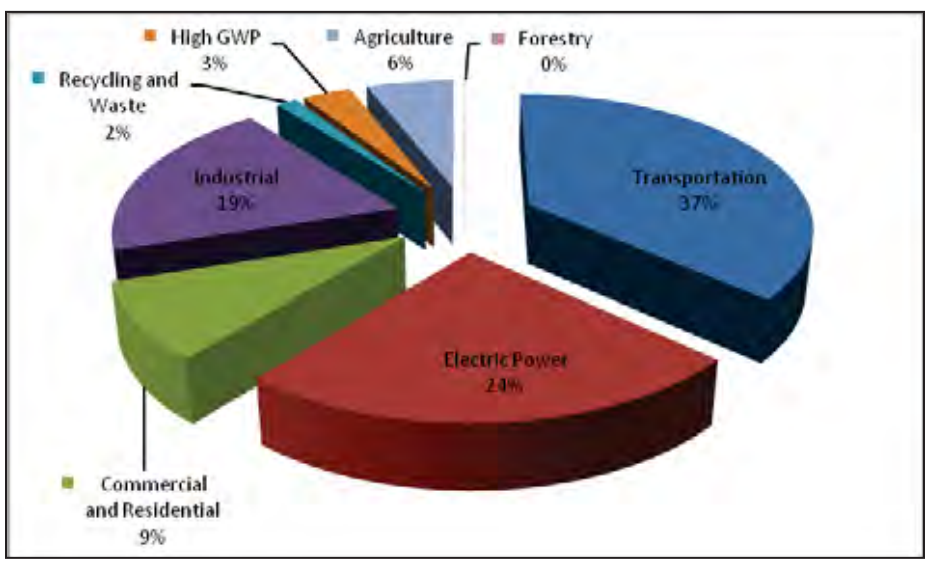
Similarly, the results of the hydraulic, hydrologic and sediment studies conducted to support this document show that the climate change scenarios are not sufficiently refined to determine effects to peak flows and therefore it is difficult to determine if climate change will have a significant impact on flood risk or geomorphology. However, if the future climate is wetter and with a faster snowmelt runoff during the spring, then peak flows would likely increase as well. However, if the climate is drier, faster snowmelt may result in peak flows that are not substantially higher (Reclamation 2012c).

Though the model used to project future flows did not identify a consistent trend, it is known that free-flowing rivers respond better to changes in climate conditions due to the ability to adjust to and absorb disturbances through flow adjustments that buffer against impacts (Palmer et al. 2008). A natural riverine system is in constant, dynamic equilibrium, absorbing highly variable flow forces by changing channel morphology and dissipating energy via sediment transport and woody debris. A natural river system is capable of using those "tools" to gradually adjust to flow regime changes due to climate-induced precipitation change. Consequently, the more physical changes the river system has been subjected to, such as changes in sediment budgets and flow regimes due to dams or land clearing, the less capable the system is of responding to or absorbing changed flow regime.

3.10.3 Existing Conditions/Affected Environment

The GHG analysis completed for the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) evaluated the following three pollutants: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O). The other two pollutants commonly evaluated in various mandatory and voluntary reporting protocols, hydrofluorocarbons and perfluorocarbons, are not expected to be emitted in large quantities and are not discussed further in this section.

Worldwide, California[3] is the twelfth to sixteenth largest emitter of CO_2 (based on data source), and is responsible for approximately two percent of the world's CO_2 emissions (California Energy Commission [CEC] 2006b). As shown in Figure 3.10-1, transportation is responsible for 37 percent of the State's GHG emissions, followed by electricity generation (24 percent), the industrial sector (19 percent), commercial and residential (9 percent), agriculture and forestry (6 percent) and other sources (5 percent). Emissions of CO_2 are largely byproducts of fossil fuel combustion. Nitrous oxide is produced naturally in soil and can be increased by various agricultural practices and activities; fossil fuel combustion is also responsible for N_2O emissions. Methane, a highly potent GHG, results largely from off-gassing associated with agricultural practices and landfills. Sinks of CO_2, which are sources that absorb more CO_2 then release CO_2, include uptake by vegetation and dissolution into the ocean. California GHG emissions in 2008 (the last year inventoried) totaled approximately 474 million metric tons CO_2 equivalent ($MMTCO_2e$) (CARB 2009).

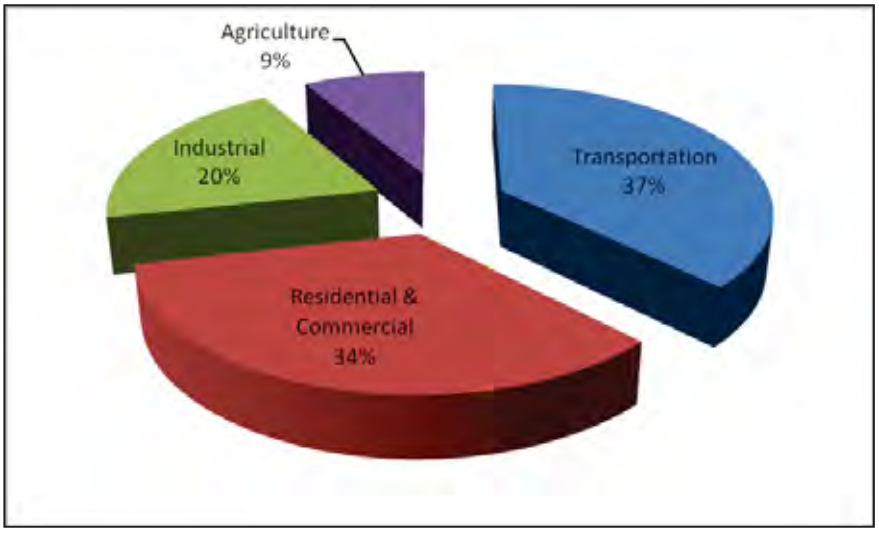


Source: CARB 2009.

Figure 3.10-1. California GHG Emission Sources (as of 2008).

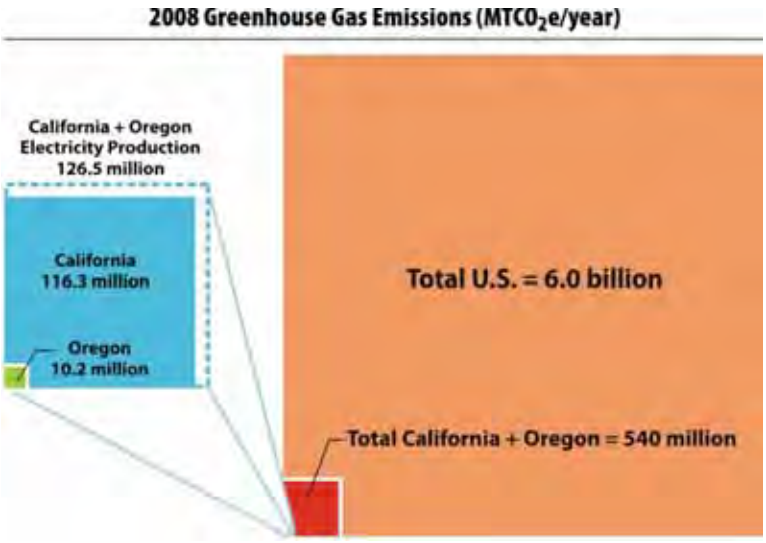
[3] Although the area of analysis for the project is restricted to portions of northern California and southern Oregon, GHG emissions data is not available at this level of detail; therefore, background emissions data (i.e., existing conditions) is presented at the State-level for both California and Oregon.

As shown in Figure 3.10-2, the distribution of emission sources in Oregon is similar to that in California, with the majority of emissions occurring from the transportation sector (37 percent), followed by the residential and commercial sector (34 percent), then by industrial sources (20 percent), and agriculture (9 percent). Oregon GHG emissions in 2007 (the last year inventoried) totaled approximately 68 $MMTCO_2e$ (Oregon 2010).



Source: Oregon 2010.

Figure 3.10-2. Oregon GHG Emission Sources (as of 2007).



Source: CARB 2011; Oregon 2010; USEPA 2011.

Figure 3.10-3. Greenhouse Gas Emissions Comparison.

Figure 3.10-3 illustrates the difference between GHG emissions associated with electricity production for Oregon and California with the economy-wide GHG emission inventories for the two States and for the United States. As shown in the figure, GHG emissions associated with electricity production are approximately 23 percent of the total emissions for Oregon and California and a fraction of the total GHG emissions for the United States.

3.10.4 Environmental Consequences

By its very nature, climate change is a cumulative phenomenon, and it is not possible to link a single project to specific climatological changes. The Proposed Action and alternatives would result in temporary GHG emissions from construction-related activities. Total GHG emissions from deconstruction or construction activities at the three dams in California (Iron Gate, Copco 1, and Copco 2 Dams) would make up 0.0007 to 0.002 percent of Statewide emissions, depending on the alternative. Emissions associated with activities at J.C. Boyle Dam in Oregon would make up 0.001 to 0.004 percent of Statewide emissions, depending on the alternative.

3.10.4.1 Environmental Effects Determination Methods

The analysis related to climate change was organized into two distinct categories: 1) issues related to how climate change would affect the Proposed Action, and 2) issues related to the quantification of GHG emissions.

The quantification of GHG emissions was performed similarly to the one for the air quality (Section 3.9) analysis with a few exceptions. Project-related emissions were compared to applicable thresholds of significance to evaluate environmental impacts from GHG.

Direct GHG emissions include those associated with on- and off-site construction equipment, construction worker commuting, and haul truck emissions. Indirect GHG emissions include changes that could occur from alterations in land use, agricultural resources, and recreation from implementation of the KHSA and KBRA. See Section 3.9, Air Quality, for additional detail relevant to the estimation of these emissions. In addition, consideration is provided in this section to the potential emissions associated with other power sources that may be used to replace the hydropower associated with the Four Facilities.

This analysis also evaluates how the GHG emissions resulting from the project might affect global climate change. GHG emissions are quantified or qualitatively described, as discussed above, for the changes associated with each project alternative, including land use changes and changes to recreational use.

3.10.4.1.1 Climate Change

The purpose of this climate change analysis is to determine how projected changes to climate conditions might affect the Proposed Action and alternatives. The Lead Agencies used the results of global climate models from leading institutions around the world, combined with publicly available, peer-reviewed studies, to identify the projected climate change effects and their consequences specific to the Pacific Northwest region and the Klamath Basin.

The main resources for identifying the project effects and general consequences were the USGCRP climate impact analyses (USGCRP 2009), the Oregon Climate Assessment Report by the OCCRI (OCCRI 2010), the regional climate change effects synthesized by the FHWA (FHWA 2010), the climate change impacts analysis prepared specifically for

the Klamath Basin by the National Center for Conservation Science and Policy; and the Climate Leadership Initiative (Barr et al. 2010). The 2009 California Climate Change Strategy also provided guidance for the analysis. For consequences specific to the project alternatives, publications by Palmer et al. (2008), Dinse et al. (2009), and Reclamation (2011c) were used to evaluate the effect of dams on a natural system's ability to adjust to and absorb disturbances caused by potential changes in climate conditions.

3.10.4.1.2. Greenhouse Gas Emissions Quantification

Emissions of GHG were quantified using the same emission factor models identified in the air quality section (Section 3.9). Emissions of CO_2, CH_4, and N_2O were estimated for on- and off-site combustion sources, including mobile and stationary sources.

Each GHG contributes to climate change differently, as expressed by its global warming potential (GWP). GHG emissions are discussed in terms of carbon dioxide equivalent (CO_2e) emissions, which express, for a given mixture of GHG, the amount of CO_2 that would have the same GWP over a specific timescale. CO_2e is determined by multiplying the mass of each GHG by its GWP[4]. This analysis uses the GWP from the IPCC *Second Assessment Report* (IPCC 1996) for a 100-year time period to estimate CO_2e. Although subsequent assessment reports have been published by the IPCC, the international standard, as reflected in various Federal, State, and voluntary reporting programs, is to use GWPs from the *Second Assessment Report*.

GHG emissions were calculated for construction activities related to dam demolition and/or fish passage construction including heavy equipment use, hauling of demolition debris to landfill, as well as worker transportation.

If a United States Environmental Protection Agency (USEPA)-approved emissions factor model (e.g., EMFAC2007, MOBILE6.2, OFFROAD, or NONROAD) does not estimate emissions of a particular pollutant, then emission factors were obtained, if possible, from the Federal Mandatory Reporting of Greenhouse Gases Rule (40 CFR Part 98).

Restoration activities would use helicopters and barges for reseeding. The Federal Aviation Administration's Emissions and Dispersion Modeling System was used to simulate emissions that could occur from landing and takeoff operations associated with aerial seed application. Emission factors for barge propulsion engines were derived from the USEPA's *Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data* (2000), while generator emissions for the seed sprayer were estimated from the USEPA's *Compilation of Air Pollutant Emission Factors* (1995).

Fugitive dust and exhaust emission factors associated with constructing the City of Yreka pipeline were estimated using the Sacramento Metropolitan Air Quality Management

[4] As an example, CH_4 has a GWP of 21, as specified in the Intergovernmental Panel on Climate Change's *Second Assessment Report* (1996). One metric ton of CH_4 is equal to 21 metric tons of CO_2e (1 metric ton x 21).

District's Road Construction Emissions Model, Version 6.3.2 (2009). The Siskiyou County Air Pollution Control District does not have a comparable model to estimate emissions from linear projects like this pipeline construction action.

The California Emissions Estimator Model (CalEEMod), Version 2011.1.1, was used to estimate exhaust emissions that would occur from grading activities associated with restoring parking lots associated with recreational facilities proposed for removal. CalEEMod makes general assumptions about the quantity and types of construction equipment needed to grade a site based on its size (acreage).

The analysis provides a quantitative comparison between removing a renewable source of energy from the hydroelectric dams and estimated emissions that may result from use of an alternative power source, such as fossil fuels, biomass, or other renewable energy sources.

Both Oregon and California have Renewable Portfolio Standard (RPS) goals that seek to increase the amount of renewable energy resources used by certain utilities. The RPS goal for California is to have 33 percent of an electricity seller's load served with renewable power by 2020 (Executive Order S-14-08; and SBX1 2), while Oregon's RPS goal is for 25 percent of a utility's retail sales of electricity to be from renewable energy by 2025 (Senate Bill 838). PacifiCorp is currently on track to meet its Oregon RPS target, but is not expected to meet California's RPS target without the use of tradable renewable energy credits (PacifiCorp 2011). Since PacifiCorp is on a trajectory to increase its use of renewable energy, any modifications to the Four Facilities, either by demolition or power generation reductions, would decrease the amount of renewable power that PacifiCorp has in its portfolio. Although short-term effects could occur from modifications to the hydroelectric dams, these effects would be offset in the long term because PacifiCorp would need to continue increasing its renewable energy share to meet the RPS goals in the two States.

3.10.4.2 Significance Criteria

At the present time, neither of the Lead Agencies has adopted significance thresholds for the analysis of GHG emissions. However, the CEQA Guidelines instructs:

"A lead agency should consider the following factors, among others, when assessing the significance of impacts from greenhouse gas emissions on the environment:

1. The extent to which the project may increase or reduce GHG emissions as compared to the existing environmental setting.
2. Whether the project emissions exceed a threshold of significance that the lead agency determines applies to the project.
3. The extent to which the project complies with regulations or requirements adopted to implement a Statewide, regional, or local plan for the reduction or mitigation of GHG emissions." (14 C.C.R. § 15064.4.)

In reference to factor number 1 stated above, the Klamath Facilities Removal would produce a temporary increase in direct GHG emissions by virtue of the construction and restoration activities, but once activities are complete, direct project emissions be reduced. With complete facilities removal, there would be no continuing operation or maintenance since the area occupied by the facilities would be returned to natural riverine and riparian setting. The partial facilities removal alternatives would still continue to have operation and maintenance emissions, but to a lesser degree than the No Action/No Project Alternative. Indirect GHG emissions would increase with the project as a result of replacing hydropower produced at the dams with power that is likely to be produced, at least in part, from fossil fuels through other regional sources.

As for factor number 2 (above) from the CEQA guidelines, the nature of the GHG emissions from the Klamath Facilities Removal differs from most projects considered highest priority for curbing emissions either on a Statewide or regional basis. Typical emission sources considered for quantitative thresholds of significance involve construction and ongoing operational emissions from stationary industrial projects with high rates of combustion emissions (for example, refineries, power plants, other processing that utilizes industrial boilers) or the construction and increased power and transportation needs from newly constructed residential/commercial projects. In these cases ongoing emissions from combustion and transportation are likely to be cumulatively considerable.

For the Proposed Action and alternatives, there are no direct operational GHG emissions. Appreciable direct emissions would occur only for a limited time as a result of construction (dam deconstruction and/or fish passage construction) and restoration. However, the Proposed Action would indirectly produce ongoing GHG emissions through conversion from the electricity produced by the local hydropower facilities to regional power from a mixture of sources likely including GHG-emitting fossil fuels.

Currently, there are no adopted numerical thresholds of significance in California that are specifically applicable to the Klamath Facilities Removal. The South Coast Air Quality Management District (SCAQMD) and the Bay Area Air Quality Management District have adopted numerical CEQA thresholds of significance for industrial stationary source GHG emissions; both districts use a threshold of 10,000 $MTCO_2e$ per year (Bay Area Air Quality Management District 2011; SCAQMD 2008). Only the SCAQMD's threshold addresses construction emissions. SCAQMD amortizes construction emissions over a 30-year period. The annual quantity is combined with a project's annual operational emissions and compared to the 10,000 $MTCO_2e$ per year threshold to determine significance.

Regarding the Statewide plan for reducing GHG emissions for factor number 3 from the CEQA guidelines, a GHG impact could be considered significant if emissions from either the Proposed Action or the alternatives exceed at least one of the two thresholds utilized in this EIS/EIR for GHG emissions. The first threshold is based on SCAQMD's methodology and as a result, GHG emissions would be significant if they exceed 10,000 $MTCO_2e$ in a year. SCAQMD developed its threshold to address emissions from

stationary source/industrial projects. However, because there are no adopted numerical thresholds for construction emissions, and the SCAQMD threshold incorporates construction emissions to its determination, using the SCAQMD method for the current project is justified.

The second manner in which a GHG impact would be significant is if GHG emissions from either the Proposed Action or the alternatives would substantially obstruct compliance with the GHG emission reductions in AB 32 and Executive Order S-3-05. Compliance with the AB 32 goal of reducing California's GHG emissions by 2020 to 1990 levels requires cutting at least 29 percent of business-as-usual emissions (i.e., emissions projected by CARB for the year 2020 without any emission reduction measures) (CARB 2008). Executive Order S-3-05 further reduces the State's emissions to 80 percent below 1990 levels by 2050. Thus, the calculated emissions from Proposed Action or from any alternative should be compared to emissions that would be produced if implemented in accordance with the assumptions CARB used to calculate its business-as-usual scenario. If emissions from the Proposed Action or alternatives are at least 29 percent below business-as-usual in 2020, impacts could be considered less than significant. For purposes of this EIS/EIR, the calculated GHG emissions from the Proposed Action or alternatives will be compared to existing numerical thresholds of significance for industrial and residential projects (factor 2) and to the Statewide plan for reducing emissions outlined in AB 32 and Executive Order S-3-05.

40 CFR 1508.27(b)(10) defines the term "significantly" under NEPA related to both context and intensity of an impact, which includes whether a proposed action "threatens a violation of Federal, State, or local law". For that reason, consideration of AB 32 and Executive Order S-3-05 informs the NEPA analysis as well.

3.10.4.3 Effects Determinations

Emissions of GHG would occur from construction activities associated with either removing dams or constructing fish passage facilities. Direct emissions of GHG would occur from engine exhaust emissions from off-road construction equipment, on-road trucks, and construction worker commuting vehicles. Emissions were estimated using various emission factor models, including CARB's EMFAC2007 and OFFROAD2007 for on- and off-road exhaust emissions and USEPA's MOBILE6.2 and NONROAD2008 for engine exhaust emissions. Fugitive dust emissions were also estimated using CARB's URBEMIS2007 (version 9.2.4) model and additional calculations from AP-42 (USEPA 1995). Detailed calculations from each alternative are provided in Appendix N.

Indirect GHG emission changes could also occur from alterations in land use, agricultural resources (including the creation of new agricultural areas), and recreation from implementation of the KHSA and KBRA. These emission changes could occur from changing open water reservoirs to one of the following categories that could replace the reservoirs:

- Grassland/pasture (including cattle grazing)

- Wetlands (with increased sequestration)[5]
- Re-planting of forests (including riparian vegetation)

Changes in recreational activities, such as decreases in motorized vehicles and increases in non-motorized vehicles, would also occur from the potential removal of the dams. It is expected that the removal of the dams would result in a decrease in motorized recreation activities from the elimination of the open water reservoirs, which would consequently result in a reduction of GHG emissions.

Sediments in reservoirs contain carbon that is formed from the decomposition of accumulated dead plankton and other debris that could be released when a dam is decommissioned. If anoxic digestion causes the carbon to be released in the form of CH_4, then there could be a net negative impact of the existing reservoirs associated with the dams because of the higher GWP of CH_4 as compared to CO_2 (Pacca 2007).

Except for emissions from power plant operations and maintenance, GHG emissions from hydropower are negligible because no fuels are burned; however, plant matter can decay in the reservoir, causing the buildup and release of CH_4 (USEPA 2007). Analyzing the magnitude of these CH_4 emissions is difficult, but it is important to understand that open water reservoirs associated with hydropower may have a certain level of CH_4 emissions from their operation. The Klamath Hydroelectric Project reservoirs have characteristics that would favor high (at least one percent of the amount of GHG emissions that could occur from removing the hydroelectric facilities) CH_4 emissions: they receive massive organic/nutrient loads from upstream, have large in-reservoir algal blooms, and have anoxic hypolimnions (See Section 3.2, Water Quality).

The USEPA has also estimated carbon sequestration rates from a variety of agricultural and forestry practices. Table 3.10-3 summarizes the carbon sequestration rates documented by the USEPA. Insufficient information is available to estimate the exact carbon sequestration that could occur from the conversion of the open water reservoirs to one of these other land uses; however, it is expected that a net reduction in carbon emissions could occur from the land use conversion.

If the land behind the removed dams is converted to agricultural use such a cattle grazing, certain agricultural practices could result in an increase in GHG emissions. For example, grasslands and pastures could serve as carbon sinks, but cattle grazing could actually counteract some of these sinks. Section 4.9 of the Federal Energy Regulatory Commission (FERC) EIS discusses this issue further. Emissions from the digestion of cattle feed and manure management would result in net GHG emissions. Additional information on the number of head of cattle and the total size of the land conversion would be necessary to estimate whether there would be a net benefit or adverse impact from possible cattle grazing.

[5] Sequestration is the process of removing carbon from the atmosphere and storing it in carbon sink.

Table 3.10-3. Representative Carbon Sequestration Rates and Saturation Periods for Key Agricultural and Forestry Practices

Activity	Representative Carbon Sequestration Rate (metric tons of C per acre per year)	Time Over Which Sequestration May Occur Before Saturating[1]
Afforestation[2]	0.6 – 2.6[3]	90–120+ years
Reforestation[4]	0.3 – 2.1[5]	90–120+ years
Changes in forest management	0.6 – 0.8[6]	If wood products included in accounting, saturation does not necessarily occur if C continuously flows into products
	0.2[7]	
Conservation of riparian buffers	0.1 – 0.3[8]	Not calculated
Conversion from conventional to reduced tillage	0.2 – 0.3[9]	15–20 years
	0.2[10]	25–50 years
Changes in grazing land management	0.02 – 0.5[11]	25–50 years
Biofuel substitutes for fossil fuels	1.3 – 1.5[12]	Saturation does not occur if fossil fuel emissions are continuously offset

Source: USEPA 2010a.

Notes:

1 Values refer to the level of time during which sequestration could be occurring. After the stated period, then there would cease to be a positive effect from the carbon sink.

2 Values are for average management of forest after being established on previous croplands or pasture.

3 Value calculated over 120-year period. Low value is for spruce-fir forest type in lake States; high value is for Douglas Fir on Pacific Coast. Soil carbon accumulation is included in estimate.

4 Values are for average management of forest established after clear-cut harvest.

5 Values calculated over 120-year period. Low value is for Douglas Fir in Rocky Mountains; high value is for Douglas Fir in Pacific Coast. No accumulation in soil carbon is assumed.

6 Select examples, calculated over 100 years. Low value represents change from 25-year to 50-year rotation for loblolly pines in Southeast; high value is change in management regime for Douglas Fir in Pacific Northwest. Carbon in wood products included.

7 Forest management here encompasses regeneration, fertilization, choice of species, and reduced forest degradation. Average estimate here is not specified to US, but averaged over developed countries.

8 Assumed that carbon sequestration rates are the same as average rates for lands under United States Department of Agriculture Conservation Reserve Program.

9 Estimates include only conversion from conventional to no-till for all cropping systems except for wheat-fallow systems, which may not produce net carbon gains. Estimates of changes in other GHG not included.

10 Assumed that average carbon sequestration rates are the same for conversion from conventional till to no-till, mulch till, or ridge till. Estimates of changes in other GHG not included.

11 See Improve/Intensity Management section in Table 16.1 of Follett et al. (2001). Low end is improvement of rangeland management; high end is changes in grazing management on pasture, where soil organic carbon is enhanced through manure additions. Estimates of flux changes in other GHG not included.

12 Assumes growth of short-rotation woody crops and herbaceous energy crops, and that burning this biomass offsets 65 to 75 percent of fossil fuel in CO_2 estimates. Estimates of changes in other GHG not included.

Key:

C = carbon

30.10.4.3.1 Alternative 1: No Action/No Project Alternative

Effects of Climate Change on the No Action/No Project Alternative

The No Action/No Project Alternatives would likely require greater management actions, policies, and mitigation measures to protect the surrounding ecosystems and communities as compared to actions that include dam removal because the Klamath Basin is more likely to experience a greater magnitude of consequences from the projected changes in climate conditions than if the dams were removed. The situation might require costly

future projects to prevent or respond to the consequences of climate change. For example, disturbances caused by drought, changes to vegetation, changes to water quality characteristics, and changes to fish and shellfish populations and patterns might not be able to be adjusted to or absorbed as easily with the dams in place as without them. The baseline temperatures on the mainstem of the Klamath River are stressful for fish, and fish rely on small areas of refugia (typically near tributary inflow). Increased ambient temperatures could increase water temperatures. Therefore climate change is likely to reduce or possibly eliminate these refugia, making the temperature in the mainstem of the river unsuitable for fish rearing and movement during critical times of the year. Increased energy expenditure for rescuing fish or removing them to controlled (hatchery-type) situations may then be necessary for maintaining viable fish populations in the Klamath Basin.

Also, free-flowing rivers, in general, respond better to changes in climate conditions due to the ability to adjust to and absorb disturbances through flow adjustments that buffer against impacts (Palmer et al. 2008). A natural riverine system is in constant, dynamic equilibrium, absorbing highly variable flow forces by changing channel morphology and dissipating energy via sediment transport and woody debris. A natural river system is capable of using those "tools" to gradually adjust to flow regime changes due to climate-induced precipitation change. Consequently, the more physical changes the river system has been subjected to, such as changes in sediment budgets and flow regimes due to dams or land clearing in the basin or riparian zones, the less capable the system is of responding to or absorbing changed flow regime.

As described in Section 3.2, Water Quality, climate change would cause general increases in water temperature that could decrease the 100 percent saturation level for dissolved oxygen. This decrease in dissolved oxygen concentration at saturation would act in opposition to successful total maximum daily load implementation. Climate change would increase the possibility of continued exceedance of the minimum dissolved oxygen objectives in the region.

As described in Section 3.3, Aquatic Resources, the temperature in the Klamath River Estuary and Pacific Ocean would remain similar to the existing conditions and climate change would continue to play a role in future temperatures. Warmer water temperatures associated with climate change would increase the frequency and duration of stressful water temperatures for cold-water species, including all anadromous fish and salmonids in the basin. For warm-water species, little effect would likely result from this level of warming.

Effects of the No Action/No Project Alternative on Climate Change

Vehicle exhaust from operation and maintenance of the Four Facilities and continued water impoundment in the reservoirs could result in GHG emissions. Under the No Action/No Project Alternative, neither dam removal consistent with KHSA nor installation of fish ladders would be completed. Since the removal of the dams or the construction of fish passages would not occur, there would be no emissions associated with construction; however, ongoing CH_4 emissions from anaerobic decay in the

impoundment would still occur under the No Action/No Project Alternative. Continual emissions would also occur from equipment use and worker commute for operation and maintenance of facilities.

The Karuk Tribe (2006) estimated the total amount of CH_4 released from Keno, J.C. Boyle, Copco, and Iron Gate Reservoirs, calculated by multiplying the reservoirs' area by areal emissions rates from reservoirs around the world with similar characteristics (poor water quality). The resulting estimate ranged from approximately 8,000 to 29,000 $MTCO_2e$ per year[6]. Without Keno Impoundment, CH_4 emissions would be approximately 4,000 to 14,000 $MTCO_2e$ per year for Iron Gate, Copco, and J.C. Boyle Reservoirs. Under the No Action/No Project Alternative, releases of CH_4 from the reservoirs would continue at the same levels. See Appendix N for detailed calculations. **There would be no change from existing conditions from GHG emissions from vehicle emissions or continued impoundment of water relative to existing conditions.**

Activities associated with several interim measures (IMs) could result in short-term and temporary increases in GHG emissions from vehicle exhaust. Several IMs would be implemented under the No Action/No Project Alternative. Several of these measures could result in increased GHG emissions:

- IM 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement
- IM 8: J.C. Boyle Bypass Barrier Removal

IM 7 would require PacifiCorp to place suitable gravels in the J.C. Boyle Bypass and Peaking reaches using a passive approach before high flow periods or to provide for other habitat enhancement. The No Action/No Project Alternative includes only 1 year of this measure. GHG emissions could occur from trucks hauling gravel to the J.C. Boyle Bypass and Peaking reaches; however, the number of trucks required to deliver gravel is expected to be minor.

IM 8 requires the removal of the sidecast rock barrier located approximately 3 miles upstream of the J.C. Boyle Powerhouse in the J.C. Boyle Bypass Reach. Potential GHG emissions are expected to be less than those quantified for the removal of Copco 1 from demolition activities.

Based on the limited amount of construction equipment expected to be used simultaneously, it is likely that emissions from implementation of the IMs would not exceed the significance criteria. **The impact on GHG emissions and climate change from implementing the IMs would be less than significant.**

[6] The emission estimation ranges provided in this section are based on a GWP of 21 for CH_4; the original Karuk Tribe calculation assumed a GWP of 23, but the calculation was changed to be consistent with the rest of the report.

Reducing a renewable source of power could result in GHG impacts from possible non-renewable alternate sources of power. Under the No Action/No Project Alternative, the Four Facilities would continue to operate under annual licenses. Continued operation would not change existing GHG emissions from the Four Facilities. While the No Action/No Project Alternative assumes annual renewal of licenses, eventual relicensing of the Four Facilities could result in the need for replacement power and subsequent changes in GHG emissions from any changes in renewable sources of power. If relicensing occurred, the amount of electricity produced could reduce as a result of redirecting a certain quantity of river flow from power generation to bypass or fish passage. If relicensing were to require the annual average electricity output to be reduced, then the reduction in power would need to be replaced with another source. These other sources of electricity may result in increased GHG emissions (i.e., coal-fired power plant(s)). **Under the No Action/No Project Alternative that assumes annual licensing, there would be no change from existing conditions from GHG emissions relative to existing conditions.**

Vehicle exhaust from several ongoing restoration actions could increase GHG emissions. Under the No Action/No Project Alternative, some restoration actions in the Klamath Basin are currently underway and would be implemented regardless of the Secretarial Determination on the removal of the Four Facilities. The Fish Habitat Restoration activities could result in GHG emissions. This project would involve some limited construction activities that could result in short-term temporary GHG emissions in the Upper Basin. In addition, the Climate Change Assessment would ensure that long-term climate change in the Klamath Basin is assessed early and continuously. **The GHG emissions related to construction of ongoing restoration actions would be less than significant.**

3.10.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action) Effects of Climate Change on the Proposed Action

The projected changes in precipitation would result in drier summers and increased frequency and severity of extreme events (USGCRP 2009; Barr et. al. 2010; OCCRI 2010). These precipitation changes would produce some adverse effects in the Klamath Basin. Adverse effects could include increased flooding, decreasing water quality (due mainly to the effects of higher water temperatures and changing vegetation), higher fire potential (with subsequent water quality impacts), and adverse low flow conditions due to summer droughts.

Average annual air temperatures are projected to increase by 3°F to over 8°F in the next century. Temperature changes would increase water temperature; water temperature increases could create stressful conditions for fish during some times of the year and reduce the migration window. The Proposed Action would create initial decreases in water temperature by removing dams and increasing river flows, but climate change could partially offset some of these temperature improvements.

The Proposed Action is better positioned to respond to the changes in climate conditions compared to the No Action/No Project Alternative. Dam removal can increase

ecosystem resiliency by restoring floodplain wetlands, which allow the river system to handle the projected changes in seasonal precipitation (Dinse et al. 2009). Also, sediment budgets may return to pre-controlled conditions, revegetation of the watershed can replace missing large woody debris, and more dynamic flow regimes can diversify channel morphology and increase habitat complexity.

Benefits of full dam removal would begin to offset the projected changes and impacts from climate change. These benefits include additional floodplain and riparian zone to reduce peak flooding impacts; improved water quality by removing large quiescent water areas that are subject to temperature increases and evaporation; increased woody debris and restored natural sediment budget to improve in-channel habitat diversity; more available stream channel habitat; a migration corridor for fish to move further upstream to find cooler water; access to the largest concentration of cold springs and spring-dominated tributaries in the Klamath Basin; and improved habitat quality, water quality, and riparian and floodplain functionality in and above Upper Klamath Lake. In contrast, the No Action/No Project Alternative would require modified management and dam operations to off-set flow regime changes; provide no new opportunities for new in-channel or riparian/floodplain habitat; and be subject to greater water quality impacts due to projected temperature increases.

As described in Section 3.2, Water Quality, removal of the reservoirs under the Proposed Action would result in a 1 to 2 degrees Celsius (^{o}C) increase in spring water temperatures and a 2 to 10 ^{o}C decrease in late-summer/fall water temperatures immediately downstream from Iron Gate Dam. These effects would decrease in magnitude with distance downstream from the dam and would not be evident by the Salmon River confluence (approximately river mile [RM] 66) (PacifiCorp 2004, Dunsmoor and Huntington 2006, North Coast Regional Water Quality Control Board 2010, Perry et al. 2011). General warming of water temperatures under climate change is projected to be on the order of 1 to 3°C in the Klamath Basin (Bartholow 2005, Perry et al. 2011), which would partially offset anticipated water temperature improvements from the Proposed Action, particularly further downstream from Iron Gate Dam where the improvements would be of smaller magnitude. However, overall the primary effect of dam removal is still anticipated to be the return of approximately 160 miles of the Klamath River, from J.C. Boyle Reservoir (RM 224.7) to the Salmon River (RM 66), to a natural thermal regime. This return would also include increased daily fluctuations in water temperature immediately downstream from Copco 1 and Iron Gate Dams, as water temperatures once again achieve equilibrium with (and reflect) daily fluctuations in ambient air temperatures. In contrast, in the Bypass Reach downstream from J.C. Boyle Dam, daily fluctuations in water temperature would decrease under the Proposed Action, as hydropower peaking flows would not occur.

As described in Section 3.3, Aquatic Resources, improvement in the river thermal regime by the Proposed Action would likely moderate the anticipated stream temperature increases resulting from climate change.

Effects of the Proposed Action on Climate Change

Vehicle exhaust from dam removal activities could increase GHG emissions in the short term to levels that could exceed the significance criteria. The emission sources would include off-road construction equipment, on-road trucks, and construction worker commuting vehicles. These emissions would be temporary, occurring only during the dam removal period of 9 months (January through September 2020). Table 3.10-4 summarizes uncontrolled annual emissions (not controlled by any mitigation measures) associated with the Proposed Action. Appendix N contains detailed GHG emissions calculations.

Table 3.10-4. Uncontrolled Direct GHG Emissions Inventories for Proposed Action – Full Facilities Removal

Location	Project Emissions ($MTCO_2e$/year)[1]			
	CO_2	CH_4	N_2O[2]	Total
	2020			
Iron Gate	4,106	4	n/a	4,110
Copco 1	1,459	1	n/a	1,461
Copco 2	970	1	n/a	971
J.C. Boyle	2,016	<1	n/a	2,016
Total Emissions	**8,551**	**6**	**n/a**	**8,558**
California Total	6,535	6	n/a	6,542
Oregon Total	2,016	n/a	n/a	2,016

Notes:

[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

[2] N_2O emissions are not estimated directly from the various emission calculation models; therefore, emissions estimates are zero for most equipment.

Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Cofferdams would be constructed at the Four Facilities during deconstruction activities. Concrete rubble, rock, and earthen materials that would come from the dam removal activities would be used as possible to construct the cofferdams. Construction of the cofferdams from materials salvaged from the dam demolition activities would reduce the need for importing new construction materials.

It is likely that sulfur hexafluoride (SF_6) would be released during deconstruction because the breakers would be emptied. Although SF_6 has a relatively high GWP, sufficient data was not available at the time of this writing to quantify emissions.

As Table 3.10-4 shows, there would be a net increase in GHG emissions from deconstruction of the dams; however, these emissions would be temporary and would not contribute to long-term emissions.

Construction related activities associated with decommissioning of the dams would contribute 8,558 $MTCO_2e$ to California's GHG emission for 1 year.[7] Amortizing these construction emissions over 30 years results in approximately 285 $MTCO_2e$ per year, well below the 10,000 $MTCO_2e$ threshold. Moreover, even without amortizing construction emissions over 30 years such emissions are 1,442 $MTCO_2e$ below the threshold. The 1990 GHG emissions level (and so the 2020 emissions target ascribed by AB 32) is 427 million metric tons of CO_2e ($MMTCO_2e$). The emissions from dam removal would be 0.002 percent of the target emissions. In 1990, GHG emissions from construction were 0.67 $MMTCO_2e$; therefore, the Proposed Action would equal approximately 1 percent of allowable construction emissions. **The 1-year construction emissions would not exceed the established significance threshold for ongoing industrial emissions. Therefore, the GHG emissions related to construction would be less than significant.**

Restoration actions could result in short-term and temporary increases in GHG emissions from the use of helicopters, trucks, and barges. Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed sediment. Upper areas would be reseeded from a barge until the reservoir levels become too low to operate and access the barge. Barge based seeding activities would only occur during January 2020 at the Iron Gate and Copco Reservoirs. Aerial application would be necessary for precision applications of material near sensitive areas and the newly established river channel. Aerial hydroseeding is scheduled to begin on March 15, 2020, and last for 10 days at Iron Gate and 20 days at Copco. Trucks would also be used as necessary to provide seeding. Additional fall seeding may be necessary to supplement areas where spring hydroseeding was unsuccessful.

Annual GHG emissions were estimated using information provided in the *Detailed Plan for Dam Removal – Klamath River Dams* (Reclamation 2012a). A combination of techniques was used to estimate emissions from reservoir restoration activities. Emissions from aerial application were estimated using the Federal Aviation Administration's Emissions and Dispersion Modeling System. Emissions from barges were estimated using the following sources:

- Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (USEPA 2000)
- AP-42, Chapter 3.3: Gasoline and Diesel Industrial Emissions (USEPA 1995)
- Title 17 California Code of Regulations, Section 93115.7: Air Toxic Control Measure for Stationary Compression Ignition Engines – Stationary Prime Diesel-Fueled Compression Ignition Engine (>50 bhp) Emission Standards

[7] The value of 8,558 $MTCO_2e$ includes emissions from the JC Boyle Dam. Although JC Boyle Dam is located in Oregon, GHG emissions related to JC Boyle Dam could affect California because climate change is a global phenomenon. Therefore, and for purposes of full disclosure, emissions related to JC Boyle Dam are being analyzed under CEQA.

- Title 13 California Code of Regulations, Section 2423: Exhaust Emission Standards and Test Procedures—Off-Road Compression-Ignition Engines

Emissions from ground support equipment were estimated using the emission factors for off-road engines identified above and EMFAC for on-road motor vehicle emissions. Table 3.10-5 summarizes emissions from reservoir restoration.

Table 3.10-5. Uncontrolled Direct GHG Emissions Inventories for Reservoir Restoration (Reseeding)

Location	Project Emissions ($MTCO_2e$/year)[1]			
	Ground Equipment	Barges	Aerial	Total
Iron Gate	29	88	149	266
Copco	32	88	298	419
J.C. Boyle	19	n/a	n/a	19
Total Emissions	80	177	447	704

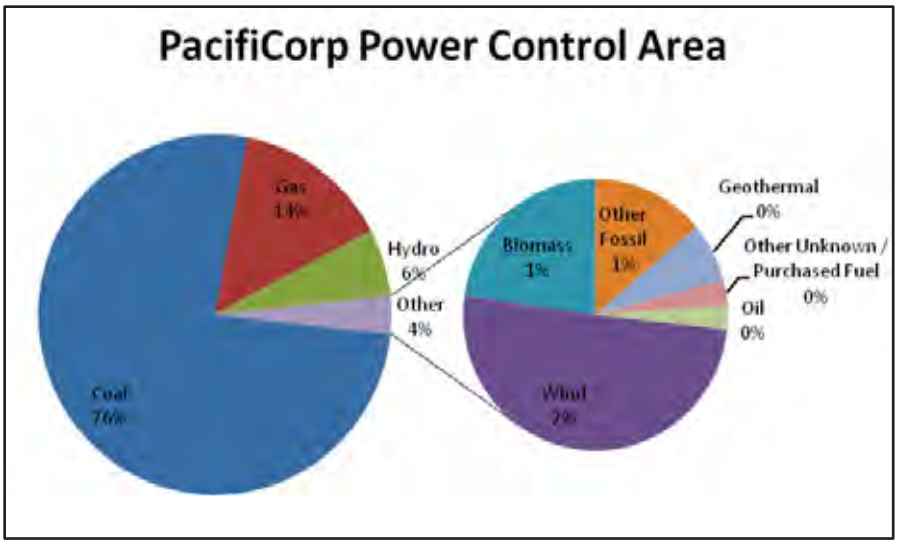
Notes:
[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.
Key:
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

As shown in Table 3.10-5, total GHG emissions would not exceed 704 $MTCO_2e$ per year. Furthermore, the addition of new grassland and other vegetation would sequester CO_2 emissions in the long term, but the sequestered CO_2 would likely not offset all of the emissions occurring during restoration on an annual basis. **The impact on GHG emissions and climate change from revegetation would be less than significant.**

Relocation and demolition of various recreation facilities could result in short-term and temporary increases in GHG emissions from vehicle exhaust. The demolition of the Four Facilities would change recreational opportunities from reservoir-based recreation to river-based recreation. This change would require several recreation facilities to be relocated or demolished. On- and off-road construction equipment would be used to complete these activities, which would occur after the dam demolition actions. Annual GHG emissions were estimated using information provided in the Detailed Plan for Dam Removal – Klamath River Dams (Reclamation 2012a) and CalEEMod, Version 2011.1.1. Approximately 160 $MTCO_2e$ would be emitted during relocation and demolition of the recreation facilities. Since dam demolition activities would be less than significant and changes to the recreation facilities would not overlap, emissions from these activities would also not exceed the significance criteria. **The impact on GHG emissions and climate change from the relocation and demolition of recreation facilities would be less than significant.**

Removing a renewable source of power by removing the dams could result in increased GHG emissions from possible non-renewable alternate sources of power. GHG emissions could occur in the event that the renewable source of power represented by the

Four Facilities was replaced by other emissions sources. As shown in Figure 3.10-4, the 2007 electricity generation resource mix for the PacifiCorp Power Control Area (PCA), which is a region of the power grid in which all power plants are centrally dispatched, is dominated by coal (76 percent), natural gas (14 percent), and hydroelectricity (6 percent). The data provided is the most recent data available from the USEPA (2010b) and represents the resource mix that would be available if any replacement energy was obtained from PacifiCorp's resource mix as of 2007. It is acknowledged that PacifiCorp's current resource mix is different than the 2007 data (PacifiCorp 2011), specifically with a decrease in the reliance on coal and an increase in reliance on natural gas, hydroelectricity, and other renewable energy sources; however, the information in the 2011 Integrated Resource Plan (PacifiCorp 2011) is not sufficient to develop emission factors.



Source: USEPA 2010b.

Figure 3.10-4. PacifiCorp Power Control Area Generation Resource Mix (as of 2007).

Although using the 2007 data provides emissions results that would be higher than the current resource mix, using Emissions and Generation Resource Integrated Database (eGRID) data is consistent with inventory requirements of multiple voluntary and mandatory reporting protocols; therefore, the 2007 eGRID data was used for the analysis.

Electricity originally produced from the Four Facilities, if removed, would likely be replaced with another source within the PacifiCorp PCA because the amount of electricity provided by the Four Facilities is approximately 2 percent of PacifiCorp's total generation capacity (CEC 2006a). Emission rates from the grid were estimated assuming that all power sources within the PCA would remain except for East Side, West Side, J. C. Boyle, Copco 1, Copco 2, Iron Gate Dams.

PacifiCorp's 2011 Integrated Resource Plan provides an overview of the company's available generation capacity. According to the Integrated Resource Plan, PacifiCorp will be at "summer peak resource deficit" beginning in 2011 (PacifiCorp 2011). This deficit is to be met in the short term with additional renewable, demand-side programs, and market purchases from other generating companies (PacifiCorp 2011). PacifiCorp outlined a series of actions in the plan to meet the widening resource deficit, including the addition of 800 megawatts (MW) of wind resources by 2020, the acquisition of 1,200 MW of demand side management programs by 2020, acquisition of 8.7 MW of solar, and economic investigation of 30 MW from solar hot water heating resources and over 100 MW of geothermal resources (PacifiCorp 2011). Although it may be possible for PacifiCorp to replace the existing hydropower from the Four Facilities with additional renewables, this analysis assumes the replacement power will come from the resource mix shown in Figure 3.10-3 of PacifiCorp power sources to provide a worst-case analysis of emissions. The analysis was adjusted so that the base load was assumed to be served by this resource mix, while peaking power would be supplied by natural gas because it is the typical fuel source for peaker power power plants.

In the long term, PacifiCorp is under obligation to meet the Renewable Portfolio Standard (RPS) goals in California and Oregon. The RPS goal for California is to have 33 percent of an electricity seller's load served with renewable power by 2020 (Executive Order S-14-08; and SBX1 2), while Oregon's RPS goal is for 25 percent of a utility's retail sales of electricity to be from renewable energy by 2025 (Senate Bill 838). PacifiCorp is currently on track to meet its Oregon RPS target, but it expected to be under California's RPS target (PacifiCorp 2011). PacifiCorp plans on using flexible compliance mechanisms (e.g., banking, earmarking, and tradable renewable energy credits) to meet California's RPS standards. In the long term, it is expected that PacifiCorp would be able to eventually replace the lost energy from the dams with other sources of renewable energy.

Two different emissions calculations are provided. In one calculation, emissions were calculated assuming there were no changes to PacifiCorp's resource mix. In a second calculation, emissions were calculated assuming that PacifiCorp met its RPS obligations (i.e., 33 percent renewable power in California). As a result, the off-peak emissions were calculated assuming that 33 percent of the power would be served by renewable power (an increase from the existing portfolio assumption of approximately nine percent renewable power).

The average annual electricity generation from the Klamath Hydroelectric Project is 716,800 megawatt-hours (MWh). This includes generation from the following developments: East Side, West Side, J.C. Boyle Dam, Copco 1 Dam, Copco 2 Dam, Fall

Creek Dam, and Iron Gate Dam. Since East Side, West Side, and Fall Creek Dam are not part of the Proposed Action, then the total amount of power that would need to be replaced would be equal to 686,000 MWh[8].

Data from eGRID was used to estimate GHG emissions from a potentially different mix of energy sources (USEPA 2010b). It is recognized that the FERC Final EIS used carbon intensity factors from Hadley and Sale (2000); however, the carbon intensity factors were based on the entire Western Electricity Coordinating Council and represented CO_2 emissions only. The eGRID method of estimating emissions is consistent with the recommendations in multiple general and mandatory reporting protocols and was based on electricity generated by PacifiCorp-owned facilities. As a result, it reflects a conservative estimate of emissions.

The Lead Agencies acquired data for all of the plants within the PacifiCorp PCA and derived emission factors from this source with the applicable dams removed from the

[8] The GHG analysis is based on an estimate of the annual reliable hydroelectric power generation for the PacifiCorp Klamath Hydroelectric Project. Power generation was estimated using annual electricity generation estimates provided for each alternative in Chapter 4 of the Federal Energy Regulatory Commission (FERC) Final Environmental Impact Statement (EIS) for Hydropower License (2007). The FERC Final EIS power generation results allowed for a quantitative comparison of GHG effects for all alternatives considered in this EIS/EIR using information publically available on June 14, 2010 when the notice of intent was published. Since that time, United States Department of the Interior (DOI) modeled annual reliable hydroelectric power generation with updated hydrology and inclusion of planned upgrades that would improve the efficiency and maximum capacity of the hydroelectric project (for the Alternative 1: No Action/No Project Alternative and Alternative 2: Proposed Action [Reclamation 2012a; Reclamation 2012b, Reclamation 2012d]). Under the Alternative 1: No Action/No Project Alternative, annual reliable hydroelectric power generation is greater than the annual generation estimates in the FERC EIS. Therefore, under the Alternative 2: Proposed Action, the DOI model generated increased annual reliable hydropower generation, increasing the estimated replacement power needed to compensate for decommissioning of power facilities, and in turn increasing the overall GHG production attributed to the Proposed Action as compared to the FERC EIS. While the overall GHG emissions may increase from something less than 400,000 $MTCO_2e$ to approximately 500,000 $MTCO_2e$ (CDM Smith 2012), the magnitude of the impact is relatively unchanged when compared to the threshold of 10,000 $MTCO_2e$. When considering this contribution to total GHG emissions from power production in the Western United States (PacifiCorp's resource mix is represented throughout the west, and the EPA estimated that GHG emissions in the Western United States are in excess of a billion $MTCO_2e$ annually), the total emissions from replacement power are relatively minor and represent only a fraction of the total. The additional emissions do not appreciably change the severity of the impact, and the impact is still considered significant and unavoidable after mitigation. No additional mitigation measures exist that could lessen the impacts beyond those already described in the EIS/EIR. For purposes of CEQA, the DOI model does not affect the analysis of Alternative 2: Proposed Action because baseline power generation will not change from what was presented in the FERC Final EIS and therefore there is no change from what is presented in the EIS/EIR. The hydroelectric facilities are not anticipated to be upgraded if there is an Affirmative Secretarial Determination and the updated hydrology does not result in greater power production (Reclamation 2012d). As a result, annual reliable hydropower generation will not be higher than current estimates so the EIS/EIR's analysis of replacement power and its related GHG emissions remains accurate.

mix. The power plants within the PacifiCorp PCA are in California, Colorado, Idaho, Montana, Oregon, Utah, Washington, and Wyoming; all or most of the emissions from these plants would occur outside of the area of analysis. Table 3.10-6 summarizes replacement power emissions that would be associated with the removal of the dams assuming that the current power resource mix was used. Table 3.10-7 summarizes replacement power emissions that would be associated with the removal of the dams assuming that PacifiCorp's RPS obligations were met.

Iron Gate, Copco 1, and Copco 2 are California RPS-eligible facilities (CEC 2011)[9]. he reduction in renewable energy sources is contrary to implementation of AB 32 but the significance would diminish as new renewable sources are developed. Although it is expected that PacifiCorp would add new sources of renewable power that would replace the removed dams, this analysis provides a conservative assumption that emissions could still occur when the dams are removed.

Table 3.10-6. Electricity Generation GHG Emissions from Replacement Sources after Removal of Four Dams (Existing Resource Mix)

Location	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
Iron Gate	116,000	66,802	2	1	66,802	38	219	67,059
Copco 1	106,000	61,043	2	1	61,043	35	200	61,278
Copco 2	135,000	77,744	2	1	77,744	44	255	78,043
J.C. Boyle	329,000	189,465	5	2	189,465	107	622	190,194
Total	686,800	395,054	11	4	395,054	224	1297	396,575

Notes:

[1] Generation based on FERC Final EIS (based on 2007 generation data).

[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Off-peak emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA (USEPA 2010b) except for the dams proposed to be removed.

[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

Key:

CO_2 = carbon dioxide
CO_2e = carbon dioxide equivalent
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds
lb/GWh = pounds per gigawatt-hour
GWP = global warming potential
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

[9] For a hydroelectric facility to qualify for California's RPS, it must be 30 MW or less. Since J.C. Boyle's rated capacity is 98.7 MW, it does not qualify as a small hydroelectric facility.

Table 3.10-7. Electricity Generation GHG Emissions from Replacement Sources after Removal of Four Dams (33 Percent RPS)

Location	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
Iron Gate	116,000	57,545	2	1	57,545	35	173	57,753
Copco 1	106,000	52,585	2	1	52,585	32	158	52,774
Copco 2	135,000	66,971	2	1	66,971	41	201	67,212
J.C. Boyle	329,000	163,210	5	2	163,210	99	489	163,799
Total	686,800	340,311	10	3	340,311	207	1020	341,539

Notes:

[1] Generation based on FERC Final EIS (based on 2007 generation data).

[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Off-peak emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA (USEPA 2010b) except for the dams proposed to be removed. It was also assumed that PacifiCorp would meet its RPS obligation.

[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

Key:

CO_2 = carbon dioxide
CO_2e = carbon dioxide equivalent
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds
lb/GWh = pounds per gigawatt-hour
GWP = global warming potential
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

As previously described for the No Action/No Project Alternative, CH_4 would be released from the reservoirs because of poor water quality conditions. Under the No Action/No Project Alternative, CH_4 emissions from the reservoirs would range from 4,000 to 14,000 $MTCO_2e$ per year, which is equivalent to approximately 1 to 4 percent of replacement power emissions[10] of the 396,575 $MTCO_2e$ per year (based on the current electricity mix).[11] Under the Proposed Action, these CH_4 emissions would cease to be a factor and would partially offset the possible increase in emissions from power replacement. Table 3.10-8 summarizes the expected range in emissions from power replacement that would occur when this emissions offset is considered.

[10] Emissions range is valid for both renewable portfolio standard assumptions (i.e., current grid mix or 33 percent renewable power).

[11] Approximately 2 to 8 percent of the 341,539 $MTCO_2e$ per year would be emitted assuming that the renewable portfolio standard goal of 33 percent was met. Emissions range is valid for both renewable portfolio standard assumptions (i.e., current grid mix or 33 percent renewable power).

Table 3.10-8. Adjusted Power Replacement Emissions Without Methane Emissions from Reservoirs

Scenario	Annual CO_2e Emissions ($MTCO_2e$/year)	CH_4 Emissions from Reservoirs ($MTCO_2e$/year)		Adjusted Emissions ($MTCO_2e$/year)[1]	
		Low	High	Low	High
Current Grid Mix	396,575	4,000	14,000	392,575	382,575
33 Percent RPS	341,539	4,000	14,000	337,539	327,539

Notes:
[1] Adjusted emissions reflect the difference between each scenario and the estimated CH_4 emissions from the reservoirs.
Key:
CO_2e = carbon dioxide equivalent
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Restoration activities at the dam sites are expected to increase the carbon sequestration in the area. As shown in Table 3.10-3, restoration of formerly inundated areas could sequester 0.3 metric tons of carbon per acre per year, while conservation of riparian buffers could sequester 0.1 metric tons of carbon per acre per year. The total amount of acreage wetland/riparian and upland acreage expected to be restored at J.C. Boyle, Copco, and Iron Gate Dams would be 272 acres and 1,602 acres, respectively. As a result, the total amount of sequestered carbon would be approximately 508 metric tons of carbon per year, or 1,862 metric tons of CO_2 per year (based on equivalent weights of carbon and CO_2). Although this sequestration would minimize the effects of GHG emissions, it would not eliminate the increased emissions from replacement power.

CARB expects that implementation of its Scoping Plan (2008) would reduce 21.3 $MMTCO_2e$ by 2020 (from 2005 baseline) from California's RPS; therefore, the possible increase in emissions from removing the dams would account for three percent of the expected emissions reduction. Under a business-as-usual scenario, which assumes that the Scoping Plan would not be implemented, this would impede California's ability to meet its emission reduction goal. **Emissions from power replacement would therefore be a significant impact**. **Mitigation Measures CC-1 through CC-3 would be implemented to reduce emissions from replacement power. Although these measures are expected to lessen the degree of significance, it is expected that GHG emissions would remain significant and unavoidable in the short term until PacifiCorp adds new sources of renewable power that would replace the removed dams.**

3.10.4.4 Interim Measures

Activities associated with several IMs could result in short-term and temporary increases in GHG emissions from vehicle exhaust. Prior to construction, IMs as described in the KHSA (KHSA Section 1.2.4) would be implemented and would control operations of the hydroelectric facilities. Several of the IMs in the Proposed Action could result in increased GHG emissions:

- IM 7: J.C. Boyle Gravel Placement and/or Habitat Enhancement
- IM 16: Water Diversions

IM 7 would require PacifiCorp to place suitable gravels in the J.C. Boyle Bypass and Peaking reaches using a passive approach before high flow periods or to provide for other habitat enhancement. The Proposed Action includes 7 years of implementing this measure. GHG emissions could occur from trucks hauling gravel to the J.C. Boyle Bypass and Peaking reaches; however, the number of trucks required to deliver gravel is expected to be minor.

IM 16 would eliminate three screened diversions from Shovel and Negro Creeks and would also require the installation of screened irrigation pump intakes, as necessary, in the Klamath River. Limited construction equipment and haul trucks would be required to remove the screened diversions.

Since dam demolition activities would be less than significant, and the scale of emissions expected from the IMs is expected to be substantially less than dam removal, it is likely that emissions from implementation of the IMs would also not exceed the significance criteria. The impact on GHG emissions and climate change from implementing the IMs would be less than significant.

3.10.4.4.1 Keno Transfer

Implementation of the Keno Transfer could cause short-term and temporary increases in GHG emissions. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on greenhouse gases compared with existing facility operations. Following transfer of title, DOI would operate the Keno Facility in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance with agreements and historic practice (KHSA Section 7.5.4). **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

3.10.4.4.2 East and Westside Facility Decommissioning – Programmatic Measures

Decommissioning the East and Westside Facilities could cause short-term and temporary increases in GHG emissions. The East and Westside canals and hydropower facilities, which are owned and operated by PacifiCorp, are located in Oregon at Reclamation's Link River Dam. Within 6 months of the enactment of Federal legislation authorizing the Secretary to make a Determination, PacifiCorp will apply to FERC for an order approving partial surrender of their hydropower license for the purpose of decommissioning the East and Westside generating facilities. PacifiCorp will then decommission the facilities in accordance with the FERC order. The Decommissioning would eliminate the need for diversions at Link River Dam into the two canals. Construction equipment used in the decommissioning action would be substantially less than the equipment required to complete dam demolition activities and the decommissioning action would be conducted in the years prior to 2020. Prior to decommissioning, PacifiCorp will request to abandon the East and Westside Facilities in place. Since dam demolition activities would be less than significant, it is likely that

emissions from the decommissioning action would also not exceed the significance criteria. **The impact on GHG emissions and climate change from the East and Westside Facility Decommissioning would be less than significant.**

3.10.4.4.3 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary GHG emissions from vehicle exhaust. On- and off-road construction equipment would be used to complete the relocation and construction of the City of Yreka Water Supply Pipeline.

These emissions would occur in 2019 and would last approximately 1 month. These construction actions would not overlap with other construction or demolition activities. It was assumed that construction of the 400 foot pipeline would occur over a space of approximately 4 acres. The Sacramento Metropolitan Air Quality Management District's Road Construction Emissions Model (2009) was used to estimate emissions associated with grubbing/land clearing, grading/excavation, and other phases. The Road Construction Emissions Model estimated that approximately 36 short tons (33 metric tons) would be emitted for the project. **The impact on GHG emissions and climate change from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

3.10.4.4.4 KBRA – Programmatic Measures

The KBRA has several programs that could cause temporary increases in GHG emissions. The following KBRA programs could cause GHG and climate change impacts from various construction activities:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- On-Project Plan
- Power for Water Management
- Climate Change Assessment and Adaptive Management
- Water Use Retirement Program
- Fish Entrainment Reduction
- Drought Plan

Construction activities associated with the KBRA programs involving construction could cause temporary increases in GHG emissions and climate change. The above KBRA programs may cause some GHG emission impacts from the use of heavy equipment. Potential KBRA construction activities include channel construction, mechanical thinning of trees, road decommissioning, fish passage and facilities construction, breaching levees, and fish hauling. Emissions would occur both from on-site construction

operations with heavy equipment and from off-site activities like the trap-and-haul of fish required under the Fisheries Reintroduction and Management Plan. Sufficient information is not currently available to quantify emissions; however, the quantity of equipment and associated emissions required to complete these activities is expected to be less than the equipment and resulting less than significant emission quantities required to complete the facility removal activities analyzed above. Emissions generated by these construction actions are not expected to exceed the SCAQMD's threshold of significance for industrial emissions (10,000 $MTCO_2e$ per year), especially when amortized over 30 years. When considered together the emissions associated with KBRA construction actions and facility removal would also not be expected to exceed the SCAQMD's threshold of significance. **The impact on GHG emissions and climate change from construction activities associated with implementing the KBRA would be less than significant. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

Operational activities associated with the Fisheries Reintroduction and Management Plan could result in temporary increases in GHG emissions from vehicle exhaust associated with trap-and-haul activities. Potential operational emissions could occur from haul trucks moving fish around Keno Impoundment and Link River. Upstream-migrating fish would be collected downstream from Keno Dam and relocated to Upper Klamath Lake or its tributaries. Downstream-migrating fish would be collected at Link River Dam (and the East Side and Westside canals) and relocated downstream from Keno Dam. Operational emissions are not expected to exceed the SCAQMD's threshold of significance, especially when amortized over 30 years, because of the limited amount of haul trucks that would be expected to be used. When considered together the emissions associated with KBRA construction actions and facility removal, the total operational emissions would also not be expected to exceed the SCAQMD's threshold of significance. **The impact on GHG emissions and climate change from operational emissions associated with implementing the KBRA would be less than significant. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

Implementation of the Power for Water Management Program of the KBRA could create new renewable energy sources which would provide affordable electricity to allow efficient use, distribution, and management of water. This could also involve the development of renewable energy sources, which would provide green energy. However, given the uncertainty as to how the Power for Water Management Program would ultimately be implemented, this analysis will not consider the program as a mitigation measure. The Power for Water Management Program could however offset some of the effects of hydroelectric facility removal. **Implementation of the Power for Water Management Program could result in beneficial effects. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

Implementation of the Drought Plan and the Climate Change Assessment and Adaptive Management Plan could affect climate change-related impacts. The Drought Plan identifies water and resource management actions to minimize risk associated with drought, which is a projected climate change impact for the Klamath Basin and the Pacific Northwest. The Climate Change Assessment and Adaptive Management Plan includes early and frequent assessment of the existing and future impacts of climate change. The Climate Change Assessment and Adaptive Management Plan is also intended to develop actions to respond to climate change and protect the resources of the basin. These plans will assist the region in planning and responding to the climate change impacts identified in this EIS/EIR over the short-term, mid-term, and long-term horizons. The Climate Change Assessment and Adaptive Management Plan could offset some of the effects of hydroelectric facility removal. **Implementation of these plans is expected to result in reduction in impacts of climate change to the resources and would have beneficial effects. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate**.

3.10.4.4.5 Alternative 3: Partial Facilities Removal of Four Dams Alternative Effects of Climate Change on the Alternative

The Partial Facilities Removal Alternative would result in the creation of a free-flowing, unimpeded river, and the effects of climate change on this alternative would be the same as for the Proposed Action.

Effects of the Alternative on Climate Change

Vehicle exhaust from dam removal activities could increase GHG emissions in the short term to levels that could exceed the significance criteria. Under the Partial Facilities Removal Alternative some of the structures at J. C. Boyle, Copco 1, Copco 2, and Iron Gate Dams would remain in place. Projected GHG emissions are generally lower for this alternative than for the Proposed Action because this alternative would generate fewer materials that would need to be removed from the sites, and hence, less truck traffic. Please see Section 3.22, Traffic and Transportation, for additional analysis of expected truck trips.

Table 3.10-9 summarizes uncontrolled annual emissions inventories for the Partial Facilities Removal Alternative. Appendix N provides detailed calculations.

It is likely that SF_6 would be released during deconstruction because the breakers would be emptied. Although SF_6 has a relatively high GWP, sufficient data was not available at the time of this writing to quantify emissions.

Table 3.10-9. Uncontrolled Direct GHG Emissions Inventories for Partial Facilities Removal

Location	Project Emissions ($MTCO_2e$/year)[1]			
	CO_2	CH_4	N_2O[2]	Total
	2020			
Iron Gate	4,114	4	n/a	4,118
Copco 1	1,459	1	n/a	1,460
Copco 2	829	1	n/a	830
J.C. Boyle	1,341	<1	n/a	1,341
Total Emissions	**7,742**	**6**	**n/a**	**7,748**
California Total	6,401	6	n/a	6,408
Oregon Total	1,341	n/a	n/a	1,341

Notes:
[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.
[2] N_2O emissions are not directly estimated from the various emission calculation models; therefore, emissions are estimated as zero for most equipment.
Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

As Table 3.10-9 shows, there would be a net increase in GHG emissions from deconstruction of the dams; however, these emissions would be temporary and would not contribute to long-term emissions. Demolition activities associated with the decommissioning of the dams would contribute 7,748 $MTCO_2e$ to GHG emission for one year.[12] Amortizing these construction emissions over 30 years results in approximately 258 $MTCO_2e$ per year, well below the 10,000 $MTCO_2e$ threshold. Moreover, even without amortizing construction emissions over thirty years such emissions are 2,252 $MTCO_2e$ below the threshold. The 1990 GHG emissions level (and so the 2020 emissions target ascribed by AB 32) is 427 million metric tons of CO_2e ($MMTCO_2e$). The emissions from dam removal would be 0.002 percent of the target emissions. In 1990, GHG emissions from construction were 0.67 $MMTCO_2e$; therefore, the Proposed Action would equal approximately 1 percent of allowable construction emissions. **The 1-year construction emissions would not exceed the established significance threshold for ongoing industrial emissions. Therefore, the GHG emissions related to construction would be less than significant.**

Activities associated with several IMs could result in short-term and temporary increases in GHG emissions from vehicle exhaust. GHG emission impacts associated with implementation of IMs would be the same as those discussed for the Proposed Action.

[12] The value of 7,748 $MTCO_2e$ includes emissions from the J.C. Boyle Dam. Although JC Boyle Dam is located in Oregon, GHG emissions related to J.C. Boyle Dam could affect California because climate change is a global phenomenon. Therefore, and for purposes of full disclosure, emissions related to J.C. Boyle Dam are being analyzed under CEQA.

The impact on GHG emissions and climate change from implementing the IMs would be less than significant.

Restoration actions would result in short-term and temporary increases in GHG emissions from the use of helicopters, trucks, and barges. GHG emission impacts associated with the restoration actions would be the same as those discussed for the Proposed Action. **The impact on GHG emissions and climate change from revegetation would be less than significant.**

Relocation and demolition of various recreation facilities would result in short-term and temporary increases in GHG emissions from vehicle exhaust. GHG emission impacts associated with the recreation facilities would be the same as those discussed for the Proposed Action. **The impact on GHG emissions and climate change from the relocation and demolition of recreation facilities would be less than significant.**

Removing a renewable source of power by removing the dams could result in increased GHG emissions from possible non-renewable alternate sources of power. As with the Proposed Action, the Partial Facilities Removal Alternative would result in decreased capacity to generate electricity from all of the dams. Although some of this infrastructure would remain under this alternative, the power-generating ability of the dams would be eliminated. As a result, electricity generation would need to be replaced from other sources of power.

As discussed for the Proposed Action, in the long term, it is expected that PacifiCorp would be able to eventually replace the lost energy from the dams with other sources of renewable power. Furthermore, some degree of GHG emissions could be offset with reforestation, but the increased carbon sequestration would not be sufficient to counteract increased emissions that may result from use of an alternative power source. The expected increase in GHG emissions from replacing these four dams with a different energy source would be the same as those shown in Table 3.10-6 and Table 3.10-7. The expected emissions increases that could occur when water is no longer impounded in the reservoirs would be the same as those shown in Table 3.10-8. **Emissions from power replacement would therefore be a significant impact. Mitigation Measures CC-1 through CC-3 would be implemented to reduce emissions from replacement power. Although these measures are expected to lessen the degree of significance, it is expected that GHG emissions would remain significant and unavoidable in the short term until PacifiCorp adds new sources of renewable power that would replace the removed dams.**

Keno Transfer

Implementation of the Keno Transfer could cause short-term and temporary increases in GHG emissions. The effects of the Keno Transfer would be the same as those for the Proposed Action. **Therefore, implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facility Decommissioning – Programmatic Measures

Decommissioning the East and Westside Facilities could cause short-term and temporary increases in GHG emissions. The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action. **The impact on GHG emissions and climate change from the East and Westside Facility Decommissioning would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary GHG emissions from vehicle exhaust. The effects of the City of Yreka Water Supply Pipeline relocation would be the same as those described for the Proposed Action. **The impact on GHG emissions and climate change from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

KBRA – Programmatic Measures

Construction activities associated with the KBRA programs involving construction could cause temporary increases in GHG emissions and climate change. Similarly to the Proposed Action, under this alternative the KBRA would be fully implemented. The effects of implementing the KBRA would be the same as those described in the Proposed Action**. The impact on GHG emissions and climate change from implementing the KBRA would be less than significant.**

Implementation of the Power for Water Management Program, the Drought Plan, and the Climate Change Assessment and Adaptive Management Plan could result in climate change-related impacts. Implementation of the Power for Water Management Program of the KBRA could create new renewable energy sources as described for the Proposed Action. Additionally, the KBRA includes two plans to assess and address climate change impacts as described in the KBRA discussion for the Proposed Action. **Implementation of these plans may cause beneficial effects to climate change.**

3.10.4.4.6 Alternative 4: Fish Passage at Four Dams Alternative Effects of Climate Change on the Alternative

The Fish Passage at Four Dams Alternative would likely result in a greater magnitude of consequences associated with climate change than the Full Facilities Removal Alternative. Greater needs for management actions, policies, and mitigation measures to protect the surrounding ecosystems and communities would likely be required without dam removal, and could result in costly future projects to either prevent or respond to the consequences of climate change. For example, disturbances caused by drought, changes to vegetation, and changes to water quality characteristics patterns might not be able to be adjusted to or absorbed as easily with the dams in place as without them.

Under existing conditions, summer and early fall water temperatures in the Klamath River regularly exceed the range of chronic effects temperature thresholds for full salmonid support (Section 3.2.3.2). The exception to this occurs in the J.C. Boyle Bypass Reach during daily powerhouse peaking periods, when warm reservoir discharges are

diverted from the Bypass Reach allowing cold spring flows to dominate hydrology and water temperatures. Under the Fish Passage at Four Dams Alternative, water temperatures in the Hydroelectric Reach and the Klamath River downstream from Iron Gate Dam would not change from existing conditions (i.e., they would still exceed chronic effects thresholds during summer months), with the exception of the J.C. Boyle Bypass Reach where the extreme daily temperature fluctuations due to hydropower peaking flows would occur less frequently (i.e., weekly rather than daily) and would approach the (warmer) natural thermal regime of the river. Areas adjacent to the coldwater springs in the Bypass Reach would continue to serve as thermal refugia for aquatic species because the springs themselves would not be affected by the Fish Passage at Four Dam Alternative. Overall, this would be beneficial.

Effects of the Alternative on Climate Change

Vehicle exhaust from construction of fish passage could increase GHG emissions in the short term to levels that could exceed the significance criteria. This alternative does not result in the removal of any excavated material from the sites, and instead only includes a reduced amount of material being hauled to the sites. Table 3.10-10 summarizes uncontrolled annual emissions inventories for the Fish Passage at Four Dams Alternative. Detailed calculations are provided in Appendix N.

Table 3.10-10. Uncontrolled Direct GHG Emissions Inventories for Fish Passage at Four Dams

Location	Project Emissions ($MTCO_2e$/year)[1]			
	CO_2	CH_4	N_2O[2]	Total
Iron Gate (2023)	1,599	1	n/a	1,600
Copco 1 (2025)	1,307	1	n/a	1,308
Copco 2 (2024)	302	<1	n/a	302
J.C. Boyle (2022)	820	<1	n/a	820
Maximum Annual Emissions[3]	1,599	1	n/a	1,600

Notes:

[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

[2] Nitrous oxide (N_2O) emissions are not directly estimated from the various emission calculation models; therefore, emissions are estimated as zero for most equipment.

[3] Construction of the fish ladders occur during different years and activities for each dam site do not overlap; therefore, the maximum emissions are shown to evaluate significance.

Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

As Table 3.10-10 shows, there would be a net increase in GHG emissions from construction of fish passages; however, these emissions would be temporary and would not contribute to long-term emissions. Constructing fish passage would contribute a maximum of 1,600 $MTCO_2e$ to California's GHG emissions for 1 year. Amortizing these construction emissions over 30 years results in approximately 53 $MTCO_2e$ per year, well

below the 10,000 $MTCO_2e$ threshold. Moreover, even without amortizing construction emissions over 30 years such emissions are 8,400 $MTCO_2e$ below the threshold. The 1990 GHG emissions level (and so the 2020 emissions target ascribed by AB 32) is 427 million metric tons of CO_2e ($MMTCO_2e$). The emissions constructing fish passage would be 0.0009 percent of the target emissions. In 1990, GHG emissions from construction were 0.67 $MMTCO_2e$; therefore, Alternative 4 would equal less than 1 percent of allowable construction emissions. **The 1-year construction emissions for fish passage would not exceed the established significance thresholds for ongoing industrial emissions. Therefore, the GHG emissions related to fish passage construction would be less than significant.**

Reducing a renewable source of power by developing fish passage could result in increased GHG emissions from possible non-renewable alternate sources of power. GHG emission effects could also occur following replacement of a renewable source of electricity with other, emission-generating sources of electric power. Although the dams would not be removed, there would be a decrease in power generation, which is necessary for successful operation of the fish passage. The FERC Final EIS (2007) states that the installation of fish passage would allow the Klamath Hydroelectric Project to generate an average of 533,879 MWh of electricity annually. Since the baseline generation (Iron Gate, Copco 1, Copco 2, and J.C. Boyle) is 686,000 MWh, the amount of power that may need to be replaced would equal 152,121 MWh per year. Table 3.10-11 summarizes replacement power emissions that would be associated with the replacement power needed after fish passage construction assuming that the current power resource mix was used. Table 3.10-12 summarizes replacement power emissions that would be needed after fish passage construction assuming that PacifiCorp's RPS obligations were met.

Table 3.10-11. Electricity Generation GHG Emissions from Replacement Sources after Fish Passage Construction (Current Resource Mix)

Alternative	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
On-Peak	97,792	41,858	2	<1	41,858	36	56	41,951
Off-Peak	54,329	45,332	<1	<1	45,332	14	229	45,575
Total	152,121	87,190	2	1	87,190	50	286	87,525

Notes:

[1] Generation based on FERC Final EIS (2007). The Fish Passage generation is based on the FERC Final EIS for the Staff Alternative with Mandatory Conditions (533,879 MWh).

[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA (USEPA 2010b).

[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

Key:

CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds per megawatt-hour
lb/GWh = pounds per gigawatt-hour
GWP = global warming potential
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Table 3.10-12. Electricity Generation GHG Emissions from Replacement Sources after Fish Passage Construction (33 Percent RPS)

Alternative	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
On-Peak	97,792	41,858	2	<1	41,858	36	56	41,951
Off-Peak	54,329	33,302	1	1	33,302	10	168	33,481
Total	152,121	75,161	2	1	75,161	46	225	75,431

Notes:

[1] Generation based on FERC Final EIS (2007). The Fish Passage generation is based on the FERC Final EIS for the Staff Alternative with Mandatory Conditions (533,879 MWh).

[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Off-peak emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA (USEPA 2010b) except for the dams proposed to be removed. It was also assumed that PacifiCorp would meet its RPS obligation.

[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

Key:

CO_2 = carbon dioxide
CO_2e = carbon dioxide equivalent
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds
lb/GWh = pounds per gigawatt-hour
GWP = global warming potential
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

As previously described for the No Action/No Project Alternative, CH_4 would be released from the reservoirs because of poor water quality conditions. Since the dams would remain in place under this alternative, CH_4 from the impounded water would continue to be emitted. CH_4 emissions from the reservoirs would range from 4,000 to 14,000 $MTCO_2e$ per year. Table 3.10-13 summarizes the expected range in emissions that could occur from power replacement and CH_4 released from the reservoirs.

Table 3.10-13. Adjusted Power Replacement Emissions With Methane Emissions from Reservoirs

Scenario	Annual CO_2e Emissions ($MTCO_2e$/year)	CH_4 Emissions from Reservoirs ($MTCO_2e$/year)		Adjusted Emissions ($MTCO_2e$/year)[1]	
		Low	High	Low	High
Current Grid Mix	87,525	4,000	14,000	91,525	101,525
33 Percent RPS	75,431	4,000	14,000	79,431	89,431

Notes:

[1] Adjusted emissions reflect the difference between each scenario and the estimated CH_4 emissions from the reservoirs.

Key:

CO_2e = carbon dioxide equivalent
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

In the long term, it is expected that PacifiCorp would be able to eventually replace the lost energy from the dams with other sources of renewable energy.

CARB expects that implementation of its Scoping Plan (2008) would reduce 21.3 $MMTCO_2e$ by 2020 (from 2005 baseline) from California's RPS; therefore, the possible increase in emissions from the replacement power generation allowing decreased electricity produced by the dams would account for one percent of the expected emissions reduction. Under a business-as-usual scenario, which assumes that the Scoping Plan would not be implemented, this would impede California's ability to meet its emission reduction goal. **Emissions from power replacement would therefore be a significant impact**. **Mitigation Measures CC-1 through CC-3 would be implemented to reduce emissions from replacement power. Although these measures are expected to lessen the degree of significance, it is expected that GHG emissions would remain significant and unavoidable in the short term until PacifiCorp adds new sources of renewable power that would replace the removed dams.**

Trap and Haul – Programmatic Measures

Implementation of trap and haul measures could result in temporary increases in GHG emissions from vehicle exhaust. Potential operational emissions could occur from haul trucks moving fish around Keno Impoundment and Link River. Upstream-migrating fish would be collected downstream from Keno Dam and relocated to Upper Klamath Lake or its tributaries. Downstream-migrating fish would be collected at Link River Dam (and the East Side and West Side canals) and relocated downstream from Keno Dam. Operational emissions are not expected to exceed the SCAQMD's threshold of significance, especially when amortized over 30 years, because of the limited amount of haul trucks that would be expected to be used. **The impact on GHG emissions and climate change from operational emissions associated with trap and haul measures would be less than significant.**

3.10.4.4.7 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative

Effects of Climate Change on the Alternative

The Fish Passage at Two Dams Alternative would result in the removal of two dams and the retention of two dams; the types of climate change effects from this alternative would be within the range of those described for the Proposed Action and the Fish Passage at Four Dams Alternatives. Temperature effects would likely be more similar to the Proposed Action than the Fish Passage at Four Dams Alternative because the Fish Passage at Two Dams Alternative would result in the removal of the two largest dams, which would have a greater role in warming the river water than the smaller dams.

Effects of the Alternative on Climate Change

Vehicle exhaust from dam removal activities or construction of fish passage could increase GHG emissions in the short term to levels that could exceed the significance criteria. This alternative would essentially be a combination of the Proposed Action and the Fish Passage at Four Dams Alternative, and would have similar effects. Table 3.10-14 summarizes uncontrolled annual emissions inventories for the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative. Appendix N provides detailed calculations.

As Table 3.10-14 shows, there would be a net increase in GHG emissions from deconstruction of the dams; however, these emissions would be temporary and would not contribute to long-term emissions. The decommissioning of the dams would contribute 6,445 $MTCO_2e$ to California's GHG emission for 1 year.[13] Amortizing these construction emissions over 30 years results in approximately 215 $MTCO_2e$ per year, well below the 10,000 $MTCO_2e$ threshold. Moreover, even without amortizing construction emissions over 30 years such emissions are 3,555 $MTCO_2e$ below the threshold. The 1990 GHG emissions level (and so the 2020 emissions target ascribed by AB 32) is 427 million metric tons of CO_2e ($MMTCO_2e$). The emissions from dam removal would be 0.002 percent of the target emissions. In 1990, GHG emissions from construction were 0.67 $MMTCO_2e$; therefore, the Proposed Action would equal approximately 1 percent of allowable construction emissions. **The 1-year construction emissions would not exceed the established significance threshold for ongoing industrial emissions. Therefore, the GHG emissions related to construction would be less than significant.**

Table 3.10-14. Uncontrolled Direct GHG Emissions Inventories for Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Location	Project Emissions ($MTCO_2e$/year)[1]			
	CO_2	CH_4	N_2O[2]	Total
	2020			
Iron Gate	3,944	4	n/a	3,949
Copco 1	1,474	1	n/a	1,475
Copco 2	269	1	n/a	269
J.C. Boyle	752	<1	n/a	752
Total Emissions (2020)	6,439	6	n/a	6,445
California Total	5,687	6	n/a	5,693
Oregon Total	752	n/a	n/a	752

Notes:

[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

[2] Nitrous oxide (N_2O) emissions are not directly estimated from the various emission calculation models; therefore, emissions are estimated as zero for most equipment.

Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river would result in short-term and temporary increases in GHG emissions from vehicle exhaust. GHG emission impacts associated

[13] The value of 6,445 $MTCO_2e$ includes emissions from the J.C. Boyle Dam. Although J.C. Boyle Dam is located in Oregon, CEQA requires GHG emissions related to J.C. Boyle Dam could affect California because climate change is a global phenomenon. Therefore, and for purposes of full disclosure, emissions related to JC Boyle Dam are being analyzed under CEQA.

with the City of Yreka water supply pipeline would be the same as those described for the Proposed Action. **The impact on GHG emissions and climate change from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

Restoration actions would result in short-term and temporary increases in GHG emissions from the use of helicopters, trucks, and barges. GHG emission impacts related to restoration activities would be similar to those described for the Proposed Action but would only occur near the Iron Gate and Copco 1 dam sites. Table 3.10-15 summarizes emissions from reservoir restoration.

As shown in Table 3.10-15, total GHG emissions would not exceed 685 $MTCO_2e$ per year. The impact on GHG emissions and climate change from revegetation would be less than significant.

Table 3.10-15. Uncontrolled Direct GHG Emissions Inventories for Reservoir Restoration (Reseeding)

Location	Project Emissions ($MTCO_2e$/year)[1]			
	Ground Equipment	Barges	Aerial	Total
Iron Gate	29	88	149	266
Copco	32	88	298	419
J.C. Boyle	n/a	n/a	n/a	n/a
Total Emissions	61	177	447	685

Notes:
[1] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.
Key:
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Relocation and demolition of various recreation facilities would result in short-term and temporary increases in GHG emissions from vehicle exhaust. Recreation facilities near J.C. Boyle Reservoir would stay intact, and the Copco 2 area does not have any developed recreation facilities. Recreation facilities at Iron Gate and Copco 1 would be removed. Annual GHG emissions were estimated using information provided in the Detailed Plan for Dam Removal – Klamath River Dams (Reclamation 2012a) and CalEEMod, Version 2011.1.1. Approximately 154 $MTCO_2e$ would be emitted during relocation and demolition of the recreation facilities. **The impact on GHG emissions and climate change from the relocation and demolition of recreation facilities would be less than significant.**

Removing or reducing a renewable source of power by removing the dams or developing fish passage could result in increased GHG emissions from possible non-renewable alternate sources of power. It is expected that removing the existing hydropower capability from the two dams (Copco 1 and Iron Gate) would reduce power generation. Replacement power generation may result in changes in emissions. Although J.C. Boyle and Copco 2 Dams would not be removed, there would be a decrease in power

generation, which is necessary for successful operation of the fish passage. The FERC Final EIS (2007) states that after retiring Copco 1 and Iron Gate the Klamath Hydroelectric Project would generate an average of 443,694 MWh of electricity annually. Since the baseline generation (Iron Gate, Copco 1, Copco 2, and J.C. Boyle) is 686,000 MWh, the amount of power that may need to be replaced would equal 242,306 MWh per year. Table 3.10-16 summarizes replacement emissions that would be associated with the replacement power needed after construction of this alternative.

Electricity that was originally produced from these dams would likely be replaced using another source within the PacifiCorp PCA; therefore, emission rates from the grid were estimated assuming that all power sources within the PCA would remain except for Copco 1 and Iron Gate Dams. Data from eGRID was used to estimate GHG emissions from the use of different energy resources (USEPA 2010b). The Lead Agencies acquired data for all of the plants within the PacifiCorp PCA and derived emission factors were derived from this source with the applicable dams removed from the mix. Table 3.10-16 summarizes the increase in emissions that could result from the use of replacement power from other sources assuming that the current power resource mix was used. Table 3.10-17 summarizes the increase in emissions that could result from the use of replacement power from other sources assuming that PacifiCorp met is RPS obligations.

Table 3.10-16. Electricity Generation GHG Emissions from Replacement Sources after Removal of Two Dams (Current Resource Mix)

Alternative	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
On-Peak	155,768	66,674	3	<1	66,674	57	90	66,821
Two Dams	86,538	72,435	1	1	72,435	22	366	72,824
Total	242,306	139,109	4	1	139,109	79	456	139,644

Notes:
[1] Generation based on FERC Final EIS (2007). The Two Dams Removed generation is based on the FERC Final EIS for the alternative that would retire Copco 1 and Iron Gate (443,694 MWh).
[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA except for the dams proposed to be removed.
[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.
Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds per megawatt-hour
lb/GWh =pounds per gigawatt-hour.
eGRID = Emissions & Generation Resource Integrated Database
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

Table 3.10-17. Electricity Generation GHG Emissions from Replacement Sources after Removal of Two Dams (33 Percent RPS)

Alternative	Generation (MWh)[1]	Annual Emissions (metric tons per year)[2]			Annual CO_2e Emissions ($MTCO_2e$/year)[3]			
		CO_2	CH_4	N_2O	CO_2	CH_4	N_2O	Total
On-Peak	155,768	66,674	3	<1	66,674	57	90	66,821
Two Dams	86,538	53,213	1	1	53,213	16	269	53,499
Total	242,306	119,888	4	1	119,888	73	359	120,320

Notes:

[1] Generation based on FERC Final EIS (2007). The Two Dams Removed generation is based on the FERC Final EIS for the alternative that would retire Copco 1 and Iron Gate (443,694 MWh).

[2] Emissions assume that 64 percent of power would be generated on-peak using natural gas; the remaining 36 percent would be generated off-peak using the PacifiCorp PCA resource mix. Emission factors were calculated from the annual emissions and generation for all sources within the PacifiCorp PCA except for the dams proposed to be removed. It was also assumed that PacifiCorp would meet its RPS obligation.

[3] GWPs from the IPCC's *Second Assessment Report* (1996) were used in the emission calculations. GWPs of 1, 21, and 310 were used for CO_2, CH_4, and N_2O, respectively.

Key:
CO_2 = carbon dioxide
CH_4 = methane
N_2O = nitrous oxide
MWh = megawatt hour
lb/MWh = pounds per megawatt-hour
lb/GWh =pounds per gigawatt-hour.
eGRID = Emissions & Generation Resource Integrated Database
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

CH_4 emissions would occur from water impounded in the reservoirs. Since Iron Gate and Copco 1 Dams would be removed under this alternative, the only remaining reservoir that would contribute to CH_4 emissions from impounded water would be at J.C. Boyle Dam. Assuming that this would be the only source of emissions, CH_4 emissions would range from 700 to 3,000 $MTCO_2e$ per year for the J.C. Boyle Reservoir, equivalent to approximately 0.5 to 2 percent of replacement power emission.[14] See Appendix N for detailed calculations. Table 3.10-18 summarizes the adjusted power replacement emissions that could occur when CH4 emissions from impounded water at J.C. Boyle Reservoir is considered.

In addition to the emissions from possible natural gas combustion, there could also be emissions associated with SF_6 leaks. Although there would be a decrease in SF_6 associated with the removal of transmission lines under this alternative, these emissions could be counteracted by increases from new power supplies that would be used to replace the existing power. As a result, determining the net SF_6 emissions is not possible. **Emissions from power replacement would be significant and unavoidable. Mitigation Measures CC-1 through CC-3 would be implemented to reduce emissions from replacement power. Although these measures are expected to lessen the degree of significance, it is expected that GHG emissions would remain significant and unavoidable in the short term until PacifiCorp adds new sources of renewable power that would replace the removed dams.**

[14] Emissions range is valid for both renewable portfolio standard assumptions (i.e., current grid mix or 33 percent renewable power).

Table 3.10-18. Adjusted Power Replacement Emissions With Methane Emissions from Reservoirs

Scenario	Annual CO_2e Emissions ($MTCO_2e$/year)	CH_4 Emissions from Reservoirs ($MTCO_2e$/year)		Adjusted Emissions ($MTCO_2e$/year)[1]	
		Low	High	Low	High
Current Grid Mix	139,644	700	3,000	140,344	142,644
33 Percent RPS	120,320	700	3,000	121,020	123,320

Notes:
[1] Adjusted emissions reflect the difference between each scenario and the estimated CH_4 emissions from the reservoirs.
Key:
CO_2e = carbon dioxide equivalent
$MTCO_2e$/year = metric tons carbon dioxide equivalent per year

City of Yreka Water Supply Pipeline Relocation - Programmatic Measures

Construction of a new, elevated City of Yreka water supply pipeline and steel pipeline bridge to support the pipe above the river could result in short-term and temporary GHG emissions from vehicle exhaust. The effects of the City of Yreka Water Supply Pipeline relocation would be the same as those described for the Proposed Action. **The impact on GHG emissions and climate change from the construction of the City of Yreka Water Supply Pipeline would be less than significant.**

Trap and Haul – Programmatic Measures

Implementation of trap and haul measures could result in temporary increases in GHG emissions from vehicle exhaust. The trap and haul measures around Keno Impoundment and Link River would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **The impact on GHG emissions and climate change from operational emissions associated with trap and haul measures would be less than significant.**

3.10.4.5 Mitigation Measures

As required by the KHSA, PacifiCorp would cooperate in the investigation or consideration of joint development and ownership of renewable generation resources, and purchase by PacifiCorp of power from renewable energy projects developed by Klamath Water and Power Authority or other parties. Although this effect cannot be quantified, the development of this power would help offset the significant impacts expected from any use of replacement power following removal of the dams.

3.10.4.5.1 Mitigation Measure by Consequence Summary

CC-1 – Use the market mechanism under development as part of AB 32 development when feasible to mitigate GHG emissions impacts. The market mechanism program under AB 32 is targeted for implementation in 2012.

CC-2 – Establish an energy audit program to enable local residences and business to determine how much energy they currently consume and to identify measures that would reduce energy consumption.

CC-3 – Establish an energy conservation plan to reduce the region's reliance on purchased electricity.

3.10.4.5.2 Effectiveness of Mitigation in Reducing Consequence

The effectiveness of the various mitigation measures would vary based on the type of measures that would be implemented. Market-based measures could potentially be 100 percent effective at offsetting the significant emissions, but may not be cost-effective depending on the availability of carbon credits. Plus, this measure would be contingent on the availability of carbon credits on the open market. If credits are scarce when they need to be purchased, then it may be difficult to offset the entire amount.

The effectiveness of the energy audits and conservation programs would vary based on the improvements that would be made following the audit. While the audits can identify deficiencies in the energy efficiency of a residential or commercial source, there is no guarantee that the identified improvements would be made. The California Air Pollution Control Officers Association published a resource called *Quantifying Greenhouse Gas Mitigation Measures* (2010) that quantifies the effectiveness of various GHG emission reduction measures. For example, if a non-residential building is constructed to be more energy efficient than the 2008 Title 24 standards, the GHG emissions from electricity can be reduced up to 0.40 percent for every 1 percent improvement over 2008 Title 24. Installing energy efficient appliances could reduce GHG emissions up to 2.59 percent.

Table 3.10-19 summarizes the GHG emissions that would be expected from power replacement activities following dam removal. All alternatives would result in significant impacts from use of replacement power following removal of the dams or reductions necessary to properly maintain fish passage. The construction and demolition emissions represent a worst-case scenario that illustrates the maximum emissions that could occur if reservoir restoration, recreation facility removal, and construction of the City of Yreka pipeline occurred in the same year as any construction or demolition activities. It is expected that certain components, such as construction of the City of Yreka pipeline, would occur in a year other than 2020; and cumulative annual emissions would be less than those shown in Table 3.10-19.

Table 3.10-19. Impact Summary Table (Without Methane Generation from Reservoirs)

Alternative	Emissions		
	Construction and Demolition (metric tons CO_2e/project)[1,2]	Power Replacement (metric tons CO_2e/year)[3]	
		(Current Resource Mix)	(33% RPS)
2	9,454	396,575	341,539
3	8,645	396,575	341,539
4	1,600	87,525	75,431
5	7,316	139,644	120,320

Notes:
[1] Construction and demolition values represent a cumulative impact from construction or demolition impacts at the Four Facilities, reservoir restoration (reseeding), recreation facility removal, and construction of the City of Yreka Water Supply Pipeline.
[2] Emissions summarized for construction and demolition activities represent the worst-case year of analysis (2020) and would only occur once.
[3] Emissions from power replacement represent an annual average value that would occur until electricity from the Four Facilities is replaced with other renewable power sources.
Key:
CO_2e = carbon dioxide equivalent
RPS = Renewable Portfolio Standard

Table 3.10-20 summarizes GHG emissions that would be projected to occur from power replacement activities with CH_4 that would be produced from impounded water.

Table 3.10-20. Impact Summary Table (With Methane Generation from Reservoirs)

Alternative	Power Replacement and CH_4 from Impounded Reservoirs Emissions (metric tons CO_2e/year)			
	(Current Resource Mix)		(33% RPS)	
	Low[1]	High[2]	Low[1]	High[2]
2	392,575	382,575	337,539	327,539
3	392,575	382,575	337,539	327,539
4	91,525	101,525	79,431	89,431
5	140,344	142,644	121,020	123,320

Notes:
[1] Low power replacement refers to minimum CH_4 emissions projected to be emitted by the reservoirs.
[2] High power replacement refers to maximum CH_4 emissions projected to be emitted by the reservoirs.
Key:
CH_4 = methane
CO_2e = carbon dioxide equivalent
RPS = Renewable Portfolio Standard

3.10.4.5.3 Agency Responsible for Mitigation Implementation

The Dam Removal Entity (DRE) would be responsible for implementing mitigation measures CC-1, CC-2, and CC-3.

3.10.4.5.4 Remaining Significant Impacts

Following implementation of the mitigation measures specified for a given alternative, GHG emissions would remain significant and unavoidable for all four action alternatives for power replacement.

3.10.4.5.6 Mitigation Measures Associated with Other Resource Areas

Mitigation Measures AR-1, 2, 5-7 would cause temporary increases in GHG emissions. These mitigation measures would involve trap and haul of fish and mollusks to protect them from the reservoir drawdown and dam demolition activities. It is anticipated that as many as 150 truck trips would be required to transport juveniles from areas downstream from Iron Gate Dam to the confluence of the Klamath and Trinity Rivers between February and April 2020. The increase in daily truck trips is expected to be minor (approximately 2 trips per day) and would not contribute substantially to the existing emissions. **The impacts associated with increases in GHG emissions from these mitigation measures would be less than significant.**

Mitigation Measure TR-1 could cause a temporary increase in GHG emissions. Relocation of Jenny Creek Bridge and culverts near Iron Gate Reservoir would occur before the other construction phases of dam removal. On- and off-road construction equipment would be used to complete the necessary construction, but would be minor compared to the dam demolition emissions. **The impacts associated with increases in GHG emissions from Mitigation Measure TR-1 would be less than significant.**

Mitigation Measure REC-1 could cause a temporary increase in GHG emissions. REC-1 calls for the preparation of a plan to develop new recreational facilities along the new river channel once the reservoirs are removed. On- and off-road construction equipment would be used to complete the necessary construction, but would be minor compared to the dam demolition emissions, and would occur after the demolition was complete. **The impacts associated with increases in GHG emissions from Mitigation Measure REC-1 would be less than significant.**

Several other mitigation measures may require construction, including Mitigation Measure H-2 (move or elevate structures with flood risk), GW-1 (deepen or replace wells), and WRWS-1 (modify water intakes). These measures could produce temporary impacts on GHG emissions during construction activities within localized areas. These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed Action and action alternatives. The same or similar elements as for the Proposed Action and action alternatives would be incorporated into these construction activities to avoid or reduce impacts on wildlife and plants, including special-status species, and sensitive habitats. **Impacts on GHG emissions from the implementation of H-2, GW-1, and WRWS-1 would be less than significant.**

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3.11 Geology, Soils, and Geologic Hazards

Geomorphology and sediment transport in the Klamath River watershed have implications on water quality and the survivability of aquatic species that use the sediment beds for reproduction (e.g., egg laying, larval stages). This section provides material relevant to the analysis of each of these issues; however, specific impacts on water quality and aquatic biology are addressed in Section 3.2, Water Quality, and Section 3.3, Aquatic Resources. This section assesses the changes to geomorphology and the potential for shoreline landslides and erosion due to sediment transport processes within the Klamath River watershed. This analysis also assesses the potential for local sedimentation in eddies and other "dead" zones in the Klamath River channel, as well as the effects on the estuary both during and following dam removal activities. Finally, this section discusses the potential for impacts from geologic hazards such as seismology and volcanology in the project area.

3.11.1 Area of Analysis

The area of analysis, or "project area," for the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) for geology, soils and geologic hazards includes the riverbed and reservoir banks at the sites of the Four Facilities as well as the riverbed and adjacent banks along the Klamath River downstream from Iron Gate Dam to its mouth at the Pacific Ocean.

3.11.2 Regulatory Framework

Geology, soils, and geologic hazards within the area of analysis are regulated by State and local laws and policies, which are listed below.

3.11.2.1 State Authorities and Regulations

- Oregon Statewide Planning Goals and Regulations (Oregon Department of Land Conservation and Development, 2001)
- Oregon Revised Statute 455.477 (Oregon, State of, 2009 edition)
- Alquist-Priolo Earthquake Fault Zoning Act (California Public Resources Code, Division 2, Chapter 7.5)
- Seismic Hazards Mapping Act (California Public Resources Code, Division 2, Chapter 7.8)

3.11.2.2 County Authorities and Regulations

- Siskiyou County General Plan, Land Use and Seismic Safety elements (Siskiyou County 1975, 1980)

3.11.3 Existing Conditions/Affected Environment

The potential removal of the Four Facilities raises concerns regarding the amount and nature of sediments stored in the respective reservoirs. Data collected to date indicate

that approximately 13.1 million cubic yards (yd^3) of deposits are stored in the four reservoirs and that these deposits consist of fine-grained particles (coarse sand and finer). The channel bed of the river mainstem downstream is primarily composed of cobble-sized material (Stillwater Sciences 2008; U.S. Department of the Interior [DOI] 2010).

3.11.3.1 Regional Geology

The Klamath Basin lies at or near the convergence of three tectonic plates that influence the geologic setting of the region: the Pacific, Juan de Fuca, and North American Plates. Consequently, the Klamath River flows through four distinct geologic provinces, each of which changes the character of the river's channel morphology and its tributary watersheds, varying the supply of inputs such as water, sediment, nutrients, and wood (Federal Energy Regulatory Commission [FERC] 2007). The Upper Klamath Basin lies in the transition zone between the Modoc Plateau and Cascade Range physiographic provinces, with the Klamath River cutting west through the Klamath Mountain province and then the Coast Range province where it reaches the Pacific Ocean near Requa, California (Figure 3.11-1; California Department of Conservation 2002; DOI 2010).

The Modoc Plateau abuts the Basin and Range Province where volcanic ramparts transition to escarpments with the valleys of the Basin and Range province. The Basin and Range province is an area of relatively young (Quaternary to Tertiary age) volcanic rocks with lesser amounts of intrusive rocks (DOI 2010). Basin and Range faults either displace the volcanic ramparts of the Modoc Plateau or are buried beneath them. The Klamath River passes through this province from the city of Klamath Falls to the Oregon-California State line. Below the State line, the river passes through the Cascades province. The portion of the basin that straddles the Modoc Plateau and Cascade Range provinces is typically called the "Upper" Klamath Basin. As the Klamath River flows towards the Pacific Ocean, downstream from Iron Gate Dam, it passes through the Klamath Mountains geomorphic province (which includes the Trinity Alps, Salmon Mountains, Marble Mountains, and Siskiyou Mountains). Rocks here are completely different from rocks upstream of Iron Gate Dam and are composed mostly of Cretaceous to Paleozoic age metamorphosed marine igneous and sedimentary rocks. Consequently, numerous faults and antiforms[1] are exposed along the river's path as it winds its way through the Klamath Mountains to the Pacific Ocean (DOI 2010).

Below river mile (RM) 40 (from the town of Weitchpec to the Pacific Ocean) the Klamath River traverses the Coast Range province. The geology of this area is underlain mostly by the Eastern Belt of the Franciscan Complex and a sliver of the Central Belt along the coast. The Eastern Belt is composed of schist and meta-sedimentary rocks (mostly metagraywacke) with minor amounts of shale, chert, and conglomerate. The Central Belt is principally an argillite-matrix mélange that contains kilometer-sized slabs of greenstone, serpentinte, graywacke, and abundant meter-size blocks of greenstone, graywacke, chert, higher-grade metamorphics, limestone, and lenses of serpentinite

[1] An antiform refers to a fold in the geology which curves upward but which the age of the geologic layers at the surface are unknown.

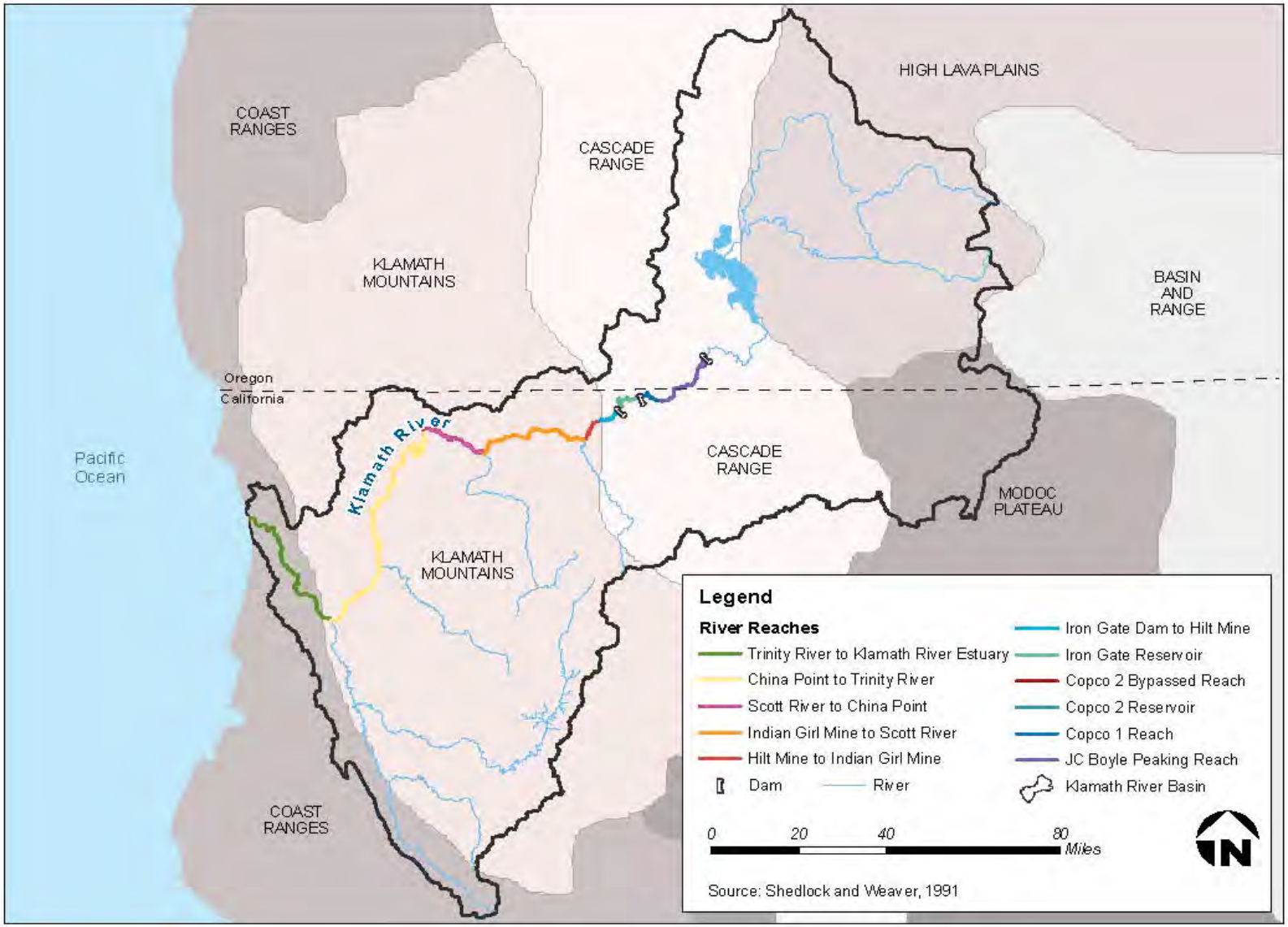

Figure 3.11-1. Klamath Basin Physiographic Provinces.

(Jayko and Blake 1987). Movement of the tectonic plates results in faulting in the Coast Range and the continued uplifting of the Franciscan rocks. This movement in conjunction with high precipitation rates and the compositionally weak nature of the rocks has resulted in high erosion rates that create steep hillslopes and high sediment yields (FERC 2007).

3.11.3.2 Geomorphology

In many ways the Klamath River is the reverse of most river systems. The headwaters flow through relatively flat, open country, and then flow through mountainous areas with input of cold water from the major tributaries. Accordingly, the river is warmer and flatter upstream of the project area, while downstream portions, beginning at the project area, tend to be colder and steeper. The Klamath River from the Oregon-California State line to downstream from Iron Gate Dam is a predominantly non-alluvial, sediment supply-limited river flowing through mountainous terrain. Downstream from the dam and for most of the river's length to the Pacific Ocean, the river maintains a relatively steep, high-energy, coarse-grained channel frequently confined by bedrock. Much of the course of the river in the Klamath Hydroelectric Reach is bedrock controlled, interspersed with relatively short alluvial reaches; thus, the influence of the Four Facilities on river geomorphology within the project area and downstream is limited. Floodplain development is minimal, and wider valleys allowing alluvial channel migration processes are rare. The following subsections provide a more detailed description of the geology and geomorphology of each of the subject reservoirs and associated river reaches, beginning with J.C. Boyle Reservoir and continuing downstream to the river estuary.

3.11.3.2.1 J.C. Boyle Reservoir

The bedrock surrounding and underlying J.C. Boyle Reservoir is principally composed of moderately well-bedded to massive, moderately well-consolidated sedimentary rocks containing volcanic material. Lava flows overlie these rocks and form many of the ridges above the reservoir. In the downstream portion of the reservoir (downstream from the Highway 66 Bridge), young lava flows line the sides of the reservoir (DOI 2010).

3.11.3.2.2 J.C. Boyle Peaking Reach

Downstream from J.C. Boyle Reservoir, the river canyon begins to open and channel slope decreases. This reach has a relatively low gradient (approximately 0.8 percent) and alternates between pools, bars, runs, and riffles. There is a wide terrace, which supports a riparian corridor of varying width along the channel, beyond which there is a floodplain. There are several side channels in conjunction with lateral bars and islands (FERC 2007).

3.11.3.2.3 Copco 1 Reservoir

The Copco 1 Reservoir is at a topographic transition area on the Klamath River, such that about 80 percent of the reservoir occupies a formerly lower gradient reach of the river. This break in stream gradient is largely the result of cinder cones and associated lava flows at the downstream portion of the reservoir (FERC 2007). Thus, geologic conditions in Copco 1 Reservoir are different than those in J.C. Boyle Reservoir, even though the bedrock beneath and surrounding both reservoirs consists primarily of rocks

formed from older volcanic flows overlain by younger lava flows. The rocks that underlie Copco 1 Reservoir contain thick deposits of airfall tuff and ash flows and there are several young volcanic eruptive cinders and cinder cones adjacent to the reservoir. Additionally a diatomite deposit along the southern downstream shore of the reservoir near Copco 1 Dam is even with or extending up to 20 feet above the reservoir surface (PanGeo 2008).[2] Several streams enter Copco 1 Reservoir, including Long Prairie Creek, Beaver Creek, Deer Creek, and Raymond Gulch. Sediment depositions and/or delta formations are present at the mouths of the larger streams in the reservoir (DOI 2010).

3.11.3.2.4 Copco 2 Reservoir

Copco 2 Reservoir is a relatively short impoundment (extending just over 0.25 mile) that lies immediately downstream from Copco 1 Dam. The reservoir is narrow and confined by a narrow bedrock canyon formed by lava flow (FERC 2007). As it is at Copco 1 Dam, rock at the Copco 2 Dam consists of a combination of lava flows and shallow intrusions. The bedrock surrounding and underlying the reservoir comprises basalt and andesite and steep slopes consisting of volcanic cobbles and boulders lie along both sides (DOI 2010).

3.11.3.2.5 Copco 2 Bypass Reach (RM 198.3–196.9)

Downstream from Copco 2 Dam, the Copco 2 Bypass Reach is characterized by a confined, boulder- and bedrock-dominated channel. The river in this reach is strongly influenced by the lava flow on the right bank of the river and there is minimal floodplain area. The average gradient of the reach is about 1.9 percent. Fossilized boulder-cobble bars dominate the channel cross section. Measurements of the bar by PacifiCorp during the FERC relicensing proceedings found that the median grain size was approximately 10 inches. Bedrock ledges also exist within the reach. Near the end of the reach, the Copco 2 Powerhouse discharges water into the Klamath River (FERC 2007).

3.11.3.2.6 Iron Gate Reservoir and Tributaries (RM 196.9–190.1)

Like Copco 1 Reservoir, Iron Gate Reservoir overlies a topographic transition on the Klamath River, where a steeper reach of river upstream (that of the Copco 2 Bypass Reach and a portion of the river inundated by Copco 1 Reservoir and Copco 2 Reservoir) transitions into the lower gradient reach downstream from Iron Gate Reservoir. In this area, the topography widens, and the channel is less restricted by the localized basalt lava flow from north of the Copco 2 Bypass Reach (FERC 2007). The reservoir has relatively steep topographic side-slopes and a narrow channel with numerous side drainages. Three of these side drainages are large, and two (Camp Creek at Mirror Cove and Jenny Creek) likely contribute substantial amounts of sediment to the reservoir. Except for these three side drainages, Iron Gate Reservoir hosts a relatively similar depositional environment throughout its length (DOI 2010).

[2] Diatomite is a chalk-like, soft, friable, earthy, very fine-grained, siliceous sedimentary rock, usually light in color. It is principally as a filter aid; but it has many other commercial applications, such as cement additives, absorbents, fillers, and insulation (USGS 2011).

3.11.3.2.7 Iron Gate Dam to Hilt Mine (RM 190-181)

The first reach downstream from Iron Gate Dam consists of a narrow floodplain and terraces confined by bedrock hills of the Western Cascade Volcanics and sedimentary rocks of the Cretaceous Hornbrook Formation. The channel is mostly single thread with a few areas of split flow that form mid-channel bars and side channels of short length. Most of the bars are at least partially vegetated, leaving few areas of exposed bars in the reach. Main tributaries that enter this reach include Brush Creek, Bogus Creek, Little Bogus Creek, Willow Creek, and Cottonwood Creek. With the exception of Cottonwood Creek, these tributaries form relatively small alluvial fans at their confluences with the Klamath River. Cottonwood Creek forms a large alluvial fan at its confluence with the river. Klamath River terraces are carved into the Cottonwood Creek alluvial fan deposits, suggesting that sediment input from Cottonwood Creek is limited to areas near and within the main channel of Cottonwood Creek (Reclamation 2012).

3.11.3.2.8 Hilt Mine to Indian Girl Mine (RM 181-174.6)

In this reach, the change in the physical characteristics of the bedrock marks a transition in channel confinement, where more resistant rocks create a narrow canyon with narrow alternating terraces along the reach length. Few bars exist in this reach; at RM 179, a mid-channel bar appears to be associated with the Williams Creek alluvial fan, which enters at the upstream end of the high terrace of the Randolf Collier rest area. The Shasta River enters from the south near RM 177 and forms a small gravel bar at its confluence with the Klamath River. The only other notable tributary in the reach is Ash Creek, which forms a fan of negligible size at its confluence with the Klamath River. Other notable features in this reach are associated with in-stream mining, including cobble-boulder benches and bars and a few wing-dam pits (Reclamation 2012).

3.11.3.2.9 Indian Girl Mine to Scott River (RM 174.6-143)

From Indian Girl Mine, the river valley broadens slightly within the canyon and allows for the preservation of broad gravelly terraces that have been extensively mined. In areas not obscured by mining, overflow channels are present on the terrace surfaces. Unvegetated bars are more prevalent in this reach and exist as point bars along the inside bends of channel meanders as well as mid-channel bar and side channel complexes. The channel maintains a mostly single thread meandering morphology with some areas of split flow around mid-channel bars.

At Gottville, several tributaries enter from the north and form a large alluvial fan complex that constricts the river and forms the Langley Falls rapid and associated large eddy directly upstream. Downstream from Gottville, between RM 166 and 161.5, the river valley narrows to about half the width of that upstream. Low terraces and point bars exist in this reach and have been extensively mined with tailings piles still visible on some of the surfaces. Channel morphology is less winding than that upstream and is single thread with a few small mid-channel bars. At the downstream end of this subreach, the Miller Gulch alluvial fan acts to constrict the channel. The river forms an eddy between the upstream end of the Miller Gulch fan and a small tributary fan from the opposite bank.

From Miller Gulch (RM 161.5) to Horse Creek (near RM 147), the river valley broadens again to include terraces with at least two levels and gravel bars. In several locations, the channel sinuosity increases. A narrow section exists in this reach from between RM 154 and RM 150 and is confined by bedrock on both sides of the river and by the Kohl Creek alluvial fan near RM 152. From RM 150 to Horse Creek, the river returns to a broader valley with a large remnant stream channel in the Cherry Flat area that has been extensively placer mined.

From Horse Creek to Scott River (RM 143), the river valley narrows and is confined by bedrock on both sides of the river. Terraces and bars are restricted to the insides of meander bends. Several small tributaries enter in this reach, forming steep alluvial fans at the confluence with the Klamath River, some of which have narrow terraces cut on their front edges. Channel morphology is single thread with a few small, unvegetated, mid-channel bars and point bars (Reclamation 2012).

3.11.3.2.10 Scott River to China Point (RM 143-118)

Downstream from Scott River from RM 143 to 132, the extent and height of unvegetated gravel bars increases and bars become more prevalent with discontinuous narrow alluvial terraces forming along the canyon margins. Large alluvial fans control river position from RM 141 to 139 along the south side of the river. At Seiad Valley, large alluvial fans from Seiad Creek, Little Grider Creek and Grider Creek form a wider alluvial valley in which terraces are cut on the front edges of the fans and large bars and riffles are formed along the river channel as a result of tributary sediment contributions to the Klamath River.

From RM 130 to 121.5, the Klamath River flows through a winding bedrock canyon with unvegetated bars located on the insides of meander bends. Valley terraces and bedrock-cored bars are prevalent in this reach. From RM 121.5 to China Point, the canyon narrows as it enters bedrock of the Jurassic Galice Formation. Bedrock benches form along the channel margins. At China Point, an extensive, unvegetated gravel bar lies on the inside of the bend along with a higher alluvial terrace. On the south side of the river, a remnant channel is elevated above the present channel. Tributaries that contribute sediment to the river in this reach include Thompson, Fort Goff, Portuguese, Grider, Walker, O'Neil, and Macks Creeks (Reclamation 2012).

3.11.3.2.11 China Point to Trinity River (RM 118-43.5)

From China Point to Deason Flat (RM 118-104), the channel is narrow with numerous valley terraces that have been extensively mined. Well-developed bars and riffles are formed at tributary confluences and meander bends. The lower three miles of this reach (RM 107-104) contain a greater number of unvegetated bars, which are formed by sediment inputs from Elk and Indian Creeks and channel constrictions downstream from RM 104. Tributaries in this reach contain large landslides, with Indian Creek watershed containing the most of any tributary.

From Deason Flat to Dutch Creek (RM 104-92), the river flows through a narrow bedrock canyon with low bedrock benches and gravelly veneers. Wider sections interspersed in this reach have small valley terraces that have been extensively mined and unvegetated gravel bars. This reach also contains notable landslides along the main stem, the largest of which is on the west side of the river between RM 98.5 and RM 93. Independence and Clear Creeks both contribute large amounts of sediment to the river in this reach.

From Dutch Creek to Trinity River (RM 92-43.5), the river is contained in a narrow bedrock canyon with intermittent alluvial reaches. This reach also includes the wider alluvial valley at Orleans (RM 58.5). Geomorphic features include valley terrace and bars, alluvial terraces and bars, bedrock benches and alluvial fans. Numerous landslides lie along the river and interact with the river through sediment contributions and controlling channel position. This reach is the downstream limit of channel mining on the Klamath River. Tributaries that are major contributors of sediment include Salmon River, Trinity River, Bluff Creek, Camp Creek and Ukonom Creek (Reclamation 2012).

3.11.3.2.12 Trinity River to Klamath River Estuary (RM 43.5-0)

From Trinity River to Cappell Flat (RM 43.5-35), a narrow bedrock canyon with few bars and no floodplain or terraces exists, and is primarily bedrock controlled. Landslides and alluvial fans are less common, but locations still exist where these features have temporarily dammed the river based on remnant boulders in the channel and deposits on opposite banks.

From Cappell Flat to Starwein Flat (RM 35-10), the river flows through a narrow, confined valley with minimal floodplain and terraces. Bars are well developed and are either alternate bars formed in straighter reaches or point bars formed at meander bends. The extent of the bars increases in the downstream direction. Tributaries create split flow channels, mid-channel bars and riffles at their confluences with the main stem. Major sediment contributors include Blue, Pecwan, Cappell, Bear, and Tectah Creeks.

From Starwein Flat to the mouth (RM10-0), the river transitions into a wide valley with floodplain surfaces and narrow terrace remnants. Well-developed bars of variable height lie along the reach and several large pools and few riffles are present. Turwar Creek is the only major sediment producer in this reach, contributing mostly fine materials to the Klamath River (Reclamation 2012). The lower seven miles of the Klamath River to its mouth at the Pacific Ocean is classified as a "Confined River System" with a relatively steep gradient. The river channel is largely confined by banks of hard bedrock, which keep it from forming shallow braided channels. Thus, the river is relatively narrow with cross-channel widths typically between 650 and 800 feet except at large bends and areas where bank/bar erosion is active. In these areas, the channel width increases up to 1,600 feet (the river makes several large bends that are controlled by the local geology). The relatively narrow river banks and highly variable flow (commonly 18,000 to +30,000 cubic feet per second [cfs]) make the river system "flashy", creating large variations in bedload capacity and bedload sediment gradations (DOI 2010).

The mouth of the river is characterized by a wave-dominated delta with a large barrier island parallel to the coastline (i.e., offshore sandbar). Behind the barrier island is a shallow lagoon about 2,500 feet long by less than 1,000 feet wide. This area of the Klamath River is highly dynamic, changing positions during large flood events and transporting most of its suspended load or silt and clay out to sea. The limited size of the lagoon is dominated by deposits of medium grained sand and silty sand with only very local accumulations of fine-grained materials (DOI 2010).

3.11.3.3 Sediment Supply and Transport

The Klamath River is supply limited for fine material (sands and small gravels), but capacity limited for large material (cobbles and boulders) (Reclamation 2012). Practically no substantial sediment is supplied to the Klamath River from the watershed above Keno Dam; because of its large surface area, Upper Klamath Lake traps practically all sediment entering it from its tributaries.

The Lead Agencies estimate average annual sediment delivery at approximately 200,000 tons per year (ton/yr) from Keno Dam to Iron Gate Dam. The Scott River supplies approximately 607,000 tons/yr; the Salmon River supplies 320,000 tons/yr; and the Trinity River supplies 3.3 million tons/yr. The total annual delivery of sediment to the ocean from the Klamath River is estimated at 5.8 million tons/yr. The total annual delivery of sediment with a size greater than 0.063 millimeters (mm) [coarse sand] is estimated to be 1.9 million tons/yr (Reclamation 2012). Table 3.11-1 provides the cumulative annual sediment carried downstream by the Klamath River and shows the proportion of coarse material and fine material within the load.

3.11.3.4 Reservoir Substrate Composition

In 2010, DOI conducted a sediment sampling study in the subject reservoirs to describe sediment composition and determine sediment thickness throughout all major sections of the reservoirs[3]. The study found that fine-grained sediment in all of the reservoirs but Copco 2 Reservoir consisted primarily of elastic silt and clay, with lesser amounts of elastic silt with fine sand. The sediment was determined to be mostly an accumulation of silt size particles of organic material such as algae and diatoms, and silt size particles of rock. The average grain size decreases nearer to the dams because smaller particles settle more slowly than larger particles. Accordingly, the upper reaches of each reservoir contained a higher percentage of silt, sand, and gravel than the lower reaches, which contain more clay, sandy elastic silt and elastic silt with trace sand. The elastic silt in all of the reservoirs had the consistency of pudding, and had very high water content (greater than 100 percent). The fine-grained sediment was also found to have a low cohesion and to be erodible; where water flowed greater than 2 to 4 miles per hour, accumulations of sediment were less than a few inches (DOI 2010). Table 3.11-2 describes the physical properties of the sediment in each reservoir, and the following paragraphs summarize the findings for each reservoir.

[3] The study also addressed the chemical composition of the reservoir sediment. A summary of these results and the associated implications are addressed in Section 3.2 Water Quality.

Table 3.11-1. Cumulative Annual Sediment Delivery to the Klamath River

Source Area	River Mile	Cumulative delivery[1]		
		Total (tons/year)	% particles ≥0.063 mm	% particles ≤0.063 mm
Keno Dam to Iron Gate Dam	192.7	151,000	16%	84%
Iron Gate Dam to Cottonwood Creek	184.9	160,961	16%	84%
Cottonwood Creek	184.9	175,560	17%	83%
Cottonwood Creek to Shasta River	179.3	177,715	18%	82%
Shasta River	179.3	199,259	19%	81%
Shasta River to Beaver Creek	163.3	231,710	21%	79%
Beaver Creek	163.3	279,869	23%	77%
Beaver Creek to Scott River	145.1	373,073	25%	75%
Scott River	145.1	980,393	29%	71%
Scott River to Grider Creek	129.4	1,048,860	30%	70%
Grider Creek to Indian Creek	108.4	1,099,934	30%	70%
Indian Creek	108.4	1,173,246	30%	70%
Elk Creek	107.1	1,211,930	30%	70%
Clear Creek	100.1	1,253,972	30%	70%
Dillon Creek	85.8	1,282,389	30%	70%
Indian Creek to Dillon Creek	85.8	1,354,759	30%	70%
Dillon Creek to Salmon River	66.5	1,440,282	30%	70%
Salmon River	66.5	1,760,904	31%	69%
Salmon River to Camp Creek	57.3	1,785,769	31%	69%
Camp Creek	57.3	1,831,523	31%	69%
Camp Creek to Red Cap Creek	53.0	1,855,021	31%	69%
Red Cap Creek	53.0	1,897,796	31%	69%
Red Cap Creek to Bluff Creek	49.8	1,913,925	31%	69%
Bluff Creek	49.8	2,014,594	31%	69%
Bluff Creek to Trinity River	43.4	2,035,830	31%	69%
Trinity River	43.4	5,353,164	32%	68%
Blue Creek	16.1	5,455,971	32%	68%
Trinity River to Mouth	0.0	5,834,091	32%	68%

Source: Adapted from Stillwater Sciences 2010

[1] Density = 1.5 tons/yd^3. Mass report in US short tons. Above Cottonwood Creek, assumes 16 percent of total load is ≥0.063 based on grains size distribution of reservoir sediment (Gathard Engineering Consulting 2006). Below Cottonwood Creek, assumes 10 percent of total load is bedload and 24 percent of suspended load is sand ≥0.063 Coarse sediment delivery to the ocean is less than presented in this table when attrition by abrasion is considered.

Key:

mm: millimeters

Table 3.11-2. Physical Properties of Reservoir Sediment

Reservoir	Location	Volume yd^3	% Clay[1]	% Silt[1]	% Sand[1]	% Gravel [1]	Liquid Limit (%)	Plasticity Index (%)	Moisture Content (%)	Porosity (%)	Dry Bulk Density lb/ft
J.C. Boyle	Upper Reservoir	380,000	17.3	26.2	56.5	0.0	45.5	14.7	173	0.82	29.5
	Lower Reservoir	620,000	38.2	49.7	12.1	0.0	173	60.6	345	0.90	16.3
	Pre-Reservoir		3.7	9.5	28.4	58.5	44.9	12.7	23.4	0.38	101
Copco I	Upper Reservoir	810,000	27.9	46.8	25.1	0.2	109.3	49.3	287	0.88	19.2
	Lower Reservoir	6,630,000	55.8	34.2	10.0	0.0	154.3	59.1	295	0.88	18.7
	Pre-Reservoir		35.6	42.2	22.2	0.0	105.0	41.5	153	0.80	32.6
Iron Gate	Upper Reservoir	830,000	35.4	43.1	21.6	0.0	70.9	29.9	192	0.83	27.0
	Lower Reservoir	2,780,000	60.7	25.5	13.5	0.4	118.7	51.4	276	0.88	19.8
	Pre-reservoir		33.6	16.9	20.4	29.1	60.6	32.5	37.9	0.50	81.8
	Upper Tributary	300,000	31.8	42.7	25.5	0.0	60.7	22.7	102	0.73	44.4
	Lower Tributary	800,000	61.8	32.0	6.1	0.0	112.2	49.6	284	0.88	19.3

Source: DOI 2010; Reclamation 2012.

[1]Clay = 0 to 0.005 mm; Silt = 0.005 to 0.075 mm; Sand = #200 to #4 sieve; Gravel = #4 to 3 inch.

Key:
yd^3: cubic yards
lb/ft: pounds per foot

3.11.3.4.1 J.C. Boyle Reservoir

As shown in Table 3.11-2, the upper portion J.C. Boyle Reservoir primarily has coarse-grained sediment, both as pre-reservoir alluvium and reservoir sediment. The reservoir has an abundance of gravel/sand bars and cobbles exposed above the reservoir water surface, with sub-surface sand and gravel found by stab-sampling. The reservoir also likely has small, local accumulations of fine grained reservoir sediment within the upper 5,000 feet of the reservoir, but most of the reservoir sediment in this section is coarse grained. The reservoir sediment becomes finer grained with distance downstream. Sediment sampling conducted by the DOI indicates that about 5,000 feet downstream, reservoir sediment is three to five feet thick and composed of silty sand to poorly graded sand with silt with less than about 15 percent fine grained material (DOI 2010).

Only thin deposits of reservoir sediment were present at the sample sites in the middle section of the reservoir. The reservoir sediment consisted of fine-grained elastic silt with substantial accumulations of organic material. Pre-reservoir material consisted of coarse grained alluvium (silty gravel and sand), and bedrock consisted of volcaniclastic rock intensely weathered/decomposed to lean clay. Reservoir sediment was thickest in the lower section of the reservoir (ranging from 14 to 22 feet thick). Sediment in the lower section was uniformly elastic silt with greater than 90 percent fine-grained material. The sediment overlaid coarse grained pre-reservoir alluvium consisting mostly of silty gravel with sand (DOI 2010).

3.11.3.4.2 Copco 1 Reservoir

The upper portion of Copco 1 Reservoir has a sediment thickness ranging from 3.5 to 8.0 feet consisting of elastic silt with sand. Sediments in the rest of the reservoir are relatively uniform and composed of elastic silt, containing between 88 and 99 percent fine-grained material. Sediment thickness in the main reservoir ranges from 1.3 to 9.7 feet deep (DOI 2010).

3.11.3.4.3 Copco 2 Reservoir

The upper 500 feet of the Copco 2 Reservoir contained deposits primarily composed of cobble boulders. Similarly, the channel invert appeared to be covered mostly with angular gravel to boulder size talus and minor interstitial sand. Flow velocities in the reservoir channel at the time of sampling were relatively fast, therefore, it is likely that sediment composed of silt and clay did not deposit or had been previously eroded. Results of core drilling attempts show that cobbles, boulders, gravel, and sand formed the deposits in the bottom of the reservoir and there is a lack of fine-grained sediment (DOI 2010).

3.11.3.4.4 Iron Gate Reservoir

Iron Gate Reservoir has relatively steep side-slopes and a narrow channel with numerous side drainages. Three of these side drainages are large, and two likely contribute substantial amounts of sediment to the reservoir. Except for the three principal side drainages, Iron Gate Reservoir has a relatively similar depositional environment throughout its length. Only the upper 6,000 feet of the reservoir has a substantial percentage of sand within the reservoir sediment. Sediment thickness ranged from 1.4 to

9.2 feet, with most samples having a thickness of less than 5 feet. Reservoir sediment was relatively uniform throughout the reservoir and consisted of elastic silt with 85 to 98 percent fine-grained material (DOI 2010).

3.11.3.5 Slope Stability/Landslides

Landslides (both into the subject reservoirs and the mainstem Klamath River) are one potential source of sediment supply to the river system. Potential landslide/rock fall areas include relatively steep slopes underlain by tuff, as well as areas of deep colluvium/talus slopes that could produce slumps and debris flows. Talus slopes are found along the Klamath River between J.C. Boyle Dam and Copco 2 Reservoir. Identified slope stability/landslide occurrences and observations at reservoirs in the study area include the following.

Recent observations of the subject reservoirs identified no areas of unstable slopes or existing landslides adjacent to J.C. Boyle Reservoir or Copco 2 Reservoir.

No areas of large-scale active landslides were observed in the slopes adjacent to Copco 1 Reservoir. Several small-to-medium sized landslide features are present on the north shore of the reservoir that may have been caused by rainfall and/or subsurface ground water flows (Figure 3.11-2). However, the preliminary evaluation conducted by PanGeo indicates that the slopes in these areas are currently stable. Other areas of past landslides include an old, inactive slide that is visible on the westernmost end of the reservoir and a colluvium fan on the north shore immediately west of Spannus Gulch. In addition to potential sediment inputs from past landslides, wave action at the shoreline of the reservoir has eroded sand and volcaniclastic tuff beneath diatomite beds and has resulted in the calving of diatomite into the reservoir creating vertical exposures as high as 20 feet in the diatomite. The diatomite that has calved into the reservoir has most likely been eroded and re-deposited within the reservoir. Elsewhere around the reservoir, shoreline erosion has been minimal (PanGeo 2008).

Within Iron Gate Reservoir, the adjacent hillside slopes are generally considered stable with no active landslide areas. However, geomorphic features suggestive of old, inactive landslides (including small slumps a few meters wide and possible slides covering square miles) were identified on the south rim slopes above the reservoir and may have contributed to past sediment input into the reservoir. In addition, a low level of wave-induced shoreline erosion at the margin of the reservoir was observed and reported in the PanGeo (2008) study. However, the erosion has not substantially undercut or disturbed the hillside slopes, and the exposed material along the shoreline comprises relatively competent volcanic or volcaniclastic rock. According to the PanGeo study, recent erosion rills in the red volcaniclastic materials underlying the hillside slopes indicate that these fine-grained materials may be vulnerable to rapid erosion in the future if subjected to concentrated water flows (PanGeo 2008).

Figure 3.11-2. Existing Potential Landslide Areas.

Potential landslide/rockfall areas downstream from the Four Facilities include all steep slopes underlain by tuff, as well as areas of deep colluvium/talus slopes that could produce slumps and debris. Talus slopes are found through the Klamath River Canyon (the stretch of river between J.C. Boyle and Copco 2 Dams). Continuous creep of talus and rapid rockfalls are likely on and near talus slopes, and the potential exists for slow-to-moderate migration of some of the large slides. Landsliding is also prevalent in the Franciscan geology of the lower Klamath River watershed and along tributary watersheds within the Klamath Mountain geomorphic province, such as the Salmon River (FERC 2007). As discussed above when describing the geomorphology of the river, existing landslide areas are present downstream from the Scott River confluence.

3.11.3.5.1 Soils

Upper Klamath River

Soils in the vicinity of the Upper Klamath River, surrounding J.C. Boyle Reservoir, and along the river south to the Oregon-California border generally consist of lacustrine and alluvial clay, silt, fine-grained sand and peat (Priest et al 2008). The primary soil association along both sides of the river is Skookum-rock outcrop-Rubble land complex with 35 to 70 percent slopes. Immediately surrounding Keno Impoundment, soils consist of the Bly-Royst complex (Natural Resources Conservation Service [NRCS] 2005).

Klamath Hydroelectric Project

Soils along the Klamath River and on reaches between the subject reservoirs are less homogenous in California. However, the various soil formations can be grouped generally into those on steeper slopes, floodplain or terrace surfaces, or directly along the river itself. The soils on steeper slopes are shallow to moderately deep and comprise a 7-8 inch surface horizon of gravelly loam, and an underlying horizon of gravelly, clayey loam. Floodplain and terrace soils are comprised of deep, well-drained alluvium and colluvium. Directly along the river, soils are comprised of unconsolidated alluvium, colluvium, and fluvial deposits. These geologically recent deposits consist of unconsolidated sand, silt, and gravels deposited by water or erosion (FERC 2007).

Below Iron Gate Dam

Soils along the Klamath River below Iron Gate Dam are generally composed of associations consisting of gravelly clay loam and gravelly sandy loam (Holland-Clallam, Skalan, Weitchpec, and Lithic Mollic Dubakella associations). Soils on steeper slopes are deeper (22 to 60 inches) than those on less steep slopes and along the floodplain. These soil associations are all classified as well-drained, with low to no flooding frequency or ability for ponding water. Soils directly along the river in floodplain areas are comprised of alluvial deposits consisting of sand and gravels (NRCS 2007 and 2008).

3.11.3.6 Faults and Seismicity

Review of available fault and earthquake epicenter maps for northern California and southern Oregon show no fault lines or earthquake epicenters beneath Iron Gate Dam or the Copco Dams and Reservoirs. However, volcanic vents occur very close to the two Copco Dams. Faults exist beneath the J.C. Boyle Dam and Reservoir. However, these faults have not moved within the past 1.5 million years and, therefore, are termed not

active (Personius et al. 2003). No earthquake epicenters are mapped beneath the J.C. Boyle Reservoir, but one of the largest earthquakes ever recorded in Oregon occurred in 1993 in and around the Klamath Falls areas approximately 15 miles north of the J.C. Boyle Reservoir.

In California, the nearest active fault to the Four Facilities is the Meiss Lake fault, approximately five miles east of the Klamath River near the California/Oregon State line in Siskiyou County. The next nearest California-zoned active fault in relation to the Four Facilities is the Mahogany Mountain fault zone approximately 6 miles east (Jennings and Bryant 2010).

3.11.3.7 Volcanic Activity and Associated Strata

The High Cascades geomorphic province consists of a narrow band of shield volcanoes built on top of the eastern portion of the Western Cascades strata. The High Cascades are represented in the vicinity of the Four Facilities by the extinct cones of Eagle Rock Mountain to the south of the Klamath River valley, the Secret Spring Mountain and McGavin Peak to the southeast, and Mount Shasta to the Northwest. There are also a series of basaltic volcanoes extending northward into Oregon towards Klamath Falls, which have been dissected by subsequent basin and range block faulting (PanGeo 2008).

In addition to the large shield volcanoes with their multiple eruptive events, numerous smaller vents and volcanoes are present in the area. The majority of the volcanism in the Upper Klamath Basin consists of single events from a given vent and most of the smaller explosive cones are formed from the interaction of flow material intersecting ground water (hydrovolcanic events). High Cascades volcanism continues to the present day (PanGeo 2008). Within the past 10,000 years, the average frequency of Mount Shasta eruptions is one every 800 years. Over just the past 4.500 years however, the average eruption frequency has increased to one every 600 years. The last known eruption occurred approximately 200 years ago (Miller 1980).

The rocks in the vicinity of the Four Facilities range in age from roughly 45 million years old up to the present. Copco and Iron Gate Dams are in the Western Cascades. The volcanic activity that formed the Western Cascades is thought to have started between 42 and 45 million years ago (Eocene) and continued until approximately 10 and 5 million years ago. Over time, the main area of volcanic activity shifted eastward and narrowed. The intensity of volcanism also diminished and erosion activity erased much of the evidence of the original volcanoes. Estimates of the thickness of the Western Cascades strata range from between 12,000 and 15,000 feet to greater than 20,000 feet (PanGeo 2008).

In the vicinity of Copco Reservoir, up to half of the Western Cascade strata are exposed in the Klamath River Canyon as a result of river down cutting. In this exposure, the Western Cascade strata are comprised of inter-bedded tuffs, ash, and lava flows dipping down to the east at approximately 25 degrees. The east dipping strata of the Western Cascade is overlain by the nearly flat lying High Cascade strata composed of younger Pliocene lava flows with a cumulative thickness of up to 500 feet. Particular zones of the

inter-bedded strata of the Western Cascade may serve as geothermal reservoirs when coupled with a heat source and sealed by overlying High Cascade lava flows, (Hammond 1983).

3.11.4 Environmental Consequences

3.11.4.1 Environmental Effects Determination Methods

The environmental consequences of the alternatives focus on changes to geomorphology and sediment transport. This analysis discusses potential increases in geologic hazards downstream from the reservoirs, as well as potential increases in erosion in the Upper Klamath Basin under implementation of each of the alternatives.

DOI used the Sedimentation and River Hydraulics-One Dimension Version 2.4 sediment transport model to analyze the potential transport of reservoir sediment downstream based on different drawdown scenarios. The analysis below uses the results of DOI's sediment transport modeling to evaluate changes in downstream sediment regimes and the effect of the changes on shoreline geology downstream from the reservoirs. The analysis also qualitatively analyzes the potential for local sedimentation in eddies and other low gradient zones in the Klamath River channel.

3.11.4.2 Significance Criteria

For the purposes of this EIS/EIR, impacts would be significant if they would result in the following:

- Substantial soil erosion into reservoir areas or along the Klamath River.
- Cause new or exacerbate existing landslides along the banks of the reservoirs.
- Incomplete flushing of sediment with substantial deposition downstream, which adversely affects other associated resources (i.e., Water Quality, Fish Resources, Mollusks, and Benthic Invertebrates).
- Exposure of people or structures to adverse effects resulting from rupture of a known earthquake fault, strong seismic ground shaking, or volcanic activity.
- Remove access to diatomite beds for extraction.

3.11.4.3 Effects Determinations

3.11.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, J.C. Boyle, Iron Gate, and Copco 1 Reservoirs would continue to trap sediment at rates similar to historical rates. Based on historic sediment trapping rates and sediment levels in each reservoir, it is estimated that approximately 23.5 million yd^3 of sediment would be stored behind the dams in 50 years time (i.e., by 2061). Studies conducted by DOI indicate that the trapping efficiency of J.C. Boyle Dam may decrease slightly as the reservoir capacity decreases but the rate at which this may happen is uncertain and is not likely to change substantially over the next 50 years (Reclamation 2012). It is likely that after the storage capacity reduces to a certain level, sedimentation in the reservoirs would stop and sediment would begin to

pass through the reservoir pools and be transported downstream. Table 3.11-3 summarizes the current estimated volume of sediment in each reservoir, the respective sediment trapping rate, and the anticipated sediment volume in each reservoir in 50 years.

No future substantial erosion or landslides are expected to occur downstream from any of the Four Facilities under the No Action/No Project Alternative. As described in Section 3.11.3 (Existing Conditions/Affected Environment), river elevation downstream from the dams is primarily controlled by large boulders and bedrock, and only limited adjustment is possible. **There would be no change from existing conditions as a result of the No Action/ No Project.**

Table 3.11-3. Estimated Future Sediment Volume in Reservoirs under the No Action/No Project Alternative

Reservoir	Original Storage Capacity (acre-ft)	Current Sediment Volume (yd^3)	Sedimentation Rate (yd^3/yr)	2061 Sediment Volume (yd^3)	% Reduction in Storage Capacity
J.C. Boyle	3,495	1,000,000	19,600	2,020,000	36
Copco 1	46,867	7,400,000	81,300	11,600,000	15
Copco 2	73	0	0	0	0
Iron Gate	58,794	4,700,000	100,000	9,900,000	10
Total	109,229	13,100,000	201,000	23,500,000	13

Source: Reclamation 2012

Key:

yd^3: cubic yards

yd^3/year: cubic yards per year

lb/ft: pounds per foot

Under the No Action/No Project Alternative, Copco 1 Reservoir would continue to prohibit access to diatomite beds. Diatomite beds are at the southern shore of the reservoir near the dam and are even with or extending up to 20 feet above the reservoir surface. Wave action at the shoreline has eroded the diatomite. Because of their location in the reservoir and existing erosion, diatomite resources are currently inaccessible for extraction purposes. **There would be no change to the existing conditions of diatomite beds under the No Action/No Project Alternative because the resources would continue to be inaccessible.**

3.11.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Soil disturbance associated with heavy vehicle use, excavation, and grading could result in erosion during removal activities. As described in the Affected Environment, shoreline erosion is generally not a substantial factor affecting the Iron Gate and J.C. Boyle Reservoirs, although it is an issue at Copco 1 Reservoir, where eroded sand and volcaniclastic tuff has resulted in the subsequent calving of diatomite into the reservoir. This existing erosion is caused by wave action in the reservoir (PanGeo 2008). Soil disturbance associated with heavy vehicle use, excavation, and grading could result

in erosion during removal activities at Iron Gate and J.C. Boyle Reservoirs and could exacerbate existing erosion at Copco 1 Reservoir. Prior to demolition, coverage under the General Stormwater National Pollution Discharge Elimination System (NPDES) Permit for Construction Activities in both Oregon and California would be required as per Section 402 of the Clean Water Act. Coverage under this permit requires the development and implementation of an Erosion and Sediment Control Plan prior to deconstruction that describes best management practices (BMPs) to prevent erosion during demolition activities. Implementation of these BMPs would minimize the potential for erosion into the reservoir areas. **Erosion impacts into the reservoir areas would be short term and less than significant.**

Drawdown of the three largest reservoirs could cause some instability along the banks of the reservoirs. The sediment deposited within the reservoirs since dam construction is expected to be relatively weak and susceptible to slumping. However, the reservoir sediment on the terraces of the reservoirs is only a few feet thick and slumping toward the river channel will only occur primarily during drawdown. After drawdown, the remaining reservoir sediment will harden and be stable. The pre-dam topography that exists underneath the reservoir sediment is expected to be relatively stable, though some slumping could occur on slopes with inclinations from 18 to 40 degrees, and would be dependent on the drawdown rate (i.e. slower drawdown rates would result in less slumping). The PanGeo (2008) study, which was described in Section 3.11.3 (Existing Conditions/Affected Environment), concluded that the hillside slopes below the pool levels behind Iron Gate, Copco 1, and J.C. Boyle Dams would likely perform relatively well and remain stable during drawdown activities. In addition, no large-scale landslides are anticipated in newly exposed areas and any new slides that may develop would most likely be below the existing water level in the reservoirs, although such slides could create higher deposition on the terraces above the newly formed river channel. **These potential landslide impacts would be short term and less than significant.**

Reservoir drawdown at Copco 1 would reduce the potential for erosion and future landslides. Because existing erosion at Copco 1 Reservoir is largely the result of wave action, emptying the reservoir would remove this source of shoreline erosion. As noted above, no large-scale landslides are anticipated in newly exposed areas during drawdown. In the long term with implementation of reservoir restoration actions including hydro seeding, landslides and erosion would not be expected at a higher frequency or of a larger size than what is currently contributed from the slopes adjacent to the reservoirs. **Thus, long-term impacts with regards to erosion and potential landslides at Copco 1 Reservoir would be less than significant.**

Drawdown of reservoirs could cause bank erosion downstream. The drawdown of the four reservoirs would occur simultaneously beginning in January 2020. Based on the current project schedule and drawdown rate restrictions, the controlled released would maintain the minimum required flows in each reach. Section 3.6, Flood Hydrology, discusses historic flow rates and discharge statistics for each of the reservoirs. The proposed drawdown rates are consistent with the historic discharge rates from the reservoirs and would be adjusted depending on the water year; therefore, flow rates

downstream from the dams are not anticipated to increase substantially above median historic rates, if at all (discharges from the reservoirs would be similar to seasonal 10-year flood flows from the reservoirs).

Although some landslides and erosive areas have been identified in the lower river, based on the expected flow rates that are similar to existing flow rates, substantial amounts of additional erosion are not expected to occur downstream from any of the dams as a result of reservoir drawdown. **Any erosion downstream would be minimal; these impacts would be short term and less than significant.**

Drawdown of reservoirs and release of sediment would result in short-term increases in sedimentation in slow-moving eddies and pools downstream from the reservoirs and in the Klamath River estuary. During reservoir drawdown in 2020, the sediment behind the four dams would be released downstream. DOI conducted modeling of the reservoir drawdown and erosion of reservoir sediment. The drawdown of Iron Gate Reservoir would ultimately control sediment released from Copco 1 and 2, and J.C. Boyle Reservoirs due to its location furthest downstream. Since all reservoirs would be drawn down concurrently, sediment released from the upstream reservoirs would remain suspended and is not anticipated to settle within Iron Gate Reservoir. However, the released sediment would likely exceed the carrying capacity of the river during some water year types, and would result in sedimentation and particle settling downstream in eddies, pools, and the Klamath River estuary. The potential for deposition downstream is dependent on particle size and the water year type in 2020, and subsequent years. In general, sediment transport capacity in a dry year would be small and any downstream sediment deposition would stay in place, until the next substantial series of storms or snowmelt came. In contrast, during a wet year, suspended sediment would be more likely to be carried through the river to the ocean without substantial settling and deposition[4].

To determine how much sediment would be moved through the river, a study compared the settling velocity[5] of the reservoir sediment to the velocity profiles downstream from Iron Gate Dam. Based on the slope of the river and composition of river substrate downstream from the dam, as well as the daily average discharge (approximately 3,000 cfs), the study found that particles with a settling velocity less than 0.23 ft/s have the potential to be mobile as suspended sediment. This corresponds to sediment particles finer than 0.68 mm (coarse sand) (Table 3.11-4; Stillwater Sciences 2004).

[4] Representative dry, median, and wet water years were defined as the 90%, 50%, and 10% exceedance flow volumes for the period from March to June at Keno on the Klamath River. The dry, median, and wet water years were 2001, 1976, and 1984, respectively.

[5] Settling velocity is the rate at which particles suspended in a fluid subside and are deposited. Settling velocity is dependent on gravitational force, the type of fluid, how smoothly and quickly the fluid is flowing, and the particle size and shape.

Table 3.11-4. Estimated Particle Sizes that would be Suspended at Average and Maximum Daily Discharge Rates

Discharge	3,000 cfs	7,000 cfs
Shear velocity	0.58 ft/s	0.76 ft/s
Maximum settling velocity for suspension	0.23 ft/s	0.34 ft/s
Corresponding particle size	0.42 mm	0.68 mm
Corresponding size class	Medium sand	Coarse sand

Source: Stillwater Sciences 2004

Key:

cfs: cubic feet per second (discharge rate)

ft/s: feet per second

mm: millimeters

Modeling conducted by DOI analyzed the deposition rate of the released sediment downstream from Iron Gate Dam for a 2-year period following commencement of drawdown activities. Three types of water year scenarios were analyzed (dry, wet, and average). The results of the modeling found that under all three water year types, fine sediment would be transported downstream as suspended sediment (Reclamation 2012). As described in the Affected Environment, sediment sampling in the reservoirs has indicated that, with the exception of Copco 1, the majority of sediment is composed of fine-grained elastic silt. Therefore, it is expected that deposition would occur in pools or along vegetated area during low-flow periods, but that the deposition would be flushed downstream during high-flow events. Any settling or sedimentation of fine sediment in eddies or pools is expected to be minimal and short-lived. Further, as described in Section 3.11.3.2, Geomorphology, there is no sandbar within the mouth of the Klamath River itself; rather the sandbar is located offshore. As a result, the majority of the suspended sediment load from the river is carried out to sea and does not remain in the estuary itself. The amount of sediment delivered to the ocean in a given year is entirely dependent on the water year type.

In a wet year, the additional sediment load from removal of the dams would be relatively small compared to a dry year. However, the amount of sediment delivered to the ocean following removal of the dams is still expected to be less than the average annual supply. The only reservoir material that would be transported to the estuary would be fine material which is not expected to deposit at the estuary (Reclamation 2012). Downstream from Iron Gate Dam, a substantial increase in sand content is expected in the reach between the dam and Bogus Creek. Sand is expected to increase by up to 40 percent in the month immediately following reservoir drawdown. Under a wet year scenario, the sand would decrease to below 20 percent within a year; however, under a median or dry scenario, a subsequent wet year would be required to flush the sand material from the bed. Downstream from Bogus Creek, it is expected that sand may take longer to be flushed downstream and under dry or median year scenarios it could

take 5 to 6 years for sand in the bed to return to equilibrium levels between Bogus Creek and Willow Creek and up to 10 years between Willow Creek and Cottonwood Creek (Reclamation 2012).

Particles greater than coarse sand would be deposited in eddies and slow-moving pools downstream following dam removal, primarily between Iron Gate Dam and Cottonwood Creek. Under the wet year scenarios, the coarse sediment load would take approximately 15 months (until March 2021) to be completely flushed downstream and into the Pacific Ocean. Although the coarse material would deposit temporarily in slow-moving portions of the river, there would be no substantial change in river bed elevation. In contrast, if drawdown were to occur during a dry year, modeling indicates that substantial deposition would still be present between Iron Gate Dam and Shasta River at the end of the 2-year modeling period. The model results as described in Section 3.3.4.3 indicated that under all three water type scenarios, the only measurable sedimentation will occur in the reach from Bogus Creek (RM 189.6) to Cottonwood Creek (RM 182.1). From Willow Creek (RM 185.0) to Bogus Creek, the reach averaged deposition is expected to be about 1.5 feet and from Cottonwood to Willow Creeks there is expected to be slightly less than 1 foot of deposition. Downstream from Cottonwood Creek, there is less than 0.25 feet of deposition expected and this is considered to be inconsequential (Reclamation 2012). Further, when considered in comparison to sediment loading from other existing sources along the Klamath River (refer to Table 3.11-1 above), the magnitude of the anticipated sediment release from behind the reservoirs is relatively small. A study by Stillwater Sciences (2010) assessed the sediment loading to the Klamath River based on the cumulative sediment load already contributed by tributaries to the river. The numeric modeling predicted high, medium, and low values for reservoir sediment release based on different hydrologic scenarios and the assumed dimensions of the new channel that would be created within the former reservoirs. The model predicted that the median fine-grained and total sediment load released by dam removal would not be substantially more than the cumulative average annual fine-grained and total sediment delivery between Iron Gate Dam and the Scott River. The model also predicted that the overall contribution of reservoir sediment to the river system decreased substantially downstream (Stillwater Sciences 2010).

The total sediment transport capacity of the river was not assessed in the Stillwater Sciences Study, and as such it does not demonstrate that the additional sediment load from dam removal would not deposit in the Klamath River. Rather, the findings of the analysis suggest that the release of sediment downstream during reservoir drawdown would not exceed the existing sediment load added by any tributary, and as such, the transport capacity of the river may be sufficient to transport the additional load, particularly since the river is supply-limited in regards to fine-grained material and sand.

Sedimentation impacts are therefore expected to be short term. The significance of impacts with regard to sediment deposition is dependent on the corresponding impacts of the deposition on aquatic biology (see Section 3.3, Aquatic Resources) and water quality (see Section 3.2, Water Quality). As discussed in these sections, sediment deposition would not result in substantial adverse impacts and no mitigation measures are indicated.

Therefore, impacts with regard to sediment deposition downstream from Iron Gate Dam would be short term and less than significant.

Drawdown of reservoirs could result in changes to seismic or volcanic activity. As described in the Affected Environment, although the Four Facilities are in a historically seismic active area, the nearest active fault is approximately five miles from the dams proposed for removal. It is noted that faults do exist under J.C. Boyle Reservoir. However, these faults are reported not to have moved within the past 1.5 million years and, therefore, are termed as not active (Personius et al. 2003). Under the Proposed Action, the Four Facilities would be removed as described in Chapter 2, Proposed Action and Description of Alternatives. Sediment currently held behind the dams would be released during the same year period. Although there is substantial literature regarding the inducement of seismicity by reservoir filling, little is documented with regard to the drawdown of reservoirs of this size. Consequently, it is not expected that reservoir draining would cause such actions. Reservoir draining is also not expected to cause volcanic activity due to the distance from volcanic hazards (e.g., Mount Shasta). Further, following removal of the Four Facilities, no new structures would be constructed in the project area. **Therefore, the impacts with regard to increased risk of hazards associated with ground rupture or seismic shaking during reservoir drawdown would be less than significant.**

Following dam removal, reservoir sediment remaining could result in changes in the amount of erosion in the river channel. Reclamation 2012 modeled sediment erosion based on representative dry, median, and wet years from the hydrologic period of record between 1961 and 2008. Sediment would continue to accrue in the reservoirs from existing conditions through dam removal. Results indicated that if dam removal occurred during a wet year, up to 57 percent of the reservoir sediment would be eroded. In contrast, if removal were to occur during a dry year, about 36 percent of the sediment would be eroded. The remaining sediment would be expected to remain on the reservoir terraces and dry. However, as discussed in Section 3.11.3.4 (Reservoir Substrate Composition), sediment in the reservoirs is fairly shallow (4-8 feet thick). Therefore, following erosion of the sediment during dam removal, the remaining sediment would be much more like a landscape veneer than a wedge along the newly formed river channel.

Field tests (Reclamation 2012) were conducted to determine the characteristics of dried reservoir sediment. Table 3.11-5 shows a comparison of the depth of wet and dry sediment samples. As the table shows, the desiccated depth of the sample was about 60 percent of the initial depth. Deep cracks developed in the soil and the sample pulled away from the container edges. The estimated reduction in volume of the sample was about 66 percent. The porosity changed from 0.82 to approximately 0.46 and the bulk density increased from 29.5 pounds per cubic foot (lb/ft^3) to approximately 87 lb/ft^3. The bulk density of the dried reservoir sediment would be similar to that of the pre-dam sediment in the reservoir area. Erosion tests conducted by the Agricultural Research Service (Simon and Bell 2010) found that the erosion resistance of dried sediment was more than 10 times higher than the resistance of wet sediment.

Therefore, minimal erosion is expected following completion of reservoir drawdown and dam removal activities. **The impact of dam removal on erosion would be long term but less than significant.**

Table 3.11-5. Comparison of Wet and Dry Reservoir Samples

Container	Initial Thickness (inches)	Final Thickness (inches)	% of Original Thickness
1	7.00	4.25	60
2	7.88	4.63	59
3	4.50	2.75	61

Source: Reclamation 2012.

Following dam removal, reservoir sediments remaining could result in changes to downstream sediment deposition. As discussed above, once dry, the remaining sediment in the former reservoir areas would be unlikely to erode downstream except during storm and other high-flow events. As previously discussed, the Klamath River is supply-limited for fine-grained material. Further, based on the estimated settling velocity of the remaining sediment and average flows during wet years and storm events, it is expected that any eroded sediment would be transported as suspended sediment flushed downstream. **Therefore, impacts of dam removal on downstream sediment supply would be long term, but less than significant.**

Following dam removal, the reservoir sediment remaining would dry and could affect restoration activities and/or future road construction activities. As discussed previously, following dam removal an estimated 44 to 62 percent of the sediment in the reservoirs would remain and is expected to settle on the terraces of the new river channel. Initial sampling conducted on the sediment indicates that once dry, it has a tendency to crack and substantially decrease in porosity. This characteristic would not necessarily limit the range of restoration activities but could limit future construction activities (e.g., access road construction, recreation facilities) that could occur in the former reservoir area. Limitations on future construction due to sediment properties are analyzed in the Reservoir Restoration Study (DOI 2011). **The potential limiting characteristics of the remaining sediment in the reservoirs would be considered a significant impact, but mitigation measure GEO-1 would reduce these impacts to less than significant.**

Following dam removal, diatomite beds near Copco Reservoir would be inaccessible. Under Proposed Action, the ownership of the reservoir land would be transferred to the Dam Removal Entity (DRE). After transfer it is likely that the DRE would not allow access to the diatomite beds for commercial extraction. Additionally, any paleontological resources potentially contained within the diatomite beds would remain inaccessible. **Therefore, there would be no change from existing conditions for diatomite beds under the Proposed Action because the resources would continue to be inaccessible.**

Following reservoir drawdown, recreational facilities currently located on the banks of the existing reservoirs would be removed. The existing recreational facilities provide

camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities would be removed. The removal of the recreational facilities would not affect sediment supplies, contribute substantially to erosion, or expose people or populations to geologic hazards. **Therefore, there would be no change in the existing conditions of geology, soils, or geologic hazards as a result of the recreational facilities.**

Keno Transfer

The Keno Transfer could have adverse effects to geology, soils, or geologic hazards. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on geology and soils compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (Klamath Hydroelectric Settlement Agreement [KHSA] Section 7.5.4). **Therefore, the implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects to geology, soils, or geologic hazards. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate water flows currently diverted at Link River Dam into the two canals, back in to Link River. Redirection of flows would not change sedimentation rates in Upper Klamath Lake and the action would have no impact to geology and soils. **Therefore, the decommissioning of the East and Westside Facilities would result in no change from existing conditions.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Following reservoir drawdown, the City of Yreka Water Supply Pipeline would be relocated. The existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. The construction of a pipe bridge would not affect sediment supplies, contribute substantially to erosion, or expose people or populations to geologic hazards. **Therefore, there would be no change in the existing conditions of geology, soils, or geologic hazards as a result of the pipeline relocation.**

KBRA – Programmatic Measures

The KBRA has one element that could result in changes to geology, soils and geologic hazards:

- Phases I and II Fisheries Restoration Plans

Phases I and II Fisheries Restoration Plans

Implementation of the Phase I and Phase II Fisheries Restoration Plans could result in construction related sediment erosion. Several ongoing resource management actions related to fishery health and water quality may be amplified under the Phase I Plan (Section 2.4.3.9). The following sections describe the ongoing actions and types of new programs that could be implemented, and their anticipated short-term and long-term effects at a programmatic level.

Floodplain Rehabilitation

Floodplain rehabilitation work would include activities to improve or restore connections between channels and floodplains to create and maintain off-channel habitat accessible to overwintering juvenile salmonids. In the short term (i.e., during construction activities), these activities may involve the use of backhoe equipment to dig channels, remove/reposition levees and dikes, and conduct mechanical planting. These construction activities could result in increased erosion as a result of ground disturbance. In the long term, increased seasonal off-channel habitat, wetland restoration, and levee setbacks, may reduce sediment erosion due as a result of potential reduction in flood flow velocity in some flood events through the reestablishment of floodplains.

Woody Debris Placement

In-stream and streambank large woody debris placement may include both mobile wood (i.e., unanchored) and complex stationary (i.e., anchored) structures and may be used to create off-channel fish habitat or provide cover in deeper pools. In the short term, these activities may involve the use of construction equipment to place large wood in the stream channel or along banks. These activities could result in increased erosion as a result of ground disturbance in construction staging areas and on the stream banks and in the streambeds.

Fish Passage Correction

Correction of fish passage issues throughout the Klamath Basin may include culvert upgrades or replacement to meet current fish passage standards and correction of other fish blockages to restore access to new or historical habitats. In the short term, these activities may include in-channel construction of culverts through existing roadways, which could result in increased erosion as a result of ground and riverbank disturbance.

Mechanical Thinning and Prescribed Burning

Mechanical thinning and prescribed burning of upland forest areas may be used to mimic some of the functions and characteristics historically provided by a natural fire regime. In the short term, thinning and prescribed burning could increase sediment erosion through reduction in groundcover. In the long term, thinning and prescribed burning may reduce the potential for catastrophic fires and the associated high rates of erosion and nutrient release (primarily phosphorus) to tributaries and the main-stem Klamath River.

Road Decommissioning

Road decommissioning would reduce road densities in areas with a high potential for slope failure and would stabilize hillsides. In the short term these construction activities could result in increased erosion as a result of ground disturbance. In the long term, these activities would decrease the incidence of road failure and would minimize a source of landslide and erosion generated input of sediment into water bodies in the Klamath Basin.

Gravel Augmentation

Gravel augmentation involves the direct placement of spawning size gravel into the stream channel. Gravel augmentation can increase spawning habitat in systems by increasing the amount of area with suitable substrate. Gravel augmentation activities may involve transportation of gravel from an off-site source using dump trucks and placement in the stream using backhoes. In the short term, this could introduce fine sediments into the river channel. Depending on the water year during which gravel augmentation takes place, this sediment could result in temporary deposition downstream.

Summary

Construction actions including the operation of construction equipment and the associated soil disturbance could result in erosion into the active river channel and could cause new or exacerbate existing landslide areas. Additionally, gravel augmentation could result in temporary sediment transport and deposition downstream from the construction site. Construction activities associated with the Restoration Plan would not occur in the same location or at the same time as hydroelectric facility removal. Therefore, erosion effects would not add to potential effects of dam removal activities. However, negative short-term effects of increased sediment erosion, and landslides generated by the restoration plan's construction activities could occur, but would be reduced by construction-related BMPs that would be implemented. **Given implementation of BMPs (see Appendix B), the short-term effects on sediment erosion and landslides and would be less than significant. In the long term, implementation of the Phase I and II Fisheries Restoration Plans would be expected to generate a beneficial reduction in sediment erosion through improved river channel stability, and generate no change from existing conditions for landslides**. **Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

3.11.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

Under this alternative, short-term demolition activities and drawdown of reservoirs would still occur; however, demolition would consist only of in-stream facilities and select ancillary facilities. Impacts to soils and sediments would be the same as those described for the Proposed Action.

Keno Transfer

The geology and soils impacts of the Keno Facility Transfer under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

East and West Side Facility Decommissioning – Programmatic Measures

The geology and soils impacts of the east and west side facility decommissioning under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the relocating the City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

KBRA – Programmatic Measures

Under this alternative, the KBRA would be fully implemented; therefore, impacts to soils and sediments would be the same as those described for the Proposed Action.

3.11.4.3.4 Alternative 4: Fish Passage at Four Dams

Short-term construction under the Fish Passage at Four Dams Alternative could change erosion patterns. Under this alternative, no demolition of the Four Facilities would take place; however, short-term construction activities would occur during installation of fish passage at the four dams. The potential exists for short-term increases in erosion along the banks of the reservoirs during construction activity. Prior to any construction, coverage under General Stormwater Permits and the development and implementation of Erosion and Sediment Control Plans would be required as per Section 402 of the Clean Water Act. **Accordingly, erosion impacts would be short term and less than significant.**

Under the Fish Passage at Four Dams Alternative, J.C. Boyle, Iron Gate, and Copco 1 Reservoirs would continue to trap sediment at rates similar to historical rates. The reservoir drawdown and sediment transport impacts described under the Proposed Action would not occur. **The reservoirs would continue trapping sediment and there would be no change from existing conditions.**

Under the Fish Passage at Four Dams Alternative, the Copco 1 Reservoir would continue to prevent access to the diatomite beds. Diatomite resources and any associated paleontological resources are currently inaccessible due to the presence of the Copco 1 Reservoir. **There would be no change from existing conditions for the diatomite beds because the resources would continue to be inaccessible.**

3.11.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Reservoir drawdown could cause instability along the banks of the reservoirs, reservoir bank instability, and construction generated erosion. Under this alternative, only Iron Gate and Copco 1 Dams would be removed and fish passage would be installed at Copco 2 and J.C. Boyle Dams. Impacts associated with short-term construction and demolition activities would be as described for the Proposed Action. **Impacts associated with reservoir drawdown and sediment transport would be similar to the impacts**

described for the Proposed Action. However, the magnitude of any impacts would be less than described for the Proposed Action due to the retention of sediment behind J.C. Boyle and Copco 2 Dams.

Following dam removal, the diatomite beds near Copco Reservoir would become more accessible. Diatomite resources and any associated paleontological resources are currently inaccessible due to the presence of the Copco 1 Reservoir. **Therefore, there would be no change from existing conditions for the diatomite beds because the resources would continue to be inaccessible.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the relocating the City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

3.11.4.4 Mitigation Measures

3.11.4.4.1 Mitigation Measure by Consequences Summary

Mitigation Measure GEO-1 – Prior to commencing construction of new recreation facilities or access roads in the former reservoir areas, geotechnical analysis of the proposed site should be conducted by a qualified geologist to determine the limitations of construction on the sediment. If geotechnical tests indicate that the sediment is not suitable to accommodate the proposed activities, the site should be avoided or a sediment removal or treatment plan should be developed and sediment should be removed prior to beginning construction activities.

Effectiveness of Mitigation in Reducing Consequences

Implementation of Mitigation Measure GEO-1 would ensure that any remaining sediment in the former reservoir areas are appropriately studied and dealt with prior to construction, such that any future proposed activities do not result in significant erosion or sedimentation downstream.

Agency Responsible for Mitigation Implementation

The Dam Removal Entity would be responsible for implementing mitigation measure GEO-1.

Remaining Significant Impacts

Following implementation of GEO-1, no significant adverse impacts associated with Geology and Soils are anticipated. If the deposition of reservoir sediment downstream resulted in adverse impacts to fish habitat or habitat for other aquatic species, impacts would be considered significant. The potential for such impacts and mitigation for them have been addressed in the relevant chapters of this EIS/EIR.

Mitigation Measures Associated with Other Resource Areas

Several other mitigation measures require construction, including mitigation measures H-2 (flood-proof structures), GW-1 (deepen or replace affected wells), WRWS-1 (modify or screen affected water intakes), REC-1 (develop new recreational facilities and access to river), TR-6 (assess and improve roads to carry construction loads), and TR-7 (assess

and improve bridges to carry construction loads). These measures could disturb soil because of construction activities associated with heavy vehicle use, excavation, and grading. Prior to demolition, coverage under the General Stormwater NPDES Permit for Construction Activities in both Oregon and California would be required as per Section 402 of the Clean Water Act (refer to Section 3.2, Water Quality, for more information). Coverage under this permit requires the development and implementation of an Erosion and Sediment Control Plan for each reservoir area. Implementation of these plans would minimize the potential for erosion during demolition activities. **These impacts would be short term and less than significant.**

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3.12 Tribal Trust

Indian trust resources consist of certain real property, natural resources and related rights, held in trust by the Federal Government for federally recognized Indian Tribes or individual Indians. Trust resources and rights cannot be sold, leased, or otherwise encumbered without approval of the United States. Trust resources attributed to tribes are called "tribal" trust resources, and trust resources attributed to individual Indians (usually called "allottees") are called "individual" trust resources. Some tribes have the trust right to use resources that are transitory or migratory in nature and that move beyond the reach of Federal or tribal management (e.g., fish and water). In such cases, it is a tribe's ability to access, use, and obtain sufficient quantities of those resources that is the trust resource. This right to obtain trust resources does not necessarily exclude other users from access to the resource. For additional information on Water Rights/Water Supply related to Tribal Trust, see Section 3.8.

In the case of the Klamath Basin Indian Tribes, the Federal Government has the responsibility to safeguard the fishery to ensure that tribes with fishing rights are able to practice those rights. Water quality and quantity are essential for success of a safeguarded fishery, with some Klamath Basin tribes also maintaining federally recognized water rights. Tribes of the Klamath Basin also use resources that may not meet the legal definition of trust resources. These resources are referred to as resources traditionally used by tribes. Resources traditionally used by tribes are those that are related to tribal cultural values associated with a tribal way of life that may not meet the definition of a trust resource, but which may or may not be entitled to legal protection under statute, regulation, or other law or regulation. Although the tribes of the Klamath Basin share many cultural values, their histories and practices are not necessarily the same. Thus, each of the six tribes may have its own set of resources that it considers important to the formation and maintenance of its culture but that the United States does not currently regard as a trust resource.

In addition to trust responsibility associated with trust resources, the Federal Government has a government-to-government relationship with federally recognized tribes based on, or otherwise arising from, treaties, statutes, executive orders and the historical relationship between the United States and Indian tribes. Cultural values related to a tribal way of life centered on rivers and lakes are composed of myriad values, styles, practices, resources, and items transmitted and evolving through time that together define the unique identities of the Yurok, Hupa, Karuk, Shasta, Klamath, Modoc, and Yahooskin (a band of Snake) cultures. Cultural values more specifically can be described as the unique manner in which tribal people access, take, prepare, administer, consider and otherwise use natural resources in unique tribal ways. To the extent that such resources and related values are diminished by ecosystem degradation, related cultures are also degraded and cultural transmissions become inhibited, which can contribute to the detriment of the mental, spiritual, and physical health of the Indians of the Klamath Basin.

This section provides a history of the Indian Tribes of the Klamath Basin, their salmon based economy and barter system, their trust resources, other resources traditionally used by the tribes, and traditional cultural practices associated with these resources. This section also documents the effects of the Klamath Hydroelectric Project dams on these resources and values and also reflects the replacement of a salmon based economy (cyclic based upon nature and natural occurring events) with that of an industrial economy (dams). The information presented in this section is primarily drawn from two 2011 United States Department of the Interior (DOI) reports: 1) Current Effects of Implementing the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA) on Indian Trust Resources and Cultural Values (2012); and 2) Potential Effects of Implementing the KHSA and KBRA on Trust Resources and Cultural Values[1] (2011).

As part of the studies, government-to-government consultations were conducted with the six basin tribes to solicit input from the tribal governments regarding their assessment of effects on Indian trust resources, tribal rights to take those resources, other resources traditionally used by tribes, and cultural values related to those resources and rights within the study area resulting from the current operations of the Klamath River. The reader should note that inclusion of any claims and assertions put forth by these tribes does not necessarily imply that the U.S. government endorses those views.

Three rounds of consultation meetings were held between the DOI and each of the six tribal governments The purpose of the first consultation meetings (Round 1) was for DOI to describe the study process of the elicit information about the histories and backgrounds of the tribes, and discuss how the dams might be currently affecting their resources and rights and related cultural values. In response, the Yurok, Resighini, Karuk, and The Klamath Tribes provided comprehensive background documents (DOI 2012 appendix X, Y and Z). The Round 2 meetings were conducted to collect comments from the tribes concerning the two technical reports and the potential effects of the Dams In Scenario and the Dams Out Scenario on their trust and other resources and rights. In Round 3, DOI sought comments from the tribes on the first draft of the Potential Effects of Implementing KHSA and KBRA on Trust Resources and Cultural Values Reports. For additional details on government to government meetings between DOI and the Klamath Basin Tribes, please see Chapter 7 Consultation and Coordination.

3.12.1 Area of Analysis

The area of analysis for Indian trust resources and other traditional resources includes the entire 263 miles of the Klamath River and the Klamath Basin.

[1] Unless otherwise cited the information in this section is drawn from these reports.

3.12.2 Regulatory Framework

Tribal Trust, within the area of analysis are regulated by several Federal laws and policies, which are listed below.

3.12.2.1 Federal Authorities and Regulations

- American Indian Religious Freedom Act
- Federal Power Act
- Executive Order 13007
- Executive Order 13084

3.12.3 Existing Conditions/Affected Environment

The information presented in this section is primarily drawn from the 2011 and 2012 DOI reports on Indian trust resources and cultural values in the study area. These reports identify Indian trust resources in the study area and document the effects of the Klamath River dams on those resources. Where no citations appear in Section 3.12.3, the information and discussion presented is based on the 2011 and 2012 DOI reports. Section 3.13, Cultural and Historical Resources, presents additional information regarding the Indian Tribes in the area of analysis.

This section presents individual histories of the six tribal governments in the study area. The federally recognized tribes in the study area include The Klamath Tribes, Quartz Valley Community, Karuk Tribe, Hoopa Valley Tribe, Yurok Tribe, and Resighini Rancheria. These tribes live along different reaches of the Klamath River and in different areas of the Klamath Basin. Each tribe has a unique history of its long-term occupation and use of the study area and establishment of its tribal government, reservations, rancherias, or other tribal lands. The section is organized by tribe to highlight the tribes' individual histories and to identify the specific Indian trust resources of each tribe and the impacts of the Klamath Hydroelectric Project on those trust resources.

3.12.3.1 The Klamath Tribes

3.12.3.1.1 The Klamath Tribes History

The Klamath Tribes are composed of three historically separate tribes: the Klamath Tribe, the Modoc Tribe, and the Yahooskin band of Snake Indians. The current membership is about 3,400 and the current total land base is approximately 600 acres[2].

The Klamath Tribes Treaty of 1864 (16 Stat. 707) (Treaty) was signed in the Wood River subbasin on October 14 near modern-day Fort Klamath. The Klamath Tribes signed the treaty, ceding more than 22 million acres of their traditional territories to the United States. These ceded lands included much of south-central Oregon as well as portions of north-central California. Based on the language in the Treaty, from the date the Treaty was signed the Klamath, Modoc, and Yahookskin became known as The Klamath Tribes.

[2] As discussed below, the land base of the Klamath Tribes was substantially eliminated as the result of the United States' Termination Policies of the 1950s.

Under the Treaty, approximately 1.9 million acres, primarily Klamath ancestral lands, were retained for the Klamath Indian Reservation. As a result, the Klamath Reservation was the largest reservation in the State of Oregon. Under the Treaty, The Klamath Tribes also reserved the rights to hunt, fish, trap, and gather plants throughout the reservation in perpetuity.

In 1887, Congress passed the General Allotment Act, which fundamentally changed the nature of land ownership on the Klamath Reservation. Under the allotment system, approximately 25 percent of the original Klamath Reservation passed from tribal to individual Indian ownership over a number of decades. Subsequently, many of these individual Indian-owned allotments passed into the hands of non-Indians.

The construction of Copco 1 Dam in 1918 and the resulting loss of anadromous fish had disastrous effects on The Klamath Tribes; however, The Klamath Tribes continued to harvest staple fish, game, and plant materials both on and off-reservation.

In 1954, as part of a nationwide effort to assimilate Indian Tribes into the cultural and economic mainstream, the Federal Government chose The Klamath Tribes for the experiment of "termination," and enacted the Klamath Termination Act (25 USC §564, et seq.). The Klamath Tribes were chosen in part because of their self-sufficiency, which was due, in part, to the resource harvest; however, termination ultimately resulted in separating the Tribes from the factors that had enabled their self-sufficiency.

Throughout the termination process, the United States divided the reservation into large timber tracts, intending to sell them to private timber companies; however, for various reasons, only one such tract was actually sold, and the government found it impossible to dispose of the others. In 1961, the United States itself purchased large forested portions of the former Klamath Reservation. This forestland became part of the Winema National Forest under the jurisdiction of the United States Forest Service. The balance of the reservation was placed in a private trust for the "remaining" tribal members who had opted to retain an interest in the tribal lands. In 1973, these remaining Indian lands were condemned and purchased by the government, and added to the Winema National Forest.

Termination ended The Klamath Tribes' status as a federally recognized Indian Tribe, dissolved the Federal recognition of the tribal government, and nullified some Federal fiduciary responsibilities to the tribal community. It did not, however, dissolve the Tribes' own government and social organization, and did not convert Indians into non-Indians... The social, economic, and cultural consequences of termination were both significant and complex and are generally viewed as dire by Klamath Tribes' members.

Reservation employment and benefits disappeared, and access to traditional lands and resources quickly eroded. Control over irrigation water supporting tribal farms diminished as well, as government-owned irrigation infrastructure was privatized and fell into non-Indian control. Under this Termination Act, tribal members were encouraged to give up their interest in tribal property in return for cash. A large majority of the tribe chose to do this. A provision of this Act continued the Indians' right to hunt, fish, trap,

and gather on the former reservation land. Cash payments for liquidated tribal assets were distributed irregularly within the tribal community, and those lands retained by tribal members were often lost to taxes and acquired by non-Indians. In addition, some non-Indian merchants, lawyers, and business people took advantage of the situation to engage in unscrupulous practices that hastened the transfer of this wealth away from tribal members. Once a model of economic self-sufficiency, the former members of The Klamath Tribes now had poverty levels that were three times those of their non-Indian neighbors.

Over the next three decades, tribal members and their families continued to reside principally on former reservation lands. Despite the loss of tribal lands, most continued to practice traditional subsistence harvests of game, plants, and fish, especially within the former reservation boundaries. Today The Klamath Tribes have re-acquired about 600 acres of their former reservation. The United States holds title to approximately 70 percent of the former reservation lands.

On August 26, 1986 The Klamath Tribes officially regained Federal recognition under the Klamath Restoration Act (25 USC §566, et seq.). However, the Restoration Act did not restore The Klamath Tribes' former reservation lands and tribal efforts to regain a tribal land base continue.

The Tribes are now acquiring lands in the former reservation as they can and are placing them in Federal trust. Significantly, for the present discussion, restoration did not restore to the Tribes the anadromous fisheries lost due to the construction of Copco 1 Dam and the other Klamath River dams. The tribal members continue to practice their cultural traditions, including traditional subsistence practices and related ceremonies. The Tribes maintain active natural and cultural resources departments.

3.12.3.1.2 The Klamath Tribes' Cultural Practices

Fishing

The Federal courts have confirmed that The Klamath Tribes' hunting, fishing, gathering, trapping, and water rights survived Termination. These resources, especially fish, have played a central role in the physical, social, and spiritual well-being of the Klamath people for millennia. The Klamath Basin from Link River to the headwaters of the Wood, Williamson, Sprague, and Sycan River subbasins once had an almost continuous geographical distribution of traditional sites and activities including resource harvest areas, ceremonial sites, and burials areas, which surrounded the major population centers.

The Klamath Tribes relied heavily on upland game (e.g., deer, elk, and pronghorn antelope) and plant foods (e.g., yampah, wild plum, and many other fruits and berries), but riverine and especially marsh resources were of equal importance. Salmon and multiple species of sucker, trout, eel, lamprey, mussels, and other fish were dietary staples, while marsh and riparian plants, such as the yellow pond lily (Wocus or Wokus), tule, cattail, and willow provided staple foods and materials for essential tools and crafts. The Klamath, Modoc, and Yahooskin traditionally recognized all of the plants and animals of their traditional territory as possessing their own spiritual powers; tribal

members took active steps from ceremonial activities to active management techniques to maintain respectful relationships with the species on which they most depended to ensure that the species would return abundantly in future years. These ritual activities were an essential part of the ceremonial tradition of the historical Klamath Tribes, and they have continued into the modern day.

The confluence of Spencer Creek and the Klamath River was a particularly important salmon fishing site for the Modoc tribe. The site also afforded fishing opportunities that were rare downstream from the Link River because of natural shallows that obstructed the salmon during low-water years until levels began to rise from springtime snowmelt. Salmon were speared there in large numbers. In the 19th century, Modocs still gathered there and "pulled salmon out with pitchforks" just downstream from this shallows. Captain Jack, leader of the Modocs during the Modoc War, was said to have fished the Klamath Canyon extensively and most commonly fished Spencer Creek. Following the Modoc War, some Modoc families maintained ties to the area. For example, Indian women married to white men stayed in the area, providing a lasting foothold in the Klamath River corridor.

Klamath Canyon, particularly the zone from Spencer Creek downstream, was a major historic center of settlement, salmon procurement, and trade for the Klamath and Modoc Indians. During salmon fishing time, Klamaths, Shastas, and Modocs occupied separate groups of structures within larger, multi-tribal communities. The communities along the Klamath Canyon floor were important centers of social, ceremonial, economic, and political activity timed to coincide with the peak salmon harvest. The presence of fish at sites downriver from the Upper Klamath Basin drew some Modocs and Klamaths downstream into the canyon; but since some fish worked their way into the Upper Basin, Klamaths and Modocs did not have to go to the canyon to fish.

Salmon were numerous throughout much of The Klamath Tribes' traditional territory, including the Upper Basin. The fish were commonly said to arrive in runs so large that "it looked like you could walk across their backs;" and the fish were packed so tightly in shallow river channels that they could be speared with ease. Klamath men used spears to catch fish, and, during the 19th and early 20th centuries, it was common knowledge that the large numbers of salmon thrashing in the Sprague, Williamson, Link, and Wood River basins would "spook the horses" and people understood not to ride close to the rivers during salmon runs to avoid being thrown. Because salmon were numerous and relatively ubiquitous, the location of fishing stations reflected not wholly the extent of fish distribution, but rather areas convenient for fishing, such as naturally available shallows where fish could be easily speared, natural barriers that caused the fish to become "bunched up," nearby settlements and secondary resources, springs and spawning grounds, and other factors that influenced the locations of salmon fishing within the Klamath and Modoc territories.

Historically, The Klamath Tribes fished not only for salmon and steelhead, but also for mullet, suckers, trout, sturgeon, eels, and lamprey. Anadromous lampreys were harvested in large numbers during salmon season, often being gigged or speared. Most

large-scale fishing within the Upper Klamath Basin was timed to coincide with salmon runs, but all species were taken at these times and places. Salmon and mullet appeared at roughly the same times and at the same places. Trout also appeared with these fish to consume the spawn of both species. Together, these fish provided a tremendous, dependable food resource for the Klamath and Modoc people.

Detailed environmental knowledge once guided tribal member movements to and between salmon fishing sites, and some of this knowledge persists today. They knew which fishing stations and which riffles would provide the right conditions for salmon fishing based on the level of the water in front of their home village. Today, experienced Klamath fishermen still possess the knowledge of how water levels near their home relate to the exposure or submersion of riffles as well as general fishing conditions at trout-fishing sites.

Salmon-fishing sites were usually accompanied by settlements or seasonal encampments. Many of the largest Klamath and Modoc winter villages were close to large salmon fishing stations. The Indians said, “where the fish were, we were.” Springtime salmon fishing marked the end of the lean winter months, and the proximity of winter villages to salmon fishing sites ensured that salmon would be detected and thus available from the onset of each year’s spring migration. Although late spring and summer involved other subsistence activities far from these villages, the fall Chinook salmon run was said to draw people back to many of these villages. The success of fall fishing had major implications for a community’s food supplies when alternative resources were limited, and a poor fall salmon run indicated a potentially difficult winter ahead. Salmon thus occupied a crucial position within the seasonal round, with salmon runs marking both the beginning and the end of annual resource procurement.

Multi-village and multi-tribal gatherings centering on the salmon harvest were important social and ceremonial events. The movement of the tribes associated with the salmon runs shaped much of Klamath and Modoc social life: “Early spring finds them leaving for favorable fishing stations where there are successive fish runs,” one local reported. Salmon fishing at certain productive fishing stations, such as those on the Klamath Canyon, Link River, and Beatty Springs, were “where you met the person you were going to marry.” Gambling contests, races, and group dances were facilitated by these large gatherings of families from different villages. Dried salmon was used in trade, particularly with interior populations such as Paiutes and interior Pit River bands, providing the Klamath and Modoc with access to trade goods from these interior locations. Mobility and social diversity of the population participating in the salmon harvest fostered multi-tribal gatherings even at sites quite distant from salmon-fishing stations. For example, Tule Lake villages, including those at the Lava Beds, served as a stopover point for Modocs, Paiutes, and other tribes traveling to and from the Klamath Canyon to catch or barter for salmon.

Salmon was also typically shared within the community. Tribal members typically caught surplus salmon to feed the elderly, children, and those with disabilities who were unable to participate in the salmon harvest. This practice also appears in classic

ethnographic studies of The Klamath Tribes and is an ongoing one today. This redistribution of the salmon catch cemented social bonds within and between communities, in addition to ensuring food security in the community as a whole. These practices are still a source of pride among many tribal members today. Young people still share the catch of other fish species, especially trout and mullet, in the traditional manner. "You always give away fish to the elders…you always give away the first deer you kill…our grandparents taught us that and young people still need to listen to that," a tribal member described. Young men who go on salmon fishing trips outside of the Upper Klamath Basin also redistribute modest quantities of salmon among tribal members, and such salmon is highly prized. Young people "always drop by to drop off fish" after these long-distance fishing trips, said one tribal member. Access to fishing sites and fishing gear is viewed as essential to a family's security; some tribal members mentioned that they have inherited fishing gear from their elders, which is understood as a sign of one's obligation to continue fishing for the extended family in the elder's absence.

Affidavits of tribal members compiled in the early 1940s suggest that between one-half and one-sixth of the aboriginal diet consisted of salmonid fish. Rates of salmon consumption likely varied over time and between individual communities and households, but a review of both written accounts and contemporary oral histories suggests that salmonid fish were consumed in large quantities by most Klamaths and many Modocs as a dietary staple.

Salmon was an essential part of the Klamath Basin ecology, with salmon carcasses in particular providing food for many species of animals and nutrients that facilitate the health of marsh plant communities. Tribal members identified the following effects associated with a reduction in salmon:

> "When the salmon leave, everything else falls apart."
> "A lot of other fish started to disappear as soon as the salmon were gone."
> "Trout fed on the salmon spawn…once the salmon were gone, they went after the sucker spawn more…and then there weren't as many trout and suckers."

The Klamath Tribes' members also report that their ancestors used to manage fish populations. Staple fish, such as salmon, trout, mullet, and suckers were harvested according to a rule that "you should never take more than you needed…you take what you need, then quit" and this rule still guides the actions of tribal members today. Chub and other species were known to eat salmon and trout eggs, and increases in chub populations corresponded with subsequent decreases in salmon and trout populations. For this reason, when fish populations were thought to be out of balance, men sometimes intentionally caught large numbers of chub and tossed them onto the banks to be eaten by birds and other creatures. This practice is said to have continued into the 20th century.

Religious Practices

Salmon played an important ceremonial and religious role in Klamath and Modoc culture. The tribes have creation stories that relate to salmon fishing and salmon fishing

sites, and most of the large salmon fishing dams were historically viewed as the handiwork of the Creator, *Gmukampc*. "…the special creation of [*Gmukampc*] was man, and whatsoever stands in direct connection with his existence, welfare, and customs, as fishing places…," noted ethnographer Gatschet (1890). Gatschet further notes that events in Klamath oral tradition were sometimes said to center on *tsiäls-hä'mi*, ("salmon time") that is part of the Klamath seasonal round.

It is understood by The Klamath Tribes that salmon possess a spirit and that this spirit must be respected and honored in order to ensure the return of the fish. Salmon fishing was guided by certain protocols, which acknowledged the belief that the fish possessed a spirit and sentient qualities. For example, unused portions of fish carcasses were put back in the water "so that they will come back" in following years. Tribal members also conducted first salmon ceremonies at the beginning of each year's run to ritually distribute salmon flesh and honor the salmon. These ceremonies could last two or three days, and involved large salmon feasts celebrating the return of the salmon and the end of winter hunger. Currently, traditional ritual activity continues by The Klamath Tribes' members to ritually ensure the return or resuscitation of salmon, mullet, and other important species and to influence water levels and water quality for the benefit of fish.

Oral Traditions

The Klamath Tribes' oral traditions, including the "*Gmukampc* tears down the fish dam" story, are said to impart teachings that still guide tribal members in dealing with moral or ethical dilemmas. These stories are tied to particular landscape features that are prominent in the vicinity of traditional salmon fishing sites. In some cases, certain landscape features of religious significance distant from salmon fishing sites also possess ceremonial associations with salmon fishing. These oral teachings relate to salmon fishing and impart lessons from *Gmukampc*, the Creator, regarding fundamental moral and ethical principles. One principal story reflects The Klamath Tribes' sentiments regarding the Klamath Hydroelectric Project and its effects on fish populations and their ability to acquire fish:

> The people who lived there [below the Chiloquin forks] had a big fish dam. They got greedy and kept building it higher, catching all the fish until no fish could get past them…the people upstream couldn't catch anything and were starving. They said the Creator got angry…and he asked the animals to help him tear down the dam….After the dam was gone, the people were all turned into rocks…they got punished. People fishing there could always see those rocks…it reminded them. (Spier 1930)

3.12.3.1.3 The Klamath Tribes' Potentially Affected Trust Resources

A government-to-government consultation meeting concerning the effects of current Klamath River dam operations on The Klamath Tribes' trust resources and other resources traditionally used by The Klamath Tribes was held on October 4, 2010. A variety of trust resources have been affected by current dam operations; however, the

meeting focused on The Klamath Tribes' fish resources and water conditions that relate to the health of the fishery. Table 13.12-1 identifies trust resources and rights associated with The Klamath Tribes.

Table 3.12-1. Effects of Current Dam Operations on Klamath Tribes Trust Resources and Rights

Trust Resource/Right	Effects
Water resources	Poor flow management (e.g., peaking regimes, flow pulses, flow homogenization, aquatic ecosystem functionality)
	Altered water temperature regime
	Reduced bedload sediment transfer in the Project Reach (JC Boyle to Iron Gate Dam) until about the Shasta River.
	Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
Aquatic resources	Loss of habitat
	Less suitable water temperature regime
	Reduced bedload transfer
	Increased potential for disease/parasites
	Reduced population size
Terrestrial resources	Reduced food availability
	Loss of riparian habitat

Source: DOI 2011, DOI 2012

Among the anadromous fish The Klamath Tribes used as staple foods are fall and spring Chinook salmon, steelhead, Pacific lamprey, and possibly coho and sockeye salmon. These fish entered the Klamath Reservation along the drainages of the Sprague, Williamson, and Wood Rivers and were also found in the open waters of Upper Klamath Lake. Historically, The Klamath Tribes also depended on a variety of other resident fish species, primarily the adfluvial and resident rainbow trout, *c'waam* or Lost River sucker, and *koptu* or shortnose sucker, cutthroat trout, Klamath smallscale sucker, Klamath largescale sucker, Pit-Klamath brook lamprey, blue chub, tui chub, and speckled dace. Although the exact quantity of fish historically consumed by The Klamath Tribes is difficult to establish, anadromous salmonids were staple foods. Anadromous salmonids were the focus of extended multifamily fishing operations often lasting weeks or months, and were an important source of wealth and stability to The Klamath Tribes prior to the construction of Copco 1 Dam in 1918.

The construction of Copco 1 Dam blocked anadromous fish runs into the Upper Klamath Basin and abruptly ended The Klamath Tribes' access to all anadromous fish. Two other major fisheries, adfluvial and resident salmonids (trout) and Catostomids (suckers), could still be used by The Klamath Tribes after the demise of the anadromous fisheries. The catostomid fishery consisted primarily of *c'waam* (Lost River sucker) and *koptu* (shortnose sucker) until the Tribes closed their fishery in 1986 to protect it in the face

of severe population declines. This move by the Tribes in turn prompted the Federal Government to list these fish as endangered in 1988 under the Endangered Species Act. As the only surviving tribal fishery, adfluvial and resident salmonids today represent an invaluable resource to tribal members.

Water quality and flows in the Klamath River and its tributaries associated with current dam operations are an important issue to The Klamath Tribes. Water conditions affect the ability of anadromous fish species to survive. The Klamath Tribes retain a right to instream water quantities in on-reservation and off-reservation locations at levels that are sufficient to support fishing and other harvest rights on former reservation lands, as affirmed in 1984 with the 9th Circuit Court of Appeals' decision in United States v. Adair, 723 F.2d 1394. A number of ritual traditions of The Klamath Tribes depend on access to clean water from natural sources, which is used in ritual purification of people, places, and objects, as well as in rituals associated with drought abatement and other environmentally restorative activities. However, the water of the Klamath River is widely viewed as inappropriate for these ritual uses because of the effects of the dams on water temperature, algae development, and other variables of water quality.

The current operations of the Klamath River dams have had a range of secondary effects on The Klamath Tribes. Among these effects are the decline of fish and wildlife in addition to the loss of cultural and social practices, diminished economic opportunity, and negative health effects resulting from dietary changes that became necessary with the loss of traditional food sources.

Tribal oral tradition suggests that the timing of catostomid (sucker) and trout population declined following the extirpation of anadromous salmonids, reflecting partial dependence of these resident fish on marine protein from salmonid sources. In recent interviews, numerous tribal members noted that the once-abundant numbers of these other culturally significant species have diminished, attributing this change in part to the absence of anadromous fish within the Upper Klamath Basin. Recent studies have confirmed that no fewer than 137 other wildlife species depend on salmon consumption for some portion of their life cycle, drawing sustenance from smolts, adult salmon, or salmon carcasses. Subsistence fish and wildlife species affected by the absence of salmon include, but are not limited to, black bear, mule deer, and a large number of waterfowl species. Several salmon-dependent wildlife species are of traditional cultural significance to members of The Klamath Tribes beyond their subsistence value, including but not limited to the Bald and Golden eagles, coyote, cougar, American marten, weasel, bobcat, red and gray foxes, northern river otter, various bat species, raven, crow, red-tail hawk, blue jay, and a variety of songbirds.

Many non-salmon species and ecologically linked plants are significant for the cultural and economic well-being of The Klamath Tribes. The Klamath Tribes traditionally used pelts, feathers, and other body parts from some of these animals in ceremonial regalia, traditional crafts, and for other purposes. In a few cases, tribal members relied on the sale of pelts from some of these species for supplemental income. In ethnographic interviews, tribal members referred to a number of culturally preferred riparian and marsh

plant species that are said to have declined in population in the last century. Foremost among these is the yellow pond lily (Wocus), a source of edible seeds that has served as one of the most important staple plant foods of The Klamath Tribes. The decline in some riparian plant species may correlate with declines in the fish population of the Upper Klamath Basin and may reflect the reduction in nutrient loading to marsh plant procurement areas.

Prior to the extirpation of anadromous salmonids from the Upper Klamath Basin, salmon were the focus of a complex of cultural traditions, including distinctive fish harvesting and processing technologies; traditional ecological knowledge relating to fish habitats and behavior; and ritual traditions centering significantly on the maintenance of harvestable fish populations through ceremonial displays of respect for the fish, the Creator, and other spiritual forces said to influence the return of the fish. Through such practices, The Klamath Tribes have always played an active role in the stewardship of anadromous fish resources, and contemporary tribal members perceive this role as a cultural right and responsibility.

The absence of the fish has compromised the ability of members of The Klamath Tribes to pass knowledge from generation to generation relating to the fish and their harvest. The importance of salmon harvest is further reflected in The Klamath Tribes' languages, place names, songs, stories, and the moral teachings provided to children. Large gatherings associated with the fish harvest once served as a venue for economic exchanges, reunion with kin from other communities, and the forging and maintenance of intercommunity ties within the larger tribal population. The demise of the fish populations has interrupted the performance of these important social and cultural functions.

Although The Klamath Tribes have the most direct interest in resources upstream of the four Klamath River hydroelectric dams, the current operations of the Klamath Hydroelectric Project have affected The Klamath Tribes' resource interests in the footprint of the dams and impoundments, and downstream from the dams in lands ceded by The Klamath Tribes. In the Klamath River corridor, for example, harvest activities historically focused on riparian resources. Plants, animals, soil, and rocks are all of concern to Klamath Tribes members, both economically and environmentally. The Indians commonly gathered riparian vegetation, including but not limited to willows for basketry and drying racks; tree species such as cottonwood for firewood; sedges, rushes, cattails, and tule for basketry mats and bedding; and a variety of berries and medicinal plants uniquely concentrated in the riparian corridor. Game in the riparian corridor, such as white- and black-tail deer, rabbit, groundhog, and birds, were also taken.

Various forms of evidence suggest that The Klamath Tribes' gathering activities were concentrated in relatively recent alluvial deposits consisting of gravel bars and fresh deposits of silt, loam, and sand-sized particles. At these sites, culturally prized early successional vegetation was abundant and desirable. For example, roots used in basketry

were unusually long, straight, and easy to dig. Additionally, tribal members gathered rocks for use as cooking stones along the riparian corridor, especially basalt cobbles and other dense, nonporous stones.

3.12.3.1.4 The Klamath Tribes' Health Impacts

Because salmon was the first dietary staple to be lost to The Klamath Tribes, its depletion was said to have initiated dramatic dietary shifts among tribal members. For a time, this fostered increased consumption of deer, mullet, and sucker, which some tribal members believe resulted in localized overuse of these resources, particularly in the light of game management practices of the State of Oregon. For some, the loss of the salmon was the catalyst for a dietary transition that led to the ultimate dependence of The Klamath Tribes on the purchase of processed foods and the use of supplementary commodity foods.

Tribal members attributed a number of historical health problems to the loss of salmon. A 1920s tuberculosis epidemic was said to have been worsened by the rapid impoverishment of the diet in preceding years. Recent Indian Health Service studies endorsed by The Klamath Tribes concluded that a host of physical ailments plaguing members of The Klamath Tribes have been linked to the demise of the aboriginal diet. Diabetes, hypertension, obesity, and related cardiovascular ailments are particularly widespread, reflecting dramatic changes in food consumption and procurement patterns. A number of tribal members expressed the view that the loss of salmon was among the most significant components of this dietary shift.

3.12.3.1.5 Alternative 1: No Action/No Project Alternative - The Klamath Tribes and Damming of the River

Continued impoundment of water could affect tribal trust resources. The current Klamath River dam operations have measurable consequences on the exercise of The Klamath Tribes' Treaty harvest rights on the former Klamath Reservation; consequences which would continue under the No Action/No Project Alternative. In response to the loss of the Klamath Reservation as a result of the 1954 Klamath Termination Act and the absence of provisions for the reservation's return in the 1986 Klamath Restoration Act, The Klamath Tribes have been actively acquiring lands within the boundaries of the former reservation and placing them in trust status. Existing and pending trust lands include properties that are transected by waters formerly housing populations of anadromous fish. These trust lands are entirely in the Upper Klamath Basin and affected by the same environmental variables that apply to that region...

Salmon have not been sighted in the areas upstream of the dams in about 100 years. However, in 1907, before the dams went into service, Barrett (1910) reports that "Fish were abundant in the lakes, salmon and salmon trout being especially esteemed by the Indians." Other firsthand observations confirm the presence of salmon before the dams were built. In the 1940s, in preparation for a lawsuit against Copco for blocking the anadromous fish runs, Bureau of Indian Affairs (BIA) Superintendent B.G. Courtright interviewed 50 older members of the Klamath Tribe and non-Indian settlers in the area about salmon in the Klamath Basin. These unpublished affidavits unanimously report there were salmon in fisheries as far upstream of Klamath Lake as the Sprague and

Williamson rivers, Upper Klamath Lake, and Spencer Creek. Spier (1930) reported that salmon in the Klamath Basin "…ascend all the rivers leading from Klamath Lake...going as far up Sprague River as Yainax, but are stopped by the falls downstream from the outlet of Klamath marsh." A tribal elder in the 1940s also stated that he had observed salmon as far up the Sprague River as Bly.

Salmon continue to be symbolically and culturally important to members of The Klamath Tribes. Moreover, tribal members insist that traditional salmon fishing stations are still being used today, whether for subsistence purposes, ceremonial activities, or instruction of children on tribal history and culture. Resources that were once harvested secondarily to the salmon harvest have now become the focus of subsistence activity at these stations, and tribal members still use certain historic campsites at these stations during subsistence, social, and ceremonial activities. Tribal members continue to participate in ritual activities "to bring back the salmon," while The Klamath Tribes government continues to explore legal and administrative options to achieve the same goal.

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin, as noted above. However, the current operations of the four Klamath River dams adversely affect the trust resources of The Klamath Tribes and other resources traditionally used by the tribes, and, by extension, their cultural values (Table 3.12-1), and their continued operation under the No Action/No Project Alternative would result in no change from existing adverse conditions.

3.12.3.1.6 Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect tribal trust resources.[3] Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by The Klamath Tribes (Table 3.12-1). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR).

KBRA – Programmatic Measures

The KBRA has several programs that could result in impacts/effects to trust resources and other traditional resources used by The Klamath Tribes. Specific KBRA programs potentially affecting trust resources and other traditional resources include:

[3] Tribal Trust Resources and other traditionally used resources are also discussed in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

- Tribal Fisheries and Conservation Management Program
- Klamath Tribes Interim Fishing Site
- Mazama Forest Project

Other KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources; these programs' effects are discussed in Sections 3.2, 3.3, and 3.5 of this EIS/EIR.

Implementation of the Tribal Fisheries and Conservation Management Program could result in impacts/effects to Trust Resources and other traditionally used resources. As the original stewards of the natural resources of the Klamath Basin, The Klamath Tribes hold special positions in the Basin and have interests in and a traditional relationship to the Basin ecosystem and its fisheries. Implementation of the Tribal Fisheries and Conservation Management Program would provide funding to assist the tribe in developing their capacity to participate in resource management activities within the Basin, particularly relating to tribal fishing and revitalization of tribal subsistence and other economic activities. The timing of and specific locations where these resource management actions could be undertaken is not certain but the improvements they are anticipated to support in trust resources would contribute to the positive effects of hydroelectric facility removal. Implementation of the Tribal Fisheries and Conservation Management Program would generate beneficial effects to trust resources and other traditionally used resources. Implementation of specific plans and projects associated with the Tribal Fisheries and Conservation Management Program will require future environmental compliance as appropriate.

Establishment of The Klamath Tribes Interim Fishing Site could result in impacts/effects to Trust Resources and other traditionally used resources. Actions associated with The Klamath Tribes Interim Fishing Site include establishment of an interim fishing site for Klamath Tribal members between Iron Gate Dam and Interstate -5. The improvement in salmon fishery access generated by development of The Klamath Tribes Interim Fishing Site would contribute to the positive effects of hydroelectric facility removal. Establishment of The Klamath Tribes Interim Fishing Site would generate beneficial effects to trust resources by providing tribal members with access to the salmon fishery prior to hydroelectric facility removal.

Implementation of the Mazama Forest Project could result in impacts/effects to Trust Resources and other traditionally used resources. Actions associated with the Mazama Forest Project include the purchase and management of 90,000 acres of timberland on former reservation land owned by the Klamath Tribe (Chui 2008; Kerr 2012). The improvement in trust resources and other traditionally used resources generated by the Mazama Forest Project would contribute to the effects of hydroelectric facility removal. Implementation of the Mazama Forest Project would generate beneficial effects to trust resources and other traditionally used resources because of the implementation of appropriate forest management plans. Implementation of specific plans and projects associated with the Mazama Forest Project will require future environmental compliance as appropriate.

3.12.3.1.7 Alternative 3: Partial Facilities Removal of Four Dams

Partial facilities removal could affect tribal trust resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for fish passage. Keno Dam would be transferred to the DOI, The East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit water, aquatic, and terrestrial resources issues related to trust resources and rights identified by The Klamath Tribes (Table 3.12-1). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.1.8 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect tribal trust resources. Under the Fish Passage at Four Dams Alternative, operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not fully resolve the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by The Klamath Tribes (Table 3.12-1). Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to trust resources and rights would persist.

3.12.3.1.9 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect tribal trust resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by The Klamath Tribes (Table 3.12-1), but not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.2 Quartz Valley Community

3.12.3.2.1 Quartz Valley Community History

Most of the Quartz Valley Community's tribal members are descendants of people of Karuk ancestry, although a few tribal members are also of Shasta ancestry. Therefore, their cultural traditions are similar to those described in the Karuk section of this report.

The Quartz Valley Community is a federally recognized tribe representing people of middle Klamath (Karuk) and Shasta Indian ancestry. The Quartz Valley Indian Reservation is in Siskiyou County near the community of Fort Jones. The population is around 126, with a tribal enrollment of about 150. Total reservation size is 174 acres. Some tribal members are descendants of the same tribal leaders that signed the unratified 1851 Treaty R negotiated between Indian Agent Redick McKee and Indian inhabitants of Scott Valley and the upper Trinity and Klamath Rivers. The original Quartz Valley Indian Reservation, once near the present-day reservation, was abolished in the 1960s.

The current Tribal mission is stated as:

> While on earth we must practice stewardship, protection, and enhancement of the air we breathe, the water we drink, the soil that supports us, and the lives we cherish. It is our duty to protect and enhance these resources for the continued prosperity of the Quartz Valley Indian Tribe and our fellow brothers and sisters we share this earth with.
>
> In partial fulfillment of the mission statement, the tribe employs several full-time and part-time positions to operate the Tribal Environmental Protection Department. Current achievements are creek restoration projects, salmon surveys, water quality monitoring, establishment of a native garden, and the recent opening of a microbiology lab for testing the Tribe's ground water.

3.12.3.2.2 Quartz Valley Community Cultural Practices Fishing, Trade and Barter, Religious Practices, and Oral Traditions

The Quartz Valley Community are of Karuk and Shasta Decent. Cultural practices and values or the Karuk people are described in Section 3.12.3.3.

3.12.3.2.3 Quartz Valley Community Potentially Affected Trust Resources

The Quartz Valley Community does not have a reserved right to the Klamath River fishery. The tribe is not reliant on Klamath River water, nor does it retain Klamath River reserved water rights. The tribe's land base is not along the Klamath River but on a tributary to the Scott River, which is a tributary to the Klamath. Therefore, there are no primary effects on Quartz Valley trust resources although there are effects on Quartz Valley resources traditionally used by the tribe, health, and cultural values and well-being.

Traditionally used fish resources of the Scott River include Chinook salmon, coho salmon, steelhead and Pacific lamprey. The Quartz Valley Indian Reservation relies on these fish for sustenance and their spiritual well being. These fish need to survive their migration through the Klamath River to and from the ocean. Therefore, the tribe has an interest in Klamath River health.

Any fishing and concomitant water rights to which the Quartz Valley Community may be entitled have not yet been determined. However, Quartz Valley tribal members have historically fished for salmon, steelhead and eels (Pacific lamprey) in the Scott River and Shackleford Creek.

Despite the lack of a recognized right by the United States or the State of California many members of tribe fish on the Klamath River, often with Karuk Tribe members to whom they are related, and have done so in an unbroken tradition dating back to time immemorial. Table 13.12-2 identifies resources traditionally used by the Quartz Valley Tribe.

Table 3.12-2. Effects of Current Dam Operations on Resources Traditionally Used by the Quartz Valley Tribe

Other Resources Traditionally Used By The Tribe	Effects
Water resources	Altered flows
	Altered water temperature regime
	Reduced bedload sediment transfer in the Project Reach (JC Boyle to Iron Gate Dam) until about the Shasta River.
	Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
	Diminished aesthetics
	Human exposure to toxic water while conducting cultural activities
	Diminished opportunity for traditional bathing
Aquatic resources	Loss of habitat
	Less suitable water temperature regime
	Reduced bedload transfer
	Increased potential for disease/parasites
	Reduced population size
	Loss of traditional salmon diet and increased risk of heart disease, strokes, diabetes, and obesity
	Depression, alienation, and possible suicide
	Tribal members leaving ancestral territory
	Lost opportunities for transmitting traditional knowledge
Terrestrial resources	Reduced food availability
	Loss of riparian habitat
	Diminished plant availability for cultural practices and related benefits
	Loss of opportunity for inter-generational traditional knowledge transmission

3.12.3.2.4 Quartz Valley Community Health Impacts

The members of the Quartz Valley Community refrained from making any comments.

3.12.3.2.5 Effects Determinations

Alternative 1: No Action/No Project – Quartz Valley Community and Damming of the River

Continued impoundment of water could affect traditionally used resources. The dams are responsible for a drastic reduction in spawning habitat and a major component of many other changes in the river system, such as water quality and water temperature. All of these changes have created an environment in which it is difficult or impossible for many species to flourish. In addition to environmental effects, the changes in the river secondarily have resulted in diminished physical, mental and social health. For thousands of years the Indians who depend on the river have been part of a functioning social, economic, and cultural health system that is currently dying.

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin. Mining activities in the Klamath Basin have significantly decreased over the last several decades, and timber extraction in the basin is more regulated at the Federal and State levels than in past decades.

However, the current management of the Klamath River adversely affects the resources traditionally used by the Quartz Valley Community and, by extension, their cultural values, and their continued operation under the No Action/No Project Alternative would result in no change from existing conditions.

Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect traditionally used resources. Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources traditionally used by the Quartz Valley Tribe. Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

KBRA

The KBRA has several programs that could result in impacts/effects to traditional resources used by the Quartz Valley Community. Specific KBRA programs potentially affecting traditional resources include the Tribal Fisheries and Conservation Management Program. Other KBRA programs would have effects on aquatic resources, water quality, and terrestrial resources; these programs' effects are discussed in Sections 3.2, 3.3, and 3.5 of this EIS/EIR.

3.12.3.2.6 Alternative 3: Partial Facilities Removal of Four Dams Alternative

Partial facilities removal could affect traditionally used resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources traditionally used by the Quartz Valley Community. Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.2.7 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect traditionally used resources. Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not fully resolve the water, aquatic, and terrestrial resources issues related to traditionally used resources identified by the Quartz Valley Community. Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to traditionally use resources would persist.

3.12.3.2.8 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect traditionally used resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address issues associated with the water, aquatic, and terrestrial resources traditionally used by the Quartz Valley Tribe but not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.3 Karuk Tribe

3.12.3.3.1 Karuk History

The Karuk Tribe has been federally recognized since 1979 and occupies territory along the middle section of the Klamath River. The 2000 United States Census reported tribal membership to be 2,702 individuals. In 2004, the California Department of Housing and Community Development reported tribal membership to be 3,164 individuals. Currently,

Karuk are one of the largest tribes in California with approximately 4,800 members. The Karuk maintain offices in Orleans, Humboldt County; Happy Camp, Siskiyou County; and the City of Yreka, Siskiyou County, all in California.

The tribe's ancestral territory was about 1.4 million acres. Currently, the Karuk own 652 acres in trust status. The Karuk Tribe is a Self-Governance Tribe under Indian Self-Determination Act of 1975 (California Department of Housing and Community Development, California Indian Assistance Program 2004, as cited in DOI 2011 and DOI 2012). The tribe has a constitution that was initiated in April 1985 and the Karuk maintain a robust Natural Resources Department.

3.12.3.3.2 Karuk Cultural Practices

The Karuk Tribe has effectively maintained its cultural identity and traditional practices. Tribal members still engage in traditional hunting, gathering, and resource management activities. This includes preservation and use of the Karuk language, basket-making, fabrication of regalia, practice of traditional religious ceremonies, and stewardship of natural resources through use of fire and harvest management techniques.

Fishing

The Klamath and Salmon River fishery and other resources supported more than 100 ancestral Karuk villages along the Klamath and Salmon Rivers. Karuk established villages on beaches, river bends, benches, and near fishing sites to exploit riverine resources. Indeed, Karuk incorporate ritual, spiritual, and technical elements of their culture to facilitate management and enrichment of local ecosystems. These culturally based natural resource management practices are articulated in the Karuk Tribe's Eco-cultural Resources Management Plan.

The Karuk diet traditionally consisted mostly of salmon, deer, and acorns. Fish, especially salmon, have always been a major food resource and the focus of ceremonies for the tribe. Karuk use several methods, both traditional and contemporary, to catch fish. Fish important to the Karuk include spring-run Chinook or king salmon, fall-run Chinook, out-migrating Chinook smolt, coho or silver salmon steelhead, trout, sucker, bullhead, sturgeon, and Pacific lamprey. Freshwater mussels also have cultural significance for the Karuk not only as food, but also as important tools. For example, a mussel tool, an *íshuvar*, is used in traditional basket-making.

Religious Practices

Ceremonies provide insight into the cultural life and underlying values of the Karuk. These ritualistic celebrations also demonstrate the interrelationship of Karuk and other tribes along the Klamath River. In one respect, the ceremonies are reenactments of stories involving the *ikxareeyavsa*, or immortal ones. However, these ceremonies go beyond symbolism to teach important practical lessons about careful management of resources, hard work, and the importance of observing rituals.

The Karuk are known among tribes in the Klamath Basin as "The Fix-the-World People" because of their role in the annual *Piky'avish*, or World Renewal Ceremonies. *Piky'avish*

starts with the First Salmon Ceremony in early spring and continues throughout late summer into early fall. The scheduling of the dance cycle is determined each year by a ceremonial leader, who also appoints a *fataveenaan* (medicine man or priest) each year. This appointment is both a source of honor and a great deal of work because the *fataveenaan* is required to undergo a lengthy ordeal of fasting, praying, and walking the medicine trails.

The First Salmon Ceremony marks the passing of the first spring Chinook salmon up the Klamath River. This migrating salmon was allowed to pass all the way up the Klamath River to its spawning ground. Indians believed that the first spring Chinook migrating upstream would leave its scales at each spawning location for the rest of the salmon run to follow. Eating this first migrating salmon of the year was considered taboo; if eaten, it was believed to cause convulsions and death. Permitting this fish to pass safely upstream lifted the taboo and allowed the people to fish for salmon in the river. The dramatic decline in the spring Chinook run has made it impossible for the Klamath Basin tribes to conduct the First Salmon Ceremony.

The Karuk and Yurok Tribes coordinate the performance of their First Salmon Ceremonies based on the appearance of fish in the Klamath River. Chinook historically spawned as far north as the Williamson River, an area that was available as spawning grounds prior to the damming of the Klamath River and the reconstruction of Klamath Lake in its present form. The First Salmon Ceremony is typically conducted around April when the fish first breech the sandbar at the mouth of the river, marking their transition from the Pacific Ocean back to the fresh water of the Klamath River.

The most important of Karuk ceremony is *Piky'avish*, or literally "fix the world." Called by different names in by different tribes, many tribes of the Klamath as well as the Pacific Northwest practice a similar ceremony. In Kroeber and Gifford's *Karok Myths* (1980), tribal member Georgia Orcutt captured the emotional nature of the *Piky'avish* as follows: "At the beginning of the *Piky'avish*, it looks like everything down, nobody happy. *Piky'avish* means 'making the world right.' *Fatawanun* [*fataveenan*] fixed it so everything is coming up nice."

According to Kroeber and Gifford (1980), the Karuk ceremony has three major aspects:

> The first is a period of usually not more than ten days during which the priest remains much in the sweathouse, fasts, and prays for abundance of food, the elimination of sickness and the stability of the world. He also visits sacred spots; and young men engage in archery contests. The second part is the climax of the ceremony, when the priest keeps an all-night vigil by a sand pile called *yuxpit*. This vigil is accompanied and followed the next day, by the Deerskin Dance, or its surrogate, an imitation affair employing branches instead of deerskins; at *Inam* [*Inaam*] and *Katamin* [*ka'tim'iin*] the War Dance is part of the dance ritual. The third part is the anticlimactic retreat of the priest and other officials.

The ceremonies feature a variety of ritual dances. The Jumping Dance (or Jump Dance) is held in the spring during the first salmon run. The Deerskin Dance is held in the fall in association with the acorn harvest and the second salmon run. It is performed in alternating years with the Medicine Dance, during which other decorated skins including martin and otter are displayed rather than the famous white deerskins. Both dances feature displays of wealth, along with dancing and singing.

According to Karuk creation stories, fishing weirs were created by one of the immortals. The fishing harpoon also appears in one of a series of creation stories that present accounts of the origins of humans, institutions, and tools. In the story, the Blue Heron develops the two-pointed harpoon so that even people without rights or nets could still catch fish. According to the story, *Chukchuk* took a long stick and fastened two smaller sticks to the end of it. He thought, "I will spear salmon. Let me make that kind. Let me make it so that if a man has no fishing place and he sees salmon he can catch them. If he has no net he will kill them in this way" (Kroeber 1925a).

3.12.3.3.3 Karuk Potentially Affected Trust Resources

In a government-to-government consultation meeting concerning Karuk Tribe trust resources affected by current dam operations held on September 30, 2010, the Karuk Tribe asserted the following as tribal trust resources: water, fish, mollusks, riparian plants, wetlands, and all other plants and wildlife dependent on a healthy river and playing a role in Karuk ceremonies. This assertion was coupled with the assertion that the United States has a trust responsibility to protect such resources and ensure that such resources are managed for the beneficial use of the Tribe and its membership. In addition, the Karuk assert that Federal Government has responsibilities to the Tribe in the areas of social welfare, education, and health and a responsibility to uphold certain Federal laws, such as the National Historic Preservation Act and the American Indian Religious Freedom Act. The United States does not necessarily agree that all of the above resources are in trust but the resources are important to the Karuk (and thus to the United States) for their traditional ceremonial use. Table 3.12-3 identifies Karuk traditionally used resources that are affected by the four Klamath River dams.

Unlike The Klamath Tribes, Congress never formally ratified the treaty negotiated between the United States and the Karuk Tribe in 1851, and no statute or executive order otherwise set aside reservation lands for the Tribe. The Karuk Tribe began efforts in 1978 to receive Federal recognition. In November 1978, the Bureau of Indian Affairs Central Office (BIA) staff conducted a field trip to Northern California. The BIA determined that the aboriginal subentities of the tribe consisted of three communities located in Happy Camp, Orleans, and Siskiyou (Yreka). See 13 IBIA 76, 78; 1985 WL 69127 (I.B.I.A.). The Assistant Secretary for Indian Affairs, in a memorandum entitled "Revitalization of the Government-to-Government Relationship Between the Karok (sic) Tribe of California and the Federal Government," notified the local offices of the Bureau of Indian Affairs on January 15, 1979, that: Based on the findings collected . . ., the continued existence of the Karoks as a federally recognized tribe of Indians has been

Table 3.12-3. Effects of Current Dam Operations on Resources Traditionally Used by the Karuk Tribe

Other Resources Traditionally Used By The Tribe	Effects
Water resources	Altered flows
	Altered water temperature regime
	Reduced bedload sediment transfer in the Project Reach (JC Boyle to Iron Gate Dam) until about the Shasta River.
	Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
	Diminished aesthetics
	Human exposure to toxic water while conducting cultural activities
	Diminished opportunity for traditional bathing
Aquatic resources	Loss of habitat
	Less suitable water temperature regime
	Reduced bedload transfer
	Increased potential for disease/parasites
	Reduced population size
	Loss of traditional salmon diet and increased risk of heart disease, strokes, diabetes, and obesity
	Depression, alienation, and possible suicide
	Tribal members leaving ancestral territory
	Lost opportunities for transmitting traditional knowledge
Terrestrial resources	Reduced food availability
	Loss of riparian habitat
	Diminished plant availability for cultural practices and related benefits
	Loss of opportunity for inter-generational traditional knowledge transmission

Source: DOI 2011, DOI 2012

substantiated. In light of this finding, I am directing that the government-to-government relationship, with attendant Bureau services within available resources, be re-established."

The United States has more recently taken lands into trust for the benefit of the Karuk Tribe, including over 810 acres in Siskiyou County and approximately 40 acres in Humboldt County. Most of the Tribe's aboriginal lands along the Klamath River, above the Klamath Trinity Confluence, now form part of the Klamath National Forest. Any fishing and concomitant water rights to which the Karuk Tribe may be entitled have not yet been determined. Regardless, the Karuk assert that an inability to use traditional resources affects their general health and well being and cultural values.

In the consultation meeting, only effects on fish and water were discussed in detail. Nonetheless, the lack of fish in the local economy has secondary effects on general tribal

health and cultural well being. The Karuk Tribe, when asked if such resources were affected by the current dam operations, emphatically responded, "Yes." Tribal representatives at the meeting stated that water quality and fish returns have diminished, and, being a tribe that lives along the river, their aesthetic quality of life has also diminished. They rarely bathe in the river, as they did historically, and in an area with fewer available fish, tribal members are likely to consume less of the traditional food base and pay less attention to the culturally inherited management traditions of a "Salmon People." This situation has exacerbated related impacts on tribal health, such as higher rates of obesity, diabetes, heart disease, stroke, and mental diseases such as depression.

Since the construction of the dams on the Klamath River, the numbers of a variety of river species have plummeted. Some of these fish had traditionally been a source of food and cultural ceremonies and practices for the Karuk Tribe, as well as a means of trade and income. Not only salmon, but also steelhead, sturgeon, suckers, lampreys, clams, mussels and other aquatic species appear to have declining populations as a result of the dams effects on water flow, temperature, and on the river environment.

Karuk believe one of the most significant impacts of the Klamath River dams is the way that the natural process of seasonal warming and cooling trends in the river is altered by the presence of reservoirs. In effect, the reservoirs appear to create a "thermal lag" in both the spring and the fall. This means that the river warms more slowly in the spring and cools more slowly in the fall than it would without the dams. The result of these thermal effects is a delay in timing of runs for the migration of fall Chinook salmon. For Karuk, this translates into a shorter fishing season in the fall. Before construction of Iron Gate Dam, Karuk fishermen report that fishing at Katimiin started in late July. Since construction of Iron Gate Dam, fish do not typically arrive at Ishi Pishi Falls until early September. In addition to limiting the number of fishing days available in the fall, the opportunity to harvest spring Chinook salmon has been completely lost to the Karuk since construction of Iron Gate Dam.

Water quality plays a very significant role in Karuk tribal culture because of its effect on culturally relevant aquatic species. Water quality also affects the ability of *Fataveenan*, or World Renewal priests, to conduct ceremonies. *Pikiavish* starts with the Spring Salmon Ceremony in early spring and continues throughout late summer into early fall. Key ceremonial participants bathe multiple times a day in the Klamath River for 10 days in a row. This is the time of year when the blooms of the toxic algae, *Microcystis aeruginosa*, are at their peak.

To avoid interfering with cultural and religious ceremonies and practices, the water conditions in the Klamath River must allow for specific species to be present in adequate supplies. This includes species that are consumed by participants, such as salmon and lamprey as well as species used in ceremonies, such as crayfish and willows. Water conditions must also be safe for what is usually termed "recreational contact" as well as human consumption.

Degraded water quality in the Klamath Basin, including the seasonal presence of algal toxins in the Klamath River and reservoirs, has impaired the ability of Karuk to use the water for cultural purposes. Known and/or perceived health risks associated with degraded water quality have resulted in the alteration of cultural ceremonies to exclude or limit ingestion of river water. Additionally, known or perceived risk of exposure to degraded water quality conditions during ceremonial bathing and traditional cultural activities, such as gathering and preparing basket materials and plants for other purposes, has resulted in an impairment of cultural use.

According to Karuk cultural biologist Ron Reed, the World Renewal Ceremony is held on the Klamath River at Clear Creek, Somes Bar, and Orleans during July, August, and September of each year. The medicine man, who leads the ceremony, walks 14 miles through the ridges and hills along the Klamath River and is joined halfway through his journey by children and adults of the tribe who follow him the rest of the way for good luck. Traditionally, when the medicine man reached the Klamath River at the end of this walk, he drank water from the river to complete the ceremony. Currently, this does not occur very often because blooms of *Microcystis aeruginosa* have led to health warnings along the river. However, children are still known to jump in the river and drink the water.

Bathing in the river is an important part of most Karuk ceremonies. For example, bathing in the Klamath River and its tributaries is a requirement for participants in the Brush Dance Ceremony. Bathing is also associated with funeral services, subsistence practices, recreational swimming, courtship, and individual hygiene. Bathing associated with funeral rituals occurs year around and includes preparation for burial and purification after burial.

Karuk tribal member collect willow roots, wild grape, cottonwood, and willow in the riparian zone along the Klamath River and use these materials to make baskets. Traditional collection of these basketry materials often involved wading in the water, and washing and cleaning the materials in the river. Willows are peeled by mouth following cleaning with river water, and plants are also collected for food, medicine, and other cultural functions. Given current degraded water quality conditions, ingestion of water as a result of traditional cultural activities or use of materials harvested from the river may pose a potential health risk.

Prior to construction of dams on the Klamath River, steelhead spawned freely not only in the Klamath River and its tributaries, but in Upper Klamath Lake and beyond. An estimated 650 miles of salmon habitat were lost with the construction of four dams in the Klamath River (unpublished report prepared for The Klamath Tribes and Yurok Tribe). This is a significant amount of habitat no longer available for spawning and rearing. In interviews with Karuk tribal members, they refer to loss of steelhead runs that were once vigorous, supplying fish even at times of the year when salmon runs were no longer taking place. Furthermore, steelhead eat juvenile salmon; therefore, without a healthy salmon run, there will not be a healthy steelhead run.

Steelhead can be a resident fish or they can be anadromous. One prevalent theory about the loss of migratory steelhead is that steelhead produced in the hatchery at Iron Gate Dam comprises a resident population. They are released from the hatchery into a nutrient-rich system immediately downstream from Iron Gate Dam, where there are no triggers to force them to migrate. They have enough food to keep them there; and no other steelhead are coming from downriver to compete with them, increase the densities, and compel them to move. The result is a resident population of non-migratory steelhead.

This lack of migratory steelhead affects the local economy and the well-being of the Karuk. Steelhead fishermen from outside the area used to pay for the privilege of fishing for the Klamath steelhead, bringing money into the local economy to the benefit of the Karuk. In the late 1960s and early 1970s, steelhead fishermen lined the banks of the Klamath River. Today, the numbers of steelhead are so low that the sport is no longer viable.

Karuk tribal members who harvest lamprey eels report an extreme decline in their numbers. Lamprey has traditionally been an important food source for the Karuk and has augmented salmon in their diet, particularly as salmon have become scarce.

Freshwater mussels have also been both an important food source for the Karuk and other groups and an essential part of tribal ceremonies. During the early 20th century, mussels were gathered for food and for use in rituals late in the season when the river flows were low. These low flow periods are unfortunately the time of year when the mussels are most contaminated. Even though there are few to be found, people continue to use freshwater mussels as a food source, but their use in ceremonies has been greatly reduced. Historically, women also used the mussel shells for spoons, tools, and jewelry.

3.12.3.3.4 Karuk Health Impacts

The Karuk have been denied traditional food sources such as salmon over the last 150 years, and have increasingly adopted western foods. The decrease in the availability of traditional foods, including salmon, trout, eel (various species of lamprey), mussels, and sturgeon, is responsible for many diet-related illnesses among Indians, including diabetes, obesity, heart disease, tuberculosis, hypertension, kidney problems, and strokes (Karuk Department of Natural Resources 2007). These conditions result from the lack of proper nutrient content in foods consumed in place of the traditional foods, as well as from the decrease in exercise associated with fishing and gathering food.

The health of many people, including the Karuk, is closely linked to the health of the river. The three largest tribes in California eat fish from the Klamath River, and the declining river system is directly related to the inability of tribal members to continue eating traditional diets. Although early anthropologists described the Klamath River tribes as some of the wealthiest people in California, since European contact, they have become some of the poorest. One result is that the Klamath corridor has some of the lowest incomes and the highest rates of hunger in California. Local populations have traditionally had much of their food supplied by the Klamath River. This continues to be

the case, but with the decline in river health this becomes increasingly difficult. Given the economic impoverishment of the region, there is no general access to healthy alternative foods without subsistence fishing and gathering (See also Section 3.16, Environmental Justice). As a result, hunger is significantly related to the presence and effects of the dams, and these effects are directly connected to the traditional subsistence economy.

The estimated diabetes rate for the Karuk Tribe is 21 percent, nearly four times the U.S. average, and the estimated rate of heart disease for the Karuk is 39.6 percent, three times the U.S. average. Spring Chinook salmon represented a large volume of healthy food for the Karuk people until the 1960s and 1970s. Diabetes is a recent occurrence in the Karuk population. In the 2005 Karuk Health and Fish Consumption Survey, Karuk families were asked when diabetes first appeared in their family and when spring salmon stopped playing a significant role in their family diet. Over 90 percent of reporting families say that before 1950 spring salmon played a significant role in the family diet and less than 15 percent reported occurrence of diabetes. By 2005, no families claimed that spring salmon played a significant role in the family diet and nearly 100 percent reported occurrence of diabetes (Norgaard 2005).

Historically, consumption of fish by the Karuk Tribe was estimated at 450 pounds per person per year, whereas in 2003, the Karuk people consumed fewer than 5 pounds of salmon per person. In 2005, more than 80 percent of Karuk households surveyed reported that they were unable to harvest adequate amounts of eel, salmon, or sturgeon to fulfill their family needs. Furthermore, 40 percent of Karuk households reported that there are fish species that their family historically caught that are no longer harvested.

Difficulty in meeting basic needs can result in overwhelming physical and psychological stress. Traditionally, fishing is done by Karuk men. With the loss of the salmon comes a loss of a man's sense of pride in being able to provide food for his family and tribe. For a tribe that has called itself The People of the Fish, there is an indisputable loss of identity when there are no fish. For a people whose belief system includes their specific role on earth, that they have a predefined relationship with nature that needs to be honored, there is a sense of failure when they are unable to fulfill that role.

The changes that have caused wildlife to becoming scarce and the rivers polluted, may make it hard for young people to understand the ways of their parents and grandparents. They wonder why the tribe focuses on ceremonies that revolve around periodic fish runs and ritual eating of salmon when the availability of fish is so erratic. Never having seen it themselves, they do not understand that in the past there could be eight yearly runs of salmon in the Klamath when all they see is one-half of a fall run. Without tradition as an anchor, young people are sometimes drawn to gangs to establish a feeling of belonging, and leave Karuk territory for cities (DOI 2011; DOI 2012).

The act of eating salmon from the Klamath River affirms sense of place, identity, connection, and community. This orientation draws individuals into relationships of responsibility to care for the fish. Such a world view and set of relationships are in stark

contrast to the separate, individualistic modality of the dominant culture in which plants and animals are "resources" and people are expected to watch out for their individual interests. Relationships between Karuk people and plants and animals fulfill profound mental, emotional, and spiritual functions. In the absence of these food species, traditional activities such as dip net-fishing, eeling, or berry picking have come to an end.

The destruction of the Klamath River fishery has led to both poverty and hunger. As described above, prior to contact with Europeans and the destruction of the fisheries, the Karuk, Hoopa, and Yurok Tribes were the wealthiest people in what is now known as California, and now they are amongst the poorest. The devastation of the resources, especially the fisheries, is directly linked to the disproportionate unemployment and low socioeconomic status of Karuk people today. This dramatic reversal is directly linked to the destruction of the fisheries resource base. Poverty and hunger rates for the Karuk Tribe are among the highest in the State and nation. Median income for Karuk families is $13,000. The poverty rate for Karuk tribal members in Siskiyou County is 88.4 to 91.9 percent. Section 3.16, Environmental Justice, offers more information regarding poverty and employment levels among populations in the area of analysis.

3.12.3.3.5 Effects Determinations

Alternative 1: No Action/No Project - Karuk and Damming of the River

Continued impoundment of water could affect traditionally used resources. The dams are responsible for a drastic reduction in spawning habitat and many other changes in the river system, such as water quality, water temperature, and flow regimes. All of these changes have created an environment in which it is difficult or impossible for many species to flourish. In addition to environmental effects, the changes in the river caused by the dams secondarily have resulted in diminished physical, mental and social health. For thousands of years the Indians who depend on the river have been part of a functioning social, economic, and cultural health system that is currently dying.

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin. Mining activities in the Klamath Basin have significantly decreased over the last several decades, and timber extraction in the basin has slowly become controlled by better regulations at the Federal and State levels.

However, the current operations of the four Klamath River dams adversely affect the resources traditionally used by the Karuk and, by extension, their cultural values, and their continued operation under the No Action/No Project Alternative would result in no change from existing adverse conditions.

Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect traditionally used resources. Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented,

and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources traditionally used by the Karuk (Table 3.12-2). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

KBRA – Programmatic Measures

The KBRA has several programs that could result in impacts/effects to traditional resources used by the Karuk. Specific KBRA programs potentially affecting traditional resources include the Tribal Fisheries and Conservation Management Program. Other KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources; these programs' effects are discussed in Sections 3.2, 3.3, and 3.5 of this EIS/EIR.

Implementation of the Tribal Fisheries and Conservation Management Program could result in impacts/effects to traditionally used resources. As the original stewards of the natural resources of the Klamath Basin the Karuk hold a special position in the Basin and have interests in and a traditional relationship to the Basin ecosystem and its fisheries. Implementation of the Tribal Fisheries and Conservation Management Program would provide funding to assist the tribe in developing their capacity to participate in resource management activities within the Basin, particularly relating to tribal fishing and revitalization of tribal subsistence and other economic activities. The timing of and specific locations where these resource management actions could be undertaken is not certain but the improvements they are anticipated to support in trust resources would contribute to the effects of hydroelectric facility removal. Implementation of the Tribal Fisheries and Conservation Management Program would generate beneficial effects to traditionally used resources. Implementation of specific plans and projects associated with the Tribal Fisheries and Conservation Management Program will require future environmental compliance as appropriate.

3.12.3.3.6 Alternative 3: Partial Facilities Removal of Four Dams Alternative

Partial facilities removal could affect traditionally used resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources traditionally used by the Karuk (Table 3.12-2). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.3.7 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect traditionally used resources. Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be

constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not fully resolve the water, aquatic, and terrestrial resources issues related to traditionally used resources identified by the Karuk Tribe (Table 3.12-2). Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to traditionally use resources would persist.

3.12.3.3.8 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect traditionally used resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address issues associated with the water, aquatic, and terrestrial resources traditionally used by the Karuk (Table 3.12-2), but not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.4 Hoopa Valley Indian Tribe

3.12.3.4.1 Hoopa Valley Indian Tribe History

The Hoopa Valley Indian Reservation is in the northeastern corner of Humboldt County in northern California, approximately 50 miles inland from the Pacific Ocean, and encompasses roughly 20 percent of Hupa aboriginal territory. The reservation, known as "the 12-mile square," is laid out geometrically with sides approximately 12 miles in length for a total of a little less than 144 square miles. At close to 90,000 acres, the reservation is the largest in California.

The northern portion of the reservation is in Yurok ancestral territory. The Trinity River bisects the reservation. A small length of the northern border of the reservation includes about a quarter mile reach of the Klamath River called Saints Rest Bar several miles upriver from Weitchpec, California. The 2000 U.S. Census counted 2,633 people on the reservation, and the tribe listed an enrollment of 2,130 in 2004.

The word Hupa is from the Yurok name for the Hoopa Valley. Hoopa is used when referring to the name of the tribe, and Hupa is used when referring to the people, place, or culture. The Hupa called themselves *Natinook-wa*, meaning "people of the place where the trails return." The Hupa are culturally related to the Yurok and also the Karuk.

Currently, the Hoopa Valley Tribe employs hundreds of people and has established a wide array of industries that support numerous business enterprises. Timber extraction,

gravel extraction, modular house manufacturing, a hotel, a restaurant, and a small casino are the major economic enterprises of the Hoopa Valley Tribe. The Hoopa Valley Tribe also maintains a modest fishery program.

3.12.3.4.2 Hoopa Valley Indian Tribe Cultural Practices

Fishing

The Trinity River is of prime importance to the Hoopa Valley Tribe because it is the river that runs through the Hoopa Valley Indian Reservation. Fish destined for the Trinity River must pass through the lower Klamath River and are therefore affected by Klamath River conditions. Poor conditions in the Klamath River could affect fish populations available to the Hoopa Valley Tribe.

The Trinity River is of unique and irreplaceable value to the Hupa. It is a vital natural resource that is the foundation of their social and cultural way of life. At its most basic level, the river has always been a source for food and other necessities of daily Hupa life. The river also provides basket materials, fish net materials, and a means of transportation. Even rocks from the river are used by Hupa people in their traditional cultural practices. Uses of the Trinity River by the Hupa people are highlighted by maintenance of fisheries and religious ceremonies (e.g., ceremonies that involve prayers offered by people trained to make medicine).

Many natural foods were available to the Hupa, with salmon and acorns providing the bulk of the native diet. When the salmon entered the Trinity River each spring and fall, the year's supply of fish was taken by Hupa using a variety of efficient devices. Other important fish include steelhead, sturgeon, and lamprey eels. Surplus stocks of fish were preserved for future consumption by drying in the smoke of fires.

Religious Practices

Religious beliefs and practices played an important role in everyday life for the Hupa people. An almost endless series of taboos had to be scrupulously observed, daily supplications were made for health and wealth, and acts were performed to ensure luck. In addition, each person was supposed to maintain a devout frame of mind throughout the day, particularly during important group rituals when reverent thoughts by participants and onlookers were considered essential for their success.

The religion of the Hupa is based on individual effort through ritual cleanliness as well as ceremonies that bring the entire tribe together. The tribes of the region, including the Hoopa, practice the annual World Renewal Ceremonies, which involve songs and dances that have been preserved for generations. The Hoopa and Yurok tribes also practice the White Deerskin Dance. These rituals are associated with the river as well as with medicine to cure sickness, but also roots, herbs, and bark used to promote spiritual health. The Brush Dance, for example, is a social event as well as a healing ceremony in which certain tribal members dance, sing, make medicine, and pray to bless a particular sick child or infant.

The Hoopa Valley Indians continue to conduct many of their traditional religious ceremonies, and the cultural significance of the Trinity River is captured in many of these ceremonies. Ancient religious sites on the river were believed to be designated by spiritual deities at a time beyond living memory are still used in current tribal rituals. Prayers conducted at the dances are directed toward the well-being of everyone, and food, particularly fish, is shared with all who attend the ceremonies.

The greatest divinity for the Hupa people is *Yimantuwingyai*, "the one lost (to us) across (the ocean)," also known as *Yimankyuwinghoiyan*, "old man over across," who establishes the order and condition of the world and is the leader of the *kihunai*, or ancestors. *Yimantuwingyai* seems to be a combination of the tricky and erotic *Wohpekumeu* and the more heroic *Pulekukwerek* of the Yurok, who is also similar to the Hupa *Yidetuwingyai*, "the one lost downstream" (Kroeber 1925b:134). A traditional story concerning *Yidetuywingyai* tells of the time when the sun and earth alone existed. From the sun and earth were born twins, *Yidetuywingyai* and the ground on which men live. This particular cosmogony has not been found among the Yurok or Karuk and may have reached the Hupa through the influence of more southerly tribes (Kroeber 1925b:134).

The White Deerskin and Jump Dances, the Flower Dance, and the Brush Dance all demonstrate the importance of the river flows to the Hupa people and how vital the rivers are to Hupa familial and tribal material well-being and self-esteem. Unfortunately, the Hupa report that, although these dances and other religious ceremonies have continued in modern times, the decline of the Trinity River's health has made their practice increasingly difficult for Hupa medicine people, dancers, and others. Thus, the adverse impacts of an unhealthy river extend beyond the fisheries to religious ceremonies.

The Hupa honor the Earth and the Creator for providing sustenance and for allowing the continuance of the tribe in two major ceremonies celebrating world renewal, the White Deerskin Dance and the Jump Dance. Both ceremonies are closely tied to the river. A Hupa name for the White Deerskin dance is *hun'q'ehch'idilye*, "along the river religious dance." This important ceremony is conducted at village sites and resting places near the Trinity River and involves travel on the river. The exact timing of the dances depends on the river and its waters. The White Deerskin Dance is held from late August into September. The Jump Dance follows 10 days after the conclusion of the White Deerskin Dance. Both dances are elaborate ceremonies that take place over a period of 10 days. As part of the rituals, the Hupa offer salmon they have caught at their fishing sites for the ceremony and to share with the participants and attendees.

The Jump Dance takes place along the river and has its own dance steps, songs, and regalia, and is dedicated to the good of the world. The completion of the Jump Dance signals a blessing for the year to come, with the hope that all people may be satisfied with small quantities and have their needs met. Both the White Deerskin Dance and the Jump Dance depend on a healthy river for fish, basket materials, bathing, and ambiance. The flows of the river are also a central element of these dances as they influence the dancers'

ability to travel the river in the manner of their ancestors. The Hupa claim that as the river's flows have declined, so has the Hupa's ability to practice these ceremonies.

The Boat Dance is a spectacular segment of the White Deerskin Dance involving dancing and singing while crossing the Trinity River. As the Boat Dance proceeds, the camps follow the dancers from the east side of the river to the west side. In this way, the dance echoes the river's flows and their connotation of river health. The next day, as the dance continues, the camps move to different sites until the dance concludes.

The Brush Dance is held for the purpose of curing a sick baby or child. Hupa people traditionally bathe in the Trinity River each morning of the dance, and they use baskets made with willows growing along the river in the ceremony. The dance is called the Brush Dance because part of the ceremony requires the participants to fill their quivers with willow brush. Operations along the Trinity River are thought to have reduced the abundance of willow brush and other basket-making materials vital to this dance.

The Flower Dance is held at various Hupa towns along the river. The purpose of this dance is to train a girl who has just reached adolescence to lead a good life as an adult woman. The girl for whom the dance is held traditionally bathes at seven sacred places in the river during training in the Flower Dance ceremony.

3.12.3.4.3 Hoopa Valley Indian Tribe Potentially Affected Trust Resources

A government-to-government consultation meeting concerning the effects of current dam operations on Hoopa Valley Indian Tribe trust resources was held on November 8, 2010. Although current operations of the four Klamath dams are more likely to affect resources of the Klamath River, Klamath water quality affects resources traditionally used by the Hoopa and their fishing rights by adversely affecting fish destined for the Trinity River, which must pass through approximately 42 miles of the Klamath River before turning up the Trinity River and through the Hoopa Valley, where Hoopa Tribal members participate in a tribal subsistence fishery. Table 13.12-4 identifies Trust Resources and rights associated with the Hoopa Valley Indian Tribe.

Table 13.12-4. Effects of Current Dam Operations on Hoopa Valley Indian Tribe Trust Resources and Rights

Trust Resource/Right	Effects
Water resources	Altered flows
	Altered water temperature regime
	Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
Aquatic resources	Loss of habitat
	Less suitable water temperature regime
	Reduced bedload transfer
	Increased potential for disease/parasites
	Reduced population size
Terrestrial resources	Reduced food availability
	Loss of riparian habitat

Source: DOI 2011, 2012

The Hoopa Valley Tribe also provided information suggesting that no mitigation was historically required for the reduction of miles of salmonid fishery habitat upriver of Copco 1 and Copco 2 Dams because such mitigation was not required when the dams were completed[4]. When other dams were constructed, mitigation was required for the loss of fish habitat, but only for the several miles between Iron Gate Dam and Copco No. 2 Dam, (i.e., the Iron Gate Fish Hatchery was built to mitigate for the loss 16 miles of habitat and not for the loss of all upriver habitat). The hatchery does not manage spring Chinook salmon because these fish were primarily affected by previous dam construction, and to a lesser extent than Iron Gate Dam.

3.12.3.4.4 Hoopa Valley Indian Tribe Health Impacts

The secondary effects of the Klamath River dams on the people of the Hoopa Valley Tribe include emotional and physical health effects such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members experience a loss of opportunity for intergenerational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunity elsewhere (DOI 2011; DOI 2012).

3.12.3.4.5 Effects Determinations

Alternative 1: No Action/No Project - Hoopa Valley Indian Tribe and Damming of the River

Continued impoundment of water could affect tribal trust resources. Members of the Hoopa Valley Tribe have offered firsthand accounts of the decline of the river and its effects on the people.

Byron Nelson, a Hupa elder, stated:

> Though many Hupa and Yurok still hold to traditional beliefs and engage in certain time-honored practices such as shamanism and basketry, the decline of the rivers' health, the center of their culture and spirituality, has led to a loss of self-esteem, an increase in cynicism, and has greatly hurt the cohesiveness and health of these tribal communities. The rivers are the focalizing element of the society; with their loss, it seems much of the hope has also been lost.

According to Nelson, cultural stress related to an unhealthy Klamath and Trinity rivers has resulted in a broad spectrum of social and educational problems, including the

[4] In this instance, the EIS/EIR is reporting the views of a Hoopa Valley Tribal member. However the now inoperable Fall Creek Hatchery was built by the California Oregon Power Company in 1919 in lieu of a fish ladder over Copco 1 Dam. The 110 feet high dam was considered too high for salmon and steelhead to pass over successfully. Furthermore, no provision could be made for safe passage of young downstream migrants. Chinook salmon eggs for the facility were collected at the Klamathon Egg taking station while steelhead eggs were obtained at Fall Creek and Bogus Creek collecting stations (Leitrtz 1970).

According to Leitrtz, the stakeholders at that time knew that anadromous fish went at least as far as Spencer Creek. While some believed they went all the way to the Sprague and Williamson, many others did not. This may explain why only minimal attempts to mitigate Copco 1 occurred.

disruption of traditional occupations and the loss of opportunities for religious practice and community participation in tribal culture. Limitations in the tribes' access to resources has restricted the practice of some of their most important traditions, including freely fishing the once prolific seasonal salmon runs and participating in the concurrent cycle of ceremonies. It appears that the access to resources may also be a cause of younger tribal members leaving the area.

The damming of the river has wide-ranging effects on the culture of the Hoopa Valley people. Despite significant degradation of the river ecosystem of the Klamath/Trinity region through the end of the 19th century and the first half of the 20th century, the Hupa persisted in their traditional reliance on the rivers and their resources. Although they found it increasingly difficult, the tribes continued to practice their ceremonies and religions; gathered vegetation for baskets, food, medicines, and other purposes; and met and ate together along the riverbanks. Fish caught by the tribes, as much as possible, continued to be an important component of their diets. Many of the current tribal members grew up with a strong physical connection to the rivers and great appreciation for the traditions and ways of life of their ancestors.

A reason for the ability of the tribes to maintain some of their traditional relationship to the rivers was that the rivers' flows remained relatively unimpeded. This all changed with the building of the dams. The dams, along with other diversions and impoundments in the Klamath/Trinity Basin, have dramatically altered the region's rivers. Fishing and traditional-use sites have become clogged with debris, and declines in fish population persist.

In the past, Federal regulations governing fishing on the Hoopa Valley Indian Reservation have permitted the taking of fish for ceremonial purposes even when the fisheries were closed to harvest. This fact is evidence that the Federal Government recognizes that fishing and fish are an integral and indispensable part of the religious and ceremonial life of the tribe. Unfortunately, the poor condition of the fishery in recent times has in some instances forced the Hupa to purchase fish from sources off their reservations to provide for all who attend their ceremonies. Tribal elder Byron Nelson stated:

> A lack of fish has resulted in the scaling down or even cancellation of ceremonies. The continual practice of ceremonies represents an important means for keeping tribal members who live off the reservations connected to their culture and families. However, without enough salmon, many do not come back; and the planning of ceremonies, once a time to appreciate nature's abundance and of spiritual celebration, often brings significant anxiety to the region's native peoples.

According to a report by the California Department of Fish and Game, the fish kill of 2002 affected all of the tribes along the Klamath River; however, the Trinity River in the Hoopa territory was also affected. Although a larger number of Klamath River fall-run Chinook died, a greater proportion of the Trinity River run was affected by the fish kill.

This is because the Trinity run is substantially smaller than the Klamath run on an annual basis, and the Trinity run was at its peak during the height of the fish kill. The effects were more pronounced in the Trinity River than the Klamath River because the fish kill occurred downstream from the confluence of the Trinity and the Klamath, and thus eliminated much of the fishing opportunity on the Trinity River.

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin, as noted above. However, the current operations of the four Klamath River dams significantly affect the trust resources of the Hoopa Valley Tribe and other resources traditionally used by the Hoopa, by extension, their cultural values, and their continued operation under the No Action/No Project Alternative would result in no change from existing conditions.

3.12.3.4.5 Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect tribal trust resources and other traditionally used resources. Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, The East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Hoopa Valley Indian Tribe (Table 3.12-3). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

KBRA – Programmatic Measures

Upon becoming a Party to the KBRA in accordance with Section 38, the Hoopa Valley Tribe will be eligible for funding to implement programs under the KBRA. The KBRA has several programs that could result in impacts/effects to Trust Resources and other traditional resources used by the Hoopa Valley Tribe. Specific KBRA programs potentially affecting Trust Resources and other traditional resources include the Tribal Fisheries and Conservation Management Program. Other KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources; these programs' effects are discussed in Sections 3.2, 3.3, and 3.5 of this EIS/EIR.

Implementation of the Tribal Fisheries and Conservation Management Program could result in impacts/effects to Trust Resources and other traditionally used resources. As the original stewards of the natural resources of the Klamath Basin the Hoopa Valley Tribe holds a special position in the Basin and has interests in and a traditional relationship to the Basin ecosystem and its fisheries. Implementation of the Tribal Fisheries and Conservation Management Program would provide funding to assist the tribe in developing their capacity to participate in resource management activities within the Basin, particularly relating to tribal fishing and revitalization of tribal subsistence and other economic activities. The timing of and specific locations where these resource management actions could be undertaken is not certain but the improvements they are

anticipated to support in trust resources would contribute to the effects of hydroelectric facility removal analyzed above. Implementation of the Tribal Fisheries and Conservation Management Program would generate beneficial effects to Trust Resources and other traditionally used resources. Implementation of specific plans and projects associated with the Tribal Fisheries and Conservation Management Program will require future environmental compliance as appropriate.

3.12.3.4.6 Alternative 3: Partial Facilities Removal of Four Dams

Partial facilities removal could affect tribal trust resources and other traditionally used resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Hoopa Valley Indian Tribe (Table 3.12-3). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.4.7 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not fully resolve the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Hoopa Valley Indian Tribe (Table 3.12-3). Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to trust resources and rights would persist.

3.12.3.4.8 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Hoopa Valley Indian Tribe (Table 3.12-3), but

not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.5 Yurok Tribe

3.12.3.5.1 Yurok Tribe History[5]

With more than 5,000 members, the Yurok Tribe is the largest tribe in California. The tribe's ancestral territory covers approximately 350,000 acres and includes approximately 50 miles of Pacific coastline. Today, the tribe's reservation, located in Del Norte and Humboldt Counties, California, encompasses approximately 57,000 acres, and consists of a strip of land beginning at the Pacific Ocean and extending a mile along each side of the Klamath River a distance of about 45 miles upriver, to just above the confluence of the Klamath and Trinity rivers. This reservation configuration came about through a complex series of Federal reports and legislative acts.

Today the Yurok Tribe, headquartered in Klamath, California, with an upriver office located in Weitchpec, California, employs more than 200 people, boasts one of the most substantial fishery programs on the entire Klamath River, and self-regulates its subsistence and commercial fishery. The tribe actively participates in the in-river and upslope restoration of its ancestral lands and has signed a collaborative management agreement with the DOI that memorializes the prime role that the Yurok Tribe maintains in managing its resource base (DOI 2011; DOI 2012).

In summary, Sloan (2011:55) states:

> The inseparable relationship of the Yurok people with the environment and resources provided by the rivers of the Klamath-Trinity Basin cannot be overemphasized. The Klamath River is a vital natural resource which is the foundation of Yurok social and cultural way of life. At its most basic level, the River has always been a source for food and other necessities of daily life…Even rocks from the river are used by Yurok people to practice their cultural ways. The Yurok River is traveled during religious ceremonies and in recreational activities, it is integral to the Yurok language and its oral tradition and truly represents the binding force of their community. Yurok use of the River developed over a long period of time as evidenced by the complexity of their religious ceremonies and practices. In aboriginal times, religious practices were integrated with fisheries management.
>
> The Yurok have many traditional dances and ceremonies which they have long practiced along the banks of the Klamath and Trinity Rivers. The Yurok's ceremonial way-of-life has greatly suffered with the deterioration of the region's rivers. The Yurok have always depended on the Klamath

[5] A detailed report documenting the history and culture of the Yurok prepared by Sloan (2011) is included in Appendix B of the DOI (2012) report.

> and Trinity Rivers and the sustenance that their flows provide, they name themselves after the rivers and much of their universe is defined in terms of their physical relation to rivers. Residency, natural and cultural resource sites, ceremonial practices, oral history, transportation routes, economic and sociological resources, indeed the Yurok identity, are all intricately woven into the ecosystems of the Klamath and Trinity Rivers. Yurok continue to live upon some of the forty-four village sites that line the Klamath and lower Trinity Rivers. These are places where Yurok have lived, fished, gathered, prayed and have been buried for countless centuries.

3.12.3.5.2 Yurok Cultural Practices

Fishing

The Yurok have long practiced their traditional dances and ceremonies along the banks of the Klamath River. Consequently, deterioration of the Klamath River affects Yurok ceremonial and traditional practices. The lives of the Yurok people have always been intricately tied to the river. Historically, they depended on the river for sustenance, and much of their world was defined in terms of their physical relation to the river. Natural and cultural sites, daily and seasonal ceremonial practices, oral traditions, transportation routes, economic resources, social relationships, and the Yurok identity were all drawn from the river.

The Yurok base time and direction on the flows of the Klamath River as much as on the rising and setting of the sun, which can be obscured by the steep terrain, deep forests, and rainy conditions of the Klamath Basin. As one Yurok elder said, “Without this river we would not know who we are, where we’re from, or where we’re going.” Under natural conditions, the rates and sounds of the river’s flow tell the Yurok both the season and the time of day. The skill of the Yurok fisherman has always been measured by his ability to navigate the Klamath River in the dark, not by the stars or landmarks, but by correlating the location and swiftness of the current and back eddies of the river with the sounds that are unique to each bend and riffle. Moreover, the Yurok people are so attuned to the river that they have a name for each characteristic of the water’s movement. Even when Yuroks are away from the river, they remain acutely aware of their location in relation to it, always measuring direction by the river’s flow. For example, it is not uncommon to refer to the burners on a kitchen stove as upriver or downriver, depending on their position. One Yurok elder said, “The river flows like our blood. It is our veins and arteries.”

Many of the Yurok cultural sites on the Klamath and lower Trinity Rivers are traditional fishing spots owned by families. Fishing spots are locations where there are deep holes, significant back eddies, and ideal spots to set a net or erect a platform out over the river. Fishing spots can be given, inherited, loaned, leased, and bought and sold, and are central to the Yurok economy. Over time, as the rivers’ flows have changed, so have the locations of these cultural sites. To this day the Yurok continue to live in some of the

village sites that line the Klamath and lower Trinity Rivers, where they still practice many of their traditions in places where the Yurok have lived, fished, gathered, prayed, and buried their dead for centuries.

The Yurok Tribe conducted subsistence fishing in 1987 through 1989. Since 1990, tribal commercial harvests have been marginal and have not provided a comfortable standard of livelihood as originally envisioned for the Yurok in the Hoopa Yurok Settlement Act. At the same time, subsistence fishing has been severely limited. The decreased harvests have had a significant adverse impact on the tribe's economies and health, as described below.

Trade and Barter

Fish are the Yurok Tribe's most valuable asset and a mainstay of their economy. Abundant fish allow Yurok to feed themselves and their families and to acquire products from outside their territory through trade. Fish was a trading commodity available to any enterprising man. A young man who diligently fished and successfully traded fish for other items could amass sufficient wealth to buy a boat, travel to collect all of the necessary items to fashion intricate ceremonial regalia, and to allow him to marry. Fish were the baseline resource that facilitated the acquisition of wealth and upward social mobility in Yurok culture.

Religious Practices

First Salmon Ceremonies were initiated around April when fish first breeched the sandbar at the mouth of the Klamath River. The ceremony was conducted to celebrate the harvesting of fish and to pray for continuing prosperity and access to subsistence resources. Written and oral tradition indicates that prior to impacts on the fishery beginning with miners who arrived during the Gold Rush, salmon were entering the river in distinguishable waves throughout the year. The major run was traditionally that of the spring salmon. George R. Field, supervisor of the cannery of the Klamath Packers Association at the mouth of the Klamath, described the runs in 1930:

> As the run of winter steelheads ceases, about March 30, spring Salmon begin to come. A few enter the Klamath in the later part of February, but the run really starts in March and slackens or almost entirely passes by the last of May. These fish average about 11 pounds in weight and are indistinguishable from those which come later, except that the eggs are always immature. These spring salmon may be caught in the smaller streams fed by melting snow at the headwaters of Salmon River during the month of May.

In early spring the first salmon to enter the Klamath River was traditionally speared and ritually eaten by Yurok medicine men, which signified the beginning of the fishing season. The beginning of fishing season also marked the construction of the fish dam at Cappell, located 33 miles from the mouth of the Klamath River. The fish dam that has not been constructed since 1913 was built by Yurok men under the supervision of a

Yurok medicine man. Dam construction sanctified the taking, distribution, and consumption of salmon. All other ceremonies were scheduled only after the fish dam ceremony took place.

Salmon are ritually managed to ensure that Yurok are provided with fish and that enough fish spawn to maintain the fishery. Yurok maintain a general reverence for salmon; however, a strong belief prevails that without proper ceremony the salmon will not return in sufficient numbers. Regardless, the river is central to most Yurok ceremonies. There are several rocks along the river etched with petroglyphs that provide instructions from the Creator to the Yurok people. One message is a warning that when the rivers stop flowing that will mark the end of the Yurok world. Accordingly, some elders have prophesied that the manipulation of flows by damming represents the beginning of the end for the Yurok.

The Brush Dance, intended as a communal focus around an ailing child, is held in many of the traditional village sites along the Klamath River. The ceremony requires the proper river setting and the availability of river resources. As a Brush Dance unfolds over a four-day period, the participants celebrate the wealth that the riverine environment provides. Baskets made of plant materials collected at the water's edge are used to hold food and ceremonial medicine. Acorns are cooked in the baskets and converted into a nourishing mush using hot rocks gathered from specific river bars. Regalia used by dancers is constructed from various plant and animal products that the riverine environment provides. Ceremonial hosts are expected to feed visitors salmon, and to fail in providing such traditional food to guests is considered an insult.

Beginning with the California Gold Rush and the appearance of large numbers of EuroAmericans in traditional Yurok territory, Yurok traditional cultural practices began to decline; however, during the 1970s and 1980s Yurok cultural practices were revitalized. Tribal elders began to teach young people traditional Yurok practices and ceremonies. The Jump Dance was conducted in Pecwan in 1984, a War Dance was held in the late 1980s, communities came together to support the revival of Brush Dances, and in 2000 the White Deerskin Dance was held for the first time in many years at Weitchpec (DOI 2011; DOI 2012).

Oral Traditions

The anthropologist Alfred Kroeber traveled throughout Yurok territory in the early 1900s interviewing Yurok people and documenting the tribe's riverine way of life. Kroeber (1976) presents 169 Yurok stories, of which 77 make direct reference to the Klamath River. Among the stories are tales and information regarding construction of fish dams, locations and origins of ceremonies held along the river, bad places in the river, locations where the first salmon was created, what one must do with salmon caught at certain locations, how the river came to flow the way it does, and death passage on the river. It is evident from transcriptions of Yurok stories that the Klamath River is an integral part of their way of life and a basis of their tradition and culture. These stories highlight a healthy and vibrant river ecosystem.

The use of the Yurok language dramatically decreased when non-Indians settled in the Yurok territory, and by the early 1980s it was near extinction. When the Yurok Tribe began to operate as a formal tribal government in 1988, the Yurok created a language revitalization program. The use of old records helped new language learners, but hearing fluent speakers was the most effective way for young people to acquire the language (DOI 2011; DOI 2012).

3.12.3.5.3 Yurok Potentially Affected Trust Resources

In a government-to-government consultation meeting concerning Yurok trust resources affected by current dam operations held on September 28, 2010, the Yurok Tribe asserted the following as Yurok trust resources: water, fish, land, wildlife, minerals, and timber. The Yurok Tribe asserted that the United States has a trust responsibility to protect such resources and ensure that such resources are managed for the beneficial use of the Tribe and its membership. The Yurok further assert that the Federal Government has other trust responsibilities to the Yurok in the areas of social welfare, education, and health. For example, Yurok believe that limited access to water, aquatic, and terrestrial resources has restricted the ability of Yurok to practice of some of their most important traditions. This includes freely fishing the once-prolific semi-annual salmon runs and participating in the cycle of ceremonies initiated concurrently. In the past, the Yurok were not inclined to leave their territory; currently, several factors, including an inability to meet subsistence needs from the fishery and a perception that the rivers are dirty, prompt younger tribal members to leave the area to find work (DOI 2011; DOI 2012).

The Yurok tribal chairperson, when asked if such trust resources were affected by the current dam operations, responded “Yes” and went on to relate that the Yurok understand that their resources are intricately interconnected to multiple ecosystems. The Yurok World Renewal Ceremonies, recently completed at the time of the meeting, were provided as an example of how Yurok understand and pray for the integrity of such ecosystems. Table 13.12-5 identifies trust resources and rights associated with the Yurok Tribe. The United States does not necessarily agree that all of the above resources are in trust (and therefore form the basis of a trust relationship), but the resources are important to the Yurok (and thus to the United States) for their traditional and ceremonial use.

3.12.3.5.4 Yurok Health Impacts

Secondary effects of the Klamath River dams on the Yurok Tribe include emotional and physical conditions such as increased obesity, diabetes, and heart disease due to loss of traditional salmon diet, and depression and alienation that can result in suicide (DOI 2011; DOI 2012).

3.12.3.5.5 Effects Determinations

Alternative 1: No Action/No Project - Yurok and Damming of the River

Continued impoundment of water could affect tribal trust resources and other traditionally used resources. The damming of the river has resulted in changes in the

Table 13.12-5. Effects of Current Dam Operations on Yurok Tribe Trust Resources and Rights

Trust Resource/Right	Effects
Water resources	Altered flows
	Altered water temperature regime
	Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
	Diminished aesthetics
	Algae clogged fishing nets
	Human exposure to toxic water while conducting cultural activities
	Diminished opportunity for traditional bathing
Aquatic resources	Loss of habitat
	Less suitable water temperature regime
	Reduced bedload transfer
	Increased potential for disease/parasites
	Reduced population size
	Diminished livelihood
	Loss of traditional salmon diet and increased risk of heart disease, strokes, diabetes, and obesity among tribal members
	Depression, alienation, and possible suicide
	Tribal members leaving ancestral territory
	Lost opportunities for transmitting traditional knowledge
Terrestrial resources	Reduced food availability
	Loss of riparian habitat
	Diminished plant availability for cultural practices and related benefits
	Loss of opportunity for inter-generational traditional knowledge transmission

Source: DOI 2011; DOI 2012

flows of the water and the resources it offers to the tribe, along with myriad losses to tradition and culture (USFWS et al. 1999). Despite significant degradation of the river ecosystem of the Klamath region through the latter 19th and first half of the 20th centuries, the Yurok persisted in their traditional reliance on the river and its resources. Although it became increasingly difficult, the tribe continued to practice its ceremonies and religions and gathered vegetation for baskets, food, medicines, and other purposes. As much as possible, Klamath River fish caught by the Yurok tribal membership continued to be an important component of the tribe's diets. Indeed, many of today's older Yurok grew up with a strong physical connection to the river and a great appreciation for the traditions and ways of life of their ancestors.

The presence of the dams on the upper reaches of the Klamath River has brought about changes in Yurok culture. Sites for fishing and traditional use have become clogged with

debris and algae, and fish populations have declined. Observers report that when tribal members try to use their traditional fishing nets, they fill with algae, which is a sign of an unhealthy river.

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin. Mining activities in the Klamath basin have significantly decreased over the last several decades. Timber extraction in the basin has slowly become controlled by better regulations at the Federal and State levels to the point where timber extraction is now better characterized as forest management.

However, the current operations of the four Klamath River dams significantly affect the trust resources of, and other resources traditionally used by the Yurok Tribe and, by extension, their cultural values, and their continued operation under the No Action/No Project Alternative would result in no change from existing conditions.

3.12.3.5.6 Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect tribal trust resources and other traditionally used resources. Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the KBRA would be implemented, the East and Westside Facilities would be decommissioned, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Yurok Tribe (Table 3.12-4). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

KBRA – Programmatic Measures

The KBRA has several programs that could result in impacts/effects to trust resources and other traditional resources used by the Yurok. Specific KBRA programs potentially affecting trust resources and other traditional resources include the Tribal Fisheries and Conservation Management Program. Other KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources; these programs' effects are discussed in Sections 3.2, 3.3, and 3.5 of this EIS/EIR.

Implementation of the Tribal Fisheries and Conservation Management Program could result in impacts/effects to Trust Resources and other traditionally used resources. As the original stewards of the natural resources of the Klamath Basin the Yurok hold a special position in the Basin and have interests in and a traditional relationship to the Basin ecosystem and its fisheries. Implementation of the Tribal Fisheries and Conservation Management Program would provide funding to assist the tribe in developing their capacity to participate in resource management activities within the Basin, particularly relating to tribal fishing and revitalization of tribal subsistence and other economic activities. The timing of and specific locations where these resource management actions could be undertaken is not certain but the improvements they are

anticipated to support in trust resources would contribute to the effects of hydroelectric facility removal. Implementation of the Tribal Fisheries and Conservation Management Program would generate beneficial effects to trust resources and other traditionally used resources. Implementation of specific plans and projects associated with the Tribal Fisheries and Conservation Management Program will require future environmental compliance as appropriate.

3.12.3.5.7 Alternative 3: Partial Facilities Removal of Four Dams

Partial facilities removal could affect tribal trust resources and other traditionally used resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Yurok Tribe (Table 3.12-4). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.5.8 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not fully resolve the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Yurok Tribe (Table 3.12-4). Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to trust resources and rights would persist.

3.12.3.5.9 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Yurok Tribe (Table 3.12-4), but not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.6 Resighini Rancheria

3.12.3.6.1 Resighini Rancheria History

The Resighini Rancheria was originally thought to consist of 228 acres. A resurvey in 1974 determined the size of the Rancheria to be 238.78 acres. It is located in Del Norte County, California. It is primarily settled by Yurok Indians affiliated with the Yurok Coast Indian Community. (Davis, R. B., Letter to Acting Superintendent of Indian Affairs. (July 27, 1973)) The Resighini Rancheria has 132 enrolled members. A population of 36 was reported to live on Rancheria lands in the 2000 U.S. Census. The Resighini Rancheria is located several miles inland from the mouth of the Klamath River and rests on the southern banks of the river, completely surrounded by the Yurok Reservation.

The land for the Rancheria was purchased from ranch owner Augustus (Gus) Resighini by the Secretary of the Interior in 1938 under the authority of the Indian Reorganization Act. The Secretarial proclamation, deeming the land "reservation," proclaimed the purchase was to "provide for the protection of the soil, the proper development of the land, and the equitable distribution of benefits from the land."(*Secretarial Proclamation proclaiming the purchased lands a reservation. (October 21, 1939))* The lands, although located mostly in the floodplain of the Klamath River, were productive hay fields and supported a substantial dairy farm. Additional letters between various Indian Agents and the central office of the Secretary, justifying the purchase, commented on the possibility of Rancheria members continuing to operate the dairy farm, produce hay, grow vegetable gardens, and perhaps receive jobs as fishing guides for the burgeoning recreational fishery that the Klamath River was, at that time, known for providing.

The original proposal to create the Resighini Rancheria described the "228-acre" tract of land as "agricultural" with conditions that are "ideal for farming or dairying."(*Merin (December 28, 1937))* However, the value of the land as agricultural was directly connected to the loss of the traditional fisheries. During the settlement of this land, disastrous flooding periodically occurred, with a 100-year flood washing through in 1964. This natural disaster led to the removal and evacuation of Indian families to other local areas.

In 1975, a band of Yurok Indians stood together and formally created a non-traditional form of government with a constitution and bylaws, which were approved and ratified by Indian commissioner Bruce Thompson from the Department of the Interior. In 1979, the Indian people who chose to return to the Resighini Rancheria began the challenge of rebuilding.

In past years, commercial and subsistence fishing was a primary means of economic and subsistence support for the Yurok along the Klamath River. However, with the closure and restrictions on tribal fishing, the Yurok people lost this means of support.

Today the Resighini Rancheria employs a dozen people and operates a campground. A former casino and cafe received flood damage in the 1990s and are no longer operational. The tribe also operates a gravel-extraction enterprise along the course of a secondary

channel to the Klamath River that runs through rancheria boundaries. Ground water wells have been assessed and are slated for improvements that will lead to better water distribution throughout the rancheria in support of several residences and the campground and for irrigating agricultural lands. The tribe recently purchased off-rancheria and adjacent fee lands totaling 196 acres. This additional acreage is mostly riparian habitat along the mainstem of the Klamath River and includes the old Waukel Flat Indian Agent site.

The Rancheria has a reserved water right per the reserved water rights doctrine. The reserved rights doctrine provides that when lands are set aside as Indian or other Federal reservations, sufficient water to fulfill the purpose of the reservation is reserved as well. Federal reserved water rights arise expressly or by implication from Federal treaties, statutes, and executive orders, and vest no later than the date the reservation was established. Unlike State appropriative rights, Federal reserved water rights are for present and future uses and may be exercised at any time and are not lost through non-use. While Federal reserved water rights may be quantified and administered by States in the context of comprehensive State water adjudication, they are otherwise governed by Federal, not State, law.

3.12.3.6.2 Resighini Rancheria Cultural Practices
Fishing, Trade and Barter, Religious Practices, and Oral Traditions

The Indians of the Resighini Rancheria are Yurok people; consequently they share their cultural practices and values with the general culture described for the Yurok Tribe. Resighini tribal members recently participated in the Weitchpec Jump and Deerskin ceremonies.

The original “Merin” proposal to create the Resighini Rancheria described the tract of land as “agricultural” with conditions that are “ideal for farming or dairying.” However, the value of the land as agricultural was directly connected to the loss of the traditional fisheries. In past years, commercial and subsistence fishing was a primary means of economic and subsistence support for the Yurok along the Klamath River. However, with the closure and restrictions on tribal fishing, the Yurok lost this means of support. Under the Hoopa-Yurok Settlement Act of 1988, 25 U.S.C. §§ 1300i, et seq., (The Settlement Act) the extended strip of land along the Klamath River was cleaved from the original Hoopa Valley Reservation and designated the Yurok reservation. Section §1300i- 1(e) then vested in the Yurok Tribe the authority to govern the Yurok Reservation and to administer the unalloted trust land and assets – including the fisheries – of the Yurok Reservation.

Pursuant to The Settlement Act, members of the Resighini Rancheria with Yurok heritage were given an opportunity to join the Yurok Tribe. The Settlement Act also provided qualified Indians of the original Hoopa Valley Reservation, which included allottees or their descendants, the opportunity to elect membership in the Yurok Tribe. 25 U.S.C. 1300i-5(c)(1). An Indian who chose not to affiliate with the Yurok Tribe (or

the Hoopa Valley Tribe) received a lump sum payment, but lost any "interest or right whatsoever in the … resources within or appertaining to… the Yurok Reservation." 25 U.S.C. 1300i-5(d)(3).

The Settlement Act also provided an opportunity for the Resighini Rancheria (along with others) to merge its lands and membership with the Yurok Reservation if a majority of the Rancheria's adult members voted in favor of such merger. 25 U.S.C. sec. 1300i-10(b). The Resighini Rancheria members did not exercise this option, the Rancheria remains a separate sovereign tribal government, and the Tribe and its lands were not extinguished through merger with the Yurok Reservation as would have occurred had its members exercised the merger option under The Settlement Act.

3.12.3.6.3 Resighini Rancheria Potentially Affected Trust Resources

In a government-to-government consultation meeting concerning Resighini Rancheria trust resources affected by current dam operations held on September 29, 2010, the Resighini Rancheria asserted the following as Rancheria trust resources: gravel (minerals); water as it relates to ground water for domestic, agricultural, and recreational (campground) uses; riparian plants; wetlands; fish; land; and wildlife. The Resighini Rancheria asserted that the United States has a trust responsibility to protect such resources and ensure that such resources are managed for the beneficial use of the Rancheria and its membership. The Rancheria further asserted that the Federal Government has trust responsibilities to the Rancheria in the areas of social welfare, education, and health. The United States does not necessarily agree that all of the above resources are trust resources but the resources are important to the Rancheria (and thus to the United States) for their traditional ceremonial use. Table 3.12-6 identifies Resighini Rancheria Trust Resources and rights and resources traditionally used by Rancheria members.

Any Klamath River salmonid fishing rights and concomitant water rights to which the Resighini Rancheria may be entitled have not yet been determined [Solicitor's Opinion M-36979 October 4, 1993]. Regardless, the general health and well being and cultural values of the members of the Rancheria are affected by a lack of fish in the local economy and overall water quality. The lack of fish in the local economy also has secondary effects on general tribal health and cultural well being. The Rancheria tribal council person, when asked during consultation if such resources were affected by the current dam operations, responded, "Yes" and went on to relate that water quality has declined, erosion of lands occurs at a higher rate, replenishment of gravel extraction beds has diminished, and fish returns are low. In addition, as a tribe that lives alongside the river, their aesthetic quality of life has diminished. The Rancheria people are at risk when they bathe in the river, tourists are less interested in visiting the Klamath River and staying in the campground, and in an area with fewer available fish, tribal members are likely to consume fewer traditional food resources. This has led to related impacts on tribal health such as higher rates of obesity, diabetes, heart disease, and stroke (DOI 2011; DOI 2012).

Table 3.12-6. Effects of Current Dam Operations on Trust Resources and Rights and Resources Traditionally Used by the Resighini Rancheria

Trust Resource/Right	Other Resources Traditionally Used By The Tribes	Effects
Water resources (ground water)		Indeterminate ground water quality
	Water resources (instream)	Altered flows
		Altered water temperature regime
		Degraded water quality caused by nutrient input, dissolved oxygen, pH, algal toxins and other contaminants
		Diminished aesthetics
		Algae clogged fishnets
		Human exposure to toxic water while conducting cultural activities
		Diminished opportunity for traditional bathing
	Aquatic resources	Loss of habitat
		Less suitable water temperature regime
		Reduced bedload transfer
		Increased potential for disease/parasites
		Reduced population size
		Less traditional salmon diet and increased risk of heart disease, strokes, diabetes, and obesity
		Tribal members leaving reservation
		Fewer opportunities for transmitting traditional knowledge
		Increase in invasive species (Asian clams)
Terrestrial Resources		Real property: erosion and flooding
		Mineral: less gravel replacement
	Terrestrial resources	Reduced food availability
		Reduced riparian habitat
		Diminished plant availability for cultural practices and related benefits
		Loss of opportunity for inter-generational traditional knowledge transmission

Source: DOI 2011; DOI 2012

The Yurok of the Resighini Rancheria bathe in the river and use its water for daily and ritualistic purposes. Because of their reliance on the river for so many aspects of their lives, they are concerned about the quality of its water. The Klamath Hydroelectric Project has effects on water quality and related environmental issues, such as watershed health, riparian habitats, erosion, sediment, turbidity, sources of pollution and temperature changes, algae blooms, low dissolved oxygen, high pH, and un-ionized

ammonia. The cumulative effects may result in health problems, not just for the people who live on the Rancheria, but also for the tourists who come and camp in the area every year, and for people who use the water for business purposes or who work for those businesses.

A 1975 Resighini Rancheria Water Resources Investigation Report states that samples were not taken of the water in the abandoned well. It also states that coliform was found in a sample taken from a stream running through the Rancheria. A second report completed by the Bureau of Reclamation (Reclamation) in 2010 to document an Environmental Assessment of the Resighini Rancheria's Water Resources states: "The Rancheria is in need of an additional source of dependable drinking water to reduce potential health risks associated with their current operation." Later, the same document states: "Hydrogeologic information is currently not available for water-bearing formation, ground water level trends, and ground water storage for the Lower Klamath River Valley ground water basin."

3.12.3.6.4 Resighini Rancheria Health Impacts

Secondary effects of the Klamath River dams on the people of the Resighini Rancheria include emotional and physical health effects such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members experience a loss of opportunity for inter-generational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunities elsewhere (DOI 2011; DOI 2012).

3.12.3.6.5 Effects Determinations

Alternative 1: No Action/No Project - Resighini Rancheria and Damming of the River

Continued impoundment of water could affect tribal trust resources and other traditionally used resources. The Klamath River dams have significantly reduced the ability of tribal members to engage in traditional and contemporary subsistence and religious practices. The availability and rights to traditional foods and basket-making materials have been affected by the presence of the dams. The dams have altered the natural flows of the river, which has affected the formation of the sand spit in terms of sand buildup and the ability of the river to clear a path through the spit to the ocean. As a result of altered functions, including increased sand build up coupled with seasonal low flows, the Rancheria has experienced more fall flooding of its lands.

The Rancheria members have noticed an invasion of clams (identified generally as "Asian clams") and wonder how that might alter the ecosystem. The tribe is not sure whether invasive species can be directly attributed to the dams, but does know that the clams have migrated from upriver to downriver. Although new species are introduced into the ecosystem with unknown consequences to Rancheria members, the Rancheria has also witnessed the demise of traditional species such as the spring run of Chinook and

the near extinction of the Klamath population of eulachon. The demise of these populations is generally attributed to poor Klamath River water quality (DOI 2011; DOI 2012).

Many historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin. Mining activities in the Klamath basin have significantly decreased over the last several decades. Timber extraction in the basin has slowly become controlled by better regulations at the Federal and State levels to the point where timber extraction is now better characterized as forest management, as noted above.

However, the current operations of the four Klamath River dams significantly affect the trust resources of the Resighini Rancheria and, by extension, their cultural values, and their continued operation under the No Action/No Project Alternative would result in no change from existing conditions.

3.12.3.6.6 Alternative 2: Full Facilities Removal of Four Dams Alternative (the Proposed Action)

Removal of the Four Facilities could affect tribal trust resources and other traditionally used resources. Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the City of Yreka Water Supply Pipeline would be installed, and the KBRA would be implemented. KBRA programs would have effects on trust resources of aquatic resources, water quality, and terrestrial resources, which are discussed Sections 3.2, 3.3, and 3.5 of this EIS/EIR. Implementation of the Proposed Action, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Resighini Rancheria (Table 3.12-5).

3.12.3.6.7 Alternative 3: Partial Facilities Removal of Four Dams

Partial facilities removal could affect tribal trust resources and other traditionally used resources. Under the Partial Facilities Removal of Four Dams Alternative, four dams and their associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the East and Westside Facilities would be decommissioned, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be installed. Implementation of the Partial Facilities Removal of Four Dams Alternative, including the KHSA and KBRA, would, in the long term, benefit the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Resighini Rancheria (Table 3.12-5). Actions addressing these issues are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

3.12.3.6.8 Alternative 4: Fish Passage at Four Dams

Fish passage at four dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish

passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Four Dams Alternative would benefit fish populations. However, implementation of this alternative would not resolve the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Resighini Rancheria (Table 3.12-5). Under the Fish Passage at Four Dams Alternative issues related to water, aquatic, and terrestrial resources related to trust resources and rights would persist.

3.12.3.6.9 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Fish passage at two dams and facilities removal of two dams could affect tribal trust resources and other traditionally used resources. Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented. Implementation of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would address the water, aquatic, and terrestrial resources issues related to trust resources and rights identified by the Resighini Rancheria (Table 3.12-5), but not to the same degree as the Proposed Action or Partial Facilities Removal of Four Dams Alternatives. Actions addressing issues related to water, aquatic, and terrestrial resources are presented in Sections 3.2, 3.3, 3.4, and 3.5 of this EIS/EIR.

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3.13 Cultural and Historic Resources

This section discusses the Proposed Action and alternatives' potential effects on cultural resources, historic properties, and historical resources.[1] United States Department of the Interior (DOI) elected to utilize the National Environmental Policy Act (NEPA) process to meet the requirements of Section 106 of the National Historic Preservation Act (NHPA) as allowed under 36 CFR Section 800.8(c). DOI defines the undertaking, for purposes of Section 106 of the NHPA, as the removal of the four PacifiCorp dams which may be a result of the Secretarial Determination. The proposed undertaking has the potential to affect historic properties triggering compliance with Section 106 of the NHPA. The analysis and consultations concerning any effects of the Proposed Action and alternatives on historic properties will be integrated into the NEPA review and documentation pursuant to the criteria identified in 36 CFR Section 800.8(c)(1)-(4). The following section also incorporates the compliance requirements of the California Environmental Quality Act (CEQA).

3.13.1 Area of Analysis

The area of analysis for cultural and historic resources includes the area of potential effects (APE) for the Proposed Action (removal of the four dams and facilities) as this represents the largest APE of all alternatives and is inclusive of all APEs for each of the other alternatives. The APE is defined as the Klamath River from the outlet at Keno Dam to the river's outlet at the Pacific Ocean (approximately 250 miles long), and extending outward for 0.5 miles from each bank of the river, plus a 0.5-mile-wide corridor from the high water mark surrounding each of the four reservoirs, and all four dams and associated facilities.

3.13.2 Regulatory Framework

The following definitions are common terms used to discuss the regulatory requirements and treatment of cultural resources:

> **Cultural Landscape** is a geographic area, including both cultural and natural resources, associated with an historic event, activity, or person or exhibiting other cultural or aesthetic values. (Birnbaum 1994). An ethnographic landscape, one type of cultural landscape, is described as a landscape containing a variety of natural and cultural resources that associated people define as heritage resources. (Birnbaum 1994). Cultural landscapes may be evaluated for eligibility as a historic property following the criteria 36 CFR Section 60.4.

[1] Revisions to this section of the EIS reflect DOI's obligations under Section 106 of the NHPA, which is being integrated into the NEPA process and documentation, including DOI's on-going consultation efforts with the consulting parties as discussed herein. The revisions in part seek to respond to comments, suggested edits, and/or proposed additions that were raised by consulting parties.

Cultural resource is a term used to describe several different types of properties, both made/modified by people and natural: prehistoric and historical archaeological sites; architectural properties such as buildings, bridges, and infrastructure; and resources of traditional or historic importance to Indian tribes and other cultural groups.

Historic properties is a term defined in 36 CFR Part 800, the implementing regulations for Section 106 of the NHPA, as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion on, the National Register of Historic Places (National Register), including artifacts, records, and material remains related to such a property. Criteria for eligibility for listing on the National Register are found at 36 CFR Section 60.4. The term includes properties of traditional religious and cultural importance (Traditional Cultural Properties or Cultural Landscapes) to an Indian tribe or other cultural group that also meet the National Register criteria.

Historical resource is a CEQA term that includes buildings, sites, structures, objects, or districts, each of which may have historical, prehistoric, architectural, archaeological, cultural, or scientific importance, and is eligible for listing or is listed in the California Register of Historical Resources (California Register).

Historic District is a significant concentration, linkage, or continuity of sites, buildings, or structures united historically or aesthetically by plan or physical development. A Historic District derives its importance from being a unified entity, even though it is often composed of a wide variety of resources. The identity of a District results from the interrelationship of its resources, which can convey a visual sense of the overall historic environment or be an arrangement of historically or functionally related properties. A District can include sites, structures, and features that, on their own, lack individual distinction, but are significant as a group. A District will have an identified theme and time period of significance.

Programmatic Agreements are negotiated agreements between Federal agencies, the Advisory Council on Historic Preservation (ACHP), and State Historical Preservation Officers (SHPOs), in consultation with other interested parties, that govern the implementation of a particular program or the resolution of adverse effects from certain complex project situations or multiple undertakings, as defined in 36 CFR Section 800.14. Programmatic Agreements may be used when effects on properties are similar and repetitive or are multi-State; when effects on historic properties cannot be fully determined prior to approval of an undertaking; when non-Federal parties are delegated major decisionmaking responsibilities; and for dealing with the potential adverse effects of complex projects or multiple undertakings.

> **Traditional Cultural Property (TCP)** is defined as a property eligible for inclusion in the National Register "because of its association with cultural practices or beliefs of a living community that (a) are noted in that community's history, and (b) are important in maintaining the continuity of the community (Parker and King 1998)."

3.13.2.1 National Historic Preservation Act of 1966, as amended in 1992

The NHPA is the primary Federal legislation governing preservation of cultural and historical resources in the United States. The NHPA established a national historic preservation program which encourages the identification and protection of cultural resources. Section 106 of the NHPA requires Federal agencies to take into account the effects of their undertakings on historic properties listed in or eligible for the National Register and afford the ACHP a reasonable opportunity to comment on such undertakings (16 USC Section 470f). The ACHP promulgated the Section 106 implementing regulations, found at 36 CFR Part 800, which sets forth the Section 106 process, including consultation requirements.

3.13.2.1.1 Compliance with Section 106 of the NHPA

As allowed under the Section 106 regulations, DOI has elected to integrate compliance with Section 106 through the NEPA process pursuant to 36 CFR Section 800.8(c)(1)-(4). This integrated approach satisfies the regulatory steps of the Section 106 process by using the NEPA process and the documentation required for the preparation of an Environmental Impact Statement (EIS)/ Record of Decision (ROD) to evaluate and resolve an undertaking's potential adverse effects on historic properties. The regulations identify specific requirements that the Federal agency must meet through the NEPA process and documentation in lieu of the Section 106 process set forth in 36 CFR Sections 800.3 through 800.6. These standards, and a description of how DOI will meet those standards, are described below.

Initiation of the Section 106 Process

The definition of the Federal undertaking is an important step in the initiation of the Section 106 process. In this case, the proposed undertaking is the potential removal of the four lower PacifiCorp dams. The proposed undertaking and the alternatives being analyzed in this EIS/Environmental Impact Report (EIR) are limited to only the selection of an approach involving partial or full dam and associated facilities removal, the installation of fish passages, and activities associated with the action alternatives. The specific details of how the proposed undertaking or the alternatives might be implemented are not fully known at this time and cannot be fully analyzed in this EIS/EIR, nor will a decision through the EIS/EIR authorize the removal of dams without additional compliance with NEPA and other Federal environmental laws, including Section 106 of the NHPA. Future decisions will evaluate how to implement the Proposed Action or other selected action alternative.

Use of the NEPA Process In Lieu of the Section 106 Procedures Set Forth in 36 CFR Sections 800.3 through 800.6

The regulations for Section 106 permit Federal agencies to integrate Section 106 compliance with the NEPA process (36 CFR Section 800.8). Due to the scope and scale of this undertaking, DOI has chosen to utilize this provision in order to reduce redundancies when complying with both laws; provide the broadest possible opportunities and greatest convenience for the public to review and consult on DOI's Proposed Action; and ensure that concerns pertaining to historic properties are fully integrated into the EIS and the ROD.

The Section 106 regulations clearly state that integrating the Section 106 compliance process with NEPA does not waive Federal agency obligations under either law. While the regulations do permit the DOI to take advantage of the NEPA process, the Agency must still adhere to the fundamental direction for compliance with Section 106. The following summarizes the DOI's actions to comply with these provisions (36 CFR Sections 800.8(c)(1) through 800.8(c)(4)).

Notifications

A Federal agency must disclose its intent to integrate the Section 106 process with the NEPA process to the appropriate SHPOs/Tribal Historic Preservation Officers (THPOs) and the ACHP prior to the review. DOI notified the ACHP, the California SHPO and Oregon SHPO, and the Yurok THPO and Karuk THPO, of its intent to implement the Section 106 regulations through the NEPA process by letter dated June 23, 2011.

Identifying consulting parties pursuant to 36 CFR Section 800.3(f)

The public involvement process for NEPA has been extensive and sustained. It has included outreach and invitations to consult to other Federal agencies, State and local governments, nongovernmental organizations, and the public. In addition, DOI has separately notified the ACHP, California SHPO, Oregon SHPO, six federally recognized Indian tribes (including the Yurok and Karuk THPOs), two Indian organizations, and other interested parties.

Identify Historic Properties and Assess the Effects

For purposes of the Proposed Action to remove the four lower PacifiCorp's dams (and for the evaluation of alternatives), DOI established as the APE the Klamath River from the outlet at Keno Dam to the river's outlet at the Pacific Ocean (approximately 250 miles long), and extending outward for 0.5 miles from each bank of the river, plus a 0.5-mile-wide corridor from the high water mark surrounding each of the four reservoirs, and all four dams and associated facilities. The effort to identify and assess effects reflects DOI's consideration of the project alternatives and is commensurate with the assessment of other environmental factors. The identification of and potential effect on some historic properties cannot be fully determined prior to approval of either the proposed undertaking or an alternative evaluated in this EIS/EIR. Future decisions regarding implementation of the selected alternative will further develop the APE and identify cultural and historic properties that may be affected by future actions such as road construction or improvements and reservoir drawdown.

DOI identified known historic properties listed or eligible for the National Register, such as the Klamath Hydroelectric Facilities, and also the types of historic properties likely to occur within this area through records searches at the North Central Information Center at California State University, Chico; the Northwest Information Center, Rohnert Park; the North Coastal Information Center, Klamath, California; the Oregon Office of Historic Preservation; the Klamath National Forest; a sacred lands search conducted by the California Native American Heritage Commission; and a review of archaeological, ethnographic, and historic information. DOI also sought information from the SHPOs, Indian tribes, Native American organizations, and the public regarding information about historic resources through the scoping process for the EIS/EIR and the initiation of consultations under Section 106 of the NHPA. This data is presented in Section 3.13.3. The potential effects of the proposed undertaking and the alternatives are discussed in Section 3.13.4.

Consult Regarding the Effects of the Undertaking with Tribes that May Attach Religious and Cultural Significance to Affected Historic Properties:
Tribal consultation for Section 106 was initiated via letters dated October 19, 2010, and June 23, 2011, and continued throughout the NEPA process through correspondence, meetings, government-to-government meetings, emails, and telephone calls. Government-to-government meetings were held with the Karuk Tribe on December 6, 2011; the Quartz Valley Community on January 9, 2012; the Hoopa Valley Tribe on January 10, 2012; the Yurok Tribe on January 11, 2012; the Resighini Rancheria on January 11, 2012; and the Klamath Tribes on March 7, 2012. Tribal consultation is ongoing.

Involve the Public in accordance with the Agency's Published NEPA Procedures
The public has been involved in the scoping process for this EIS/EIR and was provided an opportunity to review and comment on this EIS/EIR. The Shasta Nation and the Shasta Indian Nation were involved in the NEPA process and consultations with both organizations are ongoing.

Develop, in Consultation with Consulting Parties, Alternatives and Proposed Measures that Might Avoid, Minimize, or Mitigate Any Adverse Effects of the Undertaking on Historic Properties
Selection of one of the proposed alternatives, other than the No Action Alternative, would be the first part of a multi-tiered decisionmaking process. The Proposed Action and the alternatives being evaluated in this EIS/EIR will require additional environmental compliance prior to initiation of ground disturbing activities. Section 106 consultation was initiated with ACHP, SHPOs, and other consulting parties, and will be ongoing through a final decision and any future agency decisions. DOI identified known historic properties and methods to further identify and evaluate historic properties. DOI has also sought information from Indian tribes regarding the identification of areas with religious or cultural importance, and this section discusses the potential effect to such resources. Measures to avoid, minimize or mitigate adverse effects are also evaluated in this section. These measures would be offered as binding commitments for future decisions, and will help to coordinate future development through those decisions. The mitigation measures

also serve as a program of action to avoid, minimize, or mitigate the effects on historic properties, through continued consultations under Section 106 of the NHPA, associated with the selected alternative.

Review of Environmental Documents

DOI submitted the Draft EIS/EIR for review and comments to the SHPOs, Tribal Historical Preservation Officers (THPOs), ACHP, Indian Tribes, Native American organizations, and other parties identified as interested parties.

Approval of the Undertaking

The measures to avoid, minimize, or mitigate potential adverse effects associated with the Proposed Action or the selected alternative will be incorporated into the Record of Decision and represent a binding commitment as the selected alternative is carried out.

3.13.2.2 Native American Graves Protection and Repatriation Act (NAGPRA)

Section 3 of NAGPRA applies to Indian human remains and other cultural items found on Federal lands and tribal lands, and addresses the treatment and disposition of those remains and items in consultation with relevant tribe(s) (see Appendix D of NAGPRA). Any Indian human remains or other cultural items found on Federal land or tribal land affected by the Proposed Action and alternatives would be subject to the procedures under NAGPRA.

3.13.2.3 Executive Order 13007 Indian Sacred Sites

In certain instances, Executive Order (EP) 13007 of May 24, 1996, may apply to the proposed alternatives for this undertaking. EO 13007 was signed by President Clinton "to protect and preserve Indian religious practices" and states as follows:

> "**Section 1.** *Accommodation of Sacred Sites.* (a) In managing Federal lands, each executive branch agency with statutory or administrative responsibility for the management of Federal lands shall, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions, (1) accommodate access to and ceremonial use of Indian sacred sites by Indian religious practitioners and (2) avoid adversely affecting the physical integrity of such sacred sites. Where appropriate, agencies shall maintain the confidentiality of sacred sites.
>
> (b) For purposes of this order:
>
> (i) "Federal lands" means any land or interests in land owned by the United States, including leasehold interests held by the United States, except Indian trust lands;
>
> (ii) "Indian tribe" means and Indian or Alaska Native tribe, band, nation, pueblo, village, or community that the Secretary of the Interior acknowledges to exist as an Indian tribe pursuant to Public Law No. 103-454, 108 Stat. 4791, and "Indian" refers to a member of such an Indian tribe; and
>
> (iii) "Sacred site" means any specific, discrete, narrowly delineated location on Federal land that is identified by an Indian tribe, or Indian

individual determined to be an appropriately authoritative representative of an Indian religion, as sacred by virtue of its established religious significance to, or ceremonial use by, an Indian religion; provided that the tribe or appropriately authoritative representative of an Indian religion has informed the agency of the existence of such a site."

3.13.2.4 Archaeological Resources Protection Act of 1979

The Archaeological Resources Protection Act of 1979 (ARPA) (16 U.S.C. 470aa-470mm; Public Law 96-95 and amendments to it) was enacted "…to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands, and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals (Sec. 2(4)(b))." Section 4 of the statute and Sections 16.5-16.12 of the uniform regulations describe the requirements that must be met before Federal authorities can issue a permit to excavate or remove any archaeological resource on Federal or Indian lands. The curation requirements of artifacts, other material excavated or removed, and the records related to the artifacts and materials are described in Section 5 of the act. This section also authorizes the Secretary of the Interior to issue regulations describing in more detail the requirements regarding these collections. These regulations, which affect all federally owned or administered archaeological collections were issued in 1990 as 36 CFR Part 79. The primary impetus behind ARPA was the need to provide more effective law enforcement to protect public archaeological sites. Two improvements over the Antiquities Act, which was the statute designed to provide this protection prior to ARPA's enactment, were more detailed descriptions of the prohibited activities and larger financial and incarceration penalties for convicted violators. Section 6 of the statute describes the range of prohibited actions, including damage or defacement in addition to unpermitted excavation or removal. Also prohibited are selling, purchasing, and other trafficking activities whether within the United States or internationally. Section 6(c) prohibits interstate or international sale, purchase, or transport of any archaeological resource excavated or removed in violation of a State or local law, ordinance, or regulation. Section 9 requires that managers responsible for the protection of archaeological resources hold information about the locations and nature of these resources confidential unless providing the information would further the purposes of the statute and not create a risk of harm for the resources. (Summary taken from http://www.nps.gov/archeology/tools/Laws/arpa.htm.)

3.13.2.5 California Environmental Quality Act

For the purpose of this Klamath Facilities Removal EIS/EIR, California public agencies must consider the effects of their actions on both "historical resources" and "unique archaeological resources." Pursuant to Public Resources Code (PRC) Section 21084.1, a "project that may cause a substantial adverse change in the significance of an historical resource is a project that may have a significant effect on the environment." Section 21083.2 requires agencies to determine whether proposed projects would have effects on "unique archaeological resources."

"Historical resource" is a term with a defined statutory meaning (PRC, Section 21084.1 and State CEQA Guidelines, Section 15064.5 (a), (b)). The term embraces any resource listed in or determined to be eligible for listing in the California Register. The California Register includes resources listed in or formally determined to be eligible for listing in the National Register, as well as some California State Landmarks and Points of Historical Interest.

Properties of local significance that have been designated under a local preservation ordinance (local landmarks or landmark districts) or that have been identified in a local historical resources inventory may be eligible for listing in the California Register and are presumed to be historically or culturally significant for purposes of CEQA unless a preponderance of evidence indicates otherwise (PRC, Section 21084.1 and California Code of Regulations, Title 14, Section 4850).

In addition to assessing whether historical resources potentially affected by a proposed project are listed in the California Register or have been identified as historically or culturally significant in a survey process, Lead Agencies have a responsibility to evaluate them against the California Register criteria prior to making a finding as to a proposed project's impacts on historical resources (PRC, Section 21084.1 and California Code of Regulations, Section 15064.5 (a)(3)). Under California Code of Regulations (CCR), Title 14, Chapter 3, Section 15064.5 (a)(3) a historical resource is defined as any object, building, structure, site, area, place, record, or manuscript that meets the following criteria:

a) Is historically or archeologically significant, or is significant in the architectural, engineering, scientific, economic, agricultural, educational, social, political or cultural annals of California.

b) Meets any of the following criteria:

   (A) Is associated with events that have made a significant contribution to the broad patterns of California's history and cultural heritage.

   (B) Is associated with the lives of persons important in our past.

   (C) Embodies the distinctive characteristics of a type, period, region, or method of construction, or represents the work of an important creative individual, or possesses high artistic values.

   (D) Has yielded, or may be likely to yield, information important in prehistory or history.

Archaeological resources may also qualify as "historical resources" and PRC 5024 requires consultation with the Office of Historic Preservation when a project may affect historical resources located on State-owned land.

For historic structures, CEQA Guidelines Section 15064.5, subdivision (b)(3), indicates that a project that follows the Secretary of the Interior's *Standards for the Treatment of*

Historic Properties with Guidelines for Preserving, Rehabilitating, Restoring, and Reconstructing Historic Buildings, or the Secretary of the Interior's *Standards for Rehabilitation and Guidelines for Rehabilitating Historic Buildings* (1995) shall be considered as mitigating impacts to a less-than-significant level.

CEQA addresses impacts, potentially significant and significant impacts, to historical resources. Historical resources are properties that are either listed on or determined eligible for inclusion on the California Register and significant impacts are defined at CCR Section 15382 as: "…a substantial, or potentially substantial, adverse change in any of the physical conditions within the area affected by the project including land, air, water, minerals, flora, fauna, ambient noise, and objects of historic and aesthetic significance. An economic or social change by itself shall not be considered a significant effect on the environment. A social or economic change related to a physical change may be considered in determining whether the physical change is significant."

As noted above, CEQA also requires Lead Agencies to consider whether projects will affect "unique archaeological resources." PRC Section 21083.2, subdivision (g), states that "'unique archaeological resources' means an archaeological artifact, object, or site about which it can be clearly demonstrated that, without merely adding to the current body of knowledge, there is a high probability that it meets any of the following criteria:

1) Contains information needed to answer important scientific research questions and that there is a demonstrable public interest in that information.
2) Has a special and particular quality such as being the oldest of its type or the best available example of its type.
3) Is directly associated with a scientifically recognized, important prehistoric or historic event or person."

Treatment options under PRC Section 21083.2 include activities that preserve such resources in place in an undisturbed state. Other acceptable methods of mitigation under PRC Section 21083.2 include excavation and curation or study in place without excavation and curation (if the study finds that the artifacts would not meet one or more of the criteria for defining a "unique archaeological resource").

In addition, California law protects Indian human remains and associated cultural items regardless of their antiquity and provides for the sensitive treatment and disposition of those remains. Section 7050.5(b) of the California Health and Safety Code specifies protocol when human remains are discovered. The code states:

> In the event of discovery or recognition of any human remains in any location other than a dedicated cemetery, there shall be no further excavation or disturbance of the site or any nearby area reasonably suspected to overlie adjacent remains until the coroner of the county in which the human remains are discovered has determined, in accordance

> with Chapter 10 (commencing with Section 27460) of Part 3 of Division 2 of Title 3 of the Government Code, that the remains are not subject to the provisions of Section 27492 of the Government Code or any other related provisions of law concerning investigation of the circumstances, manner and cause of death, and the recommendations concerning treatment and disposition of the human remains have been made to the person responsible for the excavation, or to his or her authorized representative, in the manner provided in Section 5097.98 of the Public Resources Code.

California Health and Safety Code at Sections 8010-8011 established the California NAGPRA 2001. The State repatriation policy is consistent with and facilitates implementation of the Federal NAGPRA. The California act strives to ensure that all California Indian human remains and cultural items are treated with dignity and respect by encouraging voluntary disclosure and return of remains and cultural items by publicly funded agencies and museums in California. The act also provides a mechanism for aiding California Indian Tribes, including non-federally recognized tribes, in filing repatriation claims and obtaining responses to those claims.

CCR Section 15064.5, subdivision (e), requires that excavation activities be stopped whenever human remains are uncovered and that the county coroner be called in to assess the remains. If the county coroner determines that the remains are those of Indian Tribes, the Native American Heritage Commission must be contacted within 24 hours. At that time, the Lead Agency must consult with the appropriate Indian Tribes, if any, as identified by the Native American Heritage Commission. CCR Section 15064.5 directs the Lead Agency, under certain circumstances, to develop an agreement with the Indian Tribes for the treatment and disposition of the remains.

In addition to the mitigation provisions pertaining to the accidental discovery of human remains, the State CEQA Guidelines also require that a Lead Agency make provisions for the accidental discovery of historical or archaeological resources, generally. Pursuant to CCR Section 15064.5, subdivision (f), these provisions should include “an immediate evaluation of the find by a qualified archaeologist. If the find is determined to be an historical or unique archaeological resource, contingency funding and a time allotment sufficient to allow for implementation of avoidance measures or appropriate mitigation should be available. Work could continue on other parts of the building site while historical or unique archaeological resource mitigation takes place.”

Burials would be subject to Federal NAGPRA on Federal land and Indian land, California State burial laws in California, and Oregon State burial laws in Oregon.

3.13.3 Existing Conditions/Affected Environment

The presence of historic properties (or historical resources under CEQA) within the APE for each alternative was identified by conducting background and archival research and consulting with parties with knowledge of the area to identify known resources. In addition, through archival and background research, consultations, and knowledge of

known resources, the types of historic properties likely present in inaccessible areas (primarily areas currently inundated by the reservoirs) were identified.

Due to the nature of the action being proposed, potential effects on all historic properties cannot be fully determined prior to approval of either the Proposed Action or an alternative evaluated in this EIS/EIR. The identification and evaluation of certain resources, and the potential effects to those resources, can only be understood and addressed as particular details of how to carry out the selected alternative are developed. One particular example is historic properties and cultural resources that are thought to be currently under water that could be exposed during reservoir draw down, as a direct result of dam removal. Another example is the construction or modifications to related facilities, roads, or temporary systems that may be necessary to implement the selected alternative, which will only be known when DOI develops particular details for accomplishing the proposed alternative. As specific details are developed through designs and plans to implement the selected alternative, the designated Federal officials will conduct additional steps to identify and evaluate historic properties and alternatives to avoid, minimize, or mitigate adverse effects, in consultation with the consulting parties, in accordance with 36 CFR Part 800 and the stipulations identified in this EIS/EIR.

3.13.3.1 Regional Prehistory and Ethnography

The cultural resources area of analysis includes four culture areas; the Columbia Plateau, Great Basin, California, and Northwest Coast. These culture areas have unique histories and are occupied by different Native American cultures that exhibit diverse traits and ecological adaptations. The cultural resources analysis will focus on The Klamath Tribes, Shasta, Karuk, Hoopa, and Yurok peoples that occupy the territory along and adjacent to the Klamath River. These people have a long history of occupation of the area and traditional beliefs identify that the groups have occupied the area for time immemorial.

3.13.3.1.1 Columbia Plateau and Great Basin Culture Areas

Prehistory

The upper Klamath River and Klamath Lakes area exhibit a blend of cultural traits from the Columbia Plateau and Great Basin culture areas. The chronology of the area may be organized into the Paleoarchaic, Early Archaic, Middle Archaic, Late Archaic, and Late Prehistoric periods.

Paleoarchaic (14,000 to 7,000 Before Present [BP])

During the Paleoarchaic period, the Klamath Basin was occupied by hunter-gatherers that tended to focus on hunting large game animals, but also supplemented their diet with fish, birds, and plant resources. These groups were seasonally mobile and generally small in size (Ames et al. 1998). Two of the oldest sites in the region are Paisley Cave, which is dated at 14,200 BP (Balter 2008) and Fort Rock Cave, which is dated between 13,200 and 10,200 BP (Aikens and Jenkins 1994). The oldest site in the upper Klamath River area is the Klamath Shoal midden site, 35KL21, which yielded a date of 7,700 BP.

Early Archaic (7,000 to 4,500 BP)

Most of the archaeological evidence for early human occupation in the Klamath River Canyon dates to the beginning of the Early Archaic period (Mack 1983 and 1991). Semi-subterranean house pits first appear in the Plateau region during this period suggesting that some people were adopting a less mobile lifestyle. Typical artifacts associated with the Early Archaic include large stemmed, lanceolate, or leaf-shaped projectile points, knives, gravers, scrapers, and some cobble and ground stone tools (e.g., abraders or grinding slabs, mortars, mullers, and stone bowls).

Middle Archaic (4,500 to 2,500 BP)

The Middle Archaic period is characterized by an increase in the exploitation of riverine and marsh environments and food resources such as salmon and various plant roots/tubers. There was also an increase in the use of milling stones and pestles at sites during this period. Typical Middle Archaic artifacts include broad-necked, corner-notched, and side-notched projectile points, many types of ground stone tools, bone and antler tools (e.g., chisels and wedges), and specialized fishing gear (e.g., bone harpoon barbs and net sinkers).

Late Archaic/Late Prehistoric (2,500 to 200 BP)

Several major cultural changes occurred during the Late Period, including: the widespread appearance of pit houses; a shift to a heavy reliance on fishing; the use of storage pits for salmon; camas exploitation; the development of seasonal land use patterns (i.e., use of “winter villages”); the appearance of the bow as evidenced by the presence of small corner- and side-notched projectile points at sites; and the appearance of Olivella shell beads. Extensive trade networks became important across the region by as early as 1,500 years ago, as suggested by tools made from obsidian sources 110 to 120 miles away and the presence of beads made from marine shells.

Ethnography

The Klamath Tribes were constituted as a result of the Klamath Treaty of 1864, later ratified by Congress, and includes the Klamath, Modoc, and Yahooskin Band of Snake Indians. Prior to their placement on a shared reservation, these groups utilized overlapping resource areas in the Klamath Basin. When these groups were forcefully placed on the same reservation, they began to become more integrated. The Klamath and Modoc people occupy the entire upper Klamath Basin and adjacent interior drainages to the east, living in close association with the marsh and riverine resources of this area. The Klamath and Modoc tribes were the only populations residing in the Upper Klamath Basin prior to Euro-American contact, but they participated in salmon fishing and social gatherings along the Klamath River at least as far downstream as Seiad Valley in California. The Yahooskin principally occupy lands east of the Klamath Basin, but did participate in resource harvests, including salmon harvests, with Klamath and Modoc on the Sprague River and other Klamath River tributaries. The discussion of The Klamath Tribes will focus on the Klamath and Modoc because of their close proximity to the APE.

Stern (1998) summarizes ethnographic information regarding the Klamath Tribe collected by Barrett (1910), Spier (1930), and Berreman (1937). Deur (2011) also

presents a summary of the ethnography of the Klamath Tribes and their relationship to the Klamath River. The Klamath and Modoc are members of the Plateau Penutian language family and they speak dialects of a single language (Stern 1998). Klamath ancestral territory stretches from the southern boundary of the Deschutes River watershed in the north to Shovel Creek, which is along the Klamath River south of the Oregon and California border and from the Cascade Mountains in the west to the escarpment of Winter Rim in the east (Stern 1998). This area encompasses the Sprague River and Sycan Rivers, Sycan Marsh, Klamath Lake, and Klamath Marsh (Spier 1930; Berreman 1937). Modoc ancestral territory extends from Mount Shasta in the south to an area near the current California and Oregon border in the north and from the eastern slope of the Cascade Range near Mount Shasta to the area around Goose Lake in the east (Ray 1963). This area encompassed Lower Klamath Lake and Tule Lake.

Klamath and Modoc were both organized in villages that collectively owned productive fishing or other resource (e.g., seed or other plants) gathering areas. Influential heads of households, supported by extended families, assumed leadership roles in the villages (Stern 1998). Villages included various types of structures including semi-subterranean winter lodges for families and extended families. The Klamath and Modoc rebuilt their winter lodges in the fall. Spier (1930) identified five geographic subdivisions of winter villages:

- Klamath Marsh-Williamson River group on the southern margin of Klamath Marsh and the Lower Williamson and Sprague rivers (about 34 villages, plus four to five villages on the upper Sprague and Sycan rivers).
- Agency Lake group on Agency Lake and the northern arm of Klamath Lake (one village and one hamlet).
- Lower Williamson River group close to the mouth of Williamson River (about seven villages).
- Pelican Bay group that includes the Pelican Bay district on the west side of Klamath Lake, Four Mile Creek, and the marsh north of the lake (about eight villages).
- Klamath Falls group: along Klamath Lake south of Modoc Point (about 14 villages).

The permanent winter villages were never totally abandoned during the year. Each group of villages maintained one or more places for cremation of the dead. The ashes of cremated individuals were covered with soil and rocks. Individuals dying away from home might be interred under piles of rocks or cremated and returned to the cremation ground. Particular sweat houses, said to have been built by the legendary *Kemu'kumps*, and a hot spring were used to cleanse mourners.

Fish is the primary resource for the Klamath and Modoc; consequently settlements clustered near rivers and streams. Runs of fish began in the early spring and lasted into the fall (Spier 1930). Men, with some assistance from women, fished throughout the year from the banks of rivers or streams or from canoes using long-handled dip nets, spears,

harpoons, and hook-and-line. During parts of the year, fish drives were also used to harvest fish. Members of the tribe would drive fish toward individuals dragging triangular nets on A-frames or purse nets through the water either on foot or from a canoe. Gill nets drawn between canoes and traps were also used to acquire fish. In addition, stone barriers were constructed on some streams to restrict fish passage and facilitate fishing.

Klamath and Modoc typically left their winter villages in early spring to begin a seasonal round of harvest activities. Spring activities began with harvesting fish from the run of large suckers that took place in Upper Klamath Lake in March. Fish were dried on the branches of pine saplings and sometimes pounded into a meal and bagged for storage. As the spring sucker run subsided, Klamath and Modoc women turned their attention to digging ipos (*Carum oregonum*) roots, gathering waterfowl eggs, and scraping the cambium layers of young ponderosa pines for food. By late spring, women dug camas bulbs in wet meadows, baking them in earth ovens and sun-drying them for storage while men hunted waterfowl and other animals.

Summer was the season when women harvested wocas, the nutritious seeds of the yellow pond lily, at Klamath Marsh, Sycan Marsh, Tule Lake, Lower Klamath Lake, and other water bodies. Wocas were an important food resource and shaman conducted a ceremony at the beginning of the harvest. The seeds were processed for soup and flour. Women also collected cattail roots for drying and grinding into meal. During the summer months men hunted waterfowl and a variety of small mammals.

In fall, Klamath and Modoc gathered chokecherries, serviceberries, Klamath plums, pine nuts, blackberries, and gooseberries. Klamath and Modoc eventually moved into the high country of the western Cascades to harvest huckleberries. Women dried the berries before fires, while men hunted deer and elk and trapped furbearing mammals. Deer hunting methods included stalking and driving the animals into the lakes, rivers, or confined spaces where they could be clubbed by women in canoes or shot with bows and arrows. Whitefish were also harvested in the fall primarily by the use of dip-nets.

Klamath and Modoc sought power by visiting places where they believed that sacred beings resided and sought to gain their power through ritualized activities. Klamath and Modoc parents sent boys and girls on a power quest when they reached puberty. Fathers and mourning kinsmen sometimes sought power at the birth of a child or death of a wife or child (Stern 1998). Seekers of power often sought specific competence such as luck in hunting or fishing, war, love-making, gambling, foot-racing, or curing. Seekers of power went alone into the mountains for 5 days to fast, pile rocks, wrestle with trees, run, perhaps take sweat baths, and climb hills. Power might come in the form of a dream or a visit by a spirit, which would be followed by the seeker waking with blood in his mouth or nose and a personalized spirit song in his ears.

Shamans, mourners, and gamblers also sought power by swimming in deep river eddies. During the day, the seeker sweated and fasted, waiting in the brush until nightfall. At that time the power seeker went to the river and dove to the bottom in search of a spirit.

The seeker did not appear to be frightened even if he saw something moving under the water. Similar to other power seeking events, it is reported that sometimes a seeker surfaced from the bottom of the river unconscious, with blood flowing from his mouth and/or nose (Spier 1930).

Shamans performed important ceremonies in midwinter gatherings, first-fruit rites for wocas gathering, and other occasions. They also cured illnesses and provided spiritual and practical support during warfare. Novice shamans received their initiation as a group at midwinter ceremonies. Helpers worked with shamans over a 5-day period during the ceremonies to call spirits, interpret spirit messages, and lead the audience in singing sacred songs.

EuroAmerican expansion into Klamath and Modoc territory had a dramatic effect on their traditional cultural practices. Regardless, The Klamath Tribes exhibited considerable and well-documented persistence in their ceremonial and social traditions, particularly as they related to site-specific and resource-specific traditions. However, in 1954 Congress terminated the reservation and its trust relationship with The Klamath Tribes. The Klamath Tribes retained some rights to resources, but a majority of the tribal members withdrew from the tribe and received a portion of the tribal holdings. The trust account created for the rest of the members was later liquidated. In addition, in 1974 the Federal Government condemned thousands of forest acres that had been part of the Klamath Reservation so that the forest land could be added to the Winema National Forest (Klamath Tribes 2003).

The Klamath Tribes accomplished restoration of Federal recognition in 1986 and began to rebuild their tribal government, economy, and community. Currently, the tribal Culture and Heritage Department is working to protect, preserve, and enhance traditional cultural values (Klamath Tribes 2003). The Klamath Tribes are also pursuing a variety of economic enterprises through their Economic Self-Sufficiency Plan. (Refer to Section 3.12 Tribal Trust for additional information on traditional and current lifeways and the history of Federal recognition.)

3.13.3.1.2 Northern Interior California Culture Area

Prehistory

Previous archaeological investigations near the area of analysis were conducted in response to hydroelectric developments and highway construction projects beginning in the 1940s. The more recent investigations of Basgall and Hildebrandt (1989) and Cleland (1997a, 1997b) are the most relevant to this analysis because it is likely that the subsistence and settlement patterns they identify are similar to the patterns along the Klamath River in California.

Basgall and Hildebrandt (1989) propose a three-phase cultural chronology for the northern Sacramento River Canyon that includes the Pollard Flat Phase (2,700–5,300 BP), the Vollmers Phase (1,700–4,500 BP), and the Mosquito Creek Phase (1,900 BP to contact). The Pollard Phase appears to represent a forager population that occupied residential base camps for extended periods of time, and is characterized by

relatively large projectile points, ground stone tools, anvils, mauls, and net weights. The Vollmers Phase represents populations that were more mobile than those of the previous phase, while still maintaining residential camps, and are characterized by medium size projectile points, ground stone tools, anvils, mauls, and net weights. The Mosquito Creek Phase populations consisted of small groups that practiced a pattern of seasonal transhumance, and are characterized by small projectile points, ground stone tools, and the absence of hand stones, milling stones, hammer stones, anvils, mauls, and net weights.

Cleland's (1997a, 1997b) chronology for the Lake Britton area is divided into six periods spanning 7,000 years. The six periods include: Paleo-Indian (prior to 7,500 BP; Early Archaic-A (5,000–7,500 BP); Early Archaic-B (3,900–5,000 BP); Middle Archaic-A (3,000–3,900 BP); Middle Archaic-B (2,000–3,000 BP); Late Archaic (1,000–2,000 BP); and Emergent (150–1,000 BP).

The Paleo-Indian Period is poorly represented and indicates sporadic use of the area. The Early Archaic-A Period reflects an intensification of use of the area. Sites associated with this period are usually on mid-slope terraces and tend to be situated some distance from the Pit River. The Early Archaic-B Period reflects increased occupation of the area. Sites still tend to be situated on terraces and benches above the Pit River, but freshwater mussel shells appear at sites suggesting the exploitation of riverine resources.

The Middle Archaic-A Period is highlighted by a continued increase in the intensity of use of the area and a diversification of the overall settlement pattern. Occupation of the higher terraces above the Pit River continues, but habitation sites also occur closer to the river. The diversified settlement pattern of the Middle Archaic-A Period continues during the Middle Archaic-B Period, but there is increased occupation of sites near the

Pit River. The Late Archaic-A Period is characterized by an increase of more riverine sites. This pattern continues into the Emergent-A Period during which occupation of riverine sites intensifies.

Ethnography

Silver (1978) summarizes ethnographic information regarding Shasta collected by Dixon (1907), Voegelin (1942), and Holt (1946). Shasta territory extended north to a point about 20 miles north of Ashland, Oregon, including the Rogue River; south to Mt. Shasta; west to Seiad Valley on the Klamath River, southwest to New River; and east to Beswick (Silver 1978). Shasta groups are members of the Hokan language family.

There are several groups of Shasta that exhibit different cultural traits. Information presented here focuses on the Klamath River Shasta, called the Wiruhikwaiiruka or Kammatwa (Daniels 2003). Shasta were organized into autonomous tribelets consisting of extended family groups that occupied a group of villages. The family was the basic social unit of the Shasta, with the village being the political and economic unit. Each village had a chief, whose position was usually hereditary, to provide leadership and organize important social, political, and economic events (Silver 1978). Shamans

conducted a variety of ceremonies in villages, and Shasta considered Mount Shasta to be sacred ground that was used for healing, blessing, and ceremonies. Mount Shasta is a significant part of Shasta traditions and ceremonialism.

Shasta along the Klamath River tended to build their winter villages near the river. Villages had recognized territories with areas for each family, including fishing places with fish weirs along the Klamath. Hunting territories also were held privately over the long term, in contrast to tobacco-growing plots and acorn-gathering trees, which were claimed only for brief periods. Typical villages consisted of brush shelters, bark houses, sweathouses, assembly houses, and winter houses (Silver 1978).

During the spring and summer, Shasta established temporary hunting and gathering camps in the foothills and mountains to exploit seasonally available resources in those ecological zones. Shasta relied on a subsistence pattern emphasizing gathering, hunting, and fishing, and exploited a variety of plant and animal resources as they became seasonally available. For example, resources used by the Shasta included deer, brown bear, rabbit, a variety of small mammals, fish, birds, insects, acorns, buckeye, pine nuts, manzanita berries, and a variety of other plants. Acorns were a staple of the Shasta diet. Regardless of the variety of resources available to the Shasta, the primary components of their diet were deer, Chinook salmon, and acorns (Dixon 1907; Silver 1978).

Individual hunters and communal hunting parties hunted deer using bows and arrows, snares, dogs, and drives (e.g., driving deer over cliffs). Waterfowl and quail were taken using nets, snares, and traps (Moratto 1984). Spring and fall salmon runs were important fishing times for the Shasta. Fishing techniques included using set, dip, and long flat seine nets, basket traps, weirs, hook and line, and spears. In the spring Klamath River Shasta waited to catch salmon until a member of another Shasta group called the Kammatwa caught the first fish and performed a ritual. Klamath River Shasta could then catch and process the fish for storage but could not eat them until the Karuk performed the White Deerskin Dance ceremony. Salmon and trout were sun dried and stored in baskets for winter consumption (Silver 1978). Women and children also dove for mussels in the Klamath River during the spring.

Shasta traded pine nuts, obsidian blades, and juniper beads with their neighbors for obsidian from the Achumawi; pine nut necklaces from the Wintu; canoes from Karuk and Yurok; acorns, baskets, dentalia shells, haliotis shells, and other shells from the Karuk, Hoopa, and Yurok; and beads from Wintu (Silver 1978). Shasta also acted as a middleman for the Achumawi, who acquired dentalia shells from groups in the Columbia River area. In addition, Shasta occasionally attended Karuk, Hoopa, and Yurok dances.

EuroAmerican settlement of the study area accelerated as a result of the Gold Rush. Conflicts between Indian Tribes and EurAamericans resulted in the Rogue River Indian Wars of 1850-1857 that pushed Shasta from their traditional fishing, hunting, and village sites. A treaty in 1851 established a reservation in Scott Valley for Shasta, but conflict between EuroAmericans and Shasta persisted. Consequently, in the 1870s Shasta welcomed cultural revivalist movements such as the Ghost Dance. From the 1870s

through the 1940s most Shasta in the APE lived at the Frain Ranch or Bogus Tom Smith's Rancheria (Daniels 2003) and continued to practice their traditional subsistence activities. Currently, Shasta are attempting to preserve, protect, and maintain traditional cultural practices, including sites associated with those practices.

3.13.3.1.3 Northwest California Culture Area

Prehistory

Fredrickson (1973) identified six patterns or modes of adaptation (i.e., Post, Borax Lake, Berkeley, Mendocino, Gunther, and Augustine Patterns) for northwest California and the North Coast Ranges and assigned them to six time periods: Paleo-Indian (10,000–6,000 B.C.); Lower, Middle, and Upper Archaic (6,000 B.C.–A.D. 500); and Upper and Lower Emergent (A.D. 500–1800) periods. The patterns applicable to northwest California are the Post, Borax Lake, Mendocino, and Gunther.

The Post Pattern (12,000–8,000 BP) represents the earliest occupation of the area and is characterized by fluted, concave-base projectile points and crescents. Regardless, archaeological sites with well-defined assemblage of typical Post Pattern artifacts are not well represented in northwest California.

The Borax Lake Pattern (8,000–2,500 BP) represents a generalized hunting and gathering subsistence pattern. It is characterized by heavy, wide-stemmed points with indented bases, serrated bifaces, ovoid tools, hand stones, and milling slabs (Hildebrandt 2007). The Borax Lake Pattern is identified at sites across a wide variety of environments in Humboldt and Trinity Counties. For example, sites CA-HUM-567 and CA-HUM-367 are along Pilot Ridge and South Fork Mountain and site CA-TRI-1008 is along a river terrace adjacent to the Trinity River. Site CA-HUM-567 includes a house floor and post holes dated at 6,000 BP.

The Mendocino Pattern (5,000 BP–AD 500) appears to represent a hunting and gathering subsistence pattern that is well adapted to local environments and typically exploits seasonally available resources across different ecological zones. It is characterized by side-notched, corner-notched, and concave base dart points, hand stones, milling slabs, and in some cases small numbers of cobble mortar and pestles. The Mendocino Pattern is not clearly defined in northwestern California, but it has been identified at sites such as CA-DNO-11 at Point St. George, CA-DNO-1 and CA-DNO-26 along the Smith River, CA-HUM-351 in Humboldt Bay, and CA-HUM-538, -588, and -595 in the northern mountains of Humboldt County (Hildebrandt 2007).

The Gunther Pattern (Post A.D. 500) appears to be associated with the exploitation of marine and riverine resources. It is characterized by Gunther barbed projectile points, concave based points used for composite harpoons, spears, hooks ground and polished stone artifacts, flanged pestles, notched net sinkers, and steatite bowls. Sites representing the Gunther Pattern in Del Norte and Humboldt Counties that are associated with exploitation of marine mammals and fish include sites CA-DNO-11, CA-HUM-129, -118, and -67 (Hildebrandt 2007). The Gunther Pattern appears to represent the earliest evidence of subsistence patterns associated with the exploitation

of marine mammals and fish that is typical of the Yurok, Hoopa, and Karuk that currently inhabit northwest California and the Klamath Basin.

Ethnography

Karuk

Bright (1978) summarizes ethnographic information regarding Karuk primarily from information presented by Gifford (1939a, 1939b, and 1940) and Kroeber and Barrett (1960). Karuk occupy territory west of the Shasta, which stretches along the middle part of the Klamath River near the western boundary of Siskiyou County from Seiad to Bluff Creek just west of Orleans (Bright 1978). The Karuk Tribe has been federally recognized since 1979 and occupies territory along the middle section of the Klamath River. Karuk are members of the Hokan language family (Bright 1978). Karuk share similar cultural traits with the Yurok and Hoopa and regularly interact with each other.

Karuk were organized in villages with a relatively loose political structure. The acquisition of wealth is an important part of Karuk culture, and wealthy men assumed leadership roles because of their prestige. Villages varied in size and consisted of rectangular cedar plank houses and sweat houses. Karuk focused on the exploitation of fish and aquatic resources, but other terrestrial resources were also important supplements to their diet. Karuk also harvested acorns and hunted in upland areas around the Klamath River for deer, elk, birds, and fur bearing mammals. The hides of mammals were used for a variety of clothing and bird feathers and pelts were used for ceremonial regalia.

Plentiful fish resources facilitated the occupation of numerous villages along the Klamath and Salmon Rivers (i.e., Salter [2003] reports that 100 villages existed along the two rivers). The villages were in advantageous locations on bends of the Klamath River and bluffs above it, such as near the mouths of Camp Creek (Tishaniik), the Salmon River (Mashuashav), and Clear Creek (Inam).

Karuk tools reflect their emphasis on the acquisition of fish and other aquatic resources and include harpoons, nets, and hooks. Facilities constructed to harvest fish include weirs, dams, and fishing platforms. Karuk also constructed canoes from hollowed out logs for fishing and transportation along the Klamath River and its tributaries. Transportation along the river and streams was essential to Karuk ceremonial activity. Indeed, Karuk traditions state that the Klamath River was created to facilitate their interaction with Yurok and Hoopa and with salmon.

The political and social organization and material cultural of the Karuk are important topics, but their religious and ceremonial practices highlight their relationship to the Klamath River and its associated resources. Of particular importance are world renewal ceremonies and ceremonies for bountiful harvests of fish and other resources (Bright 1978). World renewal ceremonies include the White Deerskin and Jump ceremonies at which the earth and the creator are honored for providing food and facilitating the prosperity of the tribes. These ceremonies were and continue to be conducted at sites along the Klamath River such as Panaminik (Drucker 1936). Ceremonies to insure harvests of fish include the First Fish, First Salmon, and Fish Dam ceremonies. Other

ceremonies related to world renewal and curing are the Boat Dance and the Brush Dance. Karuk, Hoopa, and Yurok regularly attend each other's ceremonies and the ceremonies are conducted for the benefit of all the groups.

The White Deerskin and Jump ceremonies honor the earth and the creator for providing food resources and maintaining the tribes. The White Deerskin ceremony is held from late August into September, depending on the river and its waters. The Jump ceremony is conducted after the conclusion of the White Deerskin ceremony and is also held for the "good" of the world. Both the White Deerskin and the Jump ceremonies depend on a healthy Klamath River system for fish, basket materials, and bathing. The First Fish ceremony is conducted in spring and the Fish Dam ceremony is conducted to in mid-summer to celebrate the harvesting of fish and to pray for continuing prosperity and access to subsistence resources, primarily fish resources. The Boat ceremony forms part of the White Deerskin ceremony, celebrating the flows and health of the rivers. The Brush Dance is held to cure the sick, particularly children.

EuroAmerican settlement in the area of analysis accelerated as a result of the California Gold Rush. Conflicts between Indian Tribes and EuroAmericans were commonplace across Karuk territory. Consequently, Karuk welcomed cultural revivalist movements in the 1870s such as the Ghost Dance, but traditional cultural practices and numbers of Karuk continued to decline. Regardless, the Karuk persisted and contemporary Karuk continue to practice their traditional activities and are actively engaged in programs related to improving the health of the Klamath River and its fishery. (Refer to Section 3.12 Tribal Trust for additional information on traditional and current lifeways and the history of Federal recognition).

Quartz Valley Community

Most of the Quartz Valley Community includes descendants of people of Karuk ancestry, although a few members are also of Shasta ancestry. Their cultural history is similar to that described for the Karuk. The Quartz Valley Community is a federally recognized tribe representing people of middle Klamath (Karuk) and Shasta Indian ancestry. Their reservation is near the community of Fort Jones.

Yurok

Pilling (1978) summarizes ethnographic information regarding Yurok collected by Waterman (1920), Waterman and Kroeber (1934), and others. Sloan (2004, 2011) also presents a summary of the ethnography of the Yurok and the relationship to the tribe to the Klamath River. Yurok are members of the Algonquian language family. Yurok ancestral territory extends along the Pacific coast of California from Crescent City in the north to Trinidad in the south and along the Klamath River from the coast to a point near the confluence of the Klamath and Trinity Rivers and the town of Weitchpec (Pilling 1978). The Yurok Tribe's reservation consists of a strip of land beginning at the Pacific Ocean and extending a mile along each side of the Klamath River a distance of about 45 miles upriver, just above the confluence of the Klamath and Trinity rivers. The Yurok life, language, ceremonies, society, and economy are linked with the Klamath River. There are Yurok stories that reinforce the Yurok belief that the River was created in a

distinct way in order to provide Yurok people with the best of worlds (Sloan 2004, 2011). Yurok refer to the river as *HeL kik a wroi* or "watercourse coming from way back in the mountains". Contemporary Yurok often refer to the Klamath River as the "Yurok Highway" emphasizing its comparison to a blood vessel that provides the main flow of sustenance. Indeed, Karuk, Yurok, and Hoopa share similar cultural traits and traditional stories state that the Klamath River was created to facilitate their interaction with each other and with salmon.

Yurok were organized into villages and districts with a relatively loose political structure (Pilling 1978). The acquisition of wealth is an important part of Yurok culture, and wealthy men assumed leadership roles in the village, district, and family. Villages varied in size and consisted of rectangular cedar or redwood plank houses and sweat houses. Pilling (1978) cites 44 villages, 97 fishing spots, 82 significant cultural places (e.g., places used for ceremonies, gathering, and hunting), and 41 places of cultural significance along the Klamath River.

Yurok focused on the exploitation of fish and aquatic resources, but other terrestrial resources were also important supplements to their diet. Yurok harvested acorns and hunted in upland areas around the Klamath and Trinity River for deer, elk, birds, and fur bearing mammals. The hides of mammals were used for a variety of clothing and bird feathers and pelts were used for ceremonial regalia.

Yurok tools reflect their emphasis on the acquisition of fish and other aquatic resources and include harpoons, nets, and hooks. Facilities constructed to harvest fish include weirs, dams, and fishing platforms. Yurok also constructed canoes for fishing and transportation along the Klamath and Trinity Rivers and their tributaries. Transportation along the rivers and streams was essential to Yurok ceremonial activity.

One of the most important aspects of Yurok technology was the river- and ocean-going canoe or yoch, which were carved from selected redwood trees (Sloan 2004, 2011). The Yurok ocean-going canoe was from 30 to 40 feet in length, 6 to 8 feet in width and 3 feet deep. It could haul up to five tons of cargo (e.g., seal carcasses) and was customarily paddled by 5 to 20 paddlers and an oarsman who steered the boat from the back. There are historic accounts of expeditions traveling 180 miles along the coast (Sloan 2004, 2011). A typical river canoe measured 16 to 20 feet in length and 3 to 4 feet in width. River canoes were customarily paddled and/or pushed with a long pole. Yurok technology and facilities do not only serve utilitarian functions, but also include ceremonial aspects of Yurok culture. For example, facilities, such as fish weirs, were created specifically to signify the time of sacred ceremonies (e.g., the Deerskin and Jump ceremonies).

Fishing places along the Klamath River were owned by individuals, families, or groups of individuals. Fishing places were borrowed, leased, inherited, or bought and sold (Sloan 2004, 2011). Some ownership rights at fishing places depended on species of fish caught at the site, while others depended on the water level (i.e., individuals owned the right to fish at a place if the river was below or above a certain level). Yurok still

recognize this traditional form of resource management and use of the river. Families and individuals continue to use and own rights to fishing places on the Klamath River.

Like the Karuk, the religious and ceremonial practices highlight the Yurok's relationship to the Klamath River and its associated resources. Of particular importance were the Jump, Deerskin, Boat, and Brush ceremonies. The Jump and Deerskin ceremonies were held in late fall to give thanks for food resources abundance collected during the year and to insure a continued abundance of food resources for the next year (Sloan 2004, 2011).

Affluent individuals and religious leaders conducted most ceremonies, and wealthy individuals were expected to feed salmon to everyone attending the ceremonies. The Boat Ceremony was part of the Deerskin Ceremony. In this ceremony, several boats filled with participants traveled down the Klamath River. The participants thanked the river for continuing to flow and provide resources. The Brush Ceremony unfolded over a four-day period and highlighted the importance of Klamath River resources to Yurok. For example, baskets made of plant materials collected at the water's edge were used to hold food and ceremonial medicine; acorns were cooked in the baskets using hot rocks gathered at specific river bars; ceremonial regalia was made from various plant and animals that live along the river; ceremonial bathing was performed; and participants listened to the sounds made by the Klamath River.

The social and ceremonial significance of the Klamath River is evident in and reinforced by Yurok traditions. For example, there are at least 77 Yurok stories that make direct reference to the Klamath River (Sloan 2004, 2011). These Yurok stories reinforce the belief that the Klamath River was created to provide Yurok with a very good place to live.

Spanish explorers and vessels traveling from the Philippines may have interacted with Yurok along the coast in the late 1700s. Other explorers such as Peter Skene Odgen and Jedediah Smith certainly encountered Yurok along the Klamath River in the early 1800s. Regardless, EuroAmerican settlement and use of Yurok territory did not begin until after the discovery of gold in California. As a result of the discovery of gold in the Trinity River, gold prospectors inundated the region affecting Yurok traditional culture (Pilling 1978).

In 1851 a "Treaty of Peace and Friendship" was signed between the United States Government and the Klamath River Indians, but the United States Congress did not ratify this treaty. Subsequently, on November 16, 1855, the Klamath River Reserve, also known as the Klamath Indian Reservation, was established by Executive Order. The Order designated the reservation lands from the mouth of the Klamath River, one mile on each side extending approximately 20 miles upriver to Tectah Creek (Sloan 2004, 2011).

Escalating conflict between Yurok and EuroAmericans during the 1860s and 1870s over encroachment onto the Klamath Indian Reserve resulted in the gradual displacement of Lower Klamath Indians further upriver (Sloan 2004, 2011). EuroAmericans on the reserve resisted attempts to remove them, including eviction in 1879 by the United States

Army (Sloan 2004, 2011). After decades of struggle to regain their traditional homelands, the Yurok Tribe was re-organized and was granted its own reservation in 1988. As a result of the 1988 Hoopa-Yurok Settlement Act (PL-100-580), the Yurok Indian Reservation was established.

The ancestral lands of the Yurok Tribe extend unbroken along the Pacific Ocean coast (including usual and customary off-shore fishing areas) from Damnation Creek, its northern boundary, to the southern boundary of the Little River drainage basin, and unbroken along the Klamath River, including both sides and its bed, from its mouth upstream to and including the Bluff Creek drainage basin. The Yurok Tribe considers cultural resources sites along and associated with the Klamath River to be part of a larger ethnographic riverscape (Yurok Tribe 2012). Sites include over a thousand fishing holes; a fish dam (weir) site; many different types of gathering sites, including willow for basket weaving; complex trail systems that connect villages, camps, the river, prayer sites, gathering areas, and other Tribes; forty-seven villages; and graves/cemeteries. Uses of these sites include subsistence, habitation, medicinal, religious, and ceremonial purposes.

The Yurok Tribe is the largest tribe in California, with over 4,500 enrolled tribal members and over 200 tribal government employees. The Yurok Tribe is actively pursuing economic development and resource management both on the reservation and Yurok ancestral lands, including a fisheries program. (Refer to Section 3.12 Tribal Trust for additional information on traditional and current lifeways and the history of Federal recognition.)

Resighini Rancheria

The federally recognized Resighini Rancheria is located on the southern banks of the Klamath River, completely surrounded by the Yurok Reservation. The tribe is composed of Yurok Indians; therefore, their cultural history is the same as for the Yurok culture. (Refer to Section 3.12 Tribal Trust for additional information on traditional and current lifeways and the history of Federal recognition.)

Hoopa

Wallace (1978) summarizes ethnographic information regarding Hoopa primarily collected by Goddard (1903). Hoopa are members of the Athabascan language family. Hoopa ancestral territory is centered in Hoopa Valley and the area surrounding the Trinity River near its confluence with the Klamath River. Hoopa, Karuk, and Yurok share similar cultural traits and regularly interact with each other.

Hoopa were organized in villages with a relatively loose political structure. Villages typically consisted of family groups (Wallace 1978). Villages varied in size and consisted of rectangular cedar plank houses. Hoopa focused on the exploitation of fish and aquatic resources, but other terrestrial resources were also important supplements to their diet. Hoopa also harvested acorns and hunted in upland areas around the Trinity and Klamath River for deer, elk, birds, and fur bearing mammals. The hides of mammals were used for a variety of clothing and bird feathers and pelts were used for ceremonial regalia.

Hoopa tools reflect their emphasis on the acquisition of fish and other aquatic resources and include harpoons, nets, and hooks. Facilities constructed to harvest fish include weirs and dams. Hoopa used canoes for fishing and transportation along the Trinity and Klamath Rivers, but obtained their canoes from the Yurok. Transportation along the river and streams was essential to Hoopa ceremonial activity. Indeed, Hoopa believe that the Klamath River was created to facilitate their interaction with Yurok and Karuk and with salmon.

Like the Karuk and the Yurok, the Hoopa's religious and ceremonial practices highlight their relationship to a river, the Trinity River, and its associated resources. Of particular importance are world renewal ceremonies and ceremonies for bountiful harvests of fish and other resources (Wallace 1978). World renewal ceremonies include the White Deerskin and Jump ceremonies at which the earth and the creator are honored for providing food and facilitating the prosperity of the tribes. Ceremonies to ensure harvests of fish and acorns include the First Salmon ceremony and Acorn Feast (Wallace 1978). Hoopa, Karuk, and Yurok regularly attend each other's ceremonies and the ceremonies are conducted for the benefit of all the groups.

EuroAmerican settlement of the APE accelerated as a result of the Gold Rush, resulting in the establishment of the Hoopa Valley Reservation in 1864, which was then ratified by Congress. President Harrison expanded the existing Hoopa Valley Indian Reservation in 1891 to include lands within one mile on either side of the Klamath River from the Pacific Ocean to the Hoopa Valley (Salter 2003). This area included the Klamath Indian Reserve, not to be mistaken for the Klamath Tribe's reservation located in the Upper Klamath Basin.

The culture of Karuk, Hoopa, and Yurok is closely tied to the Klamath and Trinity Rivers. These tribes subsist wholly or in large part on the resources acquired from the river, most of their sacred sites are located along it, and their cultural traditions are related to it (Bright 1978; Pilling 1978; and Wallace 1978). Contemporary Hoopa practice their traditional activities and are actively engaged in programs related to improving the health of the Trinity River and its fishery. (Refer to Section 3.12 Tribal Trust for additional information on traditional and current lifeways and the history of Federal recognition.)

3.13.3.2 Historic Period

Before the influx of EuroAmericans that began in the 1840s, the APE was occupied primarily by Native Americans (as described in Section 3.13.3.1). EuroAmerican exploration of the Klamath Basin began in the early 19th century. Jedediah Strong Smith and Peter Skene Ogden explored current Siskiyou and Klamath County in 1826 and 1827 for beaver, and in 1829 a party of Hudson Bay Company trappers and explorers, led by Alexander Roderick McLeod, also passed through the area (Klamath Hydroelectric Project 2004). The fur trade ended in the mid-1840s. Largely, the area remained sparsely occupied by EuroAmericans until the late 1800s, when mining and logging attracted settlers to the area.

The discovery of gold at Sutter's Mill in Coloma in 1848 was the catalyst that caused a dramatic alteration of both Native American and EuroAmerican cultural patterns in California. A flood of EuroAmericans entered the region once news of the discovery of gold spread. Initially, the EuroAmerican population grew slowly, but soon exploded as the presence of large deposits of gold was confirmed. The population of California quickly swelled from an estimated 4,000 EuroAmericans in 1848 to 500,000 in 1850 (Bancroft 1888). The discovery of gold and the large influx of EuroAmerican immigrants had a positive effect on the growth and economic development of California, but a negative effect on Indian cultures. The discovery of gold in California marked the beginning of a relatively rapid decline of both Indian populations and culture. EuroAmericans displaced Native Americans from their traditional territory, discouraged the use of traditional languages and the practice of religious ceremonies, and EuroAmerican economic pursuits (e.g., gold mining, logging, ranching, and farming) limited the practice of traditional Indian subsistence activities.

Gold was discovered by Abraham Thompson and his party just north of the present-day location of the City of Yreka in 1851 (Hoover et al. 2002). Known as "Thompson's Dry Diggins", the population quickly exploded to 2,000 miners, and the town of Shasta Plains was established (Hoover et al. 2002). The town primarily included tents and brush shanties, but also included a saloon built out of shakes and canvas by Sam Lockhart. The first permanent house in the town was built by D.H. Lowry and his wife.

EuroAmerican settlement in the Klamath River watershed continued to grow through the 1850s due to the completion of roads such as the Southern Emigrant Road, also known as the Applegate Trail, in 1846 (Klamath Hydroelectric Project 2004). These roads brought prospectors to the region and helped to establish communities such as Henley (Cottonwood), Gottville, Happy Camp, and Somes Bar. Fertile soil and plentiful water sources provided opportunities for homesteading and the private development of agriculture and ranching by unsuccessful prospectors, particularly in the area around current Upper Klamath Lake. The expansion of EuroAmericans in southeastern Oregon resulted in execution of treaties with The Klamath Tribes and the relocation of groups of Indians in the area (Klamath Hydroelectric Project 2004).

Logging began in the Klamath Basin in the 1860s and sustained logging enterprises appeared in the 1880s (Klamath Hydroelectric Project 2004). Early companies were generally small, family-run operations managed by ranching families trying to supplement their income. In 1867, President Ulysses S. Grant signed legislation to create a land-grant subsidy for the construction of the Oregon & California Railroad (O&C) (Klamath Hydroelectric Project 2004). The grant allowed the O&C Railroad Company to select off-numbered sections from the public domain for the construction of the railroad. In 1887, the O&C Railroad Company claimed "lieu" lands on the Pekegama Plateau as compensation for other lands that had already been claimed by homesteader or military and wagon road companies. Title to these lieu lands were immediately (and illegally) transferred to the Pokegama Sugar Pine Lumber Company (PSPLC). To move the logs from the Pokegama Plateau, the PSPLC built a log chute on the rim of the Klamath River Canyon and the first railroad in Klamath County (Gavin 2003). During

this period, larger scale logging companies such as Pokegama Sugar Pine Lumber Company and Klamath River Lumber and Improvement Company were established on the north rim of the Klamath River Canyon.

The end of the nineteenth and beginning of the twentieth century witnessed an ongoing and growing immigration of EuroAmericans into the area, which was facilitated by the construction of the railroad through the region. The railroad provided a reliable means of transportation in the area and stimulated regional cultural and economic development. In addition to improving transportation, a railroad grade constructed at the northern end of Lower Klamath Lake functioned as a dike that facilitated drainage of wetlands for agriculture and control of the flow of water from the Klamath River.

The Oregon & California (O&C) Railroad constructed in 1877 was the first railway through the region (Klamath Hydroelectric Project 2004). It extended from Siskiyou County, California, to Jackson County, Oregon, and facilitated travel and the transport of goods between Sacramento and Portland. Subsequently, the Southern Pacific Railroad Company acquired the O&C Railroad, and by 1909 agricultural and lumber products of the Klamath Basin could be distributed to a nationwide market.

The first hydroelectric development in the Klamath Basin was established in 1891 in the Shasta River Canyon below Yreka Creek to provide electricity to the City of Yreka (Klamath Hydroelectric Project 2004). Four years later, in 1895, the Klamath Falls Light & Water Company built a power plant along the banks of the Link River and soon thereafter began power generation for the town of Klamath Falls (Klamath Hydroelectric Project 2004). The first decade of the 20th century brought a number of mergers and reorganizations of power companies in the APE. The California-Oregon Power Company (Copco) was one of the companies that emerged from this period of reorganization (Klamath Hydroelectric Project 2004). The Bureau of Reclamation's Klamath Project was developed by the DOI to supply farmers with irrigation water and farmland in the Klamath Basin. Link River Dam is the principle source of water for Reclamation's Klamath Project and the irrigation system and serviced areas are situated above stream of the APE.

Copco proposed to develop hydroelectric power facilities along the Klamath River. Residents in the Klamath Falls area were divided over Copco's proposal to dam and generate power on the river. Farmers feared the depletion of precious irrigation water while other businesses saw Copco operations as an addition to the local economy. Regardless, with the increasing power needs of both irrigation and lumber mills and a huge influx of military personnel stationed at Medford and Klamath Falls, it was only a matter of time before additional power generation facilities were needed in the area. Envisioned in 1911, the Klamath Hydroelectric Project was built in phases through 1962 (see Kramer [2003a, 2003b] for a detailed history of the Klamath Hydroelectric Project). Klamath Hydroelectric Project facilities were constructed by Copco beginning with Copco 1 (1918), followed by Copco 2 (1925), and reconstruction of the old East Side facility in 1924. After World War II, regional population growth prompted a new round of hydroelectric power expansion highlighted by Copco's Big Bend project (J.C. Boyle

Dam and powerhouse) in 1958 and the construction of the Iron Gate facilities in 1962. While the Iron Gate facilities were still under construction, Copco merged with Pacific Power & Light, currently PacifiCorp. PacifiCorp currently owns and operates the Klamath Hydroelectric Project.

The development of the Klamath Hydroelectric Project played a significant role in the area's economic development, both as part of a regionally significant, locally owned and operated private utility and through the role that increased electrical capacity played in the expansion of the timber, agriculture, and recreation industries during the first six decades of the 20th century. The Klamath Hydroelectric Project dams and associated facilities are recommended as eligible for inclusion on the National Register as the Klamath Hydroelectric Historic District (KHHD) under criterion a for its association with the industrial and economic development of southern Oregon and northern California from 1903-1962 (see Table 3.13.1 below) (Kramer 2003a, 2003b; Cardno Entrix 2012).

3.13.3.3 Known Cultural and Historic Resources in the APE

Record searches and archival research were conducted for the vicinity of the APE. Previously, 191 cultural resources surveys were conducted covering 30,746 acres (approximately 36 percent of the APE) and more than 680 sites were identified (Cardno Entrix 2012). Most of the surveys were conducted around Upper and Lower Klamath Lakes and on Yurok lands with very little survey coverage along the river itself. The majority of the sites within the APE are prehistoric sites associated with Indian occupation and use of the area. These sites include small lithic scatters, traditional fishing sites, ceremonial sites, and large village sites. The historic sites within the APE are mostly related to the development of agriculture and hydroelectric power.

Sixty-eight sites in the APE are recommended eligible for inclusion on the National Register. The Klamath Hydroelectric Project dams and other associated facilities also are recommended eligible for inclusion on the National Register as a historic district (Kramer 2003a, 2003b and Cardno Entrix 2012). Table 13.13-1 identifies key features of the hydroelectric system and their eligibility recommendation.

The review of ethnographic information for the study area identified TCPs and other culturally sensitive sites along and near the Klamath River. The TCPs and other sites include villages at traditional salmon fishing sites, villages associated with secondary resource procurement areas, ceremonial sites, and burial sites (cf., Daniels 2003; Deur 2004, 2011; Kreober and Barrett 1960; Sloan 2004, 2011; and Waterman 1920). Deur (2004, 2011) identified 11 TCPs along the Klamath River and Theodoratus et al. (1990) identified 3 sites along the river between J.C. Boyle Dam and Scott River that have "cultural value" to The Klamath Tribes. Daniels (2003) identified 47 ethnographic sites (e.g., habitation, hunting, fishing, gathering, and spiritual/ceremonial sites) along the Klamath River and at least 5 village sites submerged by the formation of Copco 1 Reservoir that have cultural value to the Shasta. Theodoratus et al. (1990) also identified 24 sites along the Klamath River between J.C. Boyle Dam and Scott River that have

Table 3.13-1. Klamath Hydroelectric Facilities Historic District National Register Eligibility Recommendation

J.C. Boyle	
Dam	Historic Contributing
Communications Building	Non-Contributing
Fire Protection Building	Non-Contributing
Red Barn	Non-Contributing
Maintenance Shop	Non-Contributing
Water Conveyance Features	Potentially Contributing
Steel Pipe	Historic Contributing
Flume Headgate	Non-Contributing
Open Flume/Concrete	Historic Contributing
Headgate	Historic Contributing
Forebay/Spillgates	Historic Contributing
Spillway House	Historic Contributing
Tunnel	Historic Contributing
Penstocks	Historic Contributing
Powerhouse	Historic Contributing
Substation	Historic Contributing
Armco Warehouse	Historic Contributing
Copco 1	
Dam	Historic Contributing
Gatehouse 1	Historic Contributing
Gatehouse 2	Historic Contributing
Gate Hoist System/Rails	Historic Contributing
Double Penstock	Historic Contributing
Single Penstock	Historic Contributing
Powerhouse	Historic Contributing
Copco 2	
Dam	Historic Contributing
Water Conveyance Features	Potentially Contributing
Headgate	Historic Contributing
Tunnel Intake	Historic Contributing
Concrete-lined Tunnel	Historic Contributing
Wood Stave Pipeline	Historic Contributing
Concrete Tunnel	Historic Contributing
Steel Penstocks	Historic Contributing
Timber Cribbing	Historic Contributing
Coffer Dam	Historic Contributing
Powerhouse	Historic Contributing
Iron Gate	
Dam	Historic Contributing
Spillway	Historic Contributing
Diversion Tunnel	Historic Contributing
Water Conveyance System	Historic Contributing
Water Way/Trash Racks	Historic Contributing
Pipeline	Historic Contributing
Penstock	Historic Contributing
Powerhouse	Historic Contributing
Dam Fisheries Facilities	Historic Contributing
Holding Tanks	Historic Contributing

"cultural value" to Shasta. Additionally, the Bureau of Land Management (BLM) has previously identified a culturally significant area along the Upper Klamath River for a proposed National Register District.

Gates (2003) and King (2004) identify the entire length of the Klamath River as a "riverscape," which they identify as a type of cultural or ethnographic landscape, because of the relationship between the Klamath Tribes, Shasta, Karuk, Hoopa, and Yurok and the river and its resources. Gates (2003) and King (2004) recommended the Klamath River as eligible for inclusion on the National Register as a riverscape and/or ethnographic landscape. In these recommendations, the riverscape includes both cultural resources (such as, fishing and ceremonial sites) and natural resources (such as, water and fish). The Klamath River is certainly sensitive to the present-day tribes, including the Klamath Tribes, Karuk, Hoopa, Resighini Rancheria, Quartz Valley Community, and Yurok, as well as, to other Native Americans, including the Shasta Nation and Shasta Indian Nation, and is an integral part of their traditional cultural practices, but its eligibility for inclusion on the National Register as a riverscape and/or ethnographic landscape requires formal review and concurrence by the Oregon and California SHPOs. Through consultations on the current undertaking, both the Yurok and Karuk THPOs stated support for the eligibility of the riverscape because of the importance of the river to these tribes. The riverscape and/or ethnographic landscape reports and eligibility determination have not been submitted by a Federal agency to the Oregon and California SHPOs for concurrence regarding their eligibility determination. Further research and consultations involving multiple parties is needed to fully define the "riverscape" cultural landscape as a historic property. For the current undertaking, these research and consultation efforts are identified as mitigation measures.

At least one site is known to have human remains exposed from erosion in the Upper Klamath River area. Actions by a Federal agency resulted in the reburial of the exposed remains and temporary stabilization of the river bank. Previous studies, surveys, and Federal actions, combined with ethnographic studies, indicates that there is a high probability for the presence of additional sites in unsurveyed areas, as well as, in currently submerged settings.

Based on the previously identified sites and ethnographic literature reviews, sites identified at each reservoir include primarily the historic dams and associated facilities and structures and prehistoric/ethnohistoric villages, fishing locations, and ceremonial sites. At the J.C. Boyle Reservoir, ten prehistoric sites have been identified along the shoreline. At the Copco Reservoir, eleven prehistoric sites and five ethnographic village sites (Heizer and Hester 1970) have been identified along the shoreline and within the reservoir. At Iron Gate Reservoir, twelve prehistoric sites and five ethnographic village sites have been identified along the shoreline and within the reservoir. Additional sites may be inundated and/or covered with sediment. Depending on the selected alternative for this EIS/EIR, further identification efforts would need to be taken to identify these sites.

3.13.4 Environmental Consequences

3.13.4.1 Effects/Impacts Determination Methods

Cultural resources investigations (e.g., records searches and reviews of archaeological, ethnographic, and historic information, along with consultations) resulted in the identification of more than 600 sites, one historic district, several TCPs, ethnographic villages, burials, and one potential ethnographic landscape within the APE. Identified sites will be treated as potentially eligible for the National Register and California Register for the analyses of potential effects/impacts for this EIS/EIR. In addition, certain site types likely to be identified in previously unsurveyed areas, including inundated areas, will be considered potentially eligible for potential effects/impacts analyses.

3.13.4.1.1 Studies on Effects of Reservoir Inundation on Cultural Resources

Lenihan, et al. (1981), conducted an interagency, interdisciplinary study on the effects of freshwater reservoirs on cultural resources in order to address conservation management of inundated resources. A hierarchical scheme composed of three levels of cultural resources was assessed for inundation effects: artifacts and artifact assemblages; archaeological site or loci; and regional environmental data base, settlement and resource utilization patterns. The use of the hierarchical scheme was intended to include cultural values beyond discrete sites or artifacts that include spatial, temporal, and organizational relationships between the entities within an environmental and cultural context.

This approach is particularly applicable to landscape level resources such as TCPs and ethnographic landscapes, even though these property type names came into use after the Lenihan, et. al. study. When a river with a long history of use is dammed and water is impounded, the cultural landscape is adversely affected through direct impacts to the archaeological or historic sites themselves and to the relationships of these properties to their environment and to each other on local and broader scales. Besides the changes to the environmental setting, processes of inundation that affect cultural resources are sediment transport and deposition, erosion processes of wave action along shorelines, and saturation and slumping of submerged strata (Lenihan, et. al. 1981). Environmental and biological changes are discussed in more detail in other sections of this document (Chapter 3.3, 3.5, 3.14 and others).

Four factors regarding the extent of impacts to archaeological sites by these processes include the characteristics of the reservoirs themselves (size and operation-fill rate and drawdown frequency); location of sites within the impoundment; geological foundation of a site; and characteristics of the site itself (Lenihan, et. al. 1981). Erosion processes are most damaging along the edges of the reservoirs in wave action zones that vary vertically with reservoir operations. In general, cultural resource sites located within the wave action zone are most heavily affected while inundated sites beyond the shore are less affected by erosion and may be capped with sediment. A multitude of other factors, such as, slope, vegetation coverage, substrate, soil and water chemistry, also influences the extent of the impacts to a cultural resource site from inundation. Surface artifact displacement from water movement results in an overrepresentation of heavier weight

artifacts (such as, groundstone) and an underrepresentation of lighter weight artifacts (such as, lithic flakes). Damage from vandalism, both intentional and unintentional, increases to sites exposed through erosion and reservoir fluctuations. All of these impacts limit the ability to reconstruct human behavior through artifactual, paleoenvironmental, and site analyses; through direct dating techniques and relative dating of vertical and horizontal placement; and through contextual relationships.

Surveys for previously inundated prehistoric Puebloan archaeological sites being exposed due to lowering lake levels as a result of drought at Lake Mead, the reservoir behind Hoover Dam, in Southern Nevada resulted in situations where inundation preserved the sites (Haynes 2008). Sites in shoreline locations were eroded as water regressed, resulting in extensive damage to architectural remains and in the removal of the surface artifact assemblages. In lower energy situations, inundation resulted in capping of the sites with sediment that enhanced preservation. Both architectural and non-architectural features and surface artifacts remained. In other situations, effects of inundation and drawdown resulted in differential artifact removal and secondary re-deposition. Factors contributing to impacts from inundation and later exposure include: energy levels of the reservoir at the site location; terrains upon which the sites sit; weight of artifacts; and artifact collecting once sites were exposed. The results of these surveys on lands exposed from natural drawdown at Lake Mead, a man-made reservoir, are directly applicable to the proposed drawdown of the reservoirs along the Klamath River.

3.13.4.1.2 General Effects/Impacts Application

The cultural resources section of this document considers potential effects/impacts from implementation of the Proposed Action and alternatives on historic properties and cultural resources within the APE. The findings of effects/impacts are based on criteria presented in 36 CFR Section 800.5 and in CEQA, as described in 3.13.2 Regulatory Framework. Through consultation (see Chapter 7), DOI has developed measures to avoid, minimize or mitigate adverse effects to historic properties and historical resources, including known effects and those effects for which DOI cannot fully understand at this time. Many of these measures would be offered as binding commitments in the ROD, and will help to coordinate future development through these decisions.

Additionally, due to the nature of the action being proposed, potential effects on all historic properties or historical resources cannot be fully determined prior to approval of either the Proposed Action or an alternative evaluated in this EIS/EIR. The identification and evaluation of certain resources, and the potential effects to those resources, can only be understood and addressed as particular details of how to carry out the selected affirmative alternative are developed. To address this uncertainty, DOI through consultation (see Chapter 7), is proposing measures that the designated Federal officials must follow as specific details are evaluated through future decisions that are required before the selected alternative in this EIS/EIR can be implemented. These measures, which are identified below, will be incorporated as binding stipulations in the ROD for this EIS/EIR. Further, DOI will also seek to develop additional measures through consultation with the ACHP, the SHPOs, THPOs, Indian Tribes, and other interested parties as part of the continuing NEPA process.

Under CEQA, potentially significant or significant impacts to historical resources may be mitigated to a less than significant level. If impacts cannot be mitigated or if implementation of mitigation would not reduce an impact to a less than significant level, the impacts are identified as significant and unavoidable.

3.13.4.2 Significance Criteria

The significance criteria used to assess effects/impacts to cultural resources (e.g., historic properties and historical resources) as a result of implementing the Proposed Action and alternatives include both Federal and California State criteria.

Cultural resource effects/impacts would be adverse and/or significant if implementation of the Proposed Action and alternatives result in any of the following:

- Under NHPA Section 106, "an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association (36 CFR Section800.5(a)(1))."
- Under CEQA, a substantial adverse change in the significance of an archaeological resource or an historical resource is defined as physical demolition, destruction, relocation, or alteration of the resource or its immediate surroundings such that the significance of an historical resource is materially impaired, as defined in PRC Section 21083.2 and CCR 15064.5; or
- Disturbance of any human remains, including those interred outside of formal cemeteries.

3.13.4.3 Effects Determinations

3.13.4.3.1 Alternative 1: No Action/No Project Alternative

Under the No Action/No Project Alternative, none of the actions under consideration would be implemented. The Klamath Hydroelectric Project would continue operations under the terms of an annual license until a long term license is finalized. Annual licenses would not include the actions associated with the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA).

Under the No Action/No Project Alternative current effects/impacts on historic properties/ historical resources, other cultural resources, and human remains will continue to occur. Under the No Action/No Project Alternative, the Klamath Hydroelectric Project on the Klamath River would continue to operate. The Klamath Hydroelectric Project introduced artificial water fluctuations that have resulted in inundation under reservoirs and erosion along the lower river terraces. Over the life of the Klamath Hydroelectric Project, cultural resources have been impacted by these changing water levels. Known impacts include exposing cultural materials to the public, sometimes leading to looting and illegal excavation of these sites. These circumstances are known to have exposed human remains at least one site. Actions by a Federal agency resulted in the reburial of the exposed remains and temporary stabilization of the river bank. Impacts to cultural resources also result from natural events such as increased

water flows during heavy rains and snow melt along the Klamath River and from its tributaries. Other potential ongoing impacts to cultural resources occur from development of recreation areas, housing, and other development along the river and reservoirs. Concerns regarding artificial fluctuating water levels and exposing cultural remains in the APE continue to be a concern of Federal agencies and Native Americans.

There are known ongoing effects/impacts on cultural resources due to operation of the Klamath Hydroelectric Project, natural events, and other ongoing activities. **Therefore, the No Action/No Project Alternative would result in no change from existing adverse conditions and effects/impacts on historic properties and/or historical resources in the APE.**

3.13.4.3.2 Alternative 2: Full Facilities Removal of Four Dams Alternative (Proposed Action)

Under the Proposed Action, four dams and their associated hydroelectric facilities along the Klamath River would be removed. Keno Dam would be transferred to the DOI, the KBRA would be implemented, and the City of Yreka Water Supply Pipeline would be relocated.

The Proposed Action would result in direct effects/impacts to J.C. Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and on the KHHD, which is considered eligible for inclusion on the National Register and California Register. The Proposed Action would include removal of J.C. Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Iron Gate Dam and their associated hydroelectric facilities on the Klamath River (refer to Chapter 2 Proposed Action and Description of Alternatives for additional details). These four dams and a majority of their associated facilities are assumed to contribute to the KHHD, which is considered eligible for inclusion on the National Register and the California Register due to its role in early development of electricity and economy of the southern Oregon and northern California regions. All associated and related structures have yet to be evaluated but are likely to include such properties as miscellaneous structures that are associated with construction of the dams and transmission lines that may be eligible for listing on the National Register individually or as contributing to the KHHD. Under the Proposed Action all of the dams and associated facilities would be removed. Deconstruction and construction activities, including, but not limited to, construction of coffer dams, creating access roads, grading disposal sites and staging areas, recontouring slopes, etc., will directly impact the four dams and hydroelectric facilities and other associated properties. Removal of the four dams and all associated facilities under the Proposed Action would adversely affect each dam's eligibility for inclusion on the National Register and the California Register and the overall integrity of the KHHD because a large portion of this district would be removed.

Under this action, adverse effects, as described in Section 106 of the NHPA, to the dams and the KHHD cannot be avoided and will need to be mitigated. Eligibility of the entire KHHD would be finalized to identify all contributing properties and submitted with a determination of eligibility for listing on the National Register to the Oregon and

California SHPOs. Prior to demolition, the four dams and their associated facilities would be documented for the NPS Heritage Documentation Program (Historic American Building Survey (HABS)/Historic American Engineering Record (HAER)/Historic American Landscape Survey (HALS)) (National Park Service 1990, 2005, 2007, 2010). Construction-related activities for the removal of the dams and facilities may also directly impact as yet unidentified buried cultural resources, particularly ethnographic villages in the vicinity of J.C. Boyle and Copco 1 dams.

Under CEQA, for the purpose of this EIS/EIR, mitigation measures that include HABS/HAER/HALS documentation could be implemented for the removal of dams under the Proposed Action. However the intent of Alternative 2 is to fully remove the dams, the KHHD, and much of the context for these historic resources. Therefore documentation such as HABS/HAER/HALS is the only feasible form of mitigation because avoidance and minimization measures would not be possible. As part of a conservative analysis, it has been determined that implementation of mitigation measures would not reduce impacts to historical resources to a less than significant level.

Under NEPA and CEQA and for the purpose of this EIS/EIR, the Full Facilities Removal of Four Dams would cause a significant impact to J.C. Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Iron Gate Dam, their associated hydroelectric facilities, and on the KHHD. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to the four dams and hydroelectric facilities and to the KHHD would remain significant and unavoidable.

Reservoir drawdown associated with the Proposed Action could affect/impact archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. The Proposed Action includes a drawdown of the reservoirs behind the dams. The deconstruction process would begin by gradually drawing down the reservoirs through a controlled process using existing spillway gates, conveyance pipelines and canals, and diversion conduit (refer to additional details in Chapter 2 Proposed Action and Description of Alternatives). Modeling studies indicate that drawdown would erode and flush stored sediment downstream during the 3 month drawdown period. Afterwards, the river bed in the reservoir reaches is expected to stabilize. Once eroded from the reservoir, the fine sediment would continue to be suspended in the river water during the short term following dam removal, flowing downstream to the ocean. Large quantities of sediment would remain in place in the reservoirs after dam removal, primarily on areas above the active river channel. The remaining sediments would consolidate by drying out, resulting in a decrease in thickness. Following drawdown of the reservoirs, revegetation efforts would be initiated to support establishment of native wetland and riparian species on newly exposed reservoir sediment. Impacts from the drawdown potentially affecting cultural resources include erosion, changes in sediment, and changes in river flows. Note that impacts to the dams and associated structures and features were previously discussed. Cultural resource surveys to identify cultural resources were not conducted prior to inundation, so

very little is known regarding the extent of cultural resources that would have been along the river and that would now be under water.

Most of the sediment in J.C. Boyle Reservoir is near the dam and expected to be eroded from the reservoir area. After drawdown, there would be minor amounts of sediment consolidation on the floodplain areas. Cultural resource sites identified along the edges of J.C. Boyle Reservoir include: seven prehistoric artifact scatters; one prehistoric rock shelter; one prehistoric house pit village; and the remains of one historic lumber mill (Cardno Entrix 2012). The ten sites situated along the reservoir edges are likely to already have impacts from wave action. As the drawdown proceeds, these sites would be exposed to direct impacts of erosion, artifact displacement, and slumping of sediments. Indirect impacts due to exposure are likely to include vandalism (unauthorized collecting and excavating) and unintentional damage from such activities as increased visitation to access the river. One prehistoric camp is situated at the dam and may be exposed to direct impacts of deconstruction.

Sites along the edges of the Klamath River reach between J.C. Boyle Dam and Copco Lake include: eleven prehistoric artifact scatters; two prehistoric artifact scatters with habitation debris; one prehistoric camp with a rock alignment; three prehistoric artifact scatters with rock features (two also with milling features); fifteen prehistoric sites with house pits; three prehistoric burial sites; two historic trash scatters; two historic hotel ruin sites; one historic ranch site; one historic ranch field; and one historic road (Cardno Entrix 2012). These sites may be impacted by increased flows during drawdown of J.C. Boyle Dam because they are situated right on the river's edge.

Among the reservoirs that would be removed, Copco 1 Reservoir (Copco Lake) is the widest of the reservoirs and contains the most sediment. Most of the erosion would be focused in the main channel of the reservoir where the thickness of the remaining sediment would be the greatest. Significant alluvial surfaces (the benches) would be exposed with drawdown of Copco 1. Cultural resource sites identified right at the edges of Copco Lake include: four prehistoric artifact scatters; six prehistoric artifact scatters with habitation debris (one also with a milling feature); the historic Copco Village dump; the Dam Vista homestead; and Copco Guest House (Cardno Entrix 2012). In addition, five ethnographic village sites were identified at and under Copco Lake (Heizer and Hester 1970). Native American burials and traditional use areas (for ceremonies) at and under Copco Lake have also been identified through ethnographic research and consultations. These sites are likely to be impacted from erosion, sediment shrinkage, artifact displacement, and effects of exposure. Depending on factors discussed previously on inundation impacts in general, some of these sites may remain covered in sediment, or capped, resulting in some degree of preservation.

The reservoir behind Copco 2 Dam is small with little sediment. Cultural resource sites identified below Copco 2 Dam to Iron Gate Reservoir include one prehistoric pictograph site; one historic trash and privies site; one historic canal/aqueduct; and one railroad feature (Cardno Entrix 2012).

The reservoir sediment at Iron Gate Reservoir is relatively thin since the river corridor is relatively narrow and the side slopes of the reservoir area are mostly steep. Cultural resources sites identified on the edges of Iron Gate Reservoir include: three prehistoric artifact scatters; three prehistoric artifact scatters with milling features and habitation remains; one historic field; one wall/fence; one historic architectural feature with privies, dumps and walls; and one historic homestead remains. Five ethnographic village sites were identified at and under Iron Gate Reservoir (Heizer and Hester 1970). Impacts to these sites would likely result from erosion and exposure during drawdown rather than from the effects of sediment changes.

The reservoir drawdown plans were made with consideration for minimizing flood risks downstream. Downstream flows would not be likely to increase flood risks because they would be within the range of historic flows. Should a large flood event occur during drawdown, the outlet capacity would be exceeded and the reservoir could partially refill. This would be similar to existing operations during a flood event. Because the flows would stay below historic peak flows, they would not change the floodplain or flood risks in comparison to existing conditions.

Few cultural resource surveys have been conducted along the Klamath River below Iron Gate Dam to Yurok lands at the mouth of the river. Sites identified along the river between Iron Gate Dam to its confluence with Shasta River include: one prehistoric artifact scatter; one prehistoric camp site; one prehistoric fishing locale; one prehistoric burial; one historic habitation debris site; one historic structural and landscaping remains site; and one historic bridge. Traditional use locations for ceremonies, fishing, and other purposes were identified along the river during consultations. Due to the controlled release of water flows during reservoir drawdowns, impacts to these sites are not expected, particularly below the confluence with the Shasta River, as increased river elevations will be minimal and these sites have been exposed to historic flows since their original use. Indirect impacts may result afterwards from changes in the water flows.

The riverscape, a potentially eligible or significant cultural landscape, includes villages, hunting, gathering, fishing, and spiritual locations on terraces and benches along the river, as well as the river itself and its natural resources. The overall riverscape/cultural landscape would likely benefit from dam removal by restoring the river more closely to its original setting and facilitating the practice of important Indian traditional customs, ceremonies, and economic activities. However, sites associated with it could be adversely affected through erosion, sediment changes, artifact displacement, exposure, and vandalism. Relationships between the elements of the riverscape would change as the environmental and cultural setting changes from one of dams and reservoirs back to one of a free-flowing river. The impacts of these changes are not easily assessed and will likely require surveys, research and consultations with Federal agencies, Indian tribes, Native Americans, and other interested parties to determine the effects. The same can be said of other TCPs and cultural landscapes, prehistoric or historic, which have been identified in general terms but not yet specifically identified or recorded.

Under this action, adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of reservoir drawdowns. These effects will need to be mitigated. Erosion and sediment changes resulting from drawdown of the reservoirs will likely expose and impact historic properties and cultural resources along reservoir edges and currently submerged under the reservoirs. Exposed properties will also be susceptible to vandalism and other unintentional damage. In certain situations, remaining sediment will continue to cover cultural resource sites, providing some protection from impacts. Planned revegetation will help to prevent erosion of those sediments. A cultural resources management plan would be developed, through consultations, to manage and protect endangered and exposed historic properties and cultural resources, both short term (during drawdown and construction) and long term (as the river course changes). Prior to drawdown, a plan for identifying additional, previously unknown historic properties through surveys and monitoring as land is exposed would be developed. Avoidance, minimization, and mitigation measures would be identified and implemented through consultations under Section 106 of the NHPA. Plans and agreements for the removal and disposition of human remains would be developed according to applicable Federal and State laws and regulations.

Under NEPA and CEQA and for the purpose of this EIS/EIR, reservoir drawdown would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly Native American and non-native human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, and cultural landscapes would be mitigated to a less than significant impact.

Construction activities including use of haul roads and disposal sites for demolition debris under the Proposed Action could affect/impact archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register or California Register. Ground disturbing activities associated with construction activities will likely have both direct and indirect effects/impacts on historic properties/historical resources. The debris from the demolition of the dams and facilities would be hauled to disposal sites. Modifications of the proposed haul roads and use of disposal sites could affect/impact sites that are located along the haul roads and/or at the disposal sites. As more exact locations of these haul roads and disposal sites are developed, identification of cultural resources that may be impacted can be determined. These impacts are also included in the earlier discussion on impacts of the Proposed Action on the four dams and their associated hydroelectric facilities.

Under this action adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of construction of haul roads and disposal sites. These effects will need to be mitigated. As future plans are developed for construction activities, modifications to haul roads, and identification of actual locations of disposal sites and associated staging/construction, additional identification and evaluation of historic properties/historical resources would be conducted. Opportunities to avoid historic properties/historical resources may be worked into the construction

plans. Avoidance, minimization, and/or mitigation measures would be taken as appropriate to manage those resources as a result of this action.

Under NEPA and CEQA and for the purpose of this EIS/EIR, construction activities including use of haul roads and disposal sites for demolition debris would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, and cultural landscapes would be mitigated to a less than significant impact.

Removal of the recreational facilities after reservoir drawdown may affect archaeological or historic sites that could be eligible for inclusion on the National Register or California Register or possibly prehistoric or historic human remains. The Proposed Action would change recreational opportunities from lake-based recreation to river-based recreation. Recreation facilities, such as campgrounds and boat ramps, currently located along the reservoir banks will need to be relocated down slope to be near the new river bed once the reservoir is removed. These facilities are not eligible for the National Register or California Register, and were not known to impact archaeological sites when they were built. Additional ground disturbance from removal of these facilities may affect/impact known and previously unidentified historic properties/historical resources along the river and currently submerged under reservoirs.

Under this action adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of removal and relocation of recreational facilities. These effects will need to be mitigated. Further identification and evaluation of historic properties/historical resources at facility relocation areas would be conducted. Avoidance, minimization, and/or mitigation measures would be taken as appropriate to manage those resources as a result of this action.

Under NEPA and CEQA and for the purpose of this EIS/EIR, removal of the recreational facilities would cause a significant impact to archaeological and historic sites that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites would be mitigated to a less than significant impact.

3.13.4.3.4 Keno Transfer

The Transfer of Keno Dam to the DOI could have adverse effects to historic properties or historic resources. The KHSA calls for transferring ownership and operation of Keno Dam from PacifiCorp to DOI. Upon transfer of privately owned facilities into Federal ownership, cultural resources and historic properties are then subject to Federal historic and cultural resources management laws.

Under Section 106 of the NHPA and under NEPA and CEQA for the purposes of this EIS/EIR, this action would not cause an effect/impact to historic properties or historical resources. The transfer would likely be a beneficial effect because the facilities would be subject to Federal regulation.

3.13.4.3.5 East and Westside Facilities – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects on historic resources or historic properties. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals. Following decommissioning of the facilities there would be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. Decommissioning does not typically involve deconstruction of the facilities. Instead, buildings and equipment that are too large to easily remove or fixed in place are usually fenced to prevent entry. Any deconstruction and removal of facilities would be analyzed in future environmental analyses.

Under this action, adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of changes to the facilities themselves, if they are found to be historic properties, or from associated construction activities. These effects would need to be mitigated. As plans develop for this action, identification of historic properties would need to be completed with resolution of any adverse effects developed through consultations under Section 106 of the NHPA.

Under NEPA and CEQA and for the purpose of this EIS/EIR, the decommissioning of the East and Westside Facility would have less than significant effects on historic properties or historical resources.

3.13.4.3.6 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Installation of the City of Yreka Water Supply Pipeline could affect/impact archaeological and historic sites that are eligible for inclusion on the National Register or California Register and possibly prehistoric and historic human remains. The existing water supply pipeline for City of Yreka passes under the Iron Gate Reservoir and would have to be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would either be suspended from a pipe bridge across the river near its current location, or rerouted along the underside of the Lakeview Bridge just downstream from Iron Gate Dam. The pipeline itself may be a historic property or historical resource and would need to be evaluated for eligibility. Ground disturbance required for either method of relocating the pipeline could result in the discovery of and impacts to historic and/or archaeologically significant sites. The construction of footings to support the pipe bridge and the trenching and rerouting of the pipeline to reach Lakeview Bridge could uncover previously unknown sites.

Under this action adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of installation of the City of Yreka Water Supply Pipeline. These effects will need to be mitigated. The City of Yreka Water Supply Pipeline would be recorded and evaluated to assess its eligibility to the National Register or the California Register and surveys of the area of potential effects from the pipeline work would be conducted to identify any other historic properties/historical resources that may be impacted by this action. Avoidance, minimization, and/or mitigation measures would be taken as appropriate to manage those resources as a result of this action.

Under NEPA and CEQA and for the purpose of this EIS/EIR, installation of the City of Yreka Water Supply Pipeline would cause a significant impact to archaeological and historic sites that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites would be mitigated to a less than significant impact.

3.13.4.3.7 KBRA-Programmatic Measures

The KBRA has several programs that could result in impacts/effects to cultural and historic resources that are eligible for inclusion on the National Register and/or California Register. These resources include archaeological and historic sites, TCPs, cultural landscapes, and possibly Prehistoric or historic human remains. Specific KBRA programs potentially affecting cultural and historic resources include:

- Phases 1 and 2 Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration Project
- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Klamath Tribes Interim Fishing Site
- Mazama Forest Project

Implementation of the Phase 1 and 2 Fisheries Restoration Plans, the Fisheries Reintroduction and Management Plan, the Wood River Wetland Restoration Project, the On-Project Plan, the Water Use Retirement Program, and the Fish Entrainment Reduction program, could result in impacts/effects to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly Prehistoric or historic human remains. Actions associated with the Fisheries Restoration Plans in the floodplain and river channel include: floodplain rehabilitation, large woody debris replacement, fish passage correction, cattle exclusion (fencing), riparian vegetation planting, mechanical thinning of upland areas to mimic natural forest conditions, fire treatment to mimic natural forest conditions, purchase of conservation easements/land, road decommissioning, gravel

augmentation, and treatment of fine sediment sources. The fisheries restoration actions are designed to improve aquatic and riparian habitat and potential changes in river hydraulics are intended to improve the habitats' ability to support river fisheries. These restoration actions would not occur at the same locations as construction activities for the hydroelectric facility removal. KBRA construction activities would not contribute to potential cultural and historic resource effects of facility removal actions.

Under this action, adverse effects, as described in Section 106 of the NHPA, archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric or historic human remains cannot be avoided and will need to be mitigated. Implementation of the KBRA programs listed above include ground disturbing activities that are likely to have a significant impact on cultural and historic resources that are eligible for inclusion on the National Register and/or California Register. Studies will be conducted to identify cultural resources and measures to reduce significant impacts to those resources. Implementation of specific plans and projects associated with Phase 1 and 2 Fisheries Restoration will require future environmental compliance as appropriate.

Under NEPA and CEQA and for the purpose of this EIS/EIR, implementation of the Phase 1 and 2 Fisheries Restoration Plans, the Fisheries Reintroduction and Management Plan, the Wood River Wetland Restoration Project, the On-Project Plan, the Water Use Retirement Program, and the Fish Entrainment Reduction program would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric or historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, and cultural landscapes would remain significant and unavoidable.

Establishment of the Klamath Tribes Interim Fishing Site could result in impacts/effects to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and possibly prehistoric or historic human remains. Actions associated with the Klamath Tribes Interim Fishing Site include establishment of an interim fishing site for Klamath Tribal members between Iron Gate Dam and Interstate-5. The location and timing of this project reduces the potential for any negative cultural and historic resource impacts generated by establishment of the Klamath Tribes Interim Fishing Site from contributing to the effects of the hydroelectric facility removal actions. Although negative short-term effects could occur, implementation of construction-related best management practices (BMPs) would occur.

Under this action, adverse effects, as described in Section 106 of the NHPA, archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric or historic human remains cannot be avoided and will need to be mitigated. Establishment of the Klamath Tribes Interim Fishing Site is likely to include

ground disturbing activities that could have a significant impact on cultural and historic resources that are eligible for inclusion on the National Register, if present. Studies will be conducted to identify cultural resources and measures to reduce significant impacts to those resources. Implementation of specific plans associated with the establishment of the Klamath Tribes Interim Fishing Site will require future environmental compliance as appropriate.

Under NEPA and CEQA and for the purpose of this EIS/EIR, establishment of The Klamath Tribes Interim Fish Site would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, cultural landscapes, and human remains would be mitigated to a less than significant impact.

Implementation of the Mazama Forest Project could result in impacts/effects to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and possibly prehistoric or historic human remains. Actions associated with the Mazama Forest Project include the purchase and management of 90,000 acres of timberland on former reservation land owned by the Klamath Tribe (Chui 2008; Kerr 2012). The 90,000 acres identified in the Mazama Forest Project are likely to include cultural and historic resources that are eligible for inclusion on the National Register. Forest management actions at the Mazama Forest would not be in the same location as the hydroelectric facility removal actions and there would be no negative cultural and historic resource impacts generated by these restoration actions that would contribute to the effects of facility removal actions.

Under this action, adverse effects, as described in Section 106 of the NHPA, archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric or historic human remains cannot be avoided and will need to be mitigated. While the Klamath Tribes Forest Management Plan has been developed, the specific location of management actions within the Mazama Forest have not been identified. It is assumed however that implementation of this plan is likely to have a significant impact on cultural and historic resources that are eligible for inclusion on the National Register and/or California Register. Studies will be conducted to identify cultural resources and reduce significant impacts to these resources. Implementation of specific plans and projects associated with the Mazama Forest Project will require future environmental compliance as appropriate.

Under NEPA and CEQA and for the purpose of this EIS/EIR, implementation of the Mazama Forest Project would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2,

CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, cultural landscapes, and human remains would be mitigated to a less than significant impact.

Finding of Effects Under NHPA Section 106

Under NHPA, adverse effects of the Proposed Action to known historic properties (including the KHHD) cannot be avoided. In addition, adverse effects to as yet unidentified or unevaluated historic properties expected to be identified during future identification efforts may result from this alternative. Avoidance, minimization, and/or mitigation measures would be taken as appropriate to manage those resources as a result of this action. Measures to avoid, minimize, or mitigate and resolve adverse effects, identified through consultations, will likely result in agreement documents per 36 CFR Part 800 for implementation of this alternative. **Under NHPA Section 106, Full Facilities Removal of Four Dams Alternative (Proposed Action) will have an adverse effect to historic properties.**

3.13.4.3.8 Alternative 3: Partial Facilities Removal of Four Dams Alternative

Under the Partial Facilities Removal of Four Dams Alternative, four dams and their

associated hydroelectric facilities would be partially removed to provide for volitional fish passage. Keno Dam would be transferred to the DOI, the KBRA would be implemented, and the City of Yreka water supply pipeline would be installed.

The Partial Facilities Removal of Four Dams Alternative would result in direct effects/impacts to J.C. Boyle Dam, Copco 1 Dam, Copco 2 Dam, and Iron Gate Dam and on the KHHD, which is considered eligible for inclusion on the National Register and California Register. The Partial Facilities Removal of Four Dams Alternative would include removal of enough of each dam to allow free-flowing river conditions and volitional fish passage at all times. Under this alternative, portions of each dam would remain in place, along with ancillary buildings and structures such as powerhouses, foundations, tunnels, and pipes. Some of these remaining features would likely require perpetual maintenance and security measures to prevent unauthorized entry. All tunnel openings would be sealed with reinforced concrete to eliminate trespass concerns. Table 2-21 provides a summary of facilities that would be removed or retained under the Partial Facilities Removal of Four Dams Alternative.

The four dams and most of their associated facilities and structures are presumed to be eligible for listing on the National Register as contributing to the eligibility/significance of the KHHD. The full effects to the four dams and facilities from partial removal cannot be determined until specific plans are made for the partial removal, identifying the extent of removal of the dams and facilities. Partial removal is likely to result in an adverse effect under Section 106 of the NHPA to the dams and possibly to the overall integrity of the KHHD. By following the Secretary of the Interior's Treatment of Historic Properties (National Park Service 1995), adverse effects to some of the structures may be avoided.

Under this action, adverse effects as described in Section 106 of the NHPA, and impacts under NEPA and CEQA to historic properties/historical resources are the same as for the Proposed Action. Potential effects/impacts to cultural and historic resources under the Partial Facilities Removal of Four Dams Alternative, including reservoir drawdown; relocation of the City of Yreka Water Supply Pipeline; construction activities; removal of recreational facilities; the Keno Transfer; and the East and Westside facilities decommissioning would be the same as those identified for the Proposed Action.

3.13.4.3.9 KBRA-Programmatic Measures

The KBRA has several programs that could result in impacts/effects to cultural and historic resources that are eligible for inclusion on the National Register and/or California Register. These resources include archaeological and historic sites, TCPs, cultural landscapes, and possibly prehistoric and historic human remains. Specific KBRA programs potentially affecting cultural and historic resources include:

- Phases 1 and 2 Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration Project
- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Klamath Tribes Interim Fishing Site
- Mazama Forest Project

Under this action, adverse effects as described in Section 106 of the NHPA, and impacts under NEPA and CEQA to historic properties/historical resources are the same as for the Proposed Action.

Finding of Effects Under NHPA Section 106

Under the Partial Removal of Four Dams Alternative for NHPA, adverse effects to known historic properties (including the KHHD) cannot be avoided. Under this alternative, effects would be the same as those identified for the Proposed Action/Full Facilities Removal of Four Dams Alternative. Under NHPA Section 106, the Partial Removal of Four Dams Alternative will have an adverse effect to historic properties.

3.13.4.3.10 Alternative 4: Fish Passage at Four Dams Alternative

Under the Fish Passage at Four Dams Alternative operation of the existing dams and hydroelectric facilities would continue along the Klamath River and fish passage facilities would be constructed at the four dams. Keno Dam would not be transferred to DOI and the KBRA would not be implemented.

The Fish Passage at Four Dams Alternative could affect/impact the four dams and the KHHD, other historic properties/historical resources, TCPs, cultural landscapes, or human burials. The Fish Passage at Four Dams Alternative would continue operation of the existing dams and hydroelectric facilities along the Klamath River and could continue

to affect historic properties/ historical resources. Construction of fish passages would require modifications to the four dams and/or their associated facilities, resulting in effects/impacts to the KHHD. Construction activities required for the fish passages may affect/impact as yet unidentified historic properties/historical resources. Since no reservoir drawdown would occur, the City of Yreka water supply pipeline would not need to be installed, and recreation facilities would not need to be removed or relocated, no effects to historic properties/historical resources would occur as a result of these actions.

Under this action adverse effects, as described in Section 106 of the NHPA, to historic properties and to the dams and the KHHD would occur and will need to be mitigated. Changes to the dams, their associated facilities, and the KHHD that follow the guidance found in the Secretary of the Interior's Treatment of Historic Properties (National Park Service 1995), may result in no adverse effect to these properties. Construction activities may affect other historic properties, TCPs, and cultural landscapes. Further identification and evaluation of historic properties/historical resources would be conducted to identify as yet unknown significant resources. Measures to avoid, minimize, or mitigate adverse effects to historic properties would be identified through consultations and would be incorporated into implementation of the fish passages designs, as appropriate.

Under NEPA and CEQA and for the purpose of this EIS/EIR, implementation of the Fish Passage at Four Dams would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, cultural landscapes, and human remains would be mitigated to a less than significant impact.

Finding of Effects Under NHPA Section 106

Under the Fish Passage at Four Dams Alternative for NHPA, adverse effects to known historic properties (including the KHHD) would likely occur. In addition, adverse effects to as yet unidentified or unevaluated properties may result from this alternative. The adverse effects will need to be avoided, minimized, or mitigated. Additional consultations and identification and evaluation efforts will be conducted under consultations with ACHP, SHPOs, THPOs, Indian Tribes, and other interested parties, per 36 CFR Part 800. Measures to avoid, minimize, or mitigate and resolve adverse effects, identified through consultations, will likely result in agreement documents per 36 CFR Part 800 for implementation of this alternative. **Under NHPA Section 106, the Fish Passages at Four Dams will have an adverse effect to historic properties.**

3.13.4.3.11 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative

Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, two dams, their associated hydroelectric facilities, and fish hatchery facilities along the Klamath River would be removed and fish passage facilities would be constructed at two

dams. Under this alternative, Keno Dam would not be transferred to the DOI and the KBRA would not be implemented.

The Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would result in direct effects/impacts to Copco 1Dam and Iron Gate Dam and on the KHHD considered eligible for inclusion on the National Register and California Register. The Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would include removal of two dams, their associated hydroelectric facilities, and other facilities along the Klamath River. Installation of fish passages, including all associated construction activities, at J.C. Boyle Dam and Copco 2 Dam may affect/impact those dams and their associated facilities. Deconstruction and construction activities, including, but not limited to, construction of coffer dams, creating access roads, grading disposal sites and staging areas, recontouring slopes, etc., will directly impact Copco 1 and Iron Gate dams and their hydroelectric facilities and other associated properties. These facilities contribute to the KHHD, which is presumed eligible for inclusion on the National Register and the California Register due to its role in early development of electricity and economy of the southern Oregon and northern California regions. The removal of two dams and facilities would adversely affect each dam's eligibility and possibly the overall integrity of the KHHD.

Under this action, adverse effects, as described in Section 106 of the NHPA, to the dams and the KHHD, and other historic properties cannot be avoided and will need to be mitigated. Mitigation will likely include thorough documentation of the four dams and their associated facilities to HABS/HAER/HALS levels or similar. By following the Secretary of the Interior's Treatment of Historic Properties (National Park Service 1995), adverse effects to some of the structures may be avoided. Removal of the dams and facilities and construction of fish passages may also impact as yet unidentified buried cultural resources, particularly ethnographic villages. Additional efforts to identify and evaluate historic properties/historical resources would be conducted. Possible avoidance, minimization, and mitigation measures to other currently unidentified historic properties/historical resources would be identified through consultations as appropriate.

Under CEQA, for the purpose of this EIS/EIR, mitigation measures that include HABS/HAER/HALS documentation could be implemented, but implementation of mitigation measures would not reduce impacts to historical resources to a less than significant level.

Under NEPA and CEQA and for the purpose of this EIS/EIR, the fish passage at two dams, removal of Copco 1 and Iron Gate would cause a significant impact to Copco 1 Dam and Iron Gate Dam, their associated hydroelectric facilities, and on the KHHD. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to the two dams and hydroelectric facilities and to the KHHD would remain significant and unavoidable.

Reservoir drawdown associated with the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative could affect/impact archaeological and historic sites, TCPs,

and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric or historic human remains. The Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative includes a drawdown of the reservoirs behind Copco 1 and Iron Gate Dams. The effects of the drawdown of these two reservoirs and installation of the City of Yreka water supply pipeline will be the same as described for these reservoirs in the Proposed Action. Effects on TCPs and cultural landscapes would also be as described in the Proposed Action.

Under this action adverse effects, as described in Section 106 of the NHPA, could occur to historic properties as a result of reservoir drawdowns. These effects will need to be mitigated. Erosion and sediment changes resulting from drawdown of the reservoirs will likely expose and impact historic properties and cultural resources along reservoir edges and currently submerged under the reservoirs. Exposed properties will also be susceptible to vandalism and other unintentional damage. In certain situations, remaining sediment will continue to cover cultural resource sites, providing some protection from impacts. Planned revegetation will help to prevent erosion of those sediments. A cultural resources management plan would be developed, through consultations, to manage and protect endangered and exposed historic properties and cultural resources. Prior to drawdown, a plan for identifying additional, previously unknown historic properties through surveys and monitoring as land is exposed would be developed. Avoidance, minimization, and mitigation measures would be identified and implemented through consultations under Section 106 of the NHPA. Plans and agreements for the removal and disposition of human remains would be developed according to applicable Federal and State laws and regulations.

Under NEPA and CEQA and for the purpose of this EIS/EIR, the reservoir drawdown for the removal of Copco 1 Dam and Iron Gate Dam would cause a significant impact to archaeological and historic sites, TCPs, and cultural landscapes that are eligible for inclusion on the National Register and/or California Register and possibly prehistoric and historic human remains. After implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 impacts to archaeological and historic sites, TCPs, and cultural landscapes would be mitigated to a less than significant impact.

Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative, adverse effects as described in Section 106 of the NHPA, and impacts under NEPA and CEQA to historic properties/historical resources from relocation of the City of Yreka Water Supply Pipeline; construction activities; and removal of recreational facilities; are the same as for the Proposed Action. Effects and impacts to Copco 1 and Iron Gate Dams are the same as described for these dams in the Proposed Action. Since Keno Dam would not be transferred and the KBRA would not be implemented, there would be no effects to historic properties/historical resources from these activities.

Finding of Effects Under NHPA Section 106

Under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative for NHPA, adverse effects to known historic properties (including the KHHD) cannot be

avoided. In addition, adverse effects to as yet unidentified or unevaluated properties may result from this alternative. The adverse effects will need to be avoided, minimized, or mitigated. Additional consultations and identification and evaluation efforts will be conducted under consultations with ACHP, SHPOs, THPOs, Indian Tribes, and other interested parties, per 36 CFR Part 800. Measures to avoid, minimize, or mitigate and resolve adverse effects, identified through consultations, will likely result in agreement documents per 36 CFR Part 800 for implementation of this alternative. **Under NHPA Section 106, the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative will have an adverse effect to historic properties.**

3.13.4.4 Mitigation Measures[2]

3.13.4.4.1 Mitigation Measure by Consequences Summary

Implementation of the Proposed Action and alternatives will each have an adverse effect on historic properties under Section 106 of the NHPA. Mitigation measures CHR-1 to CHR-4 identify actions to avoid, minimize or mitigate adverse effects following the process in 36 CFR Section 800.8(c)(1)(v).

Mitigation Measures Applicable to All Action Alternatives

Under all of the action alternatives, the DRE or the designated lead Federal agency if the DRE is a non-Federal entity with authority over particular aspects of the detailed plans for the action alternatives, would continue consultation with ACHP, SHPOs, THPOs, Indian Tribes and other consulting parties. (All references to the DRE below assume that the DRE will be a Federal agency. In the event that the designated DRE is a non-Federal entity, the designated lead Federal agency will assume all responsibility to carry out the measures articulated herein.) Up to and immediately following a decision on the proposed undertaking analyzed in this EIS, consultation will continue and in the short-term focus primarily on the development and preparation of a Programmatic Agreement (PA). The DRE will seek to execute the PA within one year from the issuance of a decision by the Secretary of the Interior or as soon thereafter as is practicable. The purpose of the PA is to establish a process for the continued compliance with Section 106 of the NHPA wherein the DRE will carry out consultation for the definite plan on how to implement the action alternative selected in this EIS. Such consultation, which will be established by the PA, prior to the approval of any activities that may directly or indirectly adversely affect historic and cultural resources, shall undertake planning and actions as may be necessary to avoid, minimize or mitigate adverse effects. The PA will consider for inclusion as stipulations some or all of the following general measures:

- Identify consulting parties, including the lead Federal agency for NHPA Section 106 compliance and the DRE, if not the lead Federal agency, and their roles and responsibilities;
- Define the undertaking and the APE specific to the selected action alternative;

[2] The term “mitigation measures” here is as defined by NEPA/CEQA and does not preclude avoidance or minimization as defined for Section 106 of the NHPA (36 CFR Part 800).

- Establish a timeframe for consultation in accordance with the executed PA. The timeframe should include benchmarks for meeting the different aspects of the PA, such as final identification and evaluation of historic and cultural resources;
- Establish agreed upon forms of communicating with consulting parties, and possibly consultation guidelines. For example, each consulting party could express a preference for email communication or communication through letters. Agreed upon communication also could include provisions to address when the DRE should communicate with consulting parties or when consulting parties should communicate with the DRE or other agencies. The agreement for communication also could include identified points of contact, either specific representatives or staff offices;
- Establish a cultural resources working group or advisory group to coordinate PA implementation and development of associated plans;
- Establish benchmarks and/or timelines for consultation incorporating the details of the proposed plan associated with the selected alternative with the known historic resources to ensure opportunities to modify the design for carrying out the selected alternative, e.g., coordinate the cultural resource survey work with design of access road construction associated with dam removal to ensure the consideration of alternatives to avoid, minimize or mitigate adverse effects to such identified properties.
- Identify plans to assist in management, consultation, and compliance such as, Cultural Resources Management Plan for overall management of known, to be identified, and inadvertently discovered resources; a Plan of Action for management, treatment, identification, and disposition of human remains; a Monitoring Plan for monitoring conditions and impacts to known and unknown resources; Historic Property Treatment Plans for protection, avoidance, and recovery of data from historic properties; and a Heritage Education plan for public education regarding cultural resources along the Klamath River.

Additionally, the PA will include Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4, described in detail below, which are associated with specific resource types and may or may not be applicable depending on the action alternative analyzed in the EIS and selected in the ROD.

Mitigation Measure CHR-1

Continue consultations between DRE, other Federal agencies, ACHP, SHPOs, THPOs, Indian tribes, and other consulting parties to add stipulations to the PA that outline an approach for addressing avoidance, minimization, and mitigation measures for the removal of the dams and other dam-related facilities listed or eligible for the National Register;

- Update the Klamath Hydroelectric Project Request for Determination of Eligibility (Kramer 2003) to include Iron Gate as a historic property and to identify contributing elements to the KHHD; and

- Provide a framework and timeline for continuing consultation to reach a consensus on the eligibility determination for KHHD, contributing elements, and other dam facilities; and
- Proposed measures to resolve adverse effects through minimization or mitigation may be formalized through the execution of a Memorandum of Agreement pursuant to 36 C.F.R. § 800.6; and
- Documentation of the KHHD, including the four dams and associated facilities and structures, in accordance with the NPS HABS/HAER/HALS heritage documentation standards for historic architectural, engineering, and landscape documentation and submission to the NPS archives; and
- Follow the *Secretary of the Interior's Standards for the Treatment of Historic Properties* (36 C.F.R. Part 68) as applicable for any remaining facilities or structures associated with the dams and found to be eligible either individually or as contributing properties to the National Register; and
- Consider markers, plaques, or other features to provide educational information about the historic character and importance of the dams to the area. Other forms of public outreach or educational information, including professional and public documents and other media, and Web sites, also should be considered as a component of the mitigation of the removal of the dams and KHHD.

Mitigation Measure CHR-2

Continue consultations between the DRE, other Federal agencies, ACHP, SHPOs, THPOs, Indian tribes, and other interested parties to add stipulations to the PA that outline an approach for addressing known historic properties (non-KHHD historic properties referenced in CHR-1 above) and cultural resources within the APE and as yet unidentified historic properties and cultural resources. These stipulations aim to provide a process to identify and evaluate cultural resources for eligibility for listing on the National Register and/or the California Register of Historic Places or through the Oregon National Register and Survey Program, as applicable; develop measures to avoid, minimize, or mitigate adverse effects to historic properties; and

- Establish general design guidelines for elements of dam removal and/or ladder construction that could avoid effects to historic and cultural resources, e.g., integrating design features that allow for re-use of preexisting facilities and coordinating the cultural resource survey work with design of access road construction associated with dam removal to ensure the consideration of alternatives to avoid, minimize or mitigate adverse effects to such identified properties; and
- Develop a history of human presence and use of this reach of the Klamath River and research themes for study (Historic Context and Research Design) for the identification and evaluation of historic properties/historical resources and unevaluated cultural resources, unsurveyed and previously surveyed areas, and inundated zones; and

- Develop methods to identify cultural resources and historic properties/sites of historical significance through in-field surveys, archival and historic research, consultations, and subsurface testing; ; and
- Establish an approach for considering when to submit formal nominations to the National Register for properties that meet the National Register criteria (36 C.F.R. § 60.4) and are worthy for preservation, or for the California Register of Historical Resources; and
- Develop Treatment Plans for the avoidance, minimization, and mitigation of adverse effects to historic properties/sites of historical significance, including protective measures, such as, installing riprap to prevent erosion or protective barriers. Mitigation measures would include excavation, collection, analytical, and reporting methods; and
- Develop and implement a site monitoring program to provide continued oversight of historic and cultural resources and to collect information on site conditions and effects or threats to these resources, including but not limited to erosion, recreational, agricultural and other encroachment, and looting and vandalism. Establish an entity responsible for oversight of the site monitoring program for those areas under Federal jurisdiction and direct the appropriate Federal agency to oversight over lands/sites within Federal jurisdiction. Based on the site monitoring program, the responsible entity or Federal agency shall prepare a Monitoring Plan to discuss the types and location of sites to be monitored, field methodology of monitoring and conditions recordation; data storage, retrieval and analysis; schedule; staffing and qualifications; actions to be taken for illegal activities; and other details. Set a schedule for consulting to establish a final monitoring plan. The Monitoring Plan should place an emphasis on those properties that are exposed during implementation of the selected alternative; and
- Prepare and implement an Inadvertent Discovery Plan for unanticipated discoveries of historic properties/historical resources and Prehistoric or historic human remains. The Inadvertent Discovery Plan should consider provisions that capture the exposure through erosion, reservoir drawdown, construction, or other project-related direct and indirect effects of previously inundated historic and cultural resources and sites; and
- Prepare and implement a Cultural Resources Management Plan (CRMP) to address the management and protection of historic properties/historical resources and significant cultural resources from direct and indirect effects/impacts from implementation of the selected alternative (such as, erosion, vandalism, and destruction), both short term (during drawdown and construction) and long term (as the river course changes). For those historic properties identified on Federal land or within the management authority of a Federal agency, include in the CRMP the possibility of conducting further proactive survey and evaluation opportunities pursuant to Section 110 of the NHPA as part of the Federal agency's on-going management responsibilities. The CRMP could be utilized by other entities to manage and protect historic properties and cultural resources along the Klamath River; and

- Develop a protocol document or enter into a Memorandum of Understanding, if appropriate, regarding consultations and involvement of Indian tribes, Native American organizations, and other interested parties; and
- Curate artifact collections, material, records, and data pursuant to 36 C.F.R. Part 79.1, except for resources meeting NAGPRA definitions.
- Respect and maintain the confidentiality of sensitive information following Section 304 of the NHPA, 16 U.S.C. § 470w-3, 36 CFR § 800.11(c), and the Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470hh).

Mitigation Measure CHR-3

Continue consultations between the DRE, other Federal agencies, ACHP, SHPOs, THPOs, Indian Tribes and other interested parties to add stipulations to the PA that outline an approach for identifying and evaluating TCPs and

cultural landscapes for eligibility for listing on the National Register and/or California Register, and seeking ways to avoid, minimize or mitigate adverse effects to such resources; and

- Incorporate the steps in CHR-2 for identification and evaluation, alternatives to avoid, minimize, or mitigate, and resolution of adverse effects; and
- Conduct further research, including ethnographic research, and consultation with consulting and interested parties to identify and evaluate the potential eligibility for listing on the National Register identified TCPs or the riverscape, as a landscape or TCP; and
- Develop a Cultural Resources Management Plan for the riverscape if it is found eligible for listing on the National Register; and
- Respect and maintain the confidentiality of sensitive information following Section 304 of the NHPA, 16 U.S.C. 470w-3, 36 C.F.R. § 800.11(c) and the Archaeological Resources Protection Act of 1979 (16 U.S.C. § 470hh).

Mitigation Measure CHR-4

Develop plans and consult under Section 106 of the NHPA, NAGPRA, and other Federal and State laws, as applicable, between the DRE ACHP, SHPOs, THPOs, Indian Tribes and other interested parties to add stipulations and appendices to cover exposure, management, disposition, and treatment of human remains; and

- Consult with Indian Tribes and other Indian organizations on identification, treatment, disposition, and management of Prehistoric or historic human remains exposed and/or impacted by the selected alternative, developing protocols or agreement documents as needed; and
- Identify and consult with appropriate individuals and parties on identification and disposition of historic era human remains; and
- Prepare and implement a Plan of Action for the management, consultation, treatment, and disposition of human remains, following NAGPRA on Federal and

Indian tribal lands and California and Oregon State burial laws as applicable to other lands; and

- Prepare and implement an Inadvertent Discovery Plan for unanticipated discoveries of historic properties/historical resources and human remains; and
- Consult on discoveries of historic properties/historical resources in association with human remains as identified in Mitigation Measure CHR-2.

3.13.4.4.2 Effectiveness of Mitigation in Reducing Effects/Impacts

Under NHPA Section 106, Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 would be effective at addressing adverse effects to historic properties as a result of implementing the Proposed Action or other alternatives. Under CEQA, Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 would be effective at reducing most impacts to historical resources as a result of implementing the Proposed Action or other alternatives to less than significant. However, the mitigation measures would not be effective at reducing impacts on the four dams and the KHHD that is recommended eligible for inclusion on the California Register. The Proposed Action and other alternatives would have a significant and unavoidable impact on the Klamath River dams and KHHD. Mitigation measures could be implemented for the removal of dams under the Proposed Action, but implementation of the measures would not reduce impacts to these historical resources to less than significant.

3.13.4.4.3 Agency Responsible for Mitigation Implementation

The Dam Removal Entity or Hydropower Licensee, and State agencies would be responsible for implementing Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4. It is anticipated that a mix of Federal and State agencies would be responsible for implementing the mitigation measures because implementation of the Proposed Action and alternatives requires the involvement of various Federal and State permitting, licensing, and funding agencies.

3.13.4.4.4 Remaining Significant Impacts

Under CEQA, Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 would address most impacts on historical resources associated with the Proposed Action and alternatives. However, the mitigation measures presented in this EIR/EIS would not reduce impacts on the four Klamath River dams and the KHHD that is recommended eligible for inclusion on the California Register to less than significant. Under the Proposed Action and other alternatives impacts to the four Klamath River dams and the KHHD would be significant and unavoidable.

3.13.4.4.5 Mitigation Measures Associated with Other Resource Areas

Several other resources areas include mitigation measures to address construction related effects/impacts associated with implementation of the Proposed Action or other alternatives. These mitigation measures include Rec-1 (relocation of recreational facilities at reservoirs); H-2 (flood-proof structures); GW-1 (deepen or replace affected wells); WRWS-1 (modify or screen affected water intakes); PHS-4 (repair damaged roads); PHS-5 (construct water storage tanks for firefighting); TR-6 (assess and improve roads to carry construction loads); and TR-7 (assess and improve bridges to carry

construction loads). These mitigation measures could affect/impact historic properties/historical resources, other cultural resources, and prehistoric or historic human remains.

Under NHPA Section 106 actions associated with implementing mitigation measures associated with other resource areas could cause adverse effects to historic properties. Adverse effects to historic properties that are a result of these mitigation measures can be resolved through implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4. Under CEQA, actions associated with implementing mitigation measures associated with other resource areas could result in significant impacts to historical resources. Implementation of Mitigation Measures CHR-1, CHR-2, CHR-3, and CHR-4 would reduce impacts to historical resources as a result of these mitigation measures to less than significant.

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3.14 Land Use, Agricultural and Forest Resources

This section analyzes the land use, agricultural, and forest resources impacts of the Proposed Action and alternatives. For the land use analysis, the section describes current land use types, planned uses, and land ownership and management in the area of analysis, described below. For the agricultural and forest resources analyses, the section focuses on the direct changes to land uses that would occur as a result of removal of the J.C. Boyle Dam, Copco 1 and Copco 2 Dams, and Iron Gate Dam (the Four Facilities) as described in the Klamath Hydroelectric Settlement Agreement (KHSA) and alternatives. The Four Facilities are in the Lower Klamath Basin below Keno Dam, also owned by PacifiCorp. The indirect impacts on agricultural and forest uses that may occur from changes in the water distribution in the region from implementation of the Klamath Basin Restoration Agreement (KBRA) are also described. KBRA actions are primarily focused on the Upper Klamath Basin, but also include actions in the Lower Klamath Basin.

This section does not address the potential effects of removal of the Four Facilities on property values and changes in property tax revenues. See Section 3.15, Socioeconomics, for potential effects on property values. Additionally, removal of the dams would alter the flood regime for the portion of the river downstream from Iron Gate Dam. Changes in flood risk are described in Section 3.6, Flood Hydrology.

The public scoping process identified several questions that will not be addressed in the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR). For instance, the public asked about establishing new property lines when reservoirs and the river channel reconfigure. Property line adjustments are not relevant to the EIS/EIR analysis and are not described in the KHSA (KHSA Section 7.6.4). The EIS/EIR does describe potential changes in land use that would occur if the dams were removed.

Participants in the scoping process also sought information regarding whether property owners would have first right to purchase property between the current reservoir shoreline and the newly established river channel boundary. The KHSA details that PacifiCorp's Parcel B lands including those currently inundated by the existing reservoirs will be transferred to the State of Oregon or the State of California, as applicable, or to a designated third party transferee, to be managed for public interest purposes such as fish and wildlife habitat restoration and enhancement, public education, and public recreational access (KHSA Section 7.6.4). This EIS/EIR includes an analysis of all potential property transfers outlined in the KHSA.

3.14.1 Area of Analysis

For this analysis, the land use area was defined as lands encompassed by the Federal Energy Regulatory Commission (FERC) boundary identified in the FERC EIS (2007), surrounding lands that could be affected by implementation of the KHSA and private

lands adjacent to the reservoirs and the Klamath River downstream from the reservoirs to the estuary that would be affected by the removal of the dams and loss of the reservoirs.

The Four Facilities that would be removed under the Proposed Action are in two counties, Siskiyou in California and Klamath in Oregon, and are not within any incorporated cities. The area of analysis includes the areas adjacent to the Four Facilities. The City of Yreka is included because its water supply facilities would be affected by the Proposed Action. In addition, lands downstream from the Iron Gate Dam that may be subject to flooding with or without the dams were identified (see Appendix J, "Modeled Changes to the 100 Year Flood Plain" for maps).

To account for the effects of KBRA implementation, the area of analysis includes the agricultural lands that receive water from the Bureau of Reclamation's (Reclamation) Klamath Project in Klamath, Siskiyou, and Modoc Counties, and two of the wildlife refuges in the Klamath Basin National Wildlife Refuge System, the Tule Lake National Wildlife Refuge (NWR) and the Lower Klamath NWR (Figure 3.14-1). These areas are all within the Upper Klamath Basin above Keno Dam. Reclamation's Klamath Project contains approximately 200,000 acres of farmland and 35,000 acres of wetlands in three counties along the California-Oregon border. Of the approximately 225,000 acres of irrigable land in the project, water deliveries are typically made to between 180,000 – 196,000 acres each year, depending on available water supplies (personal communication, Mike Green, March 23, 2011). Section 1.2.4 describes Reclamation's Klamath Project in more detail. Agricultural areas in the Lower Klamath Basin, downstream from Keno Dam, do not receive water from Reclamation's Klamath Project or irrigation water from any of the four reservoirs.

3.14.1.1 Klamath County, Oregon

Klamath County is in south central Oregon. The county is bordered on the south by California, on the east by Lake County, on the north by Deschutes County, and on the west by Jackson and Douglas Counties. The county, Oregon's fourth largest, has 6,135 square miles (Klamath County 2010a). Klamath County is home to about 66,380 people, with about 20,000 of those people residing in the city limits of Klamath Falls (U.S. Census Bureau 2000, U.S. Census Bureau 2000–2008). Approximately 73 percent of the County is managed by Federal and State agencies, including the United States Fish and Wildlife Service (USFWS), the United States Department of Agriculture Forest Service (USFS), the National Park Service (NPS), the Bureau of Land Management (BLM), and the Oregon Department of State Lands (ODSL).

3.14.1.2 Siskiyou County, California

Siskiyou County is in inland northern California, adjacent to the Oregon border. It is the fifth largest county in the State and has an area of approximately 6,340 square miles with a population of 44,328 (U.S. Census Bureau 2000–2008). More than 60 percent of the County is managed by Federal and State agencies, including USFS, BLM, the USFWS, and California Department of Fish and Game (CDFG). These lands are maintained in various National Forests, National Monuments, National Grasslands, NWRs, designated wilderness, other public lands and State Wildlife Areas (Siskiyou County 2010).

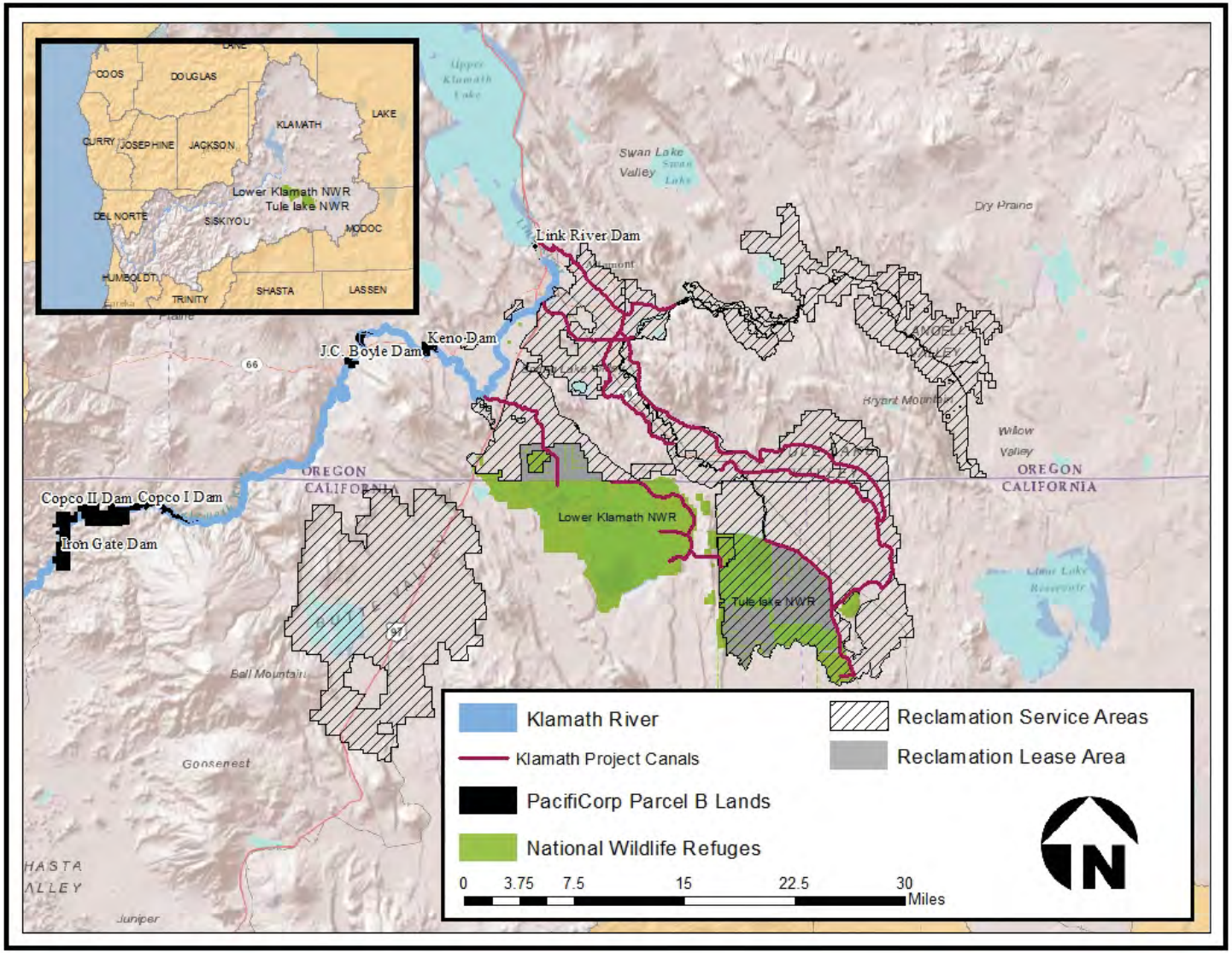

Figure 3.14-1. Reclamation's Klamath Project and National Wildlife Refuges in the Vicinity.

3.14.1.3 Modoc County

Modoc County is just east of Siskiyou County in the northeastern corner of California, where it borders Oregon to the north and Nevada to the east. The county is 4,203 square miles and has approximately 9,100 residents (Modoc County 2011). Almost 70 percent of the county is federally owned in the Modoc National Forest, the Modoc and Tule Lake National Wildlife Refuges, and BLM lands managed out of the Alturas Field Office (Modoc County 2011). Approximately 29 percent of the county is in private ownership, with the remaining one percent split between State lands, County managed property, City properties, and railroads and utility companies (Modoc County 2011). Part of the Tule Lake NWR and Reclamation's Klamath Project is in western Modoc County (Figure 3.14-1).

3.14.1.4 Klamath Basin National Wildlife Refuge System

The Tule Lake NWR and the Lower Klamath NWR are both managed for wildlife habitat and croplands. In 2009, the Lease Land Program leased 22,828 acres of the two refuges for crop production. Of this, 7,518 acres or approximately 33 percent were certified organic, up from 5,753 in 2006, and 1,584 acres were set aside for the walking wetland program, a long-term crop rotation program that alternates the land use between wetlands for wildlife uses and crops for agricultural leases (Department of the Interior [DOI] 2009a).

The Tule Lake NWR covers approximately 39,000 acres, of which 15,000 acres are dedicated to agricultural leases, in addition to another 2,300 acres dedicated to cereal grains and alfalfa cooperatively managed by the USFWS and local farmers (USFWS 2009). The farmland produces barley, oats, wheat, onions, potatoes, and alfalfa. Barley, wheat, and oats cover most of the acreage and potatoes dominate the row crops (USFWS 2010a). Not all of the land dedicated to agriculture in the NWRs is utilized each year, as some land is not leased (Personal Communication, Mike Green, March 23, 2011).

The Lower Klamath NWR is approximately 46,000 acres and straddles the California/Oregon border. Approximately 6,000 acres are leased to farmers through Reclamation's Public Lease Lands program for cereal grain and grass hay production, and another 5,000–7,000 acres are farmed under a cooperative agreement between area farmers and the USFWS (Table 3.14-1) (USFWS 2010b). The leasing and farming of the Tule Lake NWR and Lower Klamath NWR are governed by the Kuchel Act, which was signed into law in 1964. The law provides that Tule Lake NWR and Lower Klamath NWR would be set aside for wildlife habitat and leasing for agricultural use. Only 25 percent of the total land may be planted for row crops. The counties that contain the refuges are intended to receive approximately 25 percent of the net revenues collected during each fiscal year from the leasing of the Federal lands in Reclamation's Klamath Project. This revenue is paid annually to the counties that contain the refuges (Klamath, Siskiyou, and Modoc) in lieu of property tax.

The Kuchel Act also mandates that 13,000 acres of surface water area be maintained in Sumps 1A and 1B (Figure 3.14-1), areas in the refuges that are used to collect agricultural runoff and provide habitat for migrating waterfowl (Personal

Communication, Mike Green, March 23, 2011). In 1976, Congress amended the National Wildlife Refuge System Administration Act of 1966 and provided primary management responsibility to the USFWS. Following the passage of the amendment, Reclamation and the USFWS formed a cooperative agreement on the management of the public lease land. Essentially, Reclamation administers the agricultural leases on the refuge land and the USFWS manages wildlife and habitat, such as the water areas, buffer strips, wildlife use areas, and share crop land (Personal Communication, Mike Green, March 23, 2011).

Table 3.14-1. Kuchel Act Lands in Reclamation's Klamath Project, 2009

State	County	Refuge Area	Agricultural Acres	Marsh Acres	Total Acres
California	Modoc	Tule Lake	4,557	2,640.80	**7197.8**
		Lower Klamath	NA	NA	
	Siskiyou	Tule Lake	12,283.60	12,090.80	**24,374.40**
		Lower Klamath	9,529.70	28,664.50	**38,194.20**
Total Kuchel Acres, California			26,370.3	43,396.10	**69,766.40**
Oregon	Klamath	Lower Klamath	6365.9	0.0	**6365.9**
Total Acreage subject to Kuchel Act					**76,132.3**

Source: Reclamation's Payment to Counties In-Lieu-of-Taxes Report. DOI 2010a.

3.14.1.5 Land Ownership

The area at or near the Four Facilities includes lands owned by PacifiCorp, private owners, and lands managed by BLM, the State of Oregon, and Klamath County. The USFS also manages several parcels outside the Klamath Hydroelectric Project (KHP) boundary near Copco 1 Reservoir as does CDFG. Figure 3.14-2 shows land ownership around the Klamath River in the vicinity of the Hydroelectric Reach.

3.14.1.5.1 PacifiCorp Lands

PacifiCorp owns approximately 11,000 acres in Klamath County and Siskiyou County that are not directly associated with its Klamath hydroelectric facilities, and that are generally not included within the existing FERC project boundary. The KHSA describes this property as Parcel A lands (see Figure 3.14-2). Implementation of the KHSA would have no effect on disposition of Parcel A lands, which would be disposed of by PacifiCorp subject to applicable Public Utility Commission approval requirements (KHSA Section 7.6).

PacifiCorp also owns approximately 8,000 acres in Klamath County and Siskiyou County that are associated with the KHP and/or included within the FERC project boundary. The KHSA describes this property as Parcel B lands (see Figures 3.14-2 through 3.14-4). Of these lands, approximately 2,000 acres are currently inundated by the reservoirs.

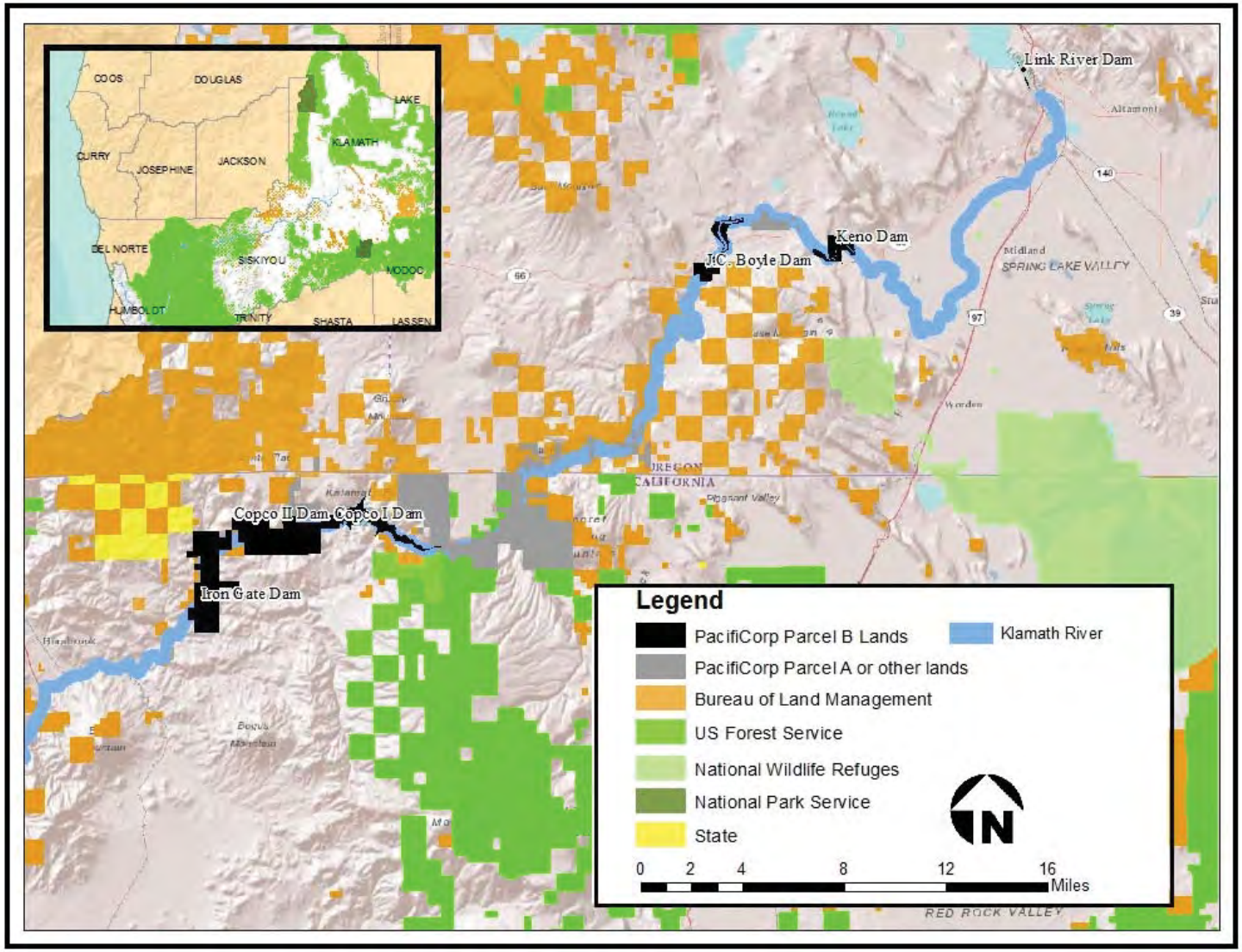

Figure 3.14-2. Land Ownership Around the Klamath River in the Vicinity of the Hydroelectric Reach.

According to the KHSA (Section 7.6.4), Parcel B lands would be transferred to the respective States (Oregon or California) or a designated third party, before facility removal. Lands owned by the State and Federal Government would not be subject to local zoning laws and regulations. The transferred lands would be managed for public interest purposes such as fish and wildlife habitat restoration and enhancement, public education, and public recreational access. The KHSA provides an option that would invoke the "meet and confer" provisions to allow for other uses. The States have no detailed plans but indicate that the approximately 2,000 acres of inundated lands would be restored to natural conditions consistent with the intent of improving fisheries in the Klamath Basin. PacifiCorp also owns electric transmission and distribution facilities, which will remain under its ownership (KHSA Section 7.6.1), and are not analyzed further in the EIS/EIR.

The land around the Keno Development would be transferred from PacifiCorp to the United States to be managed by DOI based on terms agreed to by both parties (KHSA Section 7.5). For purposes of this analysis, the transfer agreement was assumed to be complete by March 31, 2012, which is the target date for reaching an agreement (KHSA Section 7.5.2).

In addition to the above categories of lands, the KHSA identifies three parcels (East Side/West Side generating facilities lands) that may be transferred to DOI, near Klamath Falls, Oregon upon decommissioning (KHSA Section 6.4.1.C).

Ownership at or near the Four Facilities

Land ownership at or near the Four Facilities (Figures 3.14-3 and 3.14-4) is as follows:

- Keno Dam
  - The shoreline of Keno Impoundment is primarily in private ownership, with some Federal (managed by DOI) and State (Oregon) ownership, while the area near the dam is owned by PacifiCorp. The State of Oregon title extends upriver to approximately river mile 233 and includes the bed and banks of the river channel under Keno Dam and Keno Impoundment.
  - PacifiCorp and private entities own the lands along the Klamath River in the Keno Reach.

- J.C. Boyle Dam
  - PacifiCorp owns most of the land at J.C. Boyle Reservoir concentrated along the reservoir and at the dam. The FERC boundary encompasses a few acres of private property and large tracts of public and Oregon and California Railroad (O&C) land managed by the BLM including Topsy Campground and much of the land along the access road, power canal, tunnel, and bypass reach. The FERC boundary also encompasses State-owned land. The title of the State of Oregon extends upriver and includes the beds and banks of the river channel located under J.C. Boyle Dam and J.C. Boyle Reservoir.
  - Most of the land along the J.C. Boyle peaking reach of the Klamath River is public and O&C land managed by the BLM. It also includes some PacifiCorp

and other private property. A small amount of National Forest land managed by the Klamath National Forest lies near the Klamath Hydroelectric Project.

- Copco 1 & 2 Dams
  - PacifiCorp owns the lands around the powerhouses, dams, and Copco 2 Reservoir, while most of the land surrounding Copco 1 Reservoir is privately owned. The BLM also manages some public land near Copco 1 Reservoir and Copco 2 Dam.

- Iron Gate Dam
  - PacifiCorp owns the land adjacent to the Iron Gate Dam, Fish Hatchery, and Powerhouse, as well as most of the land along the Iron Gate Reservoir shoreline and the nearby transmission line right-of-way. The Iron Gate Dam vicinity also includes a small amount of private land.

3.14.1.5.2 Downstream from Iron Gate

The Klamath River passes through federally designated wilderness, National Forests, public land managed by the BLM, undeveloped private lands, and rural tribal reservations for most of its course downstream from Iron Gate Dam. There are no incorporated cities or large developed areas in the watershed downstream from Klamath Falls. Within a one-quarter mile buffer of the Klamath River downstream from Iron Gate Dam to the Estuary, there are approximately 40,500 acres of open space and public lands, 15,600 acres of agricultural lands, 290 acres of residential uses (of various densities), 24 acres of tribal reservation lands, 2,478 acres of urban reserve[1], and 26 acres of commercial use. In addition, the entire Klamath River is designated a wild and scenic river downstream from Iron Gate.

3.14.2 Regulatory Framework

Land use resources within the area of analysis are regulated by several Federal, State, and local laws and policies, which are listed below.

3.14.2.1 Federal Authorities and Regulations

- Farmland Protection Policy Act of 1981
- Federal Land Policy and Management Act of 1976
- Oregon and California Revested Railroad Grant Lands Act of 1937
- Oregon Public Lands Transfer and Protection Act of 1998
- BLM Redding Resource Management Plan and Record of Decision (1993)
- BLM Klamath Falls Resource Area Resource Management Plan and Record of Decision and Rangeland Program Summary (2008)

[1] The following communities have been designated "Urban Reserve" in their county's General Plans to accommodate future growth: Orleans, Humboldt County at RM 48; Weitchpec, Humboldt County at RM 43; Klamath Glen, Del Norte County at RM 6; Requa, Del Norte County located 0.75 miles north of RM 1.25; Requa, Del Norte County located 0.75 miles north of Estuary (General Plans – Land Use [computer file]. Sacramento, CA: California Resources Agency/ University of California, Davis, 2004.)

- BLM Medford District Resource Management Plan and Record of Decision (2008)
- Northwest Forest Plan (1994)[2]
- Fremont National Forest Land and Resource Management Plan (1989)
- Winema National Forest Land and Resource Management Plans (1990)
- Six Rivers National Forest Land Management Plan (1995)
- Kuchel Act of 1964
- Klamath Basin Compact of 1956
- Tribal Forest Protection Act of 2004
- National Wildlife Refuge System Administration Act of 1966

3.14.2.2 State Authorities and Regulations

- California Land Conservation Act of 1965 (Williamson Act)
- California's Farmland Mapping and Monitoring Program
- California Forest Practice Rules
- Oregon Exclusive Farm Use zoning program
- Oregon Forest zoning program
- Oregon Forest Practices Act
- Oregon Department of State Lands jurisdiction between river miles 208 and 233[3]

3.14.2.3 Local Authorities and Regulations

- Klamath Reservation Forest Management Plan (2008)
- Klamath County Land Use Code
- Klamath County Comprehensive Plan (2010b)
- Siskiyou County Land Development Code
- Siskiyou County General Plan (1980)
- Siskiyou County General Plan Land Use Policies (1997)
- Siskiyou County zoning ordinance
- Modoc County General Plan (1988)
- Modoc County zoning ordinance
- City of Yreka General Plan (2003)
- City of Yreka municipal code

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[2] The Northwest Forest Plan, Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, was signed April 14, 1994. The BLM Klamath Falls Resource Area incorporates direction from the Northwest Forest Plan ROD into the 1995 Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary.

[3] The State of Oregon owns the Klamath River and submerged lands between river miles 208 and 233, at and below the ordinary high water mark of the original river channel. Following potential dam removal or implementation of any of the action alternatives, any structure remaining in, on, or over, and any facilities added to the submerged and submersible lands of the navigable waters of the State shall be authorized appropriately through the Oregon Department of State Lands.

3.14.3 Existing Conditions/Affected Environment

3.14.3.1 Land Use

3.14.3.1.1 Land Use Categories

Major land use categories in the area of analysis in Oregon are agriculture, non resource, forestry, rural industrial, and rural communities (see Figure 3.14-3). Major land use categories in the area of analysis in California are Agriculture – Grazing, Forestry Resources, Open Space – Natural Resources, Rural Residential and associated services with many parcels currently vacant (see Figure 3.14-4) The main urban areas are Klamath Falls and the City of Yreka. Most of the land in the area of analysis is devoted either to agriculture/grazing or to open space and conservation of natural resources. A small portion is devoted to hydroelectric operations and recreation sites. There are residential developments on private parcels adjacent to the Klamath River throughout the watershed from Iron Gate to the Pacific Ocean. These include residential developments in and around the community of Keno and the Keno Recreation Area, and along portions of Copco 1 Reservoir.

3.14.3.1.2 Inundated Lands

In Klamath County, lands currently inundated by J.C. Boyle Reservoir do not have land use designations or zoning, and would require a zoning change and plan amendment after the land is no longer inundated (Gallagher 2011). Lands currently inundated by the reservoirs in Siskiyou County have land use designations and zoning that correspond with the adjacent lands (generally agriculture or grazing). After the Proposed Action is complete, they would not require new land use designations or zoning because they run with the land and do not change with an ownership change until there is some action that triggers rezoning and land use amendment (Plucker 2011).

3.14.3.1.3 Open Space/Recreation/Public Lands

Federal and State agencies own and/or manage public lands in the area of analysis. These include public and O&C lands owned by the United States and managed by BLM, National Forests and Grasslands owned by the United States and managed by USFS, wildlife refuges owned by the United States and managed by USFWS, and other publicly-accessible reservoirs and State lands. These areas are used for public recreation and open space, as well as forest and mineral resources. Additionally, DOI manages lands near the Keno Dam that are operated by PacifiCorp for public recreation. Other privately-owned recreation facilities (e.g., Recreational Vehicle parks) operate along the Klamath River downstream from Iron Gate Dam.

3.14.3.1.4 Residential/Developed

In the area of analysis, there are residential developments in the city of Klamath Falls, in and around the community of Keno and the Keno Recreation Area, and along portions of Copco reservoir. These developments are mostly low-density rural residential (e.g., fewer than four units per acre). Many parcels are vacant and undeveloped. There are residential areas along the Klamath River between Iron Gate Dam and the Pacific Ocean, but the land uses and designations will not be affected or changed as a result of the Proposed Action.

3.14.3.1.5 Commercial/Industrial

Besides the dam facilities themselves (zoned industrial), industrial/undeveloped and urban uses occur in the City of Klamath Falls near the East Side and West Side powerhouse developments. In addition, the Klamath Falls co-generation plant, the Collins Products lumber facility, and Jeld-Wen millwork plant are located outside city limits adjacent to Klamath River. There are commercial and industrial developments in some rural areas downstream from Iron Gate Dam, but these developments will not be affected by the removal of the Four Facilities and will not be analyzed further.

3.14.3.1.6 Rural Industrial

Rural Industrial Centers are intended to provide areas for manufacturing, processing, or movement of raw materials in locations where industrial activities have the least potential to impact surrounding rural land uses (Klamath County 2006).

3.14.3.1.7 Rural Service Center or Commercial Services

Rural service centers are unincorporated areas that contain local commercial services to meet the needs of rural residents. These include general stores, limited commercial tourist oriented operations such as accommodations and restaurants, and campgrounds. These areas are located in the areas near the Keno Impoundment and Lake Ewauna. In addition to the areas shown in the Figures 3.14-3 and 3,14-4, there are areas between Iron Gate Dam and the Pacific Ocean that provide services to local residents. However, the Proposed Project will not affect land uses or designations downstream from the Four Facilities.

3.14.3.1.8 Forest/Timber lands

About 58,000 acres is designated forestry in the area of analysis as shown in Figures 3.14-3, and 3.14-4 . These lands are owned by the United States and managed by the USFS, BLM, and private landowners for the purposes of timber harvests and other forest management practices.

3.14.3.1.9 Non Resource

Non-Resource zoning is applied to lands in Oregon that have a low value for timber production, have soils that are unsuitable for agriculture, are not important habitat for fish and wildlife or watershed protection, have not been irrigated or are not irrigable, and are not necessary for permitting adjacent farm or forestry activities (Klamath County 2006).

3.14.3.1.10 Agriculture

Agriculture is an important part of the economy for Klamath, Siskiyou, and Modoc counties. Hay, alfalfa, vegetables, nursery crops, livestock, and various grains are all grown in the three-county area that receives water from Reclamation's Klamath Project in the Upper Klamath Basin. The Agricultural Commissions of each California county prepare crop reports that focus on production at the county level. Reclamation provides annual crop reports for Reclamation's Klamath Project.

According to the California Water Plan's 2009 update, 55 percent of Reclamation's Klamath Project is in Oregon in Klamath County, and the remaining 45 percent is in California in Siskiyou and Modoc Counties (see Figure 3.14-1).

Figure 3.14-3. Land Use at Keno and J.C. Boyle Dams.

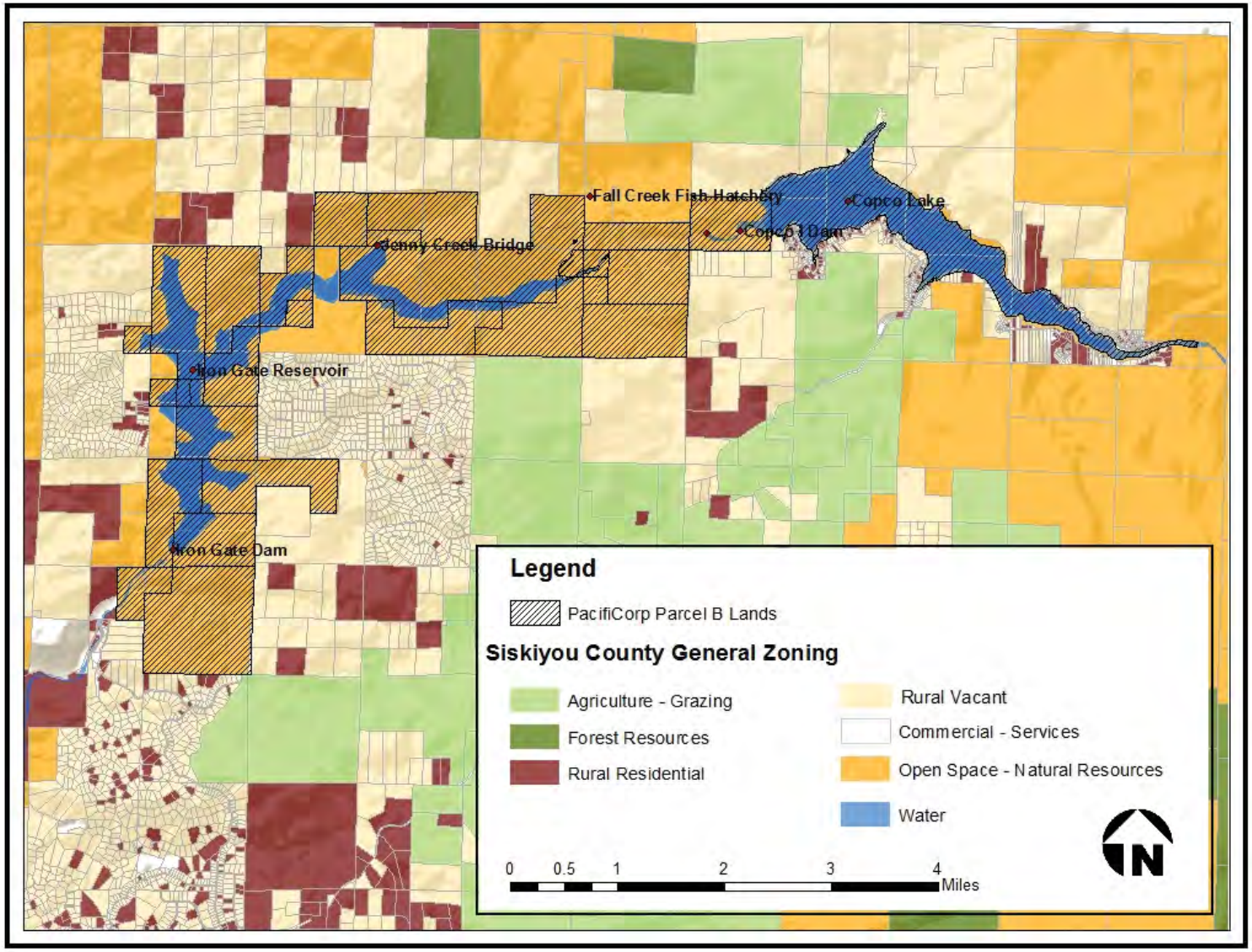

Figure 3.14-4. Land Use – Iron Gate and Copco Dams.

Reclamation's Klamath Project provides water to agricultural lands and wetlands in the upper Klamath River and Lost River Sub-basins in Klamath County, Oregon, and both Siskiyou and Modoc Counties in California. A large percentage of the 35,000 wetland acres are in California. Of the total land area in Reclamation's Klamath Project, 45 percent are in California and 55 percent are in Oregon; however, only 32 percent of the agricultural land within Reclamation's Klamath Project is located in California and 68 percent in Oregon (Personal Communication, Mike Green, March 23, 2011).

Table 3.14-2. 2009 Irrigable Lands in Reclamation's Klamath Project by State

State	Acres Irrigated	Fallow or Idle	Total Irrigable
California	65,321.30	6,313.80	71,635.10
Oregon	124,951.80	28,378	153,329.80
Total	190,273.10	34,691.80	224,964.90

Source: Reclamation's Klamath Project 2009 Crop Report. DOI 2010b.

Water is captured in the Clear Lake and Gerber Reservoirs and the Lost River for the Lost River or Eastside portion of Reclamation's Klamath Project and in Upper Klamath Lake and the Klamath River for the Klamath or Westside portion of the project (see Figure 3.14-1). The drainage area of the entire project is approximately 5,700 square miles (DOI 2009b). See Chapter 1.2.4 for additional detail regarding Reclamation's Klamath Project.

Klamath County

Agricultural land in Klamath County totals about 465,000 acres. About 33 percent of these agricultural lands are within Reclamation's Klamath Project boundaries. As shown in Figure 3.14-5, much of Klamath County's agriculture land in the area of analysis is zoned Exclusive Farming Use (Oregon Zoning (computer file) Oregon State Service Center for GIS, 1998).

Upper Klamath Lake is a major source of water through Reclamation's Klamath Project to the farmland in Klamath County as well as Siskiyou and Modoc Counties.

Siskiyou and Modoc Counties

The farmland in Siskiyou and Modoc Counties is a combination of Prime Farmland, Farmland of Statewide Importance, Unique Farmland and other classifications recognized by the State Department of Conservation (see Figure 3.14-5) (California Department of Conservation (CDC) 2010). Other classifications are farmland of local importance and grazing land which are designations made by the county. There are approximately 754,000 acres in farmland categories in Siskiyou County. Approximately 138,000 acres are in the primary categories of Prime Farmland, Farmland of Statewide Importance, or Unique Farmland. Modoc County has approximately 286,000 acres in farmland

categories. Approximately 138,000 acres are in the primary categories of Prime Farmland, Farmland of Statewide Importance, or Unique Farmland. Much of the Siskiyou County farmland is outside of the area of analysis, in the Scott River and Shasta River Sub-basins. Much of the agricultural lands in Modoc County is outside of the Klamath Basin. These areas do not receive water from Reclamation's Klamath Project, and would not be affected by changes in water allocation associated with the Proposed Action.

In California, agricultural or open space lands designated by the county may be enrolled under the Williamson Act for property tax assessment. There are no Williamson Act lands adjacent to the Four Facilities although there are Williamson Act lands in the Upper Klamath River Sub-basin. Most Williamson Act lands in the Lower Klamath Basin are in Shasta River Sub-basin and Scott River Sub-basin. In the Upper Klamath Basin, there are Williamson Act lands in the Butte and Lost River Sub-basins which are served by the Reclamation Klamath Project.

Reclamation's Klamath Project does serve lands in the Upper Klamath Basin within Siskiyou and Modoc Counties. Of the primary categories of Prime Farmland, Farmland of Statewide Importance and Unique Farmland, approximately 38,500 acres in Siskiyou County and approximately 41,500 acres in Modoc County. In the Klamath Project area, approximately 38,500 acres of these lands in Siskiyou County are considered irrigable. Approximately 33,000 acres in Modoc County are considered irrigable.

3.14.3.1.11 Lands Downstream from Iron Gate Dam Subject to Flooding

Certain lands along the Klamath River are subject to flooding. These include agriculture and grazing lands, recreation sites and unincorporated communities along the Klamath River. Flooding risk is described in Appendix J for a portion of the Klamath River downstream from Iron Gate Dam to Happy Camp as modeled for a 100 year event with and without the hydroelectric dams. Effects are discussed in Section 3.6, Flood Hydrology.

3.14.3.2 Existing Infrastructure

Existing infrastructure potentially affected by the Proposed Action are the City of Yreka water line, existing domestic wells, recreation sites and facilities, and roads. Details of utilities and public services are found in Section 3.18, Public Health and Safety, Utilities and Public Services, Solid Waste and Power, and recreation facilities are described in Section 3.20, Recreation. The existing roads are owned by PacifiCorp, the Federal Government, counties or private entities, details of which can be found in Section 3.22, Traffic and Transportation.

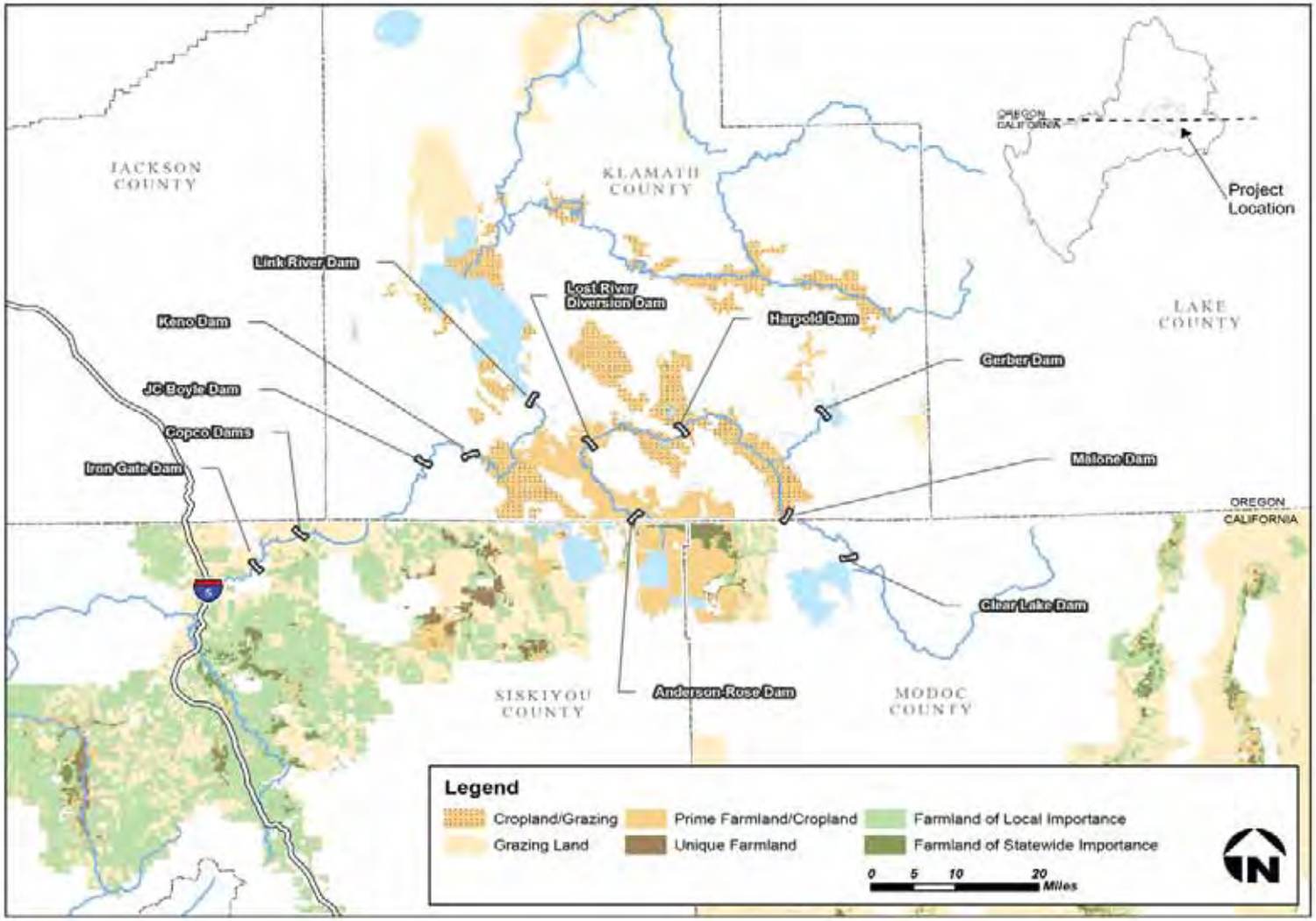

Figure 3.14-5. Upper Klamath Basin Agricultural Resources.

3.14.4 Environmental Consequences

3.14.4.1 Effects Determination Methods

The Lead Agencies reviewed the plans, codes, regulations and ordinances listed in Section 3.14.2 to aid this analysis. Existing land uses were identified from a variety of sources including Federal and State agencies and the respective counties. The effects analysis identifies direct and indirect effects on land use, agricultural and forest resources under the No Action/No Project Alternative, the Proposed Action, and the other alternatives. The types of land use effects that were analyzed included temporary effects associated with dam removal, demolition, and staging and permanent effects such as transfers of ownership, changes in land use, and required changes to local land use plans and zoning ordinances. The Lead Agencies also considered possible conflicts or inconsistencies between the proposed alternatives and Federal, State, regional, local, or tribal land use plans, policies, or controls relevant in the area of analysis. Temporary and permanent direct and indirect conversions of agricultural lands were also analyzed. In addition, the Lead Agencies examined the changes in land ownership, including the ownership and operation of Keno Dam. Section 3.20, Recreation, discusses roads and access to the new river channel, both for public access and for private owners adjacent to the reservoirs. The discussion below includes the effects on land use from new access roads for deconstruction activities. New roads that may be required to mitigate impacts from the removal of recreational facilities are discussed in the analysis of mitigation measures for other resource areas.

Changes in shoreline access are addressed in Section 3.20, Recreation, because they would not constitute a land use change. Effects on the property values of private lands adjacent to the reservoirs due to the loss of the reservoirs are addressed in Section 3.15, Socioeconomics, because the land use of those properties would not change.

This section includes an evaluation of potential conflicts between the existing and proposed land uses. Although conflicts with zoning or land use policies, in and of themselves, would not constitute a physical impact on the environment (California Environmental Quality Act (CEQA) Guidelines Section 15064(d)(1)), the act of decommissioning the dams would ultimately cause physical changes in the environment. Physical changes resulting from the Proposed Action and the various alternatives are addressed throughout this EIS/EIR. Where significant adverse environmental impacts would occur, this EIS/EIR offers mitigation measures for reducing the physical impacts on the environment that would be caused by the change in land use.

The No Action/No Project Alternative provides the baseline condition against which the alternatives were measured. In particular, under the No Action/No Project Alternative, allocations of water to the irrigators and KHP would continue as dictated under the existing agreements and the Biological Opinion's from the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service and the USFWS.

3.14.4.2 Significance Criteria

The proposed action and the alternatives analyzed in the EIS/EIR are in conformance with the Bureau of Land Management's 1995 Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary and the 1993 Redding Resource Management Plan and Record of Decision. The BLM's planning regulations state that the term "conformity" or "conformance" means that "a resource management action shall be specifically provided for in the plan, or if not specifically mentioned, shall be clearly consistent with the terms, conditions, and decisions of the approved plan or amendment" (43 CFR 1601.0-5(b)).

For the purposes of this EIS/EIR, impacts would be significant if they would result in the following:

- Conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project (including, but not limited to the general plan, specific plan, local coastal program, or zoning ordinance) adopted for the purpose of avoiding or mitigating an environmental effect.
- Convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Farmland), as shown on the maps prepared pursuant to the Farmland Mapping and Monitoring Program of the California Resources Agency, or Exclusive Farm Zone land as defined by the Oregon Revised Statutes, Chapter 308, to non-agricultural use.
- Conflict with existing zoning for agricultural use, or a Williamson Act contract.
- Conflict with existing zoning for, or cause rezoning of, forestland (as defined in Public Resources Code Section 12220(g)), timberland (as defined by Public Resources Code Section 4526), or timberland zoned Timberland Production (as defined by Government Code Section 51104(g)).
- Result in the loss of forestland or conversion of forestland to non-forest use.
- Involve other changes in the existing environment that could result in conversion of Farmland, to non-agricultural use or conversion of forest land to non-forest use.

3.14.4.3 Effects Determinations by Alternative

3.14.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, the KHSA would not be implemented and the KBRA would not be fully implemented. Under this alternative, resource management actions and restoration activities that are part of the KBRA and that are currently approved and on-going would continue to be implemented.

The No Action/No Project Alternative could conflict with applicable land use plans, policies, or regulations adopted for the purpose of avoiding or mitigating an environmental effect. The No Action/No Project Alternative would not conflict with applicable plans, policies, or regulations because no action would not result in any changes or actions that would conflict with land use, agriculture, or forest plans, policies, or regulations. **There would be no change from existing conditions to land use and agriculture from the No Action/No Project Alternative.**

The No Action/No Project Alternative could result in the conversion of farmland to non-agricultural use or conflict with Williamson Act land or agricultural zoning. No land uses would be converted directly as a result of the No Action/No Project Alternative. Under the No Action/No Project Alternative, there would be continued uncertainty for irrigators dependent on Reclamation's Klamath Project water because of allocation methods required under the Biological Opinions which make it difficult for farmers to plan for the next season. The 2001 Klamath Project Operations Plan that curtailed deliveries to project irrigators due to low water conditions and the flow requirements of the Biological Opinion's indicates potential future water allocations under the No Action/No Project Alternative. Continuing this uncertainty could indirectly result in local farmers retiring farmland to reduce their dependence on Reclamation's Klamath Project water, potentially by selling agricultural property for development or other non-agricultural uses. Irrigators would continue to respond to uncertain water allocations under the No Action/No Project Alternative. **There would be no change from existing conditions to land use and agriculture from the No Action/No Project Alternative.**

The No Action/No Project Alternative could result in the conversion of forest lands to non-forest use or conflict with forest zoning. The No Action/No Project Alternative would not directly conflict with existing zoning for, or cause rezoning of, forest land, timberland, or timberland zoned Timberland Production. **There would be no change from existing conditions in forest lands from the No Action/No Project Alternative.**

The No Action/No Project Alternative could indirectly convert farmland, to non-agricultural use or forest land to non-forest use. The No Action/No Project Alternative would not include making changes in forest land use and would not involve other changes in the existing environment which, due to their location or nature, would result in conversion of farmland to non-agricultural use or forest land to non-forest use. **There would be no change from existing conditions to farmland or forest land uses from the No Action/No Project.**

Under the No Action/No Project Alternative, ongoing restoration actions would continue to be implemented and could affect land use, agriculture, and forest resources. These actions include the Agency Lake and Barnes Ranches Project, and ongoing fisheries restoration actions. Reclamation purchased the Agency Lake and Barnes Ranches adjacent to Agency Lake in 1998 and is currently using portions of the ranches as pumped storage. These ranches have been transferred to the USFWS and are now part of the Upper Klamath NWR. USFWS is studying the possibility of breaching the dikes which would convert the 63,770 acre-feet of storage from pumped storage to passive storage in Upper Klamath Lake. The Agency Lake/Barnes Ranches Project would go through separate National Environmental Policy Act evaluations as plans are developed for future restoration activities. **Future changes would not substantively change the existing land uses or areas used for agriculture, and do not affect forest lands, and therefore, there would be no change from existing conditions.**

3.14.4.3.2 Alternative 2: Full Removal of Four Dams (the Proposed Action)

Implementation of the KHSA would include full removal of the Four Facilities, drawdown and removal of the associated reservoirs, and restoration of formerly inundated lands in the project area.

The Proposed Action could conflict with applicable land use plans, policies, or regulations adopted for the purpose of avoiding or mitigating an environmental effect. The Proposed Action would have no effect on the disposition of Parcel A lands. Activities defined in the Proposed Action would change current uses of the Parcel B lands in the vicinity of J.C. Boyle Dam from rural industrial to non-resource. Land use designations around the other reservoirs would not be changed as existing designations would be consistent with potential future land uses. Activities defined in the Proposed Action would not conflict with any applicable land use plan, policy, or regulation of an agency with jurisdiction over the project adopted for the purpose of avoiding or mitigating an environmental effect. The plans and policies described in Section 3.14.2 would not be affected by the Proposed Action, because the inundated lands in Siskiyou County already have zoning and land use designations that would not change once they are no longer inundated (Plucker 2011). In Klamath County, formerly inundated lands would require new land use designations and zoning, the designation of which would likely not conflict with any adopted plans or policies (Gallagher 2011). Private lands adjacent to the reservoirs would not have a land use change; however, those lands would no longer be adjacent to inundated land with reservoir views and that is currently used for water-based recreational purposes. In the future other land-based recreational uses could occur on the publicly owned property. Although the land use designations and zoning would not change *per se*, the functional use of the area would change and would be noticeable to the private property owners. **The Proposed Action would not conflict with land use plans, policies or regulations adopted for the purpose of avoiding or mitigating an environmental effect, and therefore, there would be no change from existing conditions.**

The Proposed Action could result in the conversion of farmland to non-agricultural use or conflict with Williamson Act land or agricultural zoning. Implementation of the Proposed Action would not involve directly converting farmland to non-agricultural uses, and would not conflict with existing zoning or Williamson Act contracts. Certain programs of the KBRA may indirectly affect agricultural lands in Reclamation's Klamath Project. These programs are discussed below in the KBRA section. **The Proposed Action would not result in the conversion of farmland to non-agriculture use, nor would it conflict with Williamson Act land or agricultural zoning, and therefore, there would be no change from existing conditions.**

The Proposed Action could result in the conversion of forest lands to non forest use or conflict with forest zoning. Implementation of the Proposed Action would not affect the forest lands or forest uses surrounding the reservoirs or in the larger area of analysis. There would be no changes in land use under the Proposed Action that would conflict

with forest use or zoning. **There would be no change from existing conditions as a result of the Proposed Action.**

The Proposed Action could impact the existing environment resulting in changes that could result in conversion of farmland to non agricultural use or conversion of forest land to non forest use. Dam decommissioning and removal would require the creation of temporary roads, staging areas and construction sites. Although existing roads provide access to the KHP facilities, new roads would be needed during deconstruction activities. Temporary construction roads and staging sites would also be required during dam removal activity (see Chapter 2). Permanent disposal sites would be needed near the dams on lands currently designated open space and/or conservation. Site access for restoration activities would require construction of temporary gravel access roads and storage pads. Because these temporary roads would be built on lands designated for industrial (dam) or open space use or on currently inundated lands, and could be returned to their original or alternate use following deconstruction, construction of the roads would not conflict with applicable plans and policies or otherwise cause a significant land use impact. The need for new roads and the capacity and use of existing roads is addressed in Section 3.22, Traffic and Transportation. **The development of temporary roads and staging/construction sites would be a less than significant land use impact.**

New, permanent roads constructed to provide access to recreation areas could constitute a change in the existing environment. Permanent roads associated with achieving public access to the river would be addressed as part of the recreation plan (mitigation measure REC-1). However, those roads would not constitute a significant land use impact because they would not take agricultural or forest lands out of production. **The development of permanent roads for public access would be a less than significant land use impact because it would not result in changes that could result in conversion of farmland to non-agricultural use or conversion of forest land to non-forest use.**

A detailed discussion of the traffic impacts and road conditions concerns is provided in Section 3.22, Traffic and Transportation, and Mitigation Measure TR-1 addresses these concerns. Therefore, the Proposed Action would not conflict with policies or regulations within the City of Yreka. **There would be no change from existing conditions as a result of the Proposed Action and pipeline relocation.**

Under the Proposed Action, removal of recreational facilities currently located on the banks of the existing reservoirs could change land use classification. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities would be removed, an action that would not result in a change of forest land uses or convert forest lands to other uses. **There would be no change from existing conditions resulting from the removal of the recreational facilities.**

3.14.4.3.3 Keno Transfer

The transfer of ownership of Keno Dam from PacifiCorp to Reclamation could result in a change in land use. The Keno Transfer would not change the use or operation of the Keno Dam or the Keno Impoundment, nor directly result in a change of land use in the surrounding area. **There would be no change from existing conditions as a result of the Keno Transfer.**

3.14.4.3.4 East and West Side Facilities – Programmatic Measures

The decommissioning of the East and Westside facilities could impact land use. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals. Although the land used for hydropower would no longer be used for that purpose, the decommissioning would not directly change the current land use of the canal system. **Therefore, the decommissioning of these facilities would have no impact on land use, agriculture, or forest resources.**

3.14.4.3.5 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The City of Yreka Water Supply Pipeline, currently under the Iron Gate Reservoir, would need to be relocated to avoid damage after the reservoir is removed, creating a change in the existing environment and surrounding environment. The Proposed Action would require the relocation, replacement, and/or burial of the existing 24-inch diameter water line and transmission facilities from the City of Yreka's Fall Creek diversion (KHSA Section 7.2.3). The Proposed Action calls for placing the City of Yreka's waterline on a pipe bridge across the river. This would require construction of footings and other infrastructure to support the pipe bridge, resulting in construction at the site. However, a structure for the purpose of water conveyance would not constitute a land use change and would not conflict with applicable regulations and codes, because the contractor would be required to obtain all building permits prior to construction. Impacts on visual resources from a pipe bridge are addressed in Section 3.19, Scenic Quality. **The relocation of the City of Yreka Water Supply Pipeline would have no impact on land use, agriculture, or forest resources.**

3.14.4.3.6 KBRA – Programmatic Measures

The KBRA has several programs that could affect land uses within the Klamath Basin:

- Fisheries Reintroduction and Management Plan
- Water Diversion Limitations
- Water Use Retirement Program
- Power for Water Management
- Mazama Forest Project

Fisheries Reintroduction and Management Plan

Construction of fish handling facilities for trap and haul operations within the Fisheries Reintroduction and Management Plan could change land use. The Fisheries Reintroduction and Management Plan includes trap and haul operations that move fish

around Keno Impoundment and Link River during times of poor water quality. Trap and haul operations would require construction of new fish handling facilities near Keno Dam and Link River Dam. Because these new facilities would be built on lands designated for industrial (dam) use, their construction would not conflict with applicable plans and policies or otherwise cause a significant land use impact. The potential land use conversions generated by development of trap and haul facilities would not be expected to contribute to any land use effects generated by the hydroelectric facility removal action analyzed above. **The development of new fish handling facilities would be a less than significant land use impact.**

On Project Plan and Water Diversion Limitations

The implementation of the Water Diversion Limitations could convert farmland to non-agricultural uses, a potentially significant effect. The Water Diversion Limitations is part of the On-Project Water Users Program and would limit water diversions to specific irrigators receiving water on Reclamation's Klamath Project, and could decrease the total acreage under cultivation or indirectly convert farmland to non-agricultural use. The Water Diversion Limitations and the On-Project Plan (KBRA 15.1 and 15.2, respectively) outline water diversion limitations to specific diversions that are intended to increase water availability for fisheries purposes, especially in drier years. Agricultural water diversion limitations would be based on annual water level forecasts for Upper Klamath Lake which could result in less available water for irrigators during drought years and result in the conversion of farmland to non-agricultural uses. Also included are allocation and delivery guidelines for water provided to the Tule Lake NWR and Lower Klamath NWR for both wildlife and agricultural interests, which include the Tule Lake Irrigation District and the Klamath Drain District.

Activities in the On-Project Plan and the Water Diversion Limitations that have the potential to impact agriculture in the region include:

- Creation of conservation easements, forbearance agreements, and/or land acquisitions intended to reduce water use for irrigation. This could result in land fallowing and/or a shift in crop types to dry land crops.
- Implementation of water use efficiency and conservation measures to reduce surface water use, including drip irrigation.
- Development of new groundwater sources, and the potential creation of new surface and groundwater storage areas.

Implementation would include the establishment of fixed, annual water diversion amounts to agricultural uses based on available water and forecast water levels in the Upper Klamath Lake. While the diversion could reduce the availability of irrigation water by up to 100,000 acre feet less than irrigators received in the past, these fixed volumes would provide a base level for agricultural diversions and establish an irrigation framework that would provide security and increased certainty for farmers, allowing

them to make decisions about the year's crops and activities based on the water forecast. This security would mitigate the effects of the lower delivery amount that may be expected in dry years.

The activities in the Water Diversion Limitations have the potential to reduce the amount of agriculture occurring on Reclamation's Klamath Project. Implementation of the On-Project Water Use Program will maximize the use of available water supplies, improve water supplies for the National Wildlife Refuges, and increase reliability for agricultural users. The conversion of farmland to non-agricultural uses that could occur as a result of agricultural diversion limitations would be a significant impact. However many of the actions described in the KBRA are anticipated to be beneficial to the environment and thus likely to have beneficial effects. The Diversion Limitations will also provide a more reliable water supply to the NWRs, a beneficial effect. The potential land use conversions generated by activities in the Water Diversion Limitations would not be expected to contribute to any land use effects generated by the hydroelectric facility removal action analyzed above. **The On-Project Plan and the Water Diversion Limitations would maximize the use of available water, increase reliability for irrigators, and benefit the long-term sustainability of agricultural practices in the Klamath Basin. Impacts are therefore expected to be less than significant and potentially beneficial in the long term.**

Water Use Retirement Program (WURP)

The WURP could result in the fallowing or conversion of agricultural land non agricultural uses, such as open space or wetland restoration areas. The WURP is part of the Off-Project Water Program and is intended to resolve the existing disputes between the Off-Project Irrigators, The Klamath Tribes, and the Bureau of Indian Affairs, and increase the stream flow into Upper Klamath Lake. The Off-Project Water Program applies to the Wood, Sprague, Sycan, and Williamson River sub-basins, all of which are upstream of Upper Klamath Lake and outside the boundaries of Reclamation's Klamath Project.

The increase of permanent inflow to Upper Klamath Lake would be accomplished through various methods outlined in the WURP. The program is intended to permanently retire 30,000 acre-feet of water rights from irrigators to permanently increase inflow to Upper Klamath Lake (KBRA Section 16.2.2). The description of the WURP program in the KBRA does not mandate how this 30,000 acre feet would be acquired, but it could include:

- Retirement of water rights and forbearance agreements
- Short-term water leasing and split season irrigation
- Upland management techniques, such as juniper removal and timber thinning
- Water efficiency measures and dry land cropping
- Natural storage improvements, such as wetlands or improved riparian areas.

While no part of KBRA implementation would directly convert agricultural land to other uses, the KBRA provisions discussed above could result in agricultural land being temporarily or permanently retired. However, the EIS/EIR cannot characterize the specific impact from the KBRA on the conversion of farmland to non-agricultural use as a result of these programs because the number of voluntary participants, acres of farmland, and the final use of the lands affected by the program is unknown. The KBRA programs would protect the sustainability of agricultural uses and communities by improving the reliability of the agricultural water supply and settling long standing disputes on the amount, timing, and other conditions of water diversion and delivery for agriculture. The potential land use conversions generated by activities in the WURP would not be expected to contribute to any land use effects generated by the hydroelectric facility removal action. The KBRA could result in the conversion of farmland to non-agricultural use or conflict with Williamson Act land or agricultural zoning, a potentially significant impact. **However, the other potential measures outlined in the WURP would improve operational efficiency and are expected to benefit the long-term sustainability of agricultural practices in the Klamath Basin. Implementation of these programs will require future environmental compliance as appropriate.**

Power for Water Management

The Power for Water Management could affect land use in Reclamation's Klamath Project area. The Power for Water Management program is intended to deliver power to eligible users at a cost that is targeted at or below the average cost for similarly situated Reclamation irrigation and drainage projects. The goals of the program include providing affordable electricity for efficient use, distribution, and management of water within Reclamation's Klamath Project and the Klamath Basin NWR System, facilitating the return of water to the Klamath River as part of the implementation and administration of the On-Project Plan, and facilitating the implementation of the WURP and Off-Project Water Settlement (OPWAS). There are three components of the Power for Water Management – the Interim Power Program, a Federal Power Program, and a Renewable Power Program. Under the KBRA a power management entity would be created to manage the delivery of affordable power to eligible users.

- The Interim Power Program is intended to maintain the power cost target for eligible users while other programs from the KBRA are implemented. The program will help to offset the impacts of rising power prices on agricultural producers, and could prevent some agricultural producers from selling their property and/or converting it to other users. The Interim Power Program is unlikely to have an adverse effect on land use, agriculture, or forest resources.
- The Federal Power Program is a management program intended to obtain and provide for the transmission and delivery of Federal preference power to eligible users. The implementation of the program is unlikely to have adverse effects on land use, agriculture, or forest resources.
- The Renewable Power Program is a combination of energy efficiency measures and renewable generation projects intended to reduce power costs for eligible power users. The Program includes development of a financial and engineering plan to identify efficiency measures and renewable energy resources. These

include solar arrays, wind farms, and biomass energy facilities. These green power projects could be constructed on land currently used for agriculture or zoned for non industrial uses, which would have an adverse effect on land use, agriculture, or forest resources.

Implementation of the KBRA would not include construction or other projects that would conflict with existing zoning or Williamson Act contracts. However, green power projects, such as solar arrays or wind farms, could be constructed to replace part of the power generation capacity lost with the removal of the Four Facilities on land currently used for agriculture or zoned for non industrial uses. This would result in a change of land use should these potential projects be sited on agricultural lands. The potential land use conversions generated by siting and construction of renewable power projects would not be expected to contribute to any land use effects generated by the hydroelectric facility removal action. The KBRA Power for Water Management would have beneficial effects on land use, agriculture, and forest resources in the short term by creating incentives for agricultural producers. Impacts associated with siting and construction of renewable energy generation projects in the Renewable Power Program could generate significant, adverse, long term effects on land use and agriculture. However, other KBRA measures analyzed in this section are expected to benefit the long-term sustainability of agricultural practices in the Klamath Basin. **When considered with other KBRA programs that would benefit agriculture, implementation of the Power for Water Management would be expected to generate a less than significant impact on land use. These effects will be analyzed in future environmental documents as necessary.**

Mazama Forest Project

The KBRA's Mazama Forest Project could result in the conversion of forest land to non-forest use or conflict with forest zoning. The Mazama Forest Project is a planned purchase of 90,000 acres of former reservation land by the Klamath Tribes (Chui 2008; Kerr 2012). The land would be managed under the Klamath Tribes Forest Management Plan. The management of the adjacent Fremont-Winema National Forest would be influenced by the Mazama Forest Project under collaboration language from the Federal Tribal Forest Protection Act. The project would allow for long term forest management and timber operations, and thus would not convert forest land to other uses or conflict with forest zoning. Implementation of specific plans and projects described in the KBRA would require future environmental compliance as appropriate. **The KBRA is not expected to convert forest land to non-forest use and would not conflict with forest zoning, therefore it is expected to result in no change from existing conditions.**

3.14.4.3.7 Alternative 3: Partial Facilities Removal of Four Dams

The effects of the Partial Facilities Removal of Four Dams Alternative would be similar to those described for the Proposed Action. However, the powerhouses at Copco 1, 2 and Iron Gate, and the warehouses and support buildings at Copco 2 would be left in place and shuttered for the foreseeable future. The shuttering would not constitute a change in land use, nor would it conflict with an applicable plan or policy. **Effects would be less than significant.**

3.14.4.3.8 Keno Transfer

The effects of the Keno Transfer would be the same as those described for the Proposed Action.

3.14.4.3.9 East and Westside Facilities – Programmatic Measures

The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action.

3.14.4.3.10 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the City of Yreka Water Supply Pipeline relocation would be the same as those described for the Proposed Action.

3.14.4.3.11 KBRA – Programmatic Measures

Under this alternative, the KBRA would be fully implemented and the potential effects would be the same as described for the Proposed Action.

3.14.4.3.12 Alternative 4: Fish Passage at Four Dams

The effects of the Fish Passage at Four Dams Alternative would be the same as those described above for the No Action/No Project Alternative, except that it would require the creation of new permanent roads to access fish ladder facilities.

Construction of permanent access roads could change land use. The Fish Passage at Four Dams Alternative would require the creation of new permanent roads. Although existing roads provide access to the KHP facilities, new roads would be needed for the fish passage alternative to provide permanent access to those facilities. Because these new roads would be built on lands designated for industrial (dam) use, their construction would not conflict with applicable plans and policies or otherwise cause a significant land use impact. **The development of new permanent roads would be a less than significant land use impact.**

3.14.4.3.13 Trap and Haul – Programmatic Measures

Construction of fish handling facilities for trap and haul operations could change land use. Trap and haul operations would move fish around Keno Impoundment and Link River during times of poor water quality. Trap and haul operations would require construction of new fish handling facilities near Keno Dam and Link River Dam. Because these new facilities would be built on lands designated for industrial (dam) use, their construction would not conflict with applicable plans and policies or otherwise cause a significant land use impact. **The development of new fish handling facilities would be a less than significant land use impact.**

3.14.4.3.14 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as those described above for the Proposed Action with respect to removal of Copco 1 and Iron Gate Dams, and the same as the Fish Passage at Four Dams with respect to the new roads.

3.14.4.3.15 Trap and Haul – Programmatic Measures

Construction of fish handling facilities for trap and haul operations could change land use. The trap and haul measures around Keno Impoundment and Link River would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **The development of new fish handling facilities would be a less than significant land use impact.**

3.14.4.3.16 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the City of Yreka Water Supply Pipeline relocation would be the same as described for the Proposed Action.

Mitigation Measures Associated with Other Resource Areas

Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. The areas that would be used for the relocation are currently inundated and their development would not result in a land use conversion or change in forest land uses. **There will be no impact to forest or agricultural land uses resulting from the implementation of Mitigation Measure REC-1.**

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3.15 Socioeconomics

This section describes socioeconomic effects of the four action alternatives and No Action/No Project Alternative. Socioeconomic effects include potential changes to economic output, labor income, and employment in the area of analysis, as well as, fiscal effects on local governments. This section also describes socioeconomic effects on Indian Tribes in the Klamath Basin. The transfer of Keno Dam's ownership to the Department of the Interior (DOI) would not result in socioeconomic effects and is not further discussed in this section.

3.15.1 Area of Analysis

The socioeconomic study area includes Del Norte, Humboldt, Modoc, and Siskiyou Counties in California and Curry, Klamath, and Jackson Counties in Oregon. The Four Facilities are in Siskiyou and Klamath Counties. The remaining counties have local economies linked to the Klamath River through fishing, recreation/tourism, or agriculture industries. Indian Tribes' economic and social welfare is also closely linked to the Klamath River. Various economic regions have been developed for the economic analysis based on where the direct economic activity would likely occur. For example, changes to irrigated agriculture as a result of the action alternatives would occur on Bureau of Reclamation's (Reclamation's) Klamath Project lands in Modoc, Siskiyou, and Klamath Counties; therefore, the economic region for irrigated agriculture effects includes these three counties. Figure 3.15-1 shows all counties in the direct area of analysis. Some economic effects for commercial fishing may occur in counties further from the Klamath Basin, most notably Mendocino, Sonoma, Marin, San Francisco, and San Mateo Counties in California and Lane, Douglas, and Coos Counties in Oregon. Section 3.15.2 defines the regions (groups of counties) and potential span of effects for each economic effect analyzed.

3.15.2 Regulatory Framework

Socioeconomics within the area of analysis is regulated by several Federal laws and policies, which are listed below.

3.15.2.1 Federal Authorities and Regulations

- Magnuson Fishery Conservation and Management Act of 1976
- Federal Endangered Species Act (ESA)
- Pacific Coast Salmon Plan and Amendments
- 1993 Solicitor's Opinion Fishing Rights of the Yurok and Hoopa Valley Tribes
- 1994 Northwest Forest Plan[1]

[1] The Northwest Forest Plan, Record of Decision (ROD) for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl, was signed April 14, 1994. The BLM Klamath Falls Resource Area incorporates direction from the Northwest Forest Plan ROD into the 1995 Klamath Falls Resource Area Record of Decision and Resource Management Plan and Rangeland Program Summary.

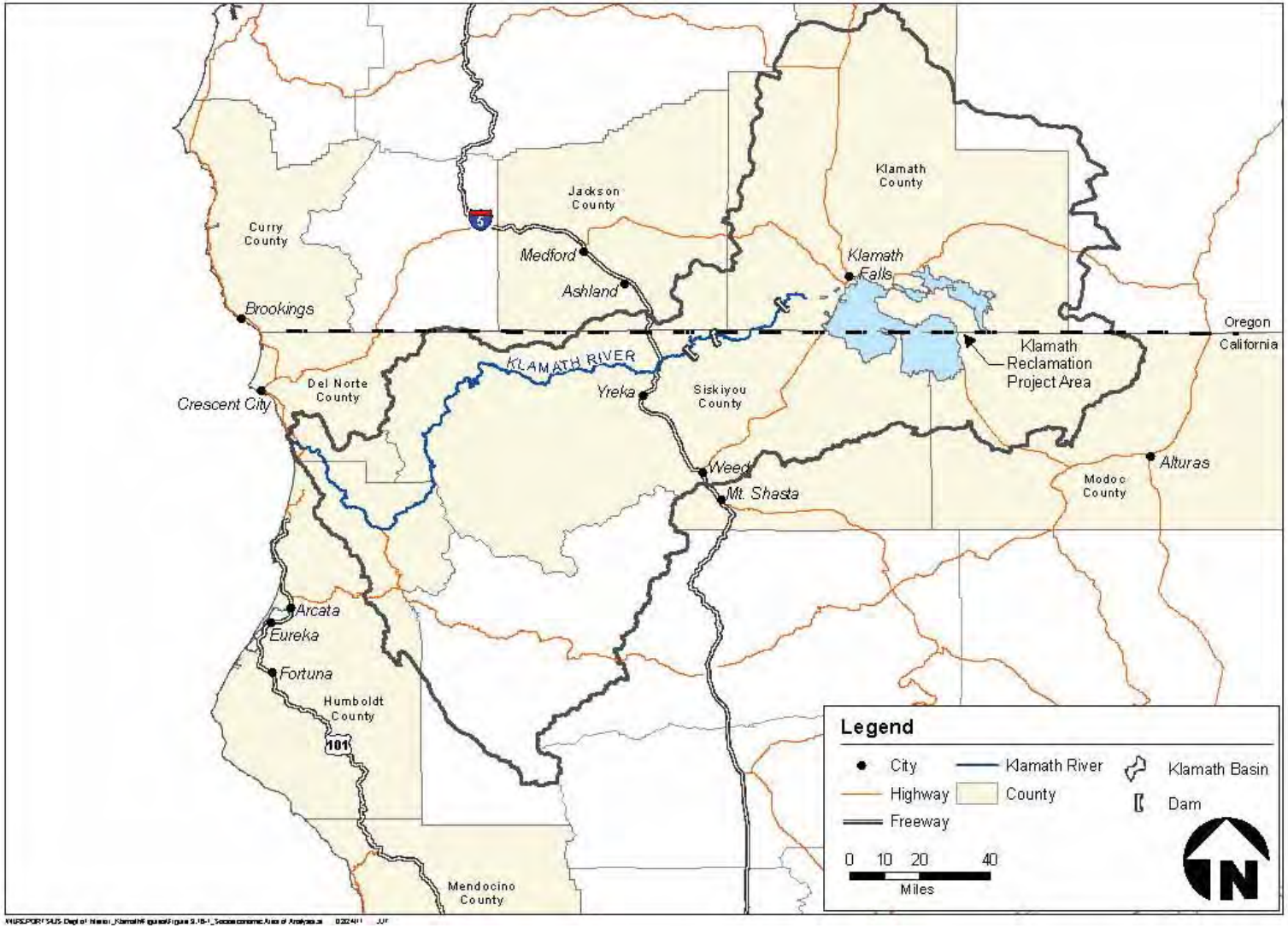

Figure 3.15-1. Socioeconomic Area of Analysis.

3.15.3 Existing Conditions/Affected Environment

This section describes regional economic conditions and economic information relevant to the specific industries in which potential economic effects could occur, such as fishing, recreation tourism, or agriculture. Much of the information in this section is taken directly from analyses contained in Reclamation (2012a and 2012b). The areas of potential effects, which for this analysis are groups of counties, vary depending on the industry and are identified below for each industry. In general, the counties in the area of analysis (except for counties in the San Francisco Bay area) are in rural areas of the States and have resource- and environmental amenity-based economies (e.g., timber, agriculture, fishing, recreation). Similar to many rural areas, the counties in the area of analysis have lower populations, incomes, and economic output and fewer employment opportunities than counties with larger urban centers in California and Oregon. Government entities and services are typically the largest employers in the counties. Appendix O includes detailed regional economic descriptions of each county. The nature and magnitude of economic effects depends on whether the economic industry is prevalent in a county.

Indian Tribes are also affected by the project alternatives. Tribes' cultural practices, subsistence, and economies are closely linked to the Klamath River. This section describes economic conditions of the tribes. Sections 3.12, Tribal Trust and 3.16, Environmental Justice describe Indian Tribes' social and cultural uses of the river in detail.

3.15.3.1 Four Facilities

The area of analysis for the Four Facilities includes Siskiyou and Klamath Counties. Table 3.15-1 summarizes the regional economy in the two counties aggregated into eight industry sector classifications for employment, labor income, and output. 2009 data is presented.

Employment is a measure of the number of jobs related to each industry. The service industry sector was 44 percent of the total regional employment in the region. The government and trade industry sector jobs provided 21 and 14 percent of regional employment, respectively.

Labor income is the sum of employee compensation and proprietor income. The largest portion of labor income in the region, 37 percent, was provided by the service industry sector. The government and trade industry sectors made up 28 and 11 percent of the total regional labor income, respectively.

Industry output represents the value of goods and services produced by businesses within a sector of the economy. The service sector produced the greatest level of output (42 percent) in the region. The manufacturing and government sectors each generated 14 percent of regional output, while the agricultural sector was 10 percent of total output.

Table 3.15-1. Summary of the 2009 Regional Economy for Klamath and Siskiyou Counties

Industry Sector	Employment[1]		Labor Income[2]		Output[3]	
	Jobs	Percent of Total	$ (million)	Percent of Total	$ (million)	Percent of Total
Agriculture	3,232	6.7	107.8	5.6	497.3	9.7
Mining	84	0.2	3.2	0.2	15.7	0.3
Construction	2,174	4.5	90.1	4.7	242.8	4.7
Manufacturing	2,621	5.4	135.7	7.0	703.6	13.7
Transportation, Information, and Public Utilities (TIPU)	1,920	4.0	109.3	5.7	394.6	7.7
Trade	6,886	14.3	220.5	11.4	455.4	8.9
Service	21,197	44.0	722.0	37.4	2,131.2	41.5
Government	10,091	20.9	539.8	28.0	697.9	13.6
Total	48,205	--	1,928.4	--	5,138.5	--

Source: Reclamation 2012b.
[1] Employment is measured in number of jobs.
[2] Income is the dollar value of total payroll (including positive effects) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Siskiyou County's unemployment rate has been higher than State averages from 1998 through 2010. Unemployment rates in 2009 and 2010 have been the highest the county has had in the past 20 years (California Employment Development Department [EDD] 2010). Klamath County has also had consistently higher unemployment rates than the State. The 2009 unemployment rate was the highest of the 12-year period (Oregon Employment Department 2010).

During the past 10 years, there has been a sharp decline in the Siskiyou County timber industry, which has been an economic base for the county historically. In 2009, the total value of the timber harvest in Siskiyou County was $11.6 million, about a $52 million decrease from 2000 (Board of Equalization [BOE] 2010b). The 2009 timber harvest was at its lowest value observed in the past 10 years. Reductions in timber harvesting have also reduced employment opportunities in the county. Similar to Siskiyou County, timber harvests in Klamath County have been declining in recent years. Timber harvests in 2008 and 2009 showed substantial decreases relative to previous years (Oregon Department of Forestry 2010). Appendix O further describes economic conditions in Siskiyou and Klamath Counties.

3.15.3.2 Commercial Fishing

The commercial fishing information provided here is taken directly from analyses contained in Reclamation (2012b) and National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service) (2012a). The area of analysis for

commercial fishing includes Curry, Coos, Douglas and Lane Counties in Oregon and Del Norte, Humboldt, Mendocino, San Mateo, San Francisco, Marin, and Sonoma Counties in California. Participants in the ocean commercial fishery potentially affected by the project alternatives consist of small, independently owned and operated trollers that land salmon south of Cape Falcon, Oregon. The fishery is a mixed stock fishery, that is, the commercial harvest includes salmon stocks from different rivers, including the Klamath River. The Pacific Fisheries Management Council (PFMC) manages the salmon fishery on the basis of 'weak stock management', whereby regulations are designed to protect weaker stocks, even if that means foregoing some harvest of the healthier stocks that comingle with the weaker ones in the ocean harvest. In the ocean, Klamath River fall Chinook salmon ranges from approximately Point Sur, California to Cape Falcon, Oregon. About 99 percent of the increase in commercial fishery revenue attributable to the project alternatives occurs in the following ocean management areas: (1) San Francisco, (2) Fort Bragg, (3) Klamath Management Zone (KMZ) (Figure 3.15-2) and (4) Central Oregon. The regional impact analysis focuses on these four areas. For purposes of this analysis, the KMZ (which straddles the Oregon-California border) is divided at the border into two areas: KMZ-OR and KMZ-CA. Tables 3.15-2 to 3.15-6 summarize the regional economy for San Francisco (San Mateo, San Francisco, Marin and Sonoma Counties), Fort Bragg (Mendocino County), KMZ-CA (Humboldt and Del Norte Counties), KMZ-OR (Curry County), and Central Oregon (Coos, Douglas and Lane Counties) in terms of employment, labor income, and output. Employment, labor income, and output related to commercial fishing are reflected in various sectors in the tables, including agriculture and services.

While Klamath River fall Chinook salmon abundance routinely constrains the troll fishery in the areas cited above, troll harvest in two additional areas (Monterey and Northern Oregon) may also become more constrained when Klamath River fall Chinook salmon is at low levels of abundance. Table 3.15-7 summarizes landings (numbers of fish) in the last three decades in all management areas south of Cape Falcon, Oregon. Tables 3.15-8 and 3.15-9 describe poundage and ex-vessel value of landings (gross landed value) over 1981-2010. Landings and value decreased from the 1980s to the 1990s. Factors contributing to this decline include more conservative management policies to protect weak stocks (including two Chinook salmon and three coho salmon stocks listed under the Endangered Species Act) and a 1993 opinion by the Department of the Interior Solicitor reserving 50 percent of Klamath-Trinity River salmon for the Yurok Tribe and Hoopa Valley Tribe. Landings are generally highest in San Francisco and lowest in KMZ-CA and KMZ-OR. Landing reductions began occurring in KMZ-CA and KMZ-OR in the mid-1980s to address conservation concerns for Klamath River fall Chinook; low landings remain persistent features in those areas. Landings in most areas rebounded during 2001-2005 but have since fallen to record lows in the past five years.

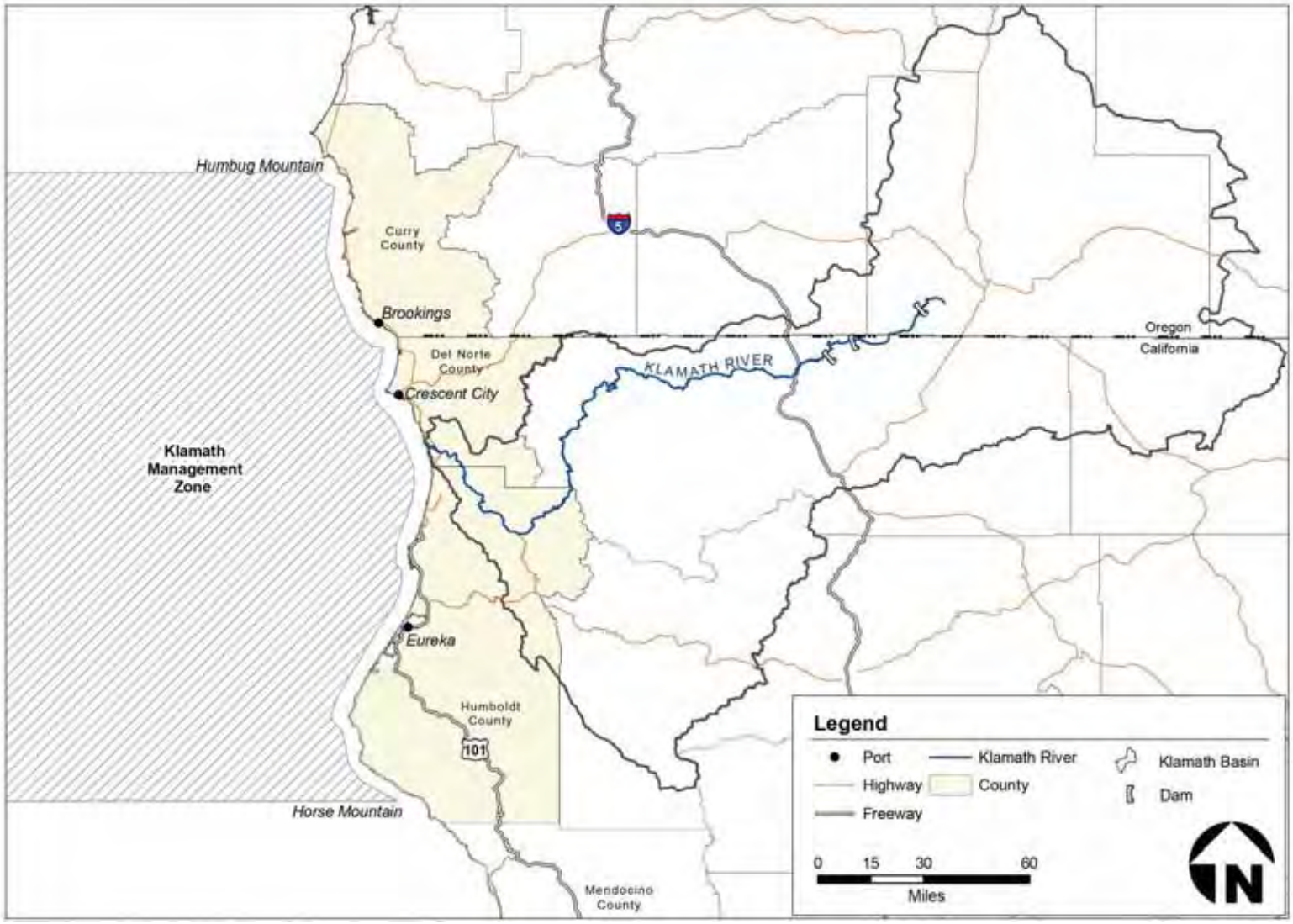

Figure 3.15-2. Klamath Management Zone Boundary and Ports.

Table 3.15-2. Summary of the Regional Economy for the San Francisco Management Area (San Mateo, San Francisco, Marin, and Sonoma Counties, CA)

Industry sectors	Employment[1]		Labor income[2]		Output[3]	
	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	10,401	0.34	570.53	0.28	1,536.15	0.26
Mining	2,683	0.09	404.25	0.20	1,529.34	0.26
Construction	153,734	5.02	11,116.50	5.43	23,970.50	4.00
Manufacturing	149,053	4.87	17,552.96	8.58	151,443.53	25.28
TIPU	98,914	3.23	6,843.29	3.34	24,426.35	4.08
Trade	372,967	12.19	19,026.25	9.30	42,067.56	7.02
Service	1,933,85	63.19	121,200.87	59.21	318,440.96	53.15
Government	338,759	11.07	27,970.63	13.67	35,749.56	5.97
Total	**1,319,896**		**204,685.28**		**599,163.95**	

Source: Reclamation 2012b
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.15-3. Summary of the Regional Economy for the Fort Bragg Management Area (Mendocino County, CA)

Industry sector	Employment[1]		Labor income[2]		Output[3]	
	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	2,339	5.83	118.11	6.82	312.39	6.49
Mining	66	0.17	1.80	0.10	9.14	0.19
Construction	2,233	5.57	115.93	6.70	281.60	5.85
Manufacturing	2,449	6.11	128.21	7.41	808.43	16.79
TIPU	1,093	2.73	58.26	3.37	346.44	7.20
Trade	6,304	15.71	250.07	14.45	520.20	10.81
Service	18,190	45.34	649.96	37.55	1,970.63	40.94
Government	7,442	18.55	408.64	23.61	564.71	11.73
Total	**40,116**		**1,730.98**		**4,813.54**	

Source: Reclamation 2012b
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.15-4. Summary of the 2009 Regional Economy for the KMZ-CA (Humboldt and Del Norte Counties, CA)

Industry sector	Employment[1]		Labor Income[2]		Output[3]	
	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	2,481	3.46	111.27	3.73	413.34	5.62
Mining	43	0.06	2.37	0.08	7.38	0.10
Construction	3,672	5.13	192.04	6.44	464.58	6.31
Manufacturing	2,465	3.44	126.28	4.23	798.32	10.85
TIPU	1,967	2.75	105.77	3.55	365.00	4.96
Trade	10,586	14.78	380.59	12.76	777.07	10.56
Service	32,462	45.32	1,113.71	37.34	3,327.87	45.21
Government	17,958	25.07	950.47	31.87	1,206.59	16.39
Total	**71,634**		**2,982.50**		**7,360.15**	

Source: Reclamation 2012b

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.15-5. Summary of the 2009 Regional Economy for the KMZ-OR (Curry County, OR)

Industry sector	Employment[1]		Labor Income[2]		Output[3]	
	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	676	7.81	20.60	6.61	53.21	6.20
Mining	25	0.29	1.26	0.41	4.39	0.51
Construction	673	7.78	21.94	7.04	67.28	7.84
Manufacturing	611	7.06	33.42	10.73	130.97	15.25
TIPU	180	2.08	11.33	3.64	43.17	5.03
Trade	1,252	14.47	38.04	12.21	74.43	8.67
Service	3,885	44.88	114.81	36.86	393.11	45.79
Government	1,354	15.64	70.07	22.50	91.97	10.71
Total	**8,656**		**311.47**		**858.53**	

Source: Reclamation 2012b

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.15-6. Summary of the Regional Economy for the Central Oregon Management Area (Coos, Douglas, and Lane Counties, OR)

Industry sector	Employment[1]		Labor income[2]		Output[3]	
	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	8,718	3.38	273.06	2.68	865.38	3.11
Mining	449	0.17	23.57	0.23	92.68	0.33
Construction	12,681	4.91	547.94	5.39	1,451.52	5.22
Manufacturing	17,716	6.87	1,012.13	9.95	5,480.22	19.70
TIPU	6,726	2.61	332.09	3.27	1,070.39	3.85
Trade	37,815	14.65	1,259.06	12.38	2,657.42	9.55
Service	130,484	50.57	4,415.17	43.41	13,062.44	46.96
Government	43,459	16.84	2,307.17	22.69	3,134.82	11.27
Total	**258,048**		**10,170.19**		**27,814.87**	

Source: Reclamation 2012b
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.15-7. Landings of Troll-Caught Chinook Salmon and Coho Salmon (# fish), 1981-2010, by Management Area

Year(s)	Management Area							
	Monterey	San Francisco	Fort Bragg	KMZ-CA	KMZ-OR	Central OR	North OR	Total
81-85 Avg	85,260	186,680	124,320	124,020	61,320	170,560	190,200	942,360
86-90 Avg	146,460	360,480	278,380	56,120	33,920	385,940	351,700	1,613,000
91-95 Avg	137,720	205,480	14,760	1,540	1,000	36,820	128,240	525,560
96-00 Avg	156,305	195,662	12,529	3,505	3,542	36,042	89,479	497,064
01-05 Avg	64,827	210,228	96,466	12,401	5,245	117,529	151,698	658,393
06-10 Avg	5,330	24,806	7,906	1,752	1,188	7,736	11,598	60,315
2001	35,940	136,630	14,993	5,523	3,599	72,272	195,001	463,958
2002	69,980	242,872	65,336	13,467	6,803	122,174	162,415	683,047
2003	36,099	202,876	248,875	4,044	5,072	132,156	182,066	811,188
2004	64,707	298,229	107,259	31,915	8,484	140,142	100,965	751,701
2005	117,408	170,531	45,869	7,054	2,266	120,900	118,044	582,072
2006	11,204	47,689	10,835	0	738	1,979	21,759	94,204
2007	14,009	75,254	16,116	8,762	4,097	24,096	11,393	153,727
2008	0	0	0	0	236	208	76	520
2009	0	0	0	0	0	979	8,738	9,717
2010	1,435	1,086	12,577	0	869	11,418	16,022	43,407

Sources: PFMC as cited in Reclamation 2012b, NOAA Fisheries Service 2012a. 2010 data are preliminary.

Table 3.15-8. Landings of Troll-Caught Chinook Salmon and Coho Salmon (1000s of pounds dressed weight), 1981-2010, by Management Area

	Management Area							
Year(s)	Monterey	San Francisco	Fort Bragg	KMZ-CA	KMZ-OR	Central OR	North OR	Total
81-85 Avg	748	1,849	1,218	967	495	1,140	1,080	7,497
86-90 Avg	1,601	3,700	2,434	624	537	2,765	2,259	13,920
91-95 Avg	1,350	1,949	194	31	32	339	869	4,764
96-00 Avg	1,699	2,155	146	37	92	435	861	5,425
01-05 Avg	756	2,704	1,268	149	204	1,124	1,605	7,810
06-10 Avg	54	318	163	24	40	86	156	841
2001	418	1,735	192	64	152	776	1,898	5,235
2002	912	3,060	872	162	218	1,223	1,722	8,169
2003	498	2,753	3,096	45	142	1,353	1,890	9,777
2004	853	3,712	1,292	373	267	1,214	1,256	8,967
2005	1,098	2,258	889	102	239	1,054	1,259	6,899
2006	87	684	273	0	45	56	290	1,435
2007	165	888	357	115	101	246	160	2,032
2008	0	0	0	0	8	0	20	28
2009	0	0	0	0	5	5	82	92
2010	20	16	187	4	43	122	226	618

Sources: PFMC as cited in Reclamation 2012b, NOAA Fisheries Service 2012a. 2010 data are preliminary.

Table 3.15-9. Ex-vessel Value of Troll-Caught Chinook Salmon and Coho Salmon ($1000s, Base Year=2012), 1981-2010, by Management Area

	Management Area							
Year(s)	Monterey	San Francisco	Fort Bragg	KMZ-CA	KMZ-OR	Central OR	North OR	Total
81-85 Avg	3,671	9,170	5,881	4,536	2,426	4,637	3,965	34,286
86-90 Avg	7,003	16,751	10,884	2,736	2,219	10,983	8,128	58,704
91-95 Avg	4,095	6,097	670	104	98	899	2,349	14,312
96-00 Avg	3,755	4,912	340	81	217	1,038	1,950	12,293
01-05 Avg	2,129	7,422	3,371	440	608	3,206	4,280	21,456
06-10 Avg	307	1,797	925	134	243	500	834	4,740
2001	1,051	4,362	483	161	311	1,586	3,878	11,832
2002	1,766	5,927	1,689	314	420	2,354	3,309	15,779
2003	1,164	6,432	7,233	105	342	3,260	4,539	23,075
2004	2,912	12,672	4,411	1,273	1,096	4,982	5,096	32,442
2005	3,754	7,719	3,039	349	872	3,846	4,577	24,156
2006	497	3,911	1,561	0	275	342	1,757	8,343
2007	925	4,981	2,002	645	607	1,451	789	11,400
2008	0	0	0	0	62	0	150	212
2009	0	0	0	0	27	11	188	226
2010	114	91	1,063	23	245	696	1,286	3,518

Sources: PFMC as cited in Reclamation 2012b, NOAA Fisheries Service 2012a. 2010 data are preliminary.

In years where a stock fails to meet its conservation goal for three consecutive years, the PFMC declares a conservation concern, and the commercial fishery is closed or otherwise highly constrained, even in areas far removed from the stock's river of origin. Multiple conservation concerns over the past five years have led to record low landings and (in some years and management areas) unprecedented closures of the commercial fishery. In 2006, the failure of Klamath River fall Chinook salmon to meet its escapement floor[2] for the third consecutive year resulted in closure of the commercial salmon fishery in KMZ-CA and major restrictions elsewhere along the coast; landings in 2006 south of Cape Falcon fell to 14 percent of the 2001-2005 average. In 2008 and 2009, the commercial salmon fishery in California was closed Statewide (the first time this had occurred in California history) and the Oregon fishery was significantly curtailed due to low escapement of Sacramento River fall Chinook. In 2010, the California commercial fishery reopened, but continuing concerns about Sacramento River fall Chinook salmon prompted restrictive regulations in both California and Oregon. The drastic fishery restrictions associated with the conservation concerns led to the provision of disaster relief for salmon-dependent fishing communities, as described in Chapter 1.

3.15.3.3 Recreation

The area of analysis for recreation includes Curry, Jackson and Klamath Counties in Oregon and Del Norte, Humboldt, and Siskiyou Counties in California. The Klamath Basin offers a myriad of outdoor recreational opportunities. Section 3.20, Recreation, describes recreation activities within the Basin. Recreation is an important asset to the regional economy because it attracts visitors from outside the region that spend money and generate economic activity locally. Recreation expenditures and economic activity generally increase with visitation levels. If recreational opportunities are adversely affected, recreational expenditures may decrease and affect the local economy, unless recreational participants engage in substitute or alternative opportunities in the region. This section describes how existing recreational activities within the Klamath Basin contribute to the regional economy. The affected area for potential economic effects associated with recreation depends on the recreation activity. The following sections identify the potentially affected area for each activity.

3.15.3.3.1 Reservoir

In the area of analysis, economic effects could occur to reservoir-based recreation at J.C. Boyle, Copco 1, and Iron Gate Reservoirs in Klamath and Siskiyou Counties. Copco 2 Reservoir does not generate significant recreation activity. Table 3.15-1 summarizes the 2009 regional economy for Siskiyou and Klamath Counties. Employment, labor income, and output related to reservoir recreation are reflected in the services and trade sectors in the table. Section 3.20.3 describes existing recreation opportunities and existing use at the reservoirs. Visitors go to the reservoir areas for overnight and day uses, and activities generally include sightseeing, camping, boating, fishing, picnicking and hiking.

[2] Escapement floor is set by the PFMC as the minimum number of salmonids that are not harvested in ocean and in-river fisheries and return to the river for spawning.

Reservoir-based recreation attracts visitors from outside the region; these visitors spend money at local stores, gas stations, and other businesses, contributing to the local economy.

3.15.3.3.2 Ocean Sport Fishing

The ocean sport fishing information provided here is taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012h). The area of analysis for ocean sport fishing includes Curry County, Oregon and Del Norte and Humboldt Counties in California. Klamath River fall Chinook salmon is harvested in sport as well as commercial fisheries. About 91 percent of the increase in angler expenditures attributable to the project alternatives occurs in the KMZ-CA and KMZ-OR management areas; therefore, these two areas are the focus of this ocean sport fishing analysis. Tables 3.15-4 and 3.15-5 summarize the 2009 regional economy in those areas. Employment, labor income, and output related to ocean sport fishing are reflected in the services sectors in the tables.

While recreational fishery regulations such as closed seasons are generally more stringent in the KMZ, they may also become more constraining in other management areas south of Cape Falcon when Klamath River fall Chinook salmon is at low levels of abundance. Tables 3.15-10 and 3.15-11 summarize recreational effort (angler days) and landings in the KMZ and other management areas south of Cape Falcon. Effort and landings in all areas have generally declined from the 1980s to the 1990s. Factors contributing to this decline include more conservative management policies to protect weak stocks (including two Chinook salmon and three coho salmon stocks listed under the ESA), and a 1993 opinion by the Department of the Interior Solicitor reserving 50 percent of Klamath-Trinity River salmon for the Yurok Tribe and Hoopa Valley Tribe. Effort and landings rebounded during 2001-2005. However, regulation of the recreational fishery has been unusually restrictive over the past five years, due to the failure of Klamath River fall Chinook salmon to meet its conservation objective during 2004-2006 and failure of Sacramento River fall Chinook salmon to meet its conservation objective during 2007-2009. The restrictions triggered by Sacramento River fall Chinook salmon concerns were particularly stringent, including near-closure of the California fishery in 2008-2009 and additional restrictions in Oregon as well.

Angler trips occur on both private and charter vessels. Charter vessels are typically run by local companies that advertise and sell fishing trips to visitors or residents. Private vessels are privately owned boats and owners do not sell trips. The majority of trips from all ports are on private vessels. From 2001 to 2010, trips on charter vessels averaged 25 percent of total salmon angler trips south of Cape Falcon, 7 percent in the KMZ-CA (excluding 2008, when the KMZ-CA was closed), and 3 percent in the KMZ-OR.

Table 3.15-10. Ocean Sport Salmon Effort (# angler days) during 1981-2010, by Management Area

Year(s)	Management Area							
	Monterey	San Francisco	Fort Bragg	KMZ-CA	KMZ-OR	Central OR	North OR	Total
81-85 Avg	12,220	78,920	9,560	46,260	56,260	63,720	87,560	354,500
86-90 Avg	49,180	98,580	15,420	77,500	58,380	61,360	103,640	464,060
91-95 Avg	71,240	92,800	20,360	29,100	22,720	25,960	38,520	300,700
96-00 Avg	63,020	94,000	19,140	18,540	18,360	8,260	13,480	234,800
01-05 Avg	47,340	83,560	28,220	21,000	18,300	34,520	48,760	281,700
06-10 Avg	14,320	24,700	9,040	9,300	7,720	14,120	32,660	111,860
2001	38,100	71,500	30,800	24,700	26,100	31,100	40,100	262,400
2002	67,900	88,800	31,800	21,600	19,700	33,400	42,400	305,600
2003	28,500	66,600	23,700	15,800	14,800	42,900	67,500	259,800
2004	56,500	106,100	30,500	25,600	18,300	40,500	68,300	345,800
2005	45,700	84,800	24,300	17,300	12,600	24,700	25,500	234,900
2006	27,700	61,300	21,000	16,400	10,700	17,200	26,300	180,600
2007	25,200	43,100	17,100	20,500	11,100	22,900	41,900	181,800
2008	0	0	400	0	4,800	7,400	14,600	27,200
2009	0	0	0	5,400	6,000	14,400	52,000	77,800
2010	18,700	19,100	6,700	4,200	6,000	8,700	28,500	91,900

Sources: PFMC as cited in Reclamation 2012b, NOAA Fisheries Service 2012h. 2010 data are preliminary.

Table 3.15-11. Ocean Sport Chinook Salmon and Coho Salmon Landings (# fish) during 1981-2010, by Management Area

Year(s)	Management Area							
	Monterey	San Francisco	Fort Bragg	KMZ-CA	KMZ-OR	Central OR	North OR	Total
81-85 Avg	6,720	86,800	4,380	34,680	28,460	60,420	70,620	292,080
86-90 Avg	30,400	99,960	10,800	65,680	37,660	74,080	112,860	431,440
91-95 Avg	58,260	93,460	18,620	21,060	10,840	37,840	44,140	284,220
96-00 Avg	52,345	82,804	14,414	8,631	6,178	3,961	5,913	174,246
01-05 Avg	31,408	77,653	24,008	15,885	7,349	27,255	45,485	229,043
06-10 Avg	4,809	15,719	4,378	7,479	2,356	7,655	23,316	65,712
2001	20,256	40,345	26,501	13,010	7,277	28,849	43,613	179,851
2002	47,729	87,308	31,409	16,426	10,042	24,817	32,001	249,732
2003	13,286	56,823	16,289	8,889	5,499	39,125	77,588	217,499
2004	44,863	130,690	23,581	23,404	8,112	30,880	64,595	326,125
2005	30,905	73,097	22,259	17,695	5,817	12,606	9,627	172,006
2006	11,308	55,598	14,368	16,644	2,473	8,783	9,989	119,163
2007	6,381	17,000	5,772	19,297	4,619	14,150	29,834	97,053
2008	0	0	6	0	2,414	3,738	4,503	10,661
2009	0	0	0	680	1,392	9,979	59,417	71,468
2010	6,356	5,995	1,743	774	884	1,623	12,835	30,210

Sources: PFMC as cited in Reclamation 2012e, NOAA Fisheries Service 2011h. 2010 data are preliminary.

3.15.3.3.3 In-River Sport Fishing

The in-river sport fishing information provided here is taken directly from analyses contained in Reclamation (2011) and NOAA Fisheries Service (2011g). In-river Chinook salmon fishing on the Klamath River occurs in Siskiyou, Humboldt, and Del Norte Counties in California. Under the project alternatives, Chinook salmon would be reintroduced in the Upper Basin (Klamath County, Oregon). Table 3.15-12 summarizes the combined regional economy for these four counties. Employment, labor income, and output related to fishing are reflected in the services and trade sectors in the table.

Table 3.15-12. Summary of the Regional Economy for Del Norte, Humboldt and Siskiyou Counties in California and Klamath County, OR

	Employment[1]		Labor income[2]		Output[3]	
Industry sector	Jobs	Percent of total	$ million	Percent of total	$ million	Percent of total
Agriculture	5,713	4.77	219.03	4.46	910.68	7.29
Mining	127	0.11	5.58	0.11	23.06	0.18
Construction	5,845	4.88	282.12	5.74	707.41	5.66
Manufacturing	5,086	4.24	261.96	5.33	1,501.95	12.02
TIPU	3,887	3.24	215.09	4.38	759.63	6.08
Trade	17,471	14.58	601.06	12.24	1,232.50	9.86
Service	53,659	44.78	1,835.74	37.38	5,459.12	43.68
Government	28,049	23.41	1,490.23	30.35	1,904.47	15.24
Total	**119,837**		**4,910.81**		**12,498.82**	

Source: Reclamation 2012e.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.

Table 3.20-12 in the Section 3.20, Recreation, provides recent harvest and effort data for the Klamath River Chinook salmon fishery downstream from Iron Gate Dam. Angler days averaged about 23,809 per year during 2001-2005 and 16,792 during 2006-2010.

Another popular Klamath River recreational fishery is the steelhead fishery, which also occurs in Siskiyou, Humboldt and Del Norte Counties. Analysis of data from steelhead report cards collected by the California Department of Fish and Game (CDFG) suggest that approximately 17,155 angler trips occurred annually on the Klamath River during 2003-2008 (Table 3.20-13). This should be interpreted as a conservative estimate of effort, as the report card requirement extends only to steelhead greater than 16 inches and thus provides limited coverage of the half-pounder fishery.

A trophy fishery for redband trout occurs in Klamath County in Upper Klamath Lake, lower Williamson River, Wood River, and the Keno Reach of the Klamath River.

According to results of a statistical creel survey conducted by Oregon Department of Fish and Wildlife (ODFW), about 15,191 angler trips (6,109 bank trips, 9,082 boat trips) occurred in Upper Klamath Lake and Agency Lake during March 18-September 30, 2009. This estimate should be viewed as conservative, as the creel survey did not cover an entire year of lake fishing and did not include angler effort in the tributaries above Upper Klamath Lake or the mainstem Klamath River below Keno Dam.

3.15.3.3.4 Whitewater Boating

The affected region for whitewater boating on the Upper Klamath and Lower Klamath River reaches includes Jackson, Klamath, Siskiyou, and Humboldt Counties. Jackson County, which includes the urban Medford area, contributes substantially to the regional economy for whitewater boating. Many commercial outfitters are based in Jackson County. The Upper Klamath River is defined as the section of the Klamath River upstream of Iron Gate Dam and the Lower Klamath River starts downstream from the Iron Gate Dam. Table 3.15-13 summarizes the 2009 economy in the four-county region. Employment, labor income, and output related to whitewater boating are reflected in services and trade sectors in the table.

Table 3.15-13. Summary of the 2009 Regional Economy for Klamath, Jackson, Humboldt, and Siskiyou Counties

	Employment[1]		Labor Income[2]		Output[3]	
Industry Sector	Jobs	Percent of Total	$ (million)	Percent of Total	$ (million)	Percent of Total
Agriculture	8,337	3.7	306.8	3.5	1,078.2	4.6
Mining	324.7	0.1	12.5	0.1	54.8	0.2
Construction	16,545	7.4	632.9	7.3	1,782.0	7.6
Manufacturing	10,604	4.7	540.8	6.2	3,225.9	13.8
TIPU	7,746	3.4	411.9	4.7	1,400.3	6.0
Trade	37,272	16.6	1,187.9	13.7	2,591.3	11.1
Service	108,382	48.2	3,642.6	42.0	10,690.4	45.8
Government	35,456	15.8	1,946.5	22.4	2,507.6	10.7
Total	224,667	--	8,681.9	--	23,330.5	--

Source: Reclamation 2012b.

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production.

Section 3.20, Recreation, describes whitewater boating activities on the Klamath River, including annual estimates for number of visitors. Many visitors are from San Francisco Bay Area, southern California, northern Oregon, and other parts of the western U.S. (PacifiCorp 2004). Boating trips can be one- or multi-day trips and typically run from May through October. Multiple outfitters in the region organize and guide boating trips. Tables 3.15-14 and 3.15-15 provide an estimate of commercially guided whitewater boating trips on the upper and lower Klamath River, respectively. The estimate of

commercially guided trips is based on Bureau of Land Management and United States Forest Service trip card data files (2010). Trip cards are required to be submitted by permitted commercial outfitters when they provide a guided whitewater boating trip on the Klamath River. The whitewater boating outfitters provide jobs to people living in the region.

Table 3.15-14. Commercially Guided Whitewater Boating Trips on Upper Klamath River from 2001 to 2009

Year	Trip Length in Days				Total
	1 Day	2 Days	3 Days	4 Days	
2001	274	17	5	0	296
2002	283	20	2	0	305
2003	248	20	1	1	270
2004	306	31	2	0	339
2005	317	27	0	0	344
2006	243	27	4	0	274
2007	276	28	1	0	305
2008	248	20	1	0	269
2009	220	7	1	0	228
Total	2,415	197	17	1	2,630

Source: Bureau of Land Management 2010, United States Forest Service 2010 as cited in United States Department of the Interior (DOI) 2012b

Table 3.15-15. Commercially Guided Whitewater Boating Trips on Lower Klamath River from 2000 to 2009

Year	Trip Length in Days									Total
	1 Day	2 Days	3 Days	4 Days	5 Days	6 Days	7 Days	8 Days	9 Days	
2000	254	48	80	13	7	1	1	0	0	404
2001	309	68	68	28	3	1	0	0	0	477
2002	242	49	68	10	6	1	1	0	0	377
2003	301	55	57	21	6	1	2	0	0	443
2004	224	47	55	13	6	1	0	1	1	348
2005	366	48	58	15	5	0	0	0	0	492
2006	230	33	44	8	1	2	0	0	0	318
2007	255	47	45	12	1	0	1	3	0	364
2008	237	26	38	18	2	0	0	0	0	321
2009	235	27	44	11	4	1	1	0	0	323
Total	2,653	448	557	149	41	8	6	4	1	3,867

Source: Bureau of Land Management 2010, United States Forest Service 2010 as cited in DOI 2012b

Table 3.15-16 provides an estimate of whitewater boating user days for the Klamath River from 1994 through 2009. A user day is defined as one user engaging in whitewater boating for any part of a day. For example, three people taking a two day whitewater boating trip would equate to six user days (3 users x 2 days: 6 user days). Analysis of data presented in PacifiCorp (2004) show that on average an estimated 93 percent of the

total user days for the upper Klamath River are associated with commercial use and 70 percent of total user days for the lower Klamath River are associated with commercial use. These percentages were applied to the estimates of commercial use from 2001 through 2009 to derive estimates of total and private use over this same time period.

Table 3.15-16. Whitewater Boating User Days on the Klamath River from 1994 to 2009

Year	Upper Klamath River			Lower Klamath River			Klamath River		
	Commercial	Private	Total	Commercial	Private	Total	Commercial	Private	Total
1994	4,471	735	5,206	8,491	3,639	12,130	12,962	4,374	17,336
1995	5,763	602	6,365	12,203	5,230	17,433	17,966	5,832	23,798
1996	5,963	244	6,207	10,280	4,406	14,686	16,243	4,650	20,893
1997	5,509	317	5,826	10,529	4,512	15,041	16,038	4,829	20,867
1998	4,081	314	4,395	11,298	4,842	16,140	15,379	5,156	20,535
1999	4,614	283	4,897	11,885	5,094	16,979	16,499	5,377	21,876
2000	5,100	269	5,369	10,449	4,478	14,927	15,549	4,747	20,296
2001	3,290	243	3,533	10,744	4,605	15,349	14,034	4,848	18,882
2002	3,369	249	3,618	9,783	4,193	13,976	13,152	4,442	17,594
2003	3,075	228	3,303	11,143	4,776	15,919	14,218	5,003	19,221
2004	3,800	281	4,081	9,708	4,161	13,869	13,508	4,442	17,950
2005	3,638	269	3,907	10,695	4,584	15,279	14,333	4,853	19,186
2006	3,714	275	3,989	8,226	3,525	11,751	11,940	3,800	15,740
2007	3,505	259	3,764	8,879	3,805	12,684	12,384	4,065	16,449
2008	3,335	247	3,582	8,643	3,704	12,347	11,978	3,951	15,929
2009	2,405	178	2,583	8,230	3,527	11,757	10,635	3,705	14,340
Average (1994-2009)	4,102	312	4,414	10,074	4,317	14,392	14,176	4,630	18,806

Source: PacifiCorp 2004 for the Upper Klamath for 1994 to 2000 (based on figures reported in Table 2.7-41) and Payne 2009 Lower Klamath for 1994 to 1999 as cited in DOI 2012b

3.15.3.4 Indian Tribes

Section 3.16, Environmental Justice, presents demographic and socioeconomic conditions for Indian Tribes in the Klamath Basin. Five of the six federally recognized tribes in the Klamath Basin are potentially affected by the project alternatives. Table 3.15-17 summarizes income, poverty, and unemployment statistics for those tribes. The table and all other tribal information provided here are taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012b-f).

Table 3.15-17. Income, Poverty and Unemployment for Affected Federally Recognized Tribes

Tribes	1999 Median Personal Income (dollars)[1]	1999 Individuals below Poverty Level (percent)[1]	2005 Unemployment Rate (percent)[2]
The Klamath Tribes	8,646	40.4	21
Karuk Tribe	4,938	53.9	63
Hoopa Valley Indian Reservation	9,757	34.4	40
Yurok Reservation	6,839	39.7	74
Resighini Rancheria	6,925	NA	60

Based on the following sources, as cited in Reclamation 2012b and NOAA Fisheries Service 2012b-f:

1 - U.S. Census Bureau 2000. Income and poverty statistics based on available data as follows: Indians residing in Chiloquin, Oregon used to represent The Klamath Tribes; Resighini Rancheria residents (whether Indian or not) used to represent Resighini Rancheria members; Indians residing on the Karuk, Hoopa Valley and Yurok Indian Reservations used to represent members of the Karuk, Hoopa Valley, and Yurok Indian Tribes respectively.

2 - Bureau of Indian Affairs 2005. The unemployment rates provided by the Bureau of Indian Affairs (BIA) pertain to the percentage of adults who are available for work but unemployed, regardless of whether or not they have recently looked for work, These rates differ from and are therefore not comparable to the unemployment rates estimated by the U.S. Bureau of Labor Statistics for the general population.

Note: Quartz Valley Community is not included in the table because information available at the time of this analysis suggested that the project alternatives would have no direct effects on Quartz Valley Community and the Quartz Valley Community was not claiming any effects (positive or negative).

For the tribes of the Klamath Basin, fish are integral to a world view that emphasizes interconnectedness, balance, and mutual respect as guiding principles. The diversity, abundance, distribution, run timing and health of fish are important indicators of how well such balance is being maintained. The seasonal round of harvest provides sustained access to food that is synchronous with the cycles of nature. Fish are honored in rituals such as the First Salmon Ceremony and (for The Klamath Tribes) the Return of the C'waam, which traditionally precede the commencement of fishing for spring-run Chinook salmon and suckers respectively. Fishing itself is a social and cultural activity – an opportunity to meet with family and friends; to engage in traditional fishing practices; to strengthen community bonds, demonstrate respect and promote food security by sharing fish with elders and others who are unable to fish; and to transmit these traditions to the next generation. Trade and barter occur both within and between tribes as a means of increasing access to fish and other valued goods, and cementing social relationships.

Table 3.15-18 summarizes Chinook salmon harvests since 1981 by the Yurok Tribe and Hoopa Valley Tribe for commercial, subsistence and ceremonial purposes. The average harvest in the 1990s was much lower than the 1980s and 2000s. Annual harvests over the last decade were lowest in 2005 and 2006 and highest in 2001. For these two tribes, harvest opportunities over the last few decades are much lower than they were historically.

Table 3.15-18. Yurok and Hoopa Valley Reservation Indian Tribes Gillnet Chinook Salmon Spring and Fall Run Harvest (# fish) from 1981 to 2010

Year	Klamath River	Trinity River	Total
1981–1990 Average	26,466	4,527	30,992
1991–2000 Average	17,130	3,200	20,905
2001	49,460	9,224	58,684
2002	35,508	4,328	39,836
2003	33,973	5,170	39,143
2004	30,938	3,715	34,653
2005	5,754	4,295	12,277
2006	9,111	5,996	15,107
2007	29,790	3,653	33,443
2008	22,869	3,471	26,340
2009	26,040	6,087	32,127
2010[1]	26,620	5,814	32,434
2001-2010 Average	27,006	5,175	32,404

Sources: PFMC as cited in Reclamation 2012b, NOAA Fisheries Service 2012b, 2012f
Notes:
1. 2010 data are preliminary

For other tribes in the Klamath Basin (who fish for subsistence and ceremonial purposes), harvest opportunities for salmonids and other fish have declined to lower levels than those experienced by the Yurok and Hoopa Valley Tribes. For The Klamath Tribes, despite the Treaty of 1864 which reserved fishing rights, their anadromous fisheries were eliminated in 1917 when Copco 1 Dam was constructed without fish ladders. Two other fisheries that had sustained the Tribes were eliminated in 1986 when growing biological concerns prompted The Klamath Tribes to close their fisheries for c'wam (Lost River sucker) and qapdo (shortnose sucker); both fish were listed as Endangered in 1988. For the Karuk Tribe, current harvest opportunities are limited to a short season at Ishi Pishi Falls. Members of the Resighini Rancheria historically fished and continue to attach cultural and subsistence value to fishing, although their current fishing opportunities are minimal. Section 3.12, Tribal Trust, describes the cultural role of fisheries for the tribes.

3.15.3.5 PacifiCorp Hydroelectric Service

PacifiCorp operates and maintains hydroelectric power plants at the Four Facilities. Operation and maintenance of the facilities provides employment and incomes in Siskiyou and Klamath Counties.

PacifiCorp provides electricity to about 1.7 million customers in six western States, including residential and commercial customers in southern Oregon and northern California (PacifiCorp 2004). Section 3.18, Public Health and Safety, Utilities and Public Services, Solid Waste, and Power, further describes PacifiCorp hydroelectric facilities and service. PacifiCorp is subject to regulations established by utility authorities in each State, which influences operations, customer rates, and cost recovery. PacifiCorp sets customer rates based on multiple factors, including energy prices, future demands, resource adequacy, overhead costs, and long-term investments. PacifiCorp uses customer rates to recover a portion of operating and investment costs. If expenditures are not

directly offset by any associated project revenues or cost reductions, the utility's rates increase, subject to regulatory approvals.

3.15.3.6 Real Estate, Property Tax and Other County Revenues

Establishment of the Copco Dams in the early 1900's and the Iron Gate Dam in the 1960's created reservoirs behind the dams. The reservoirs were opened to the general public and are used for recreational purposes. These recreational uses over time have led to light residential development of some of the privately held real estate surrounding the reservoirs.

At Iron Gate Reservoir, the majority of the land around the reservoir is held by PacifiCorp, and much of the area along the shoreline is designated for recreation use. Private parties do not own any properties that front the reservoir. Iron Gate Lake Estates has five units that have full or partial views of the reservoir. Some parcels outside of Iron Gate Lake Estates have partial views of the reservoir.

Some parcels have views of Copco 1 and Copco 2 Reservoirs. Most of these sites are along the southern shore of the reservoir along Patricia Avenue and Ager Beswick Road. Of the properties that front the reservoir, a few properties have relatively level sites, but most are elevated from the lakeshore water level and have steep terrain to access the reservoir. Properties across the roads have obstructed views due to terrain and heavy tree cover. Where the Klamath River enters Copco Reservoir, some parcels front the river along Copco Road and have views of the river.

The literature on previous dam removals and impacts to private property values is limited. The most frequently cited case studies are from the Kennebec and Penobscot Rivers in Maine (Lewis, et al. 2008; Bohlen and Lewis 2008) as well as multiple dam removals in Wisconsin (Sarakinos and Johnson 2003; Provencher, et al. 2006). The majority of previous studies on the impacts of dam removals on private property values were done on small dams and small reservoirs, and several authors noted the general lack of data and studies about property value impacts from dam removal and draining reservoirs (Provencher, et al. 2006). In terms of the direct impacts to private property values, some studies reported increases in values following dam removal (i.e., Bohlen and Lewis, 2008). Increases in values were generally related to improvements in water quality, removal of dam structures, and enhancements to the natural riparian environment. Other studies cited by Kruse and Scholz (2006) described private property values decreasing briefly and regaining value by the end of two years. These previous studies should be interpreted with some caution due to the small size of the impoundments. The conclusion should not be extended to large impoundments where such activities as fishing, boating, and swimming are especially attractive. (Provencher et al. 2006).

Kruse and Ahmann (2009) is the only study to model the effects of lot size and proximity to the Klamath River, Copco 1 and Iron Gate reservoirs on private residential property values. This study was based on reported sales data between 1998 and 2006. Using the hedonic pricing method, this study developed a statistical relationship between sales

values and a set of variables that were modeled as "indicator variables" which took on values of 1 or 0 for the following categories:

- On the shore of the reservoir
- Across the road from the reservoir
- View of either Copco I or Iron Gate Reservoirs
- On the Klamath River

The authors found that in the case of the Klamath River, results of the hedonic pricing model demonstrate that lake adjacency does have a positive and significant impact on residential property values and that, all else being equal, properties on a lake, with lake proximity or with a lake view are worth more than properties without these characteristics. The study concluded that lake adjacency does have a positive and significant impact on residential property values and that, all things being equal, properties on a lake, with lake proximity or with a lake view are worth more than properties without these characteristics. The authors also attempted to look at property value impacts associated with river frontage; however, there was an insufficient sample size to estimate any positive effect associated with river front properties adjacent to the Klamath River downstream from Iron Gate Dam.

While property values based on proximity to the reservoirs can be expected to decline with dam removal, the amount and timing of these changes were not analyzed. Kruse and Ahmann's study did not address how property values would change if a different set of environmental values develops in the future should the dams be removed, and noted that the assumption of all else being equal is likely to be unrealistic both generally and in the context of the Klamath River, as areas currently inundated by lake(s) would become accessible with dam removal. Their quantitative findings did not take into account potential future access, uses, or amenities/dis-amenities of the reservoir lands and river after dam removal and full restoration, which could influence overall results.

PacifiCorp owns all land surrounding J.C. Boyle Reservoir in Klamath County; this land is zoned as rural industrial. Land outside of PacifiCorp's ownership boundary is zoned as forestry with some public lands. Figure 3.14-4 in Section 3.14, Land Use, Agricultural and Forest Resources, shows land ownership around J.C. Boyle Reservoir. There are no private properties with views of the reservoir; therefore, private property land values at J.C. Boyle Reservoir would not be affected by the Proposed Action and alternatives, and are not further analyzed.

Siskiyou and Klamath Counties' receive tax revenues from multiple tax accounts, including property taxes paid by PacifiCorp and landowners, and sales and use tax. The counties use tax receipts for the general fund, which funds many county programs, such as health, education, public assistance, fire and emergency services, and recreation. Siskiyou County provided tax revenue data to the Lead Agencies. Table 3.15-19 summarizes Siskiyou County revenues from tax accounts over a 10-year period, which accounts for normal market fluctuations. On average, from 2000 to 2010, Siskiyou County received a majority of the total Siskiyou County revenue from property tax and sales and use tax. The remaining accounts provided 0.1 to 3.4 percent of county revenue, on average.

Table 3.15-19. Siskiyou County Average Tax Revenues from 2000 to 2010

Account Description[1]	2000–2010 Annual Average	
	Revenues	Percentage of Total Revenue
Property Taxes		
Prior Secured	$532,851	3.4%
Prior Supplemental	$19,963	0.1%
Prior Unsecured	$10,529	0.1%
Secured	$8,745,403	53.0%
Current Unsecured	$535,829	3.3%
Supplemental	$333,962	2.0%
Property Transfer Tax	$198,111	1.2%
Race Horse Tax	$167	0.0%
Sales & Use Tax	$4,757,226	29.7%
Hotel – Motel Tax	$438,865	2.7%
Local Transportation	$276,582	1.7%
Timber Yield	$391,581	2.5%
Triple Flip	$207,857	1.1%

Source: Siskiyou County 2011a

1- Property taxes include the following accounts: secured, current unsecured, supplemental, prior secured, prior unsecured, and prior supplemental

PacifiCorp pays property taxes to Siskiyou County on land owned at the Klamath Hydroelectric Project facilities. Siskiyou County received an average of $1.4 million from PacifiCorp property taxes annually (Table 3.15-20) over 2000 to 2010. In 2008 and 2009, PacifiCorp indicated that $305,000 and $290,000 of property taxes were associated with hydroelectric facilities (PacifiCorp 2009). The variation in tax payments indicated between years in table 3.15-20 was driven by an increase in investment in operating property in Siskiyou County, which has lead to an increase in assessment on property subject to tax.

Table 3.15-20. Siskiyou County Annual Tax Amount Received from PacifiCorp from 2000 to 2011

Tax Year	Tax Amount
2000-2001	$1, 257,537
2001-2002	$1,187,891
2002-2003	$1,180,011
2003-2004	$1,178,678
2004-2005	$1,184,970
2005-2006	$1,210,490
2006-2007	$1,285,173
2007-2008	$1,513,189
2008-2009	$1,637,105
2009-2010	$1,798,210
2010-2011[1]	$1,746,074

Source: Siskiyou County 2011b

[1] Includes 2nd installment which County will receive in April 2011

In fiscal year 2009–2010, Siskiyou County dispersed property taxes to the following: schools (68.04 percent), county (21.33 percent), cities (6.03 percent), and special districts (4.60 percent). Special districts include cemetery, fire, recreation, community service, flood control, county service, and sanitary districts. Of the 6.03 percent that went to cities, the City of Yreka received 2.2 percent, Mt. Shasta received 1.2 percent, Weed received 0.9 percent, Dunsmuir received 0.6 percent, and the remaining cities all received less than 0.35 percent (Siskiyou County 2010).

In 2008, property taxes levied in Klamath County were about $57.2 million. The majority of taxes were from residential ownership ($28.5 million). Utilities contributed about 14.7 percent to total property taxes, about $8.4 million in 2008 (Klamath County Assessor 2008). PacifiCorp pays property taxes to Klamath County on land owned at the Klamath Hydroelectric Project facilities. In 2010-2011, Klamath County anticipates to receive about $519,000 in property tax revenues from PacifiCorp (Turner 2011).

In Klamath County, property taxes are used to finance local governments, such as cities, school districts, fire districts, park districts, vector control districts, road districts, cemetery districts, sanitary districts, and special districts.

Klamath and Siskiyou Counties also receive funding from Federal sources. The counties received American Reinvestment and Recovery Act funds to stimulate spending during the economic recession. As of February 2011, Siskiyou County received $63.5 million and Klamath County received $55.9 million (Recovery.Gov 2011). Appendix O includes a summary of Recovery Act funds.

3.15.3.7 Irrigated Agriculture

Reclamation's Klamath Project delivers water to approximately 200,000 farmland acres and 35,000 wetland acres in Klamath, Siskiyou, and Modoc Counties, primarily along the California-Oregon border. Table 3.15-21 provides a summary of the regional economy in Klamath County, Oregon and Siskiyou and Modoc Counties, California. The agricultural sector was 7.3 percent of total regional employment, 6.0 percent of the regional labor income and 10.2 percent of output.

Table 3.15-22 summarizes crops grown and acreages in Reclamation's Klamath Project. Alfalfa, pasture, and wheat have the most irrigated acreage.

For analysis purposes, crops in Table 3.15-22 are aggregated based on the availability of data on crop prices, production costs, and yields and each group is assigned a representative crop. Table 3.15-23 shows prices of the representative crops. Prices vary annually based on market conditions. Table 3.15-24 shows gross farm revenues, based on crop yields and prices. Alfalfa had the highest gross revenue of the crops, likely a

Table 3.15-21. Summary of the 2009 Regional Economy for Klamath, Modoc, and Siskiyou Counties

Industry Sector	Employment[1]		Labor Income[2]		Output[3]	
	Jobs	Percent of Total	$ (million)	Percent of Total	$ (million)	Percent of Total
Agriculture	3,803	7.3	124.2	6.0	560.9	10.2
Mining	85	0.2	3.3	0.2	16.1	0.3
Construction	2,358	4.5	99.3	4.8	265.5	4.8
Manufacturing	2,629	5.0	135.9	6.5	706.1	12.8
TIPU	2,122	4.1	118.1	5.7	426.3	7.8
Trade	7,272	13.9	237.7	11.4	491.6	8.9
Service	22,421	43.0	752.2	36.1	2,245.1	40.8
Government	11,452	22.0	611.8	29.4	785.7	14.3
Total	52,142	--	2,082.5	--	5,497.3	--

Source: Reclamation 2012b.

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production.

Table 3.15-22. Crop Acreage Summary for Irrigated Agriculture in Reclamation's Klamath Project Lands (acres)

Crops	2005	2006	2007	2008	2009	Average
Small Grains						
Feed Barley	10,962	13,674	14,083	11,827	8,430	11,795
Malt Barley	0	278	0	4,389	3,513	1,636
Wheat						
Wheat	31,716	24,163	22,172	27,290	31,563	27,381
Oats	2,679	3,334	2,947	2,774	2,809	2,909
Other Cereals	1,006	617	600	247	834	661
Corn	0	12	42	7	5	13
Alfalfa						
Alfalfa	55,197	61,619	65,851	63,701	61,336	61,541
Other Hay	21,032	18,968	17,082	15,710	15,918	17,742
Silage	875	1,000	0	150	400	485
Irrigated Pasture						
Irrigated Pasture	40,046	42,880	43,409	44,846	44,564	43,149
Other Forage	0	93	145	0	0	48
Potatoes						
Chip Potatoes	7,450	5,890	2,640	2,430	6,688	5,020
Fresh Potatoes	3,727	9,549	8,941	9,556	5,951	7,545
Potato Seed	250	430	280	140	150	250
Onions						
Onions	2,863	3,239	3,618	3,441	3,533	3,339
Peppermint	2,394	2,922	2,846	2,682	3,200	2,809
Horseradish	913	734	810	436	421	663
Strawberry	413	259	176	536	505	378
Other	72	423	591	345	258	338
Fallow	11,711	5,949	7,746	6,500	4,962	7,374
Total	193,306	196,033	193,979	197,007	195,040	195,073

Source: Reclamation 2012c.

result of the consistently high percentage of the land base dedicated to the crop and the relatively high price of alfalfa per ton. Potatoes and onions also had high gross revenues related to other crops. The onions group, as shown in Table 3.15-22, contains a number of other vegetables and specialty crops that have had increasing amounts of acreage in past years.

Table 3.15-23. Representative Crop Prices from 2005 to 2009

Year	Small Grains	Wheat	Irrigated Pasture	Potato	Onions	Alfalfa
	$/Ton	$/Ton	$/AUM	$/Ton	$/Ton	$/Ton
2005	82.00	103.47	14.50	159.89	99.00	128.94
2006	120.00	136.06	15.40	99.43	99.00	135.00
2007	164.99	272.00	16.50	129.36	110.00	140.00
2008	300.02	225.00	16.50	155.96	126.00	200.00
2009	300.02	200.24	17.80	127.57	128.60	154.71
Average	193.41	187.35	16.14	134.44	112.52	151.73

Sources: Reclamation 2012c.
Key:
AUM: annual unit month

Table 3.15-24. Average Gross Farm Revenue Generated on Reclamation's Klamath Project Lands from 2005 to 2009

Representative Crop	Gross Revenue ($1,000)	Gross Revenue per Acre ($/acre)[1]
Alfalfa Hay	$58,769.60	$736.76
Irrigated Pasture	$6,996.10	$161.96
Onions	$21,108.20	$2,804.33
Potato	$39,910.10	$3,114.33
Small Grain	$4,706.10	$350.39
Wheat	$17,119.20	$552.87
Total Gross Revenue	$148,609.40	--

Source: Klamath Basin Hydro-Economic Model (KB_HEM) , as cited in Reclamation 2012c
1 – Gross revenue per acre based on average acreages in Table 3.15-22

3.15.3.8 Refuge Recreation

Reclamation's Klamath Project provides water supply to the Tule Lake National Wildlife Refuge (NWR) and Lower Klamath NWR. The refuges attract visitors to Klamath and Siskiyou Counties for hunting and wildlife viewing. Table 3.15-1 presents a summary of regional economy in Klamath and Siskiyou Counties. Employment, labor income, and output related to refuge recreation are reflected in services and trade sectors in the table.

In 2009, the two refuges reported a combined total of 96,300 wildlife watching visits and 10,526 hunting visits. In general, visitation to the refuges has been declining over the past decade.

3.15.4 Environmental Consequences

For purposes of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR), economic or social effects must be discussed if they are inter-related to the natural or physical environmental effects of a project. Since economic effects of the project are related to physical environmental effects, a National Environmental Policy Act (NEPA) economic analysis is required. However, NEPA does not require that economic effects be judged for significance. The California Environmental Quality Act (CEQA) does not consider economic or social changes resulting from a project as adverse effects on the environment. If a physical change in the environment is caused by economic or social effects, the physical change may be regarded as an adverse effect. Physical effects of the project alternatives are evaluated separately and do not require economic analysis; therefore, CEQA analysis and associated significance criteria are not required. The following sections describe analysis methods and potential economic effects of the project alternatives.

3.15.4.1 Effects Determination Methods

The modeling package used to assess the regional economic impacts from the expenditures associated with each alternative was IMPLAN (IMpact analysis for PLANning). IMPLAN is a commonly used, industry accepted economic input-output modeling system that estimates the effects of economic changes in a defined analysis area. MIG, Inc. developed the IMPLAN modeling system. This analysis uses the current Version 3.0 system, which was released in November 2009.

IMPLAN is a static model that estimates impacts for a snapshot in time when the impacts are expected to occur, based on the makeup of the economy at the time of the underlying IMPLAN data (2009 data is used for this analysis). IMPLAN measures the initial impact to the economy but does not consider long-term adjustments as labor and capital move into alternative uses. This approach is used to compare the alternatives. Realistically, the structure of the economy will adapt and change; therefore, the IMPLAN results can only be used to compare relative changes between the No Action/No Project Alternative and the action alternatives and cannot be used to predict or forecast future employment, labor income, or output (sales).

Input-output models measure commodity flows from producers to intermediate and final consumers. Purchases for final use (final demand), or direct effects, are inputs into the model and drive the results. Industries produce goods and services for final demand and purchase goods and services from other producers. These other producers, in turn, purchase goods and services. This buying of goods and services (indirect purchases) continues until leakages from the analysis area (imports and value added) stop the cycle. These indirect and induced effects (the effects of household spending) can be mathematically derived using a set of multipliers. The multipliers describe the change in output for each regional industry caused by a 1-dollar change in final demand. Multipliers are built into IMPLAN.

This analysis used 2009 IMPLAN data for the counties which encompass the economic regions. IMPLAN data files for the analysis area are compiled from a variety of sources including, but not limited to, the U.S. Bureau of Economic Analysis (BOE), the U.S. Bureau of Labor (BOL), and the U.S. Census Bureau.

Methods and assumptions for the regional impact analysis are further described in Reclamation 2012b. Appendix P also includes further information about IMPLAN and the methods for the KBRA regional economic impacts analysis. The following sections identify specific technical reports as relevant. This section presents the total economic effects of the project alternatives. Total effects are equal to the sum of direct, indirect, and induced effects, described above.

Regional economic total effects are presented in terms of employment, labor income, and output. IMPLAN defines these parameters as follows:

- Employment – Number of jobs, a job can be full-time, part-time, or temporary.
- Labor Income - All forms of employment income, including employee compensation (wages and benefits) and proprietor income.
- Output - Value of industry production. In IMPLAN these are annual production estimates for the year of the data set.

Using IMPLAN, this section presents quantified results for regional economic effects from changes in expenditures or revenues associated with:

- Dam decommissioning, operation and maintenance (O&M), mitigation
- Commercial fishing
- Reservoir recreation
- Ocean sport fishing
- In-river sport fishing
- Whitewater recreation
- Klamath Basin Restoration Agreement (KBRA) Fisheries, Water Resources and Tribal Programs
- Irrigated agriculture related to KBRA actions
- Refuge recreation related to KBRA actions

The KHSA Section 3.2.1(iii), signed by Secretary of the Interior Ken Salazar on February 18, 2010, directs the Secretary to undertake environmental review in support of the Secretarial Determination. All alternatives carried forward for further analysis in the EIS/EIR were analyzed using existing studies and other appropriate data as suggested in KHSA Section 3.2.1 (i), where such analysis met criteria in (40 CFR 1502.22 and 43 CFR 46.125) to incorporate available information. As part of developing the basis for the Secretarial Determination, the KHSA requires in Section 3.3.2 that the Secretary prepare a Detailed Plan, including the identification, qualifications, management, and oversight of a non-Federal Dam Removal Entity (DRE), if any, that the Secretary may designate. KHSA Section 3.3.4.D requires that an estimate of costs be prepared as part of

the Detailed Plan. The Detailed Plan analysis provides most of the information for the project description for Alternatives 2 and 3, and this information was used to analyze these two action alternatives. As described in KHSA Section 3.2.1(i), the FERC record is used to form the project description for Alternatives 4 and 5. Alternatives 4 and 5 were analyzed to ensure that the review of reasonable fish passage alternatives was comprehensive. In addition, at the time of developing a reasonable range of alternatives, the Lead Agencies recognized that the inclusion of Alternatives 4 and 5 would provide an assessment of the short- and long-term effects from a broader range of reasonable alternatives. Alternatives 4 and 5 are outside the authority of the Department of the Interior, the four facilities proposed for removal are privately owned structures, and there was no provision in the KHSA to include them in the Detailed Plan. The result is differing levels of available information for alternatives carried forward in the EIS/EIR consistent with the elements of each action alternative.

Regional economic effects were quantified for the No Action/No Project Alternative, the Proposed Action, and the Partial Facilities Removal of Four Dams Alternative. These regional economic effects provide the broadest range of economic impacts expected from implementation of any of the alternatives and bookend the expected economic impact to the area of analysis. Once that information was developed, a comparative analysis of the Fish Passage at Four Dams Alternative and Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative provide the information required to evaluate the relative impacts of each action alternative within the identified range of economic effects. Specific economic effects for construction and changes in commercial fishing, recreation, and irrigated agriculture were not individually quantified for Fish Passage at Four Dams Alternative and Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative. The missing data is relevant to reasonable foreseeable significant adverse human effects on the environment. However, that unavailable data is not essential to a reasoned choice among alternatives because potential impacts can be compared to the data developed for the No Action/No Project Alternative, the Proposed Action, and Partial Facilities Removal of Four Dams Alternative. The range of impacts anticipated for the two alternatives for which data is missing falls within the range of impacts analyzed and data developed for the remaining alternatives, though the ratio of expenditures to impacts might not have the same proportional effect across the various economic sectors. The comparative analysis required by NEPA is achieved using this qualitative method.

The socioeconomic section of the EIS/EIR addresses primarily regional economic impacts on employment, income and output that occur within the Klamath region and related ocean areas, as well as qualitative information related to tribal effects, real estate, property tax revenues, and PacifiCorp's customers' energy rates. However, changes in some resources may have effects that take the form of economic benefits and costs that may extend to individuals or entities outside and inside the regional impact area and are separate and distinct from the regional impacts considered in the EIS/EIR. For example, economic effects on hydropower resources (beyond just the rates PacifiCorp charges to individual in the region) are not evaluated as part of the regional analysis. In addition, the EIS/EIR does not include an evaluation of any non-use values held by individuals both within and outside the region. In the context of the Klamath Basin, non-use values

accrue to members of the public who value Klamath Basin environmental restoration regardless of whether they consume Klamath River fish or visit the Basin. Both hydropower and non-use values - as well as other benefits and costs - are addressed in the Final Klamath Dam Removal Overview Report for the Secretary of the Interior (DOI and DOC [NOAA Fisheries Service] 2012), a separate document from the EIS/EIR.

3.15.4.1.1 Four Facilities

Deconstruction of the dams would result in economic effects in Siskiyou and Klamath Counties. Deconstruction or construction activities would create jobs and generate additional economic activity within the region during the period of construction. Direct effects represent equipment rentals, purchase of materials, and payment for labor.

An important consideration in evaluating regional economic effects is how much money is spent within the region for construction supplies and equipment, and how many workers are employed that originate from the region. Costs for dam decommissioning were divided into expenditures that would be made inside and outside of Siskiyou and Klamath Counties. The expenditures assumed to be spent within the counties were used in IMPLAN to estimate employment, labor income, and output from dam decommissioning. Dam decommissioning expenditures made outside the analysis area would have no impact on the local economy.

Reclamation estimated total dam decommissioning costs and allocated the costs associated to within-region expenditures. Dam decommissioning costs assumed to be spent within the region are described in more detail in the Benefit Cost and Regional Economic Development (RED) Technical Report (Reclamation 2012a).The analysis assumed that the onsite construction workforce would be hired from within the region. Some workers would be brought into the region from outside areas. Money from out-of-region workers spent on goods and services within Siskiyou and Klamath Counties contributes to regional economy, while money that originates from in-region workers is much less likely to generate regional economic effects because spending from sources within the region represents a redistribution of income and output.

O&M expenditures made in the region would generate positive economic effects to the regional economy. Annual O&M expenditures for each alternative are summarized in the Benefit Cost and RED Technical Report (Reclamation 2012b). Based on estimates from Reclamation, it was assumed that 80 percent of the O&M expenditures would be made inside the two-county area. This analysis measures annual O&M effects after dam removal in the year 2020. Like the dam commissioning expenditures, in-region O&M expenditures associated were placed into relevant sectors of the economy and run through IMPLAN to estimate effects to the regional economy. This analysis does not quantify the positive effects resulting from periodic replacement costs. O&M effects would occur annually.

The in-region mitigation costs associated with the action alternatives were also analyzed in IMPLAN to estimate employment, labor income, and output effects in the regional economy. The costs associated with the major dam mitigation activities were allocated to

within-region expenditures. Dam mitigation costs assumed to be spent within the region are described in more detail in the Benefit Cost and Regional Economic Development Technical Report (Reclamation 2012b). Like the dam decommissioning analysis, the onsite mitigation workforce would be hired from within Siskiyou and Klamath Counties. The regional economic effects associated with dam mitigation costs would be spread over the 2018-2025 period and would vary year-by-year proportionate to actual expenditures.

3.15.4.1.2 Commercial Fishing

The commercial fishing information is taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012a). The regional economic analysis evaluates effects from changes in commercial fishing in the area of analysis based on annual gross revenues projected under the project alternatives. Section 3.3, Aquatic Resources, evaluates effects to fish. Five of the seven management areas account for 99 percent of total gross revenue attributable to Klamath River Chinook salmon abundance under the No Action/No Project Alternative and project alternatives. Thus the regional economic analysis focuses on those five areas: San Francisco, Fort Bragg, KMZ-CA, KMZ-OR, and Central Oregon.

The estimates of gross revenue used in this analysis are based on relative projections of Klamath River Chinook salmon harvest provided by the Evaluation of Dam Removal and Restoration of Anadromy (EDRRA) model (Hendrix 2011). The EDRRA model is a simulation model that provides 50-year projections of Klamath River Chinook salmon escapement and harvest under the alternatives. The EDRRA harvest projections pertain to Klamath River Chinook salmon and do not distinguish between spring and fall runs. Harvest is estimated for each simulated year on the basis of a new Klamath River fall Chinook salmon harvest control rule recommended by the PFMC to the NOAA Fisheries Service in June 2011. The model allocates total Klamath River Chinook salmon harvest among fisheries as follows: 50 percent to tribal fisheries, 7.5 percent to the in-river recreational fishery (up to a maximum of 25,000 fish – with any surplus above 25,000 allocated to escapement), 34 percent to the ocean commercial fishery, and 8.5 percent to the ocean recreational fishery. The 50/50 tribal/non-tribal split is a “hard” allocation specified by the United States Department of the Interior (DOI) (1993). The remaining allocations are “soft” allocations as they represent customary practice rather than mandatory conditions.

For the No Action/No Project Alternative, fishery conditions are characterized in terms of average annual troll harvest of Klamath River fall Chinook salmon during 2001-05. The years 2001-05 were selected as the base period for the following reasons: Klamath River fall Chinook salmon fell within a ‘moderate’ range of abundance during those years, abundance of Sacramento River fall Chinook salmon (the other salmon stock targeted south of Cape Falcon) also fell within a ‘moderate’ range, and constraints and policies that are likely to continue into the future (e.g., the PFMC’s weak stock management policy, consultation standards for ESA-listed salmonids, 50-50 tribal/non-tribal harvest allocation) were well established by that time. For the project alternatives, harvest is estimated on the basis of the 43 percent increase in troll harvest projected by the

EDRRA model, scaled to average annual troll harvest of Klamath River fall Chinook salmon during 2001-2005.
The following steps were taken to estimate gross revenues and regional economic effects under the No Action/No Project Alternative and the project alternatives:

- Klamath River Chinook salmon harvest was expanded to account for total salmon harvest (all stocks) in the troll fishery due to the availability of Klamath River Chinook.
- Total salmon harvest (all stocks) was converted from numbers of fish to pounds dressed weight, using 2001-2005 data on average weight of troll-caught Chinook salmon (PFMC 2011).
- Total salmon harvest (all stocks) was converted from pounds to gross revenue, using 2004-2005 data on ex-vessel price per pound (PFMC 2011).

The analysis assumes that salmon troll revenues are spent in the management area where the landings occur. The gross revenue estimates by management area were used in IMPLAN to estimate employment, labor income, and output from commercial fishing.

3.15.4.1.3 Recreation

Depending on the recreation activity, visitors typically spend money on guide fees, food, hotels, restaurants, gasoline, equipment rentals, and/or other supplies required for outdoor activities. Any change to recreation opportunities that would result from implementation of the Proposed Action or alternatives would affect visitor spending and the region's economy. Increases in recreation spending would be considered a positive effect and decreases would be an adverse effect. This recreation economic impact analysis evaluates potential changes in direct visitor spending for recreation activities and subsequent, secondary economic effects. Estimates for changes in number of visitors and daily visitor spending are needed to calculate total reduction in recreation expenditures. IMPLAN is used to evaluate secondary effects in the regional economy. The economic effects presented in this section are directly related to the recreation effects discussed in Section 3.20, Recreation.

To estimate direct effects of visitor spending on a regional economy, it is important to consider the number of local visitors to the project area versus the number of visitors that originate from outside the region, or non-local visitors. If visitors are from the region, it is more likely that recreational spending intended for the project area would be spent elsewhere in the regional economy and there would be no net change in economic activity in the region. Non-local visitors bring money into the region that would not otherwise be there, and generate new economic activity. Changes in visits by non-locals largely drive the changes in recreational spending that would occur under the project alternatives. Therefore, this analysis requires data on the number of local visitors versus non-local visitors to estimate recreation-related economic effects.

Another important consideration is the availability and proximity of alternate recreation locations in the area. If visitors have multiple regional options for recreation similar to that available in the project area, they could substitute those areas for Klamath

Hydroelectric Project area recreation and continue to spend money within the regional economy. Section 3.20, Recreation, describes alternate recreation sites in the area.

Reservoir

The reservoir recreation information is taken directly from analyses contained in Reclamation (2012b) and Reclamation (2012d). The affected area is defined as Siskiyou and Klamath Counties, which include J.C. Boyle, Copco 1 and Iron Gate Reservoirs, where reservoir recreation occurs. Nonlocal visitors to the three reservoirs (J.C. Boyle, Copco 1, and Iron Gate) spend money in the region purchasing gas, food and drink, lodging, guide services, and other items. These expenditures generate economic activity measured in terms of total industry output, labor income, and employment within the two-county economic region. Economic activity could change under the project alternatives.

Within region reservoir recreation expenditures per visit were obtained from the recreation survey presented in the PacifiCorp (2004) report. The expenditure information was gathered by expenditure category such as accommodations, food, gas, supplies and guide fees. This analysis assumes an average of $15.35 per visit. Changes to average annual within region, nonlocal visitor expenditures were run through IMPLAN to estimate regional economic effects associated with the Full and Partial Facilities Removal Alternatives.

Ocean Sport Fishing

The ocean sport fishing information is taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012h). This analysis focuses on economic effects of expenditures for ocean sport fishing in the KMZ-CA and KMZ-OR (where the effects of Klamath River fall Chinook salmon abundance are largely felt). Expenditures within the region by resident and nonresident anglers generate economic activity measured in terms of industry output, labor income, and employment. A basic assumption underlying this analysis is that any increase in expenditures by resident anglers associated with expanded fishing opportunities would be accommodated by reducing expenditures on other locally purchased goods and services, with no net change in local economic activity. For nonresident anglers, however, increases in local expenditures associated with increases in local fishing opportunities would be accomplished by diverting money that they would otherwise spend in their area of residence. Thus the economic analysis focuses on nonresident angler expenditures, which represent ‘new money’ whose injection serves to stimulate the local economy.

For the No Action/No Project Alternative, fishery conditions are characterized in terms of average annual ocean recreational harvest of Klamath River fall Chinook salmon during 2001-2005. For the project alternatives, Klamath River fall Chinook salmon harvest is estimated on the basis of the 43 percent increase in ocean recreational harvest of Klamath River Chinook salmon projected by the EDRRA model (Hendrix 2011), scaled to average annual harvest during 2001-2005.

The following steps were taken to estimate nonresident angler expenditures and regional economic effects under the project alternatives:

- Klamath River Chinook salmon harvest was expanded to account for total salmon harvest (all stocks) in the ocean recreational fishery due to the availability of Klamath River Chinook.
- Total salmon harvest (all stocks) was converted to angler days, using 2001-2005 fishery data (PFMC 2011).
- Number of angler days by fishing mode (party/charter, private boat) was estimated by multiplying total effort by the proportion of effort attributable to each mode, estimated using 2001-2005 fishery data (PFMC 2011).
- Number of angler days by nonresident anglers was estimated by using zip code of residence data collected in ocean recreational creel surveys conducted by the CDFG and ODFW to estimate the proportion of effort in each mode and area attributable to nonresident anglers.
- Average expenditures per angler day by nonresident anglers (for lodging, food, gasoline, fishing gear, party/charter boat fees, private boat fuel, equipment rental, access fees, and bait/ice) was estimated to be $200.02 for party/charter mode and $54.66 for private boat mode (in 2012 dollars), based on data collected in a 2000 economic survey of saltwater anglers conducted by NOAA Fisheries Service.
- Total within region expenditures by nonresident anglers were estimated by multiplying nonresident angler days by average nonresident expenditures per angler day. Total within region direct expenditures were run through IMPLAN to estimate regional economic impacts.

In-River Sport Fishing

The in-river sport fishing information is taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012g). For the in-river salmon fishery, the affected area includes Klamath, Siskiyou, Humboldt, and Del Norte Counties. The three California counties cover the current location of the in-river salmon and steelhead fisheries; Klamath County covers the area above the dams where salmon and steelhead could potentially recolonize under the action alternatives. Details regarding the methods, assumptions, and conclusions underlying this analysis are in the In-River Sport Fishing Economics Technical Report (NOAA Fisheries Service 2012g).

Klamath River Chinook Salmon

For the No Action/No Project Alternative, fishery conditions are characterized in terms of in-river recreational harvest of Klamath River fall-run Chinook salmon during 2001-2005. For the project alternatives, Klamath River fall-run Chinook salmon harvest is estimated on the basis of the eight percent increase in in-river recreational harvest of Klamath River fall–run Chinook salmon projected by the EDRRA model (Hendrix 2011), scaled to average annual harvest during 2001-2005. For all alternatives, harvest was converted to angler days, using 2001-2005 data on the ratio of angler days to harvest (NOAA Fisheries Service 2012g).

The proportion of angler days attributable to nonresident anglers was calculated on the basis of location-of-residence data collected in the Klamath River creel survey conducted by CDFG (Borok 2009). Location of residence is reported in the creel survey as the first three digits of the angler's zip code of residence. Each three-digit location corresponds to a Sectional Center Facility (SCF) of the U.S. Postal Service – a processing and distribution center that serves zip code destinations beginning with those three digits. For purposes of this analysis, anglers identified with SCF 955 and SCF 960 are defined as resident anglers. Because these SCFs extend beyond the boundaries of the four-county regional economic impact area, the analysis provided here likely understates expenditures by nonresident anglers and their contribution to the regional economy. Average expenditures per angler day by nonresident anglers (for lodging, food, gasoline, fishing gear, private boat fuel, and guide services) is $105.02 (in 2012 dollars), based on data from a 2004 economic survey of in-river salmon and steelhead anglers sponsored by NOAA Fisheries Service.

Steelhead

Economic effects of the No Action/No Project Alternative on the in-river steelhead fishery were analyzed on the basis of current fishery conditions, as little change in the status of steelhead is anticipated under that alternative. Estimation of regional effects for the action alternatives was precluded due to data limitations; instead those effects are expressed in qualitative terms.

The No Action/No Project Alternative is characterized in terms of average annual 2003-2008 steelhead fishing effort on the Klamath River, estimated from CDFG steelhead report card data in collaboration with Terry Jackson (CDFG). The proportion of total effort attributable to nonresident anglers is based on report card data on city/State of residence. Average nonresident expenditures per angler day (for lodging, food, gasoline, fishing gear, boat fuel, guide fees) is assumed to be $105.98 (2012 dollars), based on data from a 2004 economic survey of in-river salmon and steelhead anglers sponsored by NOAA Fisheries Service.

Half-pounders are an important component of the steelhead fishery (Hopelain 1998). However, half-pounder catch is not included on steelhead report cards (Jackson 2007), and data for this fishery from other sources is sparse. Thus the regional effects estimated for the No Action/No Project Alternative should be viewed as conservative.

Redband Trout

The recreational redband trout fishery is a well-known trophy fishery. Major fishing sites include Upper Klamath Lake, the lower Williamson and Wood Rivers, and the Keno Reach of the Klamath River. Effort estimates for Upper Klamath Lake and Agency Lake are available from a statistical creel conducted by ODFW in 2009. However similar estimates are not available for the lower Williamson and Wood Rivers or for the Keno Reach – making it difficult to infer how much is spent on this fishery. Regional economic effects of this fishery are qualitatively assessed.

Sucker

The recreational sucker fishery is not considered in the regional analysis, as that fishery closed in 1987 and is unlikely to re-open under the No Action/No Project Alternative and action alternatives.

Whitewater Boating

The affected area for whitewater boating is defined as Jackson, Klamath, Siskiyou, and Humboldt Counties. Klamath River users that engage in whitewater boating recreation spend money in the region purchasing gas, food and drink, lodging, guide services, and other items. The expenditures associated with these trips generate economic activity measured in terms of total industry output, labor income, and employment within the four county economic region.

Reclamation (2012b) and the Whitewater Boating Recreation Economics Technical Report (DOI 2012b) discuss the methods and results of the whitewater boating recreation regional economic impact analysis summarized in this section. The technical report also provides estimates of average annual whitewater boating user days for the upper Klamath and lower Klamath River. The estimate of average annual total direct expenditures for whitewater boating was derived from expenditures per user day and the number of whitewater boating user days, and total number of user days are differentiated by local versus nonlocal and commercial versus private.

Johnson and Moore (1993) estimated 78 percent of total whitewater boating activity on the Upper Klamath River is by non-local users. This same percentage was applied for activity on the lower Klamath River. The number of local user days was further adjusted to account for those local users that would have engaged in a substitute activity outside of the local area if the Klamath River was not available. Following Johnson and Moore (1993), it was assumed that 11 percent of the local user days would have been substituted to an activity outside of the local region if the Klamath River was not available. Expenditures associated with these user days represent increased economic activity to the local region and are included in the estimation of total direct expenditures. The expenditures associated with the other 89 percent of local user days would have still occurred in the local area if the Klamath River was not available and therefore, do not represent an increase in economic activity to the local region and are not included.

Expenditures per user day are differentiated by private and commercial users, where commercial use is associated with the use of a whitewater boating outfitter. Table 3.15-15 shows annual and average private and commercial user days on the upper and lower Klamath River between 1994 and 2009. Whitewater boating outfitter fees vary among upper Klamath River and lower Klamath River trips and private and commercial trips. Table 3.15-25 shows average visitor expenditures per user day on whitewater boating trips. Expenditures other than outfitter fees (e.g., accommodations, food, gas, supplies, and shuttle services) were based on Johnson and Moore (1993) and inflated to 2012 dollars. Total whitewater boating expenditures were input in the IMPLAN model to determine total economic effects.

Table 3.15-25. Expenditures per User Day for Whitewater Boating on the Klamath River (2012 dollars)

Expenditure	Upper Klamath River		Lower Klamath River	
	Private	Commercial	Private	Commercial
Outfitter Fees	$0	$157	$0	$130
Gasoline/fuel	$26	$26	$26	$26
Meals/food	$59	$59	$59	$59
Accommodations	$59	$59	$59	$59
Retail/supplies	$21	$21	$21	$21
Shuttle Services	$11	$11	$11	$11
Total	$176	$333	$176	$306

Source: DOI 2012b

3.15.4.1.4 Indian Tribes

This analysis focuses on fishing opportunities, related cultural and social practices, standard of living, and health for five of the six federally recognized tribes in the Klamath Basin (Klamath Tribes, Karuk Tribe, Resighini Rancheria, Yurok Tribe, Hoopa Valley Tribe). Based on information available at the time of this analysis, the sixth tribe, the Quartz Valley Community, was not expected to be directly affected by the outcome of the Secretarial Determination. The tribal information is taken directly from analyses contained in Reclamation (2012b) and NOAA Fisheries Service (2012b-f). Sections 3.12, Tribal Trust, and 3.16, Environmental Justice, include more detailed analysis on potential social effects to Indian Tribes.

3.15.4.1.5 PacifiCorp Hydroelectric Service

The analysis qualitatively discusses potential effects to PacifiCorp customer rates.

3.15.4.1.6 Property Values

All else equal, the removal of the Four Facilities including loss of the reservoirs could impact real estate values of parcels surrounding Copco 1 and Iron Gate Reservoirs in Siskiyou County. Dam removal could also potentially affect the value of parcels near and adjacent to the Klamath River downstream from Iron Gate Dam due to improved water quality and more robust runs of anadromous fish. The discussion in this EIS/EIR considers potential effects on reservoir and riverine property values qualitatively. Studies have shown that amenities provided by proximity to a lake have a positive correlation with land values (See Section 3.15.3.6). Thus, the loss of reservoirs could result in declines in private land values. The net value of these changes, and the time over which such changes might be observed in market prices, is uncertain.

In concept, to evaluate impacts on real estate values, one would collect market sales data for different properties with different characteristics, which would include “view amenities.” This data would include market values for land that had reservoir views, river views, and no views. All else equal, the difference in the land values for properties with different amenities would represent the impacts of such amenities on real estate

values. This is a challenging exercise in thin markets, where limited data inhibit revelation of market preferences, and where other external factors affecting real estate markets may mask or overwhelm the effects of dam removal.

3.15.4.1.7 PacifiCorp Property Taxes

This analysis discusses effects to county property tax revenues qualitatively. PacifiCorp pays property taxes to Siskiyou and Klamath Counties. After dam removal, the States of California and Oregon would assume payment of property tax assessments in the form of in-lieu fees for the lands underneath and adjacent to the reservoirs that will come under State management. In-lieu fees would be equivalent to the current assessment paid by PacifiCorp for hydroelectric properties, as defined by California Fish and Game Code Section 1504 and Oregon Revised Statutes Section 496.340:

> California Fish and Game Code Section 1504. (a) When income is derived directly from real property acquired and operated by the State as wildlife management areas, and regardless of whether income is derived from property acquired after October 1, 1949, the department shall pay annually to the county in which the property is located an amount equal to the county taxes levied upon the property at the time title to the property was transferred to the State. The department shall also pay the assessments levied upon the property by any irrigation, drainage, or reclamation district.
>
> Oregon Revised Statutes Section 496.340. Except as provided in subsection (3) of this section, whenever real property owned by the State Fish and Wildlife Commission is exempt from taxation on January 1 of any year by reason of its ownership by the State, the commission shall pay to the county in which the property is situated an amount equal to the ad valorem taxes that would have been charged against the property if it had been assessed to a taxable owner as of January 1 of such year as provided in subsection (2) of this section. The county assessor shall determine the value of such property and shall notify the commission of the determination of the county assessor. Upon request of the commission, the Department of Revenue shall review the determination of value and shall re-determine the value if it concludes the value initially determined was substantially incorrect.

3.15.4.1.8 KBRA

The KBRA identified 112 actions that could result in new economic activity in the counties within the Klamath Basin. Actions focus on fisheries restoration, monitoring, reintroduction, water resources, agriculture, and economic development for tribes and counties in the Klamath Basin. Chapter 2 describes programs and actions included in the KBRA. Appendix P includes the detailed KBRA regional economic effects analysis.

KBRA actions would increase labor income, output and employment in the region through planning and implementation of local projects and funding to local governments.

The KBRA would be implemented over a 15 year period from 2012 to 2026. Federal and State agencies provided funding estimates for KBRA actions. This analysis uses funding estimates and the IMPLAN model to estimate regional economic effects of each KBRA action. Beyond the funding programmed in the KBRA in year 15, the expectation is that Federal financial support in the Klamath Basin would return to existing conditions. Additional funds would be subject to annual appropriations.

Federal agencies identified initial base funding values for actions listed in the KBRA. Base funding was provided on an annual basis for each year that the KBRA would be implemented (2012-2026). The base funding dollars are assumed to be spent whether the KBRA is implemented or not; therefore, the base funding values are assumed for the No Action/No Project Alternative. Base funding values were run in IMPLAN to determine effects of the No Action/No Project Alternative. The KBRA funding would be in addition to the base funding that would be spent under the No Action/No Project Alternative.

To estimate in-region spending for the KBRA, project experts from Federal and State agencies and tribes were interviewed regarding the percentage of total costs that would be spent in the region. Experts were from U.S. Fish and Wildlife Service (USFWS), Reclamation, NOAA Fisheries Service, United State Geologic Survey, U.S. Forest Service, DOI, CDFG, ODFW, Karuk Tribe, Yurok Tribe, and The Klamath Tribes. Appendix P summarizes personal communication records, which are referenced as personal communications at the end of this section. Project experts considered project requirements, similar past projects, existing industries and work force in the counties to determine a percentage for in-region costs. Percentages were applied to both base funding and KBRA funding.

Once in-region spending percentages were agreed upon, project experts helped identify the appropriate industry or institution that would experience the direct economic effect, or change in demand. For the majority of actions, money would be spent in the construction sector or in local and State governments to implement activities. This analysis uses the total funds over the 15-year period and does not evaluate effects on an annual basis. The KBRA effects shown in this analysis are not annual effects; instead, they are effects over the entire 15 year period.

Irrigated Agriculture

Some KBRA actions would change agricultural water supply, on-farm pumping costs, and water acquisitions in Reclamation's Klamath Project area, which would affect irrigated agriculture and farm revenues. Details on the methodology and results of the economic analysis are in Reclamation (2012a) and the Irrigated Agriculture Economics Technical Report (Reclamation 2012c).

Hydrology modeling was based on Biological Opinions for the No Action/No Project Alternative and incorporated KBRA criteria for the Full Facilities Removal Alternative,

including the On-Project Water Users Program (KBRA Section 15) and the Drought Plan (KBRA Section 19). The hydrology modeling drives the agricultural regional analysis (Reclamation 2012c). The Klamath Basin Hydro-Economics model (KB_HEM) evaluated effects to Reclamation's Klamath Project irrigators based on the hydrology. KB_HEM measures changes to cropping patterns and gross farm revenue. Gross farm revenue was used in IMPLAN to measure regional economic effects.

KB_HEM also evaluated current pumping rates for lands irrigated within Reclamation's Klamath Project, which were compared to estimates of reduced cost of electricity and the cost of pumping ground water for irrigation under the KBRA. IMPLAN was then used to estimate regional effects from pumping cost changes. Because KBRA does not provide enough information to quantify the effects from power rates to off-project irrigators, this analysis describes those effects in qualitative terms.

KBRA programs such as the Water Use Retirement Program, the Off-Project Reliance Program, and Interim Flow and Lake Level Program were also evaluated in IMPLAN. These programs encourage voluntary water right sales or short term water leasing. The regional economic impact of water right transfers or short term water leases are measured in two stages: (1) regional economic effects from the reduction in irrigated agricultural production and (2) the regional economic impact of the water transfer compensation or lease payment to growers. Water transfer/lease payments may offset negative economic effects from reduced irrigated crop production. The net regional economic impact is the sum of the stage one and stage two effects.

Refuge Recreation

Some KBRA actions would change water supply for refuges; therefore, refuge recreation is described under the KBRA. Visitors target the refuge primarily for one of two recreational purposes: wildlife viewing or waterfowl hunting. Visitation to refuges typically lasts for no more than one-half a day. Reclamation (2012b) and the Refuge Recreation Economics Technical Report (Maillett 2011) discuss in greater detail the methodology followed and results pertaining to the direct economic contribution to the local area associated with the economic expenditures of nonlocal refuge visitors.

Expenditures associated with visitation include lodging, food and beverages, transportation, and equipment. Expenditure data was obtained from the National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. Expenditures were prorated to prevent over-estimation of the contribution based on the amount of time a typical visitor spends on the Refuge. Table 3.15-26 shows estimated daily expenditures by visitors to the NWRs for hunting and wildlife viewing activities (in 2012 dollars). Non-residents spend more on recreation than residents, and all visitors spend more on hunting than on wildlife viewing.

Table 3.15-26. Daily Expenditures per Person for Hunting and Wildlife Viewing (2012 dollars)

Economic Sector	Migratory Bird Hunting		Wildlife Viewing	
	Resident	Non-Resident	Resident	Non-Resident
Lodging	$2.54	$12.78	$9.12	$36.44
Food/drink	$16.75	$50.25	$11.74	$38.66
Air transport	$25.39	$107.57	$9.27	$33.09
Other transport	$ -	$11.95	$1.51	$3.59
Other	$13.25	$18.33	$3.13	$14.95
Total	$57.93	$200.87	$34.76	$126.73

Source: 2006 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, U.S. Fish and Wildlife Service. Expenditures updated to 2012 dollars using Western Region Consumer Price Index, U.S. Census.

3.15.4.2 Effects Determinations

As described above, the following effects determinations comply with the required NEPA analysis of socioeconomic effects. Effects of the project alternatives are compared to the No Action/No Project Alternative.

3.15.4.2.1 Alternative 1: No Action/No Project Alternative

Four Facilities

The Four Facilities would be retained under the No Action/No Project Alternative; therefore, there would be no construction activities and short-term construction related effects associated with dam removal.

Annual O&M expenditures required to continue the operation of the existing facilities could result in long-term economic effects to jobs, labor income, and employment. Table 3.15-27 summarizes the regional effects from annual O&M expenditures. IMPLAN results indicate that existing O&M generates approximately 49 jobs. Labor income and output from O&M expenditures were estimated at $2.05 million and $5.19 million, respectively. Annual O&M expenditures and associated effects to employment, labor income, and output would remain the same under the No Action/No Project Alternative relative to existing conditions for the long term.

Table 3.15-27. Regional Economic Effects from Annual O&M Expenditures for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	49	2.05	5.19

Source: Reclamation 2012b presented in 2012 dollars
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Commercial Fishing

Changes in commercial fishing harvests could change fishing revenues and affect employment, labor income, and output in the regional economy. Under the No Action/ No Project Alternative, Klamath River fall Chinook salmon would continue to be the constraining stock for the troll fishery in San Francisco, Fort Bragg, KMZ-CA, KMZ-OR, and Central Oregon. Annual gross revenue projected for each of these five areas under average abundance conditions is described in Table 3.15-28 for the No Action/No Project Alternative. Revenues range from $266,900 in KMZ-OR to $9.126 million in San Francisco (Reclamation 2012b, NOAA Fisheries Service 2012a8). Due to the very modest contribution of Klamath fall Chinook salmon to commercial salmon revenues in Northern Oregon and Monterey, those areas are not included in Tables 3.15-28 and 3.15-29.

Table 3.15-28. Annual Ex-Vessel Revenue for Management Areas for the No Action/No Project Alternative

Management Area	Revenue (2012 dollars)
Central Oregon	6,847,058
KMZ-OR	266,894
KMZ-CA	328,574
Fort Bragg	4,202,992
San Francisco	9,125,553

Table 3.15-29 shows the regional economic effects from ocean commercial fishing under the No Action/No Project Alternative. Employment ranges from 26 to 510 jobs. Labor income ranges from $0.15 million to $6.10 million. Output ranges from $0.32 million to $15.52 million.

Table 3.15-29. Regional Economic Total Effects from Ocean Commercial Fishing under No Action/No Project Alternative

Management Area	Total Effects[1]		
	Employment[2] (Jobs)	Labor income[3] ($ millions)	Output[4] ($ millions)
Central Oregon	319	4.15	9.55
KMZ-OR	26	0.15	0.33
KMZ-CA	44	0.19	0.45
Fort Bragg	162	2.45	5.62
San Francisco	510	6.1	15.52

Source: Reclamation 2012b presented in 2012 dollars.
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Commercial fishing harvests and associated effects on employment, labor income, and output in the regional economy would be similar to current conditions for the long term.

It is important to note that in years of low Klamath Chinook salmon abundance, troll restrictions would be more widespread and affect Monterey and Northern Oregon as well as the five areas noted above. Historically (e.g., 2006), the severe regulatory restrictions associated with such low abundances resulted in economic hardship for the troll fishery and prompted Federal disaster assistance for affected fishing communities.

Recreation

Reservoir

Changes to reservoir recreation expenditures could affect jobs, labor income, and employment in the regional economy under the No Action/No Project Alternative. The reservoir recreation analysis assumes that 71,584 non-local visitors would recreate at Copco 1, Iron Gate and J.C. Boyle Reservoirs under the No Action/No Project Alternative. It should be noted that a substantial blue-green algae problem exists at Copco 1 and Iron Gate Reservoirs (but not at J.C. Boyle Reservoir) sufficient to warrant health advisories related to water ingestion or contact. These advisories suggest avoiding use of water for cooking and washing, as well as avoiding the consumption of fish. While these advisories have been in place for several years, no data exists as to their impact on recreation visitation. Should these algae problems under the No Action/No Project Alternative continue, a large percentage of visits at Copco 1 and Iron Gate Reservoirs may be lost. This could reduce the level of reservoir recreation visitation. At this point, the impact of the blue-green algae problem on visitation is unknown, therefore attempting to provide algae adjusted visitation estimates are speculative. Non-local recreation at Copco 1, Iron Gate, and J.C. Boyle Reservoirs would generate average annual spending of about $1.1 million per year, which would result in regional economic activity shown in Table 3.15-30. Reservoir recreation under the No Action/No Project Alternative would be the same as existing conditions for the long term.

Table 3.15-30. Regional Economic Effects from Reservoir Recreation for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	7	0.22	0.54

Source: Reclamation 2012b presented in 2012 dollars.

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production.

[4] Total Effect = Direct + Indirect + Induced Effects

In-River Sport Fishing

Changes to in-river sport fishing opportunities could affect recreational expenditures and employment, labor income, and output in the regional economy. Annual salmon fishing effort on the Klamath River is estimated at 24,683 angler days under average abundance conditions for the No Action/No Project Alternative. The portion of this effort attributable to nonresident anglers is 15,822 angler days. Annual expenditures in the region by nonresident anglers would be $1.7 million (2012 dollars). Table 3.15-31 shows the regional economic effects from in-river salmon fishing trip expenditures for the No Action/No Project Alternative (Reclamation 2012b, NOAA Fisheries Service 2012g).

Table 3.15-31. Regional Economic Effects from In-river Salmon Fishing for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	34	0.93	2.01

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Annual steelhead fishing effort on the Klamath River is estimated at 17,155 angler days under the No Action/No Project Alternative, of which 11,103 were attributable to nonresident anglers. Annual expenditures by nonresidents in the region would be $1.2 million. Table 3.15-32 shows the estimated regional effects from in-river steelhead fishing trip expenditures for the No Action/No Project Alternative (Reclamation 2012b, NOAA Fisheries Service 2012g).

Table 3.15-32. Regional Economic Effects from In-river Steelhead Fishing for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	20	0.62	1.31

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

According to results of a creel survey conducted during May-September 2009, fishing effort for redband trout on Upper Klamath Lake totaled 15,191 angler days during that period (pers. comm. William Tinniswood, ODFW). County-of-residence data collected as part of the survey indicate that 24 percent of this effort was by nonresident anglers. Effort estimates for other major fishing sites (lower Williamson and Wood Rivers, Keno Reach of the Klamath River) are not available. A popular guide fishery occurs on the lower Williamson River. Given that demand for guide trips is generally higher among nonresident than resident anglers, the proportion of trips by nonresident anglers is likely higher on the Williamson River than in Upper Klamath Lake; however, data are lacking to verify this. The redband trout fishery would remain similar under the No Action/No Project Alternative relative to existing conditions (Reclamation 2012b, NOAA Fisheries Service 2012g).

In conclusion, in-river sport fishing opportunities and associated effects on employment, labor income, and output in the regional economy under the No Action/No Project Alternative would remain similar to existing conditions for the long term.

Ocean Sport Fishing

Changes to ocean sport fishing opportunities associated with dam removal could affect recreational expenditures in the regional economy. Table 3.15-33 summarizes annual ocean sport salmon fishing effort (in total and by nonresident anglers) and nonresident angler expenditures under average abundance conditions for the No Action/No Project Alternative. Annual nonresident expenditures total $981,500 in KMZ-CA and $223,500 in KMZ-OR (Reclamation 2012b, NOAA Fisheries Service 2012h).

Table 3.15-33. Total Annual Recreational Salmon Effort, Nonresident Effort and Nonresident Expenditures for the No Action/No Project Alternative

Management area	Angler days (Total)		Angler days (Nonresident)		Expenditures (Nonresident [2012 dollars])	
	Party/charter	Private	Party/charter	Private	Party/charter	Private
KMZ-CA	1,665	23,569	1,538	11,926	313,644	667,856
KMZ-OR	382	14,293	197	3,273	40,174	183,288

Table 3.15-34 shows the estimated regional economic effects from ocean sport fishing trip expenditures for the No Action/No Project Alternative for KMZ-CA and KMZ-OR, respectively.

Table 3.15-34. Regional Economic Effects from Ocean Sport Salmon Fishing for the No Action/No Project Alternative

Management Area	Total Effects[1]		
	Employment[2] (Jobs)	Labor income[3] ($ millions)	Output[4] ($ millions)
KMZ-CA	13	0.42	1.12
KMZ-OR	3	0.08	0.21

Source: Reclamation 2012b presented in 2012 dollars
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Whitewater Boating

Changes to whitewater boating opportunities could affect recreational expenditures and employment, labor income, and output in the regional economy. Regional economic activity under the No Action/No Project Alternative is based on the average annual whitewater boating use and in-region expenditures per user day for the upper Klamath River and lower Klamath River. Total average annual visitation for the Klamath River was estimated at 18,806 user days, where the associated within region expenditures were estimated at $4.2 million for the No Action/No Project Alternative. Table 3.15-35 displays estimates of whitewater boating recreation regional economic effects for the No Action/No Project Alternative. Whitewater boating under the No Action/No Project Alternative would remain similar to existing conditions for the long term.

Table 3.15-35. Regional Economic Effects from Whitewater Recreation for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	56	1.56	4.31

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Indian Tribes

The continuation of dam operations would contribute to existing fishing and water quality conditions of Indian Tribes in the area of analysis. Access to fish has declined relative to historical levels due to reductions in abundance and distribution and loss of

access to traditional fishing sites. Opportunities to utilize fish for subsistence and ceremonial purposes and trade and barter would continue to be limited under the No Action/No Project Alternative similar to existing conditions. Water quality conditions that affect tribal cultural practices would continue to be impaired until such time as beneficial effects of the Klamath Basin TMDLs are felt. Such beneficial effects are subject to considerable uncertainty and would not be fully realized for a number of decades. The information contained in this section is taken directly from Reclamation (2012b) and NOAA Fisheries Service (2012b-f).

The Klamath Tribes

The decline in spring-run Chinook salmon began prior to construction of Copco 1 Dam due to factors such as mining and unregulated cannery operations at the river mouth (Snyder 1931). Construction of Copco 1 Dam eliminated much of the spawning and rearing habitat for the spring run (Hamilton et al. 2010). For The Klamath Tribes, access to both fall- and spring-run Chinook salmon ceased completely with the construct of Copco 1 Dam. Out-of-area fishing and barter proved to be untenable as a regular practice due to the distances traveled, the relatively small amounts of salmon obtained, and the need to meet obligations closer to home. Moreover, salmon obtained elsewhere did not have the same cultural significance as salmon harvested by tribal members on their own fishing grounds. After almost a century without salmon, first salmon ceremonies have ceased and been replaced by ceremonies focused on other species or prayers for the return of salmon. Efforts by The Klamath Tribes to educate the younger generations regarding the cultural and social importance of salmon are challenged by the lack of direct experience with salmon in their daily lives (Deur 2011).

Lost River (c'waam) and shortnose (qapdo) suckers were also important sources of sustenance and became increasingly so after the loss of salmon harvest opportunities. Studies conducted by The Klamath Tribes, ODFW, and the USFWS in the early 1980s revealed the poor status of these populations. The Klamath Tribes drastically curtailed their sucker fishery in 1985 and closed it entirely in 1986 (Markle and Cooperman 2001). The only fish species currently available to The Klamath Tribes is redband trout. Klamath tribal regulations allow subsistence harvest of trout, five fish per day on the Williamson River and up to ten fish per day in other areas.

Karuk Tribe

The Karuk Tribe does not have federally recognized fishing rights. However, the California Fish and Game Commission allows members of the Tribe to fish with traditional hand-held dip nets at their indigenous fishing site at Ishi Pishi Falls. Karuk tribal fishing is bound by California sport fishing regulations, including bag and possession limits. The seasonal round at Ishi Pishi is much diminished and consists mostly of fall-run Chinook salmon, available in modest numbers and for a very limited period. The First Salmon Ceremony has not been practiced in traditional form in the spring for decades, due to the dramatic decline in spring-run Chinook salmon. Lamprey have also declined in abundance to such an extent that traditional family eeling spots are no longer used (Lewis 2009). Quantities of fish harvested are not sufficient to meet subsistence needs, engage in trade and barter, or even provide adequately for tribal elders.

The Karuk Tribe routinely participates in the posting of health warnings along the river in the summer that advise people to avoid contact with the water and ingestion of fish livers and to thoroughly wash fish before consumption. The Tribe's concerns extend not only to finfish but also to freshwater mussels, crayfish and food plants that contribute to their diet (Norgaard 2005). Water quality also affects cultural practices, as the Piky'avish ceremonies (which require some participants to ritually immerse themselves in the river) extend into the summer months, when water quality is at its worst. Other tribal activities (e.g., basket making, use of medicinal plants) also involve contact with the river. Basket makers wade in the river to collect basket materials such as willows and cottonwood, wash the materials in the river, and strip the willows with their teeth. Medicinal plants are often washed in the river and some water is consumed along with the plants (Karuk Tribe undated, Gates and Novell 2011).

Resighini Rancheria

The Resighini do not have tribal fishing rights but retain a strong affinity to fishing and other cultural practices such as basket weaving and use of medicinal plants. Resighini members regularly participate in World Renewal Ceremonies hosted by neighboring tribes. Today candlefish and sturgeon are rarely seen on the Klamath River, coho salmon has been listed as 'threatened' under the Endangered Species Act, and Pacific lamprey and spring-run Chinook salmon are at very low levels of abundance. The declines in fish abundances have impacted the modest fishing opportunities available to the Resighini Rancheria.

Poor water quality at certain times of year affects the quantity and quality of basket materials and also exposes basket makers (who wade in the river and also strip willows and other materials with their teeth) to adverse water conditions. Gathering and use of medicinal plants is also adversely affected by poor water quality.

Yurok Tribe

Historical declines in fish abundances have impaired the ability of Yurok tribal members to meet their subsistence needs and engage in trade and barter and commercial fishing. With the decline of spring-run Chinook salmon, the First Salmon Ceremony and the Cappell Weir have not been practiced for many decades. Water quality problems interfere with fishing operations by causing algae to become entangled in fishing nets.

The Yurok Tribe hosts the World Renewal Ceremonies, which include the Deerskin Dance and Jump Dance, every other year in the Lower Basin in rotation with the Hoopa Valley Tribe. When fish harvest is low, the Yurok Tribe must supplement the harvest with sources off the reservation to meet their obligation to share salmon and other food with ceremonial participants and attendees (USFWS et al. 1999, Gates and Novell 2011). The World Renewal Ceremonies, Brush Dance and Flower Dance involve the use of basket materials that grow along the river and immersion of some ceremonialists in the river. Poor water quality at certain times of year affects the quantity and quality of basket materials and also exposes basket makers (who wade in the river and also strip willows

and other materials with their teeth) and ceremonialists (who engage in ritual immersion) to adverse water conditions. Gathering and use of medicinal plants is also adversely affected by poor water quality.

Hoopa Valley Tribe

The decline in fish abundances on the Trinity River has impaired the ability of Hoopa tribal members to meet their subsistence needs and utilize fish for trade and barter. The Hupa incorporate traditional cultural understandings and ceremonies into their everyday life, including fish harvesting (USFWS et al. 1999). Due to the decline of spring Chinook, they have not had a First Salmon Ceremony in decades. However, they are active participants in the World Renewal Ceremonies, which they host every other year in the Lower Basin in rotation with the Yurok. When fish harvest is low, the Hupa must supplement the harvest with sources off the reservation to meet their obligation to share salmon and other food with ceremonial participants and attendees (USFWS et al. 1999, Gates and Novell 2011).

Ceremonial and cultural practices affected by Trinity River water quality include ritual immersion of some ceremonial participants in the river, basket making (which requires basket makers to wade in the river and also strip willows and other materials with their teeth), and gathering and use of medicinal plants.

In conclusion, under the No Action/No Project Alternative, the socioeconomic conditions of the Klamath, Karuk, Resighini Rancheria, Yurok and Hoopa Valley Indian Tribes would be the same as existing conditions.

PacifiCorp Hydroelectric Service

Energy rates for PacifiCorp customers would be uncertain under the No Action/No Project Alternative. Under the No Action/No Project Alternative PacifiCorp would continue to operate under the current annual license, PacifiCorp customers would stop paying surcharges associated with dam removal costs. Funds collected would be returned to rate payers or used for restoration actions. While the modified mandatory terms and conditions and prescriptions developed by the DOI and NOAA Fisheries Service in the FERC relicensing proceedings are not included in the No Action/No Project Alternative, the potential changes in customer energy rates that could be generated by implementation of these terms and conditions are characterized below in the analysis of Alternative 4. PacifiCorp considers many factors in setting customer rates which in turn are subject to Oregon Public Utilities Commission (OPUC) and California Public Utilities Commission (CPUC) approval; therefore, it is difficult to assess the size of potential rate effects or even the extent to which rates might increase at all under the No Action/No Project Alternative.

Property Values

Property values surrounding Iron Gate and Copco 1 Reservoirs could change under the No Action/No Project Alternative. Property values of parcels around the reservoirs and along the river would be subject to and fluctuate based on general economic conditions. Future values of parcels around Copco 1 and Iron Gate Reservoirs could be affected by

continued postings of health advisories for microcystin algal toxins. This analysis does not attempt to predict market conditions and future housing values. The No Action/No Project Alternative would not affect property values relative to existing conditions.

PacifiCorp Property Taxes

PacifiCorp's property tax payments to Siskiyou and Klamath Counties could change under the No Action/No Project Alternative. PacifiCorp would continue to operate the Klamath Hydroelectric Project and pay property taxes to Siskiyou and Klamath Counties. In 2008 and 2009, PacifiCorp indicated that $305,000 and $290,000 of property taxes were associated with hydroelectric facilities in Siskiyou County (PacifiCorp 2009). PacifiCorp would continue to pay a similar amount annually to Siskiyou and Klamath Counties under the No Action/No Project Alternative. There would be no substantial changes in property tax revenues to the counties under the No Action/No Project Alternative relative to existing conditions.

Ongoing Restoration Activities

Ongoing restoration activities could generate employment, labor income, and output in the regional economy. Federal agencies have identified funding for ongoing restoration actions under the No Action/No Project Alternative. Table 3.15-36 summarizes regional economic effects of ongoing restoration actions under the No Action/No Project Alternative. Effects would occur in Klamath, Siskiyou, Humboldt, and Del Norte Counties. The regional economic impacts associated with ongoing restoration actions would be spread over the 2012-2026 period and would vary year-by-year proportionate to actual expenditures. Spending on local actions would affect employment, labor income, and output in the regional economy. Impacts would mostly occur in local or State governments and the construction sector. Effects would be temporary and only occur during the implementation period.

Irrigated Agriculture

Changes in Reclamation's Klamath Project hydrology could affect farm revenues, employment, labor income, and output in the regional economy. Under the No Action/No Project Alternative, KB_HEM model results predict five drought years for Reclamation's Klamath Project. Table 3.15-37 shows the gross farm revenue by IMPLAN sector for drought years, which was used in IMPLAN to estimate the potential regional economic effects from on farm production in drought years. Table 3.15-38 summarizes regional economic effects from agriculture during drought years. The three-county region supports a total of approximately 52,000 jobs, $2,082.6 in labor income, and $5,497 million in output by comparison. Under the No Action/No Project Alternative, farm revenues would remain the same as existing conditions.

Table 3.15-36. Total Economic Effects over a 15 year period of In-Region Spending for Ongoing Restoration Actions under the No Action/No Project Alternative

Ongoing Action	Total In-Region Spending (1000$)	Total Economic Effects[1]		
		Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
Coordination and Oversight	$1,350	22	$1,024	$1,622
Planning & Implementation--Phase I and II Restoration Plans	$420	7	$319	$505
Williamson River aquatic habitat restoration	$3,735	50	$2,378	$5,277
Sprague River aquatic habitat restoration	$11,216	147	$7,000	$16,086
Wood River Valley aquatic habitat restoration	$2,997	39	$1,801	$4,420
Williamson & Sprague USFS uplands	$4,680	62	$2,921	$6,712
Upper Klamath Lake aquatic habitat restoration	$2,997	38	$1,770	$4,476
UKL watershed USFS uplands	$1,159	16	$724	$1,663
Keno Impoundment/Lake Ewauna wetlands restoration	$2,250	29	$1,325	$3,369
Keno to Iron Gate upland USFS	$504	8	$311	$732
Shasta River aquatic habitat restoration	$16,674	166	$7,991	$17,613
Shasta River USFS uplands	$606	9	$373	$878
Scott River aquatic habitat restoration	$18,720	241	$11,515	$27,139
Scott River USFS uplands	$958	14	$590	$1,389
Scott River private uplands	$2,100	29	$1,368	$3,205
Mid Klamath River & tributaries aquatic habitat restoration	$6,750	88	$4,152	$9,786
Mid Klamath tributaries USFS upland	$3,600	47	$2,215	$5,220
Mid Klamath tributaries private upland	$4,200	55	$2,585	$6,090
Lower Klamath River & tributaries aquatic habitat restoration	$18,200	234	$11,196	$26,385
Lower Klamath private uplands	$9,900	128	$6,090	$14,352
Salmon River aquatic habitat restoration	$1,650	23	$1,029	$2,400
Salmon River USFS upland	$2,082	28	$1,281	$3,018
Adult Salmonids	$7,400	115	$5,608	$8,890
Juvenile Salmonids	$4,110	64	$3,115	$4,938
Genetics Otololith	$2,055	35	$1,720	$2,719
Hatchery Tagging	$315	6	$240	$380
Disease	$316	6	$241	$380
Green Sturgeon	$2,480	39	$1,880	$2,979
Lamprey	$371	7	$282	$446
Geomorphology	$153	3	$116	$184
Water Quality	$1,545	26	$1,176	$1,985
UKL bloom dynamics	$1,545	26	$1,176	$1,985
UKL water quality/phytoplankton/zooplankton	$2,020	34	$1,537	$2,595
UKL internal load/bloom dynamics	$1,800	30	$1,370	$2,313
UKL external nutrient loading	$60	2	$46	$78
UKL listed suckers	$8,985	146	$6,834	$11,542
Tributaries listed suckers	$930	16	$708	$1,196
Keno Impoundment/Lake Ewauna water quality/algae/nutrients	$70	2	$54	$91

Source: Source: Barry 2011; Bird 2011; Hicks 2011; Mahan 2011; Nota 2011; Radford 2011; Stopher 2011; Wise 2011
2012 dollars as estimated using IMPLAN
UKL: Upper Klamath Lake USFS: United States Forest Service
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Table 3.15-37. Gross Farm Revenue for the No Action/No Project Alternative during Drought Years

IMPLAN Crop Sectors	Gross Farm Revenue for Drought Years (1,000 $)				
	2027	2043	2045	2052	2059
Grains	19,189	4,519	11,462	17,078	20,300
Vegetables	60,675	55,966	58,562	60,127	60,791
Other (Hay & Pasture)	58,387	27,640	47,250	55,815	60,457
Total	138,251	88,125	117,274	133,020	141,548

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors as cited in Reclamation 2012c.

Table 3.15-38. Regional Economic Effects from Irrigated Agriculture for the No Action/No Project Alternative during Drought Years

Drought Year	Total Effect[1]		
	Employment[2] (Jobs)	Labor income[3] ($ millions)	Output[4] ($ millions)
2027	1,361	45.20	183.56
2043	766	33.21	118.30
2045	1,076	40.24	156.34
2051	1,286	43.97	176.78
2059	1,403	45.94	187.84

Source: Reclamation 2012c presented in 2012 dollars.
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Changes in on-farm pumping costs could affect farm revenues, employment, labor income, and output in the regional economy. Electricity costs and on farm ground water pumping costs would not be impacted under the No Action/No Project Alternative.

Water acquisitions could affect farm revenues, employment, labor income, and output in the regional economy. Under the No Action/No Project Alternative, water acquisitions would not impact the regional economy. The Klamath Water and Power Agency currently manages the Water Use Mitigation Program. This plan is similar to a water leasing mitigation program in which farmers are paid to idle land in exchange for the use of the water to reduce on project demand. This is a pilot project whose authorization ends in 2012; therefore it was assumed this program will not continue under the No Action/No Project Alternative. Thus, water acquisitions would have no effect under the No Action/No Project Alternative.

Refuge Recreation

Changes in water supply could affect visitor spending for refuge recreation and affect employment, labor income, and output in the regional economy. Water supply would be similar to historical water supply operations, and therefore recreation quality and opportunities would not change. Visitor expenditures for refuge recreation under the No Action/No Project Alternative would be the same as existing conditions. Table 3.15-39 shows the regional economic effects from refuge hunting trip expenditures for the No Action/No Project Alternative. Visitor spending for the long term would not change under the No Action/No Project Alternative, and the regional economy would not be affected relative to existing conditions.

Table 3.15-39. Regional Economic Effects from Refuge Hunting for the No Action/No Project Alternative

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	11	0.26	0.62

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Tribal Program

Ongoing fisheries and conservation management by The Klamath Tribes, Karuk Tribe, and Yurok Tribe could generate employment, labor income, and output in the regional economy. Federal agencies have identified funding for fisheries and conservation management actions to be implemented by tribes under the No Action/No Project Alternative. Table 3.15-40 summarizes in-region spending and regional economic effects of tribal program actions under the No Action/No Project Alternative. Effects would occur in Klamath, Siskiyou, Humboldt and Del Norte Counties where tribes are located. The regional economic impacts associated with tribal program actions would be spread over the 2012-2026 period and would vary year-by-year proportionate to actual expenditures. Spending on local actions would affect employment, labor income, and output in the regional economy. Most actions would be implemented by tribal staff and would positively affect the economic conditions of the tribes. A portion of the funding would result in positive effects in the construction sector and professional and technical services sector. Economic effects would be the same as existing conditions.

Table 3.15-40. Total Economic Effects over a 15-year Period of In-Region Spending for Tribal Program Under the No Action/No Project Alternative

		Total Economic Effects[1]		
Action	Total In-Region Spending (1000$)	Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
Fisheries Management, Karuk Tribe	$10,468	169	$7,505	$11,643
Fisheries Management, The Klamath Tribes	$8,997	118	$5,935	$9,717
Fisheries Management, Yurok Tribe	$8,934	141	$6,792	$12,108
Conservation Management, Karuk Tribe	$4,200	68	$3,012	$4,672
Conservation Management, The Klamath Tribes	$4,200	56	$2,771	$4,537
Conservation Management, Yurok Tribe	$4,200	67	$3,188	$5,724

Source: Dunsmoor 2011; Tucker 2011; Hillemeier 2011
2012 dollars as estimated using IMPLAN
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

3.15.4.2.2 Alternative 2: Proposed Action – Full Facilities Removal of Four Dams Four Facilities

Construction activities associated with dam removal would increase economic output, employment, and labor income during the construction period in Klamath and Siskiyou Counties. Effects from dam decommissioning expenditures would occur for one year in 2020. The costs for full facility removal would be approximately $178.4 million[3] in 2012 dollars. Not all dollars would be spent within the region. Approximately $114.3 million of $178.4 million would be spent in Klamath and Siskiyou Counties. For more detail on the cost estimates and in-region spending, see the Benefit Cost and RED Technical Report (Reclamation 2012a).

IMPLAN results for employment, labor income and output are shown in Table 3.15-41. Only in-region expenditures would generate positive regional economic effects. Dam decommissioning would support approximately 1,400 jobs and generate approximately $60 million in labor income and $163 million in output. Most economic effects would be in the sector where the direct impact occurs. For dam deconstruction expenditures, this analysis assumes direct effects would mostly occur in the construction sector.

[3] Dam removal as described in this EIS/EIR would occur from May 2019 through December 2020. For this socioeconomic analysis, all effects have been described in 2012 dollars to compare economic effects of alternatives. These costs for facilities removal should not be considered a most probable cost estimate for dam removal in 2020. For a more detailed analysis of the cost of dam removal please see Detailed Plan for Dam Removal – Klamath River Dams, July 2012.

Employment created in this sector would be full and part time jobs and include contractors and subcontractors directly engaged in construction operations (such as equipment operators, drillers, carpenters, electricians, mechanics, apprentices, skilled and unskilled laborers, truck drivers, on-site record keepers and security guards), and any of their related office or administrative staff (in executive, purchasing, accounting, personnel, professional, technical activities and routine office functions, and supervisory employees). The Proposed Action would result in short term positive effects to output, employment, and labor income in the region relative to the No Action/No Project Alternative. Effects would only occur during the construction period.

Table 3.15-41. Regional Economic Effects from Dam Decommissioning for Alternative 2, the Proposed Action

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	1,423	59.70	163.32

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production
[4] Total Effect = Direct + Indirect + Induced Effects

Dam removal would reduce annual O&M expenditures for the Klamath Hydroelectric Project and could affect employment, labor income, and output in the regional economy. The Proposed Action would not require any long term annual O&M expenditures for operation of hydroelectric facilities. As a result, there would be a decrease in expenditures in the region under the Proposed Action relative to the No Action/No Project Alternative. As shown in Table 3.15-42, the regional economy would lose 49 jobs, $2.05 million in labor income and $5.19 million in output relative to the No Action/No Project Alternative. For reduced O&M expenditures, this analysis assumes direct effects would occur in the construction sector. Employment created in this sector could be full time or part time and include various types of jobs, such as engineer, management, and administrative jobs. Reduction of O&M associated with the Four Facilities under the Proposed Action would result in adverse, long-term economic effect on employment, labor income, and output in the regional economy relative to the No Action/No Project Alternative.

Table 3.15-42. Change in Regional Economic Effects from O&M Expenditures between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
Total effect[4]	-49	-100.0	-2.05	-100.0	-4.61	-100.0

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Mitigation spending after the deconstruction period could increase economic output, employment, and labor income in the regional economy. Mitigation costs associated with the Proposed Action are presented on an annual basis in Table 3.15-43. Spending on mitigation would occur within the region after construction is complete. Mitigation would generally include repaving roads, replanting vegetation, restoring river banks, and monitoring. Not all mitigation dollars would be spent within the region. Klamath County has highway, street, and bridge construction companies that provide asphalt and asphalt products for road construction. Siskiyou and Klamath Counties also have county road crews. Much of the roadwork could be done by local workers and businesses. Local workers could also provide much of the replanting and habitat restoration required for mitigation. The Benefit Cost and RED Technical Report (Reclamation 2012a) includes percentages of mitigation costs assumed to be spent within the region.

Table 3.15-43. Mitigation Costs by Facility and Year (2012 $) for Alternative 2, the Proposed Action

Year	J.C. Boyle	Copco 1	Copco 2	Iron Gate	City of Yreka Water Supply	Total
2018	1,770,000	0	0	2,420,000	0	4,190,000
2019	2,080,000	4,200,000	3,340,000	5,400,000	0	15,020,000
2020	3,250,000	10,000,000	960,000	5,020,000	1,000,000	20,230,000
2021	2,290,000	4,700,000	0	2,790,000	0	9,780,000
2022	280,000	0	0	390,000	0	670,000
2023	280,000	0	0	390,000	0	670,000
2024	280,000	0	0	390,000	0	670,000
2025	280,000	0	0	390,000	0	670,000

Mitigation spending would be temporary and would vary year by year from 2018-2025. Spending would increase employment, labor income and output in the region, as presented in Table 3.15-44. Approximately 220 jobs, $10 million in labor income, and

$31 million in output between the years 2018-2025 would be generated by mitigation expenditures for the Proposed Action. For mitigation expenditures, this analysis assumes direct effects would occur in the construction sector. Employment created in this sector could be full time or part time and include construction, management, administrative and other types of jobs. The Proposed Action would result in positive, temporary effects to employment, labor income, and output during the mitigation period (2018-2025) relative to the No Action/No Project Alternative.

Table 3.15-44. Regional Economic Effects from Mitigation Expenditures for Alternative 2, the Proposed Action

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	217	10.01	30.86

Source: Reclamation 2012b data presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

After construction and mitigation activities are complete, there would no longer be increased spending or employment in the region as a result of the Proposed Action. Some longer term monitoring activities would continue, but it would be substantially less than spending during the construction period. Output, employment, and labor incomes within the region would largely return to levels prior to construction. Some wholesale suppliers, retail businesses, hotels, motels, and restaurants that served the influx of construction workers would have increased profits for potential investments, but sales would return to pre-construction levels. Mitigation activities would return most resources, such as roads and public utilities, to at least pre-construction conditions.

Commercial Fishing

Increases in commercial fishing harvests would increase fishing revenues and associated jobs, labor income, and output in the regional economy. The Proposed Action would restore a more natural Klamath River flow regime and improve and expand spawning and rearing habitat for salmon on the Klamath River, which would benefit salmon populations. Commercial fishing landings would increase because of increased salmon abundance, which would increase fishing revenues. Table 3.15-45 shows projected revenue under the Proposed Action and changes in revenues under the Proposed Action relative to the No Action/No Project Alternative in each management area. The differences range from about $114,000 in KMZ-OR to $3.9 million in San Francisco (Reclamation 2012b, NOAA Fisheries Service 2012a).

Table 3.15-45. Annual Ex-vessel Revenue by Management Area (2012 dollars)

Management area	Revenue under Proposed Action ($)	Change in Revenue relative to No Action/No Project Alternative ($)
San Francisco	13,028,998	3,903,445
Fort Bragg	6,000,817	1,797,825
KMZ-CA	469,121	140,547
KMZ-OR	381,058	114,164
Central Oregon	9,775,879	2,928,821

Table 3.15-46 summarizes regional economic effects from the change in ocean commercial fishing revenue between the No Action/No Project Alternative and the Proposed Action. Additional employment would range from 11 to 218 jobs, labor income would increase between $0.06 million to $2.56 million, and output would increase from $0.13 million to $6.6 million compared to the No Action/No Project Alternative. Most employment, labor income, and output effects would occur in the agricultural sector of the regional economy. Employment created in this sector could be full time or part time and include various types of services, such as fishing, provision of fuel, bait, and ice, and other supporting jobs. Increases in fish landings and revenues under the Proposed Action would have a long term, positive impact on employment, labor income and output in the regional economy relative to the No Action/No Project Alternative.

Table 3.15-46. Change in Regional Economic Effects from Ocean Commercial Fishing between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Total Effects					
	Employment[1]		Labor income[2]		Output[3]	
Management Area	Jobs	Percent Change	$ millions	Percent Change	$ millions	Percent Change
Central Oregon	136	42.6	1.74	42	4.07	42.6
Fort Bragg	69	42.7	1.05	42.8	2.41	42.8
KMZ-CA	19	41.7	0.07	42	0.19	42.6
KMZ-OR	11	43.8	0.06	42.8	0.13	42.8
San Francisco	218	42.7	2.56	42	6.6	42.6

Source: Reclamation 2012b presented in 2012 dollars.

[1] Total Effect = Direct + Indirect + Induced Effects.
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Tables 3.15-45 and 3.15-46 pertain to effects that reflect average abundance conditions projected for the No Action/No Project Alternative and the Proposed Action. It is also important to note that the Proposed Action would reduce the incidence of low abundances and associated adverse economic impacts on the troll fishery. Specifically, low abundances are expected to occur in 66 percent fewer years under the Proposed Action relative to the No Action/No Project Alternative, with the greatest decline (-79 percent) occurring in the post-dam removal years.

Recreation

Reservoir

Dam removal would eliminate in-reservoir recreation activities, which could reduce recreational expenditures and affect employment, labor income, and output in the regional economy. Under the Proposed Action, dam removal would eliminate reservoir recreation activities in the short and long term. This analysis assumes the loss of recreation at Copco 1, Iron Gate, and J.C. Boyle Reservoirs under the Proposed Action relative to the No Action/No Project Alternative.

This analysis assumes an average annual reduction of 40,901 visits under the Proposed Action relative to the No Action/No Project Alternative. The change in average annual expenditures would be a reduction of $627,838. Table 3.15-47 summarizes results that compare expenditures under the Proposed Action relative to the No Action/No Project Alternative. Most employment, labor income, and output effects would occur in the services sector. Employment affected in this sector could be full time or part time. Lost reservoir recreation would be a long term adverse effect to the regional economy under the Proposed Action relative to the No Action/No Project Alternative.

Table 3.15-47. Change in Regional Economic Effects from Reservoir Recreation between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
Total effect[4]	-4	-57.4	-0.13	-59.1	-0.31	-56.9

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Ocean Sport Fishing

Changes to ocean sport fishing recreation opportunities could affect recreational expenditures in the regional economy. Increased salmon populations would attract more ocean recreational fishing effort, which would increase spending in the regional

economy. Table 3.15-48 summarizes annual salmon fishing effort (in total and by nonresident anglers) and nonresident angler expenditures for the Proposed Action (Reclamation 2012b, NOAA Fisheries Service 2012h).

Table 3.15-48. Total Annual Recreational Salmon Effort, Nonresident Effort and Nonresident Expenditures by Fishing Mode and Management Area for Alternative 2, the Proposed Action

Management area	Angler days total		Angler days nonresident		Expenditures nonresident (2012 dollars)	
	Party/charter	Private	Party/charter	Private	Party/charter	Private
KMZ-CA	2,378	33,650	2,197	17,027	448,034	953,512
KMZ-OR	545	20,407	281	4,673	57,304	261,688

Table 3.15-49 summarizes regional economic effects of ocean sport fishing in the KMZ under the Proposed Action relative to the No Action/No Project Alternative. The Proposed Action would support and increase in regional activity because of increased angler expenditures. Most employment, labor income, and output effects associated with ocean sport fishing would occur in the services sector. Employment created in this sector could be full time or part time. Recreational expenditures for ocean sport fishing would increase under the Proposed Action relative to the No Action/No Project Alternative, which would increase employment, labor income and output in the region. Effects would be long term.

Table 3.15-49. Change in Regional Economic Effects from Ocean Sport Salmon Fishing between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Total Effects[1]					
	Employment[2]		Labor income[3]		Output[4]	
Management Area	Jobs	Percent change from No Action	$ millions	Percent change from No Action	$ millions	Percent change from No Action
KMZ-CA	5.5	42.3	0.18	42.8	0.48	42.8
KMZ-OR	1.2	41.4	0.02	42.7	0.09	42.7

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Tables 3.15-48 and 3.15-49 pertain to effects that reflect average abundance conditions projected for the No Action/No Project Alternative and the Proposed Action. It is also important to note that low abundances (and associated adverse economic impacts on the ocean recreational fishery) are expected to occur in 66 percent fewer years under the Proposed Action relative to the No Action/No Project Alternative, with the greatest decline (-79 percent) occurring in the post-dam removal years.

In-River Sport Fishing

Changes to in-river sport fishing opportunities associated with dam removal could affect recreational expenditures in the local economy. Annual salmon fishing effort on the Klamath River is estimated at 26,578 angler days under the Proposed Action. The portion of this effort attributable to nonresident anglers is 17,036 angler days. Expenditures in the region by nonresident anglers are estimated at $1.789 million (2012 dollars). The annual increase in nonresident expenditures under the Proposed Action relative to Alternative would be $127,000. Table 3.15-50 summarizes increased economic activity supported by the Proposed Action relative to the No Action/No Project Alternative (Reclamation 2012b, NOAA Fisheries Service 2012g).

Table 3.15-50. Change in Regional Economic Effects from In-river Salmon Fishing between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	Percent change from No Action	$ millions	Percent change from No Action	$ millions	Percent change from No Action
Total effect[4]	2.6	7.6	0.07	7.7	0.15	7.7

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects
Values do not include the contribution of any increase in steelhead and redband fishing under the Proposed Action due to lack of quantitative data.

Table 3.15-50 pertains to effects that reflect average abundance conditions projected for the No Action/No Project Alternative and the Proposed Action. It is also important to note that low abundances (and associated adverse economic impacts on the in-river recreational fishery) are expected to occur in 66 percent fewer years under the Proposed Action relative to the No Action/No Project Alternative, with the greatest decline (-79 percent) occurring in the post-dam removal years.

The Proposed Action would result in increased numbers of steelhead spawners and provide conditions conducive to establishment of a steelhead fishery above Iron Gate Dam (Hamilton et al. 2010). However, because these changes were not quantified, it is

not possible to quantify the effects of the Proposed Action on the steelhead fishery. However, expansion of that fishery would likely generate additional expenditures, jobs, labor income, and output in the regional economy.

The Proposed Action would result in increased abundance and distribution of redband trout in Upper Klamath Lake and its tributaries and a potential seven-fold expansion of the fishery below Keno Dam (Buchanan et al. 2011). The effects of this increase could not be quantified with available data but would likely yield a notable increase in economic impacts, given the size of the potential increase in the fishery noted.

Most employment, labor income, and output effects associated with in-river sport fishing would occur in the services sector. Employment created in this sector could be full time or part time. In conclusion, employment, labor income and output in the regional economy would increase as a result of increased in-river fishing expenditures under the Proposed Action relative to the No Action/No Project Alternative. Effects would be long term.

Whitewater Boating

*Changes to whitewater boating recreation opportunities associated with dam removal could affect recreational expenditures, employment, labor income and output in the regional economy***.** The primary area of whitewater boating on the upper Klamath River occurs on the Hell's Corner Reach, which is heavily dependent on releases from the J.C. Boyle Dam to provide sufficient and predictable whitewater flows. The lower Klamath River is not dependant on reservoir releases to maintain sufficient whitewater flow, and hydrologic modeling indicated that the average number of days with acceptable flow conditions suitable for whitewater boating on the lower Klamath River would not be impacted by dam removal (see Section 3.20, Recreation).

On the upper Klamath River, the average number of days with acceptable flow conditions for whitewater boating in the Hell's Corner Reach would decrease under the Proposed Action. The Hell's Corner Reach is somewhat unique in the project area in that it provides Class V rapids during the late summer months. Analysis of predicted hydrology modeling shows that the average number days with acceptable flows for primarily commercial whitewater boating on the Hell's Corner Reach are estimated to decline by 47.3 percent during the five month period from May through September (months when the majority of whitewater boating activity occurs annually) and decline by 29.5, 36.4, and 88.2 percent in June, July and August, respectively, relative to the No Action/No Project Alternative. In terms of private whitewater boating use on the Hell's Corner Reach, the predicted hydrology modeling shows that the average number days with acceptable flows are estimated to decline by 35.6 percent during the five month period from May through September and decline by 16.1, 49.4, and 57.8 percent in June, July and August, respectively, relative to the No Action/No Project Alternative. The combination of the decline in the number of days with acceptable flows, particularly during the three months when most of the use is observed (June, July, and August), and the lack of consistency and predictability of days with acceptable flows could make it more challenging for outfitters to continue offering trips for this reach of the Upper

Klamath River in the future, and to a lesser extent also make it more challenging for private users to engage in whitewater boating activities. Therefore, it is assumed whitewater boating activity on the upper Klamath River would be negatively affected under the Proposed Action for the long term.

The economic analysis for the lower Klamath River assumes that there would not be a measurable change in visitation levels for whitewater boating on the lower Klamath River after dam removal. Whitewater boaters would continue to spend money in the local economy. Expenditures would be similar to existing levels described for the No Action/No Project Alternative.

Table 3.15-51 summarizes estimates of the changes in whitewater boating recreation regional economic activity for the Proposed Action compared to the No Action/No Project Alternative. The loss of whitewater boating activity on the upper Klamath River (primarily the Hell's Corner Reach) would result in losses in expenditures and regional economic activity in the local region as compared to the No Action/No Project Alternative. Annual losses would begin in 2020. The difference in total average annual user days between the Proposed Action and the No Action/No Project Alternative was estimated at 2,706 user days. The difference in average annual lost expenditures between the Proposed Action and the No Action/No Project Alternative was estimated as $701,170. Most employment, labor income, and output effects associated with whitewater boating would occur in the services sector. Employment created in this sector could be full time or part time. Reduced whitewater boating expenditures would result in long term adverse effects to the regional economy under the Proposed Action relative to the No Action/No Project Alternative.

Table 3.15-51. Change in Regional Economic Effects from Whitewater Recreation between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
Total effect[4]	-14	-25.2	-0.43	-27.6	-0.89	-20.6

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Indian Tribes

Dam removal would increase fish harvest for subsistence, cultural practices and commercial uses that would be beneficial to Indian Tribes residing on the Klamath River (excluding the Hoopa Valley Tribe, who reside on the Trinity River. Tribal harvest

opportunities for Chinook, Pacific lamprey and steelhead are expected to increase in varying degrees under the Proposed Action relative to the No Action/No Project Alternative. Removal of the reservoirs behind the dams would reduce or eliminate the incidence of late-summer, toxigenic phytoplankton blooms that have prompted postings of public health advisories in the Hydroelectric Reach and further downstream on the Klamath River. These water quality improvements would have beneficial effects on tribal cultural practices in the affected areas. The information contained in this section is taken directly from Reclamation (2012b) and NOAA Fisheries Service (2012b-f).

The Klamath Tribes

The return of Chinook salmon to the Upper Basin (even in small numbers) would have great cultural significance for the Klamath Tribes, who have not experienced Chinook salmon in the Upper Klamath Basin for almost a century. Spring Chinook salmon is of particular importance, as it would allow for the revival of the First Salmon Ceremony. Should spring-run Chinook salmon become sufficiently abundant to support subsistence, it would also lengthen the duration of the seasonal round for salmon. Opportunities for subsistence harvest of suckers (which has not occurred since 1986) and redband trout are also likely to increase over the long term.

Benefits to be derived from this increased access to fish would include greater social and cultural cohesion associated with harvesting activities and associated ceremonies, greater opportunity to transmit cultural values and practices to the younger generation, and greater ability to provide food security, care for elders in the community, and engage in trade and barter. Poverty and rural isolation have constrained the ability of tribal members to replace fish with healthy food alternatives. Improved fishing opportunities would increase opportunities for healthy food consumption.

Karuk Tribe

Fish population effects would provide greater opportunities for the Karuk Tribe to engage in subsistence fishing and associated cultural practices (e.g., sharing fish with elders, transmitting values to the next generation, trade and barter). Spring-run Chinook salmon is of particular importance, as it could lead to revival of the traditional First Salmon Ceremony in the spring. Also, spring-run Chinook salmon are highly desirable for their fat content and would provide quality benefits to the subsistence fishery and lengthen the duration of the seasonal round for salmon. Improved fishing opportunities would increase opportunities for healthy food consumption. Late-summer water quality improvements associated with dissipation of toxigenic phytoplankton blooms would provide healthier conditions for ceremonies and other cultural practices that involve water contact (e.g., gathering of basket materials).

Resighini Rancheria

The Proposed Action may yield benefits to Resighini Rancheria members in terms of improved access to salmonids and other fish (through fishing and trade and barter). Improved fishing opportunities would increase opportunities for healthy food

consumption. Also, given their current dedication to attending ceremonies, it is likely that the Resighini would welcome a revival of the First Salmon Ceremony that may accompany improvements in the status of spring-run Chinook salmon. Late-summer water quality improvements associated with dissipation of toxigenic phytoplankton blooms would provide healthier conditions for ceremonies and other cultural practices that involve water contact (e.g., gathering of basket materials).

Yurok Tribe

Fish population effects would provide greater opportunities for the Yurok Tribe to engage in subsistence and commercial fishing and associated cultural practices (e.g., sharing of fish with elders, transmitting values to the next generation, trade and barter). Spring-run Chinook salmon is of particular importance and would allow for revival of the First Salmon Ceremony. Also, spring-run Chinook salmon are highly desirable for their fat content and would provide quality benefits to the subsistence and commercial fisheries and lengthen the duration of the seasonal round for salmon. The tribal guide fishery would benefit and also bring additional money into the community. Improved fishing opportunities would increase opportunities for healthy food consumption. Late-summer water quality improvements associated with dissipation of toxigenic phytoplankton blooms would provide healthier conditions for ceremonies and other cultural practices that involve water contact (e.g., gathering of basket materials).

Hoopa Valley Tribe

Demand for water exports from the Klamath and Trinity Rivers originates from two separate sources: the Reclamation's Klamath Project in the case of the Klamath River, and the Central Valley Project's Trinity River Division in the case of the Trinity River. Anadromous fish that return to the Trinity River are generally distinct from fish that return to the Klamath River, although Trinity River fish must first pass through 42 miles of the Klamath River before reaching the Trinity River.

To the extent that dam removal activities cause sedimentation in areas below the confluence with the Trinity River, such activities may adversely affect Trinity River fish and fisheries (including Hupa fisheries); however, these effects are expected to be short lived (Close *et al.* 2010, Dunne *et al.* 2011, Goodman *et al.* 2011). Potential long-term benefits to anadromous Klamath River fish populations associated with dam removal are likely to have little effect on Trinity River (including Hupa) fisheries, as beneficiaries of those actions are stocks that return to the Klamath River rather than the Trinity River.

Effects of implementation of the KBRA Tribal Program are described below in the section KBRA Effects.

PacifiCorp Hydroelectric Service

Removal of the Four Facilities could result in increased energy rates for PacifiCorp customers. PacifiCorp has added an approximately 2 percent surcharge to customer rates

in Oregon and California to cover costs of dam removal. Under the Klamath Hydroelectric Settlement Agreement (KHSA), ratepayer liability is capped at $200 million, prorated between PacifiCorp's customers in Oregon (up to $184 million) and California (up to $16 million). The OPUC and CPUC issued rulings that approved dam removal surcharges for PacifiCorp customers in Oregon and California (OPUC 2010, CPUC 2011). Under the Proposed Action, customer rates would not likely increase above the existing surcharges as a direct result of dam removal costs.

Property Values and Local Government Revenues

Removal of the Four Facilities could affect property values of parcels near Copco 1 and Iron Gate Reservoirs. Private parcels with partial reservoir views, frontage/access or with river views subsequent to the action could be affected by the Proposed Action.

To address issues specific to the Proposed Action, the two valuation impact studies for private parcels at Copco 1 and Iron Gate reservoirs were completed, one in March 2011 (Bender Rosenthal Inc. 2011) and a second in June 2012 (Bender Rosenthal Inc. 2012). The studies looked at three baseline dates of property values; the June 2012 study reported on December 2004 and December 2006 dates of value and the March 2011 study reported on an April 2008 date of value.

The studies included private parcels with reservoir views of Iron Gate Reservoir and private parcels with reservoir views and frontage on Copco 1 Reservoir. These two groups of properties could be affected by dam removal due to a change in either reservoir view or frontage after the dams are removed. Parcels were excluded from the initial list of potentially impacted properties if they were (1) publicly owned; (2) PacifiCorp owned; (3) had no assessed value; (4) in an area influenced by river (i.e., had river views prior to dam removal, and would therefore not be impacted by losing a reservoir view); and/or, (5) above the reservoir ridge (i.e., too far from the reservoirs to be affected by dam removal). Based on these criteria, the study identified 1,467 parcels that potentially could be affected by the removal of Iron Gate and Copco 1 reservoirs (Bender Rosenthal Inc. 2011). Of the 1,467 parcels, about 46 percent (668) were determined to have a measurable effect from dam removal. Parcels determined not to have a measurable impact from dam removal included those that were larger than 50 acres, located east of Copco Bridge (i.e., parcels with river frontage under existing conditions), determined unbuildable, or had no view of the reservoirs. Table 3.15-52 shows potentially affected private parcels by land use category. A majority of the applicable private parcels are vacant residential land and single-family residential. The assessed land value of the potentially affected parcels was about $9.0 million (Bender Rosenthal Inc. 2011).

Table 3.15-52. Evaluated Parcels by Land Use in Siskiyou County

Land Use Category	Private Parcels in Iron Gate and Copco Neighborhoods[1] (<50 acres)	Potentially Affected Parcels
Agricultural	7	0
Commercial	5	5
Rural Single-Family Residential[1]	3	0
Rural[1]	5	3
Single-Family Residential	163	127
Timber	1	0
Vacant Commercial	4	2
Vacant Residential Land[2]	1,246	518
Vacant Rural Land[3]	33	13
Total Parcels	1,467	668

Source: Bender Rosenthal Inc. 2011

1. Compiled based on a inspection of the general area, aerial mapping, conversations with a Siskiyou County appraiser, and with broker/agents in the area
2. Topography of the impacted parcels is varying, but a heavily sloped lot may increase the cost of development, but does not prevent development
3. 20 acre minimum

While the Bender Rosenthal Inc. reports (2011, 2012) used data from individual parcels, the appraisal was completed for groups of parcels based on common attributes and/or physical characteristics. Parcels were grouped according to water-frontage, access (property access by paved road as well as to utilities), and location. To evaluate the impact of dam removal on private properties around Iron Gate and Copco 1 reservoirs, this study used a before dam removal condition and a hypothetical after dam removal condition. The after dam removal condition assumed that the dams were removed and the river had returned to its original channel with the land under the reservoirs restored to its native condition. It is anticipated that land values would reach a low point soon after the reservoirs were drained and that they would progressively increase in value over time until the terraces above the river are revegetated and the river channel is fully recovered. The differences in land value through time in this interim period could not be quantified, and the amount of time it would take for a fully recovered river channel to develop is unknown, but would likely take years.

The valuation assessment considered reservoir frontage in the before dam removal condition to change to river view in the after dam removal condition. Similarly, reservoir view in the before dam removal condition was assumed to change to no reservoir view or river view in the after dam removal condition. Each of these comparisons was completed for 2004, 2006, and 2008. The study identified a discount in land value based on reservoir view to no view and reservoir frontage to river view. However there was only a very limited amount of data for the three years examined.

Riverine water quality improvements are likely to have little effect on the value of reservoir parcels, which are not generally expected to become riverfront properties after dam removal. Available data are insufficient to quantify such short- and long-term effects. Riverine parcels in areas downstream from Iron Gate Dam that experience detectable improvements in water quality and/or fish availability may experience positive changes in value. However, available data are insufficient to quantify such effects (DOI 2012a).

Reservoir real estate values are expected to decline in the short term due to adverse landscape changes associated with dam removal. This loss in value may be partially offset over the long term as barren landscape becomes revegetated open space. However, some of this loss would be permanent as a shift from reservoir view to no view or from reservoir frontage to river view would make a parcel less desirable.

Changes in real estate values around Copco 1 and Iron Gate Reservoirs and downstream from Iron Gate Dam could affect property tax revenues to Siskiyou County. In the short term, if reservoir property values decline, there could be adverse effects on property tax revenues to Siskiyou County. In the long term, if some reservoir land values permanently decline, Siskiyou County property tax revenues might decline relative to the No Action/No Project Alternative, assuming nothing else changes that might impact property tax revenues (e.g., tax rates). If riverine property values downstream from Iron Gate Dam increase in the long term, tax revenues to Siskiyou County could increase and at least partially offset the loss of tax revenues associated with the decline in reservoir property values. Effects on property values are uncertain in the long term; therefore, it is unknown how property tax revenues would be affected.

Removal of the Four Facilities could affect property tax revenues to Siskiyou and Klamath Counties from PacifiCorp. PacifiCorp owns property around the reservoirs and pays property taxes annually to Siskiyou and Klamath Counties. PacifiCorp pays in the range of $290,000 to $305,000 in property taxes on land attributable to hydroelectric facilities at Copco and Iron Gate Dams and about $132,000 in property taxes for land attributable to hydroelectric facilities at J.C. Boyle Dam. Under the Proposed Action, the States would assume ownership of these lands and PacifiCorp would not pay property taxes on the relinquished land to the counties.

The States of California and Oregon would pay in-lieu payments on the transferred land. In California, in-lieu fees would be equivalent to the current assessment paid by PacifiCorp for hydroelectric properties, as required by California Fish and Game Code Section 1504. To make in-lieu payments to counties, the California legislature has to authorize payments. It is unknown if the California legislature would authorize payments in future years. Lost tax revenues to Siskiyou County would be an adverse economic effect. Similar to California, Oregon law (State Wildlife Fund Section 496.340) requires the State to pay the current assessed value on transferred lands. The State Department of Revenue can review and revise assessed values if it is determined substantially incorrect.

The loss in tax revenue from PacifiCorp owned lands would impact the regional economy. However, if Siskiyou and Klamath Counties receive in-lieu payments of equal value to PacifiCorp property tax payment, there would be no net effect to county revenues under the Proposed Action relative to the No Action/No Project Alternative.

Construction worker spending could increase sales and use tax receipts in Siskiyou and Klamath Counties. Construction crews for dam removal in Siskiyou County would purchase goods and services from local restaurants and stores, which would increase sales tax revenues for the county. Sales and use tax revenues are an important receipt for Siskiyou County to fund general government, health, and social programs. In 2010, sales tax in Siskiyou County was 8.25 percent (BOE 2010a). Some workers that are brought to the area would stay in hotels, motels, or campgrounds, which could also produce additional sales tax for the county. For workers staying in hotels or motels, the county could receive additional hotel-motel tax. From 2000 through 2010, hotel-motel tax made up an average of 2.7 percent of Siskiyou County tax receipts. As a result of construction worker spending, county tax revenues would increase during the construction period. Oregon has a hotel-motel tax but does not have a general sales tax, so effects on tax receipts would be more limited in Klamath County. Construction worker spending would be a temporary and positive effect to Siskiyou County and to a lesser extent Klamath County under the Proposed Action relative to the No Action/No Project Alternative.

Changes in visitation for recreation activities could affect sales tax revenues. Similar to construction worker spending, increased visitation to the counties offering recreation activities would increase sale tax revenues within the counties. Any adverse effects on visitation expenditures would decrease sales tax revenues. Changes in sales tax revenues would affect funding for county programs, such as health, education, social services and other programs funded through sales taxes. For increases in in-river recreation activities and ocean fishing, increases in sales tax revenues would be a long-term and positive effect. Decreases in reservoir recreation in Siskiyou County could reduce sales tax revenues, which would be a long-term and adverse effect of the Proposed Action relative to the No Action/No Project Alternative. Reductions in whitewater boating expenditures would also be a long term, adverse effect to county sales tax. The net effect to sales tax revenues from changes in recreation expenditures is unknown.

East and Westside Facilities – Programmatic Measures

Decommissioning of the East and Westside facilities could result in economic effects. Minor construction would be required to decommission the facilities; therefore, there would not likely be any regional economic effects. PacifiCorp would no longer need to operate the facilities, which would reduce some employee hours required for operations and maintenance. This would not be a substantial effect. Effects as a result of lost hydropower are discussed in Section 3.18.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction activities associated with the City of Yreka Water Supply Pipeline could increase economic output, employment, and labor income during the construction period in Siskiyou County. Construction of the City of Yreka Water Supply Pipeline would

temporarily increase employment, labor income and output in Siskiyou County. Local construction firms would likely have the skills available for this construction effort; therefore, the majority of the regional economic effects would occur in the county. Increased employment and spending would have secondary impacts as inputs are purchased locally and construction workers spend a portion of their income in the region. This would be a temporary effect.

KBRA – Programmatic Measures

The KBRA has several programs that could have socioeconomic effects. Specific KBRA programs potentially affecting socioeconomics include:

- Phases I and II Fisheries Restoration Plans
- Fisheries Monitoring Plan
- Fisheries Reintroduction and Management Plan
- Agency Lake and Barnes Ranches
- Wood River Wetland Restoration
- Water Diversion Limitations
- On-Project Plan
- Future Storage Opportunities
- Water Use Retirement Program
- Power for Water Management
- Off-Project Water Settlement
- Off-Project Water Reliance Program
- Emergency Response Plan
- Climate Change Assessment and Adaptive Management
- Interim Flow and Lake Level Program
- Fish Entrainment Reduction
- Upper Klamath Lake and Keno Nutrient Reduction
- Tribal Fisheries and Conservation Management Program
- Tribal Programs Economic Revitalization
- Klamath River Tribes Interim Fishing Site
- Mazama Forest Project
- Klamath County Economic Development Plan
- California Water Bond Legislation
- Drought Plan

Fisheries Program

Fish habitat restoration for the Fisheries Program could affect employment, labor income, and output in the regional economy. The KBRA includes fishery restoration, reintroduction and monitoring actions in the Upper and Lower Basin. Restoration activities would involve some degree of construction including floodplain rehabilitation, large woody debris placement/replacement, fish passage correction, cattle exclusion fencing, and riparian vegetation planting. It is likely that much of the construction could

be done by local construction workers from the region. The KBRA also includes construction of new fish facilities, which may require more out of region contractors. State and local government workers in the region would likely implement many actions, including monitoring and administration. KBRA actions would provide new jobs and increase labor income within the region during the implementation period. Table 3.15-53 summarizes regional economic effects from implementation of the Fishery Program actions under the KBRA relative to the No Action/No Project Alternative. These effects are incremental to base funding being implemented under the No Action/No Project Alternative. Effects are based on funding levels identified by Federal agencies in a revised Table C-2 of the KBRA. Effects would occur over the KBRA implementation period (2012-2026) and would vary year-by-year proportionate to actual expenditures. Some actions would be completed in less than 15 years. Table C-2 (included in Appendix P) identified the timeline for action implementation.

Implementation of Fishery Program actions would increase employment, labor income, and output in the regional economy relative to the No Action/No Project Alternative. Effects would only last during the implementation period for each action. The increases in employment, labor income, and output in the regional economy generated by Fishery Program actions would add to economic effects generated by hydroelectric facility removal that are analyzed above during the years that the project implementation overlaps.

In the long term, the Fisheries Program could support increased fish abundance in the Klamath River and tributaries and improve regional economic conditions. The increased abundance could allow for increased catch limits and fewer catch-and-release requirements, and could decrease the potential for closures of entire fishing seasons. This would attract anglers to the region and increase economic activity. An increase in fish abundance would generate additional jobs, labor income and output and would be a long-term and positive economic effect. The increases in fish abundance generated by Fishery Program actions would be expected to build upon the fish abundance improvements generated by hydroelectric facility removal that are analyzed above.

Water Resource Program

Construction, analysis, and monitoring activities under the Water Resources Program could affect employment, labor income, and output in the regional economy. The KBRA includes water resource actions to improve water supply reliability in Reclamation's Klamath Project. Actions include monitoring, analysis, and construction. It is likely that much of the construction could be done by local construction workers from the region. State and local government workers in the region would likely implement many actions, including monitoring, analysis, and administration. KBRA actions would provide new jobs and increase labor income within the region during the implementation period. Table 3.15-54 summarizes regional economic effects from implementation of the Water Resources Program actions under the KBRA relative to the No Action/No Project Alternative. Some actions could affect irrigated agriculture or refuge recreation; these programs are evaluated below.

Table 3.15-53. Regional Economic Effects of KBRA Fishery Program Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (does not include Base Funds)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
1	Coordination and Oversight	$117	3	$90	$142
2	Planning & Implementation--Phase I and II Restoration Plans	$1,211	20	$918	$1,456
3	Williamson River aquatic habitat restoration	$890	12	$568	$1,258
4	Sprague River aquatic habitat restoration	$41,994	546	$26,206	$60,228
5	Wood River Valley aquatic habitat restoration	$10,777	136	$6,476	$15,892
6	Williamson Sprague Wood Screening Diversion	$2,232	28	$1,334	$3,306
7	Williamson & Sprague USFS uplands	$4,886	64	$3,049	$7,007
8	Upper Klamath Lake aquatic habitat restoration	$10,785	134	$6,365	$16,105
9	Screening of UKL pumps	$425	6	$255	$632
10	UKL watershed USFS uplands	$1,641	23	$1,024	$2,354
11	Keno Impoundment/Lake Ewauna water quality studies & remediation actions	$29,647	366	$17,443	$44,360
12	Keno Impoundment/Lake Ewauna wetlands restoration	$1,008	13	$594	$1,508
13	Keno to Iron Gate upland private & BLM	$0	0	$0	$0
14	Keno to Iron Gate upland USFS	$713	10	$440	$1,036
15	Keno to Iron Gate mainstem restoration	$951	13	$620	$1,321
16	Keno to Iron Gate tributaries - diversions & riparian	$1,141	16	$744	$1,585
17	Shasta River aquatic habitat restoration	$0	0	$0	$0
18	Shasta River USFS uplands	$0	0	$0	$0
19	Scott River aquatic habitat restoration	$0	0	$0	$0
20	Scott River USFS uplands	$460	6	$284	$668
21	Scott River private uplands	$0	0	$0	$0
22	Mid Klamath River & tributaries aquatic habitat restoration	$0	0	$0	$0
23	Mid Klamath tributaries USFS upland	$4,574	59	$2,815	$6,631
24	Mid Klamath tributaries private upland	$1,887	25	$1,162	$2,736
25	Lower Klamath River & tributaries aquatic habitat restoration	$0	0	$0	$0
26	Lower Klamath private uplands	$25,428	326	$15,641	$36,863
27	Salmon River aquatic habitat restoration	$1,959	26	$1,206	$2,840
28	Salmon River USFS upland	$2,701	35	$1,662	$3,916
29	Reintroduction Plan	$1,631	26	$1,236	$1,960
30	Collection Facility	$6,014	78	$3,700	$8,719
31	Production Facility	$6,113	79	$3,762	$8,865

Table 3.15-53. Regional Economic Effects of KBRA Fishery Program Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (does not include Base Funds)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
32	Acclimation Facility	$4,709	61	$2,898	$6,827
33	Transport	$826	13	$627	$994
34	Monitoring and Evaluation – Oregon	$29,828	461	$22,601	$35,828
35	Monitoring and Evaluation – California	$2,995	47	$2,270	$3,599
36	New Hatchery	$5,546	72	$3,412	$8,041
37	Adult Salmonids	$9,952	154	$7,542	$11,954
38	Juvenile Salmonids	$14,630	227	$11,086	$17,573
39	Genetics Otololith	$0	0	$0	$0
40	Hatchery Tagging	$0	0	$0	$0
41	Disease	$5,214	82	$3,952	$6,264
42	Green Sturgeon	$0	0	$0	$0
43	Lamprey	$1,837	29	$1,393	$2,208
44	Geomorphology	$1,608	26	$1,219	$1,933
45	Habitat Monitoring	$2,641	42	$2,002	$3,173
46	Water Quality	$86	2	$65	$110
47	UKL bloom dynamics	$0	0	$0	$0
48	UKL water quality/phytoplankton/zooplankton	$4,143	68	$3,153	$5,324
49	UKL internal load/bloom dynamics	$1,244	21	$947	$1,599
50	UKL external nutrient loading	$3,881	64	$2,952	$4,985
51	UKL analysis of long-term data sets	$652	11	$497	$838
52	UKL listed suckers	$4,331	71	$3,294	$5,564
53	Tributaries water quality/nutrients/sediment	$4,718	77	$3,589	$6,061
54	Tributaries geomorphology/riparian vegetation	$3,637	60	$2,767	$4,672
55	Tributaries physical habitat	$3,241	53	$2,466	$4,164
56	Tributaries listed suckers	$4,777	77	$3,634	$6,136
57	Keno Impoundment/Lake Ewauna water quality/algae/nutrients	$6,048	99	$4,601	$7,770
58	Keno Impoundment/Lake Ewauna to Tributaries: Meteorology (weather stations)	$3,044	50	$2,316	$3,911
59	Remote Sensing acquisition and analysis	--	No in-region spending, no regional economic effects		

Source: Barry 2011; Bird 2011; Hicks 2011; Mahan 2011; Nota 2011; Radford 2011; Stopher 2011; Wise 2011
2012 dollars as estimated using IMPLAN
UKL: Upper Klamath Lake
USFS: United States Forest Service
BLM: Bureau of Land Management
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Table 3.15-54. Regional Economic Effects of KBRA Water Resources Program Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (not including base funding)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
60	Keno Dam fish passage	--	No in-region spending, no regional economic effects		
61	Data Analysis and evaluation	$168	3	$126	$197
62	Development of predictive techniques	$391	7	$298	$471
63	Klamath Basin Wildlife Refuges: O&M North and P Canals	--	No funding identified in C2		
64	Klamath Basin Wildlife Refuges: Walking Wetland Construction	$2,500	40	$1,955	$3,799
65	Klamath Basin Wildlife Refuges: Big Pond Dike Construction	--	No funding identified in C2		
66	On Project water plan	--	Evaluated in Irrigated Agriculture		
67	Ground Water Technical Investigation	--	No in-region spending, no regional economic effects		
68	Costs Associated with Remedy for Adverse Impact	--	No funding identified in C2		
69	D Pumping Plant	--	Transfer of funds, no regional economic effects		
70	Water Use Retirement Plan	$0	Evaluated in Irrigated Agriculture		
71	Off Project Plan and Program: Use of 30,000 ac ft above UKL	$0	Evaluated in Irrigated Agriculture		
72	Interim Power Sustainability	$0	Evaluated in Irrigated Agriculture		
73	Federal Power	--	Transfer of funds, no regional economic effects		
74	Energy Efficiency and Renewable Resources	$4,402	54	$2,278	$6,211
75	Renewable Power Program Financial and Engineering Plan	--	No in-region spending, no regional economic effects		
76	UKL Wetlands Restoration: Agency/Barnes	$2,717	34	$1,576	$4,108
77	UKL Wetlands Restoration: Wood River	$2,717	34	$1,576	$4,108
78	Drought Plan Development	--	No funding identified in C2		
79	Drought Plan Restoration Agreement Fund	--	Evaluated in Irrigated Agriculture		
80	Emergency Response Plan	--	No funding identified in C2		
81	Emergency Response Fund	--	No funding identified in C2		
82	Technical Assessment of Climate Change	--	No in-region spending, no regional economic effects		
83	Off-Project Reliance Program	--	Evaluated in Irrigated Agriculture		
84	Real Time Water Management	--	No funding identified in C2		
85	Real Time Water Management: Water Flow Monitoring and Gauges	$3,239	51	$2,455	$3,892
86	Snowpack Gauges	--	No funding identified in C2		

Table 3.15-54. Regional Economic Effects of KBRA Water Resources Program Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (not including base funding)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
87	Adaptive Management: Science and Analysis	$1,087	17	$824	$1,307
88	Real Time Management: Calibration and improvements to KLAMSIM or other modeling and predictions	$109	3	$84	$131
89	Interim Flow and Lake Level Program	--	Evaluated in Irrigated Agriculture		

Source: Barry 2011; Hicks 2011
2012 dollars as estimated using IMPLAN
UKL: Upper Klamath Lake
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Regional economic effects would be in addition to base funding being implemented under the No Action/No Project Alternative. Effects are based on funding levels identified by Federal agencies in a revised Table C-2 of the KBRA. Effects would occur over the KBRA implementation period (2012-2026) and would vary year-by-year proportionate to actual expenditures. Some actions would be completed in less than 15 years.

Implementation of Water Resource Program actions would increase employment, labor income, and output in the regional economy relative to the No Action/No Project Alternative. Effects would only last during the implementation period. The increases in employment, labor income, and output in the regional economy generated by Water Resource actions would add to economic effects generated by hydroelectric facility removal that are analyzed above during the years that the project implementation overlaps.

Irrigated Agriculture

Changes in the Reclamation's Klamath Project hydrology could affect gross farm revenue and the regional economy. Model results indicated gross farm revenue would be equal in all years under the Proposed Action relative to the No Action/No Project Alternative except for five drought years 2027, 2043, 2045, 2051, and 2059 which correspond to the years 1975, 1992, 1994, 2001, and 2008 in the historical period of record. For the five drought years 2027, 2043, 2045, 2051, and 2059, the gross farm revenue increased under the Proposed Action from the No Action/No Project Alternative. Table 3.15-55 shows gross farm revenue under the Proposed Action and the change relative to the No Action/No Project Alternative. For all drought years, regional

employment, labor income and output increase over the No Action/No Project Alternative, shown in Table 3.15-56. This would be a long term, positive effect of the Proposed Action relative to the No Action/No Project Alternative. The increases in gross farm revenue and output in the regional economy would change hydroelectric facility removal effects because facility removal does not affect irrigated agriculture.

Table 3.15-55. Gross Farm Revenue by IMPLAN crop sectors between the No Action/No Project Alternative and Alternative 2, the Proposed Action for Drought Years (1,000 $)

Drought Years	Grains		Vegetables		Other (Hay & Pasture)		Total	
	Proposed Action	Change from No Action	Proposed Action	Change from No Action	Proposed Action	Change from No Action	Proposed Action	Change from No Action
2027	21,857	2,667	60,993	319	65,688	7,301	148,537	10,287
2043	21,664	17,145	60,966	5,000	64,439	36,798	147,069	58,944
2045	21,857	10,394	60,993	2,432	65,688	18,438	148,537	31,263
2052	21,857	4,779	60,993	866	65,688	9,872	148,537	15,517
2059	21,857	1,556	60,993	203	65,688	5,231	148,537	6,990

Source: KB_HEM estimated gross farm revenue by IMPLAN crop sectors as cited in Reclamation 2012c.

Table 3.15-56. Change in Regional Economic Effects from Gross Farm Revenue between the No Action/No Project Alternative and Alternative 2, the Proposed Action

Modeled Drought Years	Total Effects[1]					
	Employment[2]		Labor income[3]		Output[4]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
2027	112	8.2	2.3	5.2	13.0	7.3
2043	695	90.6	11.2	33.8	84.0	71.4
2045	397	36.9	7.3	18.1	41.0	26.0
2052	187	14.5	3.6	8.1	20.0	11.4
2059	70	5.0	1.6	3.5	9.0	4.8

Source: Reclamation 2012c data presented in 2012 dollars.
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Increases in on-farm pumping costs could affect household income and reduce employment, labor income, and output in the regional economy. Regional employment, labor income, and output under the Proposed Action are equal to the No Action/No Project Alternative in all non-drought years. The regional effects are the same in all drought years due to ground water substitution. Irrigators are pumping more ground water in the Proposed Action compared to No Action/No Project Alternative and therefore are paying more for electricity under the Proposed Action even with a decrease in electricity rates assumed in the Proposed Action (Reclamation 2012a and Reclamation 2012c). The average annual cost of pumping ground water would be $178,000 per year.

Table 3.15-57 shows the regional economic effects as result of increased pumping costs. Because farmers are paying more for electricity to pump ground water under the Proposed Action household income would reduce by the additional money spent to pump ground water. A reduced household income due to increased pumping costs would have a relatively small negative impact on the regional economy. The increased pumping costs under the Proposed Action would not change effects of hydroelectric facility removal because facility removal does not affect irrigated agriculture.

Table 3.15-57. Change in Regional Economic Effects from Increased Pumping Costs between the No Action/No Project Alternative and Alternative 2, the Proposed Action

Impact type	Employment[1] (Jobs)	Labor income[2] ($)	Output[3] ($)
Total effect[4]	-1	-40,907	-120,933

Source: Reclamation 2012b data presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Water acquisitions via permanent, voluntary water rights sales could affect farm revenues and reduce employment, labor income, and output in the regional economy. The water acquisition programs, including the Water Use Retirement Program (WURP) and the Off-Project Reliance programs, could result in a negative regional impact. WURP would be implemented to generate on an average annual basis an additional 30,000 acre-feet of inflow to Upper Klamath Lake. The KBRA states that WURP would provide for increased stream flow and inflow into Upper Klamath Lake through actions that could include the voluntary retirement of water rights or water uses. The KBRA states that "acquisition of water rights or uses to achieve the WURP purpose will be compensated, as applicable, through market mechanisms based upon values mutually agreed to by purchaser and seller, as informed by appraisals."

Water right transfers proposed as part of WURP could affect the regional economy. The land once irrigated with the surface water right would be converted to either dryland production or fallow. If all or part of the land is converted to dryland and/or fallow, the losses to economy would be the gross revenue produced on this land.

The second aspect of WURP that could potentially affect the regional economy is the compensation for the water right. Water right holders, or the growers, would be compensated for the value of the water right. However, no compensation would be paid to those in the regional economy who do not own the water right but are affected by the grower's activities. Farm workers, agribusiness firms such as fertilizer and chemical dealers, wholesale and agricultural service providers are examples of those who do not receive compensation but would be affected by the water right sale.

The land currently being irrigated by the water rights proposed to be acquired under the WURP program are off project in the Sprague River sub-basin, the Sycan River, the Williamson River sub-basin, and the Wood River sub-basin. This land is mostly used to grow irrigated pasture to support local livestock operations.

Table 3.15-58 presents the combined impact of the lost irrigated pasture production and the associated livestock forward linkage from the 30,000 acre-foot water right sale proposed under the WURP. However, it should be noted that a portion of these effects would be offset from household induced effects resulting from household wages that are spent as a result of the compensation made to the water right holder.

Table 3.15-58. Regional Economic Effects from Lost Agricultural Production for the WURP

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	-34	-0.86	-5.85

Source: Reclamation 2012c, results presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

More information is needed to measure the direct effect on household spending of payments for water purchases proposed in the KBRA. The direct household spending is determined after accounting for debt retirement and leakages related to outside investments, household savings, and household tax payments. It is unknown how much to account for debt retirement and leakages. It can be assumed that a small amount of the

regional effects shown in Table 3.15-67 would be offset by household spending (Howe and Goemans 2003). The water purchases proposed in the KBRA would not change any effects generated by hydroelectric facility removal given that facility removal does not affect irrigated agriculture.

Water acquisitions via short-term water leasing could decrease farm revenues and reduce employment, labor income, and output in the regional economy. Other programs in KBRA, like the Off-Project Reliance Program and the Interim Flow and Lake Level Program, suggest the use of water lease programs in drought years. Water lease programs are short term programs that may have negative effects to the regional economy during water short years. The programs allow farmers to sell or lease their water for fisheries programs on a short term basis when sufficient water is unavailable for fish. The regional economy would be affected by the loss in gross farm revenue generated on the land idled by farmers who voluntarily lease water. Some of these regional effects would be offset by household induced effects when farmers spend a portion of the compensation in the local area. Since the KBRA does not specify what crops would be idled, is not possible to use IMPLAN to measure these effects. Short-term water leasing is expected to have a short term, adverse effect on the regional economy. The short-term water leasing proposed in the KBRA would not change any effects generated by hydroelectric facility removal given that facility removal does not affect irrigated agriculture.

Refuge Recreation

Changes in water supply could affect refuge recreation expenditures and employment, labor income, and output in the regional economy. Additional water supply could improve hunting and wildlife viewing, which could attract more visitors to the area. Under the Proposed Action, there would be an additional 193,830 waterfowl and 3,634 hunting trips. The addition of these trips would result in a total of $255,500 in direct expenditures within the local economies. As shown in Table 3.15-59, the Proposed Action would create an estimated 5 additional jobs, increase labor income by $0.12 million and output by $0.27 million compared to the No Action/No Project Alternative. Increased refuge water supply under the Proposed Action would improve or maintain current recreational expenditures and would positively affect the regional economy relative to the No Action/No Project Alternative.

Table 3.15-59. Change in Regional Economic Effects from Refuge Recreation between the No Action/No Project Alternative and Alternative 2, the Proposed Action

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
Total effect[4]	5	47.2	0.12	47.0	0.27	47.0

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Regulatory Assurances

Implementation of regulatory assurances under the KBRA could support employment, labor income, and output in the regional economy. The KBRA includes regulatory assurance actions that generally include planning and construction. State and local government workers in the region would likely develop plans. There would be some local construction for the Keno Impoundment/Lake Ewauna Screening action. Actions would provide new jobs and increase labor income within the region during the implementation period. Table 3.15-60 summarizes regional economic effects from implementation of Regulatory Assurance action under the KBRA relative to the No Action/No Project Alternative.

Regional economic effects would be in addition to base funding being implemented under the No Action/No Project Alternative. Effects are based on funding levels identified by Federal agencies in a revised Table C-2 of the KBRA. Effects would occur over the KBRA implementation period (2012-2026) and would vary year-by-year proportionate to actual expenditures. The Keno Impoundment/Lake Ewauna Screening action would be complete in 4 years and the Federal General Conservation Plans/Habitat Conservation Plans would be implemented over 8 years. The regulatory assurance actions proposed in the KBRA would add to the effects generated by hydroelectric facility removal on employment, labor income, and output in the regional economy during years that the projects overlap.

Table 3.15-60. Regional Economic Effects of KBRA Regulatory Assurance Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (not including base funding)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
90	Keno Impoundment/Lake Ewauna Screening	$5,470	67	$3,170	$8,270
91	Federal GCP/HCP	$5,082	79	$3,851	$6,105

Source: Barry 2011 ; Hicks 2011
2012 dollars as estimated using IMPLAN
GCP/HCP: General Conservation Plan/Habitat Conservation Plan
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

The KBRA identified actions to develop laws for California and Oregon. The States would be responsible for implementing these actions. These actions would provide some local employment to State government staff in the region. Much of the work would occur by State workers outside of the region, which would not affect the regional economy.

County Programs

Implementation of the Klamath County Economic Development Plan could support long-term economic growth in Klamath County. The Klamath County Economic Development Plan would include a study and implementation of projects for economic development associated with fisheries restoration and reintroduction, tourism and recreational development, agricultural development, alternative energy development, and The Klamath Tribes economic development (KBRA 27.3.1). Appendix C-2 of the KBRA indicates $3.2 million of funding for the plan in 2016. Implementation of these actions would support long-term economic growth in Klamath County, by providing jobs, attracting visitors, attracting new businesses to establish in the area, supporting the agricultural economy, and supporting economic growth of tribes.

The Klamath County Development Plan also calls for Klamath County to be compensated for the loss of property tax revenues from reduced agricultural land values in Reclamation's Klamath Project due to a reduction of water deliveries and reduced agricultural land values in the areas upstream of Upper Klamath Lake due to the surrender of significant water rights. Compensation of property tax losses would allow Klamath County to continue funding county programs, including education, social services, emergency services, and to put money into the general fund. The Klamath County Development Plan would positively impact the regional economy and would allow the County to continue funding county programs. The long-term effects of implementation of the Klamath County Economic Development Plan proposed in the KBRA would add to the effects generated by hydroelectric facility removal on employment, labor income, and output in the regional economy.

Funds from the California Water Bond Legislation could be used by Siskiyou County to improve economic conditions in the County and to support future economic growth. California legislation passed in 2009 proposes a bond measure to fund an economic development plan for Siskiyou County and for hydroelectric facilities removal. The bond measure, if passed, would also fund other mitigation measures to reduce the potential effect of dam removal. The California Water Bond funding legislation must be approved by voters on a future ballot. If approved, bond funds would be used for economic development in Siskiyou County ($20 million) and for hydroelectric facilities removal including mitigation for CEQA effects and protection of the City of Yreka's water supply ($250 million). Humboldt and Del Norte Counties are not included in the economic development fund. Remaining funds may be used for fisheries restoration projects in Siskiyou, Humboldt and Del Norte Counties, including removal or improvement of bridges, culverts, diversions, or other obstructions to fish passage.

The economic downturn that began in 2008 has adversely affected Siskiyou County. Appendix O presents economic measures and trends for Siskiyou County. Siskiyou County's 2009 and 2010 unemployment rates are the highest in the county since the early 1990s, and unemployment and poverty rates are consistently well above State averages.

It cannot be determined at this time how Siskiyou would distribute funds from the California Water Bond Legislation; this is a general discussion. However, the bond funds

could assist Siskiyou County in addressing unemployment, poverty, bankruptcy, and social problems and continuing funding for other county programs. Typical programs to address economic stressors include adult education programs, job opportunity and skills services, financial support programs, and childcare subsidy programs. Some funds could be used for programs to address social problems, such as substance abuse prevention and treatment, teen pregnancy prevention, and crime prevention.

Funding could also be used for programs that have had recent budget cuts, including library, fire, museum, and farm advisor. Other county programs that have struggled with funding include public health, child support services, human services, and behavioral health. Special districts would also likely receive some additional funding. More teachers could be hired, fire stations could be upgraded, or fire staff could increase. Siskiyou County could also invest in redevelopment of commercial areas and improve recreation facilities to attract more tourism to the area. Increased tourism would bring additional money into the county's economy. Siskiyou County could spend the California Water Bond Legislation funds in many ways to improve economic conditions in the county and support future economic growth. Spending would likely increase employment opportunities and labor incomes in the county. This would be a long-term, positive economic effect. The long-term effects of the California Water Bond funding proposed in the KBRA would add to the effects generated by hydroelectric facility removal on employment, labor income, and output in the regional economy.

Some funds from the California Water Legislation may be left over for fishery restoration projects in Siskiyou, Humboldt and Del Norte Counties. Implementation of these projects would result in similar economic effects described for the Fisheries Restoration Program. Fishery restoration projects implemented by the California Water Legislation would result in a long-term and positive economic effect.

Tribal Program

This section describes effects of KBRA actions defined under the Tribal Program. Socioeconomic effects to tribes related to increased fish abundance and harvest are described above in the Indian Tribes Effects section.

Construction and monitoring activities associated with Tribal Program actions would increase jobs, labor income, and output for The Klamath Tribes, Karuk Tribe, and Yurok Tribe. Federal agencies have identified funding for fisheries and conservation management actions to be implemented by tribes under the Proposed Action. Table 3.15-61 summarizes in-region spending and regional economic effects of tribal program actions under the KBRA. Effects would occur in Klamath, Siskiyou, Humboldt and Del Norte Counties where tribes are located. The regional economic impacts associated with Fisheries and Conservation Management actions would be spread over the 2012-2026 period and would vary year-by-year proportionate to actual expenditures. Some actions would not be implemented in each year of the 15-year period. For example, the Economic Development actions would be completed in one year.

Table 3.15-61. Regional Economic Effects of KBRA Tribal Program Actions Relative to No Action/No Project Alternative over a 15-year period (2012 dollars)

Table C-2 Line #	KBRA Action	15 year KBRA In Region Spending (1000 $)	Total Effects[1] of KBRA Funding (not including base funding)		
			Employment[2] (Jobs)	Labor Income[3] (1000$)	Output[4] (1000$)
100	Fisheries Management Karuk	$4,032	66	$2,891	$4,485
101	Fisheries Management Klamath	$5,503	73	$3,630	$5,943
102	Fisheries Management Yurok	$5,566	89	$4,252	$7,581
104	Conservation Management Karuk	$3,050	50	$2,187	$3,393
105	Conservation Management Klamath	$3,050	41	$2,013	$3,296
106	Conservation Management Yurok	$3,050	49	$2,315	$4,156
108	Economic Development Study Karuk	$250	6	$197	$406
109	Economic Development Study Klamath	$250	6	$197	$406
110	Economic Development Study Yurok	$250	6	$197	$406
111	Klamath Tribes: Mazama Forest Project	--	Transfer of funds to private owner for land purchase for tribe. Regional effects not quantified. Tribes would benefit in future from use of forest lands.		
112	Fishing Sites	--	No funding in KBRA		

Source: Source: Dunsmoor 2011; Tucker 2011; Hillemeier 2011
2012 dollars as estimated using IMPLAN
[1] Total Effect = Direct + Indirect + Induced Effects
[2] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[3] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[4] Output represents the dollar value of industry production.

Spending on local actions would affect employment, labor income, and output in the regional economy. Most actions would be implemented by tribal staff and would positively affect the economic conditions of the tribes. A portion of the funding would result in positive effects in the construction sector and professional and technical services sector. Implementation of the Tribal Program actions would increase employment, labor income, and output in the regional economy relative to the No Action/No Project Alternative. The Tribal Program actions could add to the effects of the hydroelectric facility removal actions analyzed above if tribal members are employed for dam deconstruction activities. The additive effects would only occur in years that project implementation overlaps.

3.15.4.2.3 Alternative 3: Partial Facilities Removal of Four Dams Four Facilities

Construction activities could increase jobs, labor income, and output in the regional economy during the construction period in Klamath and Siskiyou Counties. Partial

facilities removal is estimated to cost approximately $135.4 million[4] in 2012 dollars (Reclamation 2012b). Expenditures associated with the Partial Facilities Removal of Four Dams Alternative spent within the region were estimated to be $84.7 million (Reclamation 2012b).

The effects of partial facility removal on employment, labor income, and output are shown in Table 3.15-62. Effects would be short term and occur only during dam decommissioning, which would occur in 2020 for the duration of one year. Most economic effects would be in the sector where the direct impact occurs. For dam deconstruction expenditures, this analysis assumes direct effects would mostly occur in the construction sector. Employment created in this sector could be full time or part time and include various types of jobs, similar to those described for the Proposed Action.

Table 3.15-62. Regional Economic Effects from Dam Decommissioning for Alternative 3

	Employment[1] (Jobs)	Labor income[2] ($ millions)	Output[3] ($ millions)
Total effect[4]	1,138	48.11	131.84

Source: Reclamation 2012b data presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Changes in annual O&M expenditures for the Partial Facilities Removal of Four Dams Alternative could reduce jobs, labor income, and output in the regional economy. Annual O&M expenditures for the Partial Facilities Removal of Four Dams Alternative were estimated at $129,000. These annual O&M expenditures would partially offset the lost O&M expenditures under the No Action/No Project Alternative. However, under the Partial Facilities Removal of Four Dams Alternative annual O&M expenditures would result in a long term loss to the regional economy compared to the No Action/No Project Alternative, shown in Table 3.15-63. For reduced O&M expenditures, this analysis assumes direct effects would occur in the construction sector. Economic effects under Partial Facilities Removal of Four Dams Alternative would be long term and adverse relative to the No Action/No Project Alternative.

[4] Dam removal as described in this EIS/R would occur from May 2019 through December 2020. For this socioeconomic analysis all effects have been described in 2012 dollars to allow comparison between economic effects and alternatives. These costs for facilities removal should not be considered a most probable cost estimate for dam removal in 2020. For a more detailed analysis of the cost of dam removal please see Detailed Plan for Dam Removal – Klamath River Dams, July 2012.

Table 3.15-63. Change in Regional Economic Effects from O&M Expenditures between the No Action/No Project Alternative and Alternative 3

	Employment[1]		Labor income[2]		Output[3]	
	Jobs	% Change from No Action	$ millions	% Change from No Action	$ millions	% Change from No Action
Total effect[4]	-47.4	-96.0	-1.98	-96.0	-5.00	-96.0

Source: Reclamation 2012b presented in 2012 dollars.
[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary.
[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.
[3] Output represents the dollar value of industry production.
[4] Total Effect = Direct + Indirect + Induced Effects

Mitigation spending after the deconstruction period could increase economic output, employment, and labor income. Effects from mitigation spending would be temporary, short-term effects and would vary year by year from 2018-2025. Partial facility mitigation costs by facility and year are shown in Table 3.15-64.

Table 3.15-64. Mitigation Costs by Facility Year (2012 $) for Alternative 3

Year	J.C. Boyle	Copco 1	Copco 2	Iron Gate	City of Yreka Water Supply	Total
2018	1,520,000	0	0	2,910,000	0	4,430,000
2019	1,790,000	3,800,000	2,020,000	6,500,000	0	14,110,000
2020	2,780,000	9,050,000	580,000	6,040,000	1,000,000	19,450,000
2021	1,970,000	4,250,000	0	3,360,000	0	9,580,000
2022	240,000	0	0	470,000	0	710,000
2023	240,000	0	0	470,000	0	710,000
2024	240,000	0	0	470,000	0	710,000
2025	240,000	0	0	470,000	0	710,000
					Total	50,410,000

Source: Reclamation 2012b

The regional economic effects related to dam decommissioning mitigation for the Partial Facilities Removal of Four Dams Alternative were assumed to be the same as the Proposed Action. For mitigation expenditures, this analysis assumes direct effects would occur in the construction sector. Economic effects under Partial Facilities Removal of Four Dams Alternative would be positive and short term relative to the No Action/No Project Alternative.

Commercial Fishing, Recreation, Indian Tribe, PacifiCorp Hydroelectric Service, Property Values and Local Government Revenues, PacifiCorp Property Taxes, and KBRA

Economic effects of the Partial Facilities Removal of Four Dams Alternative would be the same as the Proposed Action.

East and Westside Facilities – Programmatic Measures

The effects of the decommissioning the East and Westside facilities would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of relocating the City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

KBRA - Programmatic Measures

Economic effects of the KBRA under the Partial Facilities Removal of Four Dams Alternative would be the same as the Proposed Action.

3.15.4.2.4 Alternative 4: Fish Passage at Four Dams

The KHSA Section 3.2.1(iii), signed by Secretary of the Interior Ken Salazar on February 18, 2010, directs the Secretary to undertake environmental review in support of the Secretarial Determination. All alternatives carried forward for further analysis in the EIS/EIR were analyzed using existing studies and other appropriate data as suggested in KHSA Section 3.2.1 (i), where such analysis met criteria in (40 CFR 1502.22 and 43 CFR 46.125) to incorporate available information. As part of developing the basis for the Secretarial Determination, the KHSA requires in Section 3.3.2 that the Secretary prepare a Detailed Plan, including the identification, qualifications, management, and oversight of a non-Federal DRE, if any, that the Secretary may designate. KHSA Section 3.3.4.D requires that an estimate of costs be prepared as part of the Detailed Plan. The Detailed Plan analysis provides most of the information for the project description for Alternatives 2 and 3, and this information was used to analyze these two action alternatives. As described in KHSA Section 3.2.1(i), the FERC record is used to form the project description for Alternatives 4 and 5. Alternatives 4 and 5 were analyzed to ensure that the review of reasonable fish passage alternatives was comprehensive. In addition, at the time of developing a reasonable range of alternatives, the Lead Agencies recognized that the inclusion of Alternatives 4 and 5 would provide an assessment of the short- and long-term effects from a broader range of reasonable alternatives. Alternatives 4 and 5 are outside the authority of the DOI, the four facilities proposed for removal are privately owned structures, and there was no provision in the KHSA to include them in the Detailed Plan. The result is differing levels of available information for alternatives carried forward in the EIS/EIR consistent with the elements of each action alternative.

Regional economic effects were quantified for the No Action/No Project Alternative, the Proposed Action, and the Partial Facilities Removal of Four Dams Alternative. These regional economic effects provide the broadest range of economic impacts expected from implementation of any of the alternatives and bookend the expected economic impact to the area of analysis. Once that information was developed, a comparative analysis of the

Fish Passage at Four Dams Alternative and Fish Passage at Two Dams, Remove Copco 1and Iron Gate Alternative provide the information required to evaluate the relative impacts of each action alternative within the identified range of economic effects. Specific economic effects for construction and changes in commercial fishing, recreation, and irrigated agriculture were not individually quantified for Fish Passage at Four Dams Alternative and Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative. The missing data is relevant to reasonable foreseeable significant adverse human effects on the environment. However that unavailable data is not essential to a reasoned choice among alternatives because potential impacts can be compared to the data developed for the No Action/No Project Alternative, the Proposed Action, and Partial Facilities Removal of Four Dams Alternative. The range of impacts anticipated for the two alternatives for which data is missing falls within the range of impacts analyzed and data developed for the remaining alternatives, though the ratio of expenditures to impacts might not have the same proportional effect across the various economic sectors. The comparative analysis required by NEPA is achieved using this qualitative method.

Four Facilities

Construction of fish passage facilities, O&M expenditures, and mitigation spending could increase jobs, labor income, and output in the regional economy during the construction period. Expenditures would occur in the region to support construction of fish passage facilities. In-region spending would increase jobs, labor income and output in Klamath and Siskiyou Counties relative to the No Action/No Project Alternative. Positive regional economic effects would only occur during the construction period. Hydroelectric facilities would continue to operate under this alternative; therefore, O&M annual expenditures would continue similar to the No Action/No Project Alternative. Some mitigation would be required for this alternative, which would result in increased in-region spending relative to the No Action/No Project Alternative.

Commercial Fishing

Changes in commercial fishing harvests could change fishing revenues and affect employment, labor income and output in the regional economy. Construction of fish passage facilities would increase migratory fish habitat availability above Iron Gate Dam, and as described in Section 3.3, Aquatic Resources, would result in increased commercial fishery populations when compared to existing conditions. Positive effects related to increased fish harvests would increase relative to the No Action/No Project Alternative, but these effects would not be as great as Alternative 2 or 3.

Recreation (Reservoir, In-River Sport Fishing, Ocean Sport Fishing, Whitewater Boating)

Changes in recreational opportunities could affect the regional economy. The dams would remain in place and visitors could use the reservoirs for existing activities, including boating, water skiing, and fishing. Spending in the region related to reservoir recreation would continue at existing levels.

The development of fish passage facilities may have a positive effect on visitation levels and expenditures for in-river sport fishing trips relative to the No Action/No Project Alternative, but these effects would not be as great as Alternatives 2 or 3.

The fish passage facilities may also have a positive effect on visitation levels and expenditures for ocean sport fishing trips relative to the No Action/No Project Alternative, but these effects would not be as great as Alternatives 2 or 3.

Implementation of the Fish Passage at Four Dams Alternative would result in a loss of acceptable flows for whitewater boating opportunities in the Hell's Corner Reach as compared to existing conditions. The flow conditions and prescriptions outlined in Chapter 2 would reduce the current daily peaking flows, which support whitewater rafting in the Hell's Corner Reach, to a minimum streamflow of 1,500 cfs, which must be provided no more than once per week. This would result in an adverse reduction in rafting trips and recreation expenditures.

Indian Tribes

Fish passage at the four dams could affect the existing fishing conditions of Indian Tribes in the area of analysis. Implementation of the Fish Passage at Four Dams Alternative would generate a positive effect on fish populations and tribal harvests for subsistence, cultural practices and commercial uses relative to the No Action/No Project Alternative. The positive economic effects generated by the KBRA for the tribes would not be realized under this alternative, and the positive economic effects generated by the development of fish passage facilities would be smaller than the effects anticipated under the Proposed Action as a result. However, increased fish harvest for subsistence, cultural practices and commercial uses would represent a positive effect for Indian Tribes, although this effect would not be as great as under Alternatives 2 or 3. Tribal ceremonies and other cultural practices involving water contact would continue to be hindered by late-fall, toxigenic phytoplankton blooms in the Hydroelectric Reach and areas further downstream.

PacifiCorp Hydroelectric Service

Fish passage at four dams could result in increased energy rates for PacifiCorp customers. PacifiCorp estimated that costs to develop fish passage at the Four Facilities consistent with the Mandatory Conditions imposed by the DOI and the United States Department of Commerce (DOC) would cost more than implementation of the KHSA (OPUC 2010). In its ruling to approve KHSA surcharges, the OPUC concluded that PacifiCorp "has demonstrated that customer costs under the KHSA are capped below projected costs to relicense and continue operation of the Klamath dams." Further, the OPUC concluded the following:

> "Ratepayers will be responsible for significant future costs for the Klamath Project (regardless of the disposition of the dams). The nature and scope of these costs has been unclear, however, since 2000 when Pacific Power [PacifiCorp] first provided notice of the Company's need to seek Federal relicensing of the Project. We are persuaded that continued pursuit of the relicensing option would pose significant risks

to ratepayers. The nature and scope of the costs involved with relicensing would remain uncertain and subject to significant escalation for a considerable period of time.

The KHSA in contrast, offers a more certain path for the Project's future, providing a timeline for continued operation until December 31, 2010, followed by transfer of the facilities to a third party responsible for removing the dams. The KHSA also caps customer costs and liabilities for Klamath dam removal and the environmental restoration of the Klamath River at a reasonable level, while providing customers with renewable replacement power. Further, we believe that Pacific Power has reasonably estimated the cost of replacement power if the Klamath dams are decommissioned. Due to significant tangible and intangible benefits associated with the KHSA, we conclude it is in the best interest of customers and find the KHSA surcharges to be fair, just and reasonable.

We reviewed the detailed economic studies of the KHSA surcharges, we analyzed the projected costs of both relicensing and decommissioning of the dams, and we asked specific questions of Pacific Power, Staff and the parties at a workshop. We considered both the quantifiable and unquantifiable benefits and risks of the KHSA and relicensing options.

We are persuaded that Pacific Power carefully analyzed the nature and scope of projected costs for both futures for the dams. As Staff and others do, we believe that there are substantial unquantified risks associated with continued pursuit of a FERC license that is not captured in the economic analysis. Pacific Power and parties deeply involved in the relicensing process, such as the Intervenor State Agencies and the Joint Parties, all testified that the relicensing option analysis significantly underestimates the true cost of relicensing.

These parties indicate that the projected relicensing costs are subject to significant risk of escalation with no guarantee that a FERC license will ever be issued due, in particular, to great uncertainty about water quality certification. Yet, even though the full expected costs of the relicensing option is not captured in Pacific Power's analysis, the analysis still shows that the KHSA results in lower rates for Oregon customers, as well as all customers of Pacific Power. If the risks associated with the relicensing scenario could be quantified, we believe that the relative economic benefits of the KHSA would likely be great.

We observe that no party testified that the relicensing option would likely result in lower rates and better service for customers. Industrial Customers of Northwest Utilities (ICNU) criticizes the KHSA surcharge rates, but does so in comparison to hypothesized "normal" ratemaking for costs associated with removing a hydroelectric dam. Ten years into a process to resolve the future of the Reclamation's Klamath Project with no "normal" resolution in sight, we conclude that it's not reasonable to compare proposed solutions to so-called "normal" ratemaking scenarios.

> Because the KHSA limits costs and manages risk better than relicensing, we find the KHSA to be in the best interest of customers, and we determine that the KHSA surcharges are, therefore, fair, just and reasonable." (OPUC 2010).

Therefore, it is assumed that, under the Fish Passage at Four Dams Alternative, customer rates would likely increase above the existing surcharges as a direct result of construction, operations and maintenance costs for fish passage facilities. The degree to which the cost could be passed to the ratepayers is not known and would be subject to Oregon and CPUCs.

Property Values and Local Government Revenues

Property values could be affected by the fish passage at four dams near Copco 1 and Iron Gate Reservoir. The dams would remain in place under this alternative; therefore, the property values of parcels with full or partial reservoir views would not change. Land values would be the same as the No Action/No Project Alternative. Property tax revenues to Klamath and Siskiyou Counties would also not change relative to the No Action/No Project Alternative.

Fish passage at four dams could affect property tax revenues to Siskiyou and Klamath Counties from PacifiCorp. PacifiCorp would continue to own and operate hydroelectric facilities and would continue to pay property taxes. County tax revenues would not change relative to the No Action/No Project Alternative.

3.15.4.2.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Analysis of Alternative 5 was conducted in a similar approach to Alternative 4. See discussion of effects analysis approach under Alternative 4 above.

Four Facilities

Construction of fish passage facilities, O&M expenditures, and mitigation spending could increase jobs, labor income, and output in the regional economy during the construction period. Expenditures would occur in the region to support construction of fish passage facilities. In-region spending would increase jobs, labor income and output in Klamath and Siskiyou Counties relative to the No Action/No Project Alternative. Positive regional economic effects would only occur during the construction period. Hydroelectric facilities at J.C. Boyle and Copco 2 Reservoirs would continue to operate under this alternative; therefore, O&M annual expenditures would continue for these sites. Positive regional economic effects would increase relative to the No Action/No Project Alternative, but be less than the Proposed Action. Some mitigation would be required for this alternative, which would result in increased in-region spending relative to the No Action/No Project Alternative.

Commercial Fishing

Changes in commercial fishing harvests cold change fishing revenues and affect employment, labor income and output in the regional economy. Removal of the Copco 1 and Iron Gate dams and the construction of fish passage facilities at J.C. Boyle and

Copco 2 dams would increase migratory fish habitat availability above Iron Gate Dam, and as described in Section 3.3, Aquatic Resources, would result in increased commercial fishery populations when compared to existing conditions. Positive effects related to increased fish harvests would increase relative to the No Action/No Project Alternative, although this effect would not be as large as Alternatives 2 or 3.

Recreation (Reservoir, In-River Sport Fishing, Ocean Sport Fishing, Whitewater Boating)

Changes in recreational opportunities could affect the regional economy. Iron Gate and Copco 1 Facilities would be removed, eliminating in-reservoir recreation at these sites. Effects would be similar to the Proposed Action. Reservoir recreation at J.C. Boyle Reservoir would continue, which would have economic effects similar to the No Action/No Project Alternative.

Visitation levels and expenditures for in-river fishing would increase because of increased fish populations under this alternative relative to the No Action/No Project Alternative, although this effect would not be as great as Alternatives 2 or 3.

Ocean sport fishing trips could also increase relative to the No Action/No Project Alternative, which would increase employment, labor income, and output in the regional economy; however, this effect would not be as great as Alternatives 2 or 3.

The loss of peaking flows in the Hell's Corner Reach would result in the river returning to natural flow conditions, with no ability to re-regulate peaking flows. Thus, there would be diminished whitewater boating opportunities in this reach. This would result in fewer rafting trips and reduced recreation expenditures and be a long-term adverse effect.

Indian Tribes

Alternative 5 could affect the existing economic conditions of Indian Tribes in the area of analysis. Implementation of Alternative 5 would generate a positive effect on fish populations and tribal harvests for subsistence, cultural practices and commercial uses relative to the No Action/No Project Alternative. The positive economic effects generated by the KBRA for the tribes would not be realized under this alternative, and the positive economic effects to tribes would be smaller than the effects anticipated under the Proposed Action as a result. However, increased fish harvest for subsistence, cultural practices and commercial uses would represent an economically positive effect for Indian Tribes, although this effect would not be as great as with the Proposed Action or Alternative 3.

PacifiCorp Hydroelectric Service

Removal of two dams and fish passage at two dams could result in increased energy rates for PacifiCorp customers. The costs for the removal of two dams and fish ladders would not be covered under the KHSA agreement and would likely become the responsibility of PacifiCorp and its ratepayers. The cost for removal of the Iron Gate and Copco 1 Dams

is approximately $124 million[5] in 2012 dollars, as estimated for removal of these two dams for the Proposed Action (Reclamation 2012a). As described above for Alternative 4, PacifiCorp has estimated that fish passage would be more costly than dam removal; therefore, it is assumed that fish passage at Copco 2 and J.C. Boyle Dams would be more than dam removal costs. Therefore, under this alternative, customer rates would likely increase above the existing surcharges as a direct result of construction, operations and maintenance costs for fish passage facilities at two dams and the removal of Iron Gate and Copco 1 Dams. The degree to which the cost could be passed to the ratepayers is not known and would be subject to Oregon and California PUCs.

Property Values and Local Government Revenues

Property values could be affected by the fish passage at four dams near Copco 1 and Iron Gate Reservoir. Parcels with views of Copco 2 Reservoir would not be affected under this alternative. As described in the affected environment, there are no parcels with views of J.C. Boyle Reservoir. Property tax payments to Siskiyou County from affected parcels around Copco 1 and Iron Gate Reservoirs would decrease relative to the No Action/No Project Alternative. In the long term, river views associated with the parcels could increase property values.

Alternative 5 could affect property tax revenues to Siskiyou and Klamath Counties from PacifiCorp Changes in ownership of hydroelectric facilities could reduce county property tax revenues. PacifiCorp property tax payments to Siskiyou County from land ownership of Copco 1 and Iron Gate Reservoirs would discontinue relative to the No Action/No Project Alternative. Effects would be similar in magnitude to the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of relocating City of Yreka's Water Supply Pipeline would be the same as those described for the Proposed Action.

3.15.4.2.6 Summary of Economic Effects

Table 3.15-65 summarizes economic effects quantified in this section. Table 3.15-66 summarize effects of ongoing restoration actions and the KBRA under each alternative.

[5] Dam removal as described in this EIS/R would occur from May 2019 through December 2020. For this socioeconomic analysis, all effects have been described in 2012 dollars to compare economic effects of alternatives. These costs for facilities removal should not be considered a most probable cost estimate for dam removal in 2020. For a more detailed analysis of the cost of dam removal please see Detailed Plan for Dam Removal – Klamath River Dams, July 2012.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Dam Decommissioning **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	No dam decommissioning under Alternative 1.	Short-term effects during the one year decommissioning. Increase of approximately 1,400 jobs, $60 million in labor income, and $163 million in output.	Short-term effects during the one year decommissioning. Increase of approximately 1,100 jobs, $48 million in labor income, and $132 million in output.	Short-term effects during the construction period. Would increase jobs, labor income, and output relative to Alternative 1.	Short-term effects during the construction period. Would increase jobs, labor income, and output relative to Alternative 1.
Operation and Maintenance **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	O&M expenditures would support 49 jobs, $2 million in labor income and $5 million in output.	No long-term annual O&M expenditures. Decrease of approximately 49 jobs, $2 million of labor income, and $5 million in output.	Decrease of approximately 47 jobs. Labor income and output would remain the same compared to Alternative 1	O&M expenditures and effect on regional economy would be similar to Alternative 1.	Decrease O&M expenditures and adversely affect the regional economy.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Mitigation **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs)[1]: 48,204 Labor Income[2]: $1,928 million Output[3]: $5,139 million	None mitigation under Alternative 1.	Temporary, short-term effects from 2018-2025. Increase of approximately 220 jobs, $10 million in labor income, and $31 million in output.	Same as Alternative 2.	Some mitigation would be required. Increase relative to Alternative 1.	Some mitigation would be required. Increase relative to Alternative 1.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Irrigated Agriculture **Economic Region:** Klamath County OR Siskiyou and Modoc Counties CA **Regional Economy:** Employment (Jobs): 52,141 Labor Income: $2,083 million Output: $5,497 million	Effects equal for all years except drought years of 1975, 1992, 1994, 2001, and 2008. 2027 — Jobs 1,361 Labor Income $45 million Output $184 million 2043 — Jobs 766 Labor Income $33 million Output $118 million 2045 — Jobs 1,076 Labor Income $40 million Output $156 million 2051 — Jobs 1,286 Labor Income $44 million Output $177 million 2059 — Jobs 1,403 Labor Income $46 million Output $188 million	Effects equal for all years except drought years. Increased job, labor income, and employment in drought years relative to Alternative 1. 2027 — Jobs +112 Labor Income +$2 million Output +$13 million 2043 — Jobs +695 Labor Income +$11 million Output +$84 million 2045 — Jobs +397 Labor Income +$7 million Output +$41 million 2051 — Jobs +187 Labor Income +$4 million Output $20 million 2059 — Jobs +70 Labor Income +$2 million Output +$9 million	Same as Alternative 2	Same as Alternative 1.	Same as Alternative 1.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Commercial Fishing **San Francisco Management Area** Employment (Jobs): 3,060,366 Labor Income: $204,685 million Output: $599,164 million **Fort Bragg Management Area** Employment (Jobs): 40,117 Labor Income: $1,731 million Output: $4,814 million **KMZ-CA** Employment (Jobs): 71,633 Labor Income: $2,983 million Output: $7,360 million **KMZ-OR** Employment (Jobs): 8,656 Labor Income: $311 million Output: $859 million **Central Oregon Management Area** Employment (Jobs): 258,047 Labor Income: $10,170 million Output: $27,815 million	Regional economic effects supported by ocean commercial fishing **San Francisco Management Area** Jobs: 510 Labor Income: $6.10 million Output: $15.52 million **Fort Bragg Management Area** Jobs: 162 Labor Income: $2.45 million Output: $5.62 million **KMZ-CA** Jobs: 44 Labor Income: $0.19 million Output: $0.45 million **KMZ-OR** Jobs: 26 Labor Income: $0.15 million Output: $0.33 million **Central Oregon Management Area** Jobs: 319 Labor Income: $4.15 million Output: $9.55 million	Increased job, labor income, and employment relative to Alternative 1. **San Francisco Management Area** Jobs: +218 Labor Income: +$2.56 million Output: +$6.6 million **Fort Bragg Management Area** Jobs: +69 Labor Income: +$1.05 million Output: +$2.41 million **KMZ-CA** Jobs: +19 Labor Income: +$0.07 million Output: +$0.19 million **KMZ-OR** Jobs: +11 Labor Income: +$0.06 million Output: +$0.13 million **Central Oregon Management Area** Jobs: +136 Labor Income: +$1.74 million Output: +$4.07 million	Same as Alternative 2.	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
In-River Sport Fishing **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	**Recreational Salmon Fishery** In-river salmon fishing trip expenditures support 34 jobs, $0.93 million of labor income and $2.01 million in output. **Recreational Steelhead Fishery** In-river salmon fishing trip expenditures support 20 jobs, $0.62 million of labor income and $1.31 million in output. **Recreational Redband Trout Fishery** Non-resident angler trips likely to remain similar to Existing Conditions. Insufficient data to quantify regional economic impacts.	**Recreational Salmon Fishery** Increase of 3 jobs and $0.07 million of labor income and $0.15 million in output. **Recreational Steelhead Fishery** Possible increase in steelhead abundance. Insufficient data to quantify regional economic impacts. **Recreational Redband Trout Fishery** Probable increase in Redband abundance and distribution. Insufficient data to quantify regional economic impacts.	Same as Alternative 2	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Ocean Sport Fishing **KMZ-OR** Employment (Jobs): 8,656 Labor Income: $311 million Output: $859 million **KMZ-CA** Employment (Jobs): 71,633 Labor Income: $2,983 million Output: $7,360 million	**KMZ-OR** Ocean sport fishing supports 3 jobs, $0.08 million of labor income, and $0.21 million in output. **KMZ-CA** Ocean sport fishing supports 13 jobs, $0.42 million of labor income, and $1.12 million in output.	**KMZ-OR** Increase of approximately 1 job, $0.02 million in labor income, and $0.09 million. **KMZ-CA** Increase of 5 jobs, $0.18 million of labor income, and $0.48 million in output.	Same as Alternative 2.	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.	Positive, long-term effects. Increase relative to Alternative 1, but less than the Proposed Action and Alternative 3.
Refuge Recreation **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	Refuge hunting expenditures supports 11 jobs, $0.26 million of labor income and $0.62 million in output.	Increase of 5 jobs, $0.12 million in labor income, and $0.27 million in output.	Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.

Table 3.15-65. Summary of Regional Economic Effects for Each Alternative

Category	Alternative 1 - No Action	Alternative 2 - Full Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 3 - Partial Facilities Removal of Four Dams Incremental changes from Alternative 1	Alternative 4 - Fish Passage at Four Dams Incremental changes from Alternative 1	Alternative 5 - Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Incremental changes from Alternative 1
Reservoir Recreation **Economic Region:** Klamath County OR Siskiyou County CA **Regional Economy:** Employment (Jobs): 48,204 Labor Income: $1,928 million Output: $5,139 million	Reservoir recreation expenditures supports 7 jobs, $0.22 million in labor income and $0.54 million in output.	Decrease of approximately 4 jobs, $0.13 million in labor income and $0.31 in output.	Same as Alternative 2.	Same as Alternative 1.	Same as Alternative 2 for recreation losses at Iron Gate and Copco 1 Reservoirs. Same as Alternative 1 because of maintained recreation at J.C. Boyle Reservoir.
Whitewater Recreation **Economic Region:** Klamath, Jackson Humboldt, and Siskiyou counties **Regional Economy:** Employment (Jobs): 224,667 Labor Income:$8,682 million Output: $23,330 million	Whitewater boating expenditures supports 56 jobs, $1.56 million in labor income and $4.31 million in output.	Decrease of approximately 14 jobs, $0.43 million in labor income and $0.89 million in output.	Same as Alternative 2.	Negative, long-term effects on the regional economy. Decrease relative to Alternative 1.	Negative, long-term effects on the regional economy. Decrease relative to Alternative 1.

Source: Reclamation 2012b for Alternatives 1, 2, and 3

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production.

Table 3.15-66. Summary of Regional Economic Effects over 15 Years of Ongoing Restoration Activities and KBRA Implementation

KBRA Program	Alternative 1 - No Action/No Project Alternative	Alternative 2, Proposed Action, Incremental Changes to Alternative 1	Alternative 3 Incremental Changes to Alternative 1	Alternative 4 Incremental Changes to Alternative 1	Alternative 5 Incremental Changes to Alternative 1
Fisheries Program **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs[1]): 119,837 Labor Income[2]: $4,911 million Output[3]: $12,499 million	Fishery restoration, reintroduction and monitoring expenditures supports 2,015 jobs, $95 million in labor income and $203 million in output.	Increase of approximately 3,917 jobs, $186.8 million in labor income and $380 million in output.	Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.
Water Resources Program **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million **Economic Region (related to Reclamation's Klamath Project):** Klamath County OR Modoc and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 52,140 Labor Income: $2,082 million Output: $5,498 million	No ongoing activities under the water resources program.	Water resources program expenditures supports 243 jobs, $11.2 million in labor income and $24.2 million in output. See for Irrigated Agriculture and Refuge Recreation Table 3.15-65 for effects of KBRA actions.	Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.

Table 3.15-66. Summary of Regional Economic Effects over 15 Years of Ongoing Restoration Activities and KBRA Implementation

KBRA Program	Alternative 1 - No Action/No Project Alternative	Alternative 2, Proposed Action, Incremental Changes to Alternative 1	Alternative 3 Incremental Changes to Alternative 1	Alternative 4 Incremental Changes to Alternative 1	Alternative 5 Incremental Changes to Alternative 1
Regulatory Assurances: **Economic Region:** Klamath County OR Del Norte, Humboldt, and Siskiyou Counties CA **Regional Economy:** Employment (Jobs): 119,837 Labor Income: $4,911 million Output: $12,499 million	No ongoing activities	Implementation of regulatory assurances would support 146 jobs, $7 million in labor income and $14.4 million in output.	Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.
County Program: **Siskiyou County CA** Employment (Jobs): 17,679 Labor Income: $755 million Output: $2,107 million **Klamath County OR** Employment (Jobs): 30,525 Labor Income: $1,174 million Output: $3,032 million	No ongoing activities	$20 million of funding for Siskiyou County would increase jobs, labor income and output. $3.2 million of funding for Klamath County would increase jobs, labor income and output.	Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.

Table 3.15-66. Summary of Regional Economic Effects over 15 Years of Ongoing Restoration Activities and KBRA Implementation

KBRA Program	Alternative 1 - No Action/No Project Alternative	Alternative 2, Proposed Action, Incremental Changes to Alternative 1	Alternative 3 Incremental Changes to Alternative 1	Alternative 4 Incremental Changes to Alternative 1	Alternative 5 Incremental Changes to Alternative 1
Tribal Program:			Same as Alternative 2.	Similar to Alternative 1.	Similar to Alternative 1.
Karuk Tribes: Siskiyou County CA Employment (Jobs): 17,679 Labor Income: $755 million Output: $2,107 million	Karuk Tribal Program expenditures supports 237 jobs, $10.5 million in labor income and $16.3 million in output.	Increase of approximately 122 jobs, $5.2 million in labor income and $8.3 million in output.			
Klamath Tribes: Klamath County OR Employment (Jobs): 30,525 Labor Income: $1,174 million Output: $3,032 million	Klamath Tribal Program expenditures supports 174 jobs, $8.7 million in labor income and $14.3 million in output.	Increase of approximately 120 jobs, $5.8 million in labor income and $9.6 million in output.			
Yurok Tribes: Humboldt County CA Employment (Jobs): 60,789 Labor Income: $2,529 million Output: $6,388 million	Yurok Tribal Program expenditures supports 208 jobs, $10 million in labor income and $17.8 million in output.	Increase of approximately 144 jobs, $6.8 million in labor income and $12.1 million in output.			

Source: Barry 2011; Bird 2011; Dunsmoor 2011; Hicks 2011; Hillemeier 2011; Lynch 2011;Mahan. L et al. 2011; Nota 2011; Radford 2011; Stopher 2011; Tucker 2011; Wise 2011

[1] Employment is measured in number of jobs. A job can be full-time, part-time, or temporary. Construction-related employment estimates include the in-field workforce plus all additional jobs generated by project construction expenditures, e.g., in retail, services, manufacturing, and other related sectors throughout the economy.

[2] Income is the dollar value of total payroll (including benefits) for each industry in the analysis area plus income received by self-employed individuals located within the analysis area.

[3] Output represents the dollar value of industry production.

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3.16 Environmental Justice

This section identifies minority and low income populations that exist within the Klamath Basin and evaluates whether the environmental impacts of each alternative would result in a disproportionately high and adverse impact on minority and low income populations (Executive Order 12898, February 11, 1994). See Section 3.12, Tribal Trust, for a detailed description of tribal history, and Section 3.13, Cultural and Historic Resources, for additional discussion of other cultural, tribal, and religious freedom issues. See Section 3.8, Water Supply/Water Rights, for a discussion of water rights in the area of analysis.

This section examines, consistent with National Environmental Policy Act (NEPA) regulations and guidelines, the Proposed Action's potential impacts on minority and low income people. As described in the Effects Determination Methods (Section 3.16.4.1), impacts were assessed to determine if any community would bear a disproportionate share of the adverse environmental consequences resulting from the Proposed Action.

The U.S. Environmental Protection Agency (USEPA) Office of Environmental Justice defines environmental justice as the following:

> The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, State, local, and tribal programs and policies (USEPA 2011).

3.16.1 Area of Analysis

The area of analysis includes Del Norte, Humboldt, and Siskiyou Counties in northern California and Klamath County in southern Oregon. In addition, all six of the federally recognized tribes with territory within the four counties are included in the area of analysis, specifically The Klamath Tribes, Quartz Valley Community, Karuk Tribe, Hoopa Valley Indian Tribe, Yurok Tribe, and the Resighini Rancheria. Environmental justice impacts from the Proposed Action and alternatives, including activities associated with implementation of the Klamath Hydroelectric Settlement Agreement (KHSA) and Klamath Basin Restoration Agreement (KBRA) would be limited to these areas.

3.16.2 Regulatory Framework

Environmental justice resources within the area of analysis are regulated by several Federal, State, and local laws and policies, which are listed below.

3.16.2.1 Federal Authorities and Regulations

- Executive Order 12898 - Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations (59 FR 7629)
- Department of the Interior (DOI) Environmental Justice Strategic Plan, 1995
- USEPA Environmental Justice Implementation Plan, 1996

3.16.2.2 State Authorities and Regulations

- California Government Code section 65040.12 (G.C. §65040.12)
- California Working Group on Environmental Justice, Senate Bill 89 (2000)
- California Interagency Environmental Justice Strategy, Senate Bill 828 (2001)
- California Environmental Protection Indicators for California, Assembly Bill 1360 (2003)
- Oregon Environmental Justice Task Force, Senate Bill 420 (2007)

3.16.2.3 Local Authorities and Regulations

- Siskiyou County General Plan (1973)
- Humboldt County General Plan (1984)
- Del Norte County General Plan (2003)
- Klamath County Comprehensive Plan (2010)

3.16.3 Existing Conditions/Affected Environment

3.16.3.1 Demographics, Income, and Employment

This section provides demographic information for the analysis of environmental effects and identifies low income and minority populations in the area of analysis.

3.16.3.1.1 Race and Ethnicity

Siskiyou, Humboldt, Del Norte, and Klamath Counties constitute the area that could experience direct or indirect effects from implementation of the Proposed Action and alternatives. While cities within these counties would also experience effects of the Proposed Action, demographic information from the counties is generally representative of the cities. Population, race, and ethnicity data from the Census 2005-2009 American Community Survey for California, Oregon, and the four counties are detailed in Table 3.16-1.

Table 3.16-1. Population, Race, and Ethnicity, 2005-2009 American Community Survey

Geographic Area	Total Population	White (percent)	Black or African American (percent)	American Indian and Alaska Native (percent)	Asian (percent)	Native Hawaiian and Other Pacific Islander (percent)	Some Other Race (percent)	Two Races Including Some Other Race (percent)	Two Races Excluding Some Other Race, and Three or More Races (percent)	Hispanic or Latino (of any race) (percent)
California	**36,308,527**	**61.3**	**6.2**	**0.8**	**12.3**	**0.4**	**15.5**	**1.1**	**2.4**	**36.1**
Del Norte County	28,729	74.1	3.4	5.1	2.9	0.6	7.7	2.6	0.5	16.1
Humboldt County	129,003	83.0	1.1	5.3	2.2	0.3	2.9	1.0	4.1	8.3
Siskiyou County	44,404	87.1	1.4	2.7	1.5	0.2	1.6	0.8	4.9	9.7
Oregon	**3,727,407**	**86.2**	**1.7**	**1.6**	**3.5**	**0.3**	**3.3**	**0.4**	**2.9**	**10.6**
Klamath County	66,170	88.9	0.5	3.6	0.9	0.2	1.8	0.4	3.8	9.4

Source: U.S. Census Bureau 2009a.

Caucasians (white) represent the highest percentage of the population in Siskiyou, Humboldt, Del Norte, and Klamath Counties. Black or African American, American Indian or Alaska Native, Asian, Pacific Islanders, other races and two or more races combined make a small percentage each county's population relative to white and are minority populations. The counties in the area of analysis all have greater percentages of American Indians than California and Oregon as a whole. Data indicate that any impacts from the Proposed Action and alternatives could disproportionately affect Indian Tribes in the area of analysis.

Table 3.16-2 shows the tribes in the area of analysis and the total tribal enrollment as of 2005. Tribal enrollment does not mean that all members live within the area of analysis, but it is still useful information for comparison purposes. The Yurok Tribe has the greatest number of tribal members, while the Resighini Rancheria has the fewest number enrolled.

Table 3.16-2. Tribal Enrollment within the Area of Analysis, 2005

Tribe	Tribal Enrollment (number of people)
The Klamath Tribes	3,579
Quartz Valley Community	222
Karuk Tribe	3,427
Hoopa Valley Indian Tribe	1,893
Yurok Tribe	4,912
Resighini Rancheria	111

Source: Bureau of Indian Affairs 2005.

3.16.3.1.2 Low Income

Low income populations in the area are identified by several socioeconomic characteristics. Specific characteristics used in this description of the existing environment, as categorized by Census 2000, are income (per capita and median family), percentage of the population below the poverty level (all persons and families), substandard housing, and unemployment rate. Census 2010 data for these categories had not been released at the time of this writing.

As shown in Table 3.16-3, based on income in 1999, as reported in Census 2000, all three California counties have greater percentages of persons and families living below the poverty level than the State of California. Klamath County also has higher percentages of persons and families living below the poverty line than the State of Oregon. All three California counties in the analysis area have lower per capita and median family incomes than the State of California. Similarly, Klamath County has lower per capita and median family incomes than Oregon.

Siskiyou and Klamath Counties output and income have also declined due to reductions in timber harvesting. During the past 10 years, there has been a sharp decline in the Siskiyou County timber industry, which has been an economic base for the county historically. In 2009, the total value of the timber harvest in Siskiyou County was $11.6 million, about a $52 million decrease from 2000 (Board of Equalization 2010). Timber harvesting also decreased and was at its lowest value in 2009 over the 10-year period. Reductions in timber harvesting have also reduced employment opportunities in the county. Similar to Siskiyou County, timber harvests in Klamath County have been declining in recent years. Timber harvests in 2008 and 2009 showed substantial decreases relative to previous years (Oregon Department of Forestry 2010). Appendix O further describes economic conditions in Siskiyou and Klamath Counties.

Table 3.16-3. Income and Poverty, 1999

Area	Per Capita Money Income (dollars)	Median Family Income (dollars)	Persons Below Poverty Level (percent)	Families Below Poverty Level (percent)
California	**22,711**	**53,025**	**14.2**	**10.6**
Del Norte County	14,573	36,056	20.2	16.4
Humboldt County	17,203	39,370	19.5	12.9
Siskiyou County	17,570	36,890	18.6	14.0
Oregon	**20,940**	**48,680**	**11.6**	**7.9**
Klamath County	16,719	38,171	16.8	12.0

Source: U.S. Census Bureau 2000a.

Table 3.16-4 shows census tract data of residents living around the Copco Reservoir in Siskiyou County. The data shows that a lower percentage of people living around the reservoir live below the poverty level relative to the county and State. As such, it is assumed that people living below the poverty level are not disproportionately represented in the areas directly around the reservoirs.

Table 3.16-4. Poverty in Siskiyou County

	Siskiyou County		Block Group 1, Census Tract 3. Siskiyou County	
Total Population	43,699		1,618	
Number of Persons with Income below poverty level in 1999	8,109	18.6%	198	12.24%

Source: U.S. Census Bureau 2000a

In 1989, 85 percent of The Klamath Tribes' population lived below the national poverty level, with a median family income of $8,750, compared to Klamath County's median family income of $27,000 (Tribal Council of Klamath Tribes 2000). Table 3.16-5 shows families living below the poverty level within the other five tribes included in the area of analysis. Except for the Resighini Rancheria, the median household income of the tribes is less than the counties and States in the area of analysis. The tribes also have more families living below the poverty level relative to the counties and States of California and Oregon.

Table 3.16-5. Income and Poverty in Tribes, 1999

Tribes	Median Household Income (dollars)	Families below Poverty Level (percent)		
		All Families	Families with Children under 18 Years of Age	Families with Children under 5 Years of Age
Quartz Valley Community	29,375	37.1	68.4	0.0
Karuk Tribe	18,000	60.0	62.1	73.0
Hoopa Valley Indian Reservation	23,384	29.0	36.9	40.5
Yurok Reservation	20,592	26.8	36.3	60.0
Resighini Rancheria	41,250	0.0	0.0	0.0

Source: U.S. Census Bureau 2000b and Federal Energy Regulatory Commission [FERC] 2007.
Note: Income and Poverty Level information is not available for The Klamath Tribes in the 2000 Census; therefore, a different source was used and relevant data is discussed above.

Other measures of low income, such as substandard housing and unemployment rate, also characterize demographic data (see Table 3.16-6) in relation to environmental justice. Substandard housing units are those that are overcrowded and lacking complete plumbing facilities. As presented in Table 3.16-6, in the area of analysis, the California counties have a smaller percentage of overcrowded housing units and/or units lacking complete plumbing facilities than the State of California. Similarly, the data show that Klamath County has a lower percentage of substandard housing units than the State of Oregon. Consequently, substandard housing is not disproportionately concentrated in the area of analysis and is not an environmental justice concern.

Table 3.16-6. Housing and Employment

Area	Housing Units			Civilian Labor Force
	Total Occupied - 2009 (number of units)	Substandard (1.01 or more occupants/ room) - 2009 (percent)	Substandard (incomplete plumbing) - 2009 (percent)	Unemployment Rate - January 2011 (percent)
California	**12,187,191**	**7.8**	**0.5**	**12.4**
Del Norte County	9,750	3	0.0	13.8
Humboldt County	52,520	2.6	0.8	12.3
Siskiyou County	19,838	2.8	0.7	21.0
Oregon	**1,464,196**	**2.6**	**0.6**	**10.4**
Klamath County	26,761	2.4	0.9	13.0

Source: U.S. Census Bureau 2009b; Employment Development Department 2011; and Oregon Employment Department 2011.

As presented in Table 3.16-6, the unemployment rate in Humboldt County was about the same as the State of California rate, while the rates in Del Norte and Siskiyou Counties were higher than those of the State. The unemployment rate in Siskiyou County was 21 percent in January 2011, which was much larger than California's 12.4 percent rate (Employment Development Department 2011). The unemployment rate in Klamath County was higher than the State of Oregon rate.

Table 3.16-7 includes labor force and unemployment rate data for each of the six tribes. All six tribes have a much higher unemployment rate than the counties and the States of California and Oregon. The counties in the study area have a substantially higher percentage of low-income population among the Indian population compared to the overall population.

Table 3.16-7. Housing, Labor, and Employment, 2005

Tribe	Available to Work (number of people)	Unemployment Rate (percent)
The Klamath Tribes	1,135	21
Quartz Valley Community	45	49
Karuk Tribe	915	63
Hoopa Valley Indian Tribe	1,043	40
Yurok Tribe	1,096	74
Resighini Rancheria	45	60

Source: Bureau of Indian Affairs 2005.

Farm laborers, which are often minority and low income persons, could be disproportionately affected by potential effects to agricultural production. Table 3.16-8 includes information about the farm labor force in the area of analysis. Due to the use of undocumented workers during harvests throughout California and Oregon, it is likely that farm labor is actually higher than numbers officially reported in the Census. Data on undocumented workers is not available for the counties; therefore, Census data is used for comparison purposes.

Table 3.16-8. Employment and Labor Force, 2005-2009, American Community Survey

Area	Civilian Labor Force (number of people)	Farm Labor (percent)
California	**16,550,706**	**1.4**
Del Norte County	10,357	3.3
Humboldt County	58,877	2.0
Siskiyou County	17,455	3.4
Oregon	**1,765,814**	**1.9**
Klamath County	28,101	2.6

Source: U.S. Census Bureau 2009c.

The above data shows that Indian Tribes are minority and low income populations that could be disproportionately affected by the project alternatives. In addition, counties in the area of analysis have lower incomes, higher unemployment rates, and more people and families living in poverty than California and Oregon and could also be disproportionately affected by project alternatives.

3.16.3.1.3 Social Programs

Tribes within the area of analysis receive Federal and State funds to run social programs, such as Medicaid, food stamps, and education. In addition, local county funds are available to tribal members for social programs, such as foster care and police protection. However, local county funds are not given directly to the tribal governments.
Table 3.16-9 shows Federal grants and direct payments made to individuals in each of the area of analysis counties. Table 3.16-10 shows the local funds that were distributed to social programs within each county in 2010. Data showing funds received by tribes in the area of analysis are not currently available.

Table 3.16-9. Federal Funds Distribution for Social Programs, 2010

Area	Grants (millions of dollars)				Direct Payments for Individuals (millions of dollars)		
	Medicaid and Other Health-Related	Nutrition and Family Welfare	Education	Other	Social Security and Government Retirement	Medicare	Food Stamps and Supplemental Security Income
California							
Del Norte County	36.5	7.0	2.2	29.4	81.7	41.3	14.5
Humboldt County	210.5	31.9	17.0	108.2	343.5	189.9	49.9
Siskiyou County	75.0	10.7	5.3	32.6	173.4	83.6	17.5
Oregon							
Klamath County	43.1	10.9	7.7	30.8	234.8	80.7	26.6

Source: U.S. Census Bureau 2010.

Table 3.16-10. Local Funds Distributed for Government Services, 2010

Area	Education (millions of dollars)	Health and Hospitals (millions of dollars)	Police Protection (millions of dollars)	Public Welfare (millions of dollars)	Highways (millions of dollars)
California					
Del Norte County	42.8	6.9	4.2	13.6	4.1
Humboldt County	44.3	9.3	4.1	10.8	4.0
Siskiyou County	44.3	6.8	6.1	9.0	9.7
Oregon					
Klamath County	50.0	7.5	3.3	0.3	6.9

Source: U.S. Census Bureau 2010.

Distribution of social services to tribal members varies greatly by tribe and geographic area. For instance, the Yurok Tribe provides social services of many types directly to its members, including general assistance, food distribution, Indian Child welfare, and other programs (Yurok Tribe 2011a); The Klamath Tribes provides health and wellness services, homeowner assistance, and drug and substance abuse programs, among other things (Klamath Tribe 2011). Other tribes may provide few or no services directly to their members. Social programs may be funded by the Federal government and provided by the tribe, or members may receive assistance directly from their local governments. For example, members of the Yurok Tribe may choose to receive the Temporary Assistance for Needy Families program from the tribe or directly from the county in which they reside (Yurok Tribe 2011b). Therefore, no generalized data are available for social programs for tribal members.

3.16.3.2 Tribal Environmental Justice Concerns

Information about tribal history and environmental justice issues in the area of analysis has been derived from the DOI's *Effects of PacifiCorp Dams on Indian Trust Resources and Cultural Values in the Klamath Basin: Background Technical Report* (DOI 2012) also referred to as *Background Technical Report Informing the Secretarial Determination Overview Report: Current Effects of Implementing the KHSA and KBRA on Indian Trust Resources and Cultural Values*. The Sociocultural/Socioeconomics Effects Analysis Technical Reports (National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries Service) 2012a-e) for each tribe further discuss potential economic effects to tribes related to the No Action/No Project Alternative.

As part of the study for the Background Technical Report, government-to-government consultations were conducted with the six Basin tribes to solicit input from the tribal

governments regarding their assessment of effects on Indian trust resources, tribal rights to take those resources, other resources traditionally used by tribes, and cultural values related to those resources and rights within the area resulting from the current operations of the four PacifiCorp dams on the Klamath River. The reader should note that inclusion of any claims and assertions put forth by these tribes does not necessarily imply that the U.S. Government endorses those views.

Three rounds of consultation meetings were held between the Cultural/Tribal Sub-team and each of the six tribal governments. The purpose of the first consultation meetings (Round 1) was for the Sub-team to describe the process of the Current Effects Background Technical Report, elicit information about the histories and backgrounds of the tribes, and discuss how the dams might be currently affecting their resources and rights and related cultural values. In response, the Yurok, Resighini, Karuk, and The Klamath Tribes provided comprehensive background documents. The Round 2 meetings were conducted to collect comments from the tribes concerning the Current Effects Background Technical Report and the potential effects of the Dams-In Scenario and the Dams-Out Scenario on their trust and other resources and rights. In Round 3, the Sub-team sought comments from the tribes on the first draft of the Potential Effects Background Technical Report.

3.16.3.2.1 Prior to Dam Installation

Six different tribal groups live within the area of analysis. Although the language groups and traditional practices vary among the tribes, all of them based their cultures, commerce, and subsistence primarily on the river and its aquatic and terrestrial resources. Salmon, steelhead, sturgeon, Lost River and shortnose suckers, and other fish (such as red band trout, eulachon and lampreys), as well as fresh water clams, fresh water mussels, and other aquatic species, occupy a central place in the diets and belief systems of the native people. Fish, particularly salmon, determined settlement patterns and have historically been the foundation of the daily and seasonal practices, subsistence, and culture of the native people (Federal Energy Regulatory Commission [FERC] 2007). The diverse indigenous peoples of the area of analysis have all retained close connections to the river and its resources and continue to rely on the river and its resources for cultural, economic and social survival (FERC 2007). Similarly, the suckers in Upper Klamath Lake, its tributaries, and nearby bodies of water are religiously and culturally important to The Klamath Tribes.

The Klamath Basin was once the third most productive salmon run on the U.S. west coast, exclusive of Alaska (Institute for Fisheries Resources and Pacific Coast Federation of Fishermen's Associations 2006), a feature that native people ritually managed for thousands of years (Karuk Tribe 2010, as cited in DOI 2012).The U.S. Court of Appeals for the Ninth Circuit recognized this importance when it concluded that the fish were "not much less necessary to the existence of the Indians than the atmosphere they breathed" (*Blake v. Arnett*, 663 F.2d 906, 909 (9th Cir. 1981), as cited in DOI 2012). The abundance of salmon has always been a measure of tribal well being (Gunther 1926, as cited in DOI 2012). Suckers were historically an important subsistence fish for The Klamath Tribes of the Upper Basin.

3.16.3.2.2 Installation of Dams

Dams were put in place on the upper Klamath River to generate electrical power and to supply water for newly established farmland in the Upper Basin (DOI 2012). Copco 1 Dam was completed in 1918, Copco 2 Dam in 1925, J.C. Boyle Dam in 1958, and Iron Gate Dam in 1962.

The tribes within the area of analysis were not consulted prior to dam construction at any of the four sites analyzed in this Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and had no political ability at the time of dam construction to actively oppose the dams. Additionally, none of the affected tribes were beneficiaries of these hydroelectric facilities but were adversely affected by their construction through the impacts to the Klamath River fishery.

3.16.3.2.3 Effects of Dams – Subsistence (Fishing, Hunting, and Gathering)

This section describes general effects of the dams that are similar across the tribes, then presents tribe-specific effects of the dams. Additional analysis of specific impacts of the dams to each tribe is presented in Section 3.12, Tribal Trust.

Tribes in the area of analysis have historically fished along the Klamath River and its tributaries for salmon and other anadromous fish at a subsistence level. Due to a decline in fisheries, tribes are currently unable to consistently fish at a subsistence level; however, some tribes continue using some fisheries for limited subsistence, economic and ceremonial purposes.. In addition to fish and other aquatic resources, tribes have historically relied on other plant and wildlife species for subsistence. Subsistence hunting has diminished over the decades, which can be attributed to many factors including the costs of hunting licenses required to comply with strict (State) regulations (Stercho 2006) and indirectly to dam construction. Tribal members still engage in traditional hunting, gathering, and resource management activities (DOI 2012); however, the current low abundance of wildlife and plant resources do not meet subsistence needs.

Water management has changed the patterns of water flows throughout the system, affecting the channel geomorphology and spawning and rearing habitat for salmonids, lamprey, and fresh water clams and mussels. The Klamath Hydroelectric Project dams block anadromous and native fish passage to and from the upper river and have converted portions of former riverine habitat to reservoir habitat, which has eliminated anadromous fish habitat and reduced the quality and quantity of salmonid habitat upstream of the dams. For example, although the magnitude of these anadromous fish migrations is unknown, historically, anadromous fish (such as fall and spring run Chinook salmon and winter and summer-run steelhead), lamprey, and Lost River and shortnose suckers could access the Klamath Basin all the way into the rivers that are tributary to Upper Klamath Lake. Currently they are limited to the area downstream from Iron Gate Dam.

The capacity of the mainstem Klamath River downstream from Iron Gate Dam to support the rearing and migration of anadromous species is limited by changes in river flow, high water temperatures, poor water quality, and disease outbreaks, especially during the summer months. The reduction in available habitat, impairment of water quality,

increase in water temperatures, changes in channel geomorphology downstream from the dams, water diversions, and factors outside the current operations (e.g., unfavorable ocean conditions) have led to a substantial decrease in salmonid populations in the Klamath Basin (NOAA Fisheries Service 2010, as cited in DOI 2012). See Section 3.3, Aquatic Resources, for additional information about current conditions and aquatic species found in the Klamath River and Section 3.2, Water Quality, for more information about water quality in the area of analysis.

Prior to construction of dams on the Klamath River, steelhead spawned freely not only in the Klamath and its tributaries, but in the Upper Klamath Lake and beyond. Hundreds of miles of salmon habitat were lost with the construction of four dams in the Klamath River. This is a significant amount of habitat no longer available for spawning and rearing.

Dam installation and operation has affected certain plant and wildlife species. Plant species in the Klamath/Trinity Region include the following: willow shoots, cottonwood, wild grape, bulrush, hazel sticks, tules, spearmint, and blackberries (Stercho 2006). An example of the affects of dam installation and operation on plant species includes, the growth pattern of willow shoots along the river banks are different than before dam installation, and firsthand accounts from tribal members indicate that the new shoots are not suitable for traditional basket weaving (Salter 2003). Wildlife species include bear, for subsistence purposes and bald eagle, blue heron, mallards, fox, otter, and fisher for ceremonial purposes, as well as deer and elk for both subsistence and ceremonial purposes (Stercho 2006). Subsistence wildlife species potentially affected by reduced salmon and steelhead populations include the black bear (DOI 2012). Other salmon and steelhead-dependent wildlife species significant to tribes beyond their subsistence value include the bald and golden eagles, coyote, and cougar (DOI 2012).

3.16.3.2.4 The Klamath Tribes

Resources (such as hunting, fishing, gathering, trapping, and water rights), especially fish, have played a central role in the physical, social and spiritual well-being of the Klamath people for millennia. The Klamath Basin from Link River to Iron Gate once had an almost continuous geographical distribution of traditional sites and activities.

The Klamath Tribes relied heavily on upland game (e.g., deer, elk, and pronghorn antelope) and plant foods (e.g., yampah, wild plum, and many other fruits and berries), but riverine and especially marsh resources were of equal importance. Salmon and multiple species of sucker, trout, eel, lamprey, and other fish were dietary staples, while marsh and riparian plants such as the yellow pond lily (Wocus), tule, cattail, and willow provided staple foods and materials as essential tools and crafts. Salmon were numerous throughout much of The Klamath Tribes' traditional territory. Historically, The Klamath Tribes fished not only for salmon and steelhead, but also for mullet (suckers), eels, and lamprey.

In 1889, the Klamath River Improvement and Lumber Company built a 10 to 12 foot high log crib, rock filled dam at Klamathon that created an obstacle for migrating fish. In 1910, the Bureau of Fisheries installed fish racks at Klamathon that further curtailed fish migration (Fortune et al. 1966). The construction of Copco 1 Dam (1918) completely blocked anadromous fish runs into the Upper Basin and abruptly ended The Klamath Tribes' access to anadromous fish. Two other major fisheries, resident salmonids (trout) and catostomids, could still be used by The Klamath Tribes after the demise of the anadromous fisheries. The catostomid fishery consisted primarily of c'waam (Lost River sucker) and koptu (shortnose sucker) until the Tribes closed their fishery in 1986 to protect it in the face of severe population declines (DOI 2012).

Quartz Valley Community

Most of the Quartz Valley Community's tribal members are descendants of people of Karuk ancestry, although a few tribal members are also of Shasta ancestry (DOI 2012).

Traditionally used fish resources of the Scott River include Chinook salmon, coho salmon, steelhead and Pacific lamprey. The Quartz Valley Community relies on these fish for sustenance and their spiritual wellbeing. These fish need to survive their migration through the Klamath River to and from the ocean. Therefore, the tribe has an interest in Klamath River health.

Since the construction of the dams on the Klamath River, the numbers of a variety of river species have plummeted. Some of these fish had traditionally been a source of food and cultural ceremonies and practices for the Quartz Valley Community. One of the most significant impacts of the Klamath River dams is the altered seasonal warming and cooling trends in the river. This translates into a shorter fishing season in the fall, in addition to limiting the number of fishing days available in the fall (DOI 2012).

Karuk Reservation

The Klamath and Salmon River fishery and other resources supported more than 100 ancestral Karuk villages along the Klamath and Salmon Rivers. The Karuk Tribe has effectively maintained its cultural identity and traditional practices. Tribal members still engage in traditional hunting, gathering, and resource management activities. This includes preservation and use of the Karuk language, basket-making, fabrication of regalia, practice of traditional religious ceremonies, and stewardship of natural resources through use of fire and harvest management techniques.

The Karuk diet traditionally consisted mostly of salmon, deer, and acorns. Fish, especially salmon, have always been a major food resource and the focus of ceremonies for the tribe. Fish important to the Karuk include spring-run Chinook or king salmon, fall-run Chinook, out-migrating Chinook smolt, Coho, or silver salmon (also called dog salmon), steelhead, trout, sucker, bullhead, sturgeon, and Pacific lamprey. Freshwater mussels also have cultural significance for the Karuk not only for food, but also as important tools.

Since the construction of the dams on the Klamath River, the numbers of a variety of river species have plummeted. Some of these fish had traditionally been a source of food and cultural ceremonies and practices for the Karuk Tribe. Karuk believe one of the most significant impacts of the Klamath River dams is the way that the natural process of seasonal warming and cooling trends in the river is altered by the presence of reservoirs. For Karuk, this translates into a shorter fishing season in the fall. In addition to limiting the number of fishing days available in the fall, the opportunity to harvest spring Chinook salmon has been completely lost to the Karuk since construction of Iron Gate Dam (DOI 2012).

Hoopa Valley Indian Reservation

The Trinity River is of prime importance to the Hoopa Valley Tribe because it is the river that runs through the Hoopa Valley Indian Reservation. Fish destined for the Trinity River must pass through the lower Klamath River and are therefore affected by Klamath River conditions.

Uses of the Trinity River by the Hupa people are highlighted by maintenance of fisheries and religious ceremonies. Many natural foods were available to the Hupa, with salmon and acorns providing the bulk of the native diet. Other important fish include steelhead, sturgeon, and lamprey eels (DOI 2012). The decline of the river, including decreased fisheries and water quality, has adversely affected the psychological health of the Hupa.

Yurok Reservation

Deterioration of the Klamath River affects Yurok ceremonial and traditional practices. The lives of the Yurok people have always been intricately tied to the river. Historically, they depend on the river for sustenance, and much of their world was defined in terms of their physical relation to the river. Many of the Yurok cultural sites on the Klamath and lower Trinity rivers are traditional fishing spots owned by families. These are places where the Yurok have lived, fished, gathered, prayed, and buried their dead for centuries.

Over time, as the rivers' flows have changed, so have the locations of these cultural sites. As with all tribes that identify as salmon people, fish have been the Yurok Tribe's most valuable asset and a mainstay of their economy. With fish in abundance, the Yurok could not only feed themselves and their families all year long, but the surplus could be used to acquire products from outside their territory.

Since 1990, tribal commercial harvests have been marginal and have not provided a comfortable standard of livelihood. The decreased harvests have had a significant adverse impact on the tribe's economies and health. Limited access to resources has restricted the ability of the Yurok to practice some of their most important traditions. This includes freely fishing the once-prolific semi-annual salmon runs and participating in the cycle of ceremonies initiated concurrently with salmon runs (DOI 2012).

Resighini Rancheria

The Indians of the Resighini Rancheria are Yurok people; consequently they share their cultural practices and values with the general culture described for the Yurok Tribe. Resighini tribal members recently participated in the Weitchpec Jump and Deerskin ceremonies (DOI 2012).

The general health and wellbeing and cultural values of the members of the Rancheria are affected by a lack of fish in the local economy and overall water quality. The lack of fish in the local economy also has secondary effects on general tribal health and cultural well being.

The people of the Resighini Rancheria bathe in the river and use its water for daily and ritualistic purposes. Because of their reliance on the river for so many aspects of their lives, they are concerned about the quality of its water. The Klamath Hydroelectric Project has effects on water quality and related environmental issues, such as watershed health, riparian habitats, erosion, sediment, turbidity, sources of pollution and temperature changes, algae blooms, low dissolved oxygen, high pH, and un-ionized ammonia. The cumulative effects may result in health problems.

Secondary effects of the Klamath River dams on the people of the Resighini Rancheria include emotional and physical health effects such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members experience a loss of opportunity for inter-generational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunities elsewhere (DOI 2012, 2011b).

3.16.3.2.4 Effects of Dams – Water Quality

Tribal needs for high quality water in the Klamath River are not limited to the biological needs of the fishery. Water quality plays a significant role for tribes in the Klamath Basin because it affects culturally relevant fish, and many tribes rely on the Klamath River for water supplies and use of water in ceremonial activities, such as drinking or bathing. Many tribal ceremonies must be practiced near the river and at times when water quality is at its lowest. Ceremonial practitioners must ritually bathe, submerge and at times even ingest the water from the River. Roots, materials and tribal medicinal plants, and other plants are gathered from the riverbank and require exposure to river water. For example, basketry often requires the weaver to use their teeth to strip bark pulled from the river, offering an avenue of direct exposure to water born toxins.

Under current conditions, water quality in the mainstem of the Klamath River has been listed as impaired due to the following caused or induced conditions (North Coast Regional Water Quality Control Board 2010, as cited in DOI 2012): organic enrichment, low dissolved oxygen, water temperature impairment, nutrient impairment, and toxic algae (microcystin) impairment. There is a direct cause-and-effect link between current Klamath Hydroelectric Project dam operations and water quality; this link was established in the *Basin Plan for the Klamath River*, prepared by the North Coast

Regional Water Quality Control Board (as cited in DOI 2012). See Section 3.2, Water Quality, for additional information about the link between the Klamath Hydroelectric Project dams and degraded water quality.

Impoundment of water in the four reservoirs shifts the seasonal water temperature patterns, producing cooler than normal water temperatures in the springtime and warmer than normal temperatures in the fall. These water temperature shifts disrupt spawning cycles for salmon and at times can produce stressful or lethal water temperature conditions for aquatic resources. Water with high concentrations of nutrients and organic matter entering these reservoirs leads to low dissolved-oxygen concentrations as organic matter decomposes, algal populations bloom and crash, and organic matter settles to the deeper portions of the reservoirs. Release of this low-dissolved oxygen water from these reservoirs, particularly during the summer and fall, produces stressful or lethal conditions for aquatic resources, such as salmon.

These reservoir algal blooms include blue-green algae, such as *Microcystis aeruginosa*, which release a toxin that can cause skin irritation, sickness, or in extreme cases, death, to exposed organisms, including humans (World Health Organization 1999). These toxins have been measured in the reservoirs and in the Klamath River for many miles downstream from Iron Gate Dam. Algal blooms have reached levels thousands of times higher than those the World Health Organization says are safe for recreation (DOI 2012). A survey of aquatic resources (fish and mussels) in the Klamath River showed a bioaccumulation of microcystin in their tissue (Kann 2008).

In addition, preliminary evaluation of dioxin results from the 2009–2010 Klamath River sediment cores (DOI 2011) indicates that dioxin is present at levels greater than screening levels for sediment disposal. In the J.C. Boyle and Copco 1 Reservoirs, levels are slightly above available national and western United States background values for fish and birds (USEPA 2010). However, dioxin levels indicate no current public health concerns from direct human exposure and the measured levels indicate no current bioaccumulatory concerns (DOI 2011).

Additionally, PacifiCorp indicated that some of the fish tissue samples from Upper Klamath Lake, Keno Impoundment, J.C. Boyle Reservoir, and Copco 1 Reservoir exceed the suggested wildlife screening value for total dichlorodiphenyltrichloroethane (DDT). Samples also showed that total polychlorinated biphenyl (PCB) values exceed the screening level for subsistence fishing in black bullhead from Keno Impoundment and in largemouth bass from J.C. Boyle, Copco 1, and Iron Gate Reservoirs (PacifiCorp 2004). See Section 3.2, Water Quality, for additional discussion and Appendix Tables E-5 through E-7 for sediment values and screening levels.

Downstream from the hydroelectric facilities, water conditions are also ideal for promoting fish disease, in that they allow parasites to thrive. The stable flows and warm water on the Klamath River, especially between the Shasta River and Seiad, contain elevated levels of the parasites that carry the fish diseases *Parvicapsula minibicornis* and *Ceratomyxa shasta* (California Department of Fish and Game 2004, as cited in DOI

2012). In some years up to 80 percent of the juvenile salmon in the Klamath River become infected and most die from these diseases (California Department of Fish and Game 2004, as cited in DOI 2012).

Freshwater mussels have also been adversely affected by the degraded water quality in the Klamath River. Freshwater mussels are an important food source for the Klamath River tribes and an essential part of some tribal ceremonies. During the early 20th century, mussels were gathered for food and for use in rituals late in the season when the river flows were low; unfortunately, this is the time of year when the mussels are most contaminated. Even though there are few to be found, people continue to use freshwater mussels as a food source, but their use in ceremonial celebration has been greatly reduced (DOI 2012).

The Klamath Tribes

Water quality and flows in the Klamath River and its tributaries associated with current dam operations are an important issue to The Klamath Tribes. Water conditions affect the ability of anadromous fish species to survive. A number of ritual traditions of The Klamath Tribes depend on access to clean water from natural sources, which is used in ritual purification of people, places, and objects, as well as in rituals associated with drought abatement and other environmentally restorative activities. Although tribal members sometimes acquire water for these purposes from the Klamath River canyon area, the Klamath River is widely viewed as being of compromised quality for these ritual uses, in part due to the effects of the dams on water temperature, algae development, and other variables of water quality (DOI 2012).

Quartz Valley Community

The Indians of the Quartz Valley Community are related to Karuk people and thus share their cultural practices and values with the general culture described below for the Karuk Tribe (DOI 2012).

Water quality and flows in the Klamath River and its tributaries associated with current dam operations are an important issue to the Quartz Valley Community. Water conditions affect the ability of anadromous fish species to survive. A number of ritual traditions of the Quartz Valley Community depend on access to clean water from natural sources, which is used in ritual purification of people, places, and objects, as well as in rituals associated with drought abatement and other environmentally restorative activities.

Given current degraded water quality conditions, ingestion of water as a result of traditional cultural activities or use of materials harvested from the river may pose a potential health risk (DOI 2012).

Karuk Reservation

The Karuk Tribe only has two public water systems, one at Happy Camp and the other at Orleans, which requires most residents to rely on individual wells and/or surface waters for domestic use (Karuk Tribe 2001).

Water quality plays a very significant role in Karuk tribal culture because its effects on culturally relevant aquatic species. Water quality also affects the ability of *Fataveenan*, or World Renewal Priests, to conduct ceremonies. *Pikiavish* starts with the Spring Salmon Ceremony in early spring and continues throughout late summer into early fall. Key ceremonial participants bathe multiple times a day in the Klamath River for 10 days in a row. This is the time of year when the blooms of the toxic algae, *Microcystis aeruginosa*, are at their peak. Bathing in the river is an important part of most Karuk ceremonies. Bathing is also associated with funeral services, subsistence practices, recreational swimming, courtship, and individual hygiene.

Karuk tribal members collect willow roots, wild grape, cottonwood, and willow in the riparian zone along the Klamath River and use these materials to make baskets. Traditional collection of these basketry materials often involves wading in the water, and washing and cleaning the materials in the river. Willows are peeled by mouth following cleaning with river water, and plants are also collected for food, medicine, and other cultural functions. Given current degraded water quality conditions, ingestion of water as a result of traditional cultural activities or use of materials harvested from the river may pose a potential health risk (DOI 2012).

Hoopa Valley Indian Reservation

The Hoopa Valley Indian Reservation hosts a seasonal abundance of surface water for drinking water supply while in contrast, ground water aquifers are quite limited. Increased areas of ground water contamination are occurring, which makes it more difficult to use ground water as a source of drinking water. The tribe is now faced with the challenge of meeting the increase demands for drinking water supply, while maintaining quality surface water in streams to protect fish, wildlife and other beneficial uses (Hoopa Valley Tribe 2008).

Yurok Reservation

Limited access to resources has restricted the ability of Yurok to practice some of their most important traditions. This includes freely fishing the once-prolific semi-annual salmon runs and participating in the cycle of ceremonies initiated concurrently. In the past, the Yurok were not inclined to leave their territory; currently, several factors, including an inability to meet subsistence needs from the fishery and a perception that the rivers are dirty, prompt younger tribal members to leave the area to find work (DOI 2012).

Resighini Rancheria

The Indians of the Resighini Rancheria are Yurok people; consequently they share their cultural practices and values with the general culture described above for the Yurok Tribe.

Both the Yurok and the Yurok of the Resighini Rancheria bathe in the river and use its water for daily and ritualistic purposes. Because of their reliance on the river for so many aspects of their lives, they are concerned about the quality of its water. The Klamath Hydroelectric Project has effects on water quality and related environmental issues, such

as watershed health, riparian habitats, erosion, sediment, turbidity, sources of pollution and temperature changes, algae blooms, low dissolved oxygen, high pH, and un-ionized ammonia. The cumulative effects may result in health problems, not just for the people who live on the Rancheria, but also for the tourists who come and camp in the area every year, and for people who use the water for business purposes or who work for those businesses (DOI 2012).

3.16.3.2.5 Effects of Dams – Tribal Health

Secondary, or indirect, effects of the Klamath Hydroelectric Project dams on tribes within the area of analysis include physical and emotional health issues.

The loss of naturally occurring resources, such as fish, lamprey, freshwater clams, and mussels, can leave tribal members with no other option than to supplement their diets with government-provided subsidies and/or store-bought food. Studies have found that supplementing or replacing traditional diets of Indian people is often detrimental to their health, contributing to the widespread occurrence of obesity and related diabetes in Indian populations today (Norgaard 2004; Yurok Tribe 2006, Acton et al. 2003; California Rural Indian Health Board [CRIHB] 2010; Trafzer and Weiner 2001, as cited in DOI 2012.

Poor water quality, as demonstrated in recurring toxic algal blooms in the Klamath River has the potential to affect human health, as water from the river plays a central role in tribal ceremonies. Poor water quality also affects drinking water, fish, freshwater clams, and mussels that the tribes eat as discussed above. Bioaccumulation screening levels for DDT and dioxins were exceeded in sediment samples taken from the Klamath River. While levels now indicate no current public health concerns from direct human exposure, there is the potential for bioaccumulation to occur in the Klamath Hydroelectric Project reservoirs.

Emotional and social health of the individuals in the tribes has also been affected indirectly by dam installation. When a people's identity and cultural practices are closely associated with a species that no longer thrives, a sense of connection and belonging is lost (Norgaard 2004, as cited in DOI 2012. Young people may feel this loss of belonging because they have never experienced the Klamath River as previous generations once did. The decline of the resource makes seasonal celebrations of the salmon runs difficult to understand and to carry out. The Yurok and Hoopa Valley Tribes continue to perform down-river boat ceremonies; however, sometimes the water is so shallow it is necessary to call Federal agencies to request water flow increases to perform the ceremony. The NOAA Fisheries Service Biological Opinion sets flow requirements downstream from Iron Gate Dam that affect river flows available for ceremonies. Section 3.3, Aquatic Resources, and Table 3.3-4 summarize these flow requirements. The factors discussed in this section indirectly affect the emotional and social health of the tribes within the area of analysis (DOI 2012).

The Klamath Tribes

Because salmon was the first dietary staple to be lost to The Klamath Tribes, its depletion was said to have initiated dramatic dietary shifts among tribal members. For a time, this fostered increased consumption of deer and mullet (suckers), which some tribal members believe resulted in localized overuse of these resources when taken in combination with fish and game management practices of the State of Oregon. For some, the loss of the salmon was the catalyst for a dietary transition that led to the ultimate dependence of The Klamath Tribes on the purchase of processed foods and the use of supplementary commodity goods.

Tribal members attribute a number of historical health problems to the loss of salmon. Recent Indian Health Service studies endorsed by The Klamath Tribes concluded that a host of physical ailments plaguing members of The Klamath Tribes have been linked to the demise of the aboriginal diet. Diabetes, hypertension, obesity, and related cardiovascular ailments are particularly widespread, reflecting dramatic changes in food consumption and procurement patterns (DOI 2012).

Quartz Valley Community

The members of the Quartz Valley Community refrained from making any comments regarding health effects (DOI 2012).

Karuk Reservation

The Karuk have been denied traditional food sources such as salmon over the last 150 years, and have increasingly adopted western foods. The decrease in the availability of traditional foods, including salmon, trout, eel (various species of lamprey), mussels, and sturgeon, is responsible for many diet-related illnesses among Indians, including diabetes, obesity, heart disease, tuberculosis, hypertension, kidney problems, and stokes (Joe and Young [1993] as cited by Nogaard2004). The estimated diabetes rate for the Karuk Tribe is 12 percent, nearly two times the U.S. average, and the estimated rate of heart disease for the Karuk is 39.6 percent, three times the U.S. average. These conditions result from the lack of proper nutrient content in foods consumed without fishing and gathering food.

Difficulty in meeting basic needs can result in overwhelming physical and psychological stress. Traditionally, fishing is done by Karuk men. With the loss of the salmon comes a loss of a man’s sense of pride in being able to provide food for his family and tribe. For a tribe that has called itself The People of the Fish, there is an indisputable loss of identity when there are no fish. For a people whose belief system includes their specific role on earth, that they have a predefined relationship with nature that needs to be honored, there is a sense of failure when they are unable to fulfill that role.

The changes that have caused wildlife to become scarce and the rivers to become polluted may make it hard for young people to understand the ways of their parents and grandparents. Never having seen it themselves, they do not understand that in the past there could be eight yearly runs of salmon in the Klamath when all they see is one-half of a fall run. Without tradition as an anchor, young people are sometimes drawn to gangs to establish a feeling of belonging, and leave Karuk territory for cities (DOI 2012).

Hoopa Valley Indian Reservation

The secondary effects of the Klamath River dams on the people of the Hoopa Valley Tribe include emotional and physical health effects such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members experience a loss of opportunity for intergenerational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunity elsewhere (DOI 2012).

Yurok Reservation

Secondary effects of the Klamath River dams on the Yurok Tribe include emotional and physical conditions such as increased obesity, diabetes, and heart disease due to loss of traditional salmon diet, and depression and alienation that can result in suicide (DOI 2012).

Resighini Rancheria

Secondary effects of the Klamath River dams on the people of the Resighini Rancheria include emotional and physical health effects such as increased obesity, diabetes, heart disease due to loss of the traditional salmon diet, and depression, alienation, and suicide. Additionally, the tribal members experience a loss of opportunity for inter-generational transmission of traditional knowledge. These conditions result in tribal members, especially young people, leaving the reservation for opportunities elsewhere (DOI 2012).

3.16.3.2.6 Effects of Dams – Economy (Commercial Fishing)

Historically, and in contrast to the current situation, the commercial salmon fishery was a substantial component of the West Coast resource-based economies. The numerous local anadromous fisheries allowed tribes, such as the Karuk and Yurok, to develop subsistence economies highly specialized in fishing (Stercho 2006). The more recent history (1976 to the present) is characterized by poor ocean condition cycles, and adverse habitat alterations (including construction of hydroelectric facilities) for all regions along the West Coast of North America (FERC 2007). These trends have caused substantial decreases in the amount of income and jobs in economies where salmon and steelhead fishing have historically been important. Coastal communities and tribes have experienced the greatest losses in this regard (FERC 2007).

The Klamath Tribes

The current operations of the dams have had a range of secondary effects on The Klamath Tribes. Among these effects are the decline in fish and wildlife other than anadromous fish (DOI 2012). These declines have resulted in a diminished economy. The Klamath Tribes were forced to close their c'waam fishery in 1986 to protect it in the face of severe (fish) population declines (DOI 2001a).

The decline in fish populations has contributed to the decline of various fish dependent species. Several salmon-dependent wildlife species are of traditional cultural significance to members of The Klamath Tribes beyond their subsistence value. Many non-salmon species and ecologically linked plants are significant for the cultural and

economic well-being of The Klamath Tribes. The Klamath Tribes members traditionally used pelts, feathers, and other body parts from some of these animals in ceremonial regalia, traditional crafts, and for other purposes. In a few cases, tribal members relied on the sale of pelts from some of these species for supplemental income.

Large gatherings associated with the fish harvest once served as a venue for economic exchanges. The demise of the fish population has interrupted the performance of the important economic, social and cultural functions.

Although The Klamath Tribes have the most direct interest in resources upstream of the four hydroelectric dams, the current operations of the Klamath Hydroelectric Project have affected The Klamath Tribes' (through a complete end to the anadromous fishery) in the Upper Basin and resource interest in the footprint of the dams and impoundments, and downstream from the dams in lands ceded by The Klamath Tribes. Plants, animals, soil, and rocks are all of concern to The Klamath Tribes members, both economically and environmentally (DOI 2012).

Quartz Valley Community

The Indians of the Quartz Valley Community are related to Karuk people and thus share their cultural practices and values with the general cultural described for the Karuk Tribe below.

Karuk Reservation

The lack of fish in the local economy has secondary effects on general (Karuk) tribal health and cultural wellbeing. Since the construction of the dams on the Klamath River, the numbers of a variety of river species have plummeted. Some of these fish had traditionally been a source of food and cultural ceremonies and practices for the Karuk Tribe, as well as a means of trade and income.

The lack of migratory steelhead affects the local economy and the wellbeing of the Karuk Tribe. Steelhead fisherman from outside the area used to pay for the privilege of fishing for the Klamath steelhead, bringing money into the local economy to the benefit of the Karuk Tribe. Today, the number of steelhead is so low that the sport is no longer viable (DOI 2012).

Hoopa Valley Indian Reservation

The Hoopa Valley Tribe maintains a modest commercial fishery program (DOI 2012). The Trinity River, like most West Coast Rivers, has experienced a decline in Chinook salmon, steelhead, and Coho runs. The Trinity's Coho salmon is currently listed as threatened under the Endangered Species Act (Hoopa Valley Tribal Fisheries).

Yurok Reservation

Fish are the Yurok Tribe's most valuable asset and a mainstay of their economy. Abundant fish allow Yurok to feed themselves and their families and to acquire products from outside their territory through trade. Fish was a trading commodity available to any enterprising man. A young man who diligently fished and successfully traded fish for

other items could amass sufficient wealth to buy a boat, travel to collect all of the necessary items to fashion intricate ceremonial regalia, and to allow him to marry. Fish were the baseline resource that facilitated the acquisition of wealth and upward social mobility in Yurok culture.

The Yurok Tribe voluntarily closes its commercial fishery in critical years out of concern for the survival of Klamath River salmon. These closures adversely affect the tribal community which relies heavily on income from the short commercial season for harvesting fall Chinook salmon. In general, declines in total numbers of fish stocks have adversely affected the ability of the Yurok Tribe to harvest for commercial purposes. In the past, the Yurok were not inclined to leave their territory; currently, several factors, including an inability to meet subsistence needs from the fishery prompt younger tribal members to leave the area to find work (DOI 2012).

Resighini Rancheria

The original "Merin" proposal to create the Resighini Rancheria described the tract of land as "agricultural" with conditions that are "ideal for farming or dairying." However, the value of the land as agricultural was directly connected to the loss of traditional fisheries. In past years, commercial and subsistence fishing was a primary means of economic and subsistence support for the Yurok including the Resighini along the Klamath River. However, with the closure and restrictions on tribal fishing, this means of support was lost. While the "fish wars" and accompanying litigation of the 1970s and 1980s reinstated Yurok fishing rights and the Hoopa-Yurok Settlement Act further confirmed that the Yurok Tribe had fishing rights. Any Klamath River salmonid fishing rights and concomitant water rights to which the Resighini Rancheria may be entitled have not yet been determined [Solicitor's Opinion M-36979 October 4, 1993].

3.16.3.2.7 Effects of the Dams – Electricity Distribution

On February 24, 1917, the California Oregon Power Company (now PacifiCorp) entered into an agreement with the Klamath Water Users Protective Association (irrigators) to extend to the water users of the Klamath Hydroelectric Project certain preferential power rates (Klamath Water Users Association 2004). This agreement was amended and further extended for a 50-year period on April 16, 1956 (Klamath Water Users Association 2004). No similar power agreement was extended to the tribes located within the area of analysis because preferential power rates are normally provided only for on-farm agricultural use. To date, non-farm irrigating Tribes in the area of analysis still do not receive energy benefits from the Klamath Hydroelectric Project operations.

3.16.3.2.8 Summary of Environmental Justice Issues

Although many other historic and current factors, such as mining, timber extraction, agricultural production, and cattle grazing, affect the environmental integrity of the Klamath Basin, the current operations of the four Klamath Hydroelectric Project dams also substantially adversely affect water quality and fishing resources of the Klamath Basin tribes and, by extension, their way of life. Due to tribes' resource-based economy, culture, dam installation has directly and indirectly resulted in environmental concerns related to fishing, water quality, health, and the economy that disproportionately affects

tribes in comparison to the general population in the area of analysis. While the tribes experienced disproportionately greater adverse effects of dam installation and operation, they did not receive any benefits of the project, including fixed-price electricity.

Current dam operations substantially contribute to compromised water quality, loss of habitat for anadromous and other aquatic species, and altered riverine ecosystem functions. These contributing factors have led to the decline of the anadromous fishery and other inter-related aquatic populations important to the continuance of an Indian river-based way of life. The decline of the anadromous fishery is directly and indirectly linked to the decline and scattering of the people, culture and language of the "Salmon People" of the Klamath Basin. The decline is manifested particularly in physical illness, mental illness, the loss of traditional knowledge, and social conflict among native peoples and between native peoples and non-natives also residing in the Klamath Basin (DOI 2012).

3.16.3.2.9 Summary of Tribal Involvement in KHSA and KBRA

As described in Chapter 1 (Introduction), the KHSA and the KBRA were signed in February 2010 by representatives of 45 organizations, including three tribes: Karuk Tribe, the Klamath Tribes, and Yurok Tribe.

In addition, comments from the tribes were solicited during the scoping period for the EIS/EIR. Comment letters were received from the following tribes: The Klamath Tribes; Karuk Tribe; Hoopa Valley Tribe; Yurok Tribe; Resighini Rancheria; and Modoc Nation. Applicable scoping comments from the tribes have been addressed throughout the EIS/EIR.

The Klamath Tribes, Karuk Tribe, Hoopa Valley Tribe, Yurok Tribe and Resighini Rancheria have all signed a Memorandum of Understanding as a Cooperating Agency. As Cooperating Agencies they were all afforded a review of a Cooperating Agency Draft EIS/EIR. Comment letters were received and those comments are addressed in this Draft EIS/EIR.

3.16.4 Environmental Consequences

3.16.4.1 Effects Determination Methods

This discussion of environmental consequences focuses on evaluating potential disproportionate adverse effects (including social, health, economic, or other environmental impacts) on low income or minority populations. This section also identifies potential benefits to low income and minority populations. The analysis relies on demographic and income data obtained from the Federal and local governments to identify disproportionate low income and minority populations in the area of analysis. The analysis does not examine alternative locations for the Proposed Action that would reduce environmental justice effects on such populations because the dams are already in place and thus the Proposed Action to remove the dams cannot take place elsewhere.

Four factors were used to determine if there were a disproportionate number of low-income individuals in the area of analysis: income, poverty, substandard housing, and unemployment. It was found that the area of analysis does not have disproportionately more substandard housing than Oregon or California; therefore no low income individuals were identified on this basis. Data does show that there are disproportionately more individuals with low incomes, living in poverty, or unemployed at a county level relative to the State(s). As shown in Table 3.16-4, within Siskiyou County, there are not disproportionately more people living below the poverty level in the Census tract that contains the Copco Reservoir (the area adjacent to the potential project deconstruction activities). These data suggest that low income individuals are not represented in the immediate area of dam deconstruction and there would be no disproportionate effects. Therefore, this analysis instead focuses on potential environmental justice effects on county residents as a whole where there are a high proportion of low income and minority individuals relative to the State.

The Lead Agencies did determine that the percentage of persons identifying as Indian reflected minority and low income populations that could be disproportionately affected. Due to minority and low income status, as well as the past Klamath watershed history, existing qualitative reports (DOI 2012), and information gathered during scoping, it was determined that tribal communities might experience disproportionate impacts from the Proposed Action that might raise environmental justice concerns. While the area of analysis examines specific tribes located within the four counties, there is the potential for members of other tribal groups to live along the Klamath River.

The area of analysis also has a substantial population of farm workers, which are mostly minority and low income individuals. Because actions related to KBRA might disproportionately affect farmers, an analysis of potential environmental justice impacts on farm workers was conducted.

The analysis of social concerns, including environmental justice, is based on an understanding of how the resources in the area of analysis are used (e.g., for fishing, ceremonies, and cultural practices) and by whom, as well as the indirect economic effects on the local community. This includes the dependence of individuals and businesses on the Klamath River resources. Based on these parameters, a qualitative analysis of social and environmental justice concerns was conducted.

NEPA requires an analysis of social, economic, and environmental justice effects; however, there is no standard set of criteria for evaluating environmental justice impacts. According to the California Environmental Quality Act (CEQA), economic and social impacts are not considered significant effects on the environment. Therefore, there is no guidance in the Initial Study Checklist included in the CEQA Guidelines (California Code of Regulations, Title 14, Division 6, Chapter 3, Sections 15000-15387), and no significance determinations are made or mitigation measures required in the impact analyses.

For the purposes of this EIS/EIR, the No Action/No Project Alternative is the basis of comparison, as required by NEPA. The No Action/No Project Alternative also represents the continuation of past environmental justice issues for tribal people that occurred since the dams were constructed.

3.16.4.2 Effects Determinations

3.16.4.2.1 Alternative 1: No Action/No Project Alternative

Continued impoundment of water at the reservoir and decline in fisheries could disproportionately affect tribal people. The issue of dam removal has been brought forward by the affected Indian Tribes in response to the long-standing environmental concerns that are a direct result of the construction and continued operation of the four Klamath Hydroelectric Project dams. In the short and long term, the four subject dams would continue to operate along the Klamath River, thus continuing the historical environmental justice impacts to tribes resulting from dam construction and operation.

The river and its aquatic resources are a central part of cultural heritages of tribal communities. As such, tribes in the area of analysis have been disproportionately affected by the Four Facilities along the Klamath River. Under this alternative, an increase in salmonid populations and improvements in water quality and aquatic species populations in the Klamath Basin would not be likely. The Klamath Tribes would continue to suffer from lack of a salmon and steelhead fishery in the Upper Basin, which would prolong disproportionate adverse impacts to The Klamath Tribes' culture, subsistence and income. The Lost River and shortnose sucker fishery would also remain closed to protect severely decreased populations in the Upper Basin. This would also continue existing environmental injustices to The Klamath Tribes.

The Quartz Valley Indian Community, Karuk, Hoopa Valley, Yurok, and Resighini Rancheria Tribes in the Lower Basin would continue to experience a declined salmon and steelhead fishery in the Klamath River under the No Action/No Project Alternative. There would be continued disproportionate adverse effect on tribes' cultural and ceremonial practices with limited access to resources. Because of decreased fisheries and shorter or no fishing seasons, Indian Tribes would be unable to meet subsistence needs and tribal incomes would remain low from reduced fishing opportunities.

Therefore, in the long term, tribes in the area of analysis would continue to be disproportionately affected by the dams, and their situation would remain an environmental concern under this alternative.

Increased traffic, air quality emissions, and noise associated with construction could disproportionately affect county residents and tribal people. Under the No Action/No Project Alternative, no deconstruction or construction would be required. Therefore, no short term deconstruction- or construction-related impacts, such as increased traffic on local roads, air pollutants, or noise, would disproportionately affect county residents or tribal people in the area of analysis.

Release of sediment from reservoirs could cause disproportionate short term impacts on county residents and tribal people. Under the No Action/No Project Alternative, sediment would not be released from the reservoirs and there would be no disproportionate short term impacts on county residents and tribal people.

Continued impoundment of water at the reservoirs could cause disproportionate long term water quality impacts on county residents and tribal people. Under the No Action/No Project Alternative, water quality in the reservoirs and Klamath River would continue to be degraded with ongoing operation of the Klamath Hydroelectric Project facilities. Degraded water quality would affect recreation opportunities for county residents and tribal people, if there is reduced access to the reservoirs and rivers. All residents and out-of-region visitors would be affected equally by loss of access to recreation. As described in Section 3.20, Recreation, there are many other recreation sites within the region that could substitute for river and reservoir recreation activities. There would be no disproportionate effects to county residents and tribal people by long-term water quality impacts to recreation.

Degraded water quality under the No Action/No Project Alternative would extend an existing environmental justice impact on the tribal communities. Poor water quality would continue to affect culturally relevant fish, water supplies, and use of water in ceremonial activities that include drinking or bathing for all tribes in the area of analysis. For example, The Klamath Tribes would continue to not be able to perform rituals that rely on clean water from natural sources because of high water temperatures and algal development. Toxic algal blooms during the summer would also continue to affect annual work renewal ceremonies for the Karuk, Hoopa Valley, and Yurok Tribes. Similarly, the Resighini Rancheria would also be unable to bathe in the river and use its water for daily and ritualistic purposes under the No Action/No Project Alternative. Degraded water quality also affects salmon, steelhead, freshwater mussels, and other aquatic species that provide subsistence or commercial fishing revenues for the tribes. Continued seasonal and annual toxic algal blooms, high water temperatures, and other water quality impairments under the No Action Alternative would continue disproportionate effects and environmental justice concerns on the tribes in the Klamath Basin.

Changes in county revenues could decrease county funding of social programs used by county residents. The reservoirs and Klamath River would not be altered under the No Action/No Project Alternative. As such, no short or long term changes to property values or local tax revenues would occur under this alternative associated with dam removal. County residents would not be disproportionately affected.

Continued impoundment of water could disproportionately impact tribal health and social wellbeing in the long term. Under the No Action/No Project Alternative, the dams would remain and current conditions in the Klamath River would continue in the short and long term. Under this alternative, the ecosystem would not be improved and aquatic species populations would not increase. Consequently, tribes would not have increased access to fish and other aquatic resources. Without access to these traditional diets, tribal

members would be required to continue supplementing their diets with store-bought food or government-provided subsidies, most of which have high concentrations of sodium, sugar, and unhealthy fats. As such, high levels of diet-related diseases, such as diabetes, obesity, and heart disease in the tribal community have the potential to continue in the long term (Norgaard 2004; Yurok Tribe 2006, Acton et al. 2003; CRIHB 2010; Trafzer and Weiner 2001, as cited in DOI 2012). For example, a host of physical ailments plaguing members of The Klamath Tribes have been linked to the demise of the aboriginal diet. Diabetes, hypertension, obesity, and related cardiovascular ailments are particularly widespread, reflecting dramatic changes in food consumption and procurement patterns (DOI 2012). Reduced tribal health would likely reduce social wellbeing of tribes because of increased sickness, disease, and stress.

In addition, aquatic resources are a critical component of traditional culture, and without any improvement to these resources, tribal members could continue to suffer from emotional and social health issues due to a loss of access to traditional resources required for continued ceremonial and cultural lifestyle and practices in the long term.

Additionally, the No Action/No Project Alternative would not result in short term concentrations of inorganic and organic contaminants at levels that adversely affect beneficial uses or are toxic to humans in the area of analysis. However, there is the potential for continued long term bioaccumulation of dioxins and DDT to occur (see Section 3.2, Water Quality, for additional bioaccumulation discussion). Therefore, under the No Action/No Project Alternative, long term improvements in tribal health and social well being would not likely occur.

3.16.4.2.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

Dam removal activities could affect fisheries and disproportionately affect tribal people. Dam removal would begin in 2020. Effects until the dams are removed would be similar to the No Action/No Project Alternative. Once complete, dam removal would improve anadromous fisheries in the Klamath River and help recovery of the endangered sucker fisheries. Restored fisheries would help reverse the environmental justice impacts to the tribes that the dams created. The tribes would be able to rely on the river to provide fish for subsistence and some tribes could resume commercial fishing operations to increase revenues. Section 3.15 describes the economic effects to tribes, including commercial fishing. The Sociocultural/Socioeconomics Effects Analysis Technical Reports (NOAA Fisheries Service 2012a-e) for each tribe also discuss potential economic effects of increased fishing for commercial and subsistence purposes. The tribes would also be able to perform cultural practices and ceremonies without restrictions because of increased fish populations. The Proposed Action would be a benefit relative to environmental justice compared to the No Action/No Project Alternative.

Increased air pollutants and noise associated with dam removal activities could disproportionately affect county residents and tribal people. Full removal of all Four Facilities would require a large amount of construction equipment and personnel. Construction crews would be housed in towns near the reservoirs and staging of

equipment would need to occur in the months leading up to the removal. The Proposed Action would require a build-up of equipment and personnel prior to reservoir drawdown and a post-construction period after the removal is complete. Equipment, personnel, and activities directly related to the drawdown and removal could be needed for months before and after actual dam removal. Temporary, short term air quality and noise impacts from deconstruction would occur (See Sections 3.9, Air Quality, and 3.23, Noise and Vibration) that would disproportionately affect Siskiyou and Klamath County residents and tribal people, which as a whole are low income relative to California and Oregon. Implementation of mitigation measures in Sections 3.9, Air Quality, and 3.23, Noise and Vibrations, would reduce the severity of these short term construction impacts. Environmental justice effects on county residents and tribal people from deconstruction would be greater under the Proposed Action relative to the No Action/No Project Alternative.

The traffic on the associated haul roads could disproportionately affect county residents and tribal people. The Proposed Action would require heavy equipment, such as large excavators, bulldozers, large dump trucks, cranes, and support equipment, to be brought to the construction area. Construction workers driving to and from the deconstruction area would also increase traffic along local roads. Section 3.22, Traffic and Transportation, identifies short term traffic impacts along haul roads that would occur as a result of deconstruction activities. These impacts include traffic flow and safety impacts. Residents in Siskiyou and Klamath Counties would be disproportionately affected by increased traffic on local roads during the construction period. Residents would be subject to short term impacts, such as increased congestion, potential traffic delays, slow moving trucks and potential safety hazards. Section 3.22, Traffic and Transportation, identifies measures to be taken to reduce traffic effects of the Proposed Action.

Tribes could be similarly affected by increased traffic. Figure 3.16-1 shows haul routes relative to tribal lands. The Klamath Tribes are the only tribe within relative distance to any of the identified haul routes; however, they are not within close enough proximity to cause a disproportionate effect. Section 3.22, Traffic and Transportation, identifies measures to be taken to reduce traffic effects of the Proposed Action. There would be no adverse environmental justice effects from traffic on tribes within the area of analysis.

Dam removal activities could provide jobs for county residents and tribal people that are low income and minority. Deconstruction activities would generate jobs in the area of analysis. Approximately 90 construction workers would be hired locally during peak deconstruction period and about 60 workers would be hired locally on average during the deconstruction period from Klamath or Siskiyou Counties. Increased employment would support low income individuals, resulting in a beneficial effect. This short-term benefit of the Proposed Action would be greater than under the No Action/No Project Alternative, which would not create any new jobs in the area of analysis.

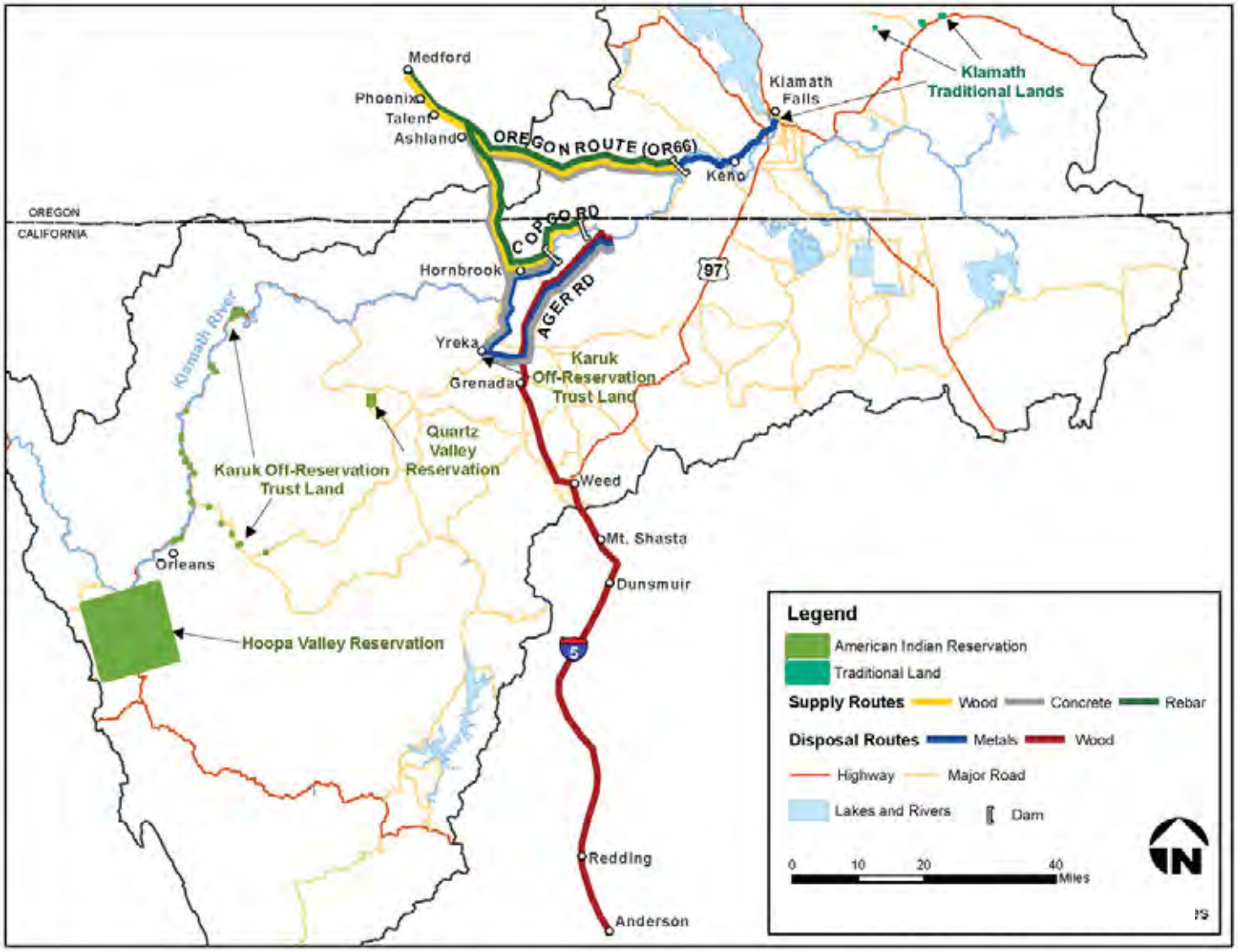

Figure 3.16-1. Tribal Lands near Haul Routes.

Section 3.15 estimates that approximately 49 jobs would be lost in the long term as a result of decreased annual operation and maintenance (O&M) from removal of the Four Facilities. These jobs losses would occur in Siskiyou and Klamath Counties. PacifiCorp may relocate employees to other jobs within the company. This would reduce some of the direct job losses as a result of the Proposed Action. Additionally, the Proposed Action would also create over 1,400 jobs within the two-county region related to short-term construction and more with KBRA implementation. These job creations would help offset losses related to O&M reductions.

Section 3.15 estimates that approximately 4 jobs related to reservoir recreation would be lost after dam removal. These jobs losses would occur in Siskiyou and Klamath Counties. As stated in the recreation section, there are multiple other recreation opportunities available within the region that could offer job opportunities, especially if visitors substitute recreation at these facilities and additional workers are needed to support new visitors. In addition, dam removal would create new recreation opportunities related to in-river sport fishing. The economic analysis estimates that approximately 3 new, long-term jobs would be created as a result of increased in-river fishing under the Proposed Action. Siskiyou County is also included in the economic region for in-river sport fishing. These new jobs would help offset the jobs lost related to reservoir recreation.

Section 3.15 also estimates that approximately 14 jobs related to whitewater boating would be lost after dam removal. The whitewater boating region (Jackson, Klamath, Siskiyou, and Humboldt Counties) supports about 5,762 jobs in the arts, entertainment, and recreation sector. Out of the total jobs in this particular job sector, the 14 jobs lost would represent approximately two-tenths of one percent (0.2 percent) of the job base.

Additionally, the loss in existing jobs would be offset by the more than 1,400 new jobs created during the decommissioning and deconstruction of the four dams. Given the location of the dams, the majority of that jobs creation would likely occur in Siskiyou County. Based on the above, the loss of jobs associated with the Proposed Action would not be a disproportionately high and adverse impact on low income populations.

Release of sediment from reservoirs could cause disproportionate short term impacts on county residents and tribal people. The Proposed Action would release sediment into the Klamath River during dam removal. Results from chemistry analysis and tests, discussed in Section 3.2, Water Quality, indicate that short term sediment release associated with the Proposed Action would not cause increases in concentrations of inorganic and organic contaminants that would adversely affect beneficial uses, be toxic to humans, or result in bioaccumulation in the Lower Basin. As such, county residents and tribal people would not be disproportionately affected by the release of sediment in the short term.

As described in Section 3.3, Aquatic Resources, the Proposed Action could reduce mussel populations in the short term as a result of sediment release. This would continue to affect subsistence for tribes that rely on freshwater mussels as a food source. Specifically, the Karuk Tribe depends on freshwater mussels for not only substance, but

also for cultural and economical value (DOI 2012). This would be a disproportionate adverse effect to the food source of tribal people in the short term. As described in Section 3.3, Aquatic Resources, implementation of Mitigation Measure AR-7 would reduce the short- and long-term effects of the Proposed Action on freshwater mussels. With implementation of Mitigation Measure AR-7 there would still be adverse affects on a portion of the freshwater mussel population and the disproportionate adverse effect to the food source of tribal people in the short term would be reduced but not completely avoided.

Dam removal activities could cause disproportionate long term water quality impacts on county residents and tribal people. Dam removal would begin in 2020. Effects until the dams are removed would be similar to the No Action/No Project Alternative. After dam removal, water quality would be expected to improve in the Hydroelectric Reach over the long term. Additionally, there would be long term beneficial effects on dissolved oxygen concentrations and decreased water temperatures downstream from Iron Gate Dam. Similar to improved fisheries, improved water quality would help reduce some of the environmental injustices that the dams have caused to Klamath Basin tribes. Improved water quality would further support restoration of anadromous and sucker fisheries, which would benefits tribes' cultural practices, subsistence, and economies. Based on proposed increased habitat availability and habitat quality, the Proposed Action would also have beneficial effects on mussels in the long term, further supporting subsistence for tribes. Reduced algal blooms would allow for contact recreation during the summer months, which would benefit tribes and county residents. The Proposed Action would be a benefit relative to environmental justice compared to the No Action/No Project Alternative.

Changes in county revenues associated with dam removal could decrease county funding of social programs. As described in Section 3.15, Socioeconomics, the Proposed Action could cause a short and long term decline in tax revenue to the counties associated with a discontinuation of tax revenue from PacifiCorp and a potential decrease in property values near the reservoirs. There could be an additional long term increase in property tax revenues resulting from increased property values near and adjacent to the Klamath River due to improved water quality. Counties use tax revenues to support programs for public health, public welfare, education and various other services. Decreases in tax receipts could reduce funding for these programs and adversely affect individuals in Siskiyou and Klamath Counties that rely on government support. Conversely increases in tax receipts could improve funding for these programs improving conditions for individuals in Siskiyou and Klamath Counties who rely on government support. It is speculative to quantify short- and long-term impacts on county social programs because many of these programs receive funding from the State and Federal Governments in addition to county funds. If funding to social programs is reduced, effects would disproportionately affect low income county residents.

Dam removal activities could disproportionately impact tribal health and social wellbeing in the long term. The Proposed Action would be beneficial to fall- and spring-run Chinook salmon, Coho salmon, and summer and winter steelhead, as described in

Section 3.3, Aquatic Resources, in the long term. Fish population increases would allow the tribes to increase subsistence fishing and once again make fish a larger component of their diet and ceremonies. Improved water quality would reduce effects to mussels, which could allow tribes to increase consumption of mussels. Consequently, they could rely less on store-bought and/or government-subsidized food (DOI 2012). In the long term, greater access to their traditional diet has the potential to positively affect the emotional, physical, and social health of the tribes (DOI 2012). Improved water quality and fish populations would also improve recreation on the Klamath River and potentially allow the Tribes to take advantage of potential recreation-tourism opportunities to improve economic welfare.

The increased flows in the Klamath River and increased fish populations could also allow ceremonies to become more relevant to younger tribe members, allow a greater sense of community within the tribe, and eventually positively affect the social wellbeing of the tribe. As such, implementation of the Proposed Action could beneficially affect tribal health in the long term. The Proposed Action could allow tribal people to gain increased self-reliance and self-sufficiency through increased subsistence and the restoration of the tribal commercial fishery.

Relocation of existing recreation facilities from the banks of the existing reservoirs down slope to the new river bed could disproportionately affect county residents or tribal people. Recreation facilities, such as campgrounds and boat ramps, currently located on the reservoir banks will need to be relocated down slope to be near the new river bed once the reservoir is removed. Impacts specific to the relocation of the recreation facilities are discussed in Section 3.20, Recreation. There would be no environmental justice impacts as a result of the relocation of the recreation facilities.

3.16.4.2.3 Keno Transfer

The Keno Transfer could have adverse effects on environmental justice issues. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the Bureau of Reclamation. This transfer would not result in the generation of new environmental justice effects impacts compared with existing facility operations. Following transfer of title, Bureau of Reclamation would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). Therefore, the Keno Transfer would have no effect on environmental justice.

East and Westside Facilities – Programmatic Measures

The East and Westside Facilities decommissioning could have adverse effects on environmental justice issues. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would stop diversions of water flows at Link River Dam into the two canals, back in to Link River. Following decommissioning of the facilities there would be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. Therefore, the decommissioning of these facilities would have no effect on environmental justice issues.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The installation of the City of Yreka Water Supply Pipeline could disproportionately affect county residents or tribal people. The existing water supply pipeline for the City of Yreka would be relocated prior to the decommissioning of the Iron Gate Reservoir. This relocation effort would not require major construction efforts and would not disproportionately impact tribes or county residents. There would be no environmental justice impacts as a result of the City of Yreka Water Supply Pipeline relocation.

KBRA – Programmatic Measures

The KBRA has several programs that could disproportionately affect low income and minority populations. Specific KBRA programs potentially affecting environmental justice include:

- Phases I and II Fisheries Restoration Plans
- Fisheries Monitoring Plan
- Fisheries Reintroduction and Management Plan
- Water Use Retirement Program
- Interim Flow and Lake Level Program
- Tribal Fisheries and Conservation Management Program
- Tribal Programs Economic Revitalization
- Klamath River Tribes Interim Fishing Site
- Mazama Forest Project
- Klamath County Economic Development Plan
- California Water Bond Legislation

Implementation of the Phases I and II Fisheries Restoration Plans, the Fisheries Monitoring Plan, the Fisheries Reintroduction and Management Plan, and the Klamath River Tribes Interim Fishing Site could disproportionately affect tribal populations. The Fishery Programs of the KBRA include restoration, monitoring, and reintroduction projects. Similar to dam removal, projects under the Fishery Programs would help restore anadromous fisheries and the sucker fishery in the Klamath Basin. Additionally the improvements in anadromous fisheries and the sucker fishery generated by the restoration, monitoring, and reintroduction projects would contribute to the effects of hydroelectric facility removal analyzed above. Tribes would be able to fish for cultural, subsistence, and commercial purposes similar to condition before the dams were installed. Fisheries restoration would help reverse past environmental injustices to the tribes.

Implementation of the Water Use Retirement Program and Interim Flow and Lake Level Program could disproportionately affect low income and minority farm workers. The KBRA proposes voluntary land fallowing and permanent water right sales which could disproportionately affect farm workers in Klamath, Siskiyou and Modoc Counties. Loss of farm labor jobs could disproportionately affect low-income, minority farm workers, who could lose a portion of their income if farms no longer required their labor. This would be a disproportionate effect on farm workers. Actions associated with hydroelectric facilities removal would not be expected to generate any farm labor jobs

and would not be expected to contribute to this short term disproportionate effect. The loss of farm jobs as a result of voluntary land fallowing and permanent water right sales would not be influenced by hydroelectric facility removal above given that facility removal does not affect irrigated agriculture and would not cause any farm job losses.

However, the core of the KBRA is to provide water reliability to farmers, which would ensure continuation of agricultural jobs in the area of analysis. In the long term, the KBRA has the potential to offset the loss of agricultural jobs and would not result in a long term environmental justice issue for farm workers.

Implementation of the Tribal Fisheries and Conservation Management Program could disproportionately affect the tribes. Implementation of the Tribal Fisheries and Conservation Management Program would provide funding to assist the tribes in developing their capacity to participate in resource management activities within the Klamath Basin, particularly relating to tribal fishing and revitalization of tribal subsistence and other economic activities. The program would provide job opportunities to tribal members, which could help reduce unemployment and increase income. Fisheries and conservation projects would also support fisheries restoration to increase fish abundance. Restored fisheries would help reverse the environmental justice impacts to the tribes that the dams created. The tribes would be able to rely on the river to provide fish for subsistence and some tribes could resume commercial fishing operations to increase revenues. The tribes would also be able to perform cultural practices and ceremonies without restrictions. The timing of and specific locations where these resource management actions could be undertaken is not certain but they would contribute to environmental justice benefits related to hydroelectric facility removal. This would benefit tribes relative to environmental justice.

Implementation of the Tribal Programs Economic Revitalization could disproportionately affect the tribes. This action includes funding for the Klamath, Karuk, and Yurok Tribes to develop economic revitalization plans, programs and projects. Implementation of the plan could potentially increase jobs and income for the Tribes. This would help reduce high poverty and unemployment rates among the Tribes. The timing of and specific locations where these economic revitalization plans, programs and projects could be undertaken is not certain but the improvements they are anticipated to support relative to environmental justice would contribute to the positive effects of hydroelectric facility removal. This would be a benefit relative to environmental justice.

Implementation of the Mazama Forest Project could disproportionately affect the tribes. The Mazama Forest Project would transfer 90,000 acres of privately owned timberland, which were formerly owned by the Klamath Tribes, back to the Klamath Tribes(Chui 2008; Kerr 2012). With ownership of the lands, the tribe could hunt, harvest timber, or use the land for other purposes. The improvement in environmental justice generated by the Mazama Forest Project would contribute to the effects of hydroelectric facility removal. This would be a beneficial effect to the Klamath Tribes relative to environmental justice concerns.

Implementation of the Klamath County Economic Development Plan could disproportionately affect low income and minority people in Klamath County. This action would provide $3.2 million of funding to Klamath County. Funding would support long-term economic growth in Klamath County and could create new job opportunities and improve public programs for county residents. The improvement in environmental justice generated by the Klamath County Economic Development Plan would contribute to the effects of construction activities associated with the hydroelectric facility removal activities. Depending on how funding is used within the county, this action could benefit low income and minority populations.

Implementation of the California Water Bond Legislation could disproportionately affect low income and minority people in Siskiyou County. If approved, bond funds would provide $20 million to Siskiyou County to use for economic development. It cannot be determined at this time how Siskiyou would distribute funds from the California Water Bond Legislation; this is a general discussion. The bond funds could assist Siskiyou County in addressing unemployment, poverty, bankruptcy, and social problems and continuing funding for other county programs. The improvement in environmental justice generated by the California Water Bond Legislation would contribute to the effects of construction activities associated with the hydroelectric facility removal activities. Programs could benefit low income and minority populations in Siskiyou County.

3.16.4.2.4 Alternative 3: Partial Facilities Removal of Four Dams

Short and long term impacts under the Partial Facilities Removal of Four Dams Alternative would be the same as those described under the Full Facilities Removal Alternative. This alternative would include the full implementation of the KBRA, the Keno Transfer, the East and Westside Facilities decommissioning, and the City of Yreka Water Supply Pipeline relocation. Environmental justice effects of KBRA would be the same as described for the Proposed Action.

3.16.4.2.5 Alternative 4: Fish Passage at Four Dams

This alternative does not include implementation of the KBRA.

Fish passage at the four dams could affect fisheries and disproportionately affect tribal people. Tribes would benefit from increased anadromous and native fish populations as a result of this alternative. Restored fisheries would help reverse the environmental justice impacts to the tribes that the dams created. This alternative would not result in disproportionate effects to tribal people relative to the No Action/No Project Alternative.

Increased air pollutants and noise associated with fish passage construction activities could disproportionately affect county residents and tribal people. Environmental justice impacts to county residents and tribal people associated with increased air pollutants associated with dam removal would be similar to those discussed under the Proposed Action. Environmental justice impacts on county residents and tribal people would be greater under the Fish Passage at Four Dams Alternative relative to the No Action/No Project Alternative.

The traffic on the associated haul roads could disproportionately affect county residents and tribal people. Environmental justice impacts to county residents or tribal people associated with traffic on associated haul roads would be similar to those discussed under the Proposed Action. Fish Passage at Four Dams Alternative would not result in adverse long term environmental justice impacts from traffic on county residents or tribes within the area of analysis.

Construction of fish passage could provide jobs for county residents and tribal people that are low income and minority. Construction activities would generate jobs in the area of analysis. Increased employment would support low income individuals, resulting in a beneficial effect. This short-term benefit to low income and minority populations of the Fish Passage at Four Dams Alternative would be greater than under the No Action/No Project Alternative.

Continued impoundment of water at the reservoirs could cause disproportionate long term water quality impacts on county residents and tribal people. Environmental justice impacts to county residents and tribal people associated with continued impoundment of water at the reservoirs causing disproportionate long-term water quality impacts would be similar to those discussed under the No Action/No Project Alternative. Fish Passage at Four Dams would degrade water quality for aquatic species that provide subsistence or commercial fishing revenues for tribes, and would continue to create disproportionate effects and environmental justice concerns on the tribes in the Klamath Basin.

Changes in county revenues could decrease county funding of social programs used by county residents. Environmental justice impacts to county residents associated with county revenues and funding for social programs would be similar to those discussed in the No Action/No Project Alternative. Fish Passage at Four Dams would not create short or long term changes to property values or local tax revenues relative to the No Action/No Project Alternative, thus county residents would not be disproportionately affected.

Fish passage and continued impoundment of water could disproportionately impact tribal health and social wellbeing in the long term. Fish passage would increase fish abundance for tribes to practice cultural traditions and to catch fish for commercial and subsistence purposes. Fish passage would improve tribal health and social wellbeing relative to the No Action/No Project Alternative. However, continued impoundment of water under the Fish Passage at Four Dams Alternative would not improve water quality in the long term, which would result in ongoing effects to fish, mussels, and habitat. Continued impoundment of water in the reservoir would not improve tribal health and social well being. Therefore, fish passage combined with continued impoundment of water would continue existing environmental injustices to the tribes and the tribes would continue to be disproportionately affected relative to the No Action/No Project Alternative.

3.16.4.2.6 Alternative 5: Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

This alternative does not include implementation of the KBRA. This alternative includes the City of Yreka Water Supply Pipeline relocation; effects of this action would be the same as the Proposed Action.

Dam removal activities could affect fisheries and disproportionately affect tribal people. Tribes would benefit from increased anadromous and native fish populations as a result of this alternative. Restored fisheries would help reverse the environmental justice impacts to the tribes that the dams created. This alternative would not result in disproportionate effects to tribal people relative to the No Action/No Project Alternative.

Increased air pollutants and noise associated with fish passage and dam removal activities could disproportionately affect county residents and tribal people. Environmental justice impacts to county residents and tribal people associated with increased air pollutants associated with dam removal would be similar to those discussed under the Proposed Action. Environmental justice impacts on county residents and tribal people would be greater under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative relative to the No Action/No Project Alternative.

The traffic on the associated haul roads could disproportionately affect county residents and tribal people. Environmental justice impacts to county residents or tribal people associated with traffic on associated haul roads would be similar to those discussed under the Proposed Action. Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would not result in adverse long term environmental justice impacts from traffic on county residents or tribes within the area of analysis.

Construction of fish passage could provide jobs for county residents and tribal people that are low income and minority. Construction activities would generate jobs in the area of analysis. Increased employment would support low income individuals, resulting in a beneficial effect. This short-term benefit to low income and minority populations of the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would be greater than under the No Action/No Project Alternative.

Continued impoundment of water at the reservoirs could cause disproportionate long term water quality impacts on county residents and tribal people. Section 3.2, Water Quality, concludes that continued impoundment of water under the Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would result in similar water quality effects as the Proposed Action. This alternative would not result in disproportionate effects to tribal people and county residents relative to the No Action/No Project Alternative.

Changes in county revenues could decrease county funding of social programs used by county residents. Environmental justice impacts to county residents or tribal people associated with changes in county revenues associated with dam removal would be the

same as discussed under the Proposed Action. Fish Passage at Two Dams, Remove Copco 1 and Iron Gate Alternative would disproportionately affect low income county residents, if funding to social programs is reduced.

Fish passage and continued impoundment of water could disproportionately impact tribal health and social wellbeing in the long term. Fish passage would increase fish abundance for tribes to practice cultural traditions and to catch fish for commercial and subsistence purposes. Fish passage would improve tribal health and social wellbeing relative to the No Action/No Project Alternative. However, continued impoundment of water under the Fish Passage at Four Dams Alternative would not improve water quality in the long term, which would result in ongoing effects to fish, mussels, and habitat. Continued impoundment of water in the reservoir would not improve tribal health and social well being. Therefore, fish passage combined with continued impoundment of water would continue existing environmental injustices to the tribes and the tribes would continue to be disproportionately affected relative to the No Action/No Project Alternative.

3.16.4.3 Mitigation Measure Analysis

3.16.4.3.1 Mitigation Measure by Consequence Summary

Implementation of mitigation measures in Section 3.9, Air Quality, and Section 3.23, Noise and Vibration, would reduce environmental justice effects related to construction.

3.16.4.4 Mitigation Measures Associated with other Resources

Mitigation measure REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. These developments would take place on lands that are currently inundated and would not create environmental justice issues for tribal members or farm workers. There would be no impact to environmental justice as a result of implementing REC-1.

3.16.4.5 Summary of Beneficial Effects

Table 3.16-11 summarizes the beneficial effects of the Proposed Action and alternatives.

Table 3.16-11. Beneficial Effects of the Proposed Action and Alternatives

Effect	Alternatives				
	1	2	3	4	5
Dam removal could improve fisheries and benefit tribes' cultural practices, subsistence and commercial fishing	NE	B	B	B	B
Construction could create jobs for county residents and tribal people	NE	B	B	B	B
Dam removal could reverse long term water quality impacts on tribal people	NE	B	B	NE	B (partial)
Dam removal could decrease disproportionate effects to tribal health and social well being	NE	B	B	NE	B (partial)
Fisheries restoration could improve fisheries and benefit tribes' cultural practices, subsistence and commercial fishing	NE	B	B	NE	NE
Improve water supply reliability to agriculture could increase farm revenues	NE	B	B	NE	NE
Funding to Klamath and Siskiyou Counties could improve county economic and social conditions	NE	B	B	NE	NE
Funding to tribes for conservation management, fisheries management, and economic revitalization would improve economic and social conditions of tribes	NE	B	B	NE	NE

Key:
Alternative 1 = No Action/No Project Alternative
Alternative 2 = Full Facilities Removal of Four Dams (Proposed Action)
Alternative 3 = Partial Facilities Removal of Four Dams Alternative
Alternative 4 = Fish Passage at Four Dams Alternative
Alternative 5 = Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative
B = Beneficial
NE = No effect

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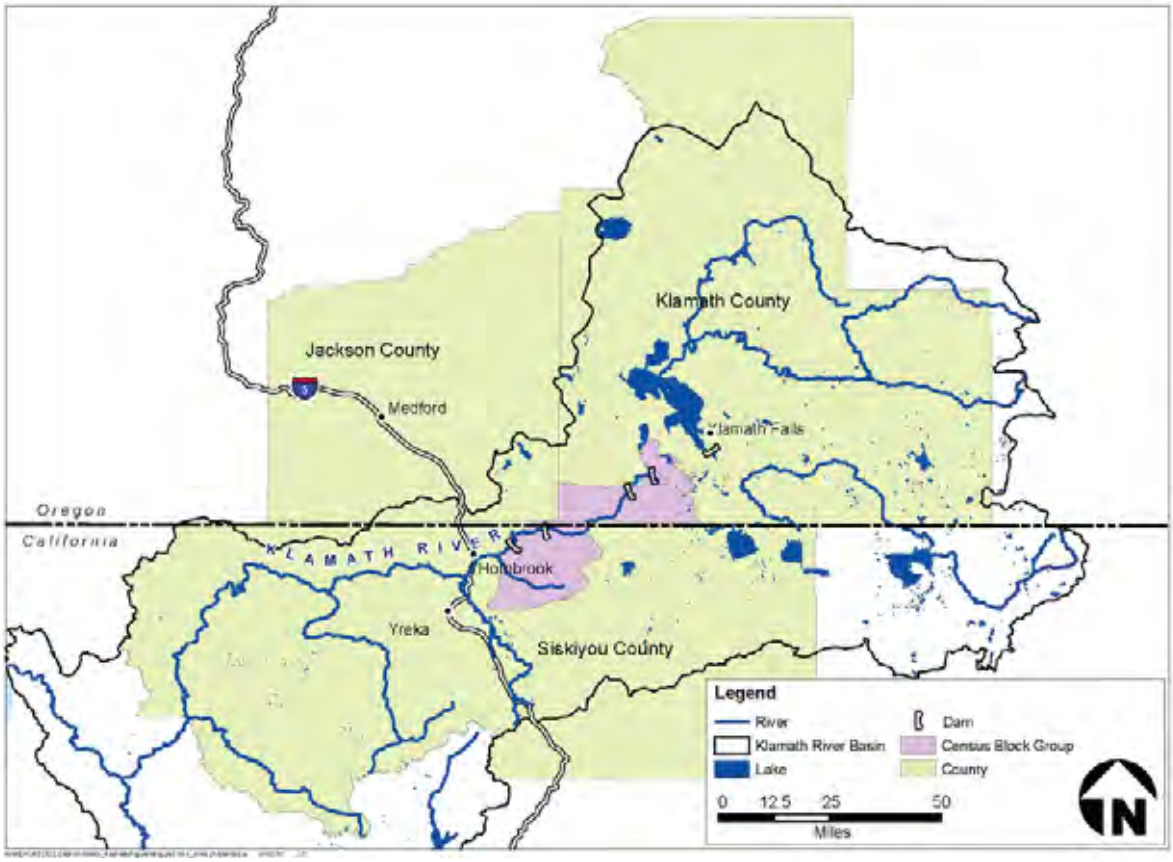
3.17 Population and Housing

The population and housing section of the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) assesses the potential effects of the temporary worker population required for construction activities of the Proposed Action and action alternatives on housing in the Klamath Basin. The effect of the Klamath Hydroelectric Settlement Agreement (KHSA) on population and housing is determined by comparing projected housing needs with projected housing availability. No displacement of existing housing units would be anticipated from any of the alternatives. This analysis uses data from the U.S. Census, county and city plans, and other sources for projected housing availability.

No impacts on population and housing are anticipated as a result of the transfer of Keno Dam's ownership to the Department of the Interior (DOI). Potential relocation of PacifiCorp employees as a result of the alternatives is not discussed in the population and housing section. This effect to PacifiCorp employees is not anticipated to take place until 2020 and would be at the discretion of PacifiCorp. Thus, any impact is too speculative to evaluate at this time. The population and housing section of this EIS/EIR does not discuss relocation of PacifiCorp employees that would occur as a result of the alternatives. As described in Section 3.15, Socioeconomics, dam removal could result in the loss of PacifiCorp jobs. It is assumed that PacifiCorp may transfer some employees to other positions within or outside of Klamath and Siskiyou Counties. This section also excludes discussion of potential indirect economic impacts that the alternatives could have on population and housing, as any such discussion would be speculative. For an assessment of potential effects on property values and employment resulting from the alternatives, see Section 3.15, Socioeconomics.

3.17.1 Area of Analysis

The area of analysis for the population and housing section consists of communities with the potential to house workers migrating into the area for construction activities of the action alternatives. The area of analysis includes a combination of urban and rural communities: Hornbrook and the City of Yreka in California and Klamath Falls and Medford in Oregon. The area of analysis also includes the residential rural areas immediately near the Copco 1 and 2 Dams and just upstream of the J.C. Boyle Dam. The Lead Agencies analyzed these communities for their potential to temporarily house workers using California Department of Finance housing and population data where available, in addition to city level and Census Block Group level 2010 U.S. Census data (U.S. Census Bureau 2010a – 2010d) and 2008-2010 American Community Survey (ACS) data (U.S. Census Bureau 2010e; 2010f), and county and city plans where available. Table 3.17-1 lists all communities included in the population and housing area of analysis. Figure 3.17-1 depicts the counties and cities/communities within the analysis scope.



Source: U.S. Census Bureau, Geography Division, 2010Census Block Groups [computer file]. Washington, DC.

Figure 3.17-1. Population and Housing Area of Analysis.

Table 3.17-1. Cities Included for Analysis

Community	County	State
City of Yreka	Siskiyou	CA
Hornbrook	Siskiyou	CA
Siskiyou County Unincorporated Areas	Siskiyou	CA
Klamath County Unincorporated Areas	Klamath	CA
Klamath Falls	Klamath	OR
Medford	Jackson	OR

3.17.2 Regulatory Framework

Regulations at the Federal, State, and local levels regarding housing are generally concerned with the proper construction, provision, and siting of housing for a variety of

incomes. Neither the Proposed Action nor other alternatives call for the construction of new homes, or the demolition of existing homes, and therefore the regulations pertaining to housing do not apply.

3.17.3 Existing Conditions/Affected Environment

The affected environment for population and housing reflects the existing populations and housing conditions within the area of analysis. This section presents the available data on population characteristics, including trends in in-migrations and demographics. The housing characteristics presented indicate the overall economic health of the housing market in the area of analysis, which helps assess the capacity for communities in the area of analysis to accommodate population growth that could result from the alternatives. This section presents demographic and housing information from the U.S. 2010 Census at the city and Census block group level, and from the ACS at the county and State level. While more recent data is available for many locales, the 2010 Census dataset remains the most comprehensive data available at the community level for all cities in the area of analysis. More recent data, where available, are included in the discussions.

This discussion presents data for all Census-designated communities and counties included in the area of analysis by county. Unincorporated areas near the dams are discussed separately. Demographic, economic and housing data are discussed on a community, county and State level. County sections include Siskiyou County in California and Klamath and Jackson Counties in Oregon.

3.17.3.1 Klamath County, Oregon

Klamath County is in the area of analysis because the unincorporated area near J.C. Boyle Dam and Klamath Falls could temporarily house workers needed for construction associated with the alternatives. The City of Klamath Falls data are presented along with data for Klamath County. Data representing the unincorporated area near J.C. Boyle Dam, which includes the community of Keno, a small unincorporated community approximately 12 miles upstream of the J.C. Boyle Reservoir, are discussed in Section 3.17.3.4. While Keno lies within Klamath County, the data are presented separately because it represents a non-census designated community.

According to the 2009 Klamath Falls Economic Opportunities Analysis (Johnson and Gardner 2009), about two thirds of Klamath County's population is within the Klamath Falls Urban Growth Boundary (UGB). Klamath Falls proper (not including rural areas in the UGB) is a city of almost 21,000 people. Housing statistics presented in this section for Klamath Falls *exclude* the unincorporated areas in the Klamath Falls UGB. Including the unincorporated areas in the UGB approximately doubles the total population of Klamath Falls. Klamath County's annual average unemployment rate in 2009 was 13.9 percent (Bureau of Labor Statistics (BLS) 2011a).

3.17.3.1.1 Demographic Data

Klamath County age demographics are consistent with the State of Oregon. In Klamath County, 25.2 percent of the population was under 19 years of age according to the U.S. 2010 Census, and 46.4 percent is over 45. Similarly, in the State of Oregon 25.4 percent of the population was below 19 years of age, with 41.2 percent over 45.

3.17.3.1.2 Housing Data

The U.S. 2010 Census reported 32,774 housing units in Klamath County with 83 percent occupied and 17 percent vacant. In Klamath Falls proper, 104 out of 1,053vacant units were for seasonal use in the 2010 Census. Table 3.17-2 contains housing estimates for Klamath Falls and Klamath County. The ACS estimates that median monthly rent in Klamath Falls and Klamath County was $706, from 2008 to 2010.

Table 3.17-2. Klamath Falls and County Housing Estimates, 2010

	Klamath Falls		Klamath County	
	Estimate	**Percent**	**Estimate**	**Percent**
Total Housing Units	**9,595**		**32,774**	
Occupied Housing Units	8,542	89.0%	27,280	83.2%
Owner-Occupied	4,076	47.7%	18,037	66.1%
Renter-Occupied	4,466	52.3%	9,243	33.9%
Vacant Housing	1,053	11.0%	5,494	16.8%

Source: U.S. Census Bureau, 2010b.
Summary File 1, Tables H3, H4, H5 and HCT1

3.17.3.2 Jackson County, Oregon

The City of Medford could temporarily house workers needed for construction associated with the alternatives. Medford's estimated population was 74,907 in 2010 (U.S. Census Bureau 2010d). This population estimate accounts for more than a third of the population of Jackson County. The City of Ashland is not explicitly included in the area of analysis due to uncertainties of housing availability during the Ashland Shakespeare Festival's peak season in the summer and early fall (Oregon Shakespeare Festival 2011); however, it is possible that some workers could find housing in Ashland, as well.

The Medford Metropolitan Statistical Area had an unemployment rate of 11.6 percent in December 2009 (BLS 2011b). Jackson County's annual average unemployment rate in 2009 was only 6.7 percent (BLS 2011b).

3.17.3.2.1 Demographic Data

Like Klamath County and Oregon overall, Jackson County has a high older age population. According to the U.S. 2010 Census, 46.7 percent of the population in Jackson County was reported as over the age of 45. Only 24.4 percent of the popultation in Jackson County is under 19 years of age.

3.17.3.2.2 Housing Data

According to the ACS, housing units in Medford increased by approximately 2,400 units between 2005 and 2010; however, there is still a shortage of affordable housing in Medford (City of Medford 2010). The city is composed of mostly single-family housing, with pockets of higher density and multi-family units. A walk-by was completed in 2004 (City of Medford 2010). There are neighborhoods in Medford with more than 50 percent renter-occupied units. The 2010 Census reports a housing vacancy rate in Medford of 7.2 percent, but in 2007, the vacancy rate was only 2.7 percent (City of Medford 2010). Table 3.17-3 contains housing estimates for Medford and Jackson County.

Table 3.17-3. Medford and Jackson County Housing Estimates, 2010

	Medford		Jackson County	
	Estimate	Percent	Estimate	Percent
Total Housing Units	**32,430**		**90,937**	
Occupied Housing Units	30,079	92.8%	83,076	91.4%
Owner-Occupied	16,606	51.9%	52,045	62.6%
Renter-Occupied	14,473	48.1%	31,031	37.4%
Vacant Housing	2,351	7.2%	7,861	8.6%

Source: U.S. Census Bureau, 2010b.
Summary File 1, Tables H3, H4, H5, and HCT1.

There is a lack of affordable housing in the City of Medford, which contributes to an elevated homelessness rate (City of Medford 2010). According to the ACS, approximately 61 percent of all renters in Medford were cost-burdened, defined as paying more than 30 percent of household income on housing (U.S. Census Bureau, 2010f). The median monthly rent in Medford was 796 dollars, compared with 706 dollars in Klamath Falls. Barriers to developing affordable housing in Medford include permitting constraints, lack of land properly zoned for low-income housing, development codes that discourage mixed-use development, among others (City of Medford 2010).

3.17.3.3 Siskiyou County, California

Siskiyou County data is presented along with data for the City of Yreka and the community of Hornbrook. The City of Yreka and Hornbrook could temporarily house workers required for construction associated with the alternatives. Section 3.17.3.4 covers other unincorporated residential areas near the dams. While the residential area surrounding Copco 1 Reservoir, referred to as Copco Village, lies within Siskiyou County, Census Block Group Data more specifically representing Copco Village is presented separately (see Section 3.17.3.4) because it represents a non-census designated community.

According to the U.S. 2010 Census, the City of Yreka was a city of nearly 7,800 people, and Hornbrook was a community of approximately 250. Siskiyou County's annual

average unemployment rate in 2009 was 14.8 percent, higher than either Klamath or Jackson Counties (BLS 2011a).

3.17.3.3.1 Demographic Data

Similar to Jackson and Klamath Counties, Siskiyou County has a high older population. According to the U.S. 2010 Census, Siskiyou County had a population where almost 53 percent were over 45 years of age. , Approximately 54 percent of Hornbrook's population and approximately 47 precent of the City of Yreka's population was over 45 years old.

3.17.3.3.2 Housing Data

Table 3.17-4 shows housing and occupancy estimates for Siskiyou County. Siskiyou County's overall vacancy rate (18.4 percent) is slightly higher than Klamath County (16.8 percent) and much higher than Jackson County (8.6 percent). Hornbrook has a high vacancy rate, at 30.8 percent, out of 156 total units in 2010. However, because the absolute number of housing units in Hornbrook is so small (156), the total number of vacant units (48) is also small. The City of Yreka and its surrounding area has a relatively low housing availability; according to the U.S. 2010 Census, only 119 housing units were available for rent in the City of Yreka. Siskiyou County's gross vacancy rate in 2010 was 18.4 percent and the City of Yreka's gross vacancy rate was 7.6 percent (U.S. Census Bureau 2010b).

Table 3.17-4. Siskiyou County Housing Estimates, 2010

	Hornbrook		City of Yreka		Siskiyou County	
	Number	**Percent**	**Number**	**Percent**	**Number**	**Percent**
Total Housing Units	**156**		**3,675**		**23,910**	
Occupied Housing Units	108	69.2%	3,394	92.4%	19,505	81.6%
Owner-Occupied	72	66.7%	1,751	51.6%	12,629	64.7%
Renter-Occupied	36	33.3%	1,643	48.4%	6,876	35.3%
Vacant Housing	48	30.8%	281	7.6%	4,405	18.4%

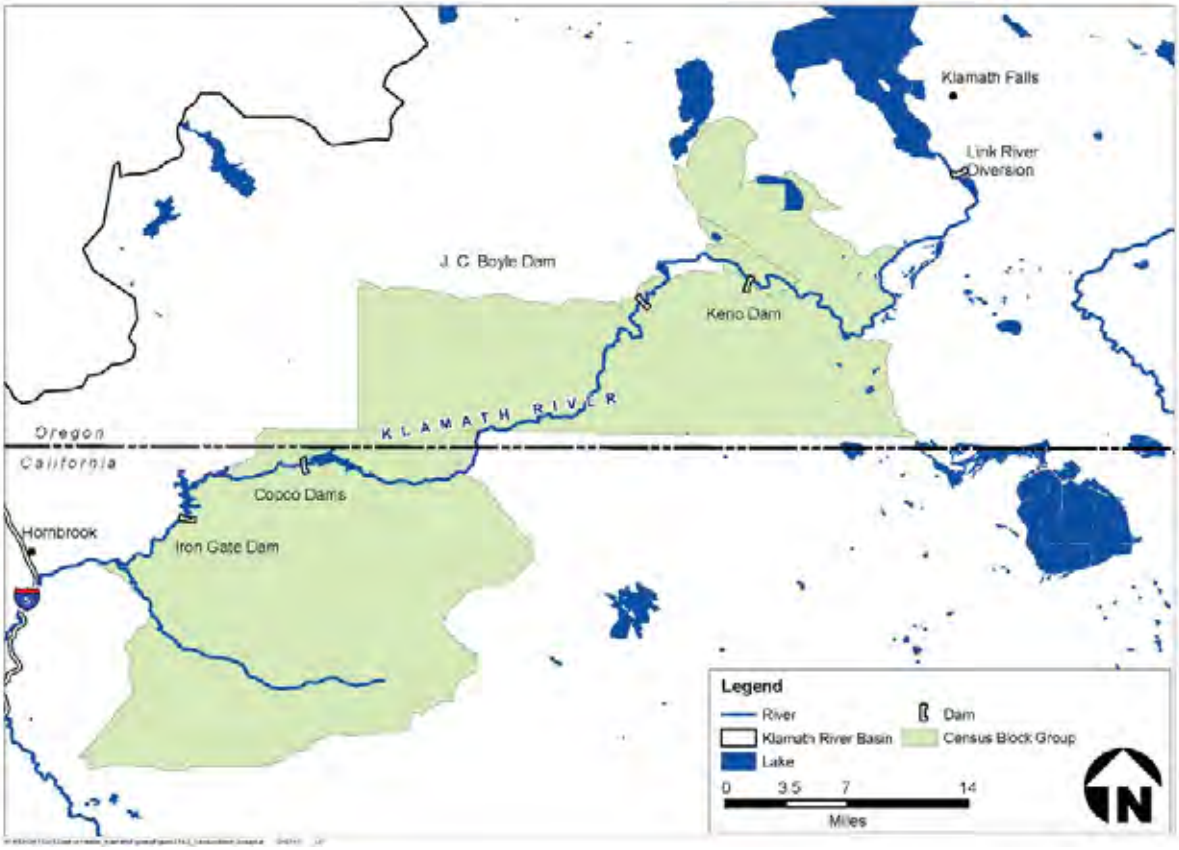
Source: U.S. Census Bureau, 2010b
Summary File 1, Tables H3, H4, H5, and HCT1.

The Yreka Housing Element reports 2008 rental costs ranging from $525 to $900 per month (City of Yreka 2009). According to the 2006-2010 American Community Survey 5-year estimate, the median rent in the City of Yreka was $841 (U.S. Census Bureau 2010e).

3.17.3.4 Unincorporated Areas

The unincorporated areas discussed in this section represent Keno (12 miles from Klamath Falls) and the residential areas surrounding Copco 1 Reservoir (26 miles from the City of Yreka). These two communities are closest to the Four Facilities, and could have possible housing impacts from worker displacement. The affected environment for Keno is presented as a compilation of the U.S. 2010 Census results from Oregon Census Tract 9703, Block Groups 2, 3, and 4. Because these block groups include Keno and its

surrounding area, this discussion refers to them as the Klamath unincorporated area. The Copco 1 Reservoir Area is described using U.S. 2010 Census results from California Census Tract 3, Block Group 1. Because this block group encompasses not only the residential area around Copco 1 Reservoir, but also other unincorporated areas around the Iron Gate Dam and surrounding areas, including the communities of Ager and Logan, this block group is referred to as the Siskiyou unincorporated area. The geographic areas encompassed by these census block groups are shown in Figure 3.17-2.



Source: U.S. Census Bureau, Geography Division, 2010Census Block Groups [computer file]. Washington, DC.

Figure 3.17-2. Census Block Groups.

3.17.3.4.1 Demographic Data

U.S. 2010 Census demographic data on age was not yet available at the block group level at the time of the writing of the EIS/EIR; therefore, U.S. 2000 Census data was used for this anaylsis.According to the U.S. 2000 Census, both the Oregon and California unincorporated areas have large populations over 45 years in age. In the

Klamath unincorporated area, 44 percent of the population is over 45 years of age, and in the Siskiyou unincorporated area 49 percent of the population is over 45 years of age.

3.17.3.4.2 Housing Data

Table 3.17-5 contains housing estimates for the unincorporated areas. The Siskiyou unincorporated area vacancy rate in 2010 was fairly large (24.6 percent, or 226 units). The vacancy rate in the Klamath unincorporated area was much lower, at 9.6 percent or 110 units.

Table 3.17-5. Unincorporated Areas Housing Estimates, 2010

	Siskiyou Unincorporated Area		Klamath Unincorporated Area	
	Estimate	Percent of Total	Estimate	Percent of Total
Total Housing Units	**918**		**1,144**	
Occupied Housing Units	692	75.4%	1,034	90.4%
Owner-Occupied	552	79.8%	881	85.2%
Renter-Occupied	140	20.2%	153	14.8%
Vacant Housing	226	24.6%	110	9.6%

Source: U.S. Census Bureau, 2010b. Summary File 1

3.17.4 Environmental Consequences

3.17.4.1 Effects Determination Methods

This analysis used both qualitative and quantitative methods to determine the effects that implementation of the alternatives would have on population and housing. Significance criteria were used to qualitatively assess the impacts of each alternative. Effects considered for this resource area would be related to availability of housing for non-local construction workers and whether the use of housing by construction workers would impact the local housing market. Implementation of the alternatives would not require any land acquisition that would require housing units to be relocated. The project description includes preliminary estimates of the numbers of workers required for construction actions. This analysis compared the housing needs associated with these workers with existing demographics and housing statistics described in the Affected Environment.

3.17.4.2 Significance Criteria

Significant impacts on population and housing would result if the project resulted in substantial population growth in the area of analysis. For the purposes of this EIS/EIR, population growth in a community is “substantial” if it would result in housing needs exceeding the number of housing units projected to be available and affordable.

3.17.4.3. Effects Determinations

This section presents the effects of each of the alternatives on population and housing. For all alternatives except for the No Action/No Project Alternative, some level of construction or deconstruction would be involved at all Four Facilities. Construction labor would require up to 250 workers during the peak construction period. As described in Section 3.15, Socioeconomics, peak construction at J.C. Boyle, Copco 2, and Iron Gate Facilities generally overlap; peak construction at the Copco 1 Facility would occur separately. Peak number of workers required to implement the alternatives range from 175 to 195 workers at one time for Copco 1, Copco 2 and Iron Gate Dams (in California), and from 30 to 55 workers at one time for J.C. Boyle Dam (in Oregon). Potential mitigation measures increase these estimates by as much as 20 workers. Workers that could not be provided by the local communities would need to commute from a near-by community, either a more rural, unincorporated community such as Keno or Hornbrook, or a more urban area such as the City of Yreka, Medford, or Klamath Falls. Table 3.17-6 lists approximate travel distances to the dams from each of these communities for the J.C. Boyle Dam. For the Copco 1, Copco 2, and Iron Gate Dams, the City of Yreka and Medford are communities that might house workers, along with Hornbrook and the rural areas immediately around Copco 1 Reservoir. The capacity of each of these communities to house the workers needed for each of the alternatives is discussed below.

It is likely that some of the workforce required for the deconstruction alternatives could be satisfied with local residents; however, some non-resident workers are likely to be necessary for specialized tasks. Section 3.15, Socioeconomics, assumes that about 90 percent of the unskilled labor and 20 percent of the skilled labor could be supplied locally from Klamath and Siskiyou Counties during peak construction (approximately 98 workers). The remaining approximate 150 workers needed during peak construction would have to be brought into Klamath and Siskiyou Counties. During non-peak construction, all unskilled as well as skilled workers could be provided locally. It is further assumed that one housing unit would be required per non-local worker.

Table 3.17-6. Approximate Commute Distances[1] (miles)

	Klamath Falls	Medford	City of Yreka	Hornbrook	Keno
J.C. Boyle	20	55	70	55	8
Copco 1 & 2	50	50	27	21	40
Iron Gate	60	44	22	8	50

[1] Distances were approximated using Google Maps, and are only accurate to within 5 miles.

There are a limited number of PacifiCorp-owned housing units at the dam sites. Because the noise analysis in this EIS/EIR estimates high noise levels at these housing facilities resulting from the alternatives (see Section 3.23, Noise and Vibration), these facilities are not included as potential housing sources for the population and housing section.

It is assumed that relocation of the City of Yreka's water supply pipeline and new construction or demolition of recreation facilities would occur during non-peak construction (before and after dam deconstruction activities, respectively). Therefore, the workers required for these construction activities would not add to the peak housing needs in Klamath and Siskiyou Counties. Additionally, the number of workers required to complete these construction activities would be less than the peak number required for implementation of the action alternatives. Thus, it is assumed that the housing units described in the analysis of the action alternatives would accommodate workers necessary for water supply pipeline relocation and relocation or demol**ition of recreation facilities.**

3.17.4.3.1 Alternative 1: No Action/No Project Alternative

Under the No Action/No Project Alternative, there would be no change to the Four Facilities and associated facility operations and no impacts on population and housing. The No Action/No Project Alternative would not result in construction activities taking place at the sites of the Four Facilities. There would be no influx of temporary workers and no impacts on population and housing. Population and housing would follow current trends. **There would be no change from existing conditions to population and housing under the No Action/No Project Alternative.**

Ongoing Resource Management Actions

Ongoing resource management actions and programs would continue to take place under the No Action/No Project Alternative. Construction, implementation, and monitoring activities associated with these ongoing activities could result in increases in new jobs throughout the Klamath Basin and a demand for more workers.

Ongoing actions considered for impact to population and housing under the No Action/No Project Alternative include:

- Fish Habitat Restoration
- Williamson River Delta project
- Agency Lake and Barnes Ranches project

Construction, restoration, and monitoring activities associated with ongoing activities could create new jobs and could employ non-local workers, who would need housing for the duration of their employment. Construction activities necessary for ongoing resource management include floodplain rehabilitation, large woody debris placement, fish passage correction, cattle exclusion, riparian vegetation planting, mechanical thinning to promote conifers, and channel construction. As described in Section 3.15, Socioeconomics, effects would occur in Klamath, Siskiyou, Humboldt, and Del Norte Counties and regional impacts would be spread over the 2012-2026 period. Employment-related effects would vary by year proportionate to actual expenditures to carry out ongoing restoration activities. Effects from spending on local actions and related changes in employment would mostly occur in local or State governments and the construction sector. **While it is anticipated that the majority of these jobs could be filled with local workers, some amount of workers (both skilled and unskilled) may**

need to be hired from outside of the local areas. It is anticipated that the effects on population and housing would be less than significant.

3.17.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Construction activities involved in dam removal could employ non-local workers, who would need housing for the duration of their employment. During peak deconstruction periods, implementation of the Full Facilities Removal of Four Dams Alternative would require up to 250 total workers with 195 working at the Copco and Iron Gate Facilities combined, and up to 55 workers at the J.C. Boyle Facility. Both of these numbers include administrative and management staff. At the Copco and Iron Gate Facilities, 78 workers would be provided from within the region and 117 would be required from outside of the region. At J.C. Boyle, 20 workers would come from within the region and 35 from outside of the region. Therefore, the housing need would be up to 117 housing units for the California facilities and 35 housing units for the Oregon facility. Peak worker needs would occur between November 2019 and September 2020.

For J.C. Boyle Dam, communities that could possibly house workers include the Klamath unincorporated areas and Klamath Falls. In 2010, only 110 housing units were vacant in the Klamath unincorporated areas. Recent Klamath County plans (Johnson and Gardner 2009) do not include growth projections for the Klamath unincorporated areas, but a sudden increase in 35 workers could stress the housing market in the Klamath unincorporated areas since not all vacant properties are available for rent. However, an increase of 35 workers in Klamath Falls on a temporary basis could likely be absorbed by that city. With a current population of approximately 21,000 people and a projected increase in population of more than an additional 10,000 people by 2030 due to in-migration (Johnson Gardner 2009), these 35 workers in Klamath Falls would result in a 0.1 percent population increase. It is likely that, workers required for full removal of the J.C. Boyle Dam could be accommodated between the Klamath unincorporated areas and the City of Klamath Falls.

For the Copco 1, Copco 2, and Iron Gate Dams, large communities that could house workers include the City of Yreka and Medford. In 2010, there were more than 2,351 vacant housing units in Medford, or approximately 7 percent. . The high total number of housing units available indicates a strong likelihood that Medford could accommodate most, if not all, housing needs associated with the Proposed Action.

The City of Yreka's housing market has limited available housing. For example, in 2008 only 41 housing units were available for rent. Projecting the City of Yreka's current planned housing expansion to 2019 would result in 202 more housing units in the City of Yreka in 2019 (the beginning of construction) than are present in 2010. Because these new units are planned to accommodate anticipated growth regardless of the project alternative chosen, it is uncertain how many of the planned units would be available to non-local workers for the alternatives.

There are several other potential housing possibilities that could accommodate housing needs both in California and Oregon, including:

- *Hornbrook*. According to the 2010 Census, Hornbrook had 88 vacant housing units not for seasonal use. *Copco 1 Reservoir*. In 2010, in the Siskiyou unincorporated area, the vacancy rate was approximately 25 percent. Vacant units used for seasonal or recreational use may become available for rent since dam removal could lead to decreases in the number of non-local visitors to the region due to losses of reservoir recreation activities and loss of access to recreation sites at the dam (described in Section 3.15, Socioeconomics). Additionally, Section 3.15, Socioeconomics, assumes that losses in recreation spending would directly affect accommodation services in Klamath County. Recreational use of vacation homes near the reservoirs could decrease, making these seasonal homes available to workers.
- *Campgrounds and Recreational Vehicle (RV) Parks*. It is also likely that the local campgrounds near the dams would be available as temporary housing. In addition to campgrounds at Iron Gate and Copco 1 Reservoirs, the Bureau of Land Management maintains a campground along the Klamath River in Oregon, and another near the State line (Bureau of Land Management (BLM) 2011a and 2011b). RV parks in Hornbrook and the City of Yreka may also be available (Siskiyou County Visitor's Bureau 2011).
- *Hotels*. Among the various hotels in the City of Yreka, there are more than 600 rooms available via a simple internet search.[1] In addition, Klamath Falls contains more than 1,000 hotel rooms. Non-local temporary workers who have short contracts may prefer this housing option to renting a more permanent housing unit.

Peak workforce estimates apply to a several-month period. Because of the short duration of workforce needs, temporary housing may be desirable to non-local workers. Hotels and RV/camping options would very likely compensate for any shortage of more permanent housing in Medford, the City of Yreka and Klamath Falls. For the purposes of this EIS/EIR, population growth in a community is "substantial" if it would result in housing needs exceeding the number of housing units projected to be available and affordable. **Because the housing needs associated with construction activities could be met with resources in the area of analysis**, **these housing impacts would be less than significant**.

Dewatering of the reservoirs would result in recreational facilities currently located on the banks of the existing reservoirs to be removed following drawdown. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities will be removed. This facility removal will be done following the deconstruction of the dams, but will not require large crews or specialized labor that would need to be brought in from out of the area. **There would be no change from existing conditions for population and housing resulting from the removal of the recreational facilities.**

[1] Information collected using www.expedia.com on January, 26, 2011.

Keno Facilities Transfer

The transfer of the Keno Facility to DOI could result in additional workers. Keno Dam is an unmanned facility which requires minimal operations and maintenance. Recreation facilities owned by PacifiCorp in the vicinity of Keno Dam will also be transferred to either the State or county as described in the KHSA Section 7.5. Operation of Keno Dam and of the recreation areas are expected to continue in the current fashion. **The transfer of the facility and recreation lands would result in no change from existing conditions for population and housing.**

East and Westside Facilities Removal – Programmatic Measures

The decommissioning of the East and Westside Facilities could result in additional workers. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA will eliminate the need for the current diversion of water at Link River Dam into the two canals. Following decommissioning of the facilities there will be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. The number of workers required for the decommissioning will be fewer than those required for the Proposed Action. **Therefore, there would be no change from existing conditions for population and housing as a result of the decommissioning.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Dam removal at Iron Gate would require the relocation of the City of Yreka Water Supply Pipeline. The construction of the pipeline would take place during the deconstruction period and would not require an increase in construction workers or construction time. The relocation would occur after drawdown of the reservoir was complete and would not interfere with the deconstruction schedule. **There would be a less than significant impact to population and housing as a result of the pipeline relocation.**

KBRA – Programmatic Measures

Construction activities associated with implementation of several Klamath Basin Restoration Agreement (KBRA) programs could result in increases in new jobs throughout the Klamath Basin and a demand for more workers. The following programs could cause these impacts:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- On- Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Klamath River Tribes Interim Fishing Site
- Power for Water Management Program
- Additional Water Conservation and Storage

Construction and monitoring activities associated with the above-listed KBRA programs could employ non-local workers who would need housing for the duration of their employment. The creation of jobs and potential need to employ non-local workers could strain local housing availability and result in short and long-term increases in population in communities with the potential to house workers migrating into the area. It is anticipated that the majority of workers could be satisfied locally. The timing of and specific locations where these KBRA programs could be undertaken is not certain but it is assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. However, as described in Section 3.17.3, it is assumed that there is sufficient housing supply in the current stock to accommodate non-local workers. **Thus, it is expected that population and housing effects from construction and monitoring of KBRA programs would be less than significant. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

3.17.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

Construction activities involved in dam removal could employ non-local workers, who would need housing for the duration of their employment. Implementation of the Partial Facilities Removal of Four Dams Alternative would result in less facility removal. However, during peak deconstruction periods, implementation of the Partial Facilities Removal of Four Dams Alternative would require the same number of workers at each facility as described for the Proposed Action. These numbers include administrative and management staff. This would require the same number of workers from within and outside of the region as described for the Proposed Action. Peak worker needs would occur between November 2019 and September 2020.

Peak housing requirements for deconstruction at the Iron Gate and Copco Facilities could be met with housing available in Medford, the City of Yreka, Hornbrook, Copco Village, and other options as described above for the Proposed Action. Peak housing requirements for the J.C. Boyle Dam construction could be met by housing available in Klamath Falls and the Klamath unincorporated areas. Because the Partial Facilities Removal of Four Dams Alternative would require the same number of workers as the Proposed Action, the detailed discussion of housing availability provided in the Proposed Action section also applies to this alternative.

For the purposes of this EIS/EIR, population growth in a community is “substantial” if it would result in housing needs exceeding the number of housing units projected to be available and affordable. **Because the housing needs associated with construction activities could be met with resources in the area of analysis, these housing impacts would be less than significant**.

Keno Facilities Transfer

The transfer of the Keno Facility to DOI could result in additional workers. Potential impacts for the Keno Facilities Transfer would be the same as those described under the Proposed Action. **The transfer of the facility and recreation lands will have no change from existing conditions for population and housing.**

East and Westside Facilities Removal – Programmatic Measures
Potential impacts from the decommissioning of the East and Westside Facilities would be the same as under the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures
Potential impacts from the City of Yreka Water Supply Pipeline relocation would be the same as under the Proposed Action.

KBRA – Programmatic Measures
Implementation of the KBRA would have the same effects as the Proposed Action.

3.17.4.3.4 Alternative 4: Fish Passage at Four Dams

Construction activities involved in fish passage creation could employ non-local workers, who would need housing for the duration of their employment. Implementation of the Fish Passage at Four Dams Alternative would result in fish passage installation at the Four Facilities. During peak construction periods, implementation of the Fish Passage at Four Dams Alternative would require up to 75 workers at the Copco and Iron Gate Facilities combined, and up to 20 workers at the J.C. Boyle Facility. These numbers include administrative and management staff. Because detailed schedules for this alternative are not available, work force estimates assume that an average work force level at each facility would be required throughout construction actions at each facility. Of the workers at Copco and Iron Gate Facilities, it is assumed that 36 would come from within the region and 59 would come from outside of the region. Of the workers at J.C. Boyle, it is assumed that 10 would come from within the region and 20 would come from outside of the region. These housing requirements for construction at the J.C. Boyle Dam could be met by housing available in Klamath Falls and the Klamath unincorporated areas, while the housing requirements for construction at the Iron Gate and Copco Facilities could be met with housing available in Medford, the City of Yreka, Hornbrook, Copco Village, and other options described above for the Proposed Action. Because the Fish Passage at Four Dams Alternative would require fewer workers than Proposed Action, the detailed discussion of housing availability provided in the Proposed Action also applies to this alternative.

For the purposes of this EIS/EIR, population growth in a community is "substantial" if it would result in housing needs exceeding the number of housing units projected to be available and affordable. **Because the housing needs associated with construction activities could be met with resources in the area of analysis, housing impacts from this alternative would be less than significant**.

3.17.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Construction activities involved in dam removal and fish passage creation could employ non-local workers, who would need housing for the duration of their employment. Implementation of Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would result in full removal of the Copco 1 and Iron Gate Dams and fish passage construction at J.C. Boyle and Copco 2 Dams. During peak deconstruction/

construction periods, implementation of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would require a total peak construction workforce of up to 205 workers. This includes up to 175 workers at the Copco and Iron Gate Facilities combined, and up to 30 workers at the J.C. Boyle Facility. These numbers include administrative and management staff. At the Copco and Iron Gate Facilities, 69 workers would be provided from within the region and 106 would be required from outside of the region. At J.C. Boyle, 9 workers would come from within the region and 21 from outside of the region. Therefore, the housing need would be up to 106 housing units for the California facilities and 21 housing units for the Oregon facility. Peak worker needs would occur between November 2019 and September 2020.

Peak housing requirements for construction at J.C. Boyle Dam could be met by housing availability in Klamath Falls and the Klamath unincorporated areas. Peak housing requirements for activities at the Copco and Iron Gate Facilities could be met with housing available in Medford, the City of Yreka, Hornbrook, Copco Village, and other options as described above for the Proposed Action. Because the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would require fewer workers than the Proposed Action, the detailed discussion of housing availability provided in the Proposed Action section also applies to this alternative.

The housing needs associated with construction activities could be met with resources in the area of analysis. **Because this alternative would not result in a substantial increase in population growth or in housing unit needs, the housing impacts from this alternative would be less than significant**.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures
Potential impacts from the City of Yreka Water Supply Pipeline relocation would be the same as under the Proposed Action.

3.17.4.4 Mitigation Measures

3.17.4.4.1 Mitigation Measure by Consequence Summary

No mitigation measures are proposed.

3.17.4.4.2 Mitigation Measures Associated with other Resources

Construction of new recreation facilities could require additional workers affecting population and housing. Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the reservoir banks will need to be relocated down slope to be near the new river bed once the reservoir is removed. Impacts specific to the relocation of the recreation facilities are discussed in Section 3.20, Recreation. The planning and construction of these sites would take place after the deconstruction of the dams and would require a much smaller work force than the Proposed Action. Most, if not all of the labor required to replace the recreational facilities could be drawn from the local work

force. **Therefore, the implementation of REC-1 would have a less than significant impact on population and housing.**

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3.18 Public Health and Safety, Utilities and Public Services, Solid Waste, Power

This section presents the Public Health and Safety, Utilities and Public Services, Solid Waste, and Power analyses. Public health and safety includes potential impacts associated with construction-related health and safety risks, including fires and emergencies, and disease vectors. Another safety issue, the potential for changes in flooding downstream from the reservoirs, is discussed in Section 3.6, Flood Hydrology. Utilities and public services include potential impacts on electricity, natural gas, water supplies, stormwater management, wastewater, solid waste, telecommunications, public roads, police, and fire services. The power analysis examines the potential impacts on existing power facilities and the resulting loss of power production. The economic impacts from changes in PacifiCorp customer rates as a result of dam removal costs are discussed in Section 3.15, Socioeconomics.

3.18.1 Area of Analysis

The area of analysis differs based upon the specific resource being analyzed. The primary area of analysis includes the Klamath Hydroelectric Project (KHP), the Klamath River downstream from Iron Gate Dam, counties and communities in the area, and areas in the Upper Klamath Basin that could be affected by implementation of the Klamath Basin Restoration Agreement (KBRA) (see Figure 3.18-1). As shown in Figure 3.18-1 the Klamath Basin includes lands managed for public use, including health and safety and public services, by both the US Forest Service (USFS) and the Bureau of Land Management (BLM).

3.18.1.1 Public Health and Safety Area of Analysis

The area of analysis for public health and safety includes the area in the immediate vicinity of the Klamath Hydroelectric Project as well as areas identified as construction/demolition areas and staging areas for the alternatives. These areas will have construction and physical changes to the environment that may result in public health and safety concerns.

3.18.1.2 Utilities and Public Services Area of Analysis

The area of analysis for utilities and public services includes the counties and communities where both permanent residents and temporary workers would live and use community resources and services, and the areas where substantial construction activities would occur. Some of the major communities in the area of analysis potentially affected by the alternatives are listed below in Table 3.18-1.

3.18.1.3 Solid Waste Area of Analysis

The area of analysis for solid waste includes the landfills and waste management facilities in Siskiyou County, California and Klamath County, Oregon.

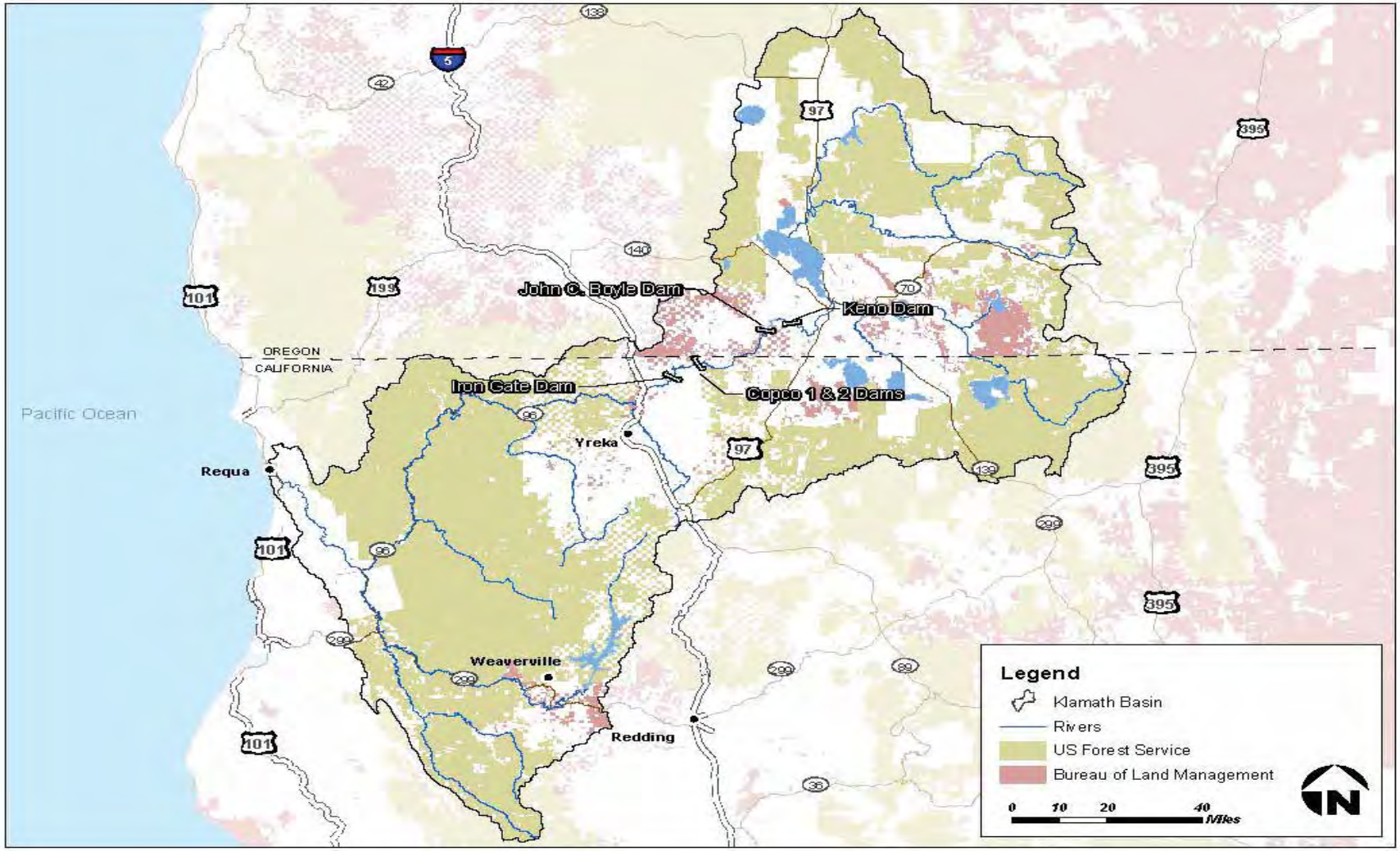

Figure 3.18-1. Klamath Basin.

Table 3.18-1. Example Communities in the Area of Analysis with Utilities and Public Services Potentially Affected by Alternatives

County	Community	State
Siskiyou	City of Yreka	CA
	Hornbrook	CA
	Copco Village	CA
	Beswick	CA
	Weed	CA
Klamath	Malin	OR
	Merill	OR
	Klamath Falls	OR
	Chiloquin	OR
	Keno	OR

3.18.1.4 Power

The area of analysis for power includes the Klamath Hydroelectric Project (KHP), which is owned by PacifiCorp and covers 64 river miles from the Link River Dam in Oregon to Iron Gate Dam in California, and the PacifiCorp service area within the Klamath Basin.

3.18.2 Regulatory Framework

Public Health and Safety, Utilities and Public Services, Solid Waste, and Power within the area of analysis are regulated by Federal, State and local laws, authorities and regulations, which are listed below.

3.18.2.1 Federal Laws, Authorities and Regulations

- Federal Energy Regulatory Commission (FERC) Founding Legislation: Title 42, chapter 84, Subchapter IV, Section 7171
- United States Department of Energy Organization Act of 1977
- Resource Conservation and Recovery Act; 42 U.S.C Section 6901 et seq. (1976)
- 29 CFR Part 1910: Occupational Safety and Health Standards
- 29 CFR Part 1925: Safety and Health Standards for Federal Service Contracts
- 29 CFR Part 1926: Safety and Health Regulations for Construction
- 29 CFR Part 1952: Approved State Plans for Enforcement of State Standards

3.18.2.2 State Authorities and Regulations

- California Public Utilities Commission (CPUC)
- Oregon Public Utilities Commission (Oregon PUC)
- Oregon Administrative Rules (OAR) Chapter 860
- California Code of Regulations (Title 14, Chapter 3)
- California Integrated Waste Management Act (AB 239)

- Oregon Department of Environmental Quality (ODEQ), OAR Chapter 340, Division 94 (OAR-340-94), and by adoption, 40 CFR Part 258 (2009).
- State Occupational Safety and Health Programs, certified under Section 18 of the Occupational Safety and Health Act of 1970 (California, certified 1973; Oregon, certified 2005)
- ODEQ, Water Quality Control. OAR Chapter 340, Division 41 (OAR-340-41) (2010).

3.18.2.3 Local Authorities and Regulations

- Siskiyou County General Plan (Siskiyou County 1993).
- Siskiyou County Source Reduction and Recycling Element (Siskiyou County 1997)
- The Yreka General Plan 2002–2022 (City of Yreka 2003).
- The Klamath County Comprehensive Plan (County Solid Waste Management Plan) (Klamath County 2010a).

3.18.3 Existing Conditions/Affected Environment

This section describes the existing conditions/affected environment for public health and safety, utilities and public services, solid waste, and power.

3.18.3.1 Public Health and Safety

This section analyses the potential impacts of the alternatives on police, fire, and other emergency response times and effectiveness; whether the alternatives and construction activity would restrict access to emergency centers or evacuation routes, and whether the project or its construction would directly create or increase the risk posed by an existing hazard. An analysis of the potential affects in geologic hazards including seismology, earthquakes, and landslides in the project area is appears in Section 3.11, Geology, Soils, and Geologic Hazards. The potential for changes in flood risk downstream from the Four Facilities is described in Section 3.6, Flood Hydrology.

3.18.3.1.1 Emergency Centers

Figure 3.18-2 shows the locations of the hospitals and fire stations within the area of analysis. No hospitals and only one fire station (Copco Lake Fire Department Station 210), at Copco 1 Reservoir, lie directly within the area of analysis. The nearest hospitals are Sky Lakes Medical Center in Klamath Falls, Oregon (roughly 20 miles east northeast of J.C. Boyle Dam), Ashland Community Hospital in Ashland, Oregon (roughly 35 miles north northwest of Iron Gate Dam), and Fairchild Medical Center in the City of Yreka, California (roughly 18 miles southwest of Iron Gate Dam).

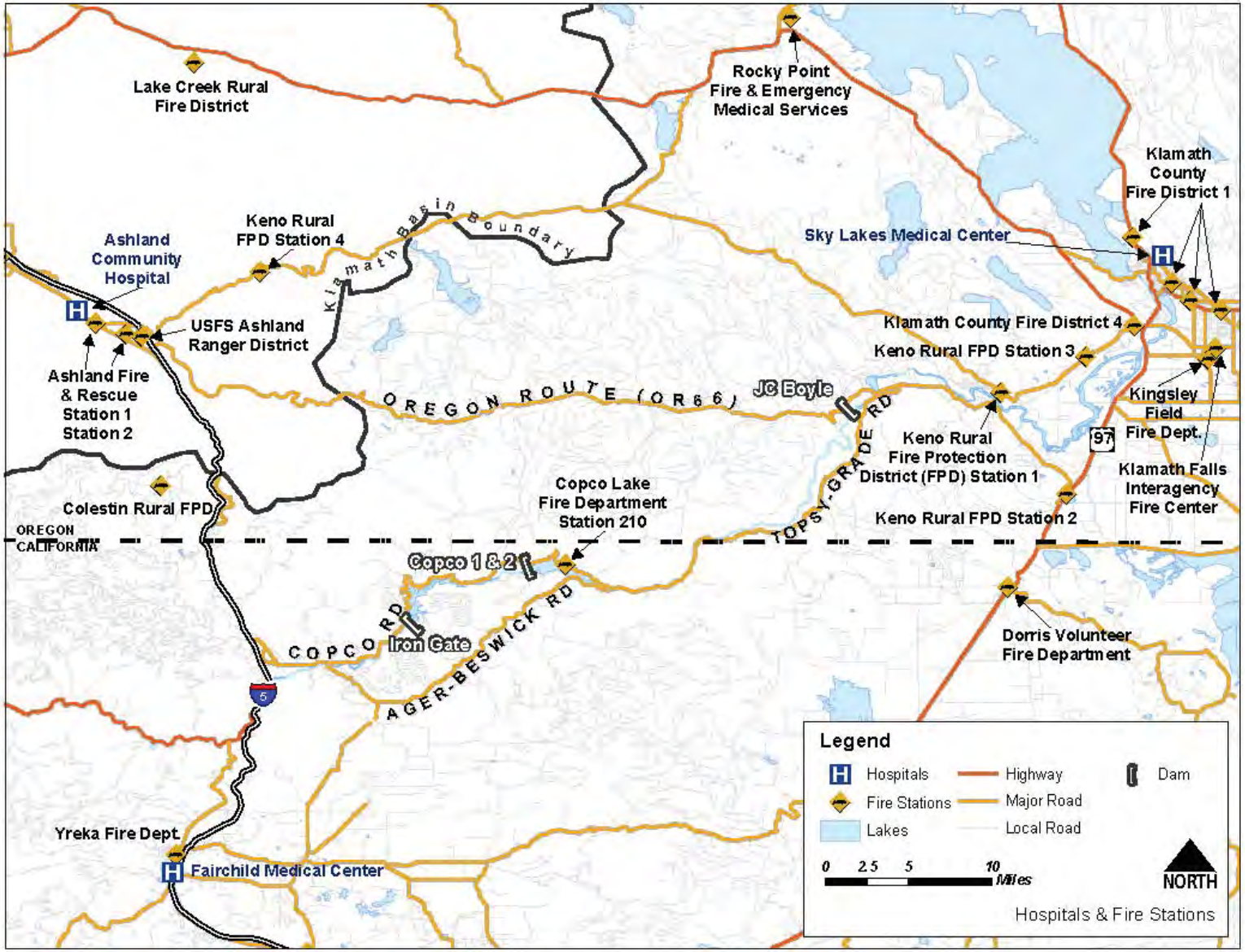

Figure 3.18-2. Hospitals and Fire Stations near the Project Area.

3.18.3.1.2 Fire Risk and Protection

Figure 3.18-3 shows fire hazard in the project area as mapped using MODerate-resolution Imaging Spectroradiometers by the United States Department of Agriculture Forest Service (United States Department of Forest Service (USFS), Remote Sensing Applications Center, 2010). During the dry season, areas surrounding reservoirs are at risk for fires, particularly at the interface between residential development and open space. As shown in the figure, the fire threat is high to very high in the areas surrounding the Four Facilities (CalFire 2007, Oregon Department of Forestry 2006).

Fire protection in the action area is provided by Federal agencies, the State forestry and fire prevention agencies, and a variety of city, county and volunteer fire stations. Federal agencies include the USDA Forest Service, which is responsible for wildland fire protection on National Forest lands and providing assistance to other Federal entities when requested; and the BLM, which is responsible for wildland fire protection on land managed by the BLM and providing assistance to other Federal, State, and local agencies when requested.

Fire protection at the State level is provided by CalFire in California, who, in conjunction with county and volunteer fire departments, is also responsible for fire protection throughout the unincorporated areas of the State. There are CalFire stations in the project vicinity, including the City of Yreka and Hornbrook. In Oregon, the Department of Forestry responds to wildland fires in the State resource areas and on federally managed lands. The ODF works with the BLM and the Forest Service to prevent and fight wildfire on the federally managed lands as well.

City-operated fire stations include the Yreka Fire Department, and the Mount Shasta Fire Department. There are also a number of county fire stations throughout the project area, including the Copco Fire Department, Happy Camp, Seiad Valley, Etna, Fort Jones, Montague, Butte Valley, McCloud, Dunsmuir, and Mount Shasta (Fire Department Directory 2010).The nearest fire stations to the project area are the Copco Fire Department, Keno Rural Fire Protection District Station in Oregon (east of Keno Dam), Yreka Fire Department (City of Yreka, California), and Colestin Rural Fire Protection District (in Oregon northwest of Iron Gate Dam). The Colestin Rural Fire Protection District and the Hilt Fire Company in Northern California operate as one agency out of geographic necessity. Legally, however, they are two separate entities (Colestin Rural Fire District 2005). The Hilt volunteer fire department jurisdiction includes the California side of the Colestin valley, and also covers part of northern Siskiyou County, down to the Hornbrook boundary (Colestin Rural Fire District 2011).

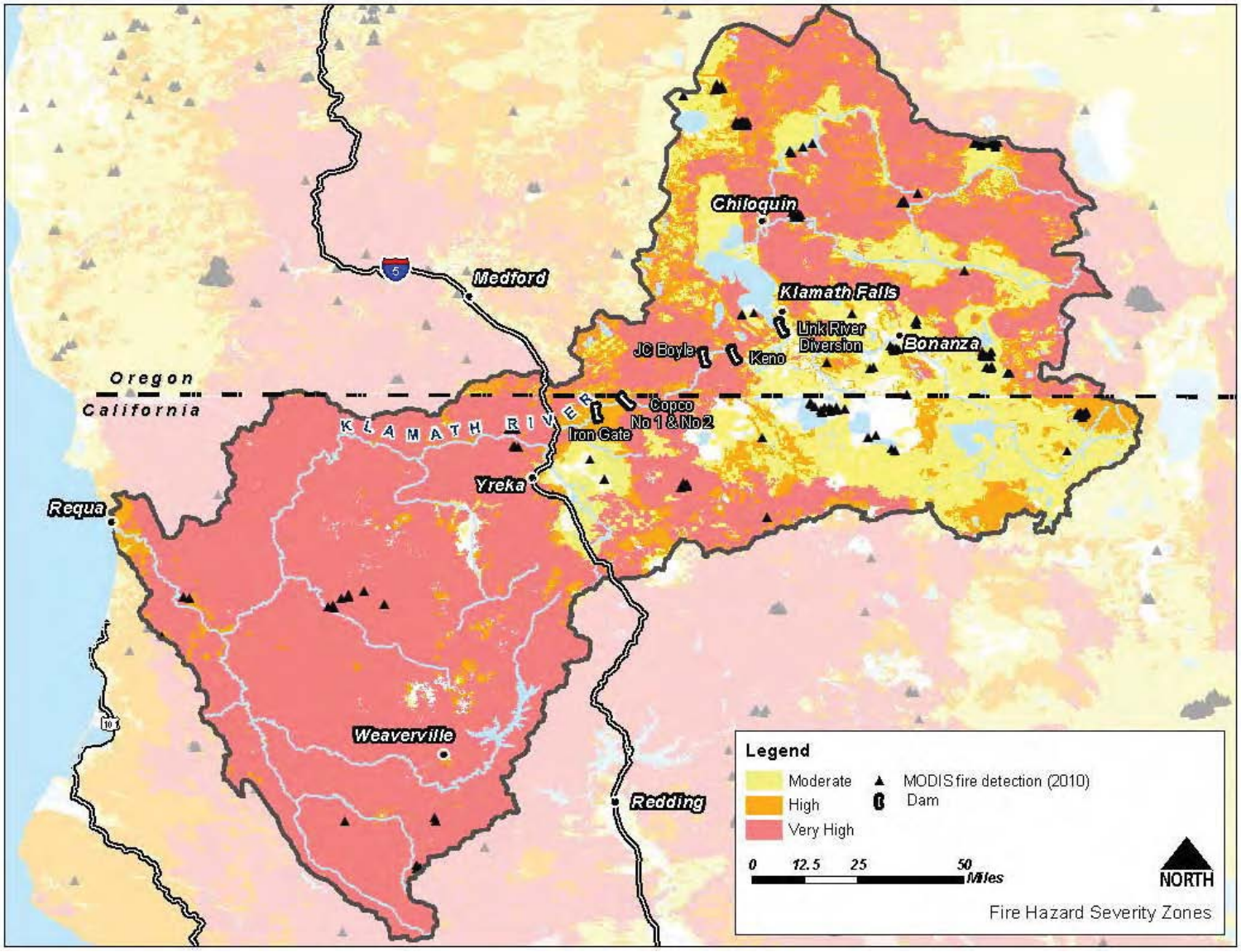

Figure 3.18-3. Fire Hazard in the Area of Analysis.

Table 3.18-2 below lists the fire protection entities and the areas they serve.

Table 3.18-2. Fire Protection Agencies in the Project Area

Agency	Federal/State/Local	Jurisdiction
USDA Forest Service	Federal	National Forests, federally managed land
Bureau of Land Management	Federal	Bureau of Land Management lands, federally managed land
CalFire	State of California	State Resource Lands, California,
Oregon Department of Forestry	State of Oregon	State Resource Lands, Oregon
Klamath County Fire District	Local, County of Klamath	Unincorporated County lands and the City of Klamath Falls
Colestin Rural Fire District	Local, County of Jackson	County Fire District in Jackson County, Oregon
Siskiyou County Fire Protection Districts: Copco Lake, Hornbrook, Montague, South Yreka, Tulelake, Etna, Ft. Jones, Weed	Local, County	Unincorporated County Lands throughout Siskiyou County
Mount Shasta Fire Department	Local, City of Mount Shasta	Mt. Shasta Municipal Boundaries
Yreka Fire Department	Local, City of Yreka	City of Yreka Municipal boundaries

No region or State-wide fire plans were identified for the action area. However, Siskiyou County began developing a Multi-Jurisdictional Hazard Mitigation Plan in July of 2010. As of the writing of this document, that plan has not been adopted. A Community Wildlife Preparedness Plan was completed in 2008. The document identifies "…most County, State, and Federal roads in the region" as emergency evacuation routes (Firesafe Council of Siskiyou County 2008). The Community Wildfire Protection Plan also identifies a number of locations as evacuation sites, including the Hornbrook School and Grange.

3.18.3.2 Utilities and Public Services

Utilities and public services are provided in the area of analysis by PacifiCorp, Pacific Gas and Electric (PG&E), AT&T, a number of cellular telephone companies, and through the local municipalities. The municipalities in the area (including the City of Yreka, Mount Shasta, and Klamath Falls) provide water and solid waste collection within their borders. Public schools are operated through the county school districts in both Siskiyou and Klamath Counties, which provide kindergarten through high school education throughout the project area. There are a number of private schools in the project area as well, serving students in the small towns throughout the counties, such as Dorris, Mount Shasta, Tulelake, Chiloquin, the City of Yreka, and Klamath Falls A full list of these utility and public service providers are presented in Table 3.18-3 by county and community.

Table 3.18-3. Utilities and Public Services in the Study Area

County	Electricity	Natural Gas	Water Service	Wastewater	Stormwater	Telecommunications	Police and Fire	Schools
Siskiyou County	Siskiyou County is served primarily by PacifiCorp.[1] Currently, electricity supplies generated in the area of analysis are primarily hydropower, with the closest PacifiCorp generation facilities in Siskiyou and Klamath Counties located on the Klamath River. Given the interconnected design of the regional power grid electricity generated at the Four Facilities may be used for local demand or it may be used to meet demands in other communities. Likewise, power generated by PacifiCorp and other generators in other communities may be used in Siskiyou and Klamath Counties.	Natural gas is supplied by PG&E (California Energy Commission (CEC) 2010b).	Municipal and Industrial water supply is not provided by the county; it is provided by cities and towns in the county (Dean 2010). Areas in Siskiyou County not served by local municipalities obtain water from private wells.	The county does not provide wastewater treatment. Residences in the unincorporated county are served by on-site septic systems (Dean 2010). Cities, as described below, are responsible for wastewater treatment.	Stormwater management is done by the individual municipalities within the county.	Wired telephone services are provided by AT&T and Pac-West (Wise 2010).Multiple cellular companies also provide wireless service in the area,	Police services are provided by the Siskiyou County Sheriff's Department (Siskiyou County 2010b). Fire protection is provided by 12 fire protection districts: Happy Camp District, Copco Lake District, Hornbrook District, South Yreka District, Scott Valley District, Callahan District, Montague District, Gazelle District, Butte Valley District, Tulelake District, Mount Shasta District, and the Dunsmuir District (Siskiyou County 1975).	The Siskiyou County Office of Education oversees the school districts and educational programs (Siskiyou County Office of Education, 2010). The county has charter schools, elementary schools, high schools, and a unified school district (Siskiyou County Office of Education 2010). There are a number of private schools in the county, located within the incorporated cities and larger settlements in the County, including Dorris, Mount Shasta, the City of Yreka, and Tulelake,
City of Yreka	PacifiCorp provides electrical power (CEC 2010a).[1]	Natural gas is provided by PG&E (CEC 2010b).	The City of Yreka currently receives its municipal water supply from Fall Creek (City of Yreka 2010a). The City of Yreka's main transmission line runs under Iron Gate Reservoir upon the lakebed (City of Yreka 2010b). The City of Yreka's water supply is piped from the Fall Creek Pumping Station near Copco 1 Reservoir through a 24-inch pipe for 23 miles to the City of Yreka (City of Yreka 2003). Current water use in the winter is approximately 1 mgd; however, in the summer this use increases up to approximately 6 mgd (City of Yreka 2003). The City of Yreka obtains its water based on a State water right allowing withdrawal of up to 15 cfs (9.7 mgd) (City of Yreka 2010a).	The city has one wastewater treatment plant that treats and disposes of both domestic and industrial sewage generated within the city's boundaries (City of Yreka 2010c). The facility is designed to accommodate up to 1.3 mgd of average dry weather flow. The City of Yreka's general plan reported that average dry weather flow in 2003 was between 0.7 and 0.9 mgd (City of Yreka 2003).	Stormwater management is the responsibility of the City of Yreka's Public Works Department.	Wired telephone service is provided by AT&T and Pac-West. Multiple cellular companies also provide wireless service in the area,	Police services are provided by the City of Yreka Police Department and Fire services are provided by the Yreka Fire Volunteer Department (City of Yreka 2010d; City of Yreka 2010e).	The City of Yreka is served by the Yreka Union Elementary School District and the Yreka Union High School District (Siskiyou County Office of Education, 2010). There is a private Bible academy in the City of Yreka that serves students from Kindergarten through 11th grade.
Hornbrook	Electricity is provided by PacifiCorp (Wise 2010).	Natural gas in the county is supplied by PG&E (CEC 2010b).	Water supply in Hornbrook comes from private ground water wells (Wise 2010).	Residents use on-site septic systems for wastewater treatment (Dean 2010).	Stormwater runoff is conveyed through natural drainages (Dean 2010).	Wired telephone services are provided by AT&T (Dean 2010). Multiple cellular companies also provide wireless service in the area,	The Siskiyou County Sheriff provides police protection services to the community of Hornbrook (Wise 2010).	Yreka Union School District serves the community of Hornbrook (Wise 2010).

Table 3.18-3. Utilities and Public Services in the Study Area

County	Electricity	Natural Gas	Water Service	Wastewater	Stormwater	Telecommunications	Police and Fire	Schools
Copco Village	Electricity is provided by PacifiCorp (Wise 2010).	Natural gas in the county is supplied by PG&E (CEC 2010b).	Water supply in Copco Village comes from private ground water wells (Wise 2010).	Wastewater service is provided by on-site septic systems (Dean 2010).	Stormwater runoff is conveyed through natural drainages (Dean 2010).	Wired telephone services are provided by AT&T (Dean 2010). Multiple cellular companies also provide wireless service in the area,	The Siskiyou County Sheriff provides police protection services to the community of Copco Village (Wise 2010).	Yreka Union School District serves the community of Copco Village (Wise 2010).
Beswick	Electricity is provided by PacifiCorp (Wise 2010).	Natural gas in the county is supplied by PG&E (CEC 2010b).	Water supply in Beswick comes from private ground water wells (Wise 2010).	Wastewater is treated in on-site septic systems (Dean 2010).	Stormwater runoff is conveyed in natural drainages (Dean 2010).	Wired telephone services are provided by AT&T and Pac-West (Wise 2010). Multiple cellular companies also provide wireless service in the area,	The Siskiyou County Sheriff provides police protection services to the community of Beswick (Wise 2010).	Yreka Union School District serves the community of Beswick (Wise 2010).
Klamath County	PacifiCorp provides electric power to the county (Dobry 2010).	Avista Utilities provides natural gas services to the county (Dobry 2010).	Water supplies in the unincorporated county come from private ground water wells as well as numerous private water companies that serve some community subdivisions (Dobry 2010). Additionally, some water is provided by the City of Klamath Falls (Dobry 2010).	Wastewater in the county is provided by the Klamath County Community Development On-Site Sanitation Division (Klamath County 2010b).	Stormwater flows through roadside ditches and natural drainages (Gallagher 2010).	Wired telephone service is provided by USWest. Multiple cellular companies also provide wireless service in the area, (Gallagher 2010).	The Klamath County Sheriff Department provides police protection in the county (Klamath County 2010c). Klamath County is served by 17 fire districts: Bly Fire District, Bonanza Fire District, Chemult Fire District, Chiloquin Fire District, Crescent Fire District, Central Cascades Fire District, Harriman Fire District, Keno Fire District, Klamath County Fire Districts numbers 1 through 5, La Pine Fire District, Malin Fire District, Merrill Fire District, and North Klamath Fire District (Klamath County 2010c).	The Klamath County School District includes 20 schools, including elementary, junior high, and senior high schools (Klamath County School District 2010). Schools serving the project area include Chiloquin Elementary and Junior and Senior High Schools, Keno Elementary, and Merrill Elementary. A number of private schools are located throughout the county, including Bonanza, Chiloquin, and Klamath Falls.
Merrill	PacifiCorp provides electric power to Merrill.	There is no natural gas supplied to Merrill (Fuller 2010).	Water supply comes from city ground water wells on Front Street (Fuller 2010).	Wastewater is treated in Merrill's wastewater treatment plant (Fuller 2010).	Stormwater flows through natural drainages; Merrill does not maintain any constructed stormwater infrastructure (Fuller 2010).	Wired telephone service is provided by Century Link (Fuller 2010). Multiple cellular companies also provide wireless service in the area,	The Merrill City Police Department provides police protection services in the city (Fuller 2010). Fire protection services are provided by the Merrill Rural Fire Protection District, a primarily volunteer fire company serving the town and surrounding area.	Merrill Elementary School and Lost River High School serve the City of Merrill. Both schools are within the Klamath County School District (Fuller 2010).

Table 3.18-3. Utilities and Public Services in the Study Area

County	Electricity	Natural Gas	Water Service	Wastewater	Stormwater	Telecommunications	Police and Fire	Schools
Klamath Falls	PacifiCorp provides electricity to Klamath Falls.	Amerigas and Klamath Natural Gas Services provide natural gas in Klamath Falls	Klamath Falls' Water Division is responsible for providing water to more than 40,000 residents in the urban area. The division operates and maintains 13 ground water wells, 21 pumping stations, and 22 water reservoirs with a total storage capacity of 16 million gallons (City of Klamath Falls 2010a). Klamath Falls' water supply comes from ground water wells.	Wastewater collection and treatment service is provided by the City of Klamath Falls Wastewater Division. The division services nearly 20,000 city residents and Klamath Basin area customers (City of Klamath Falls 2010b). In addition to sewage collection and treatment, the division provides stormwater collection services, and sewage treatment for a major residential development and a major resort/residential development outside of the city limits (City of Klamath Falls 2010b). Equipment and facilities include two wastewater treatment plants, 11 wastewater pumping stations, four stormwater pumping stations, and stormwater collection lines. Wastewater treatment facilities process an average combined 4.2 mgd of wastewater from over 7,100 service connections (City of Klamath Falls 2010b). Within the Klamath Falls Urban Growth Boundary, wastewater treatment is provided by the South Suburban Sanitary District.	The City of Klamath Falls Wastewater Division manages the stormwater infrastructure in the city (City of Klamath Falls 2010b).	Wired telephone service in the city is provided by Qwest. Multiple cellular companies also provide wireless service in the area,	The Klamath Falls Police Department is responsible for police services in the city (City of Klamath Falls 2010b). Fire protection is provided by the Klamath County Fire District No. 1. The existing fire district serves an area of 201 square miles containing approximately 52,000 residents (Klamath County Fire District 2010).	Klamath Falls City Schools oversees a mix of elementary, junior high and high school, and alternative education schools in the city (Klamath Falls City Schools 2010). There are 11 schools in the district.
Chiloquin	PacifiCorp provides electricity in Chiloquin.	Chiloquin does not use natural gas resources (Foreman 2010).	The City of Chiloquin supplies water to all city residents as well as some residents that are outside of the city but within the urban service area. Municipal water supplies come from one ground water well (Foreman 2010).	Chiloquin has a city wastewater treatment plant (Foreman 2010).	Chiloquin maintains roadside drainages for stormwater runoff (Foreman 2010).	Wired telephone service is provided by Century Link (Foreman 2010). Multiple cellular companies also provide wireless service in the area,	Police and public safety in Chiloquin is provided by the Klamath County Sheriff and the Oregon State Police (City of Chiloquin 2010a). Fire service is provided by the Chiloquin-Agency Lake Rural Fire Protection District, a volunteer fire department that serves a 105-square-mile area that encompasses the city and the areas to the north and east (Klamath Fire 2005).	Three county schools in the city serve children living in Chiloquin: Chiloquin Elementary and Chiloquin Junior and Senior High Schools (City of Chiloquin 2010b; Foreman 2010).

Key:
CEC: California Energy Commission
PG&E: Pacific Gas and Electric

3.18.3.3 Solid Waste

County and local landfill and waste processing facilities are described below.

3.18.3.3.1 Siskiyou County

Solid waste in the Siskiyou County is handled by the General Services Sanitation Department (Siskiyou County 2010a). Siskiyou County has transfer stations in Mount Shasta, Happy Camp, Tulelake, the City of Yreka, and in the Salmon River Area (Siskiyou County 2010a). Yreka Sanitary Landfill is a Class III landfill 2 miles southwest of the City of Yreka, California. It is owned by the City and County of Siskiyou and operated by the City of Yreka. Class III landfills accept construction debris, most household garbage, greenwaste, carpet, and other types of non-hazardous waste. Hazardous wastes, such as batteries, paints, and hazardous materials must be disposed of in Class I facilities which are lined to prevent the contamination of underlying soils and ground water.

3.18.3.3.2 Klamath County

The Klamath Falls Landfill is a demolition only, unlined landfill 2 miles northeast of Klamath Falls, Oregon. It is owned by the County of Klamath and operated by the Klamath County Community Development-Solid Waste Division. A second waste transfer station is located on the south side of Klamath Falls. The Keno Transfer station is located south of the community of KeNo. Hazardous waste, soils contaminated by hazardous materials, and lead acid batteries are all prohibited at County Solid Waste Disposal Sites. There are numerous other transfer stations located throughout the county, but it is unlikely these would be used for deconstruction debris as they have limited capacity and restrictions on the types of materials that may be disposed of at the transfer station.

3.18.3.3.3 Shasta County

The Anderson Landfill is located in the city of Anderson in Shasta County, and is a hazardous waste disposal site that will accept a variety of construction and demolition related wastes, including creosote-treated wood. While the landfill is located just over 100 miles from Iron Gate Dam, the remaining capacity and materials accepted make it a likely recipient of dam materials from the deconstruction activities (Table 3.18-4).

3.18.3.3.4 Lane County

The Delta Sand & Gravel Demolition Landfill located in Eugene, Oregon, accepts dirt, rock, concrete, building demolition materials, and green waste. The landfill is over 200 miles from Iron Gate Dam, but may be used for some of the building debris removed from the project sites (Table 3.18-4).

The Ecosort Material Recovery Facility is also located in Eugene, and accepts wood, concrete, asphalt, metal, and aluminum. This is a recycling center that has no set capacity as materials are recycled and reused elsewhere.

3.18.3.3.5 Jackson County

The Dry Creek Landfill in Eagle Point has approximately 165,000,000 cubic yards of remaining capacity and accepts construction/demolition debris, mixed municipal refuse, and contaminated soils (Table 3.18-4). Located only 54 miles from Iron Gate Dam, it is likely this facility would receive some share of the materials generated by dam deconstruction from the proposed project.

3.18.3.3.6 Summary of Local Landfills and Transfer Facilities

Several landfills in the project area could receive solid waste from deconstruction activities. Table 3.18-4 summarizes regional landfills and recycling centers closest to the Iron Gate Dam.

Table 3.18-4. Regional Landfills and Recycling Centers and Type of Waste Accepted

Facility Name	Address	City, State/ County	Remaining Capacity (yd^3)	Wastes Accepted	Distance from Iron Gate (mi)
Yreka Solid Waste Landfill	Off Oberlin Rd; 2 mi SE of the City of Yreka	The City of Yreka, CA/ Siskiyou	3,924,000	Construction/demolition, mixed municipal	26.7
Dry Creek Landfill	6260 Dry Creek Road	Eagle Point, OR/ Jackson	165,000,000	Construction/demolition, mixed municipal, contaminated soils	54.0
Klamath Falls Landfill	801 Old Fort Road	Klamath Falls, OR/ Klamath	435,000	Construction/demolition, contaminated soils	89.0
Yreka Med. Vol. Transfer Station	Off Oberlin Rd; 2 mi SE of the City of Yreka	the City of Yreka, CA/ Siskiyou	Recycling facility	Inert, metals, mixed municipal	26.7
Ecosort Material Recovery Facility	3425 E 17th Avenue	Eugene, OR/ Lane	Recycling facility	Wood, concrete, asphalt, metal, aluminum	209
Delta Sand & Gravel Demolition Landfill	999 Division Street	Eugene, OR/ Lane	1,000,000 of general excavation and 200,000 of concrete	Dirt, rock, concrete, building demolition, clearing debris and brush removal.	215
Anderson Landfill, Inc	18703 Cambridge Road	Anderson, CA/ Shasta	11,914,025	Construction/Demolition (including creosote treated wood), green waste, mixed municipal, tires	134

Source: CalRecycle 2010, Loeschen 2010, Oregon Department of Environmental Quality 2007, Sorensen 2010, United States Environmental Protection Agency 2006

Key:
yd3 = cubic yards
mi = miles
SE = southeast

3.18.3.4 Power

The KHP, operated by PacifiCorp, provides power to residential, industrial, and agricultural customers across the PacifiCorp service area (Figure 3.18-4). The KHP consists of seven hydroelectric facilities and one reregulating facility with an installed capacity of approximately 169 megawatts (MW) and a total average annual electric output of 716,800 megawatts hours (MWh), as shown in Table 3.18-5 (FERC 2007). Six of the generating facilities are on the Klamath River, with the seventh on Fall Creek, a tributary to the Klamath River that enters at River Mile 196.3, between Iron Gate and Copco 2 Reservoirs. Keno Dam is a reregulating facility with no generating capacity. The KHP covers 64 river miles, from the Link River Dam in Oregon to Iron Gate Dam in California (California Energy Commission [CEC] 2003).

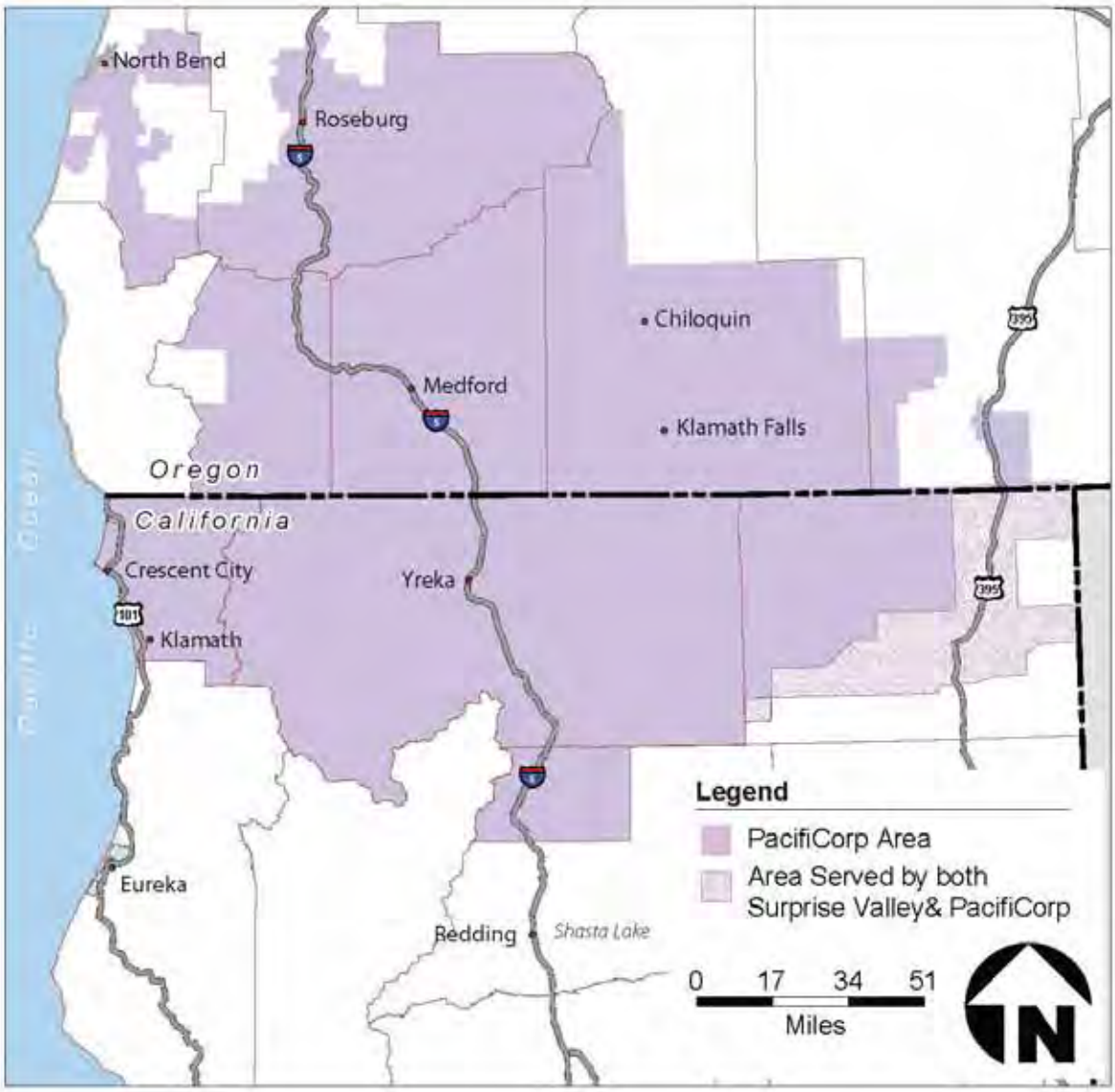

Figure 3.18-4. PacifiCorp Service Area.

Table 3.18-5. Klamath Hydroelectric Project Facilities

Facility Name	Generating Facility	Total Authorized Generating Capacity (MW)	Average Annual Generation (MWh)	Location	River Mile (RM)
Link River Dam	East Side Power canal	3.19 MW	15,400	Klamath Falls, OR	RM 254
	West Side Power canal	0.6 MW	3,400	Klamath Falls, OR	RM 254
Keno Dam and Impoundment	None (Re-regulating facility with no power generation capabilities)	None	None	20 miles downstream from East Side and West Side Powerhouses	RM 233
J.C. Boyle Dam and Reservoir	J.C. Boyle Powerhouse	97.98 MW	329,000	OR	RM 224.7 (Dam) RM 220.4 (Powerhouse)
Copco 1 Reservoir	Copco 1 Powerhouse	20.0 MW	106,000	CA	RM 198.6
Copco 2 Reservoir	Copco 2 Powerhouse	27.0 MW	135,000	CA	RM 196.8
Iron Gate Dam and Reservoir	Iron Gate Dam Powerhouse	18.0 MW	116,000	CA	RM 190
Fall Creek (On Klamath River tributary that flows into upper Iron Gate Dam Reservoir)	Fall Creek Powerhouse	2.2 MW	12,000	CA	196.3
Total:		**168.97**	**716,800**		

Key:
MW = megawatts
Source: FERC 2007

PacifiCorp has, in its 2004 relicensing submission to FERC, described plans to decommission the East Side and West Side Powerhouses. These two facilities are located at the Link River Dam, and as shown in Table 3.18-4, have a combined nameplate capacity of less than 4 MW. The cost to install screening on these facilities to protect the federally listed suckers in Upper Klamath Lake would be prohibitive given the small amount of power they produce (FERC 2007). The Proposed Action would remove four of the eight facilities (J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams). These Four Facilities under consideration for removal have a nameplate generation capacity of approximately 163 MW of electricity, and produce an average of 686,000 MWh annually (see Table 3.18-5). J.C. Boyle is able to produce peaking power during periods of high demand (FERC 2007); but, due to a number of factors, such as limited storage capacity in the reservoirs and flow restrictions imposed by the Biological Opinions for coho salmon and the sucker species, the rest of the project is operated more as a “run of the river” facility (CEC 2006).

While an excess of generation capacity exists in the Northwest sub region, transmission constraints prevent much of the power generated in the Northwest Power Pool from being used south of the project area in areas that are constrained by electrical supply (North American Electric Reliability Corporation 2010). PacifiCorp's 2008 Integrated Resource Plan provides an overview of the company's available generation and transmission capacity. According to the Integrated Resource Plan, which assumes relicensing of all of the company's hydroelectric facilities, PacifiCorp will be "summer peak resource deficit" in 2011 (PacifiCorp 2008). This deficit was to be met in the short term with additional renewable, demand-side programs, market purchases from other generating companies, and improvements to the efficiency of coal fired plants (PacifiCorp 2008). PacifiCorp outlined a series of actions in the plan to meet this deficit, including the addition of 144 MW of wind resources in 2009 through company owned resources and purchases, and the addition of 269 MW of wind resources in 2010 with company owned resources and 119 MW of power purchases (PacifiCorp 2008). These improvements and purchases will allow PacifiCorp to meet the expected load across their service area.

3.18.4 Environmental Consequences

3.18.4.1 Environmental Effects Determination Methods

3.18.4.1.1 Public Health and Safety

The impact analysis for public health and safety focuses on proposed deconstruction activities surrounding the Four Facilities and associated reservoirs and how these would affect the health and safety of the general public and construction workers. Other sections in the Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report (EIS/EIR) describe several public health and safety impacts. Section 3.11, Geology, Soils, and Geologic Hazards discusses Geologic stability of nearby soils (i.e., slumping and landslides) and geologic hazards such as seismology and volcanology. Section 3.3, Aquatic Resources, and Section 3.2, Water Quality, discuss water quality impacts. Changes in hydrology and flooding are discussed in Section 3.6, Flood Hydrology, and Section 3.8, Water Supply/Water Rights. Section 3.22, Traffic and Transportation, discusses the impact to area roads and bridges, and safety issues associated with the Proposed Action and vehicular traffic. Impacts on the recreational areas, with the exception of potential impacts to visitors using the areas, are discussed in Section 3.20, Recreation. Impacts to visitors as a result of the proposed deconstruction are discussed in this section.

3.18.4.1.2 Utilities and Public Services

The Lead Agencies determined the impacts on utilities by examining utilities and services in the project area and how they would be affected by demolition activities. The discussion of utilities also covers the demands for electricity and natural gas that would result from deconstruction and construction activities. Removal of hydropower facilities and resulting changes in hydropower production are addressed below in the hydropower section. The Proposed Action and alternatives do not have the potential to affect schools in terms of additional students or longer bus routes. However, if the Proposed Action is carried out, there could be reduced tax revenue available to fund local schools.

Section 3.15, Socioeconomics, discusses impacts to local tax revenues. The Proposed Action would not require new or expanded stormwater or wastewater facilities; therefore, these services and utilities are not discussed further. Geothermal resources have been identified in the area, but no plans exist to develop these resources as part of the Proposed Action. Any future development of geothermal resources would require focused environmental compliance and review, and development of these resources is not discussed further.

3.18.4.1.3 Solid Waste

The Lead Agencies determined the solid waste impacts by assessing the ability of local facilities to accept non-hazardous materials that could not be disposed of at the dam sites. Deconstruction of the dams is anticipated to generate solid waste comprising earth, concrete, metal, wood planks, and asphalt. It is assumed that most of this material that cannot be safely disposed of on-site would be considered inert material and could be disposed of in Class III landfills (See Table 3.18-3, Regional Landfills and Recycling Centers and Type of Waste Accepted). In addition, a large portion of deconstruction and construction debris, such as the asphalt, concrete, rebar, metal from the powerhouses and transmission infrastructure, and reclaimed lumber, would be diverted from landfills through reuse and recycling. No solid waste would be generated after deconstruction is complete.

3.18.4.1.4 Power

The analysis for power focuses on changes to existing hydropower facilities and the potential need for replacement power production after the Proposed Action and alternatives have been implemented.

3.18.4.2 Significance Criteria

3.18.4.2.1 Public Health and Safety

For the purposes of this EIS/EIR, impacts on public health and safety would be significant if an alternative would do the following:

- Impair implementation of or physically interfere with an adopted emergency response plan or emergency evacuation plan.
- Expose people or structures to a significant risk of loss, injury or death involving construction safety hazards, emergency routes, or wildland fires, including where wildlands are adjacent to urbanized areas or where residences are intermixed with wildlands.

3.18.4.2.2 Utilities and Public Services

For the purposes of this EIS/EIR, impacts on utilities and public services would be significant if the alternative would do the following:

- Result in substantial adverse physical impacts that create the need for new or physically altered governmental facilities, the construction of which could cause significant environmental impacts, in order to maintain acceptable service ratios, response times or other performance objectives for any of the public services: fire protection; police protection; schools; parks; other public facilities.
- Result in increased demand for utilities that could exceed the capacity and outputs of existing facilities/infrastructure, and require new or expanded facilities/infrastructure that could result in significant environmental impacts.
- Be served by a landfill with insufficient permitted capacity to accommodate solid waste disposal needs.
- Not comply with Federal, State, and/or local statutes and regulations related to solid waste.

3.18.4.2.3 Power

For the purposes of this EIS/EIR, impacts on power would be significant if an alternative would do the following:

- Require or result in the construction of new facilities or expansion of existing facilities, the construction of which could cause significant environmental effects.
- Result in insufficient power supplies available to serve existing customers.

3.18.4.3 Effects Determinations

3.18.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, no deconstruction or construction would occur at the Four Facilities. Thus, no change to risk of public safety as a result of construction related safety risks, emergency routes, or wildland fires would occur under the No Action/No Project Alternative. Because no deconstruction or construction activities would occur under the No Action/No Project Alternative, no changes in the provision of public services and utilities would result from the No Action/No Project Alternative.

Under the No Action/No Project Alternative, hydropower generation would continue subject to the conditions of the Bureau of Reclamation (Reclamation) Biological Opinions, which could have the potential to decrease hydropower production. Hydropower generation is controlled by the allowed ramping rates in the J.C. Boyle Bypass Reach and the minimum flow requirements downstream from Iron Gate Dam allowed by the annual license (see Chapter 2 for a description of these requirements). Until a new license is issued, operations would continue under the annual license terms and the terms of the Biological Opinions issued by Reclamation with consultation from National Oceanic and Atmospheric Administration Fisheries and the U.S. Fish and Wildlife Service (Reclamation 2010). The flows downstream from Iron Gate Dam are governed by the 2010 Biological Opinion, which supersede the terms of the annual license. However, the flows and ramp rates downstream from J.C. Boyle Dam are still governed by the FERC project license. Peaking generation would continue, but the flow limitations would not allow “no load to full two-unit peaking events” which is able to

increase flows by up to 3,000 cfs (PacifiCorp 2006). Two- unit operations would only be done when inflows to J.C. Boyle are high enough to run both units, or run one unit in continuous operation and use the second unit for peaking generation. PacifiCorp estimates that power generation would be reduced by 40 percent over the long term at J.C. Boyle, and by up to 100% during summer time peak demand periods due to the daily flow change limits discussed above. However, PacifiCorp maintains adequate power supplies to provide service to its customers in the Project Area. **There would be no change from existing conditions for the provision of hydropower from the No Action/ No Project Alternative.**

Ongoing Management Activities

Construction activities related to the ongoing restoration and management activities could impact public health and safety. Under the No Action/No Project Alternative, there would be some limited construction activities associated with ongoing habitat restoration projects. Construction associated with these projects would be short term and an applicable public health and safety plan would be developed for each project to ensure construction workers and the public were not adversely affected during construction and operation. **There would be no impact to public health and safety from these ongoing management activities**.

3.18.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

The Proposed Action involves removal of all features, with the exception of buried features, at the Four Facilities.

Construction activities could result in public health and safety risks. Earthwork and blasting have the potential to cause injuries from flying rock and other debris. Large construction vehicles and other equipment used for deconstruction and activities (referred to in this document as construction equipment) operating in and around the project area would pose a safety hazard to the general public. Work within waterways would pose hazards to boaters, if boating were allowed in the construction zone. **Construction impacts on public health and safety would be significant, but Mitigation Measure PHS-1 would reduce this impact to a less-than-significant level.**

Construction activities could increase public hazards by placing construction equipment in waterways, roadways, and other areas accessible by residents, recreational visitors, and potential spectators of the deconstruction activities. The dam demolition and construction areas (referred to in this sub-section as construction areas) would be closed off to the public while they are under construction to reduce hazards; however, the use of the roadways for truck hauling of materials could interfere with existing emergency evacuation plans and increase response times for emergency vehicles. Due to the rural nature and the low concentration of roads in the area, most roads are used as evacuation routes in the event of fire or other emergencies. Figure 3.18-2 shows the locations of the hospitals and fire stations within the area of analysis. Figure 3.23-1 in Section 3.23, Noise and Vibration shows potential haul routes that would be used for transporting materials as part of the Proposed Action. Although the dams are not directly on major

roadways (Route 66, Copco Road, and Interstate 5), these roads would likely need to be accessed to transport materials and equipment to and from the dam sites and to landfills or nearby borrow areas for disposal. **The placement of construction equipment in areas potentially accessible by residents and recreational visitors would be a significant impact. The use of the roadways for truck hauling of materials could also be a significant impact on public safety. Implementation of Mitigation Measures PHS-1 and PHS-2 would reduce these impacts to a less-than-significant level.**

Construction and demolition activities could increase the risk of wildfires. As shown in Figure 3.18-3, the fire threat in the areas surrounding the Four Facilities is categorized as high to very high (CalFire 2007). During the dry season, the areas surrounding J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs are at risk for wildfires, particularly at the interface between residential development and open space. Deconstruction activities, particularly those that may result in accidental spills of flammable liquids or use of equipment that generates heat, such as welding, grinding, torch-cutting, gas and diesel generators, and other construction activities could result in open sparks or flame in vegetated open space could further aggravate the risk of fire. **The risk of fire would be a significant impact to public health and safety, but implementation of Mitigation Measure PHS-2 would reduce this impact to a less-than-significant level.**

Removal of the dams could eliminate a water source for wildfire services and could increase response times. Currently, helicopter fire crews use water from the reservoirs and the Klamath River to fight wildfires in the project vicinity (Dodds 2010). Under the Proposed Action, removal of the J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs would remove a potential water source for fire fighting. The Klamath River would remain after dam removal, and surface water modeling (described in Section 3.6, Flood Hydrology and Section 3.8, Water Supply/Water Rights) indicates that flows in the Klamath River downstream from the removed dams would remain unchanged. As such, helicopter fire crews could still obtain water from the Klamath River, Ewauna Lake, or Upper Klamath Lake.

The loss of the reservoirs could increase turnaround times for helicopters fighting wildfires in the project area. While it is possible for some specialized equipment to fill the water tanks from water bodies with depths as little as 18 inches, others require depths in excess of 36 inches, depending on the equipment used and the discretion of the pilot (personal communication, Henderson Aviation, January 19, 2011). Therefore, use of the Klamath River as an alternate source of water might be possible after removal of the reservoirs. However even in remote areas wildfires originate in the wildland urban interface. As discussed, the loss of the reservoirs could increase turn-around time for helicopters refilling buckets but the presence of the Klamath River and nearby reservoirs would still provide a water source for fighting fire in the wildlands surrounding the Copco area. Initial response times would not be changed by the loss of the reservoirs, and existing fire fighting assets, such as the air tankers in Klamath Falls, and the water

source of Lake Ewauna, would still be in place and available. **The loss of the reservoirs would have a less than significant impact on fire suppression in the area.**

Removal of the reservoirs could eliminate a water source for residential firefighting in and around Copco Village, potentially increasing the risk to homes from fire. Comments received during the scoping period expressed concern that the loss of the reservoirs, particularly Copco 1 Reservoir, could endanger the existing residential areas by removing an easily accessible water source for both engines and helicopters. As discussed, the loss of the reservoirs would increase turn-around time for helicopters refilling buckets, and could eliminate easily accessible water sources for trucks, and increase turn-around times for trucks operating in the Copco Village. The presence of the Klamath River, existing water systems, and existing fire fighting resources ensures that assets for firefighting are present in the area. **The loss of Copco 1 Reservoir would have a less than significant impact on the water supply for residential firefighting in and around Copco Village.**

Implementation of the Proposed Action could affect police services. Construction activities would involve staging and stockpiling areas and equipment that would be kept on-site for the duration of construction. Security services would be provided by the construction contractor and would not increase the need for police services or the number of police personnel. **There would be no change from existing conditions in police services.**

Implementation of the Proposed Action could require the use of electricity and natural gas supplies in the study area. Implementation of the Proposed Action would require the use of heavy equipment to draw down and deconstruct the dams. The Dam Removal Entity (DRE) would supply power for these activities using gasoline and diesel-powered generators; power for these activities would not originate from the grid. No natural gas would be used for implementation of the Proposed Action. Thus, there would be no demand for municipal electricity or natural gas supplies during deconstruction as part of the Proposed Action, and would be no resulting increase in demand on these utilities. **There would be no change from existing conditions for electricity or natural gas supplies in the study area due to construction activities.**

Under the Proposed Action, recreational facilities currently located on the banks of the existing reservoirs would be removed following drawdown and could affect public health and safety. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities will be removed. The deconstruction could have health and safety impacts as a result of the construction equipments and work site safety issues. **The removal of the recreational facilities could impact public health and safety. The implementation of Mitigation Measures PHS-1 and PHS-2 would reduce these impacts to less-than-significant**

Implementation of the Proposed Action could affect public services and utilities in the counties and cities in the study area. Construction of the Proposed Action would result

in short-term population increases in the area from construction workers. There could be a maximum of 100–220 workers during overlap in construction schedules for removal of all four dams. Construction workers could remain in the area for the duration of deconstruction, a period of approximately 1 year. While many of these workers might already live in the surrounding communities described under the affected environment, the need for construction workers could result in an influx of people in the area as out of area workers and their families move in for the duration of the project. Because deconstruction activities would occur temporarily, no permanent population increases would be expected. Therefore, no permanent increase in demand of public services or utilities would occur. There would not be a need for the construction of new government facilities such as water supply, wastewater treatment, or stormwater drainage.

Construction workers working at the deconstruction sites would require restroom facilities which would be provided by portable units. No other utilities would be required at the construction site. Construction workers would not deteriorate service ratios and would not require any new utilities. **Public service and utility impacts would be temporary and less than significant.**

Implementation of the Proposed Action could result in the need for new roads. Transportation of dam waste materials would require the development of haul roads. All new roads would be temporary and would be developed and maintained by the DRE. The DRE would remove temporary roads and return the road areas to their previous conditions after deconstruction is complete. No new public roads would be required for the Proposed Action; therefore, there would be no impact on local government services responsible for road maintenance. **The construction of new haul roads would result in less than significant impacts on local roads and government services.**

Implementation of the Proposed Action could affect road conditions. Construction equipment could stress road beds, causing cracking and settling, and increase the amount of maintenance and repairs that would be required to keep the roads in serviceable condition (see Section 3.22, Traffic and Transportation for more details). Indicators of road impacts, such as rutting and unevenness in the road surface, surface cracking, and road bed slumping could occur. Roadway effects would vary based on climate, the weight of the trucks and their loads, the composition of traffic, and other variables. However, the DRE would be responsible for repairing any road damage under the terms of the construction contract. **Impacts on road conditions would be less than significant given the terms of the construction contract.**

Activities associated with the Proposed Action could generate a substantial amount of solid waste that would exceed capacity of facilities to receive the waste. The Proposed Action would involve removal of all appurtenant features, with the exception of buried features, at the Four Facilities. Although activities associated with deconstruction would generate a substantial amount of solid waste, material recycling would reduce the amount of waste disposed in landfills in the surrounding counties. At J.C. Boyle Dam, waste concrete and earth materials would be used to refill the original borrow pits on the right

abutment of the dam and also would be placed into the eroded scour hole through the hillside below the forebay spillway structure. For Copco 1 and Copco 2 Dams, concrete rubble would be buried on the right abutment within an on-site disposal area at Copco 1 Dam. At Iron Gate Dam, excavated embankment materials would be disposed of 1 mile upstream of the dam on the left abutment at the original borrow site. Approximately 300,000 cubic yards (yd^3) of excavated embankment material would be used to fill the concrete-lined side channel spillway, chute, and flip-bucket terminal structure[1]. Concrete rubble from Iron Gate Dam would be buried within an on-site disposal area.

All mechanical and electrical equipment from the J.C. Boyle Dam would be hauled to the Klamath Falls Landfill, while mechanical and electrical equipment waste from Iron Gate, Copco 1, and Copco 2 Dams would be hauled to the Yreka Transfer Station. At both the Klamath Falls Landfill and the Yreka Transfer Station, mechanical and electrical equipment and scrap metal would be salvaged and recycled.

As shown in Table 3.18-6, the total amounts of inert solid waste generated under the Proposed Action would be 1,241,500 yd^3 of earth, 126,000 yd^3 of concrete, 4,500 tons of rebar, and 7,200 tons of metals. As described above, all of the waste concrete and earth are expected to be disposed of in on-site disposal areas or in the original borrow pits. A portion of the metals would be recycled, in accordance with relevant construction debris recycling regulations, at the Yreka Transfer Station, the Yreka Sanitation Landfill, and the Klamath Falls Landfill. Given that the combined remaining permitted Class III landfill capacity available at the Klamath Falls Landfill and the Yreka Solid Waste Landfill is 4.3 million yd^3, the regional landfills in the surrounding counties would be capable of handling the additional waste generated by the Proposed Action. In addition, Dry Creek Landfill, also in the vicinity of the project area, has 165 million yd^3 of disposal capacity, and could be utilized for disposal.

With the majority of the earth and concrete to be disposed of on-site, and the availability of recycling facilities for the metals and rebar removed from the Facilities, the landfills described in Table 3.18-3 will receive less than the total amount of debris described in Table 3.18-6. The disposal capacities of the existing surrounding landfills are anticipated to be sufficient for the waste generated by the Proposed Action, and the waste generated would not conflict with the solid waste policies and objectives of AB939. **The solid waste impacts associated with the Proposed Action would be less than significant.**

[1] A Flip-Bucket is a type of energy dissipater that takes excess water from the reservoir and directs it downstream at a sufficient distance to prevent the spillover from creating a plunge pool or otherwise eroding the footing of the dam (Bureau of Reclamation, Development of Hydraulic Structures, Thomas J. Rhone, 1988. http://www.usbr.gov/pmts/hydraulics_lab/history/Rhone/index.html)

Table 3.18-6. Summary of Solid Waste Generation for Each Action Alternative

Dam Location	Earth[2] (yd^3)	Concrete[2] (yd^3)	Metal (tons)	Wood – Hazmat[1] (tons)	Rebar (tons)
Proposed Action - Full Facilities Removal					
J.C. Boyle	140,000	40,000	3,000	-	2,400
Copco No. 1	-	62,000	1,200	-	900
Copco No. 2	1,500	12,000	2,000	550	600
Iron Gate	1,100,000	12,000	1,000	-	600
Total	**1,241,500**	**126,000**	**7,200**	**550**	4,500
Partial Facilities Removal of Four Dams					
J.C. Boyle	140,000	20,000	2,000	-	1,200
Copco No. 1	-	57,500	200	-	600
Copco No. 2	0	4,500	500	550	200
Iron Gate	1,100,000	8,000	500	-	400
Total	**1,240,000**	**90,000**	**3,200**	**550**	2,400
Fish Passage at Four Dams					
J.C. Boyle	-	2,800	-	-	90
Copco No. 1	-	5,800	-	-	190
Copco No. 2	-	1,000	-	-	30
Iron Gate	-	7,000	-	-	230
Total	-	**16,600**	-	-	**540**
Fish Passage at Two Dams					
J.C. Boyle	-	2,800	-	-	90
Copco No. 1 (removed)	-	62,000	1,200	-	900
Copco No. 2	-	1,000	-	-	30
Iron Gate (removed)	1,100,000	12,000	1,000	-	600
Total	**1,100,000**	**77,800**	**2,200**	-	**1,620**

Source: Reclamation 2012
Notes:
[1] Wood power poles not included. See Section 3.21, Toxic/Hazardous Materials for further information regarding wood waste.
[2] In-place volumes shown. Increase volumes by 20 percent for earth and 30 percent for concrete for transportation purposes.
Key:
yd^3: cubic yards

The Proposed Action would remove existing hydropower facilities, resulting in a loss of hydropower. Under the Proposed Action, four of the seven power generating facilities of the KHP would be removed. PacifiCorp would continue to own its Fall Creek Facility, and its continued operation is not part of the Secretarial Determination. Also, as noted above, PacifiCorp proposed to decommission its East Side and West Side facilities as part of relicensing (FERC 2007). The installed capacity of the Four Facilities that would be removed is approximately 163 MW and FERC rates the project's dependable capacity as

42.7 MW[2] (CEC 2006). As shown in Table 3.18-4, the Klamath Hydroelectric Project has a total average annual electric output of 716,800 MWh, while the Four Facilities under consideration have an annual average output of 686,000 MWh (FERC 2007).

Dam decommissioning would require replacement power to serve the customers in the project area. According to the Western Electricity Coordinating Council's (WECC) 2009 Power Supply Assessment, the Northwest region has a large surplus power supply resulting from increased generating resources and a demand reduced due to the economic downturn; however, this surplus may be overstated based on the way the power supply model solves supply deficits (WECC 2009).

In addition to the surplus, the power is generated in the Northwest with hydroelectric facilities, which are able to provide peaking power, but not sustained heavy load production (WECC 2009). Nevertheless, all energy forecasts show the Northwest region having an energy surplus at the beginning of the 2010 forecast period that, while in decline over the study period (2010 – 2018), are sufficient to meet the needs of the sub region through 2018 (WECC 2009). The surplus capacity may not be able to be sustained over a prolonged cold spell or heat wave, due to the nature of hydro generation.

Removal of the Four Facilities would result in the loss of 163 MW of nameplate capacity, or 686,000 MWh from the Northwest Power Pool. This accounts for approximately 1.8 percent of PacifiCorp's power portfolio. While the loss of the power generated may have some impact to the local area, the effects of the loss to the Northwest Power Pool, in light of the scale of the additional generation needed to meet demand over the next 10 years, is minimal.

With the generation capacity of most of the KHP gone, PacifiCorp would be required to buy replacement power on the open power market (PacifiCorp 2004). Given the loss of the KHP, PacifiCorp would need to purchase at least 42.7 MW from other sources to meet their obligations (PacifiCorp 2004).

PacifiCorp's Integrated Resource Plan for 2008 discusses a number of different technologies for meeting the power needs in the Northwest Region forecast for 2018: geothermal, wind, natural gas, coal, and cogeneration (PacifiCorp 2010). Each of the replacement power options would involve some uncertainty specific to the power source.

[2] Dependable capacity is the MW output of a generator or group of generators during a period of low water or other operational constraints that coincide with a peak electrical system load -- essentially a worst case scenario for generation capacity, where low water coincides with peak demand. The dependable capacity is the number of megawatts that can be produced for at least four to six hours under these conditions. This is generation based on real world operations at a hydropower generating facility, whereas nameplate capacity is the amount of power that the turbines are capable of generating with all other conditions being perfect (CEC 2003).

Natural gas plants would require a large amount of fuel, and the future costs and availability of gas supplies are uncertain (PacifiCorp 2004). Cogeneration facilities use excess steam from industrial plants, and the technology is a common form of power generation; however, cogeneration would require an industrial partner and the siting of a potential cogeneration plant (PacifiCorp 2004). Coal plants would require longer construction times and cost more than natural gas plants, but would have much lower operational costs (PacifiCorp 2004). The major issue associated with coal fired plants would be the uncertainty of future carbon tax prices, which could increase the overall cost of the power. The climate change and green house gas emission consequences of these replacement power alternatives are addressed in Section 3.10, Greenhouse Gases/Global Climate Change.

In addition to replacement power, the electrical transmission system that delivers power from existing generation plants in the northwest to the Klamath area is in need of investment. PacifiCorp is planning a series of transmission system upgrades and additions (PacifiCorp 2011a). This project, called the Energy Gateway Transmission Expansion, is intended to upgrade the western electrical transmission system, which has not received a major upgrade in nearly 20 years (PacifiCorp 2011a). Transmission constraints remain an impediment to delivering replacement power to the KHP area. PacifiCorp is currently planning a new transmission line that will connect eastern Idaho to Southern Oregon at the Captain Jack substation outside of Klamath Falls, Oregon (PacifiCorp 2011b). The line would help to balance and transfer the power generated in PacifiCorp's East Side region with the demand in the West (PacifiCorp 2011b).

In addition to the replacement power options and the planned transmission upgrades, PacifiCorp acquired the 520 MW Chehalis gas plant (PacifiCorp 2010). In 2006, MidAmerican Energy Holding Company purchased PacifiCorp from ScottishPower. As a condition of the purchase, MidAmerican agreed to PacifiCorp's preexisting commitment to obtain an additional 1400MW of renewably sourced energy by 2015 if cost effective, and to bring 400MW of renewable energy online by the end of 2007 (Oregon Public Utilities Commission 2006).

Under the Klamath Hydroelectric Settlement Agreement, the United States Department of the Interior would acquire power from the Bonneville Power Administration (Klamath Basin Signatories 2010). The power would be delivered to the Captain Jack or Malin substations, and transferred by PacifiCorp to customers throughout the company's service area (Figure 3.18- 4, PacifiCorp Service Area). In summary, even without implementation of the Proposed Action, there would be a need to build more generating capacity generally across the Northwest over the next 10 years; PacifiCorp's plans to upgrade transmission capacity; and the KHP's capacity is relatively small in relation to

the overall demand and generation capacity in the Northwest region. **The loss of electrical generating capacity/ hydropower from the Proposed Action would be a less than significant impact[3].**

The loss of the reservoirs could increase available mosquito habitat and increase the risk of disease transmission. During scoping, members of the public raised a concern that the loss of the lakes would result in an increase in swampy lands and standing water in the footprint of the current reservoirs. The additional standing water could provide mosquito breeding habitat, increasing mosquito population numbers and the chances of disease transmission through insect bites. However, the removal of the reservoirs will reduce the amount of standing water in the vicinity of the existing lakes by returning the river to its free flowing condition. The removal of the reservoirs, the increase in flow to the Klamath River, and the restoration of the river channel will result in less standing water than currently exists in the long term. **The removal of the reservoirs would increase the amount of mosquito breeding areas in the short term, and would have a less than significant impact on disease transmission.**

Keno Transfer

Under the Proposed Action, the Keno Facility would be transferred to the DOI, which could cause adverse effects to Public Health and Safety. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on Public Health and Safety, Utilities and Public Services, Solid Waste, or Hydropower compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **Therefore, the Keno Transfer would result in no change from existing conditions and would have no impact on public health and safety and public utilities.**

East and Westside Facilities- Programmatic Measures

Under the Proposed Action, the East and Westside Facilities will be decommissioned, resulting in the loss of generated power. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals.

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[3] This lost hydropower analysis significance determination relies on facility production rates provided in the 2007 FERC Final EIS. As noted these production rates currently account for approximately 2% of PacifiCorp's total production portfolio (CEC 2006). Potential upgrades that would improve the efficiency and maximum capacity of the hydroelectric project have been estimated to provide 22% improvements in power production efficiency (Auslam et al 2011). While a number factors influence power production, if this 22% increase in power production efficiency were directly applied to the project's annual average electric output of 716,800 megawatts hours, the Klamath Hydroelectric Project output would increase to approximately 860,160 megawatts hours which would account for approximately 2.5% of PacifiCorp's total production portfolio, assuming no other changes in the portfolio. As noted in this section PacifiCorp has system wide efficiency and power production upgrades planned to meet forecasted power shortages in 2018. These upgrades are assumed to replace the power production lost from dam removal even with the potential efficiency upgrades and the determination that this impact would be less than significant would not change.

Following decommissioning of the facilities there will be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. As shown in Table 3.18-4, the total combined power generating capacity of the facilities is approximately 3.8 MW. The loss of these facilities would not impact PacifiCorp's ability to provide power to the region. The complete decommissioning of the facilities, according the terms of the appropriate public health and safety plan would have no impact to Public Health and Safety. **The impact to public health and safety and public utilities from the decommissioning of the East and Westside Facilities would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The Proposed Action deconstruction could affect the City of Yreka's municipal water supply. As described in the environmental setting, the City of Yreka's municipal water supply pipeline passes under Iron Gate Reservoir and could be affected during construction activities. To avoid potential disruption to the city's water supply, the DRE would construct a pipe bridge to suspend the pipeline above the river during and following construction. The work on the pipeline would be planned and implanted in such a way that the pipe would be disconnected for only a short period of time, as dictated by the existing storage capacity, to avoid disrupting water service to the City of Yreka. Thus, there would be no disruption in municipal water supply under the Proposed Action. **The deconstruction of Iron Gate Dam would have a less than significant impact on the City of Yreka's water supply.**

The proposed above-ground location of the City of Yreka water supply pipeline could increase the risk of vandalism to the pipeline. The proposed pipeline would be suspended from a pipe bridge over the Klamath River, increasing the risk of vandalism to the exposed pipe. PacifiCorp has an above-ground pipeline at J.C. Boyle, and they have found that the pipeline has occasionally been the target of vandalism (including shooting). The vandalism, however, has not penetrated the pipe or disrupted the use of the pipe. During the design process, the Lead Agencies would work with the City of Yreka to design the pipe walls and coating to be bullet resistant, thereby reducing the potential public health impact. The areas around the pipeline would be fenced to prevent physical access to the pipe from the river bank. **With the proposed fencing and design elements, the risk of a disruption in service or damage to the City of Yreka Water Supply Pipeline due to vandalism would be less than significant.**

KBRA – Programmatic Measures

The KBRA includes several programs that could affect utilities and public services, solid waste, and power, including:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- On-Project Plan
- Water Use Retirement Program

- Power for Water Management Program
- Emergency Response Plan
- Fish Entrainment Reduction

Prescribed burning and mechanical thinning under the Phases I and II Fisheries Restoration Plans could affect public services and utilities. Prescribed burning and mechanical thinning in forests are KBRA actions associated with the Fisheries Restoration intended to mimic natural fire regimes. The efforts reduce the potential for catastrophic fires and subsequent erosion by reducing the available fuel sources for wild fire.

Prescribed burning can affect public services by using public resources to monitor and manage burning which can leave other areas more vulnerable during the prescribed burn. Mechanical thinning has limited effects on utilities and public services. There is some potential for damage to utility lines from falling trees and branches, but these are minimal and addressed through project level plans and environmental analysis. Adverse effects are short term and less than significant and addressed through proper project planning.

Burning and thinning also have long term beneficial effect to public services. These fuel reduction treatments help to slow wildfires, provide defensible areas, and increase the natural resistance to wildfire by removing excess fuels that can help increase the chance that a wildfire will have catastrophic impacts. The long term benefits of fuel reduction in terms of fire prevention outweigh the adverse effects of the actions. The timing of and specific locations where these burning and thinning actions could be undertaken is not certain but it assumed that some of these actions could occur at the same time and in the vicinity of the hydroelectric facility removal actions analyzed above. The short term effect burning and thinning actions could contribute to the significant impact to public services and utilities of construction activities associated with hydroelectric facility removal. As described above the affect of facility removal on fire risk could be reduced to a less than significant level with mitigation reducing the severity of any interaction with burning and thinning actions. **The effects of prescribed burning and mechanical thinning could be potentially significant in the short term, but implementation of Mitigation Measure PHS-2 would reduce this impact to a less than significant level. The long term effects of fuel reduction are beneficial. Implementation of Prescribed Burning and Mechanical Thinning under the Phases I and II Fisheries Restoration Plans will require future environmental compliance as appropriate.**

Construction activities associated with the KBRA programs could result in public health and safety impacts. Potential construction activities could include a variety of restoration actions and habitat improvements. The Fisheries Reintroduction and Management Plan, the Wood River Wetland Restoration, and elements of the On-Project Plan contain construction components that could have distinct health and safety issues related to the construction activities. Prior to implementing construction, an applicable public health and safety plan would be developed to ensure construction workers and the public would not be adversely affected during construction and operation. **Impacts from the**

restoration and habitat improvement action in the KBRA on public health and safety and public utilities are expected to be long term and beneficial. Some short-term impacts related to construction activities could occur during the implementation of the restoration and habitat improvement projects. Implementation of these restoration and habitat improvement actions will require future environmental compliance as appropriate.

Implementation of the Power for Water Management Program could create new renewable energy sources. Implementation of the Power for Water Management Program (KBRA Section 17) would provide affordable electricity to eligible users to allow efficient use, distribution, and management of water. This could also involve the development of renewable energy sources, which would provide green energy. This would be a beneficial effect on public utilities. Implementation of the Power for Water Management Program will require future environmental compliance as appropriate. **The Power for Water Management Program would have long term, beneficial effects to public utilities.**

Completing the Emergency Response Plan could have beneficial effects on Public Services and Public Safety. The Emergency Response Plan is intended to prepare water managers and emergency responders for potential failure of Reclamation's Klamath Project dikes or other facilities that affect the storage and delivery of water to Reclamation's Klamath Project irrigators. The plan will include a process to prepare for potential emergencies, identify available funding sources for responding to emergencies, a prioritization method for funding emergency responses, and a process to implement emergency responses. The response plan will create new protocols for emergency responders in the area, but new funding sources would offset the costs of training and planning required to prepare effectively for the emergencies covered in the plan.

The Emergency Response Plan could rely on alternative sources of water to meet the irrigation requirements of Reclamation's Klamath Project irrigators. This could reduce local water supplies and effect public utilities in the event of an emergency. These effects would be short term, until the emergency was addressed and supplies rebounded after the use of emergency supplies was finished. **The effects of the Emergency Response Plan on public health and safety would be beneficial as the Plan is intended to address impacts from a failure of the levies and other infrastructure that could adversely affect health and safety. Any impacts to utilities and public services from creating the plan would be beneficial by improving the capacity of local agencies to respond to emergencies.**

3.18.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities Removal of Four Dams Alternative, certain project features would be retained, while meeting the requirements for a free-flowing river and for volitional fish passage through all four dam sites. There would be no appreciable difference between the impacts of the Partial Facilities Removal of Four Dams and the Proposed Action Alternatives, except as noted below. As it would be for the Proposed

Action, implementation of Mitigation Measures PHS-1 and PHS-2 would mitigate the impacts of the Partial Facilities Removal of Four Dams Alternative to a less-than-significant level.

Retained structures could have the potential to result in public health and safety risks. The presence of powerhouses, tunnels, penstocks and other equipment would have the potential to cause injuries resulting from entrapment and falls. Implementation of this alternative would include installing appropriate fencing and blocking access to retained facilities. **These safety hazards would be a less than significant impact given that fencing and access restrictions are part of the construction activities associated with the project.**

Construction activities could generate a substantial amount of solid waste that would exceed the capacity of facilities to receive the waste. Under the Partial Facilities Removal of Four Dams Alternative, certain project features would be retained, while meeting the requirements for a free-flowing river and for volitional fish passage through all four dam sites. As with the Proposed Action, construction and demolition activities would produce solid waste. As shown in Table 3.18-5, the total amount of inert solid waste that would be generated under the Partial Facilities Removal of Four Dams would be 1,240,000 yd^3 of earth, 90,000 yd^3 of concrete, 2,400 tons of rebar, and 3,200 tons of metals. As with the Proposed Action, all the waste concrete and earth would be disposed in on-site disposal areas or in the original borrow pits, and a portion of the metals would be recycled, in accordance to relevant construction debris recycling regulations, at the Yreka Transfer Station, the Yreka Sanitation Landfill, and the Klamath Falls Landfill. In addition, Dry Creek Landfill, also in the vicinity of the project area, has 165 million yd^3 of disposal capacity, and could be utilized for disposal. The disposal capacities of the existing surrounding landfills are anticipated to be sufficient for the waste generated by activities associated with the Partial Facilities Removal of Four Dams Alternative, and the waste generated would not conflict with the solid waste policies and objectives of AB939. **The solid waste impacts associated with the Partial Facilities Removal of Four Dams Alternative would be less than significant.**

East and Westside Facilities – Programmatic Measures

The effects of the decommissioning of the East and Westside Facilities would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The Proposed Action deconstruction could affect the City of Yreka's municipal water supply. As described in the environmental setting, the City of Yreka's municipal water supply pipeline passes under Iron Gate Reservoir and could be affected during construction activities. To avoid potential disruption to the city's water supply, the DRE would construct a pipe bridge to suspend the pipeline above the river during and following construction. The work on the pipeline would be planned and implanted in such a way that the pipe would be disconnected for only a short period of time, as dictated by the existing storage capacity,

to avoid disrupting water service to the City of Yreka. Thus, there would be no disruption in municipal water supply under the Proposed Action. **The deconstruction of Iron Gate Dam would have a less than significant impact on the City of Yreka's water supply.**

The proposed above-ground location of the City of Yreka Water Supply Pipeline could increase the risk of vandalism to the pipeline. The proposed pipeline would be suspended from a pipe bridge over the Klamath River, increasing the risk of vandalism to the exposed pipe. PacifiCorp has an above-ground pipeline at J.C. Boyle, and they have found that the pipeline has occasionally been the target of vandalism (including shooting). The vandalism, however, has not penetrated the pipe or disrupted the use of the pipe. During the design process, the Lead Agencies would work with the City of Yreka to design the pipe walls and coating to be bullet resistant, thereby reducing the potential public health impact. The areas around the pipeline would be fenced to prevent physical access to the pipe from the river bank. **With the proposed fencing and design elements, the risk of a disruption in service or damage to the City of Yreka Water Supply Pipeline due to vandalism would be less than significant.**

KBRA – Programmatic Measures

The KBRA would be fully implemented under this alternative. The public health and safety, public services, and hydropower impacts of the KBRA under the Partial Facilities Removal of Four Dams Alternative would be the same as for the Proposed Action.

3.18.4.3.4 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, no facilities removal would be conducted at the Four Facilities. Fish passageways will be built at each of the Four Facilities in the form of pool & weir, vertical slot, ice harbor, or hybrid fish ladder with auxiliary water systems. The impacts associated with the Fish Passage at Four Dams Alternative would be similar to those of the Proposed Action, except as noted below. As it would be for the Proposed Action, implementation of Mitigation Measures PHS-1 and PHS-2 would mitigate the impacts of the Partial Facilities Removal of Four Dams Alternative to a less-than-significant level.

Construction activities could generate solid waste that would exceed the capacity of facilities to receive the waste. Under this alternative, construction of fish passageways would generate solid waste. As shown in Table 3.18-5, the total amount of inert construction solid waste generated under the Fish Passage at Four Dams Alternative would be 16,600 yd^3 of concrete and 540 tons of rebar from demolition and replacement of the existing fish ladder at J.C. Boyle Dam. As with the Proposed Action, all of the waste concrete is expected to be disposed of in on-site disposal areas or in the original borrow pits and a portion of the metals would be recycled, in accordance to relevant construction debris recycling regulations, at the Yreka Transfer Station, the Yreka Sanitation Landfill, and the Klamath Falls Landfill. In addition, Dry Creek Landfill, also in the vicinity of the project area, has 165 million yd^3 of disposal capacity, and could be utilized for disposal. The disposal capacities of the existing surrounding landfills are anticipated to be sufficient for the waste generated by activities associated with the Fish

Passage at Four Dams Alternative, and the waste generated would not conflict with the solid waste policies and objectives of AB939. **The solid waste impacts associated with the Fish Passage at Four Dams Alternative would be less than significant.**

Impacts on Hydropower resulting from the Fish Passage at Four Dams Alternative would reduce power generation compared to the No Action/No Project Alternative. Providing fish passage at the Four Facilities would allow the hydroelectric facilities to remain in place, but hydropower generation would be subject to significant reduction from additional bypass flows, changes to flows in the peaking reaches, and flows required for fish passage structures as compared with the No Action/No Project Alternative. These additional flow releases would be needed to support fish migration in the J.C. Boyle and Copco 2 bypass reaches and peaking reaches. All dams would require flows to support fish bypass structures.

Although the hydropower loss would vary from 100 percent to 73 percent in the peak demand summer months with additional bypass and fish flows (PacifiCorp 2006), the loss of this power would not require the construction of additional electrical generating facilities or infrastructure, as described under the discussion of Proposed Action effects. **The loss of power would be less than significant.**

3.18.4.3.5 Alternative 5: Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate

Under the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, facilities would be removed at Copco 1 and Iron Gate Dams, and fish passage facilities would be constructed at J.C. Boyle and Copco 2 Dams. Because only Copco 1 and Iron Gate Dams (and not J.C. Boyle or Copco 2 Dams) would be removed under this alternative, there would be less demolition than under the Proposed Action. As it would be for the Proposed Action, implementation of Mitigation Measures PHS-1 and PHS-2 would mitigate the impacts of the Partial Facilities Removal of Four Dams Alternative to a less-than-significant level. The impacts of the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to those of the Proposed Action, except as noted below.

Construction activities could generate solid waste that would exceed capacity of facilities that receive the waste. Under the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, facilities would be removed at Copco 1 and Iron Gate Dams. Fish passage facilities would be constructed at J.C. Boyle and Copco 2 Dams. As with the other action alternatives, construction and demolition activities would produce solid waste.

As shown in Table 3.18-5, the total amount of inert construction and demolition solid waste generated under the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be 1,100,000 yd^3 of earth, 77,800 yd^3 of concrete, 2,200 tons of metals, and 1,620 tons of rebar. As with the Proposed Action, all of the waste concrete and earth would be disposed of in on-site disposal areas or in the original borrow pits and a portion of the metals would be recycled, in accordance to relevant construction debris

recycling regulations, at the Yreka Transfer Station, the Yreka Sanitation Landfill, and the Klamath Falls Landfill. Given that the combined remaining permitted Class III landfill capacity available at the Klamath Falls Landfill and the Yreka Solid Waste Landfill is 4.3 yd^3, the regional landfills in the surrounding counties should be capable of handling the additional waste generated by the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative. In addition, Dry Creek Landfill, also in the vicinity of the project area, has 165 million yd^3 of disposal capacity, and could be utilized for disposal. The disposal capacities of the existing surrounding landfills are anticipated to be sufficient for the waste generated by activities associated with the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, and the waste generated would not conflict with the solid waste policies and objectives of AB939. **The solid waste impacts associated with the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be less than significant.**

Impacts on Hydropower resulting from the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would reduce power generation compared to the No Action/No Project alternative. Under this alternative, Iron Gate and Copco 1 Dams would be removed, leaving Copco 2 and J.C. Boyle Dams. The total authorized power production that would be lost under this alternative would be 38 MW, or 0.4 percent of PacifiCorp's total generating capacity. Additionally, operations of the remaining dams would require bypass flows and fish passage structure flows further decreasing hydropower production, as noted for the Fish Passage at J.C Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative. This alternative would result in a small amount of power lost compared with PacifiCorp current generating capacity and planned generating and transmission capacity upgrades. As discussed for the Proposed Action, PacifiCorp will acquire surplus power from other existing facilities to serve the project area and no additional facilities or infrastructure would be necessary. **The reduced power impacts would be less than significant.**

3.18.4.4 City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The Proposed Action deconstruction could affect the City of Yreka's municipal water supply. As described in the environmental setting, the City of Yreka's municipal water supply pipeline passes under Iron Gate Reservoir and could be affected during construction activities. To avoid potential disruption to the city's water supply, the DRE would construct a pipe bridge to suspend the pipeline above the river during and following construction. The work on the pipeline would be planned and implanted in such a way that the pipe would be disconnected for only a short period of time, as dictated by the existing storage capacity, to avoid disrupting water service to the City of Yreka. Thus, there would be no disruption in municipal water supply under the Proposed Action. **The deconstruction of Iron Gate Dam would have a less than significant impact on the City of Yreka's water supply.**

The proposed above-ground location of the the City of Yreka Water Supply Pipeline could increase the risk of vandalism to the pipeline. The proposed pipeline would be suspended from a pipe bridge over the Klamath River, increasing the risk of vandalism to

the exposed pipe. PacifiCorp has an above-ground pipeline at J.C. Boyle, and they have found that the pipeline has occasionally been the target of vandalism (including shooting). The vandalism, however, has not penetrated the pipe or disrupted the use of the pipe. During the design process, the Lead Agencies would work with the City of Yreka to design the pipe walls and coating to be bullet resistant, thereby reducing the potential public health impact. The areas around the pipeline would be fenced to prevent physical access to the pipe from the river bank. **With the proposed fencing and design elements, the risk of a disruption in service or damage to the City of Yreka Water Supply Pipeline due to vandalism would be less than significant.**

3.18.4.5 Mitigation Measures

3.18.4.5.1 Mitigation Measure by Consequences Summary

Mitigation Measure PHS-1: A public safety management plan will be prepared and implemented to maintain public safety during all phases of construction and demolition. Components of the plan will include the following:

- Public notification of the location and duration of construction and demolition activities, pedestrian/bicycle path/trail closures, and restrictions on reservoir use (i.e., boating, water skiing, fishing, swimming).
- Verification with local jurisdictions that construction blockage of existing roadways will not interfere with existing emergency evacuation plans.
- Verification with local jurisdictions that construction use of existing roadways for truck hauling of materials will not substantially interfere with response times of emergency vehicles.
- Adequate signage will be installed regarding the location of construction and demolition sites and warning of the presence of construction equipment.
- Fencing of construction staging areas and of construction and demolition areas if dangerous conditions exist when construction and demolition are not occurring.
- Temporary walkways (with appropriate markings, barriers, and signs to safely separate pedestrians from vehicular traffic) and detour signage where an existing sidewalk or pedestrian/bicycle path/trail will be closed during construction and demolition.

Mitigation Measure PHS-2: Prior to initiating construction and demolition activities, the Dam Removal Entity, in consultation with the appropriate city, county, and State fire suppression agencies will prepare and implement a Fire Management Plan. The plan will include fire prevention and response methods including fire precaution, pre-suppression, and suppression measures consistent with the policies and standards in the affected jurisdictions. Additionally, fire suppression equipment will be required on-site at all times and emergency contact numbers will be posted in case of a fire. This plan will include provisions that areas of construction and deconstruction work involving welding, grinding, torch-cutting, gas and diesel generators and other construction activities that could result in open sparks or flame be cleared of dried vegetation or wetted-down to prevent wildfires.

3.18.4.5.2 Effectiveness of Mitigation in Reducing Consequence

Implementation of PHS-1 and PHS-2 would reduce potential public health and safety risks to a less than significant level.

3.18.4.6.3 Agency Responsible for Mitigation Implementation

The DRE would be responsible for implementing mitigation measures PHS-1 and PHS-2.

3.18.4.6.4 Remaining Significant Impacts

Following implementation of Mitigation Measures PHS-1 and PHS-2, no significant adverse impacts associated with public health and safety, utilities and public services, solid waste, and power are anticipated.

3.18.4.6.5 Mitigation Measures Associated with Other Resource Areas

Several other mitigation measures require construction, including mitigation measures H-2 (flood-proof structures), GW-1 (deepen or replace affected wells), WRWS-1 (modify or screen affected water intakes), REC-1 (develop new recreational facilities and access to river), TR-6 (assess and improve roads to carry construction loads), and TR-7 (assess and improve bridges to carry construction loads). Construction required for the mitigation measures would not require substantial equipment or materials and would not pose risks to public health or safety. **Construction associated with these mitigation measures would have temporary and less-than-significant effects on public health and safety, solid waste, and public utilities and services. There would be no change from existing conditions for power.**

Mitigation REC-1 would develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. Impacts specific to the relocation of the Recreation Facilities are discussed in Section 3.20, Recreation. The facilities would be built to current standards, and maintained by the final title holder of the exposed land. **The replacement of recreational facilities would have a less than significant impact on public health, safety, solid waste, and public utilities and services. There would be no change from existing conditions for power.**

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3.19 Scenic Quality

This section analyzes the effects on scenic quality from implementation of the Proposed Action and alternatives to the Proposed Action. The analysis primarily entails the identification and description of changes to scenic resources in the landscape. Scenic quality is the essential resource that supports the recreational activity of "sightseeing" discussed in Section 3.20, Recreation. Other potential aesthetic impacts associated with odor, noise and physical contact are described in Sections 3.2, Water Quality, 3.4, Algae, 3.9, Air Quality, 3.20, Recreation, and 3.23, Noise and Vibration.

3.19.1 Area of Analysis

The area of analysis for the evaluation of scenic quality includes the vicinities and the areas within sight lines of the Four Facilities, as well as areas identified as construction/ demolition areas and staging areas for the Proposed Action and alternatives. The area of analysis also includes the Upper Klamath Basin where activities associated with the implementation of the Klamath Basin Restoration Agreement (KBRA) could occur. Because retention or removal of these dams could affect scenic quality aspects such as water clarity, fish viewing opportunities, and riparian and channel characteristics of the river below the dams, the area of analysis also includes the Klamath River from Iron Gate Dam to the Pacific Ocean.

3.19.2 Regulatory Framework

Scenic resources within the area of analysis are regulated by several Federal, State, and local laws and policies, which are listed below.

3.19.2.1 Federal Laws, Authorities and Regulations

- Federal Land Policy and Management Act (43 U.S.C. 1701 et seq.)
- Clean Water Act (CWA) (33 USC § 1251 et seq.)
- Bureau of Land Management (BLM) Draft Upper Klamath River Management Plan Environmental Impact Statement/Environmental Impact Report (EIS/EIR) and Resource Management Plan (RMP) Amendments (2003)
- BLM Klamath Falls Resource Area RMP and Rangeland Program Summary and Record of Decision (1995)
- BLM Visual Resource Management Methodology (1980)
- U.S. Forest Service (USFS), Klamath National Forest Land and RMP (1995)
- Wild and Scenic Rivers Act (WSRA) (16 U.S.C. 1271 et seq.)
- Redding Resource Area RMP and Record of Decision (ROD) (BLM, 1993)
- Klamath Falls Resource Area RMP, ROD, and Rangeland Program Summary (1995)
- U.S. Forest Service (USFS), Six Rivers National Forest Land and RMP (1995)
- USFS Scenery Management System (1995)
- National Park Service (NPS) River Administering Agency

3.19.2.2 State Laws, Authorities and Regulations

- Oregon Parks and Recreation Department, Klamath River Scenic Waterway Rules (Oregon Revised Statute [ORS] 390 et seq.)
- California WSRA (California Public Resources Code [CPRC] Section 5093.54)

3.19.2.3 Local Authorities and Regulations

- Siskiyou County General Plan (1973)
- Siskiyou County Zoning Ordinance (1994)
- Klamath County Comprehensive Plan (2010)
- City of Klamath Falls Comprehensive Plan (1981)
- City of Klamath Falls Community Development Ordinance (1980)
- City of Klamath Falls Parks Recreation and Open Space Master Plan (1998)

3.19.3 Existing Conditions/Affected Environment

This section provides an overview of the basin's scenery resources and how these resources are identified and analyzed through the Visual Resource Management (VRM) process. A description of scenic resources, as defined by the BLM, will be used as the No Action basis for comparison. Per the BLM VRM system, impacts to the affected environment will be evaluated by measuring potential impacts to the current Visual Resource Inventory (VRI) (scenery conditions) as well as perceivable contrast with the characteristic landscape when viewed from Key Observation Points (KOPs).

In response to the Federal Land Policy and Management Act and subsequent agency-specific regulations, Federal land management agencies such as the BLM and USFS developed systems specifically designed to inventory, evaluate and manage for scenic (visual) resources on public lands. To evaluate scenic resources under BLM jurisdiction and to develop management objectives for those resources, the BLM developed the VRM system. Bothe the USFS and BLM's scenery resource goal is to conserve the landscape's natural appearing "characteristic landscape". The BLM's VRM policy consists of three primary components; 1) Maintaining an up-to-date VRI, 2) Establishing VRM Classes as part of RMPs, and 3) Evaluating Project Planning for physical impacts and plan conformance (BLM 2007).

VRI consists of three data components; scenic quality, visual sensitivity, and distance zones (BLM 2007), with a foundational emphasis on protection of the landscape's natural appearing "characteristic landscape". Together, these three elements comprise a final VRI class that reflects the current naturally occurring physical condition of the visual resource within a geographic area. This information defines the existing condition/ affected environment for visual resources. Current state of BLM VRI will be described under the Affected Environment section.

VRI information is considered along with other resource conditions and goals during RMP analysis in order to delineate final VRM Classes for every acre of BLM land. These management classes are not equivalent to the physical condition of the visual resource, but instead, equate to the management goal for a particular area. All BLM

lands are assigned one of four VRM Classes, ranging from Class I, which reflects the highest value and protection for scenery, to Class IV, which reflects the least value and protection for scenery. The VRM Classes represent the baseline for determining plan conformance during project planning. The nature of VRM Class designations applicable to the area of analysis are described later in this section.

BLM uses the contrast-rating system process (BLM 2007) to help assess the degree of visible contrast within primary landscape features, with respect to landscape character elements of form, color, line, and texture. The contrast-rating system is utilized to not only assess the potential physical impacts from ground disturbing activities (and thus impacts to the visual resource inventory, or existing conditions. Degrees of contrast in a range of none/weak/moderate/strong roughly coincide with VRM Class I, II, III, and IV, accordingly.

The USFS has a parallel system, known as the Scenery Management System (SMS). The primary components of the SMS are similar to BLM's VRM system (e.g., BLM's scenic quality versus SMS' inherent scenic attractiveness; visual sensitivity/public concern levels, and distance zones/seen areas and distance zones).

Ownership of lands varies geographically across this Project (see Figure 3.19-1). While the description of the scenic resources within a particular land management agency's jurisdiction will be referenced in respect to agency system terminology, to obtain consistency, the BLM's VRM methodology is used for the entire Project area in terms of describing the potential physical effects to scenic quality, even though only a portion of the project area is actually subject to BLM VRM management objectives.

3.19.3.1 Applicable Visual Resource Management Class Designations within the Area of Analysis

The area surrounding the Four Facilities contains no Class I visual resources. The lands in the area of analysis primarily fall under two classes:

- **Class II** The objective of this class is to retain the existing character of the landscape. The level of change to the characteristic landscape should be low. Management activities may be seen, but should not attract the attention of the casual observer. Any changes must repeat the basic elements of form, line, color, and texture found in the predominant natural features of the characteristic landscape.

- **Class III** The objective of this class is to partially retain the existing character of the landscape. The level of change to the characteristic landscape should be moderate. Management activities may attract attention but should not dominate the view of the casual observer. Changes should repeat the basic elements found in the predominant natural features of the characteristic landscape (BLM 2007).

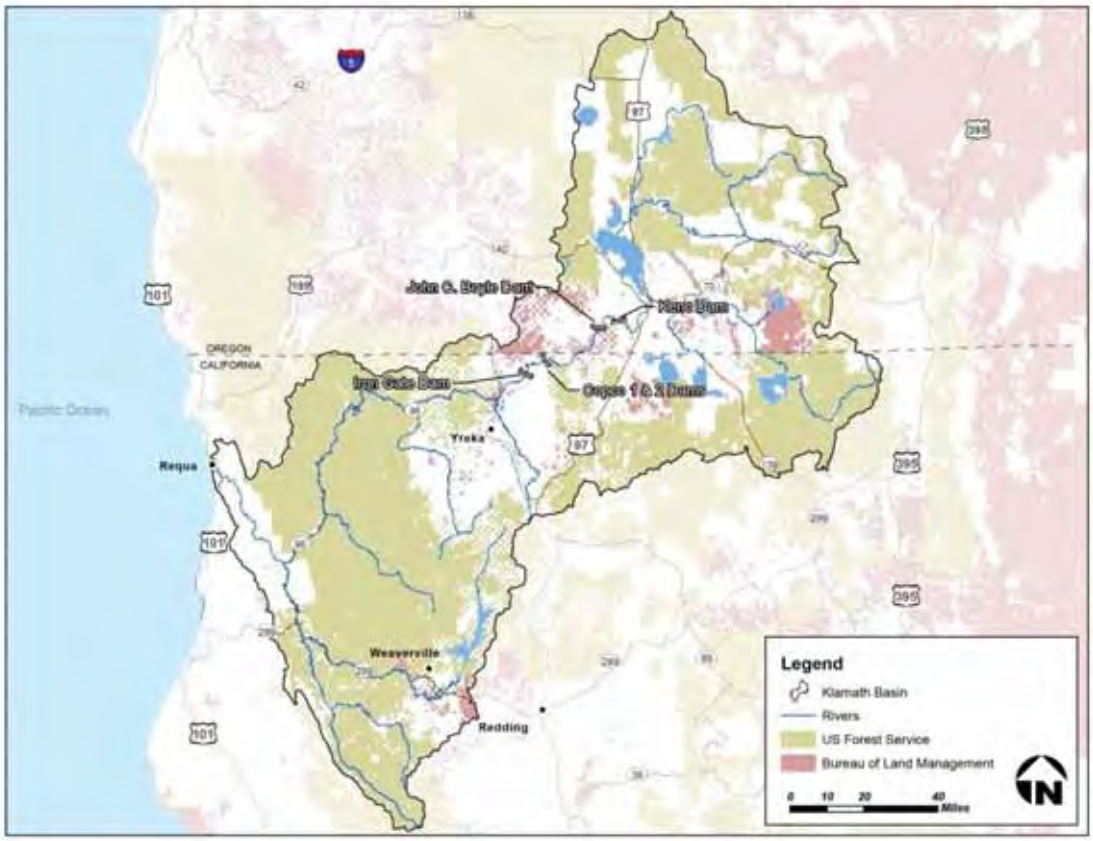

Figure 3.19-1. Project Area Land Ownership for BLM and USFS.

Currently, there is no up-to-date VRI record on file for the BLM lands within the area of analysis, but there is final VRM Class guidance for the area. For the purposes of this document, the site-specific, project level inventory would be limited to the area of analysis as defined in Section 3.19.1 and based upon a combination of original data from the 2004 PacifiCorp Technical Report with additional analysis from several KOPs.

The following represent the conclusions for the baseline VRI within the area of analysis, according to the three components (scenic quality, visual sensitivity, distance zones).

In terms of scenic quality, BLM's VRM methodology classifies public land as either Class A, B, or C scenic quality (inherent scenic attractiveness), with A being the most distinctive and Class C being the most common, in terms of variety of key factors such as; color, water, vegetation, landform, influence of adjacent scenery, scarcity, and cultural modifications (BLM 2007). Analysis by the Lead Agencies concluded that all of the project area would be contained within Class A landscapes because of the following key factors:

- **Color -** Some intensity or variety in colors and contrast of the soil, rock and vegetation, but not a dominant scenic element
- **Water –** Water flowing or still, dominant in the landscape when viewed from most KOPs, but not always clear and clean appearing
- **Vegetation -** A variety of vegetative types as expressed in interesting forms, textures, and patterns
- **Landform -** Steep canyons, some interesting erosional patterns or variety in size and shape of landforms; or detail features which are interesting though not dominant or exceptional
- **Influence of adjacent scenery -** Adjacent scenery moderately enhances overall visual quality
- **Scarcity -** Distinctive, though somewhat similar to others within the region
- **Cultural modifications –** Some modifications add favorably to visual variety while other add little or no visual variety or may be discordant

Based on the point system assigned to each of these key factors, the scenery in the project area scores within the range of Class A scenic quality.

In terms of visual sensitivity, BLM's VRM methodology rates landscapes as either High, Moderate, or Low visual sensitivity to document the public's relative level of concern for visual quality. The Lead Agencies concluded that all of the area of analysis would be considered High visual sensitivity because recreational sightseers are highly sensitive to changes in visual quality, public interest and controversy created in response to proposed activities, portions of the area of analysis are within the viewshed of residential areas, and most of the Klamath River has been designated under the National WSRA.

In terms of distance zone analysis, BLM's VRM methodology classifies public lands as either a Foreground-Middleground, Background, or Seldom Seen. The Lead Agencies concluded that all of the area of analysis would be located with the foreground-middleground distance zone because of the proximity of views from recreational access sites along the river, campgrounds, KOPs along scenic highways, riverside and/or reservoir communities and residences, rivers, or other viewing locations are less than 3 to 5 miles away.

Thus, in combining these three layers according to BLM's VRI Matrix the area of analysis would be classified as a VRM II (Class A scenic quality of high visual sensitivity as viewed from a foreground/middleground distance zone – see highlighted cells in VRI Matrix (Table 3.19-1), from an inventory context.

3.19.3.1.1 Wild and Scenic River Designated Rivers in the Area of Analysis

Several river segments within the Klamath Basin have been designated under the WSRA. Four of these Wild and Scenic River (WSR) segments could potentially be affected by dam removal: the Klamath River (Oregon and California segments), the Sprague River

Table 3.19-1. Visual Resource Inventory Matrix

		Visual Sensitivity						
		High			Medium			Low
Special Areas		I	I	I	I	I	I	I
Scenic Quality	A	II	II	II	II	II	II	II
	B	II	III	III* IV*	III	IV	IV	IV
	C	III	IV	IV	IV	IV	IV	IV
		f/m	b	s/s	f/m	B	s/s	s/s
		DISTANCE ZONES						

Source: BLM 2007
Notes:
Highlighted cells indicate visual resource inventory determinations for the affected environment
*If adjacent area is Class III or lower assign Class III, if higher assign Class IV
Key:
b: background
f/m: foreground/middleground
s/s: seldom seen

and the Sycan River. The Sprague River and Sycan River are in the Fremont-Winema National Forest. Potential scenic impacts to the Sprague and Sycan rivers could result from KBRA project implementation.

When the California portion of the Klamath River was designated under the National WSRA in 1981, “outstandingly remarkable” recreational or scenic values were not identified, only “outstandingly remarkable” fisheries values. Scenic values along WSRs are protected by the WSRA to various degrees but all segments have requirements to maintain at least a generally natural appearance along their waterways. The natural appearing scenic quality within the more immediate and prominent portions of these rivers is protected along these segments by both the National WSRA and applicable Federal agency Land and Resource Plans.

In 1990, BLM found the 5.3-mile section of the Klamath River from the Oregon-California State line to the slack water of Copco 1 Reservoir to be eligible and suitable for WSR designation. The river segment is free-flowing and possesses outstandingly remarkable scenic, recreational, fish, and wildlife values. This river segment is not a designated WSR and is not protected under the National WSRA and its Section 7(a) requirements. BLM is required within its authorities, to protect this suitable river segment’s free-flowing character, water quality, and outstandingly remarkable river values. This segment of the Klamath River is also listed on the Nationwide Rivers Inventory to insure protection of its river values (NPS 2009).

For the Federal Energy Regulatory Commission (FERC) Final EIS (2007), PacifiCorp conducted a detailed visual evaluation of the project vicinity as summarized in the Final EIS (2007) and documented it in the *Land Use, Visual, and Aesthetic Resources Final Technical Report* (PacifiCorp 2004). This evaluation involved identifying and photographing KOPs during different seasons and the reservoirs at different water levels in 2002 and 2003. Figure 3.19-2 shows the locations of the KOPs in the PacifiCorp report (PacifiCorp, 2004). The results of this study are used in the Klamath Facilities

Figure 3.19-2. Key Observation Points from PacifiCorp (2004) Report.

Removal EIS/EIR to establish the existing environmental setting of the area of analysis, and are described below. To verify that current conditions are similar to 2003 conditions, photographs taken from selected locations in October 2010 were compared to the 2003 photographs. Appendix Q presents this comparison. In addition, photographs from the Final FERC EIS (2007) are included in Appendix Q to identify typical scenic/ landscape character along the Klamath River, including its elements of canyon-walled enframement, channel configuration, water clarity, bank and riparian appearance.

3.19.3.1.2 Klamath Basin

The Klamath Basin contains widely varied scenic resources, including wetlands, upland, rangeland, National Wildlife Refuges (NWRs), farmland, timberlands, and urbanized areas. Section 3.5, Terrestrial Resources, provides detailed descriptions of the landscape along the Klamath River throughout the area of analysis. Sightseeing opportunities to enjoy the scenic resources are widely available in the Klamath Basin generally, and more specifically within its three segments (above, between and below the reservoirs created by the Four Facilities). The Upper Klamath Basin includes the headwaters of the Klamath River in south-central Oregon and north-central California, agricultural areas and the Upper Klamath Basin NWR Complex, which comprises six refuges and contains Reclamation's Klamath Project. Scenery in the area served by Reclamation's Klamath Project. Regionally, a variety of public lands contain notable scenic resources. Table 3.20-1 in Section 3.20, Recreation, lists locations in the area of analysis and surrounding region that offer wildlife viewing, and opportunities for sightseeing, leisure driving, photography, and other forms of recreation that benefit from scenic quality within the area of analysis. Section 3.20, Recreation, discusses recreation resources and includes the activity of sightseeing as a key element of the recreation experience.

The Upper Klamath Basin is the area of analysis for scenic resource effects that would be associated with implementation of the KBRA. However, specific locations for actions associated with implementation of the KBRA have yet to be identified, so no specific analysis is possible regarding the effects that would be associated with KBRA implementation in the Upper Klamath Basin. Instead, general effects of the multiple components of the KBRA on scenic resources in the Klamath Basin will be discussed.

The area of analysis for the Klamath Hydroelectric Settlement Agreement (KHSA) includes the Klamath River from J.C. Boyle Dam and reservoir to the Pacific Ocean and the Four Facilities. The following subsections describe scenic resources in the area of analysis.

3.19.3.2 Klamath River

PacifiCorp (2004) viewed seven KOPs from Keno Impoundment to the J.C. Boyle Reservoir, nine KOPs in the J.C. Boyle bypass reach, eight KOPs in the Hell's Corner Reach (the river between J.C. Boyle Powerhouse and Copco 1 Reservoir), seven in the Copco 1 Reservoir area, twelve in the area of Iron Gate Reservoir, and three downstream from Iron Gate Dam. Many of the reaches have similar general characteristics with the aesthetic differences between high flows and low flows varying depending on the

individual physical features (e.g., rocks, vegetation, bends, width of channel, depth of water) of each reach. During low flows, more rocks and vegetation were visible at the river edges than at high flows.

These KOPs are not intended to be comprehensive, but were selected to represent typical views (including scenic overlooks) for members of the public from riverside and/or reservoir communities and residences, recreational access sites, campgrounds, Scenic Byways (Highway [HWY] 96/State of Jefferson Scenic Byway and HWY 96/Bigfoot Scenic Byway), State HWYs 96, 169, and 101. Other "sightseeing areas" below Iron Gate Dam could have potential scenery effects to sensitive public viewpoints.

Klamath River components are part of the National Wild and Scenic Rivers System (NWSRS) because of their free-flowing condition and "outstandingly remarkable" values. Scenery associated with WSRs is protected by the WSRA. Scenery within two WSR segments of the Klamath River could be affected by the project alternatives:

- Oregon Klamath River Component. The segment of the Klamath River beginning immediately downstream from the J.C. Boyle Powerhouse and flowing eleven miles to its terminus at the Oregon-California State Border is classified as scenic and possesses outstandingly remarkable scenic use values. The Upper Klamath River (upstream of Iron Gate Dam) was evaluated by BLM in 1977 and 1981, and received a Class A scenic quality rating, the highest scenic quality classification. The 2006 Preliminary Determination Report (completed for the Section 7 WSR requirement during FERC relicensing of the PacifiCorp facilities) stated that the Upper Klamath WSR increased the visual variety in the canyon flowing through diverse topography and dropping to form a series of pools and rapids. The unique landforms, water, and vegetation create an ever-changing landscape from desert to more mountainous terrain, and steep canyons and vertical cliffs with diverse vegetation (Bonacker et al. 2007).
- California Klamath River Component: The mainstem segment of the Klamath River beginning 3,600 feet downstream from Iron Gate Dam and flowing 189 miles to the Pacific Ocean mainstem is classified as recreational with portions of the tributaries classified as scenic and wild. Scenery within the California Klamath WSR is dominated by natural settings. Its characteristic river flows, water appearance, anadromous fish and riparian vegetation within a forested river canyon are the primary scenic aspects. Since 1981, flow regimes have varied moderately in response to water resource competition within the Klamath Basin. During summer months, these have typically been caused by water diversions (Van de Water et al. 2006). As described in Sections 3.2, Water Quality, and 3.20, Recreation, reduced water clarity and discoloration resulting from algae blooms has impaired the scenic character of reaches downstream from Iron Gate Dam (River Mile [RM] 190.1) to the mouth of the Klamath River (RM 0.0).

3.19.3.3 Four Facilities Setting

3.19.3.3.1 Reservoirs

PacifiCorp (2004) described the area landscape from 11 KOPs in the vicinity of the reservoirs, including 3 in the J.C. Boyle Reservoir area, 2 in the Copco 1 Reservoir area, and 6 in the Iron Gate Reservoir area. All reservoirs were viewed under high pool and low pool conditions, and at J.C. Boyle Reservoir and Copco 1 Reservoir the maintenance condition was also observed. In general, the reported visual observations of the reservoirs indicated that under normal operating conditions, the four reservoirs share the visual characteristics of open expanses of relatively flat water. Also, as described in Sections 3.2, Water Quality, and 3.20, Recreation, reduced water clarity and discoloration from algae blooms occur seasonally, typically peaking in late summer to early fall (Karuk Tribe of California 2009).

3.19.3.3.2 PacifiCorp's Hydroelectric Project Facilities

PacifiCorp viewed the hydroelectric project area scenic characteristics at the following 10 KOPs of the project facilities (alphanumeric designations refer to KOP designations and accompanying photographs in the PacifiCorp (2004) report):

- BB1: J.C. Boyle Dam
- BB8: J.C. Boyle Powerhouse and Penstocks
- BB9: J.C. Boyle Transmission Line
- C3 Copco 1 Dam and Powerhouse
- C4: Copco 2 Dam
- C6: Copco 2 Powerhouse
- C7: Copco Transmission Line
- IG8 Iron Gate Transmission Line
- IG9 Iron Gate Dam and Powerhouse from Iron Gate Fish Hatchery
- IG10 Iron Gate Fish Hatchery and Fish Ladder

In the PacifiCorp (2004) report, the views of the Four Facilities from these KOPs were characterized using the BLM VRM system. The report describes each of the Four Facilities in the context of the BLM VRM classification for the surrounding area. These observations may be summarized by facility as follows:

- **J.C. Boyle Facilities -** The PacifiCorp report concluded that the J.C. Boyle Dam, Powerhouse, penstocks, and transmission line were not consistent with VRM Class II and III of the surrounding area. Although the line of the dam follows the site's topography, its large size makes it very noticeable against the natural setting. The powerhouse and penstocks have prominent colors and strong lines, which make them also apparent in the landscape. Although the transmission line is distant from the viewer, it rises above other features in the distance and is visible for its length and height.
- **Copco 1 Facilities -** Copco 1 Dam and Powerhouse were not considered to be consistent the VRM Class III of the surrounding area. The size and prominence of these facilities were considered to dominate the view from the KOP. However, the Copco transmission line was typically at a distance from the viewing points

and would blend into the sky and not obstruct views of other parts of the landscape. Thus, the transmission line was considered to be consistent with VRM Class III objectives.

- **Copco 2 Facilities -** Copco 2 Powerhouse was not considered to be consistent with of the VRM Class III of the surrounding area because its size and prominence dominates the view from the KOP. On the other hand, although the Copco 2 Dam is large, it has been designed with colors and lines that blend with the landscape, and when viewed in isolation, could hence be considered to be consistent with VRM Class III objectives.
- **Iron Gate Facilities -** The Iron Gate Dam, Powerhouse, and transmission lines were considered to be consistent with the VRM Class III objectives of the surrounding area in detailed visual evaluation of the project vicinity as summarized in the Final EIS (2007) and documented it in the *Land Use, Visual, and Aesthetic Resources Final Technical Report* (PacifiCorp 2004). Although the dam and powerhouse are large, their colors and lines blend with the landscape. Similarly, the transmission line was typically at a distance from the viewing points and would blend into the sky and not obstruct views of other parts of the landscape. In instances where the support poles of the transmission lines were prominent, it was only for a short time while a viewer walks or drives by.

3.19.4 Environmental Consequences

3.19.4.1 Effects Determination Methods

To determine the significance of effects on scenic resources, the Lead Agencies inventoried the scenery that would be affected by the Proposed Action and alternatives; identified the changes that would occur to those scenic resources in terms of degree of contrast, relative size or scale, distance, and visibility; and the magnitude of the potential changes. The effects method involves two stages: inventory and analysis.

3.19.4.1.1 Inventory

In the inventory stage, the Lead Agencies identified sensitive sightseeing areas within the watershed using maps of the Klamath Basin that identify land ownership, zoning, existing land use, roads, floodplains, notable scenic features and KOPs. Areas considered for sightseeing included riverside and/or reservoir communities and residences, recreational access sites, campgrounds, National Forest Scenic Byways (HWY 96/State of Jefferson Scenic Byway and HWY 96/Bigfoot Scenic Byway), State HWYs 96, 169, and 101. The Lead Agencies determined the relative visibility from travel routes or observation points, or specific points with views of the Klamath River and the Four Facilities to show the characteristic landscape types found at significant viewpoints. A detailed discussion of the VRI process is provided in Section 3.19.3, Affected Environment.

The area of analysis experiences four distinct seasons. Flows in the Klamath River, water levels in the reservoirs, and the appearance of vegetation vary seasonally. The Lead Agencies used the detailed visual evaluation of the project vicinity as summarized in the Final FERC EIS (FERC 2007) and documented in the *Land Use, Visual, and Aesthetic Resources Final Technical Report* (PacifiCorp 2004) to characterize the area of analysis

because this report included viewing the KOPs during different seasons and at different water levels over an extended time period. This PacifiCorp report provided an assessment of a baseline measure of the scenic appeal of the Project area through a Scenic Quality Evaluation consistent with the BLM inventory process. Scenic quality and sensitivity information were delineated and/or inventoried and documented spatially, in a manner that follows physical features in the landscape in the PacifiCorp (2004) report.

3.19.4.1.2 Analysis

For this EIS/EIR, the contrast rating worksheets provided in the BLM VRM process were not completed for the KOPs. Although the contrast rating forms were not filled out for this EIS/EIR, the scenic quality impact analysis is built on the premise that many of the scenery conservation design principles identified in the forms would be applied by the Definite Plan.

In the analysis stage, the Lead Agencies identified changes in scenic quality by establishing a level of contrast [i.e., no effect (visual contrast is imperceptible), weak, moderate, and strong (contrast caused by the action would be substantial)] considering effects on form, line, color, texture, and comparing to approved VRM objectives for the area (Class). The Lead Agencies also determined whether the techniques that would be used in the Proposed Action and alternatives would ensure that surface-disturbing activities would harmonize with the surrounding natural environment. The Lead Agencies also considered light pollution effects that could be generated during construction.

It should be noted that a significance in visual contrast as defined under the BLM VRM system is not the same as a significance determination for the purposes of this EIS/EIR. The BLM VRM process is used as guidance for assessing the impacts of the Proposed Action and alternatives. The significance criteria used for significance determination for the purposes impact analyses are defined in the following section.

3.19.4.2 Significance Criteria

For the purposes of this document, an alternative would result in significant impacts if it would do any of the following:

- Cause a landscape to be inconsistent with the VRM classification of the surrounding area as defined for the purposes of this analysis.
- Result in a substantial adverse change to scenic resources, including, but not limited to landforms, trees, and rock outcroppings viewed from a river segment, community, recreation site area, trail, scenic highway, or designated wild and scenic river reach, by altering the characteristic (i.e., natural, pre-development) state.
- Remove historic properties.
- Create a new source of light or glare that would adversely affect day or nighttime views in the area.

3.19.4.3 Effect Determinations

This section describes the potential effects of the alternatives on scenic resources. Although the Proposed Action and alternatives could result in substantial short-term and long-term scenery disturbances associated with the hydroelectric project area, the broader, historic "characteristic landscape" would still remain. Several project features would improve the characteristic landscape's key features (e.g., historic river segments, canyons and water quality appearance). The following discussion provides specific details on the impacts. The analysis considers the existing scenic character/landscape character, degree of existing disturbance and resulting scenic disturbance resulting from the proposed activity.

3.19.4.3.1 Alternative 1: No Action/No Project

Under the No Action/No Project Alternative, no construction or physical changes would occur; thus, there would be no changes in the short term to the existing scenic quality of the dams, reservoirs, surrounding areas and adjacent river reaches.

Continued impoundment of water at the Four Facilities could result in water quality impacts that could have long-term impacts on scenic quality. As described in Section 3.2, Water Quality, degradation of water quality could continue in the long term, if the dams are not removed. **The No Action/No Project Alternative would not change this existing condition**.

Not removing the facilities could have the impact that they would remain inconsistent with the VRM classification of the surrounding area (where such inconsistency is defined as a criteria of significance). PacifiCorp's analysis (2004) identified the following project features as being currently inconsistent with their VRM classification. Under the No Action/No Project Alternative, these features would remain inconsistent with their VRM classification:

- Class II VRM classification–the J.C. Boyle powerhouse and penstocks, J.C. Boyle Dam, bypass canal, and transmission line.
- Class III VRM classification–Copco No. 1 Dam and powerhouse, Copco No. 2 powerhouse and substation, and Iron Gate Hatchery and fish ladder.
- While not identified as being inconsistent with the surrounding area by PacifiCorp's 2004 analysis, Iron Gate Dam, bypass spillway, powerhouse, penstock, and associated landform and vegetation disturbances are also inconsistent with their Class III VRM classification and would remain so under the No Action/No Project Alternative (personal communication with J. Mosier, Klamath National Forest, April 26, 2011). **The No Action/No Project Alternative would not change this existing condition.**

Ongoing Restoration Actions

Under the No Action/No Project Alternative a number of Ongoing Restoration Actions are currently underway and would be implemented regardless of the Secretarial Determination on the removal of the Four Facilities.

Fish Habitat Restoration Actions

These actions would result in short-term impacts on scenic resources during construction. Ongoing restoration activities for fish habitat would occur throughout the Klamath Basin. These activities may include floodplain rehabilitation, large woody debris replacement, fish passage correction, cattle exclusion fencing, riparian vegetation planting, mechanical thinning of upland areas to mimic natural forest conditions, fire treatment to mimic natural forest conditions, purchase of conservation easements/land, road decommissioning, gravel augmentation, and treatment of fine sediment sources. **During construction, impacts on scenic resources would be potentially significant, albeit temporary. No mitigation measures could be implemented to lessen the impact on scenic resources; therefore it would be significant and unavoidable in the short term.**

These actions could result in long-term impacts on scenic resources. Restoration activities would be anticipated to result in scenery more consistent with the naturally established, characteristic landscape. **Therefore, they have the potential to be beneficial to scenic resources in the long term.**

3.19.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

The Proposed Action involves removal of dams and all appurtenant features, with the exception of buried features, at the Four Facilities. The Proposed Action would include reservoir drawdown and removal of four dams. This would expose the former inundated areas to view. After drawdown, the Dam Removal Entity (DRE) would perform restoration activities of the exposed areas. Restoration plans would include stabilizing and revegetating the newly exposed reservoir areas with various herbaceous species through hydroseeding, aerial hydromulching, and planting. Various woody species would also be planted. Invasive and non-native species would be controlled. The hard lines of the dam and large expanses of water in the reservoirs would be changed to a more historic, characteristic scenery displaying natural river canyon landforms with vegetation enframing a continuous river. This scenic change would be visible for a very long distance around the reservoir sites and most reservoir KOPs, and would be permanent. Figures 3.19-3, 3.19-4, and 3.19-5 show aerial photos of the existing reservoirs with an overlay of historic river channels. The historic channel represents what the extent of the Klamath River is expected to be in the long term following removal of the Four Facilities. However, until the restoration is complete, the area would appear barren and/or sparsely vegetated.

In addition, the existing water supply pipeline for the City of Yreka passes under the Iron Gate Reservoir and would be relocated prior to decommissioning to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would be suspended from a pipe bridge across the river near its current location. Surveys are still required to determine if the bridge is adequate to support the construction traffic from the decommissioning activities. If the existing wooden bridge is not adequate to support the construction traffic, it will be replaced in the same location with a concrete bridge. In addition, the Proposed Action includes removal of existing and construction of new recreation facilities, such as campgrounds and boat ramps, currently located on the reservoir banks down slope to be near the new river bed once the reservoir is removed. Activities described in the KBRA are included in the Proposed Action as connected actions.

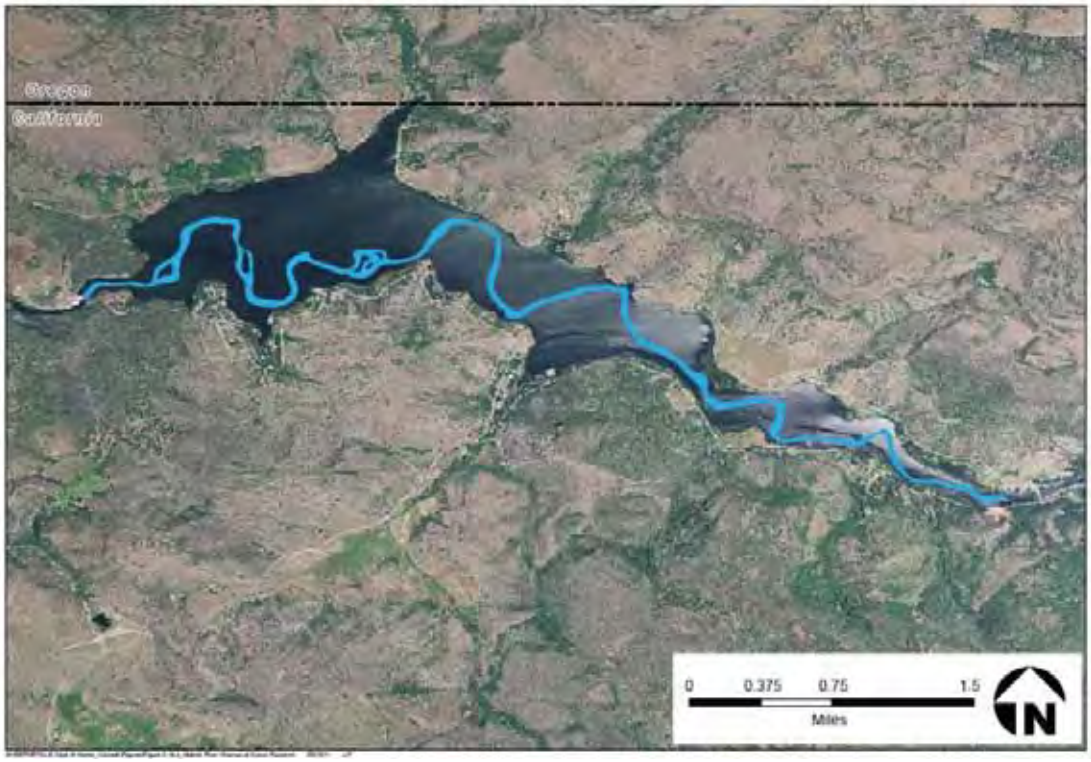

Figure 3.19-3 Historic River Channel for J.C. Boyle Reservoir.

Figure 3.19-4 Historic River Channel at Copco I Reservoir.

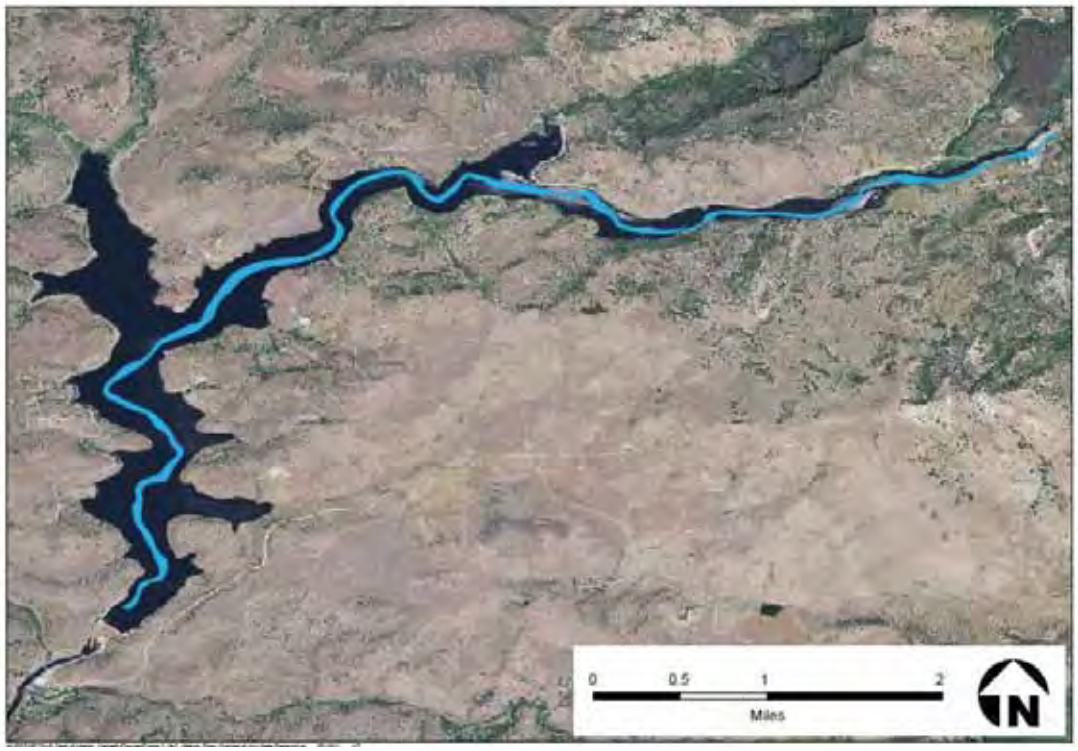

Figure 3.19-5. Historic River Channel at Iron Gate Reservoir.

The Proposed Action would result in impacts on scenic resources from removal of the Four Facilities. Under existing conditions, some of these facilities do not blend with the natural landscape and can dominate views due to their form, line, color, size or locations, particularly those that appear taller than other natural features from a distance. Since the facilities are inconsistent with the VRM classification for the surrounding area, their removal would result in a landscape that would appear more similar to the surrounding characteristic natural landscape. Figures 3.19-6 and 3.19-7 show photo-simulations of the removal of Iron Gate Dam and Copco 1 Dam, respectively. **Removal of the facilities as part of the Proposed Action would be a beneficial effect.**

The Proposed Action would result in impacts on scenic resources from the removal of some historic properties. Some of the facilities (the Copco 2 facilities shown in Figure 3.19-8, for example) are considered historic properties (FERC 2007), and their removal would require consultation with the Oregon and California State Historic Preservation Office (see Section 3.13, Cultural and Historic Resources). In general, the BLM VRM process is based upon the premise that natural appearing landscapes are more highly valued by the public than modified landscapes. Therefore, the removal of the Four Facilities which would then be replaced by natural landscape would be preferred. However, some historic scenery elements may be considered socially valued and their elimination from the scenic character would be considered a significant scenery impact of the project. **The impact on historic properties would be a permanent significant impact. No mitigation measures could be implemented to lessen the visual impact of the loss of historic properties; therefore it would be significant and unavoidable.**

Figure 3.19-6. Iron Gate Dam before removal (top) and a simulation of what the facility could look like after full removal (bottom) except for Landform/Vegetation restoration details which cannot be fully depicted until completion of the Definite Plan.

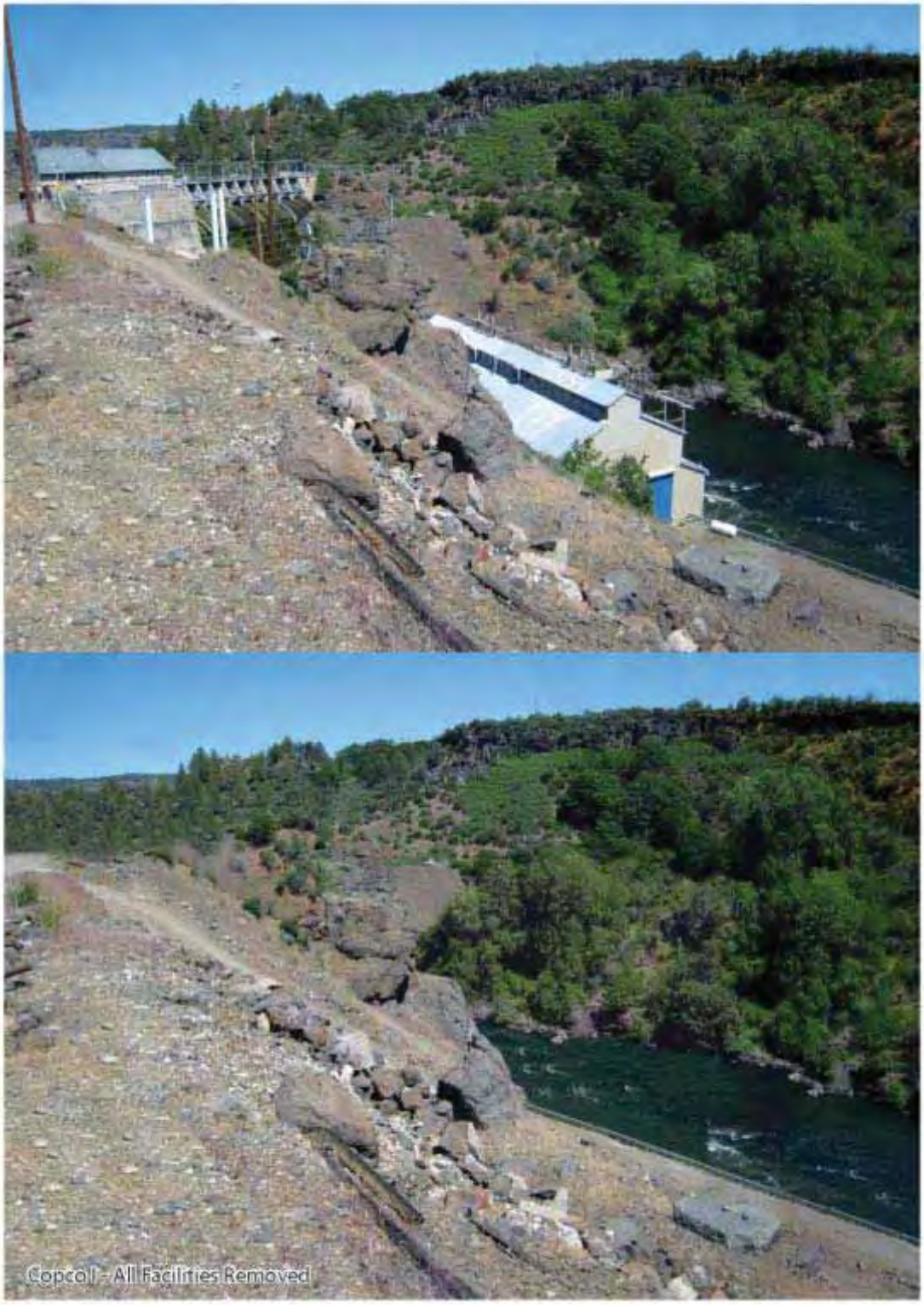

Figure 3.19-7 Copco 1 Dam before removal (top) and a simulation of what the facility could look like after full removal (bottom) except for Landform/Vegetation restoration details which cannot be fully depicted until completion of the Definite Plan.

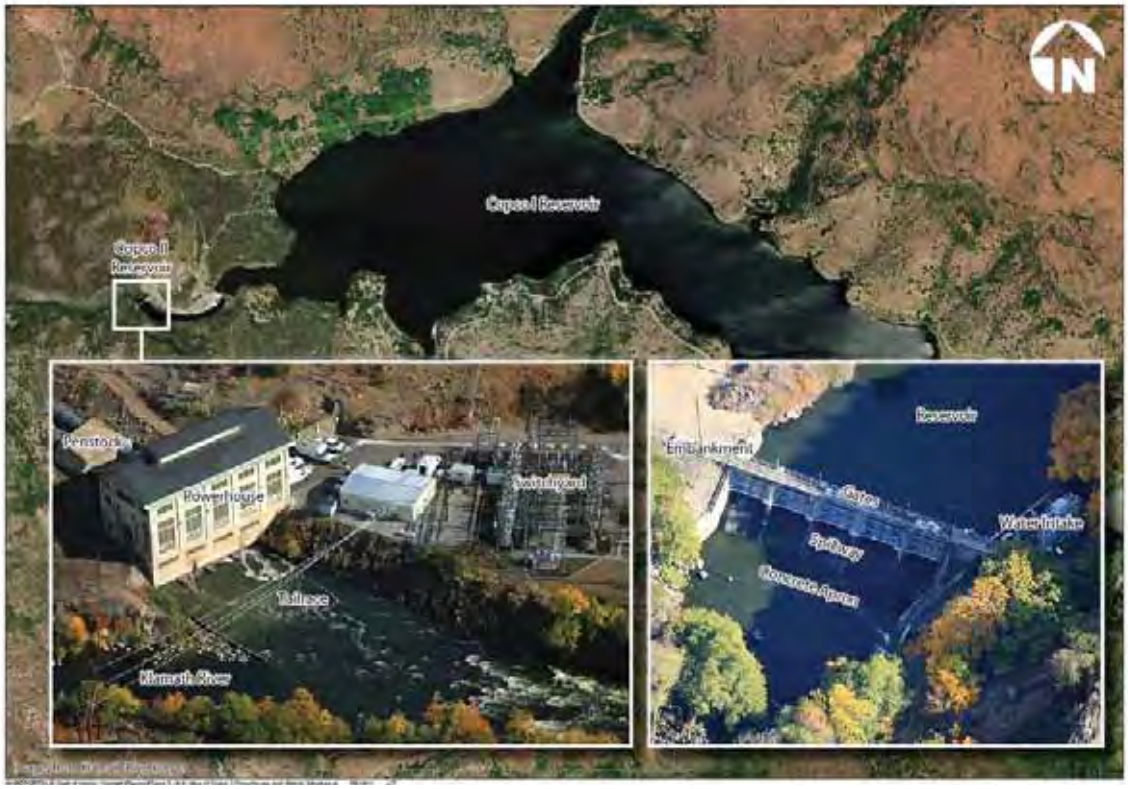

Figure 3.19-8. View of Copco 2 Powerhouse and Historic Structure.

Removal of the Four Facilities could result in short and long-term impacts on scenic resources in formerly inundated reservoir areas. The Proposed Action would include removal of the dams' associated reservoirs, and substantial changes would occur in the former reservoir area during drawdown and until restoration is complete. The Klamath River in the vicinity of the reservoirs would be restored to its historic channel width and depth (see Section 3.6, Flood Hydrology), exposing all previously inundated areas except the historic river channel. The receding water would expose reservoir sediments at the bottom of the reservoir. Since sediment in the reservoirs is less than five feet deep in general, the river channel would not appear to be entrenched or flowing through mud, but rather, would appear very similar to conditions before the river was impounded (with exception of vegetation not yet becoming established). Depending on the sediment, odors may be evident while the reservoir bottoms dry out and new vegetation is established (riverside revegetation planned as part of the project is described below). Erosion of the reservoir sediment and slumping of the sediment is anticipated, followed by drying, cracking, and hardening of the sediment prior to the establishment of vegetation. Existing wetland vegetation on the reservoir shorelines may also die off temporarily, though it may repopulate the newly formed exposed banks (Bureau of Reclamation 2011).

The Proposed Action would involve stabilizing and revegetating the newly exposed reservoir areas with herbaceous and woody vegetation. Until the restoration was complete, however, the area would appear barren and/or sparsely vegetated. The facilities removal schedule estimates that removal of the facilities and appurtenant structures would be completed in stages and would take approximately a year and a half with the objective of revegetation of 75 percent of the reservoir area by desirable vegetation that would provide minor and temporary scenery improvements within three years following dam removal. As discussed, establishment of woody vegetation with cover and density similar to adjacent natural woodlands would take many years to attain. This schedule translates to approximately four and a half years during which the area of analysis would be in a highly visible state of transition, and several more years where contrast from adjacent natural woodlands would be evident. The exposure of previously inundated areas would be considered a moderate contrast from the existing condition because it would dominate the landscape and would encompass a large area surrounding the river. It would likely be visible from various KOPs around each of the reservoirs.

Although revegetation of herbaceous species in barren and/or sparsely vegetated areas may be achieved in the short term (1 to 3 years), it should be noted that this is not necessarily consistent with restoration of natural appearing vegetation patterns below and above the reservoir line. Natural appearing vegetation patterns with woody riparian vegetation may take long term (10 to 50+ years) to develop. Although the condition is considered temporary because the characteristic landscape is expected to be rehabilitated, some adverse scenery impacts would be extensive and long term. In a report prepared for the California State Coastal Conservancy, Philip Williams and Associates, LTD estimated that it will take 30 years for the river corridor habitats to fully recover from the dam removals (Phillip Williams and Associates [PWA] 2009). **The impact on scenic resources would be a significant impact that would occur in both the short and long term, until vegetation has become established. No mitigation measures could be implemented to lessen the impact on scenic resources; therefore it would be significant and unavoidable.**

Deconstruction and restoration activities could result in short-term impacts on scenic resources in the immediate vicinity of the Four Facilities. Removal of the Four Facilities and associated structures would be completed in stages over one year, with primary deconstruction activities occurring over a three-month period. During the deconstruction, the area of analysis would have large construction vehicles and equipment, temporary structures (e.g., trailers, portable toilets, security fencing, temporary power supply, fueling stations), temporary access roads, equipment storage areas, material stockpiles, piles of demolition materials (rock, concrete, steel), and other common construction items that would detract from the natural surroundings. The construction activities would be considered weak to strong contrasts, depending on the amount of vehicles, equipment, and materials in any given area. Some stockpiling areas may be visible but may not stand out in some areas because the color and form of the materials may blend in to the surrounding landscape. However, typically temporary stockpiling of dam fill materials, larger vehicles, and equipment would be a moderate to strong contrast as the color and form would stand out substantially from the existing landscape. Some scenic resources,

such as trees, rocks, and vegetation, particularly in the immediate vicinity of the dams, would need to be removed. Dust emissions from project activities may also temporarily impact views and enjoyment of the river. However, as part of the decommissioning plan, prior to initiation of deconstruction or construction activities, the contractor will be required to prepare and implement a worker Health and Safety Plan prior to the start of construction activities. The Health and Safety Plan will include proper housekeeping and best management practices (BMPs) to keep the construction areas orderly and suppress dust emissions, as required.

During deconstruction, the area would be inconsistent with the VRM classification for the surrounding area. After construction, all vehicles, equipment, and stockpiles would be removed and the area would be restored. **The impact on scenic resources would be significant; this impact would occur temporarily, until deconstruction was complete. No mitigation measures could be implemented to lessen the impact on scenic resources; therefore it would be significant and unavoidable in the short term. As described above, removal of the facilities would benefit scenic resources in the long term through the restoration of the characteristic natural landscape.**

Replacement of the existing wooden Lakeview Bridge just downstream from Iron Gate Dam with a concrete bridge could result in short and long-term impacts on scenic resources. If it is determined that the Lakeview Bridge is not adequate to support the construction traffic from the decommissioning activities, it would be replaced with a concrete bridge in the same location. There would be short-term significant impacts on scenic quality during construction from the presence of construction equipment. Long-term impacts on scenic quality from the change from a wooden to concrete bridge would be less than significant. **The impact on landscape would be a temporary significant and unavoidable impact; however, in the long-term impacts on scenic quality would be less than significant.**

Demolition of existing recreation facilities, such as campgrounds and boat ramps, from the reservoir banks would result in short and long-term impacts on scenic resources. Due to the presence of construction equipment and temporary loss of vegetation, there would be short-term significant impacts on scenic quality during demolition of some of the existing recreation facilities at the reservoirs. In the long term, impacts on scenic quality would be less than significant given implementation of Mitigation Measure REC-1 (the development of a plan to provide similar recreational resources and infrastructure) as well as the revegetation of the drained reservoir lands. ***The impact on landscape would be a temporary significant and unavoidable impact; however, in the long-term impacts on scenic quality would be less than significant.***

Deconstruction could create a new source of light or glare that could adversely affect nighttime views in the area. Temporary lighting would be erected for nighttime activities, and security lighting might be required during deconstruction. This light could cause glare that would adversely affect day or nighttime views in the area, particularly for visitors and residents whose homes are near the dam sites, such as the residences near the

Copco Development. **The impact on nighttime views would be a significant impact that would occur temporarily, until deconstruction was complete. Mitigation Measure SQ-1 would reduce this impact to less than significant.**

Drawdown and removal of the four reservoirs could cause temporary changes in the appearance of the Klamath River in the area of the Four Facilities and downstream from Iron Gate Dam. As part of the Proposed Action, the reservoirs would be drawn down, allowing the Klamath River to return to a natural channel depth and width. Hydrologic modeling (see Section 3.6, Flood Hydrology) indicates that the flows in the Klamath River would not be expected to be substantially different from historic conditions after the effects of the initial drawdown passed. Water flow levels are expected to remain very similar to current flow levels and the existing river channel configuration patterns would likely be continued. In the short term, water aesthetics (clarity, turbidity (depth of view), and color) in the receding reservoir and downstream river reaches would likely be affected as the sediment behind the dams erodes and washes downstream (see Section 3.2, Water Quality). In addition to reducing water clarity for a few weeks, the temporary pulse of sediment could also cause possible short term deposition in eddies and slack water pools until subsequent annual flood events move the sediment to the ocean. Depending on the severity of the color change, this would represent a weak to moderate contrast from the existing condition and could be visible from quite a distance, especially from higher elevation viewpoints along the river canyon. **The impact on the appearance of the Klamath River would be a temporary significant impact. No mitigation measures could be implemented to lessen the impact on scenic resources; therefore it would be significant and unavoidable. The impact on scenic resources would be temporary but remain significant and unavoidable.**

Removal of the Four Facilities could result in long-term impacts on scenic resources from changes to water quality. As described in Section 3.2, Water Quality, removal of the dams at the Four Facilities is expected to improve water quality in the long term. The changes are expected to reduce the river's summer algae concentrations, resulting in changes in both water clarity and coloration. An improvement in water quality could result in some improvement in scenic resources, such as water clarity or fish viewing opportunities. These improvements would be most noticeable from on-river and riverside viewpoints, and much less noticeable from river canyon roadway and community viewpoints. **Improvements to water quality would have a beneficial effect on scenic resources.**

Keno Transfer

The Keno Transfer could have adverse effects to scenic quality. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on scenic quality compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **Therefore, the transfer of Keno to the DOI would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects on scenic quality. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need to divert water at Link River Dam into the two canals. There would be temporary visual resource effects during facility deconstruction activities. Long-term effects would be dependent on future land use, which is not identified at this time. **Therefore, the decommissioning of the East and Westside Facilities would have a less then significant effect on scenic quality.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Construction of a new, elevated City of Yreka Water Supply Pipeline and steel pipeline bridge to support the pipe above the river could result in short and long-term impacts on scenic resources. The new prefabricated steel pipe bridge would likely be three spans with a center span of 200 feet and two end spans of 100 feet. The spans would be supported on concrete piers. The new pipeline would be connected to the existing buried pipeline at each end of the bridge. New structures would be painted (or manufactured) to blend with the natural color of the landscape. **The impact on scenic quality would be a significant impact that would occur in both the short and long term. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.**

KBRA – Programmatic Measures

The KBRA, which is a connected action to the Proposed Action, includes several programs that could result in impacts on scenic resources, including:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management
- Fish Entrainment Reduction
- Wood River Wetland Restoration
- Water Diversion Limitations
- On-Project Plan
- Water Use Retirement Program (WURP)
- Interim Flow and Lake Level Programs
- Klamath Tribes Interim Fishing Site
- Power for Water Management Program
- Additional Water Conservation and Storage

Phases I and II Fisheries Restoration Plans

Construction activities associated with the Fisheries Restoration Plan - Phase I and Phase II could result in impacts on scenic resources. The Fisheries Restoration Plan would include measures to restore riparian and floodplain vegetation throughout the Klamath Basin. Actions that could have impacts on scenic resources within the project

area include those where construction or restoration activities would occur, due to the presence of construction equipment and temporary loss of vegetation. These actions include the following:

- Floodplain rehabilitation
- Wetland and aquatic habitat restoration
- Woody debris placement
- Fish passage correction
- Cattle exclusion fencing
- Mechanical thinning and prescribed burning
- Road decommissioning
- Gravel augmentation

These actions would result in temporary impacts on scenic resources within localized construction areas. The restoration actions would not occur in the same location or at the same time as the hydroelectric facility removal actions to contribute to or change potential effects of dam removal on scenic resources. **Therefore, impacts on scenic resources would be less than significant during construction.**

The Fisheries Restoration Plan- Phase I and Phase II could result in long-term impacts on scenic resources. These programs are intended to benefit fish populations and therefore increase fish viewing opportunities, which would result in beneficial effects to scenic resources. In addition, actions are anticipated to result in scenery more consistent with the naturally established, characteristic landscape**.** These actions would not occur in the same location as hydroelectric facility removal actions and would not affect any scenic improvements as a result of dam removal. **However, they are anticipated to result in beneficial effects to scenic resources.**

Fisheries Reintroduction and Management Plan

Construction activities associated with fish collection facilities would introduce new features into the landscape. Trap and haul operations within the Fisheries Reintroduction and Management Plan would require construction of fish collection and handling facilities below Keno and near Link River Dams to seasonally move fish around Keno Impoundment/Lake Ewauna during times of poor water quality. Constructing these facilities would result in temporary impacts on scenic, and the fish handling facilities would remain in the long term to change the visual landscape. The handling facilities would not be in the same visual area as the Four Facilities; therefore, construction of fish handling facilities would not compound the effects of facility removal actions. **The impacts on scenic resources would be less than significant during construction. However, the impact to scenic resources from the addition of the fish management structures could be a significant, permanent impact. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.**

Wood River Wetland Restoration

The Wood River Wetland Restoration Project could result in long-term impacts on scenic resources. This project would be a new project designed to provide additional water storage for a total of 16,000 AF of storage in or adjacent to Agency Lake (see Section 2.4.3.8). Depending upon the final outcome of the project design it could provide additional wetland habitat with naturally established, characteristic landscapes beneficial to scenic resources. However, if changes result in more open water storage only (no wetlands), this is not consistent with the naturally established, characteristic landscape. **Open water storage views would be a less than significant impact to scenic resources. Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow, Lake Level Program Power for Water Management Program, and Additional Water Conservation and Storage**

Construction activities associated with the WURP could result in impacts on scenic resources. Construction actions would include removal of juniper trees. This could result in temporary impacts on scenic resources within localized areas. Juniper removal actions would be in a different location from the removed Four Facilities, which would reduce the potential for any scenic quality impacts generated by juniper removal actions from contributing to the effects of facility removal. **Therefore, impacts on scenic resources would be less than significant during construction.**

The Water Diversion Limitations, On-Project Plan, WURP, and Interim Flow, Power for Water Management Program, Additional Water Conservation and Storage, and Lake Level Programs could result in long-term impacts on scenic resources. Changes in land uses, including changes from ranchland to water storage areas, could occur under these programs. These actions would not occur at the same location or time as hydroelectric facility removal, which would reduce the potential for any scenic quality impacts generated by these programs from contributing to the effects of facility removal. **These changes have the potential to be beneficial if they result in landscapes (wetlands) that are consistent with the naturally established, characteristic landscape. However, if changes result in more open water storage only (no wetlands), this is not consistent with the naturally established, characteristic landscape and would be a less than significant impact to scenic resources.**

Fish Entrainment Reduction

Construction activities associated with Fish Entrainment Reduction could result in impacts on scenic resources. Construction actions would result in temporary impacts on scenic resources within localized construction areas. Fish entrainment reduction construction actions would not occur at the same location or time as the hydroelectric facility removal actions. As a result, scenic quality impacts generated by these construction actions would not contribute to or change the scenic quality effects of facility removal actions. **Therefore, impacts on scenic resources would be less than significant during construction.**

Fish Entrainment Reduction could result in long-term impacts on scenic resources. This action is anticipated to benefit fish populations and therefore increase fish viewing opportunities, which would result in beneficial effects to scenic resources. However, the entrainment reduction facilities would likely be inconsistent with the naturally established, characteristic landscape, which would be an adverse effect. The installation of fish screens would occur at various existing water diversion structures for the Reclamation's Klamath Project and would not result in a substantial change from existing inconsistencies with natural landscapes. Entrainment reduction facilities would not be near the Four Facilities and would not contribute to or change any scenic quality impacts of facility removal. **Impacts on scenic resources would be less than significant.**

Klamath Tribes Interim Fishing Site

Construction activities associated with the Klamath Tribes Interim Fishing Site could result in impacts on scenic resources. Construction actions would result in temporary impacts on scenic resources within localized construction areas. This construction action would not occur in the same location as the Four Facilities removal actions. As a result, it would not contribute to or change any scenic quality impacts of facility removal. **Impacts on scenic resources would be less than significant during construction. In the long-term changes generated by the presence of the interim fishing site would be anticipated to retain consistency with the naturally established, characteristic landscape and would be a less than significant.**

3.19.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

Under the Partial Facilities Removal of Four Dams Alternative, certain project features would be retained, while providing the requirements for a free-flowing river and for volitional fish passage through all Four Facilities. Table 3.19-2 summarizes which facilities would be retained under the Partial Facilities Removal of Four Dams Alternative.

Figures 3.19-6 and 3.19-7 show photo-simulations of the removal of Iron Gate Dam and Copco 1 Dam, respectively.

The Partial Facilities Removal of Four Dams Alternative could result in impacts on scenic resources from the removal of the Four Facilities and some appurtenant facilities. Impacts on scenic resources would be similar to the Proposed Action. The facilities which remain could continue to be inconsistent with the VRM classification for the surrounding area. Removal of some facilities would result in a landscape that would appear more similar to the surrounding characteristic natural landscape. **Therefore, there would be a beneficial effect on scenic resources. For facilities that stay in place, there would be no change from existing conditions.**

Table 3.19-2. Summary of Features that Would Be Removed under the Proposed Action Alternative and that would be Retained under the Partial Facilities Removal Alternative

Feature	Proposed Action - Full Facilities Removal	Partial Facilities Removal
J.C. Boyle		
- Steel Pipeline and Supports	Remove	Retain
- Powerhouse	Remove	Retain
- Tailrace Channel Area	Remove	Retain
- Power Conveyance Intake	Remove	Retain
- Canal Intake (Screen) Structure	Remove	Retain
- Canal Spillway Channel Area	Remove	Retain
- Tailrace Flume Walls	Remove	Retain
Copco 1		
- Powerhouse	Remove	Retain
- Powerhouse intake structure	Remove	Retain
- Penstocks	Remove	Retain
- Diversion Intake and Gate Structure	Remove	Retain
Copco 2		
- Steel Penstock, Supports and Anchors	Remove	Retain
- Powerhouse	Remove	Retain
- Embankment Section	Remove	Retain
- Switchyard	Remove	Retain
- Tunnel Intake Structure	Remove	Retain
Iron Gate		
- Powerhouse	Remove	Retain
- Fish Hatchery	Retain	Retain

Source: River Design Group. 2010a.

Under the Partial Facilities Removal at Four Dams Alternative the DRE would remove some of the historic properties. (see Section 3.13, Cultural and Historic Resources) In general, buildings are considered visually dominant modifications to the naturally established "characteristic landscape," however, some facilities could be identified as positive scenery attributes valued for their appearance as historic and cultural features. Therefore, the effects related to the removal of historic properties could be positive, negative, or neutral to scenic resources depending on the historic building. For example, the Copco 2 powerhouse is often perceived as a positive scenery attribute while the J.C Boyle powerhouse is not (compare Figures 3.19-8 with 3.19-9). Under the Partial Facilities Removal at Four Dams Alternative, the J.C. Boyle powerhouse, Copco No. 1 powerhouse, and Copco No. 2 powerhouse would remain as visually dominant modifications to the naturally established "characteristic landscape". The facilities which remain could continue to be inconsistent with the VRM classification for the surrounding

Figure 3.19-9. View of J.C. Boyle Powerhouse.

area. The condition of the remaining structures could degrade over time, particularly the facilities that would no longer be in use (J.C. Boyle powerhouse and Copco No. 2 powerhouse), and would likely not receive as much maintenance as the facilities still in use. **The impact on historic properties would be a permanent significant impact. No mitigation measures could be implemented to lessen the visual impact of the loss of historic properties; therefore, it would be significant and unavoidable.**

Partial Removal of the Four Facilities could result in short and long term impacts on scenic resources in formerly inundated reservoir areas. The effects would be similar to the Proposed Action**. The impact on scenic quality would be a significant impact that would occur in both the short and long term, until vegetation has become established. No mitigation measures could be implemented to lessen the impact on scenic quality; therefore it would be significant and unavoidable.**

Deconstruction and restoration activities could result in short-term impacts on scenic resources in the immediate vicinity of the Four Facilities. Deconstruction activities would not meet the VRM classification for the surrounding area. **This impact would occur temporarily, until deconstruction was complete. No mitigation measures could be implemented to lessen the impact on scenic quality; therefore it would be significant and unavoidable in the short term.**

*Construction of a new, elevated of a City of Yreka water supply pipeline and steel pipeline bridge could result in impacts on scenic quality***.** The impact on the scenic quality would be the same as the Proposed Action. **It would be a significant impact that would occur in both the short and long term. No mitigation measures could be implemented to lessen the impact on scenic quality; therefore it would be significant and unavoidable.**

Replacement of the existing wooden Lakeview Bridge could result in impacts on scenic quality. The impact on the scenic resources would be the same as the Proposed Action. **The impact on the landscape would be a temporary significant impact; however, the long term impact on scenic quality would be less than significant.**

Relocation of existing recreation facilities could result in impacts on scenic quality. The effects on scenic resources would be the same as for the Proposed Action. **The impact on the landscape would be a temporary significant impact; however, the long term impact on scenic quality would be less than significant.**

Deconstruction could create a new source of light or glare that would adversely affect nighttime views in the area. The effects would be the same as the Proposed Action**. This would be a significant impact that would occur temporarily, until deconstruction was complete. Mitigation Measure SQ-1 would reduce this impact to less than significant.**

Drawdown and removal of the four reservoirs could cause temporary changes in the appearance of the Klamath River in the area of the dams and downstream from Iron Gate Dam. The effects would be the same as those described for the Proposed Action. **The impact on the Klamath River would be a temporary significant impact. No mitigation measures could be implemented to lessen the impact on scenic resources; therefore, the impact on scenic quality would be temporary but significant and unavoidable**.

The Partial Facilities Removal at Four Dams Alternative could result in water quality impacts that could have long-term beneficial effects on scenic resources. The effects would be the same as those described for the Proposed Action. **Restoring the river's water quality would have a beneficial effect on scenic quality.**

Keno Transfer

The effects of the Keno Transfer to visual resources would be the same as under the Proposed Action.

East and Westside Facilities – Programmatic Measures

The effects of East and Westside Facilities decommissioning would be the same as for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures
The effects of the City of Yreka Water Supply Pipeline relocation would be the same as for the Proposed Action.

KBRA – Programmatic Measures
Under the Partial Facilities Removal of Four Dams Alternative, the KBRA would be fully implemented and the effects would be similar to those described for the Proposed Action.

3.19.4.3.4 Alternative 4: Fish Passage at Four Dams
Under the Fish Passage at Four Dams Alternative, no facilities removal (except for demolition of existing fish ladders) would be conducted at the Four Facilities. Fishways would be built at each of the four dams in the form of pool and weir, vertical slot, ice harbor, or hybrid fish ladder with auxiliary water systems.

Continued impoundment at the reservoirs would result in water quality impacts that could have long-term impacts on scenic quality. As described in Section 3.2, Water Quality, water quality conditions would remain the same as the under the No Action Alternative. **There would be no change from the existing condition.**

Continued existence of the Four Facilities could have the impact that some areas would remain inconsistent with the VRM classification of the surrounding area. In general, retained structures and facilities would not benefit scenic quality since they are visually dominant modifications to the naturally established "characteristic landscape". In addition, under the Fish Passage at Four Dams Alternative, PacifiCorp's analysis (2004) identified some project features as being currently not consistent with the VRM classification of the surrounding area. Therefore, the areas with these structures would not be able to achieve consistency with the VRM classification of the surrounding area. **There would be no change from the existing condition.**

Demolition, construction, and restoration activities for the fishways could cause short-term adverse effects on the scenic vistas in the immediate vicinity of the Four Facilities. Under the Fish Passage at Four Dams Alternative, selective demolition would be required to accommodate modifications for the fishways and appurtenances. During construction, the area of analysis could have large construction vehicles and equipment, temporary structures (e.g., trailers, portable toilets, security fencing, temporary power supply, and fueling stations), temporary access roads, equipment storage areas, material stockpiles, and other items that would detract from the natural surroundings in terms of scenery, noise, and smells. Bare soil expanses would be visible where temporary roads were constructed, and where excavated soil was moved. Some scenic resources, such as trees, rocks, and vegetation in the work area could be removed. The construction activities would be considered moderate contrasts as the color and form of vehicles and equipment would stand out from the existing landscape but would be unlikely to be visible from great distances. **The impact on scenic resources would be significant; this impact would occur temporarily, until construction was complete. No mitigation measures could be implemented to lessen the impact on scenic quality; therefore it would be significant and unavoidable.**

Construction could create a new source of light or glare that could adversely affect nighttime views in the area. Temporary lighting would be erected for nighttime activities, and security lighting might be required during deconstruction. This light could cause glare that would adversely affect day or nighttime views in the area. This effect could affect visitors and residents whose homes are near the dam sites, such as the residences near the Copco Development. **The impact on nighttime views would be a significant impact that would occur temporarily, until deconstruction was complete, but Mitigation Measure SQ-1 would reduce this impact to less than significant.**

Construction of fishways could cause changes in the appearance of the Klamath River in the area of the Four Facilities and downstream from Iron Gate Dam. No long-term changes to the water levels in the reservoirs and downstream river reaches would be expected with the construction of the fishways. In the short term, water aesthetics (clarity, turbidity (depth of view), and color) in the reservoir and downstream river reaches could be affected by construction in the waterways. It is anticipated that gravity diversions, coffer dams, physical barriers (e.g., sand/gravel bag berms, sheetpiling, concrete blocks), and pumps would be required to isolate and/or dewater work areas for the water intakes and construction of the V-screens within the reservoirs. In addition, nets or screens would be required to prevent aquatic organisms from entering the work area. All of this equipment could cause short-term scenic and water quality impacts while employed. Any change in color from increased sediment would represent a weak contrast from the existing condition because it would likely not be visible for long distances and would occur on a small scale. Additionally, implementation of a Stormwater Pollution Prevention Plan and other measures described in Water Quality would reduce the impacts associated with clarity and color changes. **The impact on the appearance of the Klamath River would be a less than significant, temporary impact**.

Fishways could cause substantial long-term impacts on scenic resources. The addition of the fishways would change the scenic character in the vicinity of the dams by adding hardscape elements that would blend with the facility features but would not blend with the natural landscape and could dominate views due to their size. At Copco 1 and Iron Gate Dams, the fishway structures would be particularly large (see Table 3.19-3) in order to accommodate the vertical drops, which would be 124 feet and 157 feet, respectively. Figures 2-23 (J.C. Boyle), 2-24 (Copco 1), 2-26 (Copco 2), and 2-286 (Iron Gate) from Chapter 2, Proposed Action and Description of the Alternatives, show conceptual layouts for the fishways.

Although the fishways have not yet been designed, they likely could display angular geometry, continuous straight lines, and flat surfaces that may moderately contrast with the colors, forms, and textures of the surrounding characteristic landscape, or may be insignificant compared to scenery impacts of the existing dam facilities. Installation of V-screens at J.C. Boyle, Copco 2 and Iron Gate and a floating surface bypass collector at

Table 3.19-3. Minimum Structure Footprint for Fish Ladders under the Fishway Alternatives

Dam	Minimum Structure Footprint (sq. ft.)
Fishway at Four Dams	
J.C. Boyle	8,712
Copco 1	17,928
Copco 2	3,168
Iron Gate	22,608
Total	52,416
Fishway at Two Dams	
J.C. Boyle	8,712
Copco 2	3,168
Total	11,880

Source: River Design Group 2010b.

Copco 1 would introduce new permanent facilities near the existing intakes visible from the surface of each reservoir but would not be anticipated to dominate the landscape given their relative scale when compared to the dam facilities. Example cast in place pool and weir fish ladders that are proposed for use at the four dams are shown in Figures 3.19-10 and 3.19-11. **The impact to scenic resources from the addition of the fishways could be a significant, permanent impact. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as Fishway design, coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.**

Trap and Haul – Programmatic Measures

Construction activities associated with fish collection facilities would introduce new features into the landscape. Trap and haul operations would require construction of fish collection and handling facilities at below Keno and near Link River Dams to seasonally move fish around Keno Impoundment/Lake Euwana during times of poor water quality. Constructing these facilities would result in temporary impacts on scenic resources at Keno and Link River Dams, and the fish handling facilities would remain in the long term to change the visual landscape. **The impacts on scenic resources would be less than significant during construction. However, the impact to scenic resources from the addition of the fish management structures could be a significant, permanent impact. The impacts on scenic resources would be less than significant during construction. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.**

Figure 3.19-10. Example of cast in place pool and weir fish ladder used for fish passage, similar to that proposed for upstream fish passage for all four dams under this alternative.

Figure 3.19-11. Example of fish ladder built into steep bedrock similar to Copco 1 option (photo courtesy of GEI Consultants).

3.19.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, all facilities would be removed at Copco 1 Dam and Iron Gate Dam, and fish passage facilities would be constructed at J.C. Boyle and Copco 2 Dams.

The effects of the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be similar to those of the Proposed Action and the Fish Passage at Four Dams Alternative.

As with the Proposed Action, demolition of Copco 1 and Iron Gate Dams could have long-term scenic effects, including the removal of two dams and reservoirs, and changes from reservoir to river views in the areas near Copco 1 and Iron Gate Dams. **Restoring natural riverine scenery would be a beneficial effect.**

As with the Fish Passage at Four Dams Alternative, the addition of fishways at the J.C. Boyle and Copco 2 Developments could have long-term impacts on scenic resources. **The impact to scenic resources from the addition of the fishways could be a significant, permanent impact. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as Fishway design, coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.**

Temporary deconstruction and construction scenic impacts would be similar to those under the Proposed Action for Copco 1 and Iron Gate Dams sites and could be significant. **No mitigation measures could be implemented to lessen these temporary impacts on scenic quality; therefore they would be significant and unavoidable.**

Some areas would remain inconsistent with the VRM classification of the surrounding area. The project features that are currently inconsistent with their VRM classification and would remain as visually dominant modifications to the naturally established "characteristic landscape" are: the J.C. Boyle powerhouse and penstocks, J.C. Boyle Dam, bypass canal, and transmission line and Copco No. 2 powerhouse and substation, and the Iron Gate Dam, bypass spillway, powerhouse, penstock, and associated landform and vegetation disturbances. **There would be no change from the existing condition**.

Lighting impacts would be the same as those under the Proposed Action at the J.C. Boyle and Copco 2 sites and could be significant. **Mitigation measure SQ-1 would reduce this impact to less than significant.**

Trap and Haul – Programmatic Measures

Construction activities associated with fish collection facilities would introduce new features into the landscape. The trap and haul measures around Keno Impoundment and Lake Euwana would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **The impacts on scenic resources would be less than significant during**

construction. However, the impact to scenic resources from the addition of the fish management structures could be a significant, permanent impact. Implementation of Mitigation Measure SQ-2, as determined by the Definite Plan, including measures such as coloration, screening from sensitive viewpoints, etc. would reduce impacts on scenic quality; however these impacts could still be significant and unavoidable.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the City of Yreka Water Supply Pipeline relocation would be the same as for the Proposed Action.

3.19.4.4 Mitigation Measures

The following mitigation measures would reduce the scenic quality impacts associated with the Project.

3.19.4.4.1 Mitigation Measure by Consequences Summary

Mitigation Measure SQ-1 - When practical, as determined by the Definite Plan, scenic quality measures/mitigations (location, design, coloration, screening, etc) shall be identified for all structural, landform and vegetation-altering components of the Project Alternatives. These measures would include one or more of the following: 1) determining the most aesthetically beneficial location and configuration of constructed facilities to reduce visual disturbance; 2) development of scenically harmonious design components into constructed facilities such as edges, borders, and surface textures that blend with surrounding topography and landscape; 3) coloration of constructed facilities, such as colored concrete that mimics as closely as practical the adjacent native soil, bedrock, or vegetation; and 4) screening of constructed facilities, or portions thereof, from sensitive viewpoints through the planting of native riparian or upland vegetation. The application of one or more of these measures, where feasible, will minimize scenery disturbances as needed to either achieve the Project's Visual Resource Management (VRM) classes, or achieve the most natural appearing scenic quality possible while meeting other Project objectives.

Mitigation Measure SQ-2 - To reduce nighttime light and glare on surrounding residences during construction, the DRE will require the use of reflectors, shields, directional lighting, or other appropriate methods to reduce glare. All lighting will be turned off when not in use and/or motion-controlled lighting will be used, where feasible. Permanent lighting needed for security will be selected to be "dark sky friendly[1]" to reduce glare to the surrounding area. "Dark sky friendly" lighting accessories or alternatives to typical lighting systems will be used, where feasible.

[1] http://www.darksky.org/mc/page.do?sitePageId=118983&orgId=idsa

3.19.4.4.2 Effectiveness of Mitigation in Reducing Consequences

Implementation of mitigation measure SQ-1 would reduce nighttime light and glare on surrounding residences to less than significant.

Implementation of mitigation measure SQ-2 would reduce Project associated scenery disturbances to the most natural appearing conditions possible and achieve the highest consistency with Project VRM Classes.

Agency Responsible for Mitigation Implementation

The DRE will be responsible for implementing mitigation measures SQ-1 and SQ-2.

Remaining Significant Impacts

The temporary, short-term impacts from deconstruction, construction, and restoration remain significant and unavoidable as no feasible mitigation can reduce all impacts to less than significant. Some long-term changes in scenic resources, including scenery disturbances due to removal of historic facilities, changes from reservoir to river views, and the construction of fishways and fish handling facilities under some alternatives would be significant and unavoidable.

Mitigation Measures Associated with Other Resource Areas

Several other mitigation measures involve construction work, including mitigation measures H-2 (flood-proof structures), GW-1 (deepen or replace affected wells), WRWS-1 (modify or screen affected water intakes), PHS-4 (repair damaged roads), PHS-5 (construct water storage tanks for firefighting), REC-1 (develop new recreational facilities and access to river), TR-6 (assess and improve roads to carry construction loads), and TR-7 (assess and improve bridges to carry construction loads). Construction equipment associated with the mitigation measures would detract from the natural surroundings. The construction activities would be considered weak to moderate contrasts, depending on the amount of vehicles, equipment, and materials in any given area. Effects would be temporary and would not disrupt large expanses of the natural setting. The impact on scenic quality from implementation of mitigation measures listed above would be less than significant.

3.19.5 References

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3.20 Recreation

3.20.1 Area of Analysis

The recreational setting within the Klamath Basin is characterized by an expansive rural landscape that offers a myriad of outdoor recreational opportunities. Within the basin, there are five national forests (Klamath, Fremont, Winema, Six Rivers, and Modoc), one joint national and State park (Redwood), one national park (Crater Lake), two national monuments (Lava Beds and Cascade - Siskiyou) and five National Wildlife Refuges (NWRs) (Klamath Marsh, Tule Lake, Clear Lake, Upper Klamath, and Lower Klamath) that make up the Klamath Basin NWR System. There are 297 miles of Klamath River Wild and Scenic Rivers (WSR) which include segments of the Klamath, Scott and Salmon Rivers and Wooley Creek. These segments are analyzed as those WSR segments most likely to be affected by the proposed alternatives. There are also extensive public and private recreational opportunities along the Klamath River and its reservoirs. Federal and State agencies, including the United States Forest Service (USFS), Bureau of Land Management (BLM) (including the Northern California District, and Lakeview and Medford Districts in Oregon), United States Fish and Wildlife Service (USFWS), the National Park Service (NPS), and California Department of Fish and Game (CDFG), are responsible for managing these lands which are located in Klamath and Jackson Counties, Oregon, and Siskiyou County, California. Figure 3.14-1 in Section 3.14, Land Use, Agriculture and Forest Resources, shows the management of lands in the Klamath Basin. The analysis of potential effects on the Oregon and Klamath WSRs is also included in this section.

The area of analysis includes recreation areas and access along the Klamath River from its headwaters in Oregon to the mouth of the river at the Pacific Ocean. Recreational areas within and directly adjacent to the Klamath Basin are described to provide an overview of regional opportunities. Impacts on recreation opportunities as a result of the alternatives would be limited to those within the Klamath River corridor; therefore, the analysis focuses on those recreational facilities and opportunities adjacent to the Klamath River. Descriptions of recreational opportunities, activities, and settings are presented here by geographic location, including within the Klamath Basin, upstream of J.C. Boyle Reservoir, between J.C. Boyle Reservoir and Iron Gate Dam, and downstream from Iron Gate Dam. Section 3.20.4.3 presents an assessment of potential impacts of the alternatives, including the Proposed Action to remove J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams (the Four Facilities), on recreational resources.

3.20.2 Regulatory Framework

Recreation within the area of analysis are regulated by several Federal, State, and local policies, which are listed below.

3.20.2.1 Federal Authorities and Regulations

- BLM Redding Resource Management Plan and Record of Decision (1993)
- BLM Klamath Falls Resource Area Resource Management Plan and Rangeland Program Summary and Record of Decision (1995)
- BLM Klamath Falls Record of Decision and Resource Management Plan (2008)
- BLM Medford District Resource Management Plan and Record of Decision (2008)
- Wild and Scenic Rivers Act (WSRA) (16 U.S.C. 1271 et seq.)
- Federal Land Policy and Management Act (43 U.S.C. 1701 et seq.)
- U.S. Forest Service Six Rivers National Forest Land and Resource Management Plan
- U.S. Forest Service Fremont National Forest Land and Resource Management Plan
- U.S. Forest Service Klamath National Forest Land and Resource Management Plan
- National Park Service (NPS) General Management and Strategic Plan, Redwood National Park
- Federal Endangered Species Act (ESA)
- Federal Wild and Scenic Rivers Act, October 2, 1968

3.20.2.2 State Authorities and Regulations

- California Wild and Scenic Rivers Act
- Oregon Parks and Recreation Department, Oregon State Scenic Waterways Act, Klamath River Scenic Waterway Rules

3.20.2.3 Local Authorities and Regulations

- City of Klamath Falls Parks Recreation and Open Space Master Plan

3.20.3 Existing Conditions/Affected Environment

3.20.3.1 Regional Opportunities

Rivers, streams, and lakes are common throughout the mountainous landscape, and grasslands exist in the high plateau areas of the region. A large number of public lands are in the region, including five national forests, five NWRs, one national park, one joint national and State park, and two national monuments. These areas provide sightseeing, camping, hiking, fishing, wildlife viewing, and other recreational opportunities (Figure 3.20-1). In addition, a number of the lands have rivers or river segments designated as WSRs. Table 3.20-1 provides a summary of the opportunities offered on public lands within and adjacent to the Klamath Basin.

3.20.3.1.1 River-Based Recreation

A number of rivers cross the region, including four rivers designated as Wild and Scenic under the WSRA (Sprague River, Sycan River, Smith River, and Trinity River). Portions of the Klamath River (generally described above in Section 3.20.1), are designated as Wild and Scenic under Section 2(a)ii of the WSRA. Other rivers in the Klamath Basin, as shown on Figure 3.20-1 include the Salmon River, Scott River, and Clear Creek. These rivers provide a variety of recreational opportunities, including sightseeing, fishing, and whitewater boating. Figure 3.20-1 shows the location of these rivers relative to the Klamath River. Table 3.20-2 provides a summary of the rivers, the fish species caught,

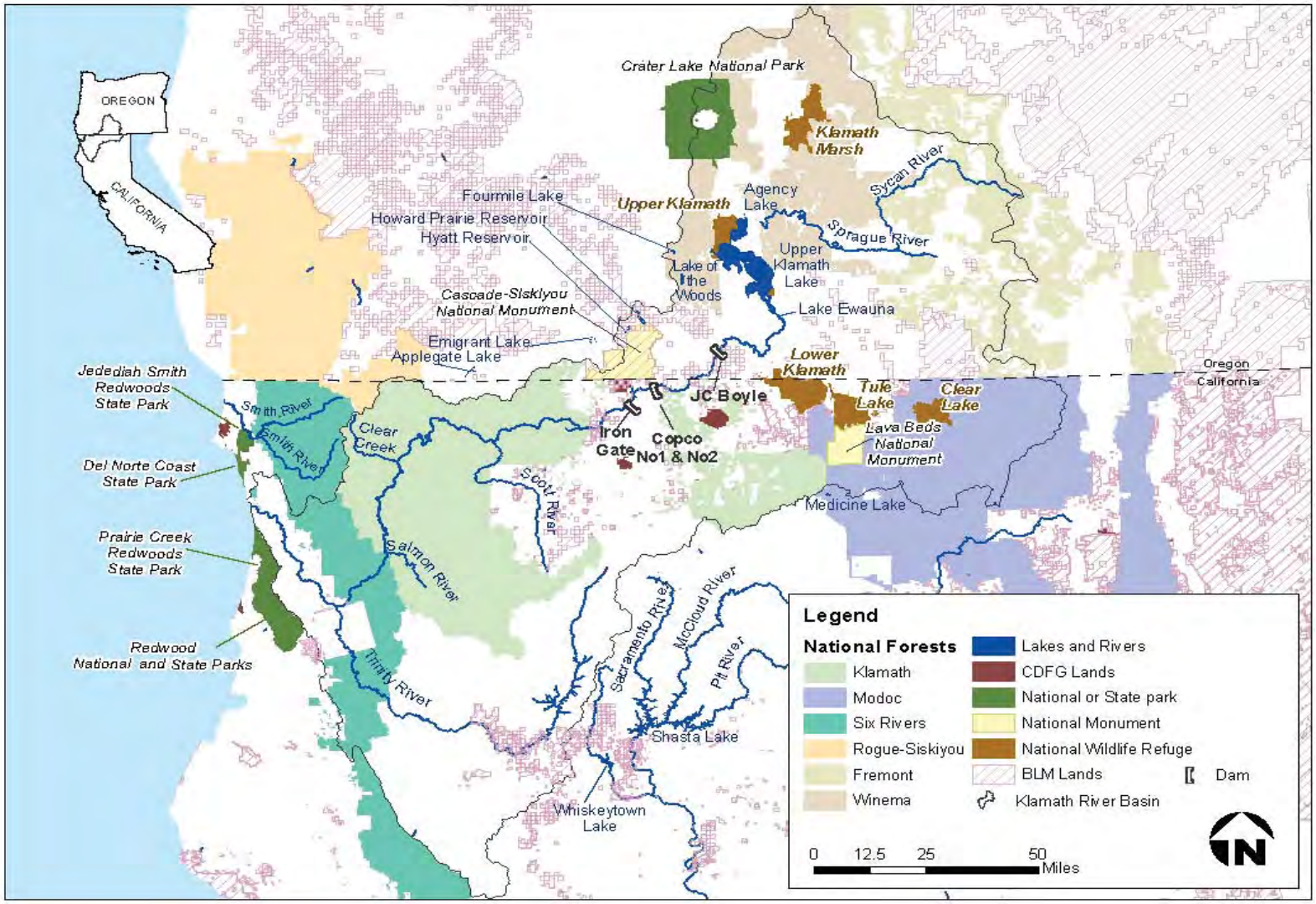

Figure 3.20-1. Regional Recreation Areas.

Table 3.20-1. Public Lands Offering Recreational Opportunities in the Vicinity of the Klamath River

Name	Size	No. of Campgrounds	Recreational Activities Available											
			Sightseeing	Hiking	Picnic Areas	Fishing	Boating	OHV	Wildlife viewing	Skiing	Rock climbing	Mountain biking	Snow play	Other
Klamath National Forest	1.7 million acres	28	X	X		X	X	X	X	X	X	X	X	hunting, equestrian use, spelunking, golf
Fremont National Forest	1.2 million acres	1	X	X		X				X		X		hunting, equestrian use, backpacking, leisure driving
Winema National Forest	1.1 million acres	6	X	X	X	X	X			X			X	backpacking, snowmobiling
Six Rivers National Forest	1 million acres	5	X	X		X	X		X					hunting, backpacking
Lava Beds National Monument	46,500 acres	1	X	X					X			X		caving
Crater Lake National Park	183,000 acres	2	X	X						X		X		swimming, snowshoeing, snow camping
Klamath Marsh NWR	40,600 acres	0	X						X					waterfowl hunting, photography

Table 3.20-1. Public Lands Offering Recreational Opportunities in the Vicinity of the Klamath River

Name	Size	No. of Campgrounds	Recreational Activities Available											
			Sightseeing	Hiking	Picnic Areas	Fishing	Boating	OHV	Wildlife viewing	Skiing	Rock climbing	Mountain biking	Snow play	Other
Lower Klamath NWR	53,600 acres	0	X						X					waterfowl hunting, photography, automobile touring
Upper Klamath NWR	14,900 acres	0	X		X		X		X					waterfowl hunting, photography
Redwood National and State Parks	133,000 acres	4	X	X	X	**X**	**X**		**X**			X		backpacking, equestrian trails, scenic drives
BLM - Cascade-Siskiyou National Monument	53,000 acres	3	X	X		X	X		X	X	X	X		snowmobiling, equestrian use, hunting
BLM - Klamath Falls Resource Area	215,000 acres	5	X	X	X	X	X	X	X				X	rafting, swimming, snowmobiling

Key:
OHV: off-highway vehicle
NWR: National Wildlife Refuge
BLM: Bureau of Land Management

Table 3.20-2. Rivers Providing Recreational Fishing Opportunities in the Region

River	Fish Species Caught[1]	Common Types of Fishing
McCloud River	Native trout	Fly fishing, bank fishing
Pit River	Native trout; brown trout; smallmouth bass; rough fish	Fly fishing, bank fishing
Rogue River	Chinook salmon, steelhead	Drift boat, powerboat, fly fishing
Salmon River	Chinook salmon, steelhead, resident trout	Fly fishing, bank fishing
Scott River	Chinook salmon, steelhead, resident trout	Fly fishing, bank fishing
Smith River	Chinook salmon, steelhead	Drift boat, powerboat, fly fishing, bank fishing
Trinity River	Chinook salmon, steelhead, sturgeon, American shad, lamprey	Drift boat, powerboat, fly fishing, bank fishing
Upper Sacramento	Chinook salmon, native and stocked trout, American shad	Fly fishing, bank fishing
Klamath River	Redband trout, salmon	Fly fishing, bank fishing, drift boat

Source: FERC 2007

[1] Information is based on species caught within the 2003-2004 time period.

and the typical types of fishing methods (e.g., boat, bank, fly). Table 3.20-3 summarizes the whitewater boating opportunities in the region. The Oregon WSRs, in particular, have outstanding recreational and/or scenic values along the length of the designated segments. The California WSRs are classified as wild, scenic, and recreational along the length of the designated segments (National Wild and Scenic Rivers 2009).

3.20.3.1.2 Reservoir-Based Recreation

Numerous opportunities for reservoir and lake-based recreation are available in the vicinity of the Proposed Action area. Table 3.20-4 provides a summary of the lakes and reservoirs in the region, including facilities and use levels. Within Klamath County and Jackson County, Oregon and Siskiyou County, California, there are more than 85 boatable lakes, containing nearly 40 boat ramps (Boat Escape Web site 2002). The area also has more than 180 high-elevation and wilderness lakes in Siskiyou County (Federal Energy Regulatory Commission [FERC] 2007). In addition to boat ramps, these lakes provide nearly 2,300 developed campsites within less than a two-hour drive from the subject reservoirs. Some reservoirs in the region are also stocked with trout or warm water fish such as perch or bass. Angling occurs at the many lakes and reservoirs in the region and many are known for having excellent fisheries.

3.20.3.1.3 Federal- and State-Managed National Forests, Public Lands, and Parks

Klamath National Forest

The Klamath National Forest consists of about 1.7 million acres, and the 300 miles of rivers within the forest include 202 miles of designated WSR segments (see Section 3.20.3.5). The Klamath River flows for 107 miles through the Klamath National Forest west of Interstate 5 (I-5) to the National Forest's border with the Six Rivers National Forest at Ishi Pishi Falls. The Klamath National Forest provides uncrowded, high quality opportunities for sightseeing, fishing, wildlife viewing, whitewater and flat water boating, hiking and horseback riding along 1,100 miles of trails, hunting, mountain biking, cross-country skiing, off-highway vehicle (OHV) and snowmobile use, mountain

Table 3.20-3. Rivers with Whitewater Boating Opportunities in the Region

River	Generalized Use Levels	Boating Class Type[1]	Miles of Boatable Whitewater	Factors Affecting Use Levels
Clear Creek	Low	III-V	7	Difficult access
Klamath River (above CA/OR State line)	Moderate	III-IV+	31	Remote, not suited for beginner or intermediate boaters, unless accompanied by a commercial outfitter
Klamath River (downstream from Iron Gate Dam)	Moderate	II-V	122	Most skill levels, easy access, 186 miles support multi-day floats, shoreline camping, scenery, many outfitters, commercial use
North Umpqua River	Moderate	II-IV	32	Easy access, most skill levels, scenery, boatable year round, shoreline suitable for camping
McCloud River	Moderate	II-IV	35	Proximity to I-5, most skill levels, low flows in summer
Pit River	Low	IV-V	34	Fragmented/short runs with long stretches of flat water between, remote location
Rogue River	High	II-V	100+	Easy access, most skill levels, scenery, boatable year round, shoreline suitable for camping, many commercial outfitters
Salmon River	Moderate	II-V	44	Requires advanced/expert boating skills, commercial use
Scott River	Low	III-V	20	Recommended for expert boaters only
Smith River	Low	II-V	100+	Requires advanced/expert boating skills, low summer flows
Upper Sacramento River	Low	III-V	36	Proximity to I-5, average solitude
Trinity River	Moderate	II-V	100+	Most skill levels, easy access, commercial use

Source: FERC 2007

[1] As rated by the American Whitewater International Scale of Difficulty (American Whitewater 1998).

climbing, and spelunking. There are 34 developed campgrounds within the forest, and dispersed day and overnight use occurs in various locations throughout the forest (FERC 2007; U.S. Department of Agriculture [USDA] 2010).

Six Rivers National Forest

The Six Rivers National Forest encompasses more than 1 million acres of land located east of the redwood belt of northwestern California and the Hoopa Valley and Yurok Indian Reservations, extending from the Oregon border south through Del Norte, Siskiyou, Humboldt, and Trinity Counties. The Klamath River runs for 20 miles through the Six Rivers National Forest from west of Ishi Pishi Falls to the boundary of Hoopa Tribal lands. Recreational opportunities in the Six Rivers National Forest include 24 developed campgrounds, 400 miles of trails for hiking and sightseeing along 365 miles of designated WSRs, backpacking, whitewater boating on 100 miles of the Smith River and approximately 50 miles of the Trinity River, world-class salmon and

Table 3.20-4. Comparison of Subject Reservoirs with Lakes and Reservoirs in the Region

Lake or Reservoir	Distance from Nearest Subject Reservoir (mi)	Surface Water (acres)	Number of Developed Campsites	Number of Developed/ Improved Boat Launches	Number of Developed Picnic Areas	Generalized Use Levels
Subject Reservoirs						
J.C. Boyle	N/A	420	16	2	4	Low
Copco 1	N/A	1,000	0	2	2	Low
Copco 2	N/A	40	0	0	0	Low
Iron Gate	N/A	944	37	3	6	Moderate
Other Lakes and Reservoirs in the Region						
Hyatt Reservoir	15	1,250	172	2	1	Moderate
Emigrant Lake	16	806	110	2	2	Moderate
Howard Prairie Reservoir	17	2,000	303	4	1	Moderate
Upper Klamath Lake	20	85,120	269	6	1	Moderate
Lake of the Woods	21	1,113	190	3	1	High
Fourmile Lake	26	740	25	1	0	Low
Agency Lake	28	5,500	43	3	0	Low
Applegate Reservoir	36	988	66	3	1	Low
Medicine Lake	46	408	72	1	1	Low
Gerber Reservoir	62	3,830	50	2	1	Moderate
Trinity Lake Unit	73	16,535	500	7	2	Moderate
Whiskeytown Lake	87	3,200	139	3	1	Moderate
Shasta Lake	87	29,500	320	7	7	High
Lost Creek Reservoir	178	3,430	202	1	2	N/A
Willow Lake	31	927	66	7	8	N/A
Willow Valley Reservoir	69	200	1	1	1	N/A
Lake Siskiyou	46	160	1			N/A
Juanita Reservoir	14	55	23	2		N/A
McCloud Reservoir	58	520	6	1	1	N/A

Source: PacifiCorp 2004a; Jackson County Parks 2010; VisitUsa.com 2010.

Key:
mi: miles
N/A: not available

steelhead fishing and hunting opportunities. The Six Rivers National Forest is also home to many rare and endangered plants and flowers that are attractive for botanical tours (USDA 2009).

Redwood National and State Parks

Redwood National Park is one of four park units jointly managed as Redwood National and State Parks under a cooperative management agreement between the NPS and the California Department of Parks and Recreation (California State Parks). Together with three State parks-Prairie Creek Redwoods, Del Norte Coast Redwoods, and Jedediah Smith Redwoods State Parks-the parks encompass 133,000 acres. These parks preserve the largest remaining sections of ancient coast redwood forest, including some of the world's tallest and oldest trees and provide forest and stream habitat for threatened and endangered birds and salmonids (NPS 2005). Recreational opportunities include four developed campgrounds, hiking, backpacking, horseback riding, scenic drives, visitor centers, and ranger-led programs designed to inform and inspire the public on this unique ecosystem (NPS 2009).

Fremont-Winema National Forest

The Fremont-Winema National Forest is located in south-central Oregon on the eastern slopes of the Cascade Mountain range. The combined forest area consists of 2.3 million acres. The lowest elevations of the forest adjoin Upper Klamath Lake where there are marshes, lakes, forested slopes, and wide basins. There are 22 developed campgrounds and 9 day-use areas across the forest. Recreational opportunities include sightseeing, fishing, wildlife viewing, hiking, downhill skiing, and hang gliding (FERC 2007).

Modoc National Forest

The Modoc National Forest is located along the California-Oregon State Line and is the most northeasterly of the national forest units in the Pacific Southwest Region. The forest consists of approximately 2 million acres. The Modoc National Forest does not draw as large a volume of recreational travel compared to other forests closer to population centers, with the exception of the one-month open deer season which is known to attract as many as 10,000 hunters. Other recreational opportunities include fishing, camping, hiking, and sightseeing (USFS 2011).

BLM Klamath Falls Resource Area

Located in the BLM Lakeview District, the public lands administered by the Klamath Falls Resource Area are in southern Klamath County on the eastern slope of the Cascade Range. In addition to BLM-administered land (212,000 acres), there are 21,000 acres of non-federally owned surface land underlain by subsurface Federal mineral estate within the Resource Area that are also administered by the BLM (BLM 1995). The two main recreation areas located in the Klamath Falls Resource Area include the Klamath WSR and the Wood River Wetland (BLM 2011). The Klamath WSR area is located 30 miles southwest of Klamath Falls. While travel is limited to rough gravel roads and jeep trails, the area is utilized for wildlife viewing, hunting, fishing, biking, hiking, and camping, among other recreational activities (BLM 2011). The Klamath Falls Resource Area Management Plans (BLM 1995 and 2008) list 15 developed and semi-developed

recreation sites including day-use and campsites, and four developed trails. The Wood River Wetland area is open to the public year-round for day-use only, and includes paved parking, a trail, a canoe launch, picnic areas, toilets, and interpretive signs (BLM 2011).

Recreational activities that take place at the Wood River Wetland area include wildlife viewing, botanical sightseeing, hunting, fishing, canoeing, hiking, and biking (BLM 2011).

Cascade-Siskiyou National Monument

Located in the BLM Medford District, the Cascade-Siskiyou National Monument was designated a national monument by presidential proclamation in 2000. The national monument is located where the Cascade, Klamath and Siskiyou mountain ranges converge and consists of 54,000 acres of BLM-administered lands (BLM 2011). The area is recognized for its remarkable biological diversity and varied landscape, as well as important archaeological and historical resources. The Hyatt Lake Recreational Area is the only developed recreational site within the monument and includes many developed campgrounds (BLM 2008). The major recreational activities within the monument include camping, hiking, horseback riding, sightseeing, hunting, fishing, cross-country skiing, snowmobiling, rock climbing, and nature study (BLM 2008). The majority of the monument is undeveloped and visitor use is estimated as light to moderate throughout. The Hyatt Lake Recreational Area receives moderate use during April through October. In 2003, records show that over 14,000 people visited the recreational area (BLM 2008).

3.20.3.2 Recreation Opportunities along the Klamath River Segment Upstream of J.C. Boyle Reservoir

3.20.3.2.1 Recreation Facilities and Opportunities

Upstream of J.C. Boyle Reservoir, a small number of developed recreation facilities exist. The following paragraphs provide brief descriptions of each facility and the recreational opportunities available.

Agency Lake is connected to the northern arm of Upper Klamath Lake. Although Agency Lake has no marina, there are two public boat launches and it has a fishery that features trophy redband trout. Other popular recreational activities at the lake are sightseeing, including wildlife viewing of waterfowl, otter, mink, deer, and bald eagles (and waterfowl hunting) (Southern Oregon Directory and Guide 2010). The BLM's Wood River Wetland Management Area is on Agency Lake. As shown in Table 3.20-4, a number of campgrounds surround the lake.

Upper Klamath Lake is the largest freshwater body of water in Oregon. In the northern portion of the lake, Pelican Bay is known for its population of redband trout and is an extremely popular destination for fly-fishing. The bay is also a popular location for canoeing and kayaking, as well as sightseeing and wildlife viewing. Other popular

activities in Upper Klamath Lake include sailing and waterfowl hunting. As shown in Table 3.20-4 above, there are numerous campgrounds and boat launches surrounding the lake.

The Link River segment of the Klamath River, an approximately 1-mile stretch downstream from Link River Dam, has only one developed recreational facility, the Link River Nature Trail. This 1.4-mile trail is for pedestrian use only and follows a gated access road on the west side of the Link River Bypass Reach. The Link River Nature Trail is popular for sightseeing, hiking, walking, jogging, trout fishing, and bird watching (FERC 2007).

The Keno Impoundment/Lake Ewuana provides various recreational opportunities, including fishing, picnicking, boating, camping, sightseeing, and wildlife viewing. In the fall, waterfowl hunting is a popular activity at Keno Impoundment/Lake Ewuana. Although most of the land adjacent to the reservoir is privately owned, Lake Ewauna has several public access areas, including the City of Klamath Falls Veterans' Memorial Park/Boat Launch, Miller Island Boat Launch, the Klamath Wildlife Viewing Area, and the Keno Recreation Area and Campground (PacifiCorp 2004). Table 3.20-5 provides a summary of the facilities and estimated annual visitation and capacity as assessed by PacifiCorp as part of relicensing studies for the Klamath Hydroelectric Project (KHP) (PacifiCorp 2004).

Table 3.20-5. Keno Impoundment/Lake Ewauna Developed Recreation Facilities

Site Name	Facilities	2001/2002 Est. Annual Use (Recreation Days[1,2])	Est. Facility Use vs. Capacity
Klamath Falls Veterans' Memorial Park/Boat Launch	Boat launch, day use area	42,500	Exceeding capacity
Miller Island Boat Launch and Klamath Wildlife Viewing Area	Boat launch, wildlife viewing trail, and a portable toilet	7,300	Approaching capacity
Keno Recreation Area and Campground	Campsites (26), day use area, restrooms, boat launch and boarding dock	6,000	Below capacity

Source: PacifiCorp 2004; FERC 2007.

Notes:

[1] Recreation days are defined as one visitor to a recreation area for any reason in a 24-hour period.

[2] Data for PacifiCorp Reservoir use was collected by PacifiCorp in 2001 and 2002. No more recently collected data exists or is available.

The Klamath Falls Veterans' Memorial Park provides a boathouse and boat launch ramp on the northern shoreline of Keno Impoundment/Lake Ewuana and is managed by the City of Klamath Falls, Department of Parks and Recreation. Along the northwestern end of the lake, the Klamath Wingwatchers Lake Ewauna Nature Trail provides opportunities

for bird watching and hiking. This 1.8-mile trail connects Veterans' Memorial Park to the Link River trail, along the Link River to the north. Another trail is currently under construction on the northeastern side of the lake (Klamath Birding Trails 2010).

The Miller Island Boat Launch is on the east shore of Keno Impoundment/Lake Ewuana about 6 miles south of Klamath Falls, and is managed by the Oregon Department of Fish and Wildlife. The facility is accessed by Miller Island Road, which runs three miles through the Klamath Wildlife Area and Miller Unit, which provides an entrance station area, parking area, wildlife viewing trail, and a portable toilet. The Keno Recreation Area and Campground on the southwestern shore of the Keno Impoundment/Lake Ewuana provides a campground, day use area, and boat launch. The campground has 26 developed campsites, restrooms, and a recreational vehicle (RV) dump station. Recreational opportunities in this area include camping, fishing, picnicking, sightseeing, and boating. The Keno Recreation Area consists of upper and lower use areas, with the upper area adjacent to the campground and the lower area adjacent to the boat launch (FERC 2007).

3.20.3.2.2 Whitewater Boating Opportunities

The Klamath River downstream from Link River Dam provides approximately one mile of river suitable for whitewater boating and other river-based activities. Recreational studies of this reach have not detected whitewater boating use; however, there are anecdotal accounts of boating use occurring in the reach (FERC 2007). There is one short Class III/IV rapid and one Class II/III ledge drop in this segment of the river.

The Klamath River downstream from Keno Dam provides approximately five miles of river suitable for whitewater boating, although not much boating use is reported for this reach, perhaps due to its level of access and short run length, including a flat water paddle above J.C. Boyle. The reach is rated Class III difficulty, and flows acceptable for whitewater boating opportunities range from 1,000 to 4,000 cubic feet per section (cfs). Table 3.20-6 provides a summary of acceptable flow ranges for whitewater boating and other flow-dependent recreational activities in the Klamath River (from the Keno Reach to the ocean).

Fishing Opportunities

Fishing is allowed from September 30 until June 16 on the Klamath River downstream from Link River Dam. The highest use in this area occurs from late winter through spring; this area is mainly used by City of Klamath Falls local residents. At lower flow times, anglers use the river at a few sites where there is access for bank fishing through thick riparian vegetation. Catch records indicate that although angler success is consistently low, there is a greater percentage of larger fish caught in this reach than between J.C. Boyle Dam and the State line. Table 3.20-6 below summarizes flows acceptable for fishing opportunities in the various reaches of the Klamath River.

Table 3.20-6. Acceptable Flow Ranges for Various River-Based Activities for Reaches of the Klamath River

River Reach (Length of Reach)	Activity	Low Value (cfs)[1]	High Value (cfs)[1]
Keno Reach (5.0 miles)	Whitewater Boating – Standard	1,000	4,000
	Play Boating	1,100	1,800
	Fishing	200	1,500
J.C. Boyle Bypass Reach (4.3 miles)	Whitewater Boating – Standard	1,300	1,800
	Fishing	200	1,000
Hell's Corner Reach (16.4 miles)	Whitewater Boating/Kayaking[2]	1,000	3,500
	Whitewater Boating/Commercial Rafting[2]	1,300	3,500
	Fishing[3]	200	1,500
Copco 2 Bypass Reach (1.3 miles)	Whitewater Boating	600	1,500
	Fishing	50	600
Iron Gate to Scott River (47 miles)	Whitewater Boating/Fishing	800	4,000
Scott River to Salmon River (76 miles)	Boating	800	7,000
	Fishing	800	4,000
Salmon River to Trinity River (23.1 miles)	Whitewater Boating/Fishing	800	10,000
Trinity River to Ocean (43.4 miles)	Whitewater Boating/Fishing	1,800	18,000

Source: Recreation Sub-Team 2010 (See Appendix R of this EIS/EIR); PacifiCorp 2004; FERC 2007.

Notes:

[1] Values were determined by the recreation sub-team (2010) from relicensing documents (PacifiCorp 2004; FERC 2007) and consultation with USFS and BLM representatives.

[2] Flows are within the desirable range during the daily peak hydroelectric operations period (between 10:00 AM and 2:00 PM).

[3] Flows are within the desirable range for at least 4 hours during the daily non-peak hydroelectric operations period (either between 5 AM and 11 AM or between 3 PM and 9 PM).

Key:
cfs: cubic feet per second

3.20.3.3 Recreation Opportunities in the Klamath River Segment Between J.C. Boyle Reservoir and Iron Gate Dam

3.20.3.3.1 Recreation Facilities and Opportunities

The subject dams impound four water bodies on the Klamath River: J.C. Boyle, Copco 1, Copco 2, and Iron Gate Reservoirs. In addition to these reservoirs, there is a stretch of unimpounded river between J.C. Boyle Reservoir and Copco Reservoir. Figures 3.20-2(a), (b), and (c) show the locations of these reservoirs, and the following sections describe recreational opportunities at each of these areas.

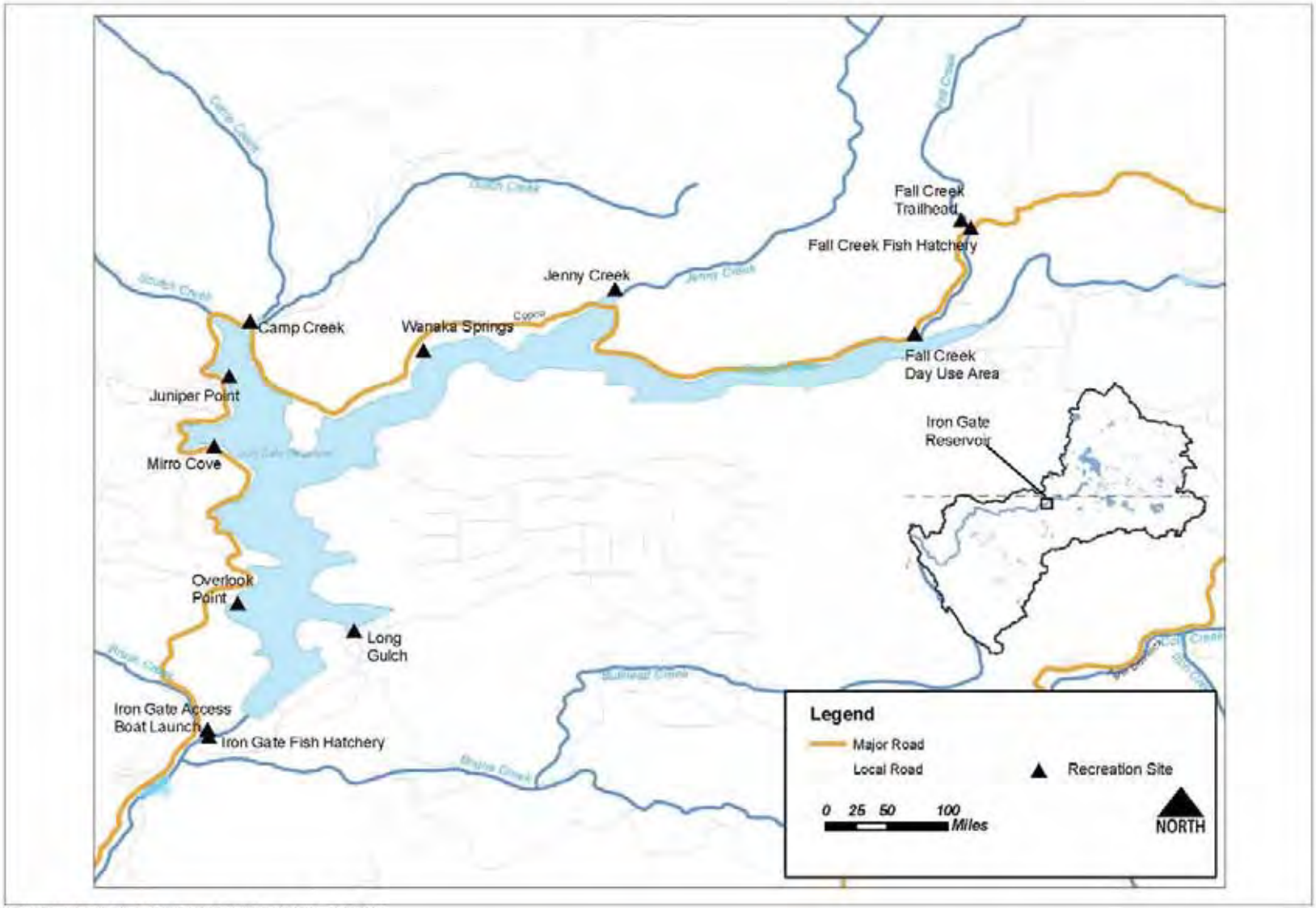

Figure 3.20-2a. Iron Gate Recreation Areas.

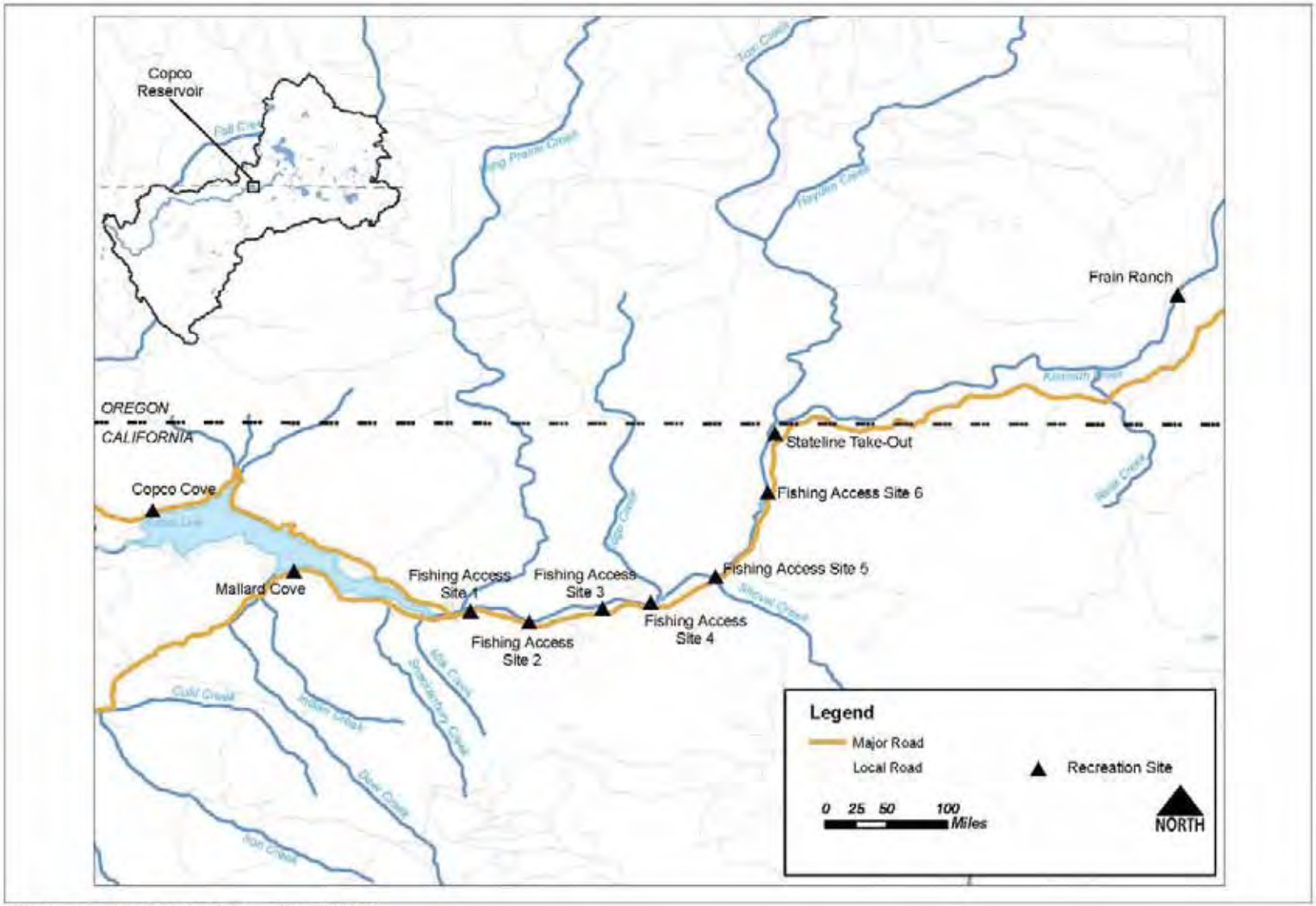

Figure 3.20-2b. Copco Recreation Areas.

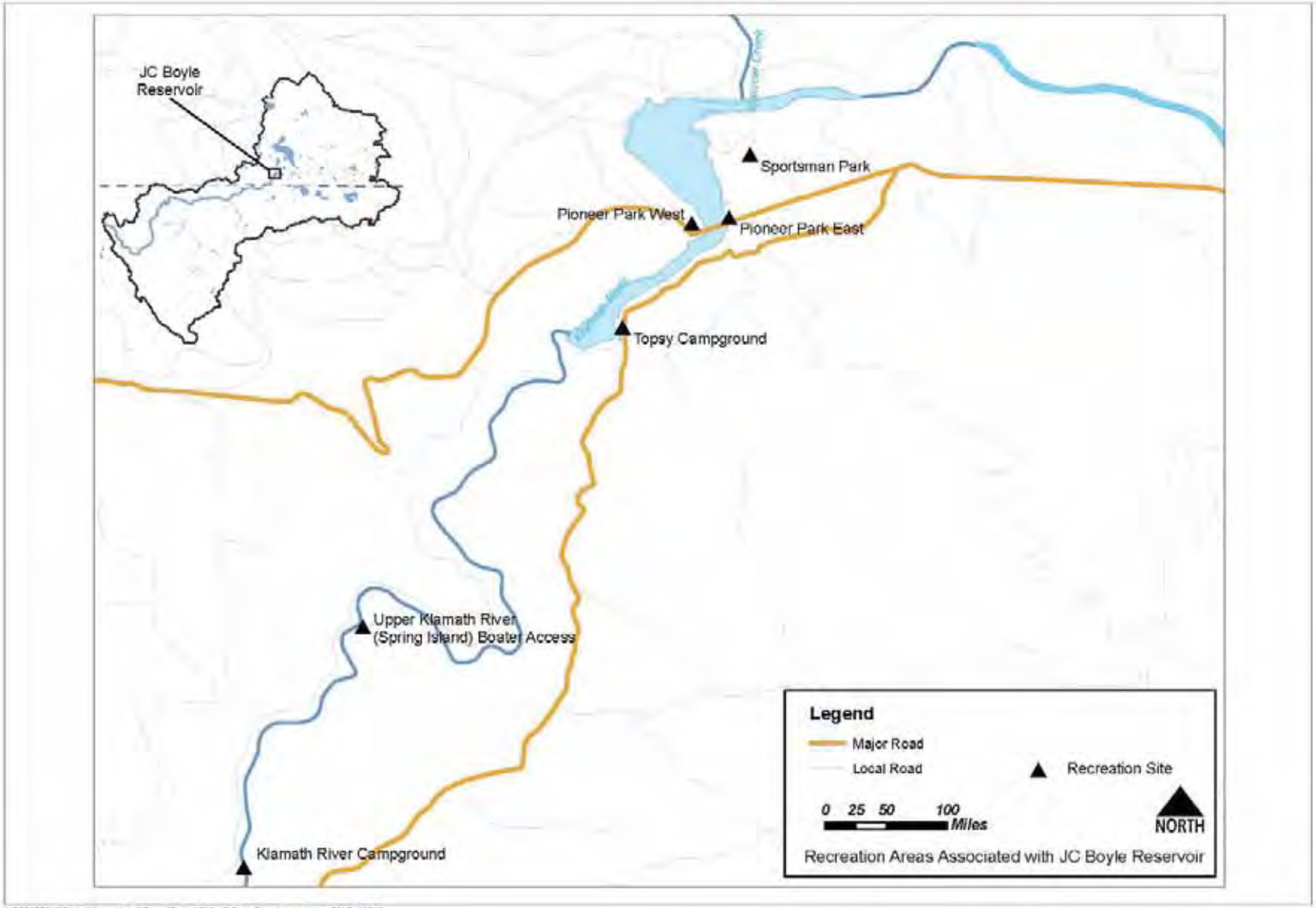

Figure 3.20-2c. J.C. Boyle Recreation Areas.

J.C. Boyle Reservoir

J.C. Boyle Reservoir encompasses about 420 surface acres and is about 3.6 miles long. Developed public recreational facilities at the reservoir include Pioneer Park, Sportsman's Park, and Topsy Campground (Table 3.20-7).

Table 3.20-7. J.C. Boyle Reservoir Developed Recreation Facilities

Site Name	Ownership	Facilities	2001/2002 Est. Annual Use	Est. Facility Use vs. Capacity
Pioneer Park	PacifiCorp	Picnic areas, boat launches, interpretive signs, restrooms	16,700	Below capacity
Topsy Campground	BLM	Campsites (16), an RV dump, two day use areas, a boat launch with boarding dock, an accessible fishing pier, restrooms	5,600	Below capacity
Sportsman's Park	Klamath County	Shooting ranges, dirt racetracks, archery courses, a model aircraft flying field, OHV area, restrooms	12,600	Below capacity

Source: PacifiCorp 2004; FERC 2007.

Pioneer Park is owned and operated by PacifiCorp and it lies off Oregon State Highway 66 (State Highway 66) east and west of Spencer Bridge. Pioneer Park is a day use area that provides picnic areas, boat launches, interpretive signs, and two restroom facilities. It has an improved boat ramp on the east shore just off State Highway 66, and a picnic area and unimproved boat launch on the west shore. Popular activities at this location include sightseeing, boating, fishing, swimming, and picnicking (PacifiCorp 2004).

Topsy Campground is managed by the BLM. The campground is south of State Highway 66 off Topsy Grade Road, a gravel road maintained on an as-needed basis by BLM, private owners, timber companies, and PacifiCorp. This site features a campground with 16 sites, an RV dump, two day use areas, a boat launch with boarding dock, an accessible fishing pier, and two restroom facilities. The campground is available to the public and BLM charges fees for day use and camping at this facility (PacifiCorp 2004).

Sportsman's Park, approximately 0.25 mile east of the reservoir, is a multi-use recreation area owned by Klamath County and leased long term to Klamath Sportsman's Park Association. The facility does not provide developed reservoir access, but does provide river access for fishing. The park contains shooting ranges, dirt racetracks, archery courses, and a model aircraft flying field. The park also has facilities for self-contained RVs and some tent camping. Annual membership passes and single-day passes for use of the park are available to the general public for a fee (PacifiCorp 2004; Klamath Sportsman's Park 2010).

Hell's Corner Reach

The Hell's Corner Reach of the Klamath River from J.C. Boyle Reservoir to Copco Reservoir extends about 16.4 river miles. Several public fishing and boat access areas exist along this reach, as summarized in Table 3.20-8.

Table 3.20-8. Hell's Corner Reach Developed Recreation Facilities

Site Name	Facilities	2001/2002 Est. Annual Use (Recreation days)	Est. Facility Use vs. Capacity
Spring Island Boater Access	Launch area, shoreline fishing access, restrooms	5,200	Below capacity
Klamath River Campground	Campsites (3), shoreline fishing and boating access, restrooms	1,000	Below capacity
Stateline Take-out	Boat put- in/take-out, shoreline fishing access, restrooms	2,700	Approaching capacity
Fishing Access Sites1-6	Shoreline fishing access, parking	3,600	Below capacity

Source: PacifiCorp 2004; FERC 2007.

The Spring Island boater access is adjacent to (downstream from) the J.C. Boyle Powerhouse and is managed by BLM. This site provides car-top whitewater boat launching and shoreline fishing access. The Klamath River Campground, managed by BLM, is about three miles downstream from the J.C. Boyle Powerhouse. The campground has three developed campsites and the shoreline which can be used for fishing and boater access. The State line take-out access area, at the Oregon/California State line, includes upper and lower areas and is co-managed by BLM and PacifiCorp. The facility provides shoreline fishing and boat launching access. The fishing access sites provide access to the Klamath River in six locations between the State line take-out access area and Copco Reservoir.

Copco 1 Reservoir

Copco 1 Reservoir, which covers about 1,000 water surface acres and is about 4.5 miles long, has two publicly available day use facilities: Mallard Cove and Copco Cove that are owned and operated by PacifiCorp. These facilities provide day use access, and although they are not official campgrounds, camping occasionally occurs at both locations. Table 3.20-9 summarizes the facilities and estimated use during 2001/2002 at both of these areas.

Table 3.20-9. Copco 1 Reservoir Developed Recreation Facilities

Site Name	Facilities	2001/2002 Est. Annual Use[1]	Est. Facility Use vs. Capacity
Mallard Cove	Picnic area, restrooms, boat launch with boarding dock	7,600	Below capacity
Copco Cove	Picnic area, restrooms, boat launch with boarding dock	1,250	Below capacity

Source: PacifiCorp 2004; FERC 2007.

Note:

[1] Recreation days are defined as one visitor to a recreation area for any reason in a 24-hour period. Estimated use was during the 2001/2002 study period (PacifiCorp 2004).

Mallard Cove, on the south shore of Copco Reservoir, is accessed off Ager-Beswick Road and includes day use facilities, two restrooms, and a boat launch with boarding dock. Copco Cove, on the western shoreline of Copco Reservoir, off of Copco Road, has a small picnic area, two restrooms, and a boat launch with boarding dock (PacifiCorp 2004).

Copco 2 Reservoir

Copco 2 Reservoir is relatively small (approximately 40 water surface acres and about 0.3 mile long) and has a narrow configuration with steep and difficult shoreline access. Copco 2 Reservoir has no recreation facilities and no public access (FERC 2007).

Iron Gate Reservoir

Iron Gate Reservoir is approximately 944 water surface acres and 6.8 miles long. The reservoir has the highest concentration of recreation sites of all the developments associated with the PacifiCorp facilities. The developed facilities at Iron Gate Reservoir are owned and managed by PacifiCorp and include a trail (Fall Creek Trail), five combination day use and campground areas (Jenny Creek, Camp Creek, Juniper Point, Mirror Cove, and Long Gulch), three day use areas (Fall Creek, Overlook Point, and Wanaka Springs), and a fish hatchery and associated day use area (Iron Gate). Recreational opportunities include sightseeing, swimming, fishing, boating, and day and overnight use. Summer and weekend use is quite high at the reservoir, due to the popularity of bass tournaments, waterskiing, and camping. Table 3.20-10 summarizes the facilities at these sites and PacifiCorp's estimated annual recreation visitation and capacity during the 2001/2002 study period.

The Fall Creek Day Use Area is at the upper end of the reservoir and includes a picnic area, boat launch access, and restroom facilities. This small day use area is adjacent to the CDFG Fall Creek Fish Hatchery and provides access to Fall Creek Trail. Fall Creek Trail is a short (0.1 mile) trail located adjacent to the Fall Creek Fish Hatchery where visitors can hike up to Fall Creek Falls.

Wanaka Springs Day-Use Area provides picnic areas, a fishing dock, and restroom facilities, and some informal camping occurs in the area.

Table 3.20-10. Iron Gate Reservoir Developed Recreation Facilities

Site Name	Facilities	2001/2002 Est. Annual Use (Recreation days)	Est. Facility Use vs. Capacity
Fall Creek Day Use Area and Fall Creek Trail	Picnic area, boat launch access, restrooms, hiking trail	4,150	Below capacity
Overlook Point	Restrooms	1,900	Below capacity
Wanaka Springs Day Use Area	Fishing dock, restrooms	4,150	Exceeding capacity
Jenny Creek Day Use Area and Campground	Campsites (6), restrooms	3,700	Approaching capacity
Camp Creek Day Use Area and Campground	Campsites (13), boat launch, boarding and fishing docks, swimming area, a RV dump station, sports field, interpretive display restrooms	15,250	Exceeding capacity
Juniper Point Day Use Area and Campground	Campsites (9), a fishing dock, restrooms	4,700	Exceeding capacity
Mirror Cove Day Use Area and Campground	Campsites (10), a boat launch, restroom	11,140	Exceeding capacity
Long Gulch Day Use Area and Campground	Picnic sites, boat launch, restrooms	5,200	Below capacity
Iron Gate Fish Hatchery	Picnic area, picnic shelter, visitor center/interpretive kiosk, restrooms, trail to river	2,200	Below capacity

Sources: PacifiCorp 2004; FERC 2007.

Overlook Point is on the west side of the reservoir, approximately 0.75 mile upstream of the dam. The facility has picnic sites on moderately steep topography, providing a good view of the reservoir and surrounding landscape.

Jenny Creek Day Use Area and Campground includes six sites and a restroom facility. Jenny Creek is on the north side of the reservoir and provides a creekside setting for picnicking and bank fishing.

Camp Creek is along a narrow reach on the north side of Iron Gate Reservoir. The surrounding hilly, semi-arid landscape and the reservoir provide pleasant views. Camp Creek has several campsites designed primarily for RV campers, with a large overflow RV camping area. Juniper Point Day Use Area and Campground has several picnic areas that are occasionally used as campsites, a fishing dock and restroom facilities.

Mirror Cove is a day use area and campground centrally located on the west side of the reservoir. The site offers several picnic sites that are occasionally used as campsites, a boat launch, and restroom facilities. This particular location is popular for group camping and is used extensively by local water-ski clubs. This boat launch is the nearest access to a competitive water-ski course placed in the western area of the reservoir.

Long Gulch Day Use Area and Campground is on the east side of the reservoir directly across from Overlook Point. Facilities at this location include picnic sites, restroom facilities, and a boat launch. Land along an adjacent ridge is occasionally used for dispersed camping and day use (PacifiCorp 2004).

Below Iron Gate Dam, the Iron Gate Fish Hatchery is operated by CDFG and includes a public day use area adjacent to the hatchery and an undeveloped boat launch across the river from the hatchery. The day use area includes a picnic area, a picnic shelter, visitor center/interpretive kiosk, restroom facilities, a trail to the river, and seasonal interpretive tours. Fishing is prohibited in this area, in addition to 3,500 feet downstream from the dam.

Visitor Use and Perception

PacifiCorp conducted a visitor survey in 2004 to assess recreational use and visitor perceptions of facilities associated with the Four Facilities, including the subject reservoirs. The majority of visitors surveyed (approximately 60 percent) were from Klamath County and Jackson County, Oregon. The remaining visitors were from California, approximately half of which came from Siskiyou County. When asked to indicate all activities participated in while visiting the subject reservoirs, more than half of the visitors surveys included resting/relaxing as one of the activities. When surveyed on their perception of crowding at the reservoirs, the mean score of respondents was 3.2 (on a 9-point scale from 1 – not crowded to 9 – extremely crowded), indicating that visitors did not feel overly crowded while participating in recreation activities. Further, approximately 39 percent of respondents had changed their visits to the subject reservoirs from other lakes in the area to avoid crowding. When surveyed regarding management options of the reservoirs, survey respondents indicated opposition to the collection of user fees at either day use sites or facility campgrounds (PacifiCorp 2004).

In response to the survey question “Has water quality ever affected your visit to the Klamath River area?” approximately two-thirds of recreational users of the subject reservoirs had negative perceptions of water quality, commenting on its color, turbidity, and odor. The source of visitor concerns was primarily the brown, foamy water in free-flowing reaches and regular, extensive algae blooms that occur throughout the reservoirs. Visitors reported that the algae produces bad odors, fouls fishing lines, and reduces the area available for fishing, swimming, and wading (FERC 2007).

Whitewater Boating Opportunities

Whitewater boating opportunities are provided on the J.C. Boyle Bypass Reach, the Hell’s Corner Reach, and the Copco 2 Bypass Reach. The J.C. Boyle Bypass Reach includes about 5 miles of the Klamath River downstream from J.C. Boyle Dam and upstream of the J.C. Boyle Powerhouse. This reach provides Class III to IV+ rapids, and acceptable whitewater boating flows range from 1,300 cfs to 1,800 cfs; however, this reach is typically dewatered with only 100 to 300 cfs base flow. Therefore, the majority of the year there is almost no boating use on this stretch of the river.

BLM manages whitewater boating use in the Hell's Corner Reach, a 16.4-mile reach from below J.C. Boyle Reservoir to the Fishing Access Site 1 take-out (see Figure 3.20-2b). This reach provides Class III to IV+ rapids during daily peaking flows from the PacifiCorp hydropower operations (between 10AM and 2PM), and acceptable whitewater boating flows range from 1,300 cfs to 3,500 cfs for commercial rafting and heavier loaded boats. Acceptable minimum flows for kayaking and private boaters are 1,000 cfs. Outside of the daily peaking flows, flow rates within this reach do not meet the acceptable range to create or enhance whitewater boating opportunities.

The average estimated annual whitewater boating use from 1994 through 2009 on this reach was 4,414 recreation days, peaking in the mid-1990s at around 6,000 recreation days per year. Whitewater boating use occurs typically during April through October, with about 80 percent of the commercial rafting use occurring during July through September. Commercial boating use accounted for about 93 percent of the whitewater boating use on this reach (United States Department of the Interior [DOI] 2011).

Commercial boating use is allowed by permit only. There is a set commercial capacity of 10 outfitters or 200 clients per day on this reach. There is no limit for private boating capacity, although BLM has established 250 persons per day as the overall whitewater boating carrying capacity of the reach. Factors that constrain the carrying capacity of the reach are vehicle congestion at the take-out locations near Copco 1 Reservoir and the limited size and number of areas that are available to scout rapids (FERC 2007). Rafting use in this area, above Copco 1 Reservoir in particular, depends upon operation of the J.C. Boyle Powerhouse upstream (FERC 2007).

The Copco 2 Bypass Reach is approximately 1.3 miles long, extending from Copco 2 Dam to the Copco 2 Powerhouse and whitewater boating opportunities are limited due to lack of flow. However, the reach could provide Class IV whitewater opportunities at acceptable flows range from 600 to 1,400 cfs.

3.20.3.3.2 Fishing Opportunities

PacifiCorp conducted a visitor use survey in 2002 to obtain information on existing visitor demand, needs, and recreational activities within the area between J.C. Boyle Reservoir and Iron Gate Dam. The results of the survey indicated that 33 percent of visitors to the area participate in bank fishing, both along the river and reservoirs. Survey respondents also indicated that fishing for trout on river reaches in this area is considered very good, and the two most popular reaches for fishing opportunities are Keno Reach downstream from Keno Dam and J.C. Boyle Bypass Reach downstream from J.C. Boyle Dam. Further downstream, opportunities for trout fishing exist below J.C. Boyle Powerhouse (Hell's Corner Reach). This reach (between J.C. Boyle Powerhouse and the State line) is popular with anglers, and catch records indicate good angler success, although fish size is typically smaller than fish caught below Keno Dam and rarely exceeds 16 inches (FERC 2007).

Recreational opportunities downstream from Hell's Corner Reach, between the California/ Oregon State border and Iron Gate Dam, are also quite popular, especially for

angling. In 1974, a 6-mile reach of the Klamath River, from the California/Oregon State line to Copco 1 Reservoir, was designated as Wild Trout water by the State of California and is managed under the Wild Trout Program (CDFG 2010) (see also Section 3.3, Aquatic Resources). Demand for recreational angling is high in this area. The Klamath River between the Copco 1 and Iron Gate Developments has poor public access and no documented fishing activity.

3.20.3.4 Recreation Opportunities along the Klamath River Segment Downstream from Iron Gate Reservoir

3.20.3.4.1 Recreation Facilities and Opportunities

The USFS (Klamath and Six Rivers National Forests) manages the majority of the river corridor from downstream from Iron Gate dam to the confluence with the Trinity River. Other areas downstream from Iron Gate area are also managed by the NPS, BLM, tribes and private land owners. Table 3.20-11 summarizes the river-based recreational opportunities available on the Klamath River downstream from Iron Gate Dam.

Table 3.20-11. River-Based Recreation Opportunities below Iron Gate Dam

Reach	Length (miles)	Current Recreation Opportunities
Iron Gate Dam to Shasta River	13	Sightseeing, Fishing (especially from boats), tubing and swimming, whitewater boating (rare), waterplay
Shasta River to Scott River	34	Sightseeing, Fishing, canoeing, whitewater boating, locational playboating, waterplay
Scott River to Indian Creek	36	Sightseeing, Fishing, canoeing, whitewater boating, waterplay
Indian Creek to Salmon River	40	Sightseeing, Fishing, whitewater boating, canoeing, hiking, waterplay
Salmon River to Trinity River	40	Sightseeing, Fishing, waterplay

Source: PacifiCorp 2004.

There are two privately developed recreation facilities along the river below Iron Gate Dam. One is R Ranch, near Hornbrook. The R Ranch is a large private recreation complex used by RV campers and day users who are members of the R Ranch Landowners' Association. The R Ranch has two separate campgrounds. Cottonwood Campground is just off of I-5, farther away from the Klamath River and offers full RV hookup sites and an RV dump station. Klamath Campground is a few miles east of Cottonwood and I-5 and 2 miles downstream from Iron Gate Dam along 1.7 miles of the Lower Klamath River. This campground contains a large lodge and provides opportunities to fish, hunt and view natural scenery and wildlife.

The Klamath Ranch Resort is a private recreation complex open to the public. It is located ¼ mile below Iron Gate dam and consists of a barn, private residence, historic restaurant, RV park and boat launches.

There are also private land areas near the I-5 corridor, in Seiad Valley, at Happy Camp, and near the mouth of the Salmon River at Somes Bar. In general, these areas have several homes and associated, sparsely populated, rural development. These areas have considerable opportunities to camp, swim, picnic, or relax along this portion of the river. There are also some opportunities for sightseeing, hiking, walking, or biking along the river. In addition, there are some popular short hikes from the river up the tributaries, such as Ukonom and Clear Creek. Land-based recreation points along the river are generally near developed access points for boaters and anglers and a few developed USFS and private campgrounds (PacifiCorp 2004). In addition, there are two National Scenic byways located along this segment of the river and within the Klamath and Six Rivers National Forests. The "State of Jefferson" National Forest Scenic Byway is located primarily on California State Highway 96 (State Highway 96) between Shasta River to Happy Camp, and the "Bigfoot" National Forest Scenic Byway is located on Highway 96 from Happy Camp to California State Highway 299 (State Highway 299). These byways provide excellent views for sightseers within the Klamath and Six Rivers National Forests and access to numerous other recreational activities (America's National Scenic Byways 2010). Downstream from the Trinity River confluence, the Klamath River flows through the Yurok, Hoopa and Resighini Indian Reservations and Redwood National Park, as well as public land managed by the BLM and privately owned lands. A number of private RV and tent campgrounds are along the river in Redwood National Park, and just outside of the park in the City of Klamath. These campgrounds provide opportunities for bank fishing, camping, and picnicking. Other recreation opportunities in the area are associated with the national park and the adjacent State parks (Jedediah Smith, Del Norte Coast, and Prairie Creek Redwood State Parks), which offer hiking, hunting, and wildlife viewing. Table 3.20-4 provides a summary of the facilities associated with these parks.

Public Health Issues

As discussed in Section 3.2, Water Quality, concentrations of chlorophyll-a and *Microcystis aeruginosa* have exceeded World Health Organization (WHO) guidelines for protection from adverse effects in recent years, in both Copco 2 and Iron Gate reservoirs, as well as reaches of the Klamath River downstream from Iron Gate Dam. In 2005 and 2008, the North Coast Regional Water Quality Control Board (NCRWQCB), Karuk Tribe, United States Environmental Protection Agency (USEPA) and other local, State, and Federal agencies issued a warning to residents and recreational users of the river to use caution when near these algal blooms due to possible health effects of exposure to *Microcystis aeruginosa* and its microcystin toxin. Effects range from mild, non-life threatening skin conditions to permanent organ impairment and death, depending upon exposure time and intensity (FERC 2007). As identified in comments received during the scoping period for this Klamath Facilities Removal EIS/EIR, these water quality issues and public health warnings have resulted in reduced recreational activity in affected river segments in recent years.

3.20.3.4.2 Whitewater Boating Opportunities

Extensive whitewater boating opportunities exist downstream from Iron Gate Dam. Depending on the river segment and level of flow, there are opportunities for play, standard, and big water boating on Class II and III waters.[1] These runs are boatable in rafts, kayaks, inflatable kayaks, and open canoes. Table 3.20-6 summarizes the acceptable flow ranges for reaches downstream from Iron Gate Dam.

Although not as challenging as the Hell's Corner Reach upstream, there are a few rapids that are sometimes rated Class IV, including Hamburg and Upper Savage on the Otter's Playpen run, Rattlesnake on the day-use run below Happy Camp, and Dragon's Tooth between Ferry Point and Coon Creek Access. There is also a well-known kayak playboating wave known as the "School House Wave" between Skehan Bar and Gottville. This wave is typically available during low to moderate summer flows and is popular with local kayakers from the Mount Shasta, Klamath Falls, and Ashland areas (PacifiCorp 2004). There is also a Class VI rapid at Ishi Pishi Falls (Somes Bar) that boaters are strongly advised to portage around (Cascade Outfitters 2010).

The primary whitewater boating season is in summer (June through August), when water temperatures are warm; however, the river can be boated in most months of the year (PacifiCorp 2004). There is less whitewater rafting downstream from the Trinity River confluence after the river turns northwest into strong prevailing winds. There are fewer developed river access points along this reach than in the reaches upstream. This reach is located within the boundaries of the Yurok Tribe Indian Reservation. Data collected by the USFS and BLM indicate that substantially more whitewater boating occurs on the Klamath River below Iron Gate Dam than in the Klamath River upstream to J.C. Boyle Dam. From 1994 through 2009, the average annual number of user days was 14,392 per year. However, whitewater boating in this portion of the Klamath River has decreased somewhat in recent years. In part, this decline is due to the presence of microcystin blooms in the river. Total user days from 2000 through 2003 ranged from 13,976 to 15,349 per year, whereas from 2005 through 2009, total user days ranged from 11,751 to 15,279 per year (DOI 2011).

3.20.3.4.3 Fishing Opportunities

The Klamath River downstream from Iron Gate Dam has high quality angling opportunities extending nearly 200 miles to the Pacific Ocean and is open to fishing year-round. This reach, designated a national WSR (see Section 3.20.3.5 below) attracts and supports several fishing outfitter services that focus on salmon, steelhead, and trout fisheries. A review of outfitters conducted as part of the Secretarial Determination process identified over 50 outfitters providing sport fishing, boat fishing, and/or fly fishing trips on the Klamath River. Twenty-seven river access sites within the Klamath National Forest provide access for fishing in this section of the river. Use at the sites varies; however, most are rated as light usage (Klamath National Forest 2010). Tables 3.20-12 and 3.20-13 provide recent use data for Chinook salmon and steelhead fishing on the Klamath River. As shown in the table, angler success varied annually, but

[1] As rated by the American Whitewater International Scale of Difficulty (AW 1998).

Table 3.20-12. Estimated Number of Recreational Salmon Angler Days and Chinook Salmon Harvest on the Klamath River (excluding the Trinity River), 2001-2010

Year	# Angler Days	Chinook Salmon Harvest (# Fish)		
		Adults	Grilse	Total
2001	28,251	9,621	1,365	2,904
2002	24,993	9,769	651	4,942
2003	23,259	7,322	589	10,986
2004	24,751	3,463	2,293	10,420
2005	17,789	1,029	912	7,911
2006	12,141	57	5,202	5,756
2007	19,597	4,975	257	1,941
2008	15,249	1,560	4,039	5,259
2009	20,755	4,820	2,033	5,232
2010	16,219	2,610	1,570	5,599
01-05Avg	23,809	6,241	1,162	7,403
06-10Avg	16,792	2,804	2,620	5,425

Source: CDFG 2011

Table 3.20-13. Estimated Number of Recreational Steelhead Angler Days on the Klamath River (excluding the Trinity River), 2003-2008

Year	# Angler Days
2003	19,183
2004	14,345
2005	13,216
2006	19,371
2007	15,622
2008	21,192
03-08Avg	17,155

Source: NOAA Fishery Service 2011

was much greater in the first half of the decade than in the latter half. The USFS reported that the decline in fish production in the past few decades triggered a similar decline in the guide and resort industry, as well as sport fisheries (FERC 2007) (see also Section 3.15, Socioeconomics).

In addition, decreased abundance of anadromous fish species resulted in restrictions on the fishing seasons for certain runs of Chinook salmon in 2006 and 2008 (National Oceanic and Atmospheric Administration [NOAA] Fisheries Service 2006).

Downstream from the Trinity River confluence, angling in the Klamath River is dependent on the annual status of the fall-run Chinook salmon run, so the number of businesses that offer angling guide services changes from year to year. The main run of

Klamath River Chinook salmon peaks in late fall and is normally over by mid-January each year; the steelhead season normally starts in November (see also Section 3.3, Aquatic Resources).

Anglers fish from boats and the bank. Most of the boat fishing occurs from drift boats or rafts. Fishing regulations allow anglers to keep up to five trout per day and most of the fishing activity occurs in summer and fall. Limits on salmon and steelhead have varied over the years, and regulations depend on whether the fish is wild or from the Iron Gate Hatchery. Most anglers catch and release steelhead (PacifiCorp 2004).

3.20.3.5 Wild and Scenic Rivers Conditions

Two segments of the mainstem Klamath River are designated WSRs, one in Oregon and one in California (Figure 3.20-3). The reach in Oregon, between the J.C. Boyle Powerhouse and the Oregon/California State line was designated a WSR in 1994. In California, the entire river beginning 3,600 feet below Iron Gate Dam to the estuary was designated a WSR in 1981 because of the outstandingly remarkable anadromous fisheries, including that of salmon and steelhead trout. WSR boundaries include variable-width linear corridors which typically include not more than 320 acres per linear mile (averaging up to approximately 0.5 miles in width along the river corridor); however, some protections for designated outstanding remarkable values can extend beyond the designated boundaries.

3.20.3.5.1 Oregon Klamath River WSR Component

The Oregon Klamath WSR , beginning immediately downstream from the J.C. Boyle Powerhouse and flowing 11 miles to its terminus at the Oregon/California State line, was added to the NWSRS through Section 2(a)(ii) of the WSR Act. The river is classified as scenic and possesses outstandingly remarkable scenic, recreational, fish, wildlife, pre-history, history, and American Indian Traditional Use values. The following subsections summarize the existing conditions in the Klamath River at the time of the WSR designation (1994) of the Oregon component.

Scenic

The Upper Klamath River (upstream of Iron Gate Dam) was evaluated by BLM in 1977 and 1981, and received a Scenic Quality Class A rating, the highest scenic quality classification. The 2006 Preliminary Determination Report (completed for the Section 7 WSR requirement during FERC relicensing of the PacifiCorp facilities) stated that scenery associated with the 11 mile Upper Klamath WSR is the main visual element in the region and exhibits more landform variety than the surrounding plateau (Bonacker et al. 2007). As the river canyon cuts across the plateau, it is characterized by cliffs, steep slopes, upland benches, alluvial terraces and the meandering river channel, “which can all be encompassed in a single view” (Bonacker et al. 2007). The unique landforms, water, and vegetation create an ever-changing landscape from desert to more mountainous terrain, and steep canyons and vertical cliffs with diverse vegetation (Bonacker et al. 2007).

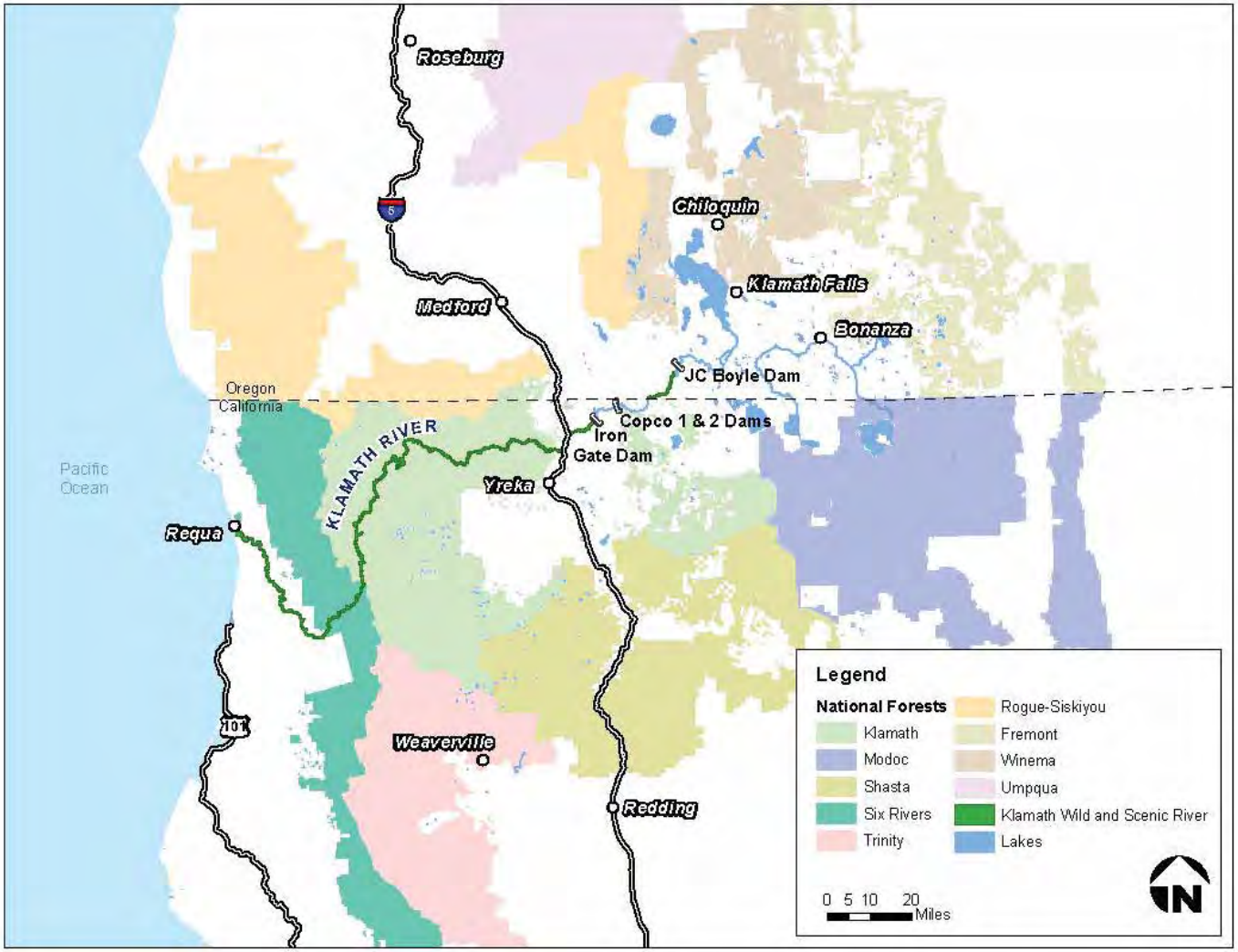

Figure 3.20-3. Klamath Wild and Scenic River Corridor.

Recreation

In the WSR designation, whitewater boating and recreational fishing were specifically mentioned by the Secretary as outstandingly remarkable values of the Upper Klamath WSR. Other popular recreation activities that occurred and continue within the recreation settings along the WSR reach include sightseeing, camping, hunting, OHV use, river swimming and water play, and upstream reservoir fishing and power boating (Bonacker et al. 2007). However, poor water quality conditions have adversely affected water play and river swimming within the WSR area (see section below). In 1994, at the time of the designation, the typical flow regime consisted of reliable and predictable daily hydropower peaking as provided by the KHP. Releases typically peaked in the mid-morning hours, and base flows typically occurred during the hours from late afternoon/early evening until morning. These releases provide whitewater boating opportunities throughout the summer and fall.

Water Quality

As stated in the 2006 Preliminary WSR Determination Report for the FERC relicensing EIS, during the fall, winter, and spring, at base flow, the water appearance is not influenced by the addition of spring water because water released from the reservoir has less algae, nutrients, and turbidity. However, at the time of designation, summer base flow resulted in shallow, slow-moving waters with large amounts of visibly algae-covered rocks.

Peaking operations from the KHP change the relative proportions of cool spring water from the Bypass Reach and warm water from the reservoir and powerhouse, which causes large artificial diurnal temperature fluctuations with higher daily maximum temperatures during power generation as compared to a run-of-river scenario. During peaking events, water appearance changes to a brownish, murky color; it is difficult to see to any depth; and large quantities of algal foam are produced and coalesce in river eddies below major rapids. During off-peak periods the relative contribution of cold clear spring discharge from the bypass reach dominates the flow (Bonacker et al. 2007).

Fisheries

The Upper Klamath River supports a genetically unique population of redband trout and two endangered species, the Lost River and shortnose suckers. The WSR designation report specified redband trout as an outstandingly remarkable value and also listed federally endangered Lost River and shortnose suckers, Klamath largescale suckers, and slender sculpin as “notable species.” At the time of designation, native fish species known or suspected to occur in the Upper Klamath WSR included redband/rainbow trout; Klamath smallscale, Klamath largescale, shortnose, and Lost River suckers; tui and blue chubs; lampreys (perhaps Klamath and Klamath pit brook); sculpins (perhaps marbled only); and Klamath speckled dace (Bonacker, et al. 2007).

Wildlife

The eligibility report identified that the WSR component provided a diversity of habitats for national, regional, and locally important populations of indigenous wildlife species, including exceptional populations of birds of prey, game and other birds, ringtail cats,

river otters, and other species. Numerous Federal and/or State-designated threatened or endangered species (including Federal and State species of concern) including peregrine falcons (*Falco peregrinus*), western pond turtles (*Clemmys marmorata marmorata*), and Townsend's big-eared bats (*Corynorhinus townsendii*) are dependent on the Klamath River. In addition, a high percentage of the wildlife species found in the Oregon Klamath WSR were identified to be directly dependent upon, or disproportionately use, riparian habitat for breeding, foraging, resting, and migration (Bonacker et al. 2007).

3.20.3.5.2 California Klamath River WSR Component

The segment of the Klamath River in California, beginning 3,600 feet below Iron Gate Dam and flowing 189 miles to the Pacific Ocean, as well as portions of three tributaries (Salmon and Scott Rivers and Wooley Creek) were added to the NWSRS in 1981 through Section 2(a)(ii) of the WSR Act. The mainstem California Klamath WSR is classified as recreational with portions of the tributaries classified as scenic and wild. The anadromous fishery is the outstandingly remarkable value for the entire 286 miles of the designated component, which includes the tributaries. The following subsections summarize the existing conditions in the Klamath River at the time of the WSR designation.

Scenic

Scenery within the California Klamath WSR is dominated by natural settings. Its characteristic river flows, water appearance, anadromous fish and riparian vegetation within a forested river canyon are the primary scenic aspects. Since 1981, flow regimes have varied moderately in response to water resource competition within the Klamath Basin. During summer months, these have typically been caused by water diversions (Van de Water et al. 2006). Also, as described in Sections 3.2, Water Quality, and 3.19, Scenic Quality, reduced water clarity and discoloration resulting from algae blooms has impaired the historic scenic character of reaches downstream from Iron Gate Dam. The level of reduced water clarity and discoloration and resulting scenic quality effects is dependent on viewer location. Views from on-river, in-river, or riverside viewpoints are most likely to display substantial changes to scenic quality indicators, while these changes are less likely to be noticed as viewed from nearby river canyon roadways and communities.

The river’s lowest historic flows since the WSR designation can be identified by gage data from United States Geological Survey (USGS) gage no.11516530 near Iron Gate Dam. The lowest monthly summer time flows within the 21-year historical record at Iron Gate Dam before 1981 represents the lower limits of characteristic flow variability, which still expresses its historic scenic character. Before 1981, USGS records show no Iron Gate Dam flow releases of less than 700 cfs; however, flows of less than 700 cfs occurred during 17 months between 1981 and 2004 (Van de Water et al. 2006). Since 2004, no flows of less than 700 cfs have occurred. The lowest monthly mean flows occur in summer (July and August) and have ranged from 823 to 1,373 cfs (USGS 2011). Similar to the scenic quality changes related to water quality conditions described above,

seasonal and project-induced changes in flow and resulting scenic quality changes are more likely to be observed by on-water, in-water and riverside viewpoints than nearby river canyon roadways and community viewpoints.

Recreation

The flows released from Iron Gate Dam greatly influence the river's summer recreation season's whitewater boatability, challenge levels, safety hazards, potential for equipment damage, and the opportunity to access and experience the river's full range of rapids and channels. Exceptionally low summer time flow releases are especially adverse to California Klamath WSR boating activities. Table 3.20-14 compares flows at the time of the 1981 designation to flow conditions required for whitewater boating and recreational fishing (see Table 3.20-6 for optimal flow ranges) (Van de Water et al. 2006).

Table 3.20-14. Comparison of 1981 Flows to the Acceptable Range for Whitewater Boating and Fishing

Month	Flows (cfs)	Whitewater Boating	Fishing
January	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
February	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
March	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
April	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
May	1,000	In acceptable boating flow range/optimal playboating range	In optimal range
June	710	Does not meet minimum boatable flow or playboating opportunities	Does not meet minimum fishing flow
July	710	Does not meet minimum boatable flow or playboating opportunities	Does not meet minimum fishing flow
August	1,000	In acceptable boating flow range/optimal playboating range	In optimal range
September	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
October	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
November	1,300	In acceptable boating flow range/optimal playboating range	In optimal range
December	1,300	In acceptable boating flow range/optimal playboating range	In optimal range

Source: Van de Water et al. 2006.
Key:
cfs: cubic feet per second

Although precise estimates of available recreation days in 1981 are not available, commercial recreational whitewater boating activity on the Klamath National Forest portion of the California Klamath WSR increased by approximately 34 percent between

1981 and 2005 (Van de Water et al. 2006). However, commercial activity on the lower Klamath River has decreased somewhat since 2005 from a recorded 10,695 user days to 8,230 user days in 2009, a trend consistent with other western rivers. Private recreational whitewater boating activity has followed a similar pattern, with the greatest number of user days between 1995 and 2005 (ranging from 4,193 to5,230) and decreasing somewhat since 2005 to a low of 3,525 user days in 2009, as summarized in Section 3.15, Socioeconomics (DOI 2011).

Water Quality

Water quality issues have existed since the time of WSR designation and there is evidence indicating that these issues may have increased since that time, and even more progressively over the past 5 years (Kann and Corum 2009). Water quality issues in the Klamath, including algae blooms and microcystin toxin from one species of blue-green algae, affect river recreation users (see discussion of Public Health Issues in Section 3.20.3.4 above). Results of the toxic algal monitoring program conducted by the Karuk Tribe between 2005 and 2007 at 16 near shore stations in the Klamath River below Iron Gate Dam indicate that nearly 60 percent of samples taken between June and September exceeded the moderate risk level as defined by the WHO (Kann and Corum 2009). Additional sampling conducted in 2007 shows that the microcystin toxin is found as far downstream as the Yurok Reservation, near the river mouth (Kann 2006). In addition, the entire length of the California WSR currently does not meet NCRWQCB water quality objectives for temperature (NCRWQCB 2007). A detailed description of existing water quality is provided in Section 3.2, Water Quality.

Fisheries

The Klamath River was designated a WSR because of its free-flowing condition and its outstandingly remarkable anadromous fisheries, including that of salmon and steelhead trout. Even at the time of designation, decreasing salmonid trends in the Klamath River system were identified as being affected by various factors, including dam construction and operations related to hydropower generation in the Klamath River. Such factors have resulted in increased summer water temperatures, changed the natural flow regime, decreased dissolved oxygen levels in portions of the river, and blocked access to more than 350 miles of spawning, incubation, and rearing habitat. Scientific evidence shows that Chinook salmon, coho salmon, cutthroat trout, and steelhead trout were historically present above Iron Gate Dam (Hamilton et al. 2005).

According to a 1981 California Department of Water Resources (CDWR) study, spawning conditions in the reach immediately downstream from Iron Gate Dam were already impaired due to a coarsening of the bed below the dam. Although the reach below Iron Gate Dam was historically a prime spawning area, by 1981 the reach produced few salmon and the riffles within the reach contained cobbles too large for salmon to move. Prior to the 1981 WSR designation, the reach between Iron Gate Dam and Shasta River was scoured by daily peak flows from Copco 1 and Copco 2 operations prior to the construction of Iron Gate Dam (Van de Water et al. 2006).

Streambed armoring as a result of low flows and reduced gravel recruitment can decrease habitat diversity within channels, making the river less hospitable to juvenile salmonids. Armoring can also lead to the cementation of spawning gravels, impairing the ability of spawning adults to make redds. Armoring can also decrease the amount of habitat available (interstitial spaces) to macroinvertebrates, an important food source for fish. Given the findings of the 2006 study, it appears that much of the riverbed coarsening had occurred prior to the WSR designation (Van de Water et al. 2006). However, impacts from dams progress over time so one would expect that continued sediment depletion (by the retention of sediment behind the dams) would continue to worsen spawning habitat below the dam (Ligon et al. 1995; Kondolf 1997; and Grant et al. 2003).

River flows also affect fisheries' population and abundance. Table 3.20-14 shows the monthly flows at the time of the WSR designation. Flows are a key component of cumulative effects from water management on the aquatic environment. The flow regime downstream from Iron Gate Dam affects aquatic resources through instream flow influences on physical habitat (depth, velocity, substrate, and cover) and on water quality that may affect the prevalence of disease pathogens (Bartholow et al. 2005).

Estimates of abundance for anadromous fisheries at the time of the WSR designation are not available for all species. Table 3.20-15 provides estimates of abundance at the time of designation, or as near as possible to the time of designation for those species for which data is available. As discussed in Section 3.3, Aquatic Resources, the abundance of anadromous fisheries has decreased since the time of the WSR designation. Specific units of coho salmon in the Klamath River were listed as threatened under the ESA in 1997. Similarly, the green sturgeon was listed by NOAA Fisheries Service as a Species of Concern in 2005 and designated as threatened under the ESA in 2010. The Lost River and shortnose sucker were designated as endangered in 1988 after the WSR designation in California and after the designation in Oregon.

Table 3.20-15. Estimated Abundance of Fish Species at the 1981 WSR Designation

Species	Estimated Abundance
fall Chinook salmon	Natural spawners – 4,000 (1981)
	Iron Gate hatchery spawners – 21,595 (1981)
coho salmon	3,400 (1984)
summer Steelhead	110,000 (average 1977-1991)
winter Steelhead	20,000 (average 1977-1991)

Source: Van de Water et al. 2006

Wildlife

Wildlife populations have not been systematically surveyed on the Klamath River. Baseline data were not collected in 1981; therefore, population numbers or trends are not available for most species in specific areas like the WSR corridor.

Riparian vegetation provides habitat for feeding, breeding, and sheltering for willow flycatchers, western pond turtles (a species of special concern in California) and various other wildlife species along the river. There is no reference condition for the riparian vegetation in 1981 (Van de Water et al. 2006). The project area includes a large number and diversity of wildlife species. Surveys conducted by PacifiCorp in 2002 and 2003 identified five amphibian species, numerous bird species, including 19 species of birds of prey, and numerous mammal species, including black-tailed jackrabbit, mule deer, and California ground squirrels. See Section 3.5, Terrestrial Resources, for further discussion of wildlife populations within the Klamath River corridor.

3.20.3.5.3 Eligible and Suitable WSR Section on the Klamath River

In 1990, BLM found the 5.3-mile section of the Klamath River from the Oregon/ California State line to the slack water of Copco 1 Reservoir to be eligible and suitable for WSR designation under Section 5(d)(1) of the Act. The river segment is free-flowing and possesses outstandingly remarkable scenic, recreational, fish, and wildlife values. This river segment is not a designated WSR and is not protected under the WSRA and its Section 7(a) requirements. The BLM is required within its authorities, to protect this suitable river segment's free-flowing character, water quality, and outstandingly remarkable river values. This segment of the Klamath River is also listed on the Nationwide Rivers Inventory (NRI) (NPS 2009). If a river is listed in the NRI, the Federal agency involved with the action must consult with the land managing agency in an attempt to avoid or mitigate adverse effects of any proposed water resources projects. This consultation is required pursuant to a directive from the Council on Environmental Quality.

3.20.4 Environmental Consequences

3.20.4.1 Effects Determination Methods

This discussion of environmental effects considers the implications of the Proposed Action and identified alternatives on the potential changes to river- and reservoir-based recreation opportunities, activities, and settings within the study area. The relocation of the City of Yreka's water supply pipeline is not expected to result in any impacts to recreational resources; therefore, it is not addressed in this section of the EIS/EIR. The analysis presented below includes an assessment of both short-term and long-term effects on access, flow-dependent recreational activities, recreational fishing, and other recreational activities associated with the existing Klamath River corridor and reservoir recreational facilities within the study area.

3.20.4.1.1 Recreational Setting, Facilities, and Access

Likely changes to recreational use and access under each identified alternative were assessed qualitatively, including changes from reservoir-based recreational opportunities to more river-based opportunities in the areas where the dams, recreational facilities, and/or PacifiCorp facilities would be removed. The short-term effects analysis includes a discussion of potential areas where recreational access would be restricted due to

construction activities. The assessment of long-term effects discusses potential changes in the recreational setting and experience, changes in water quality and reservoir area revegetation.

3.20.4.1.2 Whitewater Boating Opportunities

Optimal and acceptable flows for whitewater boating opportunities along reaches of the Klamath River were assessed as a part of the technical review completed for the Secretarial Determination. The range of acceptable flows resulted from the Final Technical Report, Klamath Hydroelectric Project (PacifiCorp 2004b). Flow values that fall within these ranges are considered acceptable flow levels for the various activities (see Table 3.20-6).

The Lead Agencies conducted hydrologic modeling to assess changes in the availability of acceptable flows under the various alternatives. The Lead Agencies subjected the modeling results for each water year type to a statistical analysis (paired T-tests) to determine whether the difference in number of days meeting the acceptable range of flows following dam removal (both on an annual and monthly basis) would be statistically significant. The Lead Agencies used a qualitative approach to assess the effects of the identified alternatives on whitewater boating access and existing whitewater boating opportunities.

3.20.4.1.3 Recreational Fishing Opportunities

The Lead Agencies used the results of the hydrologic modeling to; determine whether changes in flow would affect recreational fishing opportunities (i.e., number of days with optimal flows for recreational fishing), qualitatively assess potential changes in fisheries populations and abundance; and determine effects of changes from reservoir-based fishing opportunities to river-based opportunities.

3.20.4.1.4 Other Recreational Opportunities

The analysis also includes an assessment of other recreational activities, such as sightseeing, swimming/wading/tubing, fish and wildlife viewing, and camping that occur within the river corridor and a qualitative discussion of the effects of the various alternatives on these activities. The discussion here covers both anticipated short-term effects, such as construction-related effects, and long-term effects, such as changes in reservoir-based swimming opportunities.

3.20.4.2 Recreation Significance Criteria

For the purposes of the EIS/EIR, the following Recreation impacts would be significant if they would result in the following:

- Substantial restrictions on recreational access or reduction in the quality of recreational experiences in the vicinity of the subject reservoirs;
- Substantial decreases in the availability of reservoir/lake-based recreational opportunities;
- Substantial reduction in the quality of water-contact-based recreational activities;
- Substantial decreases in access for whitewater boating opportunities;

- Substantial changes in the amount of days providing acceptable flows for recreational activities.

3.20.4.3 Effects Determinations

3.20.4.3.1 Alternative 1: No Action/No Project

The No Action/No Project Alternative would not change existing recreation access and opportunities. Under the No Action/No Project Alternative, no change to existing conditions, recreational facilities or opportunities at J.C. Boyle, Copco 1, or Iron Gate Reservoirs would occur. Similarly, whitewater boating and recreational fishing opportunities in reaches between J.C. Boyle Dam and Copco Reservoir and downstream from Iron Gate Dam would remain as described in the Affected Environment. As described in the Affected Environment, recreation activities in the reaches between J.C. Boyle Dam and Copco Reservoir (e.g., Hell's Corner Reach) are flow-dependent and rely on daily peaking hydropower operations.

Under the No Action/No Project Alternative, these operations would continue and opportunities for whitewater boating and fishing in these reaches would remain as described. Within the subject reservoirs and downstream from Iron Gate Dam, poor water quality conditions and decreased abundance of anadromous fish species have resulted in adverse existing conditions for recreational activities, including complete closures of fishing seasons for certain species and public health warnings against water-contact-based activities during algal blooms in the summer. **Under the No Action/No Project Alternative, existing impacts on recreational fishing within the river and water-contact-based activities at the subject reservoirs would have no change from existing conditions.**

3.20.4.3.2 Ongoing Restoration Actions

Ongoing restoration actions would continue to take place under the No Action/No Project Alternative. Construction and implementation activities associated with these ongoing projects could result in effects to recreational resources and opportunities in the areas where construction takes place.

Ongoing actions considered for impact to recreational resources under the No Action/No Project Alternative include:

- Ongoing restoration actions
- Agency Lake and Barnes Ranches project

Construction activities associated with ongoing programs could temporarily restrict access to recreational opportunities. Construction activities including channel construction, floodplain rehabilitation, fish passage and facilities construction, and breaching levees would likely involve the use of heavy equipment along floodplain and riparian areas and could result in restrictions to public access for recreational activities, such as sightseeing, bank fishing, swimming, and wading. Because restoration activities would occur throughout the entire basin, specific sections of the river could be closed for a period of time throughout implementation of the ongoing restoration programs.

However, as described in the Affected Environment section, there are a number of recreational areas offering similar activities and settings throughout the basin. It is likely that for any particular project, there would be an alternative recreational area nearby that could be used during temporary closures. **Thus, potential impacts to recreational opportunities would be less than significant. Implementation of specific projects will require future environmental compliance as appropriate.**

Construction activities could result in short-term water quality impacts which could affect recreational opportunities. Erosion and sedimentation during construction activities has the potential to temporarily decrease water quality and reduce water visibility for boaters, swimmers, and fisherman. These short-term water quality impacts would be anticipated to occur throughout the basin where construction activities take place. Specific sections of the river could be affected for a period of time throughout implementation of the ongoing restoration programs. However, following implementation and related construction activities for ongoing restoration programs water quality and clarity in Upper Klamath Lake would be expected to improve. Additionally, as described above, short-term impacts would be offset by the ability of visitors and local recreationalists to use recreational areas with similar activities and settings throughout the basin. **Potential impacts would be short term and, with implementation of construction best management practices (BMPs), would cause less than significant water quality related recreational impacts. Implementation of specific projects will require future environmental compliance as appropriate.**

Ongoing actions correcting fish passage issues, reintroducing and monitoring fish species, and restoring aquatic habitat could increase recreational fishing and wildlife viewing opportunities in the basin. It is expected that correction of fish passage issues throughout the basin would restore fish access to new and historic habitats and result in increased fish populations. Ongoing restoration programs could continue to improve fish passage and habitat conditions in the basin which could benefit recreational fishing opportunities. **It is expected that continued implementation of restoration programs would benefit recreational experiences throughout the Klamath Basin. Implementation of specific projects will require future environmental compliance as appropriate.**

3.20.4.3.3 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Demolition activities could temporarily restrict recreational access in the vicinity of the reservoirs. Short-term demolition activities associated with dam removal would result in temporary loss of access to recreational facilities at the subject reservoirs and associated reservoir-based recreational opportunities. Access could remain restricted for an additional period following completion of dam removal as restoration activities are conducted on the former reservoir area and existing recreational areas are modified to accommodate the new river channel. However, as described in Section 3.20.3.1, Regional Opportunities, a number of reservoirs and lakes are present within and adjacent to the Klamath Basin and provide similar opportunities for recreational activity. **Therefore, temporary impacts on recreational access in the vicinity of the subject reservoirs would be less than significant.**

Temporary impacts from demolition activity (i.e., increased noise and dust) could decrease the quality of recreational experiences in the vicinity of the reservoirs. As described in Section 3.9, Air Quality, and Section 3.23, Noise and Vibration, the use of heavy vehicles and equipment during dam removal would result in a temporary increase in dust and ambient noise in the vicinity of the subject reservoirs. These increases could indirectly result in a decrease in the quality of recreational experiences at nearby facilities that would not have restricted access during construction (e.g., trails and private parks not directly affected by construction). Specific effects related to noise and dust are discussed in detail in their respective sections; with regard to recreational activities, increases in ambient noise and air pollutants could impede visitors' ability to rest and relax, and disrupt bird and wildlife viewing opportunities. These effects would last for the duration of demolition activity; however, as shown in Figures 3.20-2(a-c), the majority of recreation facilities and access points at the subject reservoirs are located a distance away from the dams and would continue to provide opportunities for recreation until drawdown is completed. Further, as described in Section 3.20.3.1, Regional Opportunities, numerous other recreational areas are available within the vicinity of the subject reservoirs that provide similar recreational opportunities. **Therefore, these temporary noise and dust impacts would be less than significant.**

Dam removal could permanently decrease the availability of reservoir/lake-based recreational opportunities in the area of analysis. The removal of the Four Facilities would eliminate existing opportunities for reservoir-based recreation activities, such as power boating, waterskiing, lake swimming, and flat water boat angling, provided at J.C. Boyle, Copco 1, and Iron Gate Reservoirs. As discussed in the Affected Environment section, the subject reservoirs are popular recreational areas for sightseeing, fishing, camping, swimming, boating, and wildlife viewing and attract visitors primarily from the surrounding communities in Klamath and Jackson County, Oregon and Siskiyou County, California. As indicated in the responses to visitor use surveys conducted by PacifiCorp, the reservoirs are popular recreation areas in part because they are uncrowded relative to other lakes in the area and do not require user fees. Some activities associated with reservoir recreation could still be possible in the newly created river channel (e.g., swimming and wading). However, due to increased flows, certain reservoir-based recreation such as swimming opportunities and flat water boating may be limited in the newly formed river channel during certain times of year and in wet water years. Additionally, the types of river-based recreational opportunities available following dam removal including camping in a river setting as opposed to camping in a lake/reservoir setting, may not appeal to the same recreational users who currently visit and recreate at J.C. Boyle, Copco 1, and Iron Gate Reservoirs. Thus, there would be a permanent loss of reservoir-based recreational opportunities at the project reservoirs. While new recreation opportunities would exist along the newly formed river, there could be a change in user type. People specifically seeking lake or reservoir-based recreation would have to travel to and use other lakes and reservoirs in the region.

As shown in Table 3.20-4, a number of other lakes and reservoirs are in the vicinity of the subject reservoirs and provide similar opportunities for recreation in an uncrowded

setting. Specifically, Table 3.20-4 shows that Fourmile Lake, Agency Lake, Applegate Reservoir, and Medicine Lake, located from 26-46 miles away from the subject reservoirs, each have low generalized use levels as well as similar or greater surface area, number of developed campsites, and number of improved boat launches. These four regional lakes have fewer developed picnic areas (PacifiCorp 2004). Given the presence and proximity of these regional lakes as well as the other lakes and reservoirs summarized in Table 3.20-4, the loss of the subject reservoirs would not result in a substantial decrease in regional lake-based recreational opportunities. Further, recreational opportunities would remain available on and along the newly created river channel. **Therefore, impacts on the regional availability of reservoir-based recreational opportunities would be less than significant**.

Dam removal could permanently remove recreational facilities associated with the reservoirs. Under the Proposed Action, the recreational facilities constructed to accommodate reservoir recreation, with the exception of Topsy Campground, Fall Creek and Jenny Creek Day Use Areas, and the Iron Gate Fish Hatchery Day Use Area, would be completely removed and the former recreation areas, parking areas, and access trails would be regraded and revegetated (Reclamation 2011). This would result in a permanent decrease in river access points. Dam removal would permanently decrease the availability of reservoir recreational opportunities (as described above), and the removal of existing recreational facilities would limit access to recreational opportunities along and within the newly formed river channel. However, as described in Section 3.20.3.1 Regional Opportunities, a number of reservoirs and lakes are present within and adjacent to the Klamath Basin and provide similar opportunities for recreational activity. **These impacts on recreational facilities associated with the subject reservoirs would be considered permanent; however, implementation of Mitigation Measure REC-1, while providing for a different type of use would ensure that these impacts in the long term would be less than significant.**

Dam removal could adversely affect developed recreational facilities upstream and downstream from the subject reservoirs. No impacts on recreational facilities upstream of the dam removal sites would occur as a result of removal of the Four Facilities because any changes to flow and water quality would occur downstream from J.C. Boyle Dam and Topsy Recreation site on J.C. Boyle Reservoir will be reconfigured to provide river access. However, as discussed in Section 3.3, Aquatic Resources, removal of the dams would help restore the presence of anadromous fish to the Klamath River above J.C. Boyle reservoir which would beneficially affect recreational fishing at these upstream facilities. Removal of the dams is expected to result in water quality improvements downstream from Iron Gate Dam (see Section 3.2, Water Quality), which could improve visitor perceptions and attract a greater number of visitors to existing recreational facilities. However, land-based facilities would not be physically affected by removal of the dams and drawdown of the reservoirs, since, as discussed in Section 3.11, Geology, Soils, and Geologic Hazards. The river is largely confined by bedrock and there would be little change to floodplain areas or the river channel itself. **Any impacts on upstream and downstream recreational facilities would be less than significant.**

Sediment release downstream during reservoir drawdown could decrease the quality of water-contact-based recreational opportunities. As discussed in Section 3.2, Water Quality, drawdown of the reservoirs would result in short-term increases in turbidity downstream from the PacifiCorp reservoirs. Turbidity would be most pronounced immediately downstream from Iron Gate Dam (between Iron Gate Dam and Bogus Creek), and less so farther downstream, and is expected to be flushed through the system quickly (less than 2 years). This increase in turbidity would reduce visibility for boaters, swimmers, and fisherman during the sediment flushing period and could result in reduced public draw for these activities (e.g., swimmers might be less likely to enter the river and fisherman might be less successful due to the reduced water clarity). Increased turbidity would also affect safety considerations during swimming if swimmers are unable to see the river bottom or navigate around obstacles, such as large boulders or logs beneath the water surface. However, impacts would be temporary; following completion of reservoir drawdown activities, water quality and clarity would be expected to improve as sediments are flushed downstream and into the Pacific Ocean. Impacts would not be widespread throughout the river; opportunities for fishing and swimming in non-turbid waters would remain available during the drawdown period.

Sediment release could also decrease the quality of water-contact-based recreational opportunities if sediment released downstream resulted in longer-term deposition in pools, eddies, slack water, and beaches and decreased the availability of these areas for recreational activity. As discussed in Section 3.11, Geology, Soils, and Geologic Hazards, modeling was conducted to determine the potential for such deposition following dam removal. The results of the modeling indicated that following dam removal, deposition would occur primarily between Iron Gate Dam and Cottonwood Creek and there would be no substantial change in river bed elevation. The Proposed Action was developed to allow reservoir drawdown to occur during winter months when precipitation, river flows, and turbidity are naturally highest. Suspended sediments would be highest during the period of greatest reservoir drawdown (January through Mid March 2020), as erodible material behind the dams is mobilized downstream (Reclamation 2012). During normal to dry water years, suspended sediment concentrations would begin to decline in late March 2020 and would continue declining through early summer 2020 (Reclamation 2012). If it is a wet year, it may take longer to drain the reservoirs and the high concentrations may extend until June. Suspended sediments will be near background conditions for all water year types within the first year following removal. (Aquatic Resources Section 3.4.3.2.1.1) Therefore, it is unlikely that sediment release would decrease the availability of pools, eddies, or beaches for recreational activity, even temporarily. **Therefore, impacts on the quality of water-contact-based recreational opportunities would be short term and less than significant.**

Changes in water quality associated with dam removal could positively affect water-contact-based recreational opportunities. Dam removal is expected to result in long-term improvements in water quality, notably decreased prevalence of microcystin toxin (see Section 3.2, Water Quality). As discussed in Section 3.2, Water Quality and

3.20.3.2 above, microcystin toxin has been associated with public health risks for recreational bathing waters and health warnings issued in 2005 and 2008 by the USEPA and other agencies warned recreation visitors to use caution due to potential health effects. In addition, about two-thirds of recreation visitors to the subject reservoirs had negative perceptions of water quality, stating concerns of bad odors and algae blooms, which restrict areas available for fishing, swimming and wading. These adverse effects related to water quality negatively influenced the quality of the recreational experience for visitors and also resulted in safety risks to the recreational visitors. **Because existing conditions for water-contact-based recreational activities are considered adverse due to water quality, improved water quality conditions would result in long-term beneficial effects.**

Dam removal could impede access for whitewater boating opportunities. Dam removal would not affect whitewater boating access locations, as access areas are at established areas along the Klamath River channel, outside of the subject reservoirs and would not be affected by dam removal. As discussed in the impact analysis above and in Section 3.11, Geology, Soils, and Geologic Hazards, drawdown of the reservoirs would not result in substantial changes to the floodplain or river channel. Thus, no impacts to land-based recreational facilities are expected. **Therefore, there would be no adverse impacts on whitewater boating access downstream from Iron Gate Dam.** However, in the reaches between the existing dams, particularly in the Hell's Corner Reach, whitewater boating access would likely be affected due to dam removal activities and sedimentation, as discussed previously. **Impacts in reaches between the existing dams would be short term and less than significant**.

Dam removal could increase the number of days with acceptable flows for various whitewater boating and recreational fishing in the Keno Reach and reaches downstream from Iron Gate Dam. The Lead Agencies modeled the average number of days providing acceptable river flows in specific reaches each month for specific recreational activities, both with and without dam removal (full modeling data is presented in Appendix R; DOI 2011). Table 3.20-16 presents a summary of the model results, and Figures 3.20-4 through 3.20-11 show the results for each of the river reaches. For the Keno Reach (see Figure 3.20-4) and the reaches downstream from Iron Gate Dam (Figures 3.20-8 through 3.20-11), the changes in the availability of flows within the acceptable flow ranges for whitewater boating and fishing opportunities would be negligible. However, as described in Section 3.20.3.2, existing difficult access to the Keno Reach, including a flat water paddle above J.C. Boyle Dam, currently limits recreational use of this area. Dam removal would likely improve access to the Keno Reach and would benefit whitewater boating and fishing opportunities in this area. **Given negligible changes in flows and improvements in access, there would be long-term beneficial effects on whitewater boating and fishing opportunities in the Keno Reach. Impacts in reaches downstream from Iron Gate Dam would be less than significant.**

Table 3.20-16. Estimated Number of Days Meeting the Range of Acceptable Flows for Recreational Activities on the Klamath River

River Reach	Activity	Acceptable Flow Range		Total Avg. No Days Annually		
		Low Value (cfs)	High Value (cfs)	Dams In	Dams Out	Percent Change
Keno Reach	Whitewater Boating	1,000	4,000	151	139	-7.9%
	Fishing	200	1,500	246	238	-3.5%
J.C. Boyle Bypass Reach	Whitewater Boating	1,300	1,800	5	41	793.6%
	Fishing	200	1,000	107	142	32.6%
Hell's Corner Reach	Whitewater Boating/Kayaking	1,000	3,500	332	189	-43%
	Whitewater Boating/Rafting	1,300	3, 500	278	119	-57.1%
	Fishing	200	1,500	234	228	-2.7%
Copco 2 Bypass Reach	Whitewater Boating	600	1,500	10	223	2,083.8%
	Fishing	50	600	14	3	-79.4%
Iron Gate to Scott River	Whitewater Boating/Fishing	800	4,000	278	281	1.0%
Scott River to Salmon River	Boating	800	7,000	243	246	1.4%
	Fishing	800	4,000	175	182	4.2%
Salmon River to Trinity River	Whitewater Boating/Fishing	800	10,000	207	211	1.8%
Trinity River to Ocean	Whitewater Boating/Fishing	1,800	18,000	239	238	-0.2%

Source: Reclamation 2012b; Reclamation 2012c; PacifiCorp 2004; FERC 2007; Greimann 2012
Key:
cfs: cubic feet per second

Dam removal could increase the number of days with acceptable flows for whitewater boating and recreational fishing in the J.C. Boyle and Copco 2 Bypass Reaches. There would be a substantial increase in the availability of whitewater boating flows within the acceptable flow range for the J.C. Boyle Bypass Reach, particularly during the May through July time period. Based on the modeling results, under the dams out scenario, there would be a shift from the availability of acceptable fishing flows during July/August time period to March through May time period (see Figure 3.20-5 and Appendix R for full data). For the Copco 2 Bypass Reach there would be a substantial increase in whitewater boating opportunities during the July through September time period (see Figure 3.20-7 and Appendix R for full data) and a slight reduction in length of time for Copco 2 for fishing, primarily a reduction during May time period in the availability of acceptable flows. **Therefore, there would be long-term beneficial effects on whitewater boating in the J.C. Boyle and Copco 2 Bypass Reaches. In regards to fishing opportunities in these reaches, the impacts would be less than significant.**

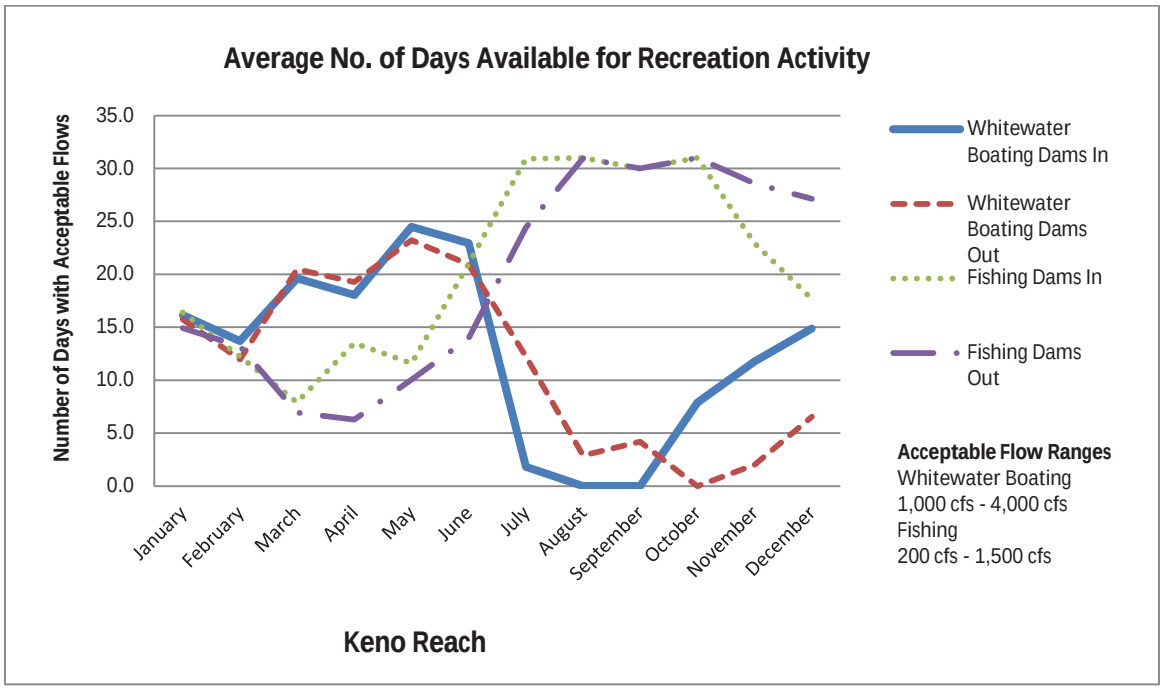

Figure 3.20-4. Comparison of Available Recreation Flows - Keno Reach.

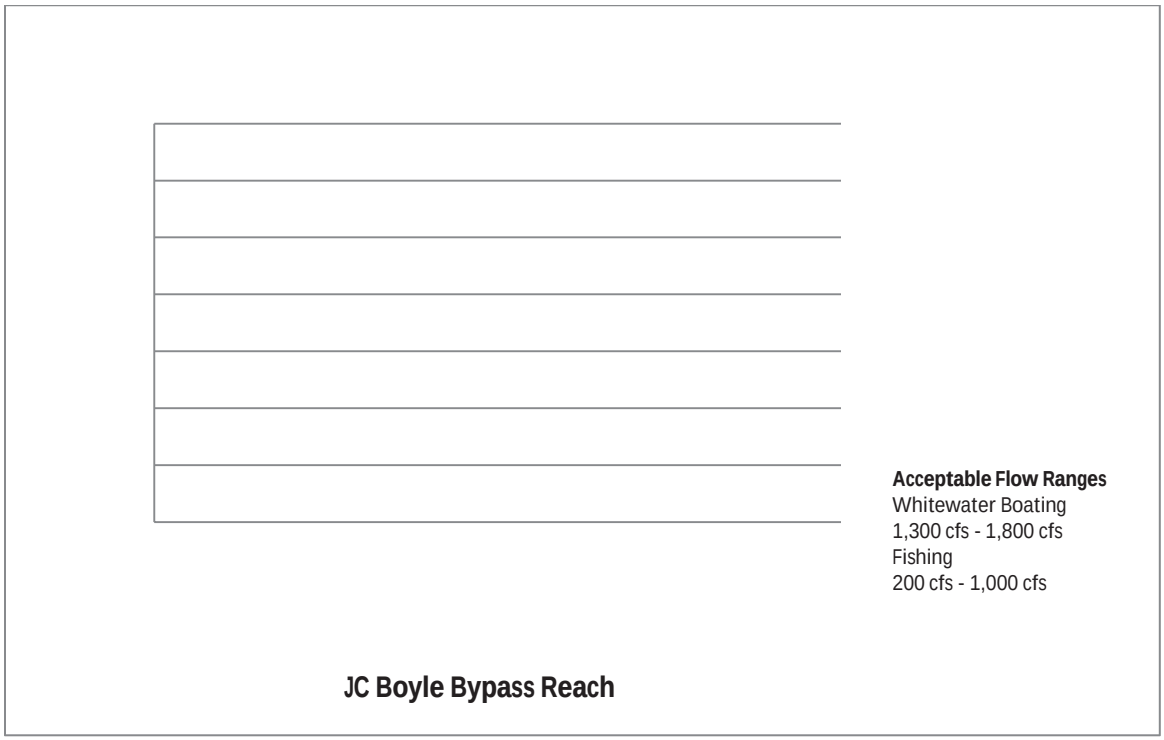

Figure 3.20-5. Comparison of Available Recreation Flows - JC Boyle Bypass Reach.

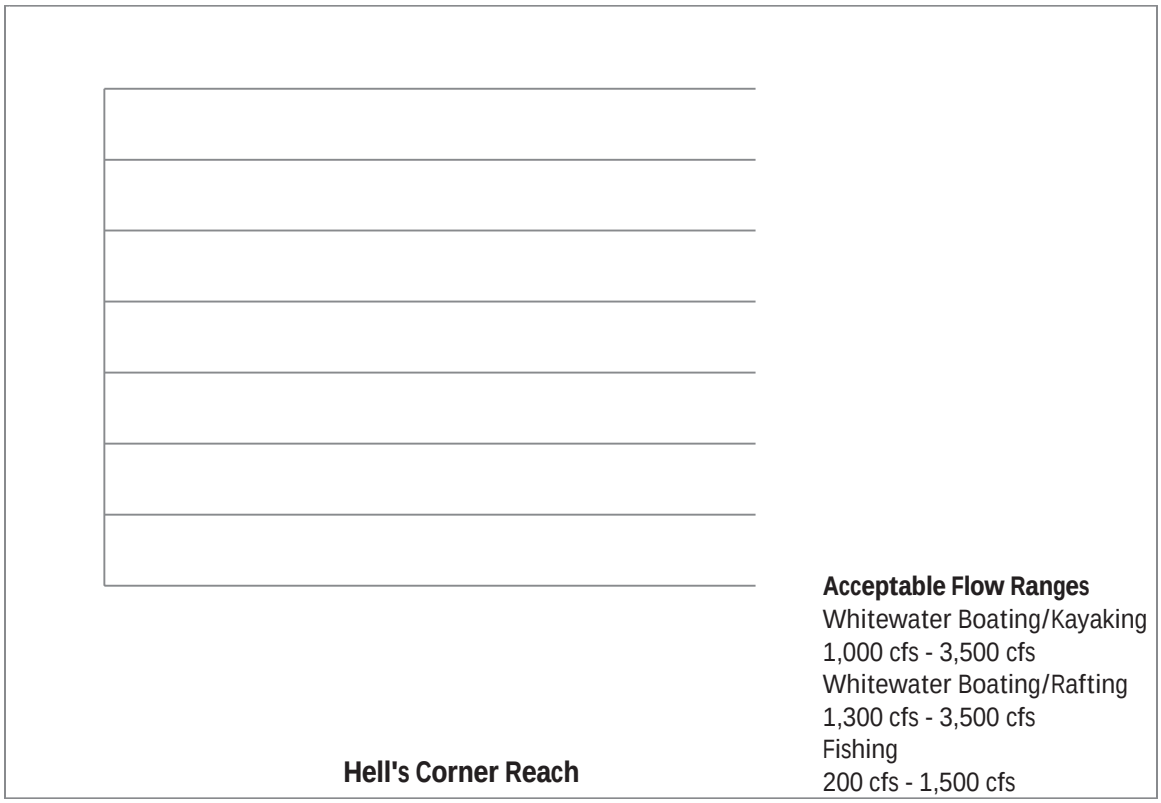

Figure 3.20-6. Comparison of Available Recreation Flows - Hell's Corner Reach.

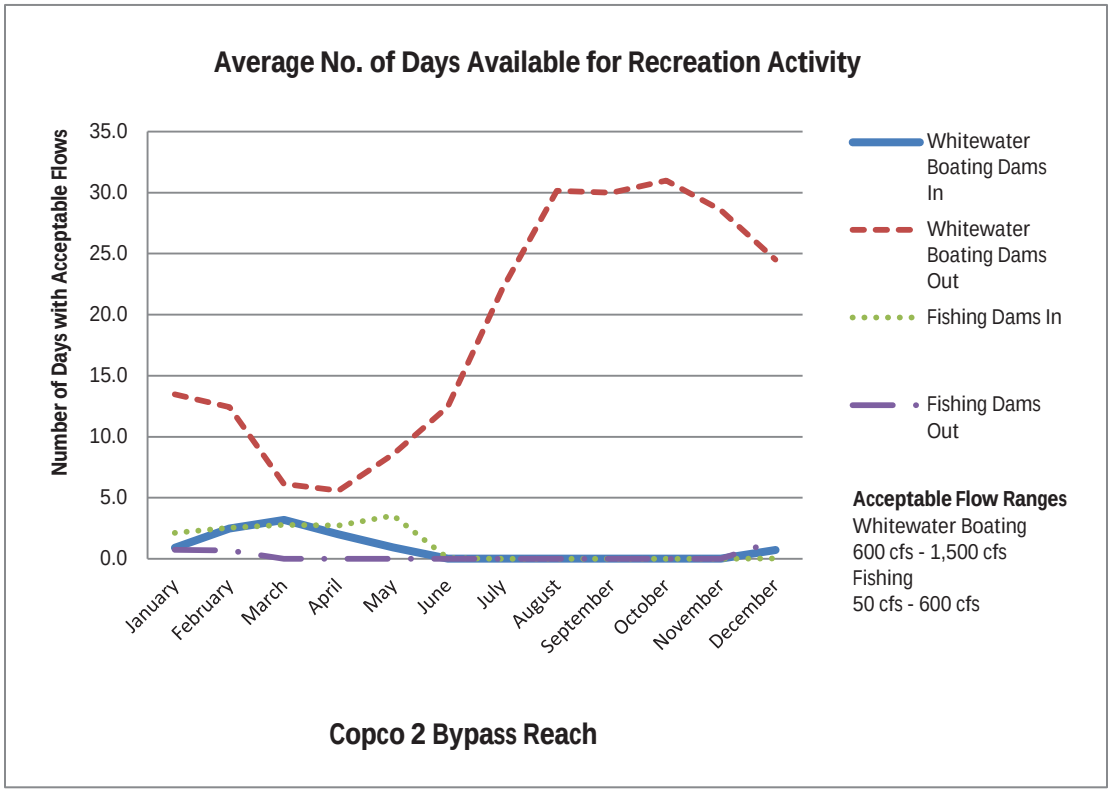

Figure 3.20-7. Comparison of Available Recreation Flows - Copco 2 Bypass Reach.

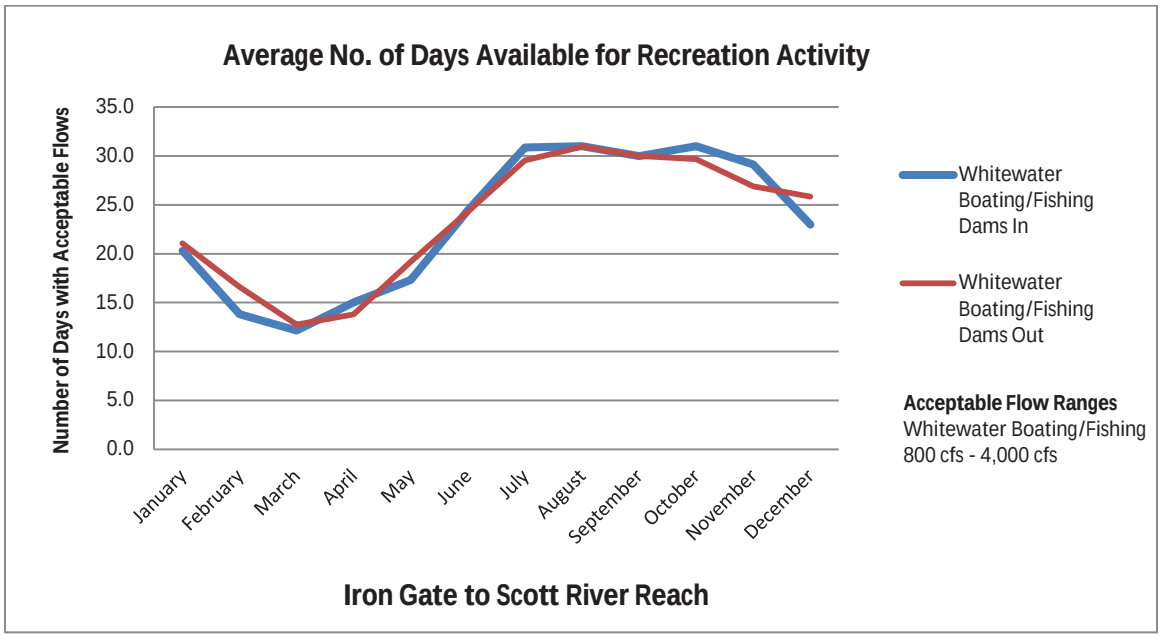

Figure 3.20-8. Comparison of Available Recreation Flows - Iron Gate to Scott River Reach

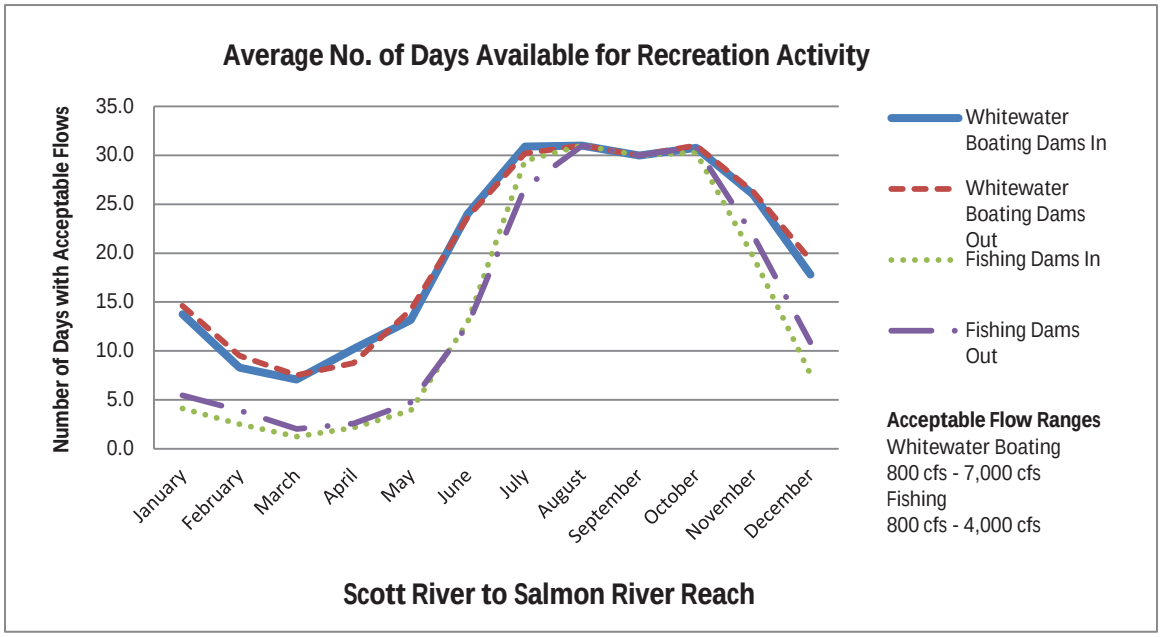

Figure 3.20-9. Comparison of Available Recreation Flows - Scott River to Salmon River Reach

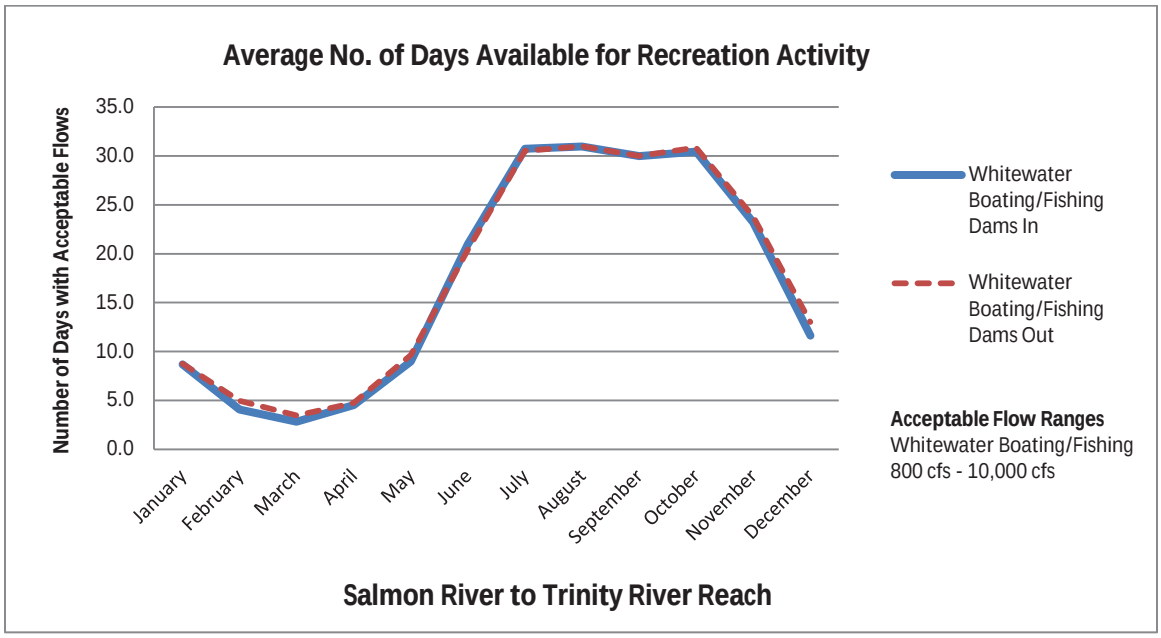

Figure 3.20-10. Comparison of Available Recreation Flows - Salmon River to Trinity River Reach

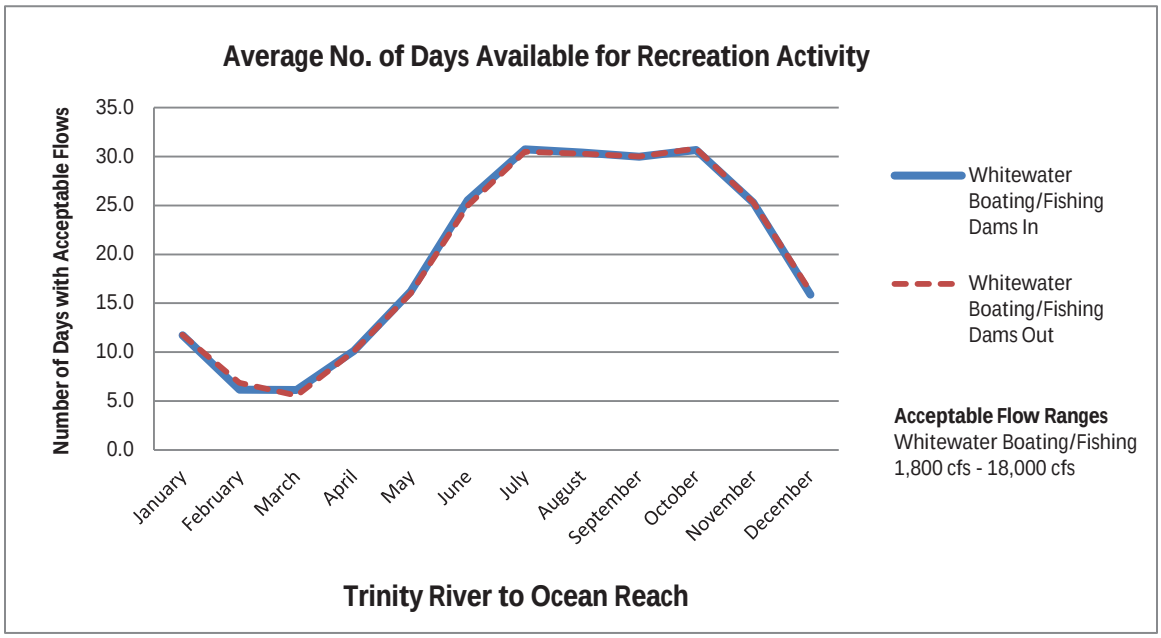

Figure 3.20-11. Comparison of Available Recreation Flows - Trinity River to Ocean Reach

Dam removal could decrease the number of days with acceptable flows for whitewater boating in the Hell's Corner Reach. For the Hell's Corner Reach (see Figure 3.20-6), there would be loss of acceptable flows for whitewater boating opportunities as compared to existing conditions For flows in the range of from 1000-3500 cfs there are modeled decreases of 49%, 58% and 35% respectively in the high demand months of July, August and September. Similarly, for flows from 1300-3500 cfs the reductions would be 36%, 88% and 76% for the same months (Recreation Sub-Team 2010; PacifiCorp 2004b; FERC 2007; Greimann 2012). See Appendix R.

Currently, the Hell's Corner Reach is the only Class IV+ rapids in the region with late summer flows. Whitewater rafters can boat on the Hell's Corner Reach from April through October due to hydroelectric peaking power and flows historically generated by J.C. Boyle Powerhouse to meet high power demand periods. In terms of fishing opportunities, there would be a reduction in the availability of acceptable flows during April; however, overall, the impacts would be minor. **Impacts on whitewater boating opportunities in the Hell's Corner Reach would be significant and unmitigable**. **Impacts on fishing would be less than significant.**

Dam removal could result in increased fisheries populations and abundance, which would improve recreational fishing along the river. As discussed in Section 3.3, Aquatic Resources, removal of the dams would improve habitat conditions for anadromous fish species and redband trout and is expected to result in increased populations of these species. The increased fisheries populations and abundance would beneficially affect recreational fishing opportunities. More specifically, the increased abundance and extent would allow for enhanced fishing opportunities and could decrease the number of closures of entire fishing seasons over the long term. Species specific analysis of the economic effects of increased recreational fishing is presented in Section 3.15, Socioeconomics. **These effects on recreation-based fisheries would be long term and beneficial.**

Implementation of Mitigation Measure REC-1could permanently reduce recreational opportunities in the Klamath Basin. As described below in Section 3.20.4.4, Mitigation Measure REC-1 involves the development of a plan to develop new recreational facilities and river access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam following dam removal. However, replacement of recreation facilities would not necessarily be like for like but rather would be designed to accommodate a similar level but different type of use. This would require the creation of new gravel roads for vehicle and visitor access to the new recreation sites. While there would be a permanent loss of some recreation areas in the vicinity of the existing reservoirs, the combination of the implementation of REC-1 and the presence of regional recreation areas and opportunities (Table 3.20-4) would compensate for the loss of recreation areas at the subject reservoirs. **The impact from implementing Mitigation Measure REC-1, would be less than significant.**

3.20.4.3.4 Wild and Scenic River Assessment

The following section provides an assessment of the effects of Alternative 2 - full facilities removal on each of the four resources specified in the WSR Act Section 7(a) (fish, wildlife, scenery, and recreation river values). The following evaluation criteria were used to assess the effects of the proposed project as compared with conditions present at the time of WSR designation.

Evaluation Criteria for each of the four protected resources specified in the WSR Act Section 7 (a) (scenic, recreational, fish, and wildlife) criteria have been developed to assess the effects of the alternatives as compared with conditions at the date of the river's designation into the NWSRS (see Section 3.20.3.5 for conditions discussion). For each designated river component, the type (positive or negative) and duration (short term or long term) of the effects are described. The magnitude of these effects are analyzed in the Preliminary Section 7(a) Wild and Scenic Rivers Act Determination. The effects are characterized as unchanged, increased, or decreased (or similar conclusion), by value (scenic, recreational, fisheries, and/or wildlife), for that resource.

Scenery was evaluated using the following criteria:

- Water flow character (river flows and accompanying river width, depth and channel inundation or exposure)
- Water appearance (clarity, turbidity, depth of view, color, prominence of algae)
- Fish and wildlife viewing
- Riparian vegetation
- Natural appearing landscape character (the visual effects of facilities and structures as viewed from within the designated W SR corridor)

Recreation was evaluated using the following criteria:

- Whitewater boating
- Recreational fishing
- Other recreational activities (water play, swimming, camping)
- Recreational setting (water quality related aesthetic odors, tastes, contacts and public health and safety aspects)

Fishery was evaluated using the following criteria:

- Stream flow regime
- Water temperature
- Water quality (physical, biological and chemical)
- Aquatic habitat (geomorphic condition sediment transport regime and substrate quality)
- Fish species population conditions, specifically:
    a. Anadromous salmonid fish species
    b. Resident fish species
    c. Species traditionally used and culturally important to Native Americans

Wildlife was evaluated using the following criteria

- Changes in habitat for affected species

Scenic Evaluation

Dam removal could result in changes to water flow character (river flows and accompanying river width, depth, and channel inundation or exposure) compared with conditions present when the Oregon Klamath WSR was designated as a National WSR. Short-term effects would result in a period of increased flows during the time of reservoir drawdown. The changed character of the river width would include areas of exposed substrate where water elevations recede. As modeled by Reclamation (see Section 3.6, Flood Hydrology), dam removal would eliminate the daily hydropower peaking releases with their associated large daily river level fluctuation(Reclamation 2012). This will reduce the appearance of sediment deposition and changes in turbidity and clarity of the water on a daily basis. River width and depth are defined by the geology of the region and the surrounding bedrock. As discussed in Section 3.11, Geology, Soils, and Geologic Hazards, river elevation and form downstream from J.C. Boyle dam are primarily controlled by large boulders and bedrock, and only limited adjustment is possible. As described in Section 3.20.3.5, above, the degree of visibility of these scenic quality effects is dependent on viewer location. Views from on-river, in-river, or riverside viewpoints are most likely to display changes to these scenic quality indicators, while views from river canyon roadways and communities are less likely to find these scenic quality changes to be as noticeable or substantial. **Therefore, for these reaches, the long-term scenic quality impacts would be positive due to the reestablishment of free-flowing water conditions.**

Dam removal could result in changes to water flow character (river flows and accompanying river width, depth, and channel inundation or exposure) compared with conditions present when the California Klamath WSR was designated. Downstream, in the California Klamath WSR, as discussed in Section 3.11, Geology, Soils, and Geologic Hazards, any substantial adjustment in river elevations or geomorphology would have already occurred in previous floods and no substantial changes to river morphology would occur following removal of the Four Facilities. Further, modeling conducted by Reclamation indicates that no long-term impacts would occur with regard to sediment deposition in pools, eddies, slack water, or beaches, and short term effects would be limited to the area immediately below Iron Gate Dam. **Free flowing river conditions as well as re-establishment of a more natural river channel would result in long-term scenic quality benefits for the California WSR component.**

Dam removal could result in changes to water appearance (clarity, turbidity, depth of view, color, and prominence of algae) compared with conditions present when the California and Oregon components were designated as National WSRs. As discussed in Section 3.2, Water Quality, removal of the PacifiCorp facilities would eliminate the major sources of water quality problems associated with the dams (i.e., the reservoirs). Removal of the dams and reservoirs would enhance downstream water appearance for the Oregon and California Klamath WSR scenery through its benefits of superior mixing and

oxygenation of waters upstream of the WSR, renewal of streambeds through more frequent, high flow flushing events, and reversal of suspected nutrient increases within J.C. Boyle, Copco 1, and Iron Gate Reservoirs. Section 3.2, Water Quality, provides a detailed discussion of improvements to water quality, including reduced floating algae, and increased water clarity. Although removal of the dams would likely result in short-term increases in turbidity and decreased water clarity due to high suspended sediment concentrations during the year following reservoir drawdown, particularly in the California Klamath WSR, long-term impacts would result in improved water appearance.

As discussed in Section 3.3, Aquatic Resources, spawning gravels released downstream from within the retired reservoirs would restore some natural sediment processes and contribute to scour of attached downstream algae. The deposited sand and gravel on the downstream reaches would be a less favorable habitat for the algae because of greater particle mobility during high-flow events. This would result in positive long-term impacts on scenic water appearance (improved clarity and algae reduction) within the river between Iron Gate Dam and the Shasta River confluence, and would likely have similar but reduced downstream benefits.

At the time of the Oregon Klamath WSR designation, the water appearance during summer base flow conditions was of slow-moving waters with large amounts of visible algae-covered rocks, and during peaking events the water appearance was altered to brown and murky colors with large quantities of algal foam. Information about scenery water appearance condition at the time of California Klamath WSR designation is lacking; however, it is likely that the trend of increasing habitat for attached algae with its associated water coloration, cloudiness, and limitations on depth of view was already underway at the time of WSR designation (Van De Water et al. 2006). Removal of the dams would restore natural sediment movement in the streambed and would reduce opportunities for algae attachment, to a degree not possible in 1981 and 1994 due to the presence of the Four Facilities. **Thus, while there would be short-term negative water clarity impacts on scenic quality due to turbidity and silt which could be exposed on river banks, long-term effects to scenic quality would be beneficial for both the California and Oregon Klamath WSR components.**

Dam removal could result in changes in opportunities for fish and wildlife viewing compared with conditions present when the California and Oregon Klamath WSRs were designated. As discussed in Section 3.3, Aquatic Resources, removal of the Four Facilities would increase the abundance of anadromous fish in the Klamath River. The potential restoration of the anadromous fish populations would largely be the result of the increase of anadromous fish habitat within the Upper Klamath Basin, along with water quality improvements within the Oregon and California Klamath WSRs downstream from the Four Facilities. The increased population of fish species would improve scenic fish viewing attractions in both the California and Oregon Klamath WSRs. Increased fish viewing would be most prominent during fish migration, spawning, or holding periods, when the fish concentrate at particular reaches, pools, riffles, and falls. **Fish and wildlife**

viewing impacts to scenic quality would be long-term and beneficial as compared to the conditions at the time of the 1981 and 1994 designations for the Oregon and California Klamath WSRs.

Dam removal could result in changes in opportunities for river-dependent wildlife viewing compared with conditions present when the California and Oregon Klamath WSRs were designated. Specific effects on river-dependent wildlife populations and scenic viewing opportunities are unknown. As discussed in Section 3.5, Terrestrial Resources, riparian habitat within the Oregon Klamath WSR and potentially beyond, in the Iron Gate Dam to Shasta River segment of the California Klamath WSR, would be improved by removal of the dams, and proportional increases in wildlife presence related to the increase in abundance of anadromous fish in the river and scenic wildlife viewing would be expected. **Therefore, impacts on river-dependent wildlife populations and scenic viewing opportunities would be long term and beneficial as compared to the conditions at the time of the 1981 and 1994 designations.**

Dam removal could result in changes to riparian vegetation compared with conditions present when the Oregon Klamath WSR was. As discussed in Section 3.5, Terrestrial Resources, removal of the Four Facilities would result in elimination of the reservoirs and associated aquatic habitat. However, following dam removal and downstream sediment flushing, the new river channel would conform to the pre-dam channel alignment (Gathard Engineering Consultants 2006). Riverbank stabilization and re-vegetation of riverbank with native plantings would be conducted at each reservoir after the drawdown is complete. Thus, riparian habitat at reservoirs would increase with restoration following drawdown. PacifiCorp estimated that decommissioning and removal of the Four Facilities would add about 184 acres of riparian vegetation. This estimate was based on the assumption of an average riparian corridor width of 100 feet along the 3.6-mile length of the J.C. Boyle Reservoir, the 4.5-mile length of the Copco Reservoir, the 0.3-mile length of the Copco 2 Reservoir, and the 6.8-mile length of the Iron Gate Reservoir (FERC 2007). **Establishment of woody species along the newly formed riparian corridor is expected to take several years; however, these changes to vegetation would result in long-term, beneficial effects on riparian vegetation aspects of scenic quality within the areas immediately upstream and downstream from the Oregon Klamath WSR component as compared to conditions at the time of the 1994 designation.**

Dam removal could result in changes to riparian vegetation compared with conditions present when the California Klamath WSR was designated . Removal of the Four Facilities would result in a more natural riparian vegetative community immediately downstream from Iron Gate Dam due to sediment deposition and scour and gravel transport. Improved riparian vegetation would increase the presence and scenic variety of the vegetation within the WSR. **This would likely increase overall scenic riparian vegetation aspects of scenic quality over conditions present at the California Klamath WSR's 1981 date of designation and result in long-term beneficial effects.**

Dam removal could result in changes to the natural appearing landscape character as compared with conditions present when the Oregon Klamath WSR was designated. As discussed in Section 3.19, Scenic Quality, removal of J.C. Boyle Dam would result in a more natural setting and character in the areas immediately upstream and downstream from the Oregon Klamath WSR. **J.C. Boyle dam was present at the time of the 1994 WSR designation of the Oregon component, its removal would restore the Oregon Klamath WSR to a more natural flow regime and landscape character and would result in long-term beneficial scenic quality effects.**

Dam removal could result in changes to the natural appearing landscape character as compared with conditions present when the California Klamath WSR was designated. The California Klamath WSR is downstream from the Four Facilities; therefore, removal of the dam and associated facilities would not result in any changes to the overall landscape character in this segment of the river. However, as discussed in Section 3.2, Water Quality, water clarity in the WSR component is expected to improve, as is the quality of the riparian vegetation. **These improvements would result in a more natural flow regime and landscape character for the California Klamath WSR and result in a long term positive scenic quality effect.**

Recreation Evaluation

Dam removal could improve opportunities for whitewater boating compared with conditions present when the California and Oregon Klamath River WSRs were designated. Whitewater boating opportunities relating to river flow following removal of the Four Facilities would likely be similar to conditions in 1981 for the California Klamath WSR. As discussed in the impact analyses above, and as shown in Table 3.20-6 the number of days acceptable for commercial whitewater boating during the popular summer months would decrease for the Oregon Klamath WSR in the Hell's Corner Reach, following removal of the dams(Appendix R). For the California Klamath WSR downstream from Iron Gate Dam, following removal of the dams, the number of days available for whitewater boating would be very similar to the number of days currently available. **Therefore, long-term whitewater boating impacts due to changes in flow would be negative for the Oregon Klamath WSR. No impacts to whitewater boating opportunities due to flow would occur for the California Klamath WSR. Removal of the dams would also result in long-term improvements to water quality conditions over existing conditions and the 1981 and 1994 conditions. With improved water quality, the whitewater boating recreation experience would improve in both the Oregon and California Klamath WSRs. Therefore, long-term whitewater boating impacts due to improved water quality would be beneficial for both the California and Oregon WSR components.**

Dam removal could increase opportunities for recreational fishing compared with conditions present when the California and Oregon Klamath River WSRs were designated. As discussed in the impact analyses above, removal of the Four Facilities would not affect water flow such that days with acceptable flows for recreational fishing would substantially increase or decrease. However, as described in Section 3.3, Aquatic Resources, the geographic extent of the Klamath River fish habitat would be substantially

expanded compared to 1981 and 1994 conditions. It is also expected that water quality conditions would improve, thereby reducing fish disease. Increased fish populations would likely result in fewer catch and keep fishing restrictions. **Thus, recreational fishing impacts would be long term and beneficial for both the California and Oregon WSRs.**

Dam removal could result in changes to opportunities for other recreational activities (water play, swimming, camping) compared with conditions present when the California and Oregon Klamath River components were designated as National WSRs. During the period of dam removal and shortly afterwards, sediment release could decrease the quality of water contact activities. However, initial reservoir drawdown will occur in the coldest high flow months of winter and early spring when recreation uses is at its lowest. This impact would be short term. In the long term, dam removal would improve water quality and thus water contact-based recreation activities. Short-term, negative impacts would occur as a result of the construction activities and staging areas and likely restricted access and use of recreation facilities and opportunities during the period and in the areas where dam removal occurred. **Thus for the Oregon Klamath WSR there would be short term negative impacts to other recreational activities due to construction activities and increased sediment in the river. In the long term dam removal would be long term and beneficial as compared to the 1994 conditions. For the California Klamath WSR, dam removal would not affect recreational activities access downstream from the dams. However dam removal would result in improved water quality in the long term thus there would be long-term beneficial effects on recreational activities in these areas as compared to the 1981 conditions.**

Dam removal could improve the recreational setting (water-quality related aesthetics, odors, tastes, contacts, and public health and safety aspects) compared with conditions present when the California and Oregon Klamath WSRs were designated. Although there would be short-term, negative impacts on water quality due to the increased sediment load in the river during initial drawdown activities, particularly in the Oregon Klamath WSR, as discussed in Section 3.2, Water Quality, following completion of reservoir drawdown, dam removal would improve water quality conditions as compared with conditions present at the time of the 1981 and 1994 designations. There could be short-term, negative impacts (lasting less than two years) during reservoir drawdown due to the potential for sediment to clog fishing holes, or possibly make the river less navigable, or even less accessible along shorelines temporarily blocked by sediment deposits.

Alternatively, new beaches and riparian areas may become established to increase the variety of shoreline settings. Most of these effects would be temporary and many aspects of the WSR's recreation setting would be considerably improved once the river stabilizes. The improved water quality conditions following completion of drawdown activities would improve the recreational setting overall (i.e., with improved clarity during swimming and fishing and reduced malodors and tastes [Bartholow et al 2005]). With regard to public health, improved water quality would also reduce potential human health

risks associated with water-contact-based activities. **Therefore, impacts on the recreational setting would be long term and beneficial for both the California and Oregon Klamath WSR.**

Fisheries Evaluation

Dam removal could alter stream flow regime compared with conditions present when the California and Oregon Klamath WSRs were designated. Section 3.6, Flood Hydrology, discusses historic flow rates and discharge statistics for each of the reservoirs. The proposed drawdown rates are consistent with the historic discharge rates from the reservoirs and would be adjusted depending on the water year; therefore, flow rates downstream from the dams are not anticipated to increase substantially above historic rates, if at all. As such, conditions during the drawdown period are expected to remain largely unchanged as compared to stream flow regimes at the time of the 1981 and 1994 designations.

Following removal of the Four Facilities, the Klamath River would return to a natural flow regime in the reaches where the reservoirs currently exist. Restoration of the natural flow regime would improve water quality conditions, likely reducing the occurrence of myxozoan parasites (*Ceratomyxa shasta* and *Parvicapsula minibicornis*) that are known to negatively affect salmonids. Removal of the hydroelectric reservoirs would eliminate populations of blue-green algae that produce toxins that can result in acute and chronic effects on fish, including increased mortality, reduced fecundity, reduced feeding, and habitat avoidance. **Stream flow regime impacts would be long term and beneficial for both the California and Oregon Klamath WSR.**

Dam removal could decrease fall water temperature and increase spring water temperature compared with conditions present when the California and Oregon Klamath WSRs were designated. Removal of the Four Facilities would improve water quality conditions over existing conditions and the 1981 and 1994 conditions. As described in Sections 3.2, Water Quality, and 3.3, Aquatic Resources, following dam removal, the temperature regime downstream from Iron Gate Dam would be more suitable for salmon. As part of its relicensing procedure, PacifiCorp modeled changes in water temperature that could result following removal of the dams. The modeling results show that from Iron Gate Dam to Clear Creek temperatures in the spring and early summer would be as much as 5°C warmer, but cooler in later summer and fall than under existing conditions. Temperatures currently remain greater than 20°C in dry years with little variability in July and August. Although summer temperatures would likely be more variable following dam removal, the median temperatures would be substantially lower than current conditions. Summer and fall temperatures would therefore be more conducive to salmon rearing, migrating, and spawning than the conditions that were probable at the date of designation (Van de Water et al. 2006). However, as discussed in Section 3.2, Water Quality, in reaches above J.C. Boyle Reservoir and downstream from Clear Creek, there would be little to no change in the existing temperature regime. **Water temperature impacts would therefore be long term and beneficial for the California Klamath WSR, and there would be no change from existing conditions in the Oregon Klamath WSR.**

Dam removal could improve water quality characteristics (physical, biological, and chemical) compared to conditions present when the California and Oregon Klamath WSRs were designated. Removal of the Four Facilities would eliminate the major sources of water quality problems in the Upper Klamath Basin and enhance downstream water quality for salmonids. Removal of the dams would also reduce conditions that foster fish disease outbreaks.

As discussed in Section 3.2, Water Quality, following dam removal, long-term dissolved oxygen levels would be anticipated to meet applicable Basin Plan objectives. However, modeling indicates that nitrogen loading downstream from Iron Gate Dam would increase slightly above existing levels due to the release of sediments from the reservoirs, but the removal of a lacustrine environment in the reservoir area would reduce the abundance of algae that form habitat for the intermediate host for at least two salmon pathogens. The improved water quality conditions would reduce fish crowding, which, as discussed in Section 3.3, Aquatic Resources, would result in reduced temperature-induced stress and could allow for spawning to begin earlier in the fall. **Impacts on water quality characteristics would therefore be long term and beneficial for both the California and Oregon Klamath WSRs.**

Dam removal could alter geomorphic conditions, sediment transport regime, and substrate quality compared with conditions present when the California and Oregon Klamath WSRs were designated. As discussed in Section 3.11, Geology, Soils, and Geologic Hazards, and Section 3.3, Aquatic Resources, sediment stored in the subject reservoirs would be released downstream. The released sediment would have short-term, negative effects on aquatic habitat, but following completion of reservoir drawdown, the increased spawning gravel released from upstream could enhance spawning habitat. Restoring natural sediment processes would contribute to scour of attached algae (e.g., *Cladophera* spp.), and deposited sand and gravel would be a less favorable substrate for the algae because of greater particle mobility during high-flow events than the existing armored substrate. A reduction in such algae would lead to reduced habitat for the fish pathogen's alternate host.

Information about habitat conditions at the time of WSR designation is lacking; however, it is likely that trends of river coarsening, increasing habitat for attached algae, and reduced recruitment and maintenance of riparian vegetation were already underway at the time of WSR designation due to PacifiCorp facilities and operations. The Proposed Action would reduce those trends in the long term, and restore natural sediment transport processes, which were no longer in place by 1981 and 1994. Following the initial drawdown period and flushing of reservoir sediment downstream, aquatic habitat conditions would be expected to be improved from conditions in 1981 and 1994 in the long term. **Therefore, impacts on aquatic habitat conditions would be long term and beneficial for both the California and Oregon Klamath WSRs.**

Dam removal could improve conditions for anadromous fish species compared with conditions present when the California and Oregon Klamath WSRs were designated. As discussed in Section 3.34.3.2.2.3, Aquatic Resources, dam removal would result in

beneficial long-term effects on anadromous salmonids. Dam removal would also restore connectivity to hundreds of miles of potentially usable habitat in the Upper Klamath Basin and would create additional spawning and rearing habitat within the Hydroelectric Reach. However, sediment released during dam removal could be sufficient to cause substantial smothering of spawning gravels, pool infilling, gill abrasion, and changes to holding and migration patterns in the river reaches immediately below Iron Gate Dam. These impacts would be short term (lasting less than two years), as sediment is expected to be flushed through the river system relatively quickly. In the long term, dam removal is expected to eliminate the source of most of the water quality issues on both the California and Oregon Klamath WSRs that are influenced by the presence of the PacifiCorp facilities. In particular, dam removal would reduce late summer and fall heating, summertime dissolved oxygen depletion, and in-reservoir nutrient cycling with resultant summer releases of nitrogen downstream. Removal of the Four Facilities would also eliminate a fish barrier and allow fish to spawn in a greater number of areas. Consequently, fish disease outbreaks could be diminished. Removal of the Four Facilities would also result in habitat conditions that more closely resemble natural conditions (e.g., flow and temperature ranges would be more reflective of climatic forces than of water regulation). However, continuation of the operation of the Iron Gate Fish Hatchery would reduce some of the beneficial effects of dam removal by continuing pressures on natural stocks that would improve with dam removal. Even so, Chinook salmon, coho salmon, and steelhead abundance would still be expected to increase over 1981 and 1994 levels in the long term. **Long-term beneficial effects on conditions for anadromous fish species would result for both the California and Oregon Klamath WSRs.**

Dam removal could improve conditions for native resident fish species compared with conditions present when the California and Oregon Klamath WSRs were designated. As discussed in Section 3.3, Aquatic Resources, removal of the Four Facilities would improve conditions for native resident fish species by restoring connectivity between the Lower and Upper Klamath River, and by returning a natural flow regime to the reaches where the reservoirs currently exist, thereby improving water quality. Dam removal would also likely result in diminished non-native fish habitat and populations, reducing competition for space and resources with native resident fish. Because the non-native fish were introduced and occur in other nearby water bodies, their loss would not be considered significant from a biological perspective and is not included in this effect evaluation. **Therefore these impacts on the conditions for native resident fish species would be long term and beneficial in both the California and Oregon Klamath WSRs.**

Dam removal could improve conditions for species traditionally used and culturally important to Indian Tribes compared with conditions present when the California and Oregon Klamath WSRs were designated. As discussed in Section 3.3, Aquatic Resources, removal of the Four Facilities would improve conditions for culturally important fish species (e.g., Chinook salmon, coho salmon, steelhead, and lamprey) by restoring connectivity between the Lower and Upper Klamath River, and by returning a

natural flow regime to the reaches where the reservoirs currently exist and downstream from Iron Gate Dam, thereby improving water quality. Dam removal would also likely result in diminished non-native fish habitat and populations, reducing competition for space and resources with native resident fish. **Impacts on the conditions for species traditionally used and culturally important to Indian Tribes would be long term and beneficial in both the California and Oregon Klamath WSRs.**

Wildlife Evaluation

Dam removal could result in changes to habitat for special status species compared with conditions present when the California and Oregon Klamath WSRs were designated. Elimination of hydropower peaking flows in the Oregon Klamath WSR would result in beneficial establishment of riparian vegetation over the long term due to fine sediment released into this section would allow the establishment of such vegetation.

Riparian vegetation in the California Klamath WSR downstream from the Iron Gate Dam would also benefit from dam removal, especially in the reach between the Iron Gate Dam and the Shasta River confluence. Special status species that are dependent on riparian habitat, such as the willow flycatcher, northwestern pond turtle, and yellow breasted chat, would benefit greatly from successful riparian habitat recovery from Iron Gate Dam downstream to the Klamath River's confluence with the Shasta River. Downstream from that point, the riparian-dependent wildlife would still benefit from increased diversity and amounts of riparian vegetation, but these benefits might be offset by some potential short-term impacts as the released sediment moves downstream into areas that are currently in better condition.

In addition to improving riparian habitat, the Proposed Action would result in improvements in fish resources in the long term following dam removal, thus providing increased forage for wildlife species that depend upon fish as a food source. The area currently blocked by dams would provide additional available habitat for anadromous fish. The increase in habitat quality and quantity should allow the number of anadromous fish to increase substantially. Increased numbers of fish would also create greater foraging opportunities for riparian and riverine species such as bald eagle, river otter, osprey and black bear. **Therefore, there would be long-term, beneficial effects on habitat for special status species in both the California and Oregon Klamath WSRs.**

3.20.4.3.5 Eligible and Suitable WSR Section on the Klamath River

In addition to the designated WSR segments, the reach from the Oregon and California State-line to Copco was found eligible and suitable and is a candidate for WSR designation, but has not been designated into the National WSR System. The potential outstandingly remarkable values are scenic, fish, wildlife, recreation (whitewater boating and fishing), and historic. This candidate WSR reach is included in the project area and effects are evaluated as part of this EIS. This section summarizes the main effects of the Proposed Action on this segment's river values. Short terms negative effects on water quality, scenic, recreation, fishery, and wildlife river values are likely due to the high suspended sediment concentrations during reservoir drawdown. These effects are expected to last less than two years. In the long term, dam removal would return this

reach of river to a more natural river flow, improve water quality, enhance habitat for fish and wildlife, and restore riparian vegetation. **Thus, dam removal would result in long-term beneficial effects to this candidate WSR reach's free-flowing condition, water quality, scenic, wildlife, fishery, and recreation river values.**

Keno Facilities Transfer

Transfer of the Keno Facility from PacifiCorp to DOI could affect recreational opportunities. Keno Dam is an unmanned facility which requires minimal operations and maintenance. Recreation facilities owned by PacifiCorp in the vicinity of Keno Impoundment/Lake Ewauna will also be transferred to DOI as described in the KHSA Section 7.5. Operation of Keno Dam and of the recreation areas are expected to continue in their current fashion. **The transfer of the facility and recreation lands will result in no change from existing conditions.**

East and Westside Facilities Decommissioning – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects on recreational resources. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a connected action to the Klamath Hydroelectric Settlement Agreement (KHSA) would terminate the diversion of water flows currently diverted at Link River Dam into the two canals. Following decommissioning of the facilities there will be no change in outflow from Upper Klamath Lake or inflow into Keno Impoundment/Lake Ewauna. **Therefore, there will be no change from existing conditions caused from decommissioning the East and Westside Facilities.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The City of Yreka Water Supply Pipeline, currently under the Iron Gate Reservoir, would need to be relocated to avoid damage after the reservoir is removed, creating a change in existing recreational resources. As a connected action to the Proposed Action, the relocation, replacement, and/or burial of the existing 24-inch diameter water line and transmission facilities from the City of Yreka's Fall Creek diversion would be required (KHSA Section 7.2.3). This connected action would involve placing the City of Yreka's waterline on a pipe bridge across the river. This would require construction of footings and other infrastructure to support the pipe bridge, resulting in construction at the site. The relocation of the pipeline would not impact recreational resources. In coordination with the City of Yreka, measures such as installation of fencing to protect the water supply intake maybe considered. **There would be no change from existing conditions.**

Another option under consideration is to place the pipeline along the Lakeview Bridge at Iron Gate Dam rather than creating a new span for the pipeline. The pipe would be relocated from its current route and cross the river along the underside of the bridge. Surveys are still required to determine if the bridge is adequate to support the pipeline and the construction traffic from the decommissioning activities. This option would not affect recreational resources. **There would be no change from existing conditions as a result of the Proposed Action and pipeline relocation.**

3.20.4.4 KBRA – Programmatic Measures

The Klamath Basin Restoration Agreement (KBRA) has several programs that could result in short-term and long-term changes to recreational opportunities in the Klamath Basin. Such changes would be the result of temporary construction activities as well as long-term increases in aquatic habitat and fish populations, improvements to water quality, and improvements to terrestrial resources. Specific KBRA programs potentially affecting recreational opportunities include:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- Water Diversion Limitations
- On-Project Plan
- Water Use Retirement Program (WURP)
- Climate Change Assessment and Adaptive Management
- Interim Flow and Lake Level Program

Construction activities associated with the KBRA programs could temporarily restrict access to recreational opportunities. Construction activities including channel construction, fish passage and facilities construction, breaching levees, and fish hauling would likely involve the use of heavy equipment along floodplain and riparian areas and therefore could result in restrictions to public access for recreational activities, such as sightseeing, bank fishing, swimming, and wading. Because restoration activities would occur throughout the entire basin, specific sections of the river could be closed for a period of time throughout implementation of the KBRA programs. However, as described in the Affected Environment section, there are a number of recreational areas offering similar activities and settings throughout the basin. It is likely that for any particular project, there would be an alternative recreational area nearby that could be used during temporary closures. Construction related to KBRA programs could occur in the same location and time as construction actions for the hydroelectric facility removal and affect access to or availability of recreation resources. However, because of the multitude of resources in the region, effects to recreation under both the KBRA and KHSA would be less than significant. **Thus, potential impacts to recreational opportunities are anticipated to be less than significant. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

Construction activities associated with KBRA programs could result in short-term water quality impacts which could affect recreational opportunities. Erosion and sedimentation during construction activities has the potential to temporarily decrease water quality and reduce water visibility for boaters, swimmers, and fisherman. These short-term water quality impacts would be anticipated to occur throughout the basin where construction activities take place. Specific sections of the river could be affected for a period of time throughout implementation of the KBRA programs. However, following implementation and related construction activities for KBRA programs including the Wood River

Wetland Restoration, and the Interim Flow and Lake Level Program, WURP, water quality and clarity would be expected to improve. Additionally, as described above, short-term impacts would be offset by the ability of visitors and local recreationalists to use the recreational areas with similar activities and settings throughout the basin. Construction related to KBRA programs could occur in the same location and time as construction actions for the hydroelectric facility removal and affect water quality at recreation resources. However, because of the multitude of resources in the region, effects to recreation under both the KBRA and KHSA would be less than significant. **Potential impacts would be short term and, with implementation of construction BMPs, are anticipated to result in less than significant water quality related recreational impacts. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

Fire treatment proposed in the Fisheries Restoration Plan could alter the visual setting and result in decreased recreational visitors to the Klamath Basin. As described above for the No Action/No Project Alternative, it is expected that landscape scale prescribed fire treatments would result in a short-term adverse effect of the visual quality of the burned area, which could directly affect the number of recreational visitors to the area. In the short term, prescribed fire treatments would be less than significant. Prescribed fire treatment actions would not occur in the same location and at the same time as hydroelectric facility removal actions; therefore, potential for any visual quality improvements generated by these prescribed fire treatment actions would not change effects of facility removal. **The return of forests to a more natural condition is anticipated to result in long-term beneficial effects. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

KBRA actions correcting fish passage issues, reintroducing and monitoring fish species, and restoring aquatic habitat could increase recreational fishing and wildlife viewing opportunities in the basin. It is expected that correction of fish passage issues throughout the basin would restore fish access to new and historic habitats and result in increased fish populations. KBRA programs such as the Fisheries Reintroduction and Management Plan, include actions to restore and create fish habitat and wetlands for endangered fish species. Additionally, projects such as Water Diversion Limitations would increase water availability for fisheries. It is anticipated that these programs and projects would result in increased fish populations and abundance, which would beneficially affect recreational fishing opportunities. More specifically, the increased abundance would allow for increased catch limits and fewer catch and release requirements, as well as decrease the potential of closures of entire fishing seasons as those that occurred on the Klamath River in the recent past. Correction of fish passage issues as a result of the KBRA would support the positive improvements to recreation from increased fish populations due to hydroelectric facility removal. **These changes are anticipated to result in beneficial effects to recreational experiences throughout the Klamath Basin. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

KBRA programs resulting in long-term water quality improvements could increase recreational opportunities throughout the Klamath Basin. KBRA programs including the Fisheries Restoration Plans Phase I and II; Fisheries Reintroduction and Management Plan; WURP; and, Interim Flow and Lake Level Program would result in long-term benefits to water quality throughout the Klamath Basin. As described in Section 3.2, Aquatics Resources, improvements in water quality would enhance fisheries habitat in the Klamath River and tributaries. Improvement of water quality as a result of KBRA actions would support positive improvements to recreation from improved water quality due to hydroelectric facility removal. **It is anticipated that improvements in fish habitat and abundance would result in beneficial effects to recreational opportunities in the Klamath Basin. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

KBRA programs that enhance terrestrial wildlife and plant resources could increase recreational opportunities throughout the Klamath Basin. KBRA programs including Fisheries Restoration Plans Phase I and II; Water Diversion Limitations; On-Project Plan; WURP; and, Interim Flow and Lake Level Programs would result in long-term benefits to terrestrial species as a result of restored floodplain and riparian vegetation and habitat areas. While short-term construction activities involved in the implementation of some of these programs would result in short-term adverse impacts on terrestrial resources, the long-term effects of habitat restoration would be expected to benefit terrestrial species in the Klamath Basin. Improvement of terrestrial wildlife and plant resources as a result of the KBRA would support positive improvements to wildlife viewing due to hydroelectric facility removal. **It is anticipated that improvements and increases in terrestrial wildlife habitat would result in beneficial effects to recreational wildlife viewing and recreational hunting opportunities in the Klamath Basin. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

3.20.4.4.1 Alternative 3: Partial Facilities Removal of Four Dams

Under this alternative, short-term demolition activities and drawdown of reservoirs would still occur; however, demolition would consist only of in-stream facilities and select ancillary facilities; other ancillary facilities associated with the KHP would remain in place. Recreation facilities would be removed with the exception of Topsy Campground, Fall Creek and Jenny Creek Day Use Areas, and the Iron Gate Fish Hatchery Day Use area, as under the Proposed Action and the impact would therefore be the same as described previously.

Keno Facilities Transfer

Transfer of the Keno Facility from PacifiCorp to DOI could affect recreational opportunities. Keno Dam is an unmanned facility which requires minimal operations and maintenance. Recreation facilities owned by PacifiCorp in the vicinity of Keno Impoundment/Lake Ewauna will also be transferred to DOI as described in the KHSA Section 7.5. Operation of Keno Dam and of the recreation areas are expected to continue

in their current fashion. **The transfer of the Keno Facility and recreation lands would result in no change from existing conditions in relation to recreational resources or facilities.**

East and Westside Facilities Removal – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects on recreation. The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action. **Therefore, the decommissioning activities would result in no change from existing conditions in relation to recreation resources or facilities.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The City of Yreka's Water Supply Pipeline would need to be relocated to avoid damage after the removal of Iron Gate Reservoir; this action could create a change in existing recreational resources. The effects of relocating the City of Yreka's Water Supply Pipeline would be the same as those described under the Proposed Action. **There would be no change from existing conditions.**

KBRA – Programmatic Measures

Under this alternative the KBRA would be fully implemented; therefore, impacts on recreation facilities and opportunities would be the same as described for KBRA under the Proposed Action.

Wild and Scenic Rivers

With regard to WSRs, impacts would be similar as for the Proposed Action.

3.20.4.4.2 Alternative 4: Fish Passage at Four Dams

The Fish Passage at Four Dams Alternative could change existing recreation access and opportunities. Impacts under this alternative would be similar to those described under the No Action/No Project Alternative. Because the dams would remain in place, none of the expected beneficial changes to water quality would occur; therefore, beneficial effects with regard to water-contact-based activities described under the Proposed Action would not occur. The recreational setting (campgrounds, day use areas, and water access areas) would remain as described in the Affected Environment section. **Under the Fish Passage at Four Dams Alternative, existing conditions for recreational fishing within the river and water-contact-based activities at the subject reservoirs would not change from existing conditions.**

Implementation of the prescriptions provided by the USFWS, DOI, and United States Department of Commerce in the FERC 2007 EIS could change whitewater boating opportunities in the Hell's Corner Reach. There would be a loss of acceptable flows for whitewater boating opportunities in the Hell's Corner Reach as compared to existing conditions. The prescriptions set minimum streamflow requirements for the Peaking Reach downstream from J.C. Boyle Powerhouse. A minimum streamflow of 1,500 cfs must be provided no more than once per week as opposed to existing conditions where acceptable whitewater flows are maintained a majority of days. In addition, there would

no longer be predictable flows in terms of known timing for flow releases as under the existing conditions. **Impacts on whitewater boating opportunities in the Hell's Corner Reach would be significant and unavoidable**.

Fish passage facilities could result in increased fisheries populations and abundance, which could improve recreational fishing along the river. As discussed in Section 3.3, Aquatic Resources, installation of fish passage at the dams would likely beneficially affect anadromous fisheries in the Klamath River, although not to as great a degree as under the Proposed Action. Increased abundance and population of recreational fishery species would likely result in beneficial effects on recreational fishing downstream from Iron Gate Dam. More specifically, the increased abundance would allow for increased catch limits and fewer catch and release requirements, and would decrease the number of potential fishing season closures such as those that occurred on the Klamath River in the recent past. Species specific economic analysis of the effects of increased recreational fishing is presented in Section 3.15, Socioeconomics. **Impacts with regard to recreational fishing opportunities would be long term and beneficial.**

3.20.4.4.3 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Dam removal could permanently remove recreational facilities in the area of Copco 1 and Iron Gate Reservoirs. Under this alternative, Copco 1 and Iron Gate Dams would be removed, but Copco 2 Dam and J.C. Boyle Dam would remain in place. The impacts would be similar to those described for the Proposed Action for the areas surrounding the Copco 1 and Iron Gate Reservoirs; recreation facilities at these sites would be removed. **Impacts on recreational facilities at Copco 1 and Iron Gate reservoirs would be considered permanent and significant; however, implementation of Mitigation Measure REC-1 would reduce these impacts in the long term to less than significant.**

Dam removal could permanently decrease the availability of reservoir/lake-based recreational opportunities. Reservoir-based recreational opportunities (e.g., swimming, bathing, wading, and reservoir-fishing) would be lost at Iron Gate and Copco 1 Reservoirs, although visitors would still be able to travel to J.C. Boyle Reservoir for these activities; thus, adverse impacts would be fewer and smaller in scale than those described for the Proposed Action. **Impacts on the regional availability of reservoir-based recreational opportunities would be less than significant**.

Dam removal could change whitewater boating opportunities in the Klamath River. With regard to changes in whitewater boating opportunities, the existing Copco 1 and Iron Gate Reservoirs would be converted to free-flowing riverine reaches over the long term, and depending on the river channel and access, could provide additional opportunities for whitewater boating in these reaches (Appendix R). However, as noted under the Proposed Action impact analysis, flows following dam removal were not modeled for areas currently inundated by reservoirs. While it could be expected there would be additional opportunities for whitewater boating in these reaches, no records exist of the condition or suitability of the presently inundated areas for whitewater boating activities. With details of the condition of these areas lacking, it is too

speculative to determine the quality and quantity of whitewater boating opportunities that could be realized due to dam removal in areas currently inundated by reservoirs. **Thus, while new whitewater boating opportunities would likely exist in the areas previously inundated by the reservoirs, impacts would be less than significant.**

Loss of peaking flows in the J.C. Boyle Peaking Reach could affect whitewater boating opportunities in the Hell's Corner Reach. The loss of peaking flows in the Hell's Corner Reach would result in the river returning to natural flow conditions, with no ability to regulate for peaking flows. Thus, there would be diminished whitewater boating opportunities in this reach. **Impacts on whitewater boating opportunities in the Hell's Corner Reach would be significant and unmitigable**.

Changes in water quality associated with dam removal could positively affect water-contact-based recreational opportunities. As discussed in Section 3.2, Water Quality, improvements in water quality are expected; however, these improvements would be less than as described under the Proposed Action. Therefore, beneficial effects on water-contact-based recreation would occur as described for the Proposed Action, in the river channel below Copco 1 Dam. Beneficial effects would not be anticipated to occur in or below the J.C. Boyle Reservoir (as described above, there are little to no recreational facilities at Copco 2 Reservoir). Also, as discussed in Section 3.3, Aquatic Resources, populations and abundance of anadromous fish would increase under this alternative (although not to the same degree described for the Proposed Action); therefore, beneficial effects on recreational fishing would be similar, but less than those described for the Proposed Action. **Because existing conditions for water-contact-based recreational activities are considered adverse due to water quality, improved water quality conditions would result in long-term beneficial effects.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The City of Yreka's Water Supply Pipeline would need to be relocated to avoid damage after the removal of Iron Gate Reservoir; this action could create a change in existing recreational resources. The effects of relocating the City of Yreka's Water Supply Pipeline would be the same as those described under the Proposed Action. **There would be no change from existing conditions.**

3.20.4.5 Mitigation Measures

3.20.4.5.1 Mitigation Measure by Consequences Summary

REC-1 – At least one year before starting dam removal activities, the dam removal entity (DRE) will prepare a plan to develop new recreational facilities and river access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. The purpose of the plan is to mitigate for recreational facilities that will be removed during dam removal. The intent is to provide resources and infrastructure which will support similar levels yet different types of use. The plan will be developed in consultation with appropriate State and Federal agencies, counties (e.g., BLM, CDFG,

Siskiyou and Klamath Counties) and stakeholder groups, and will include an implementation schedule for construction of recreational facilities and river access areas.

3.20.4.5.2 Effectiveness of Mitigation in Reducing Consequences

Implementation of Mitigation Measure REC-1 will ensure that access to the Klamath River at and near the location of the removed reservoirs will remain available following dam removal. The potential for fewer recreational opportunities than currently exist would be less than significant (See Section 3.20.4.3)

3.20.4.5.3 Agency Responsible for Mitigation Implementation

The DRE would be responsible for implementing mitigation measure REC-1.

3.20.4.5.4 Remaining Significant Impacts

Changes in flows in the Hell's Corner Reach and decreases in whitewater boating along this part of the river would be a significant and unavoidable impact.

3.20.4.5.5 Mitigation Measures Associated with Other Resource Areas

Mitigation Measures AR-1, 2, 5-7 could interfere with river based recreation downstream from Iron Gate Dam. These mitigation measures involve trap and haul of fish and mollusks to protect them from the reservoir drawdown and dam deconstruction activities. These mitigation measures would include trapping activities in the Klamath River that could interfere with river based recreation between February and April 2020. However, as described in Section 3.20.3.1, Regional Opportunities, a number of other river recreation areas are present within and adjacent to the Klamath Basin and provide similar opportunities for recreational activity. **Temporary impacts on recreational access from Mitigation Measures AR-1, 2, 5-7 would be less than significant.**

Mitigation Measure TR-1 could interfere with reservoir based recreation in Iron Gate Dam. The bridge crosses Jenny Creek at the point it enters Iron Gate Reservoir. Relocation of the Jenny Creek Bridge and culverts would occur before the other construction phases of dam removal. In comparison to the dam removal, equipment and time required for this construction would be minimal, but it could affect reservoir based recreation near the bridge. However, it will not restrict reservoir based recreation in other areas of the reservoir from other access points. **Impacts on recreational access from Mitigation Measure TR-1 would be less than significant.**

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3.21 Toxic/Hazardous Materials

This section describes impacts related to the presence and/or use of hazardous, toxic, and radiological waste (HTRW) within the area of analysis for the Proposed Action and alternatives.

3.21.1 Area of Analysis

The area of analysis includes the area in the immediate vicinity of Keno, J.C. Boyle, Copco 1, Copco 2, and Iron Gate Dams, including their associated reservoirs, and areas identified as construction/demolition and staging areas for the alternatives. This section also addresses impacts related to HTRW at a programmatic level within the Klamath Basin Restoration Agreement (KBRA) area of analysis because specific locations of potential construction sites have not been identified.

3.21.2 Regulatory Framework

Hazardous materials, substances, and waste within the area of analysis are regulated by several Federal, State, and local laws and policies, which are listed below.

3.21.2.1 Federal Laws, Authorities and Regulations

- Resource Conservation and Recovery Act (42 USC 6901 et seq.)
- Hazardous Materials Transportation Act (49 USC Section 1801 et seq.)
- Clean Water Act (33 USC 1251 et seq.)
- Comprehensive Environmental Response Compensation and Liability Act and Superfund Amendment Reauthorization Act (43 USC 9601 et seq.)
- 40 CFR 260-279 Federal Regulations on hazardous waste management
- 42 USC 11001 et seq. Emergency Planning and Community Right to Know Act
- Toxic Substances Control Act (15 USC 2601 et seq.)

3.21.2.2 State Laws, Authorities and Regulations

- California Hazardous Waste Control Law (California Health and Safety Code [HSC] Section 25501 et seq.)
- Carpenter-Presley-Tanner Hazardous Substances Account Act (HSC Section 25300 et seq.)
- Unified Hazardous Waste and Hazardous Materials Management Regulatory Program (HSC Section 25404 et seq.)
- Solid Waste Management (Oregon Revised Statute [ORS] 459, and Oregon Administrative Rule [OAR] 340-093)
- Hazardous Waste and Hazardous Materials (ORS 465 and 466, and OAR 340 Divisions 100 to 106, 109, 111, 113, 120, 124, 135, and 142)
- General Environmental Quality (ORS 468, 468a, and 468b)

3.21.3 Affected Environment/Environmental Setting

3.21.3.1 Sites with Potential HTRW Concerns

As described in Section 3.21.4.1, Effects Determination Methods, a database search was conducted by consultant Environmental Data Resources (EDR) of sites within a 1-mile radius of the area of analysis where there is potential concern for the presence of HTRW (EDR 2010a and 2010b). Potential HTRW sites included spill sites, sites with leaking underground storage tanks, emergency response to releases sites, brownfields (urban development sites previously built upon), hazardous material incidents, and voluntary cleanup sites, among others. No recorded reviews or site inspections were performed on these sites identified from the database searches. Four potential HTRW sites within the area of analysis were identified by the EDR search. Two of the listings only indicated the presence of underground and aboveground storage tanks at the Copco Lake Store and the "Pacific Power – Iron Gate,"; but there was no evidence of spills. One listing referenced health limit exceedences in water samples from the Copco Lake Municipal Water Company for radium-228, arsenic (total), bromodichloromethane, dichloroacetic acid, and total haloacetic acids between 2004 and 2006, and for aluminum in water samples collected since 2004. The remaining listing resulted from a minor spill which was remediated and is no longer a site of concern, as described below:

- **21630 Copco Road (Map Location #2 – 21630 Copco Road, Hornbrook, CA)**. This site, which is the Copco 2 powerhouse, had a spill of non-polychlorinated biphenyl (PCB) transformer oil and is listed in the California Hazardous Material Incident Reporting System and the Emergency Response Notification System databases. According to the EDR report, in 1999, a bushing failed at a transformer adjacent to the Klamath River releasing transformer oil. Most of the non-PCB transformer oil was contained, and less than 1 quart made it to the Klamath River. According to PacifiCorp, Siskiyou County conducted the site review and approval of the transformer fire spill cleanup (EDR 2010a).

In addition to the four sites described above, the EDR database research identified 162 "orphan sites," which are those sites that could not be mapped or "geocoded" due to inadequate address information, along the two corridors of the Klamath River. After further research, seven orphan sites were identified within the area of analysis. Two of these seven were listings of National Pollutant Discharge Elimination System-permitted facilities and a Waste Discharge System facility, which do not present concerns related to HTRW. Another two of the listings indicated the presence of both aboveground and underground storage tanks at Iron Gate Salmon & Steelhead Hatchery and the J.C. Boyle Power Plant, in addition to the Copco 2 tank discussed above. There is no database-documented evidence of spills at Iron Gate or J.C Boyle. One site, listed on the Emergency Response Notification System, is the Copco 2 powerhouse minor spill described above. The remaining two sites were listed on the California Facility and Manifest Database and the leaking underground storage tank (LUST) databases. No

additional information was available on the Regional Water Quality Control Board Geotracker database or the California Department of Toxic Substances Control Envirostor database regarding these sites:

- **DFG Iron Gate Fish Hatchery (Hornbrook, CA).** This site is listed in the California EnviroStor Database (DTSC 2012). No additional information on the presence of HTRW at the site is available.
- **Weyerhaeuser Co., Klamath Mill Site (Highway 66 West, Klamath Falls, OR).** This site is listed in the underground storage tank (UST) and Geotracker databases (SWRCB 2012). No additional information on the presence of HTRW at the site is available.

In addition to the EDR database search, the following items were found from other sources:

- In 2009, at the Copco 1 Warehouse, soil known to be contaminated by petroleum products was removed from a former lube rack area. The final report and site cleanup were approved by a letter from Siskiyou County in 2010 (personal communication with R. Dean, Siskiyou County, March 30, 2011).
- In 2009, a former landfill site at Copco 2 Dam was removed per Siskiyou County review and approval (personal communication with R. Dean, Siskiyou County, March 30, 2011).
- Copco 2 Dam's fueling facility has two aboveground storage tanks (1,000-gallon gasoline and 500-gallon diesel). No known spills or cleanups occurred at this facility.

3.21.3.2 HTRW at PacifiCorp Dams and Associated Facilities

The existing dams and hydroelectric facilities have components that contain potentially hazardous materials. This analysis assumes that all painted structures, equipment, and metalwork in the project area contain heavy metals, such as lead. Window caulking, electrical wiring and components, building materials, and some coatings may contain asbestos. Tests for lead paint and asbestos are usually performed to characterize material and equipment prior to equipment removal and structure demolition. While PacifiCorp has tested their facilities for lead paint and asbestos in the past, the Lead Agencies have not verified the presence or absence of these materials as part of the development of this EIS/EIR or the Detailed Plan. In addition, surrounding soils may contain heavy metal contaminants where coatings have flaked off of the painted structures, equipment, and metalwork.

In the mid-1980s, PacifiCorp tested all of its accessible oil-filled electrical equipment for the presence of PCB materials (personal communication with T. Hepler, Reclamation, December 23, 2010.). All accessible power generation equipment was certified by PacifiCorp as "PCBs-free", if it had concentrations of PCBs that were less than 50 parts per million. Certain closed systems, such as transformer bushings, cannot be tested until time of disposal. Thus, small quantities of PCBs may be present in hydraulic fluids,

soils, and in older fluorescent light fixtures. Old light switches may contain mercury. Other hazardous materials at the dams and hydroelectric facilities may include transformers, batteries, bushings, oil storage tanks, bearing and hydraulic control system oils, lead bearings, and creosote-treated wood in the wood-stave penstocks.

It is unlikely that the dams themselves include naturally hazardous materials such as fibrous chrysotile asbestos that is a common mineral component found in serpentine rock. Serpentine is a rather weak metamorphic rock that would not typically be used in the manufacture of concrete which is what makes up the Copco dams. J.C. Boyle and Iron Gate dams are earthfill dams that are underlain by relatively young volcanic rocks of the Cascade Range geomorphic province. It is assumed that the earthen fill of those dams was derived locally from quarries excavated into the volcanic rock. The closest exposures of ultramafic rocks (i.e., serpentinized rocks) with reported occurrences of asbestos (Van Gosen and Clinkenbeard, 2011) lie approximately 18 miles due west of Iron Gate dam in the Round Mountain vicinity of the Klamath Mountains geomorphic province. Due to the distance and the relative weakness of serpentine rock compared to young volcanic rock in an engineered fill, it is unlikely that serpentine rock from the Round Mountain area was used in the construction of the dams. However, based on the age of the structures at Iron Gate and J.C. Boyle dams the concrete in the structures may contain fly ash, which has raised concerns about the presence of mercury or other toxic substances. However, the United States Environmental Protection Agency (USEPA) recognizes the beneficial uses of fly ash and considers it safe when it is encapsulated in concrete or other building materials (USEPA 2011). There is also a potential for changes to pH in river water during demolition of concrete.

As part of the Secretarial Determination studies, reservoir sediment cores were analyzed for a suite of inorganic and organic contaminants to assess the potential environmental and human health impacts of sediment release. Sediment contaminant levels in samples from the Klamath River were collected at multiple sites and at various sediment depths per site in J.C. Boyle Reservoir, Copco Reservoir, Iron Gate Reservoir, and the Klamath River Estuary, for a total of 77 samples (Department of the Interior (DOI) 2010)., The sediment evaluation process followed screening protocols of the Sediment Evaluation Framework (SEF)[1] for the Pacific Northwest, issued in 2009 by the interagency Regional SEF Team.

The SEF sediment chemistry screening process indicated that the sediment deposits in the Klamath River reservoirs are not highly contaminated. There are few positive exceedances of relevant screening values, and therefore little positive indication that substantial aquatic toxicity, or ecological or human health risk, would likely result from exposure to the sediments. Results from elutriate and sediment toxicity bioassays and sediment bioaccumulation tests carried out for the Secretarial Determination studies are used to provide additional information beyond simple comparisons of sediment contaminant levels to individual-contaminant regional or national screening levels. The

[1] The SEF is a regional guidance document that provides a framework for the assessment and characterization of freshwater and marine sediments in Idaho, Oregon, and Washington (Regional Sediment Evaluation Team 2009).

results of sediment and elutriate toxicity bioassays provide a direct assessment of potential toxicity that takes into account possible interactive effects of mixtures of multiple contaminants, and of potential contaminants that may be present but were not individually measured. Each of these biological testing approaches have been conducted on the same reservoir sediment samples evaluated in the chemistry screening described above. The results of the study are presented in Section 3.2. See Section 3.2.4.3.1.7 and Appendix C.

3.21.3.3 School Sites in the Project Area

As shown in Figure 3.21-1, the closest existing schools to the area of analysis are Hornbrook Elementary School, Willow Creek Elementary School, Bogus Elementary School, and Keno Elementary. All four of these schools are located more than a mile away from the dam facilities. Keno Elementary is 0.25 miles from the Keno Impoundment at its nearest point.

3.21.3.4 Hazardous Waste Disposal Facilities

Any hazardous waste generated from the demolition of the dams and associated hydroelectric facilities would need to be disposed of in designated hazardous waste landfills. This would include treated wood waste, PCBs present in transformers and other electrical equipment, asbestos-containing materials in building materials, fuels and oils, concrete dust (if it generates high pH waste) and soils or other material contaminated with lead from the use of lead-based paint.

The Anderson Landfill in Anderson, California, located 122 miles from Hornbrook, California, is permitted to accept hazardous waste, including treated wood waste. The Anderson Landfill had an estimated remaining capacity of 4,925,975 cubic yards (70 percent of capacity remaining) in 2000, with an anticipated closure date of 2055.

3.21.4 Environmental Consequences

3.21.4.1 Effects Determination Methods

To evaluate whether the construction/demolition areas contain existing hazardous materials, EDR conducted a search of regulatory databases to identify facilities within the vicinity of the dams where hazardous materials are known to be present based on regulatory records of investigation and/or remediation conducted under the oversight of Federal, State, or local agencies. The area of analysis was divided into three corridors along the Klamath River within Oregon and California (EDR 2010a, 2010b, and 2011). The first corridor starts where Keno Impoundment/Lake Ewauna meet in Oregon and follows approximately 18 miles of the Klamath River within south central Oregon to the Keno Dam in Keno, Oregon. The second corridor includes the northeastern point of the J.C. Boyle Reservoir to the J.C. Boyle Powerhouse, and covers approximately 8 miles of the Klamath River within south central Oregon. The third corridor includes the northeastern point of the Copco 1 Reservoir, Copco 1 Dam, Copco 2 Dam, Iron Gate Reservoir, and Iron Gate Dam, and covers approximately 12.5 miles of the Klamath

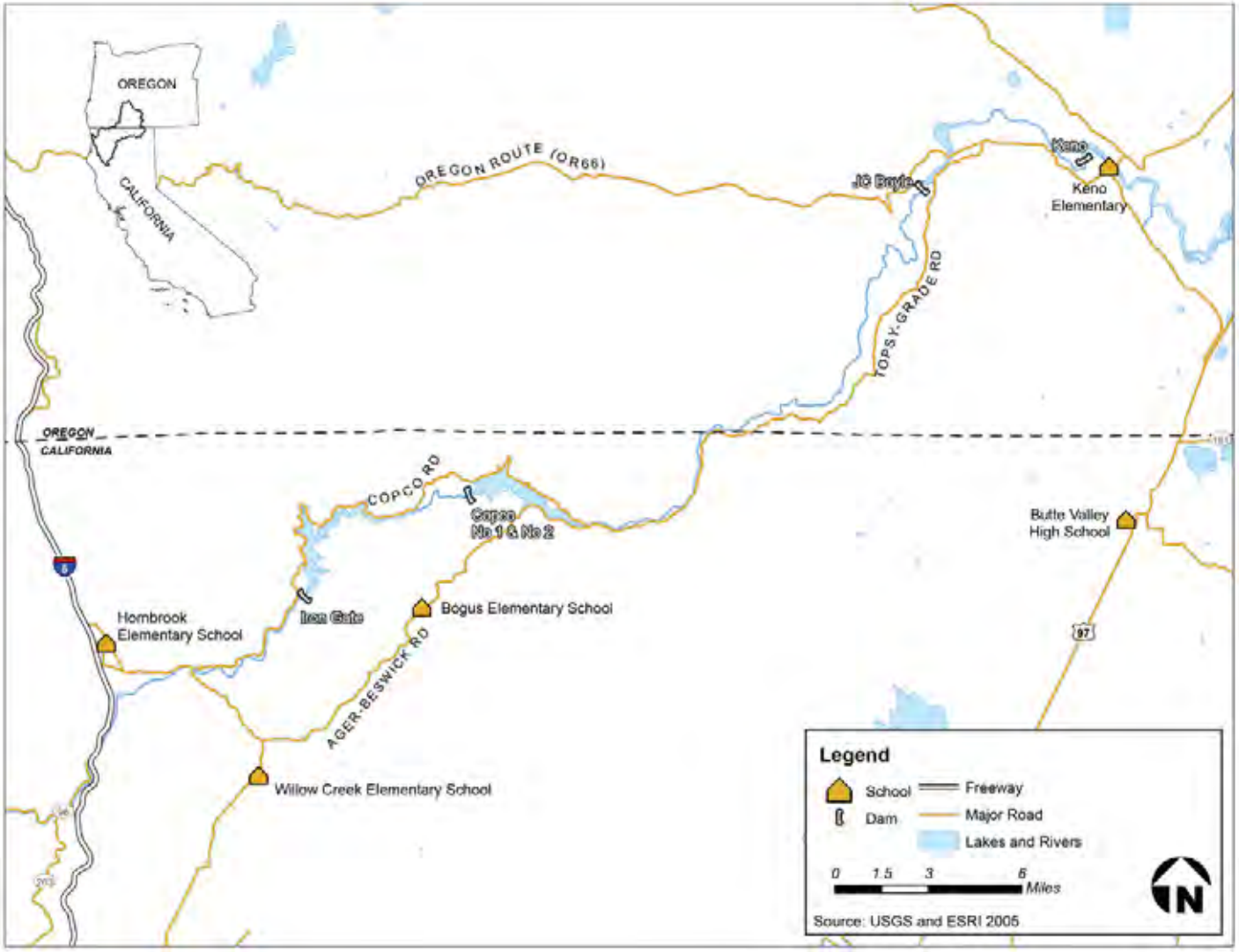

Figure 3.21-1. School Sites in the Project Area.

River within northern California. A 2-mile buffer was added for the records research to account for ground water migration and contaminant transport and to account for the width of the reservoirs. Figures 3.21-2, 3.21-3, and 3.21-4 show the area searched and an overview of the identified HTRW sites.

Database information on these sites was augmented by searching online databases of regulatory agencies to verify the closure status of sites or obtain information on the type and extent of contamination at the sites. Information on hazardous materials associated with existing dam components was obtained from PacifiCorp.

Although the databases search by EDR are updated regularly, there may be contaminated sites that have not yet been identified and are absent from the databases. A complete Phase I Environmental Site Assessment was not performed because such investigations tend to remain valid for only 6 months and, as a result, are typically done closer to the time of construction.

3.21.4.2 Significance Criteria

For the purposes of this Environmental Impact Statement/Environmental Impact Report (EIS/EIR), impacts related to HTRW would be significant if an alternative would result in any of the following:

- Creation of a significant hazard to the public or the environment through the transport, use, or disposal of hazardous materials;
- Creation of a significant hazard to the public or the environment through reasonably foreseeable accident conditions involving the release of hazardous materials into the environment;
- Generate hazardous emissions or handle hazardous or acutely hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school; or
- Be located on a site which is included on a list of hazardous materials sites and, as a result, create a significant hazard to the public or the environment.

3.21.4.3 Effects Determinations

The following sections contain descriptions of the hazardous waste effects that would occur under each alternative.

There are no schools located within one quarter mile of construction areas; the nearest schools are located more than 3 miles away. Therefore, there would be no impacts related to emissions or handling hazardous materials, substances, or waste within one-quarter mile of an existing or proposed school. For this reason, the third significance criterion listed above does not apply to any of the alternatives and will not be considered further in this analysis.

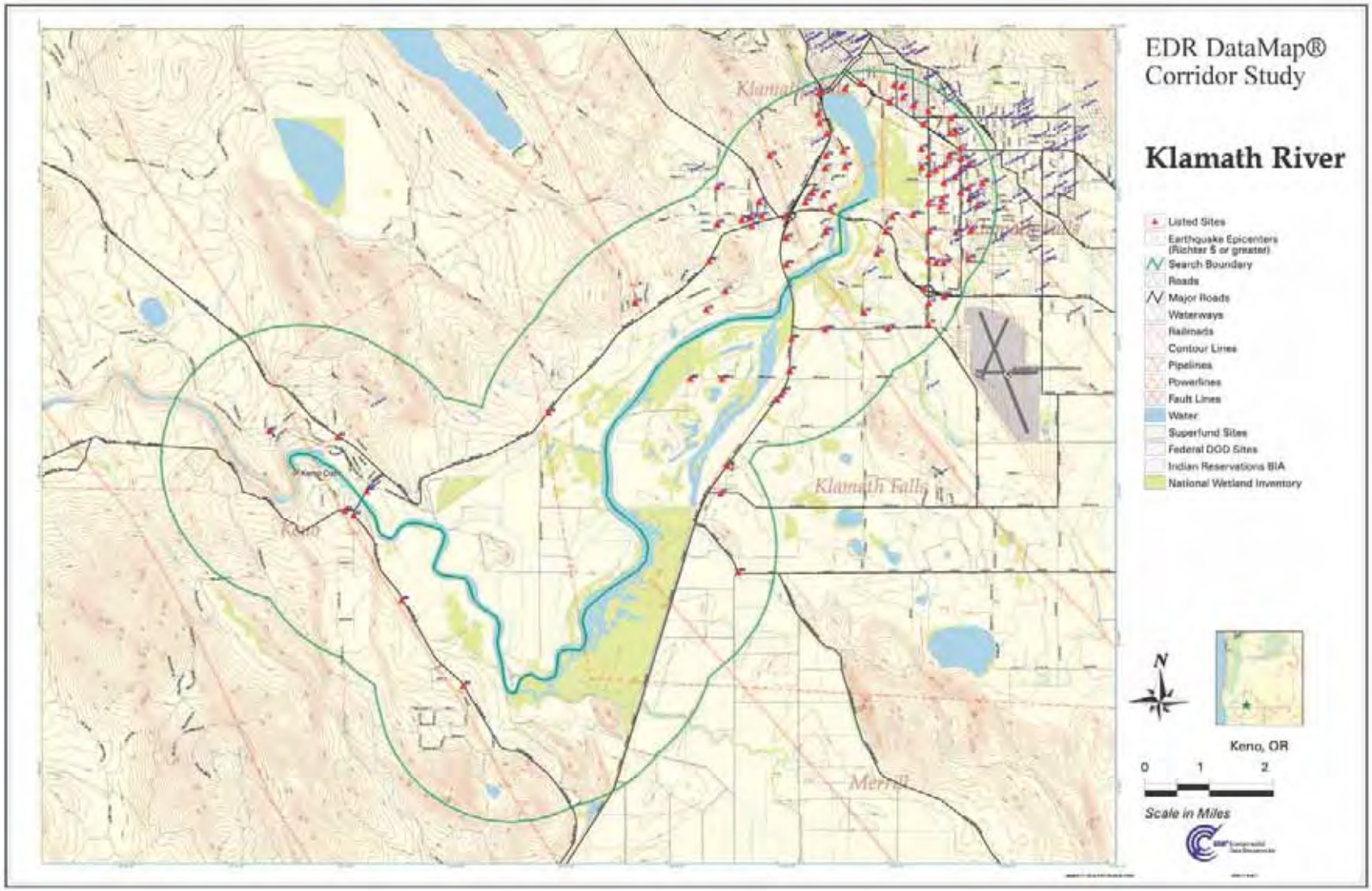

Figure 3.21-2. HTRW Sites, Keno Dam and Keno Impoundment/Lake Ewauna.

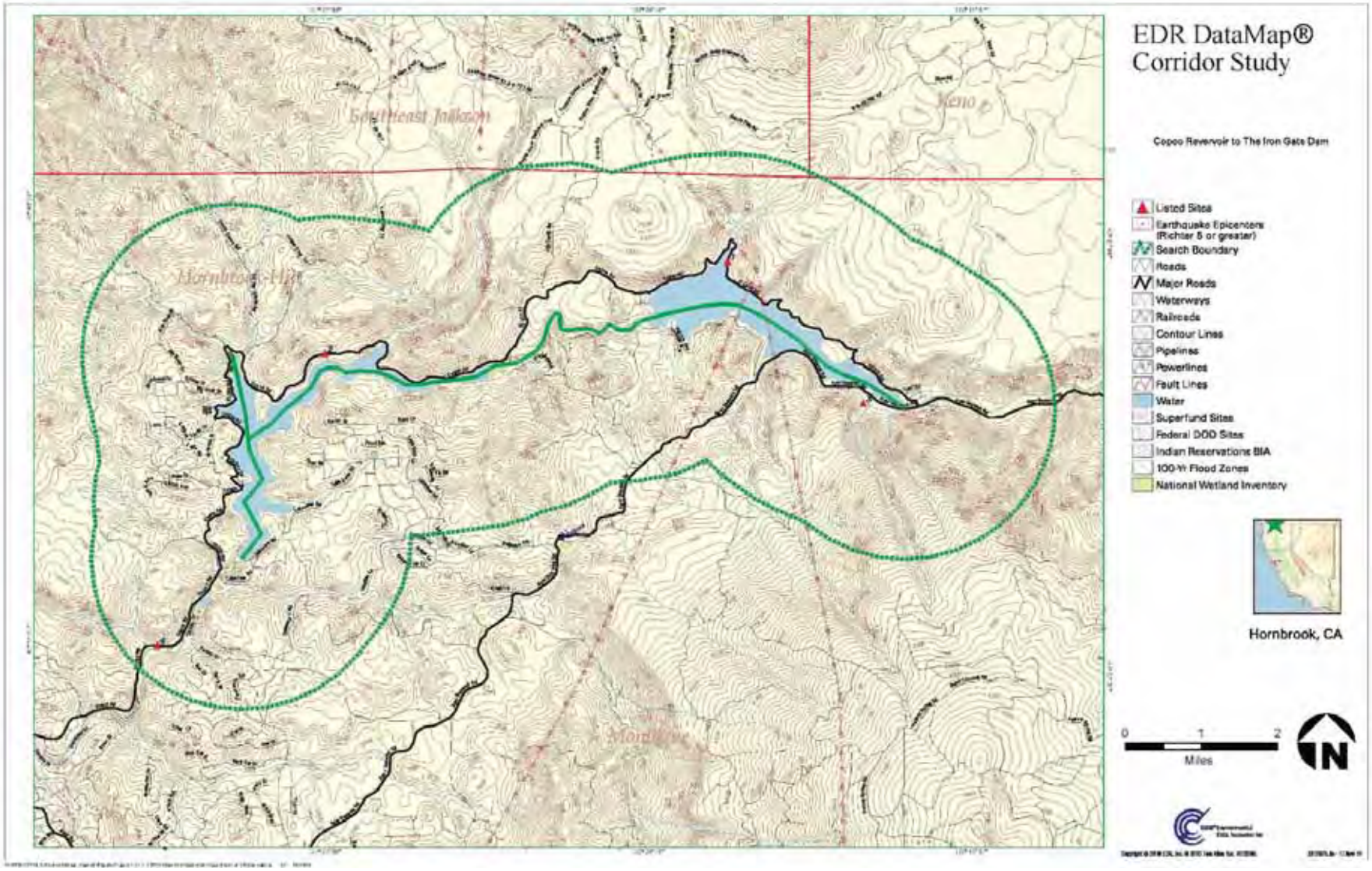

Figure 3.21-3. HTRW Sites, Iron Gate and Copco Dams and Reservoirs.

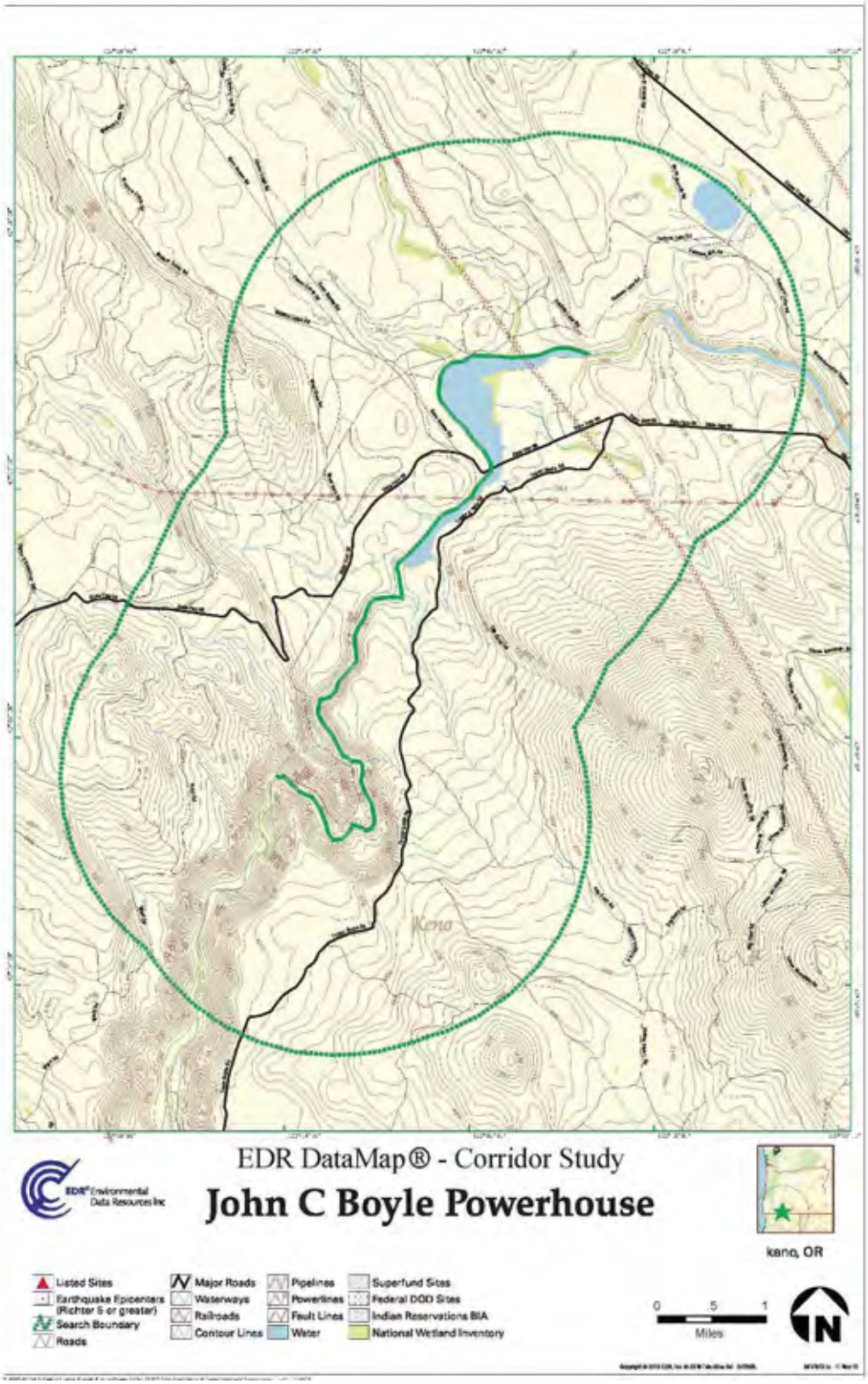

Figure 3.21-4. HTRW Sites, J.C. Boyle Dam and Reservoir.

To assess hazardous waste effects that could occur under each alternative, the analysis focused on potential hazards that could be encountered during deconstruction of the dam facilities, construction of fish passageways, and resultant restoration of the deconstruction/construction areas. The potential resulting risk to the public from these activities are described qualitatively. To identify potential hazards to the public from the alternatives, the inventory of existing hazardous materials at the dams and associated facilities was reviewed to assess potential risks associated with their deconstruction and removal. In addition, the EDR database search was used to identify known hazardous material sites within the area of analysis that could be disturbed during deconstruction/ construction activities.

According to the information provided in the EDR search, construction areas for the Proposed Action and the other action alternatives are not located near sites where hazardous materials are known to occur. Since the EDR report identified a very small number of sites of concern located within one mile of the construction areas, the potential for hazards related to encountering contaminated soil or ground water from these sites is low, however, this risk is discussed below.

3.21.4.3.1 Alternative 1: No Action/No Project

The No Action/No Project Alternative could create a hazard to the public or the environment through the handling, transport and disposal of HTRW. Under the No Action/No Project Alternative, no new construction or demolition would occur at the four Klamath dams so existing known hazardous sites would not be disturbed and would not pose a threat to public safety. Hazardous components of the existing dams, such as transformers, bushings, tanks, lead bearings, creosote-wood staves, and asbestos-based insulating products, would not be disturbed. Any hazardous waste generated or used during operation of the existing dams and hydroelectric facilities and during construction of the Ongoing Restoration Actions (e.g., at Wood River, Barnes, etc.) would be the same as under existing conditions. **Therefore, there would be no change from existing conditions related to HTRW under the No Action/No Project Alternative.**

3.21.4.3.2 Alternative 2: Full Facilities Removal of Four Dams (the Proposed Action)

The Proposed Action involves removal of all appurtenant features, with the exception of buried features, at the Four Facilities.

Facility deconstruction could occur on sites included on a list of hazardous materials sites and, as a result, create a significant hazard to the public or the environment. As summarized in Section 3.21.3.1, the EDR database search identified two listed hazardous sites within one mile of the area of analysis. One site involved a spill of non-PCB transformer oil on Copco Road in 1999, but less than one quart reached the Klamath River. Siskiyou County conducted the site review and approval of the transformer fire spill cleanup. The other reported site was the Copco Lake Municipal Water Company reporting health limit exceedances of radium-228, arsenic (total), bromodichloromethane, dichloroacetic acid, and total haloacetic acids in 2004 and 2006 and detections of aluminum exceeding both the health and legal limits since 2004. Due to the distance of

these two sites from the Four Facilities and construction areas, there is no potential to encounter HTRW from these two sites during construction and demolition activities under the Full Facilities removal of Four Dams alternative. . The EDR database search did not identify any other reported spills within the area of analysis; however, the databases searched by EDR are constantly being updated and require reporting by others to be complete. As such, there is the possibility that an unknown (i.e., unreported and unlisted) contaminated site could be encountered. **There would be no change from existing conditions related to posing a hazardous chemical risk from materials currently at the dam sites.**

Facility deconstruction could create a significant hazard to the public or the environment through the transport, use, or disposal of HTRW during construction. Hydroelectric facilities operate using a variety of chemicals (e.g., lubricants, transformer oils, bearing oils, etc.) that would be removed under decommissioning. The presence of a UST at the J.C. Boyle Power Plant does not indicate a spill; however, care should be exercised when conducting work in these areas. As part of the decommissioning plan, prior to initiation of deconstruction or construction activities, the contractor will be required to prepare a Hazardous Material Management Plan (HMMP) for review by the Dam Removal Entity in case contaminated media are encountered. The purpose of this plan is to have an established plan of action if known or unknown hazardous materials (e.g., soil or ground water contamination, asbestos and hazardous coatings requiring abatement, high pH generated during demolition of concrete, etc.) are encountered during construction/ deconstruction and to establish best management practices (BMPs) to reduce the potential for exposure to hazardous wastes. The HMMP will contain the following:

- Definition of a protocol for proper handling, transport, and disposal of hazardous materials (e.g., creosote-treated wood staves, high pH concrete particles) if they are encountered during construction or deconstruction.
- Definition of a protocol for proper emergency procedures and handling, transport, and disposal of hazardous materials if an accidental spill occurs during construction.
- Establishment of BMPs to reduce the potential for spills of HTRW. Typical BMPs to reduce the potential for spills may include, but are not limited to:
    - Having a spill prevention and control plan with a designated supervisor to oversee and enforce proper spill prevention measures;
    - Providing spill response and prevention education for employees and subcontractors;
    - Stocking appropriate clean-up materials onsite near material storage, unloading and use areas;
    - Designating hazardous waste storage areas away from storm drains or watercourses;
    - Minimizing production or generation of hazardous materials on-site or substituting chemicals used on-site (e.g., herbicides during restoration) with less hazardous chemicals;

- Designating areas for construction vehicle and equipment maintenance and fueling with appropriate control measures for runon and runoff; and
- Arranging for regular hazardous waste removal to minimize onsite storage.

Hazardous materials at the dam settings could include creosote-treated wood staves, asbestos, batteries, transformers, bearing and hydraulic control system oils, oil storage tanks, mercury light switches, and PCBs. In addition, coatings containing heavy metals in the powerhouse and on the exterior surfaces of the steel penstock and air vent pipes, surge tanks, bulkhead gates, and generator gantry crane would require specialized abatement and disposal. The volumes of most of these materials requiring special disposal (e.g., asbestos insulation and lead-based paint) have not been estimated because they cannot be easily quantified before abatement activities have been conducted.

Removal of Copco 2 Dam would generate an estimated 725 tons of treated wood material (creosote wood staves) that would require transport and disposal (analysis of impacts to regional waste facility capacity is presented in Section 3.18, Public Health and Safety, Utilities and Public Services, Solid Waste, and Power). In addition, if it is determined that the Lakeview Bridge just downstream from Iron Gate Dam is not adequate to support construction traffic from the decommissioning activities and needs to be replaced, creosote-treated wood from the bridge would require transport and disposal. Because the Anderson Landfill has an estimated remaining capacity of 4,925,975 cubic yards, the regional landfills in the surrounding counties should be capable of handling the additional generated waste hazardous waste. Licensed contractors would be selected to transport any waste designated as hazardous. The contractors would be required to comply with all hazardous waste laws for transport and disposal of hazardous materials. **With implementation of the HMMP during construction, impacts from the transport, use, and disposal of HTRW from dam removal would be less than significant.**

Facility deconstruction could create a significant hazard to the public or the environment through the abatement and disposal of asbestos and lead-based paint during construction. In addition, as noted under existing conditions, paint coatings on the buildings and structures may have flaked off into the surrounding soil, creating localized areas of soil contamination that would need to be properly excavated and disposed of. However, as part of the decommissioning plan, the demolition contract will require evidence be provided to the responsible Federal agency prior to issuance of demolition permits that a qualified asbestos and lead-based paint removal contractor/specialist has been procured to remove or otherwise abate asbestos and lead-based paint prior to or during demolition activities in accordance with Federal, State, and local regulations. In addition, evidence will be provided to the responsible Federal agency that the demolition contract provides for construction contracts and/or land/building leases, provisions shall be included requiring continuous compliance with all applicable government regulations and conditions related to hazardous materials and waste management. **Therefore, impacts associated with abatement and disposal of asbestos and lead-based paint would be less than significant.**

Facility deconstruction could create a significant hazard to the public or the environment through the accidental release of hazardous materials into the environment during construction. Construction equipment would require the use of hazardous materials (e.g., diesel and gasoline fuels, hydraulic oil). Restoration activities under the Proposed Action would require trucks for hauling equipment and raw materials including spawning-size pea gravel, aircraft for applying hydromulch, discing equipment, backhoes, and other equipment. Restoration could also include the application of herbicides or pesticides. Fuels, oils, and other hazardous materials used during construction could be accidentally released within construction, staging, and access areas through spills, fueling, and equipment repair.

As part of the decommissioning plan, the contractor will be required to prepare and implement a worker Health and Safety Plan (HASP) prior to the start of construction activities. The HASP will, at a minimum, identify the following:

- All contaminants that could be encountered during excavation activities
- All appropriate worker, public health, and environmental protection equipment and procedures
- Proper housekeeping and BMP procedures to prevent spills or migration of herbicides/pesticides
- Emergency response procedures
- Most direct route to a hospital
- Site Safety Officer

The plan will require documentation that all workers have reviewed and signed the plan**.**

With implementation of the HMMP and the HASP during construction of the Proposed Action, impacts from the accidental introduction of hazardous materials would be less than significant.

Drawdown of the reservoirs would require removal of recreational facilities currently located on the banks of the existing reservoirs. The existing recreational facilities provide camping and boating access for recreational users of the reservoirs. Once the reservoirs are drawn down, these facilities will be removed. Construction equipment used for the removal would require the use of hazardous materials (e.g., diesel and gasoline fuels, hydraulic oil). Fuels, oils, and other hazardous materials used during removal could be accidentally released within construction, staging, and access areas through spills, fueling, and equipment repair. An HMMP and HASP would be prepared, as described above. **With implementation of the HMMP and the HASP during construction of the Proposed Action, impacts from the accidental introduction of hazardous materials during the removal of the recreational facilities would be less than significant.**

Keno Transfer

The transfer of the Keno Facility to DOI could result in affects to HTRW. The Keno Transfer would result in a transfer of ownership of the Keno facility to DOI. There

would be no changes in operations or land use of the Keno Facility with the Keno Transfer. In addition, the EDR search did not identify any sites of concern related to HTRW that would change ownership under the Keno Transfer. Due diligence would be required prior to the Keno Transfer to ensure that any hazardous or toxic wastes and materials present on the properties are identified and fully disclosed. Should any be discovered, proper management would be necessary for PacifiCorp or DOI to manage the materials. **Therefore, the implementation of the Keno Transfer would result in no change from existing conditions.**

East and Westside Facilities – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects in terms of toxics and hazardous materials. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp is a part of the Klamath Hydroelectric Settlement Agreement (KHSA). Currently, PacificCorp diverts water at Link River Dam into the two canals. These diversions would cease with the decommissioning of the East and Westside facilities. Following decommissioning of the facilities there would be no change in outflow from Upper Klamath Lake or inflow into the Link River. Appropriate health and safety plans would be created to limit the potential of toxic releases during decommissioning. **Therefore, there would be less than significant effects from the decommissioning activities.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Removal of Iron Gate Reservoir would require the relocation of the City of Yreka Water Supply Pipeline, which could create a significant hazard to the public or the environment through the accidental release of hazardous materials into the environment during construction. The existing water supply pipeline for City of Yreka passes under the Iron Gate Reservoir and would be relocated prior to the decommissioning of the reservoir to prevent damage from deconstruction activities or increased water velocities once the reservoir has been drawn down. The pipeline would either be suspended from a pipe bridge across the river near its current location, or rerouted along the underside of the Lakeview Bridge just downstream from Iron Gate Dam. Construction equipment used for the relocation would require the use of hazardous materials (e.g., diesel and gasoline fuels, hydraulic oil). Fuels, oils, and other hazardous materials used during construction could be accidentally released within construction, staging, and access areas through spills, fueling, and equipment repair. An HMMP and HASP would be prepared, as described above. **With implementation of the HMMP and the HASP during construction of the Proposed Action, impacts from the accidental introduction of hazardous materials during the pipeline relocation would be less than significant.**

KBRA – Programmatic Measures

The following KBRA programs would entail construction, and therefore could result in impacts related to HTRW:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration Project

- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Power for Water Management Program
- Additional Water Conservation and Storage

Construction activities associated with the KBRA programs could create a hazard to the public or the environment through the transport, use, or disposal of hazardous materials encountered during construction. Exact locations and construction plans have not yet been determined for the KBRA construction activities. Impacts related to creating a hazard through routine transport, use, and disposal of hazardous materials would be comparable to those described above for the Proposed Action. The potential for encountering contamination during construction activities for KBRA programs and the extent and frequency of excavation, transport, and disposal are unknown. At the time of implementation of KBRA programs, the entity implementing a KBRA program would follow environmental compliance guidelines with regards to applicable toxic and hazardous material laws. These construction actions would not be in the same location or occur at the same time as the hydroelectric facility removal actions. As a result, KBRA construction actions would not contribute to the potential hazardous material effects of facility removal actions. **Therefore, impacts from hazardous materials encountered during construction for KBRA would be less than significant.**

Construction activities associated with the KBRA programs could create a significant hazard to the public or the environment through the accidental release of hazardous materials during construction activities. Construction could require the use of equipment that use hazardous materials (e.g., fuels and oils) and an accidental release of these hazardous materials could occur. BMPs described in the affected environment would reduce any likelihood of accidental release. As noted above, at the time of implementation of KBRA programs, the implementing entity would follow environmental compliance guidelines with regards to applicable toxic and hazardous material laws. These construction actions would not occur in the same place or at the same time as the hydroelectric facility removal actions. As a result, these actions would not contribute to the effects of facility removal actions. **With implementation of standard BMPs during construction for the KBRA, impacts from the accidental introduction of hazardous materials would be less than significant.**

3.21.4.3.3 Alternative 3: Partial Facilities Removal of Four Dams

The Partial Facilities Removal of Four Dams Alternative could create a significant hazard to the public or the environment through the transport, use, or disposal of hazardous materials encountered during construction or the accidental release of HRTW during construction. Under the Partial Facilities Removal of Four Dams Alternative, certain project features at the Four Facilities would be retained. Impacts related to HTRW for the Partial Facilities Removal of Four Dams Alternative would be the same as that associated with the Proposed Action. Table 2-22 in Chapter 2, Proposed Action and Description of the Alternatives, lists features that would be removed under the Proposed

Action, but would remain in the Partial Facilities Removal of Four Dams Alternative that could potentially reduce the amount of hazardous waste requiring abatement or disposal. Although all of the specifically identified powerhouse hazardous materials (transformers, batteries, and insulation) would be removed under both alternatives, some materials that contain hazardous coatings could be retained under the Partial Facilities Removal of Four Dams Alternative and would be stabilized through ongoing maintenance activities (e.g., painted penstocks that are left in place under this alternative would be recoated periodically as maintenance). **With implementation of the HMMP and the HASP during construction, impacts associated with the handling, transport, and disposal of hazardous materials and the accidental release of hazardous materials during construction of the Partial Facilities Removal of Four Dams Alternative would be less than significant.**

Keno Transfer

The effects of the Keno Transfer would be the same as those described for the Proposed Action.

East and Westside Facilities – Programmatic Measures

The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the relocation of the City of Yreka Water Supply Pipeline would be the same as the Proposed Action.

KBRA – Programmatic Measures

The KBRA would be fully implemented under this alternative. Effects would be the same as the Proposed Action.

3.21.4.3.4 Alternative 4: Fish Passage at Four Dams

Under the Fish Passage at Four Dams Alternative, no facilities removal would be conducted. This alternative would include the construction of fish passageways at each of the Four Facilities. Known hazardous materials associated with the facility structures would remain in place and there would be no anticipated handling, transport, or disposal of HTRW.

The Fish Passage at Four Dams Alternative could create a significant hazard to the public or the environment through the accidental release of hazardous materials into the environment during construction. Construction would require the use of hazardous materials (e.g., fuels and oils) within construction areas. The scale of the construction would be much smaller for the construction of the Fish Passage at Four Dams Alternative than it would be under the Proposed Action and Partial Facilities Removal of Four Dams Alternatives. **With implementation of the HMMP and the HASP during construction, impacts from the accidental release of hazardous materials would be less than significant.**

3.21.4.3.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

The Fish Passage at Two Dams Alternative could create a significant hazard to the public or the environment through the transport, use, or disposal of hazardous materials encountered during construction or the accidental release of HRTW during construction. Under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative, the Dam Removal Entity would remove the facilities at Copco 1 and Iron Gate Dams. Fish passage facilities would be constructed at J.C. Boyle and Copco 2 Dams. Impacts related to hazardous materials for the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative would be the same as for the Proposed Action at the Copco 1 and Iron Gate Dams, and would be the same as for the Fish Passage at Four Dams Alternative at J.C. Boyle and Copco 2 Dams. **With implementation of the HMMP and the HASP during construction, impacts associated with the handling, transport, and disposal of hazardous materials and the accidental release of hazardous materials would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of the relocation of the City of Yreka Water Supply Pipeline would be the same as the Proposed Action.

3.21.4.4 Mitigation Measures

3.21.4.4.1 Mitigation Measure by Consequence Summary

Impacts associated with hazardous materials under each of the alternatives would be less than significant with the implementation of the HMMP and HASP; therefore, no mitigation measures would be required.

3.21.4.4.2 Mitigation Measures Associated with Other Resource Areas

Construction of new recreation facilities could release hazardous materials. Mitigation measure REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. Construction equipment used for the new construction would require the use of hazardous materials (e.g., diesel and gasoline fuels, hydraulic oil). Fuels, oils, and other hazardous materials used during construction could be accidentally released within construction, staging, and access areas through spills, fueling, and equipment repair. An HMMP and HASP would be prepared, as described above. **With implementation of the HMMP and the HASP, impacts from the accidental release of hazardous materials during construction of new recreation facilities would be less than significant**.

3.21.5 References

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3.22 Traffic and Transportation

This section describes how the Proposed Action and alternatives could affect the area's transportation and circulation. This section includes a description of the area of analysis, the local and direct access routes identified to be used during construction, the existing non-motorized transportation network, and transit resources. This section also contains an analysis of future traffic volumes resulting from each alternative and describes mitigation measures to reduce impacts during construction. Appendix S includes tables that support this transportation and circulation analysis, and Appendix T describes 2020 Traffic Volume Projections.

3.22.1 Area of Analysis

The area of analysis for the Klamath Hydroelectric Settlement Agreement (KHSA) includes roadways in Siskiyou and Shasta Counties in California and Klamath and Jackson Counties in Oregon. The area of analysis for the KHSA is rural with very low-density development. Most of the private property is undeveloped and/or used as grazing land for cattle with the exception of several small communities in the vicinity of Copco 1 and Iron Gate Reservoirs. Figure 3.22-1 depicts the transportation network in the area of analysis for the KHSA. The area of analysis for the Klamath Basin Restoration Agreement (KBRA) constitutes the entirety of the Klamath Basin and can be characterized as both urban and agricultural.

Table 3.22-1 lists the dam sites within the KHSA along with the corresponding regional and local roads that access each site.

3.22.2 Regulatory Framework

This analysis uses Oregon Department of Transportation (ODOT) and California Department of Transportation (Caltrans) accepted methods for measuring impacts on roadways. The Lead Agencies used these guidelines in the absence of county level guidelines. Caltrans measures traffic capacities in terms of a Level of Service (LOS). In California, the Siskiyou County General Plan is used as a guide in determining significance (1988). The ODOT system of congestion measurement is different from the LOS system that Siskiyou County and Caltrans use. The ODOT, Klamath County, and Jackson County, use a volume-to-capacity (v/c) ratio.

Where roadway planning level capacities were desired, and were not available from ODOT, Caltrans or County sources, the Lead Agencies used Caltrans accepted guidelines developed by the Florida Department of Transportation (FDOT) to outline roadway planning capacities in the project area.

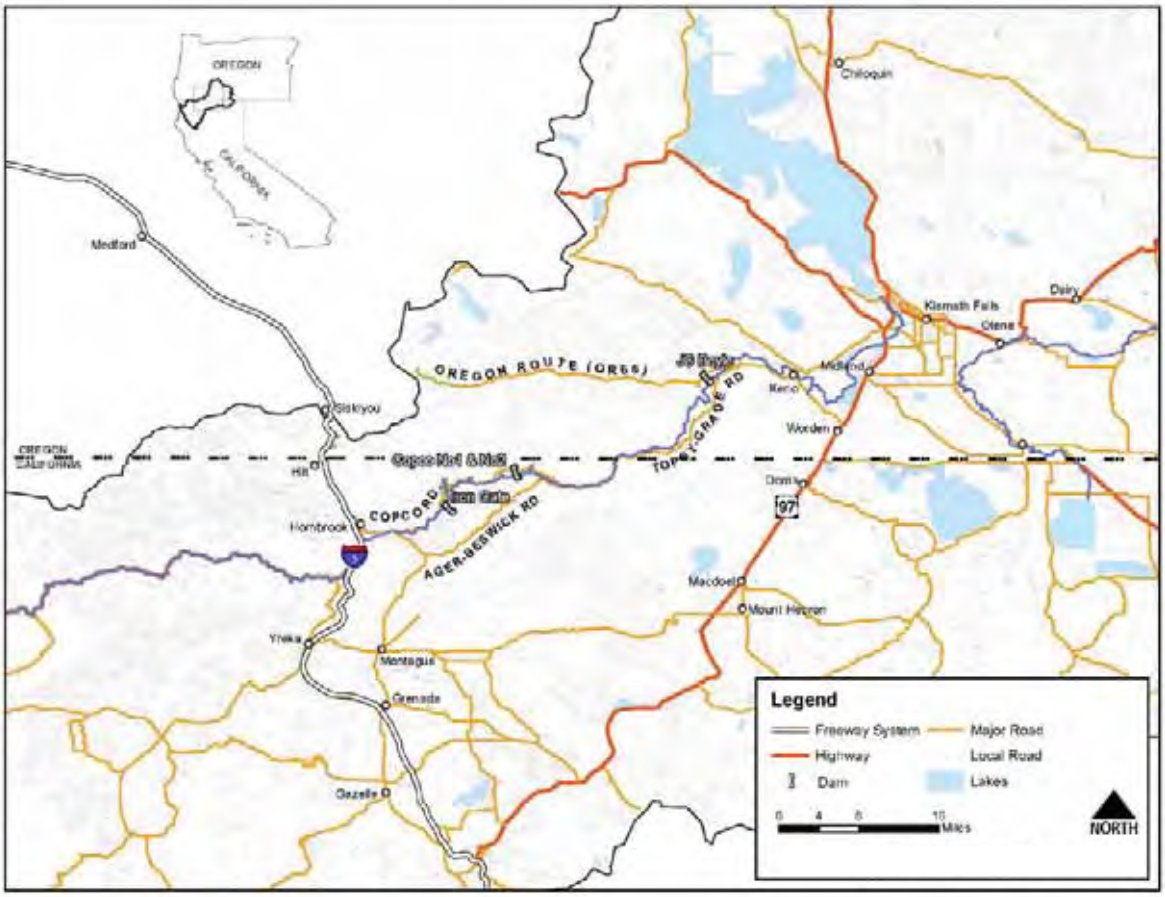

Figure 3.22-1. Regional Access Routes Relative to the KHSA.

Table 3.22-1. Local and Regional Access Roads Relative to KHSA

Dam Site	Interstate Access Road	Regional Access Road	Local Access Road
J.C. Boyle	Interstate 5 (1-5) (in Oregon) and US97	Oregon Route (OR) 66	Topsy Grade Road
Copco 1	I-5 (in California)	Copco Road	Ager-Beswick Road
Copco 2	I-5 (in California)	Copco Road	Ager-Beswick Road
Iron Gate	I-5 (in California)	Copco Road	Lakeview Road

Source: CDM field observation, Oct 2010.

3.22.2.1 Significance Criteria

For the purposes of the Klamath Facilities Removal Environmental Impact Statement/ Environmental Impact Report (EIS/EIR), effects would be significant if they resulted in one or more of the following conditions or situations:

- An alternative conflicted with an applicable plan, ordinance, or policy establishing measures of effectiveness for the performance of the circulation system.[1] (Traffic Flow Effects)
- Non-compliance with county planning regulations. (Traffic Flow Effects)
- Traffic related to implementation of the alternative resulted in a LOS worse than level C in Siskiyou County.[2] (Traffic Flow Effects)
- Traffic related to implementation of the alternative resulted in a v/c ratio of more than 0.75 for OR66 or 0.70 for U.S. Route 97 (US97).[3] (Traffic Flow Effects)
- Traffic related to implementation of the alternative traversed blind corners or sharp turns; if large trucks would be turning onto and off of roadways with high speed limits; and/or if conflicts would occur at existing recreation sites where passenger cars may consistently turn in and out. (Traffic Safety Effects)
- An alternative conflicted with adopted policies, plans, or programs regarding public transit. (Public Transit Effects)
- Project-related vehicle volumes were great enough to exceed the capacity of a road in the area of analysis. This would slow or impede general vehicle traffic along a roadway and delay public transit service. Effects would also be significant if construction activities were adjacent to public transit passenger pick up/drop off facilities and inhibited vehicle travel or transit vehicle turning movements. (Traffic Flow Effects)
- An alternative resulted in the following Non-Motorized Transportation Effects:
    - Substantial degradation of road conditions that interfered with non-motorized vehicle use.
    - Conflict with adopted policies, plans, or programs regarding bicycle or pedestrian facilities.
    - Deconstruction or construction traffic crossing or running along existing non-motorized transportation facilities.
    - A need for the narrowing or rerouting of non-motorized transportation infrastructure such as a bicycle lane or sidewalk.

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[1] Taking into account all modes of transportation including mass transit and non-motorized travel and relevant components of the circulation system, including but not limited to intersections, streets, highways and freeways, pedestrian and bicycle paths, and mass transit.

[2] In California, progressively worsening traffic conditions are given the letter grades “A” through “F.” While most motorists consider an “A,” “B,” or “C” LOS as satisfactory, LOS “D” is considered marginally acceptable. Congestion and delay are considered unacceptable to most motorists; these conditions would result in LOS “E” or “F” ratings. LOS analyses can be very detailed but for the purposes of this analysis LOS will only be discussed when referring to industry-accepted general planning standards for roadway capacity. LOS C is the threshold for capacity for California roads in this analysis. According to the Siskiyou County General Plan, LOS worse than level C is not acceptable (Siskiyou County 1988).

[3] In Oregon, several different thresholds apply to various roads. A v/c ratio of 1.0 is equivalent to a poor LOS (E or F) with long delays. Klamath and Jackson Counties and ODOT are willing to accept a certain amount of congestion during peak periods to encourage drivers to find other modes of transportation or other times to travel. Jackson County requires that I-5 have a v/c ratio no higher than 0.85 (Jackson County 2005). Klamath County requires that OR66 have a v/c ratio no greater than 0.75 and US97 have a v/c ratio of no greater than 0.70 (Klamath County 2004).

3.22.3 Existing Conditions/Affected Environment

3.22.3.1 KHSA – River Reach Road Network

The following describes the characteristics of the roadways within the KHSA transportation analysis area. The Lead Agencies recorded these characteristics during site visits and relied on existing traffic volume data for the subject roadways from ODOT and Caltrans.

- **I-5** – a major north/south interstate highway that runs the length of California and continues through Oregon. This is a main regional access road for the Four Facilities on the Klamath River. Through Siskiyou and Jackson Counties, I-5 has four lanes. The posted speed limit is 70 miles per hour (mph) in California and 65 mph in Oregon. The portion of I-5 in California closest to the Iron Gate Dam has more than 17,000 vehicles per day in Annual Average Daily Traffic (AADT) in its peak month, and averages 15,200 AADT. In Oregon, near the intersection with OR66, traffic volumes are closer to 14,300 AADT.
- **OR66** – Known locally as Green Springs Highway, this road also carries the ODOT designation of Highway Number 21. OR66 is a two lane, east/west, asphalt State highway. It is approximately 32 feet wide and the posted speed limit is 55 mph in some locations. Some sharp curves on OR66 require posted speed reductions. OR66 connects I-5 to the J.C. Boyle Dam and to US97 and intersects I-5 approximately 14 miles north of the California border. Traffic counts from 2009 along OR66 show 9,500 AADT just east of I-5 and 500 AADT closest to the J.C. Boyle Dam.
- **US97 –** Known locally as the California-Dalles Highway, this road carries the ODOT designation of Highway Number 4 and is a four-lane, north/south, asphalt US highway. A barrier divides the northbound and southbound lanes and it has a wide shoulder. The posted speed limit is 65 mph and AADT in 2009 was 9,700 vehicles.
- **Copco Road** – a minor collector that leads from I-5 to the Iron Gate, Copco 1 and Copco 2 Dams. Copco Road is a paved, two-lane road in good pavement condition with few pavement cracks or ruts and is approximately 27 feet wide. Copco Road maintains this character from its intersection with I-5 east to a point about 10 miles from the Copco Developments near the Juniper Point Picnic Area. The section between the intersection of Copco Road with Ager Road and the Juniper Point Picnic Area, contains intermittent pavement surfacing that has not been as well maintained as the portions to the west of Ager Road. The final 3 miles, from Camp Creek Road near the Juniper Point Picnic Area to the Copco Dams, are gravel and narrow, and less than 18 feet wide in some locations. The posted speed limit on Copco Road from I-5 to the Juniper Point Picnic Area is generally 55 mph with a few sharp curves, especially in the portions that run along the Iron Gate Reservoir. AADT for this analysis is based on field observation. See Figure 3.22-2 for a photo of a portion of Copco Road.

Source: Camp Dresser & McKee (CDM) 2010

Figure 3.22-2. Copco Road (north of river, facing west).

- **Topsy Grade Road and Ager-Beswick Road –** The roads known as Topsy Grade Road in Oregon and Ager-Beswick Road in California run along the southern side of the Klamath River and connecting the Copco 1 Reservoir to the J.C. Boyle Dam. The road sections between those two locations the road are mostly unimproved with natural surfacing. While these road sections have several different surfacing and sizing characteristics along it, the relevant portion, Topsy Grade Road near the J.C. Boyle Dam, is partially gravel and partially paved. It provides access to the Topsy Grade Recreation Area from OR66. Topsy Grade Road would give access to OR66 from the J.C. Boyle construction site, and Ager-Beswick Road would provide haul access, via Patricia Avenue (with construction of a temporary access connection along the dam abutment), from Copco 1 to the City of Yreka, California.
- **Unpaved access roads –** each dam has a small network of one lane, gravel access roads leading from either Copco Road or OR66 to the dams themselves. These roads are no wider than 15 feet and are no longer than ½ mile. Most of the traffic along these roads consists of PacifiCorp's technicians accessing the facilities and recreational users.
- **J.C. Boyle unpaved access roads** – While this road network shares the same characteristics of the other unpaved access roads, it has a small bridge linking the north and south sides of the dam. This is a key link and might play a role in construction activities. Figure 3.22-3 is a photo of this bridge.

Source: CDM 2010

Figure 3.22-3. Access Bridge at J.C. Boyle Dam.

- **Lakeview Road** – a local road that accesses the Iron Gate Dam itself. Lakeview Road intersects with Copco Road at the entrance to the Iron Gate Recreation Area. A one-lane bridge crosses the river (see Figure 3.22-4) at this intersection linking to Lakeview Road. Lakeview Road is a gravel road that leads up to the top of Iron Gate Dam. It is approximately 24 feet wide and has a steep embankment on the east side, without a guardrail. Lakeview Road connects to an unnamed bridge access road. The narrow, gravel access road leads onto the top of Iron Gate Dam. For the purposes of further analysis, Lakeview Road would be considered an unpaved access road except when discussing the bridge.

Source: CDM 2010

Figure 3.22-4. Bridge Accessing Lakeview Road (looking south).

- **Baseline Transit Service -** The Siskiyou Transit and General Express is the only transit service in the KHSA area of analysis. It is a regional service that connects the downtowns of Dunsmuir, Weed, Mt. Shasta, Grenada, McCloud, the City of Yreka, Montague, Fort Jones, Greenview, Etna, Klamath River, Horse Creek, Hamburg, Seiad Valley and Happy Camp. Service is very limited, sometimes running only one or two times a week. One route branches into the area of analysis and currently runs twice a week: the Hornbrook route. The Hornbrook route follows I-5 north into Hornbrook, turns east on Copco Road and then turns south (well before reaching the Iron Gate Dam) at Ager Road heading towards Montague, California.

  In addition, Greyhound bus service runs on US97 connecting Klamath Falls to other cities in the region and to nearby Amtrak stations (Siskiyou County 2008). As with the Siskiyou Transit and General Express, this service is limited and is along a major U.S. highway.

- **Non-motorized Transportation Network –** The area of analysis has very few or no sidewalks and no designated bicycle routes of any kind. Because various camp and recreational sites exist throughout the KHSA area of analysis, it should be expected that bicycle riders and pedestrian travel along the river reach road network will be limited in capacity.

  Specific information about the haul routes needed for construction and deconstruction activities as well as potential right-of-way requirements is provided in the Detailed Plan for Facilities Removal which will be produced if there is a Secretarial Determination. There would be subsequent environmental analysis on this plan to analyze traffic and transportation impacts from the Proposed Action.

3.22.3.2 KBRA – Road Network

The Upper Klamath Basin road network exhibits many of the same characteristics of the local access roads and other routes described for the KHSA area of analysis. Activities to be implemented that would likely affect transportation include the Phase I and Phase II Fisheries Restoration Plans. KBRA activities might include decommissioning local access roads, upgrading and/or replacing culverts to improve fish passage, and using backhoes and dump trucks to reshape channels and deliver gravel to augment fish spawning. Exact locations of these activities are currently undefined.

3.22.4 Environmental Consequences

3.22.4.1 Environmental Effects Determination Methods

3.22.4.1.1 Traffic Flow Effects

The scope of this analysis includes all roads that would experience construction related traffic. Routes were identified between each construction site and anticipated disposal sites. The greatest traffic flow effects would be nearest to the construction sites and those portions of the road were used during this analysis to assess potential impacts.

The Lead Agencies considered two components of traffic growth in evaluating future year conditions. First, the team determined an annual background growth rate based on historical data from 2000 through 2009. The Lead Agencies used that data to create a trend line and project baseline traffic volume to 2020. See Appendix T for the graphs showing these projections. Second, the Lead Agencies collected construction data including the number of construction trucks, construction truck routes and timing, number of workers, and worker traffic routes and timing. Lead Agencies provided this data for the project alternatives and added to the network any increases in traffic expected from each of the alternatives.

In addition to construction trucks hauling materials, construction workers accessing the sites may affect traffic flows in the area. Using construction worker forecasts and the current traffic volumes along available access roads, Lead Agencies projected traffic increases from workers. To access Iron Gate, Copco 1 and Copco 2 Dams, workers must travel along I-5 to Copco Road or Ager-Beswick Road. The worker access trip counts were assigned to these two roads. The J.C. Boyle Dam has two different directions from which workers might originate. In consideration of the current traffic volume to the east and west of J.C. Boyle Dam along OR66, this analysis uses the percentages of AADT to indicate how many workers might originate their trips from the east or from the west. Based on this analysis, the Lead Agencies assume that 12 percent of workers traveling to J.C. Boyle Dam would come from the west, taking I-5 to OR66 and 88 percent would come from the east, taking US97 to OR66.

The Lead Agencies used Caltrans accepted guidelines developed by the FDOT, along with road characteristics, to outline roadway planning capacities in the project area. The FDOT publishes a concise LOS Planning Handbook (2009) with service volume tables correlated to different roadway types and geometries, based on the Highway Capacity Manual (HCM). The HCM contains vast technical data that is very specific to traffic engineering technical analysis. The FDOT LOS Planning Handbook takes the detailed technical data from the HCM and summarizes it into a user friendly format that is appropriate for planning level analyses, such as is the case with this assessment.

Because the project area is remote and not generally considered to have peak commute times, the Lead Agencies assumed that existing traffic would largely be uniform throughout various times of day.

3.22.4.1.2 Traffic Safety Effects

Based upon site visits and map analysis, combined with review of planned truck hauling routes, the Lead Agencies identified roads with potentially hazardous points along them. Safety hazards include blind corners or turnouts and sharp turns or areas where slow construction traffic might conflict with high roadway speed limits. The Lead Agencies also assessed potential visibility hazards due to dust.

3.22.4.1.3 Public Transit Effects

The Lead Agencies examined the local and regional deconstruction traffic routes for each alternative and compared them to existing local and regional transit service routes to determine potential conflicts. The analysis relates traffic volumes to transit service because any road segments with projected traffic volumes over their functional LOSs could have disruptions in transit service.

3.22.4.1.4 Non-Motorized Transportation Effects

The Lead Agencies identified existing bikeways within the area of analysis and categorized them by class (bike path, bike lane, or bike route). The team also compared bikeways to construction traffic routes and timing to determine potential effects on the mobility and safety of cyclists and pedestrians. The team also reviewed available local or county planning documents addressing bicycle planning in the area of analysis to evaluate potential effects on planned bikeways. Although the project area would be a low pedestrian traffic area, the analysis addressed potential areas of conflict between trucks and pedestrians as well.

3.22.4.1.5 Road Condition Effects

In order to adequately assess the structural integrity and load carrying capacity of each road's surfacing section, a detailed geotechnical analysis would need to be conducted; this is out of the scope of this analysis.

3.22.4.2 Effects Determinations

3.22.4.2.1 Alternative 1: No Action/No Project Alternative

Traffic Flow Effects

Changes in traffic volumes could affect traffic flow. Any increase in traffic flow associated with the No Action/No Project Alternative would not exceed the planned LOS or v/c ratios for any roads in the area of analysis. **There would be no change from existing conditions from traffic flow effects.**

Traffic Safety Effects

Implementation of the Interim Measures (IMs) could cause traffic safety effects associated with sharp turns along Copco Road and OR66. Implementation of several IMs, including IM 7 – J.C. Boyle Gravel Placement and Habitat Enhancement (for one year) and IM 8 – J.C. Boyle Bypass Barrier Removal could result in increased traffic from haul trucks and construction workers; however, any increases in traffic flow would be minor and would not contribute substantially to the number of vehicles on the road. **This fact combined with the installation of signage at sharp turns along OR66 and Copco Road would reduce traffic safety effects associated with implementation of the interim measures to less than significant.**

Road Condition Effects

Changes in the road conditions could occur. Roads in the area of analysis would not experience wear greater than that for which they were designed under the No Action/No

Project Alternative. Any minor traffic safety conflicts would be mitigated through best management practices. **There would be no change from existing conditions from road condition effects.**

Public Transit Effects

Changes in public transit could occur. Public transit service would experience no negative effects from the No Action/No Project Alternative. Any minor public transit effects would be mitigated through best management practices. **There would be no change from existing conditions from public transit effects.**

Non-motorized Transportation Effects

Changes in non-motorized transportation could occur. There are no anticipated negative effects on non-motorized transportation due to the No Action/No Project Alternative. Any non-motorized transportation effects would be mitigated through best management practices. **There would be no change from existing conditions from non-motorized transportation effects.**

Ongoing Restoration Actions

While the KBRA would not be fully implemented under the No Action/No Project Alternative, ongoing restoration actions from Fish Habitat Restoration could have traffic and transportation impacts during construction activities.

Construction activities associated with the continued implementation of ongoing restoration actions could cause temporary effects to traffic and transportation. Construction activities including channel construction, floodplain rehabilitation, fish passage and facilities construction, and breaching levees would likely involve the use of heavy equipment and construction vehicles. **Construction activities that would occur for the ongoing restoration programs are anticipated to result in potentially significant impacts to traffic and transportation. Best management practices incorporated into the project would minimize any traffic impacts to less than significant.**

3.22.4.2.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

Traffic Flow Effects

Transportation of equipment and supplies associated with dam facility deconstruction activities could result in temporary traffic flow effects on I-5, OR66, US97, and access roads. No long-term or permanent traffic volume increases or long-term changes in traffic patterns are expected as a result of the Proposed Action, including any changes resulting from shifts in recreation use described in Section 3.20, Recreation. Therefore, any transportation impacts associated with the Proposed Action would be limited in duration to the proposed deconstruction or construction period. The deconstruction and reservoir restoration schedule for the Proposed Action extends 18-months starting in May 2019. Work completed in 2019 would include small scale construction staging activities and analysis of road and bridge condition and any repair work that might be

identified during this analysis. The peak deconstruction activity and associated traffic would be generated in 2020; therefore this analysis is focused on the year 2020 when the largest effects would be anticipated.

The traffic projections for 2020, based on data from 2000 through 2009, indicate a decrease in baseline traffic on I-5 in California and OR66. In light of the recent increases in the cost of fuel and other economic factors, the years 2007 to 2009 may be an anomaly. When that data was excluded, I-5 showed an increase, but OR66 still showed a small decrease in the 2020 projection compared to baseline. In each case, the combined total of the projected baseline traffic volumes and the traffic that would result from implementation of each of the alternatives would not exceed the significance criterion for I-5, OR66, or US97 for any of the alternatives.

Table 3.22-2 consolidates the roadway planning capacities and the anticipated traffic for each alternative, and contains projected LOSs and v/c ratios. Appendix S presents a detailed analysis of the hauling and worker trips for each alternative. Hauling trips include trips to a local recycling facility in Klamath Falls, Oregon and the City of Yreka, California as well as truck trips for additional deconstructed materials to disposal sites outside of the project boundaries. As Table 3.22-2 shows, none of the main roads in the area of analysis would experience volumes in excess of their planned LOS or v/c ratio due to traffic resulting from implementation of the Proposed Action or the other alternatives. **Traffic flow effects on I-5, OR66, US97, and access roads would be less than significant.**

Transportation of equipment and supplies associated with dam facility deconstruction activities could result in temporary traffic flow effects on on-site roads. The only routes of concern with respect to traffic effects are the on-site gravel roads at each dam. The short but frequent heavy vehicle trips anticipated as part of dam deconstruction and reservoir restoration (the Proposed Action could generate over 1,500 AADT at some locations) could cause traffic flow concerns. Signage and construction traffic management to reduce construction traffic generated impacts would be implemented. **Traffic flow effects on on-site roads would be less than significant.**

Construction activities associated with the demolition of recreation facilities could result in temporary traffic flow effects on I-5, OR66, US97, and access roads. The demolition of recreation facilities would take place following dam deconstruction activities. Truck trips associated with construction activities at recreation sites would occur after the peak traffic period calculated for dam deconstruction activities. **Therefore, traffic flow effects on I-5, OR66, US97, and access roads would be less than significant.**

Table 3.22-2. Traffic Flow Projections

Roads	Road Type	Planning Capacity			No Action/No Project			Full Facilities Removal of Four Dams (Proposed Action)		
		LOS	v/c Ratio	AADT	LOS	v/c Ratio	AADT	LOS	v/c Ratio	AADT
I-5 (California)	Limited Access Interstate Highway	C	--	49,900	A	--	18,350	A	--	18,597
I-5 (Oregon)	Limited Access Interstate Highway	--	0.85	63,700	--	0.24	15,100	--	0.24	15,112
OR66	State Highway	--	0.75	40,800	--	0.01	490	--	0.01	582
US97	US Highway	--	0.70	48,000	--	0.19	9,300	--	0.20	9,380
Copco Rd	Major Roadway	C	--	5,500	A	--	250	A	--	515
Topsy Grade Rd	Major Roadway	--	0.85	5,500	--	0.04	200	--	0.04	202
Unpaved Access Roads	Site Internal Gravel Roads	--	0.95	N/A	--	N/A	30	--	N/A	1,240
Roads	**Road Type**	**Partial Facilities Removal of Four Dams**			**Fish Passage at Four Dams**			**Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate**		
		LOS	v/c Ratio	AADT	LOS	v/c Ratio	AADT	LOS	v/c Ratio	AADT
I-5 (California)	Limited Access Interstate Highway	A	--	18,593	A	--	18,454	A	--	18,530
I-5 (Oregon)	Limited Access Interstate Highway	--	0.24	15,111	--	0.24	15,104	--	0.24	15,104
OR66	State Highway	--	0.01	574	--	0.01	514	--	0.01	514
US97	US Highway	--	0.20	9,373	--	0.20	9,320	--	0.19	9,320
Copco Rd	Major Roadway	A	--	511	A	--	354	A	--	430
Topsy Grade Rd	Major Roadway	--	0.04	202	--	0.04	200	--	0.04	200
Unpaved Access Roads	Site Internal Gravel Roads	--	N/A	1,240	--	N/A	102	--	N/A	966

Source: 1. Caltrans Traffic Data Branch, 2. FDOT 2009, 3. Klamath County 2004, 4. ODT 2010, 5. Amador County Transportation Commission, 2004.
Key:
v/c: volume-to-capacity ratio
AADT: Annual Average Daily Traffic
LOS: Level of Service

Traffic Safety Effects

Activities associated with the Proposed Action, would cause traffic safety effects at each deconstruction site, on Copco Road, Topsy Grade/Ager-Beswick Road, and on OR66. The Lead Agencies have identified three potential areas of concern within the area of analysis.

Haul truck movement on unpaved roads could cause traffic safety effects associated with dust along gravel roads. High trip volumes would create a substantial amount of dust in dry conditions on Copco Road, Lakeview Road, Topsy Grade/Ager-Beswick Road, and the roads leading to and surrounding each dam. Parts of these roads have gravel surfaces. The dust would create a substantial visibility hazard for vehicles on the deconstruction sites throughout the area. Installation of signage, dust abatement and proper construction traffic management that would be implemented as a part of the Proposed Action would reduce the severity of this effect. **Visibility hazards caused by traffic-related dust generation would be a less than significant impact.**

Transportation of materials to and from the dam sites could cause traffic safety effects associated with vehicle turnouts along Copco Road, Topsy Grade/Ager-Beswick Road and OR66. If Copco Road, Topsy Grade/Ager-Beswick Road, Iron Gate and Copco 1 Reservoir Recreation Sites are open,[4] there would be substantial safety concerns regarding traffic at the entrance to each small recreation parking area; this includes the boat launch downstream from Iron Gate Dam. The access road for the J.C. Boyle Dam is immediately off of OR66, where the posted speed limit is 55 mph. This location, while providing a clear view of oncoming traffic, would have a safety conflict related to speed differentials between construction vehicle traffic and normal vehicular traffic. Construction vehicles could pose safety risks to passenger and other vehicles traveling on roads in the project area. Construction vehicles travel at slower speeds, require more acceleration and deceleration time, and slow or stop traffic to make turns. Left turns across oncoming traffic could pose safety risks if truck acceleration is slow and oncoming speed limits were high. The following locations could experience traffic safety hazards related to conflicts between construction vehicles and regular traffic:

- Three boat launches and three camp sites along Copco Road.
- The recreation area accessed from Topsy Grade Road.
- One boat launch (access to the Klamath River) downstream from Iron Gate Dam, immediately adjacent to the bridge.

The installation of construction signage on OR66 and Copco Road in accordance with the Manual of Uniform Traffic Control Devices would reduce all traffic conflicts and alert oncoming traffic to slow merging construction traffic. **Traffic conflicts at vehicle turnouts along Copco Road, Topsy Grade/Ager-Beswick Road, and OR66 would be a less than significant impact.**

[4] With the removal of the facilities, reservoir recreation opportunities would no longer exist. It is possible that Copco and Topsy Grade Roads may be completely closed to non-project related traffic during deconstruction with the exception of provisions for local residential access.

Vehicles associated with dam removal could cause traffic safety effects associated with sharp curves along Copco Road and OR66. Both OR66 and Copco Road have several sharp turns that could require large construction vehicles to travel at very slow speeds. Copco Road narrows along certain portions of the roadway, and has many winding turns, mirroring the shore of the lake. **The installation of signage at sharp turns along OR66 and Copco Road would reduce this impact to less than significant.**

The removal of existing recreation facilities could result in traffic impacts along adjacent roadways. As described in Section 3.20, Recreation, some recreation facilities, such as campgrounds and boat ramps, currently located on the reservoir banks would need to be removed once the reservoir is drained. These construction activities would occur at different times than dam removal deconstruction activities; thus, there would be no overlap in traffic volumes associated with deconstruction of the dams. **This fact combined with the installation of signage at sharp turns along OR66 and Copco Road would reduce traffic safety effects to less than significant.**

Road Condition Effects

Existing roads and bridge structures near the dam sites may not have adequate strength capacity for construction vehicles. Under the Proposed Action, further analysis of road conditions and bridge weight capacities would be necessary. Roads in the area of analysis do not have heavy traffic volumes and some do not have traffic from heavy vehicles, such as construction trucks. Some of the roads in the area of analysis may not have been designed to sustain heavy loads.

Three existing bridges in the area of analysis might be important for deconstruction efforts, but could be incapable of supporting and withstanding the weight of heavy deconstruction and hauling vehicles. Initial analysis of these bridges by the Lead Agencies indicated the potential need for repair or replacement prior to dam removal. Siskiyou County's schedule for maintenance of these facilities is unknown. Bridges include:

- A bridge at Iron Gate Dam connecting Copco Road to Lakeview Road. This is the only route that provides access to the south side and top of Iron Gate Dam.
- A bridge at J.C. Boyle Dam that provides access to the south side and top of that dam from OR66. At this location, an alternate route via Topsy Grade Road would allow construction vehicles to access the dam and avoid the bridge.
- Daggett Road Bridge used to access the Copco 2 Powerhouse.
- Jenny Creek Bridge was constructed on accumulated sediment. Preliminary engineering assessments identified the potential for movement of sediment during reservoir draw down that could deem the bridge structurally unsound. Replacement of the bridge at an alternate location would be necessary.

While many of these roads and bridges were put in place to facilitate the construction of the Four Facilities, it is unknown whether they are in good enough condition to withstand the weight and frequency of trips during deconstruction. As part of the development of

the construction plan, an in depth analysis of bridge and road capacity and state of repair would be conducted by the dam removal entity (DRE), with remedial actions taken prior to the commencement of facility deconstruction.

In addition to the local county roads in the project area, the access ramps to Interstate 5 may also see an increase in heavy construction traffic during deconstruction activities. The increased traffic load could accelerate the rate of wear at these on- and off-ramps, requiring additional maintenance and/or repairs in order to maintain the ramps to existing standards.

Following completion of dam deconstruction additional analysis of road condition would be completed and where needed, as a result of wear generated by deconstruction repairs and or replacement actions would be completed. **Construction traffic could have significant impacts on roads and bridges in the project area. Analysis of road and bridge condition and repair prior to and following dam deconstruction along with implementation of Mitigation Measure TR-1 would reduce any impacts to less than significant.**

Public Transit Effects

Trip volumes and routes of material hauling and worker trips could affect regional transit service. While there are small overlaps between minor haul routes and public transit routes, deconstruction traffic is not expected to interfere with public transit service. **Effects on regional transit service would be less than significant.**

Non-motorized Transportation Effects

Heavy vehicle traffic could cause non-motorized transportation (pedestrian and cyclist) effects. Although the area of analysis has no non-motorized transportation facilities, cyclists and pedestrians might travel along Copco and Topsy Grade/Ager-Beswick Roads in a limited capacity due to the recreational nature of the area. These pedestrians and cyclists would have to travel along the road itself, and could encounter safety hazards when sharing the road with large hauling vehicles, which could occupy much of the available road width, generate dust, or vary speeds around corners. Development of appropriate signage to notify of potential conflicts within the area would reduce this impact by warning drivers and non-motorized users. **The safety hazard for non-motorized transportation would be a less than significant impact.**

Interim Measures

Implementation of the IMs could result in temporary traffic flow effects on I-5, OR66, US97, and access roads. Implementation of several IMs, including IM 7 – J.C. Boyle Gravel Placement and Habitat Enhancement (for seven years) and IM 16 – Water Diversions could result in increased traffic from haul trucks and construction workers; however, any increases in traffic flow would be minor and would not contribute substantially to the number of vehicles on the road. **Traffic flow effects on I-5, OR66, US97, and access roads from implementing the interim measures would be less than significant impact.**

Implementation of the IMs could cause traffic safety effects associated with sharp turns along Copco Road and OR66. Implementation of several IMs, including IM 7 – J.C. Boyle Gravel Placement and/or Habitat Enhancement, IM 8 – J.C. Boyle Bypass Barrier Removal, and IM 16 – Water Diversions could result in increased traffic from haul trucks and construction workers; however, any increases in traffic flow would be minor and would not contribute substantially to the number of vehicles on the road. **This fact combined with the installation of signage at sharp turns along OR66 and Copco Road would reduce traffic safety effects associated with implementation of the IMs to less than significant.**

Keno Transfer

The transfer of the Keno Facility to United States Department of the Interior (DOI) could result in effects to traffic and transportation. The Keno Transfer, which is part of the Proposed Action, is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on transportation compared with existing facility operations. Following transfer of title, DOI would operate the Keno Facility in compliance with applicable law and would provide water levels upstream of Keno Facility for diversion and canal maintenance consistent with agreements and historic practice (KHSA Section 7.5.4). **The transfer of the facility and recreation lands would result in no change from existing conditions from traffic or transportation.**

East and Westside Facilities Decommissioning – Programmatic Measures

The decommissioning of the East and Westside Facilities could generate adverse traffic and transportation effects. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA would eliminate the need for diversions at Link River Dam into the two canals. Decommissioning of the facilities would generate some construction traffic. Routes used by this construction traffic would be signed and appropriate safety measures would be incorporated. **Decommissioning the facilities would have less than significant effects on traffic or transportation.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

Activities associated with relocation of the City of Yreka Water Supply Pipeline and relocation or demolition of recreation facilities could cause traffic safety effects associated with sharp curves along Copco Road and OR66. These construction activities would occur at different times than dam removal deconstruction activities; thus, there would be no overlap in traffic volumes associated with deconstruction of the dams. **This fact combined with the installation of signage at sharp turns along OR66 and Copco Road would reduce traffic safety effects to less than significant.**

Construction activities related to the relocation of the City of Yreka Water Supply Pipeline could result in temporary traffic flow effects on I-5, Copco Road, and access roads. Relocation of the City of Yreka Water Supply Pipeline would occur prior to the start of dam deconstruction.

Therefore, related construction activities for pipeline relocation would take place well before the peak deconstruction activity involved in dam removal. **Traffic flow effects on I-5, Copco Road, and access roads would be less than significant impact.**

KBRA – Programmatic Measures

Construction activities associated implementation of several KBRA programs could cause traffic effects including increases in traffic, the presence of increased numbers of heavy construction equipment, and temporary road closures or detours. The following programs could cause these impacts:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration Project
- On- Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Klamath River Tribes Interim Fishing Site
- Power for Water Management Program
- Additional Water Conservation and Storage

Construction activities associated with the above-listed KBRA programs could cause temporary traffic effects. KBRA program implementation could result in temporary closures and/or traffic detours associated with culvert upgrades or replacement. In some cases, local access roads could be decommissioned. Minor amounts of vehicular traffic might need to identify alternate routes. Gravel augmentation activities for streambeds could result in gravel deliveries to various locations using dump trucks and placement using backhoes, which could cause traffic flow and safety effects and road condition effects. Construction activities including channel construction, mechanical thinning of trees, road decommissioning, fish passage and facilities construction, breaching levees, and fish hauling could cause temporary increases in traffic and traffic safety effects. It is assumed that construction related to some of these programs could occur on the same roads as the hydroelectric facility removal actions and could contribute to the effects of facility removal on traffic and transportation. **Due to the potentially large amount of construction activities that would occur for the various KBRA programs could generate adverse traffic effects; however, the implementation of best management practices would minimize any traffic impacts to less than significant. Additional traffic analysis and environmental compliance would be completed as appropriate.**

Operational activities associated with the Fisheries Reintroduction and Management Plan could result in temporary traffic effects associated with trap-and-haul activities. Haul trucks would be required to seasonally relocate anadromous fish species around the Keno Impoundment/Lake Ewauna during periods of poor water quality. Haul trucks would carry upstream-migrating fish from the downstream from Keno Dam to areas in Upper Klamath Lake and its tributaries. They would also carry out-migrating fish from Link River Dam to areas downstream from Keno Dam. Haul trucks would increase

traffic on the roads between these sites. Haul trucks may travel on OR66 and US97, access roads, and on-site roads. As shown in Table 3.2-2, area roads carry substantially fewer vehicles in the Proposed Action than the Planning Capacity; additional truck trips for trap and haul operations would not substantially change traffic conditions. Hauling activities would occur after the peak traffic-generating period of facility removal because fish cannot access Keno Dam until after removal of the Four Facilities; however, some construction traffic associated with completing removal activities and reservoir restoration may occur at the same time as hauling operations. Construction traffic related to dam removal and hauling operations, taken together, could increase the severity of the traffic effects, but the combined traffic would likely still be less than the peak traffic during dam deconstruction. The timing of these trap and haul operations from the hydroelectric facility removal actions analyzed above reduce the potential for any negative traffic effects generated by these trap and haul actions from contributing to the effects of facility removal actions. **The traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant. Implementation of specific plans and projects described in the KBRA would require future environmental compliance as appropriate**.

3.22.4.2.3 Alternative 3: Partial Facilities Removal of Four Dams Alternative

Traffic Flow Effects

Traffic flow effects for the Partial Facilities Removal of Four Dams Alternative would be the same as those for the Proposed Action. **Traffic flow effects on I-5, OR66, US97, and access roads would be a less than significant impact. Traffic flow effects on on-site roads would be a less than significant impact.**

Traffic Safety Effects

Traffic safety effects for the Partial Facilities Removal of Four Dams Alternative would be the same as those for the Proposed Action. **Implementation of Alternative 3 would be less than significant.**

Road Condition Effects

Road condition effects for the Partial Facilities Removal of Four Dams Alternative would be the same as those for the Proposed Action. **Construction traffic could have significant impacts on roads and bridges in the project area. Analysis of road and bridge condition and repair prior to and following dam deconstruction along with implementation of Mitigation Measure TR-1 would reduce any impacts to less than significant.**

Public Transit Effects

Public transit effects for the Partial Facilities Removal of Four Dams Alternative would be the same as those for the Proposed Action. **Implementation of Alternative 3 would be less than significant.**

Non-motorized Transportation Effects

Non-motorized transportation effects for the Partial Facilities Removal of Four Dams Alternative would be the same as those for the Proposed Action. **Implementation of Alternative 3 would be less than significant.**

Keno Transfer

The effects of the Keno Transfer would be the same as those described for the Proposed Action.

East and Westside Facilities Decommissioning – Programmatic Measures

The effects of decommissioning the East and Westside Facilities would be the same as those described for the Proposed Action.

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of relocating the City of Yreka Water Supply Pipeline would be the same as those described for the Proposed Action.

KBRA – Programmatic Measures

The Partial Facilities Removal Alternative would include full implementation of the KBRA. Therefore, impacts related to KBRA actions would be the same as under the Proposed Action, discussed above.

3.22.4.2.4 Alternative 4: Fish Passage at Four Dams

Traffic Flow Effects

Construction activities associated with the Fish Passage at Four Dams Alternative could result in temporary traffic flow effects on I-5, OR66, US97, access roads, and on-site roads. Under this alternative there would be intermittent construction hauling trips on I-5, OR66, and US97. The only roads experiencing daily heavy vehicle trips would be the local unpaved roads adjacent to each dam. These roads would have 18 daily vehicle trips for fish passage construction, comprised of mainly concrete delivery from nearby batch plants. Material hauling trips would be limited, and worker trips would make up the majority of construction-related traffic. If concrete delivery were not provided at batch plants near the construction sites, then concrete delivery could come from either Klamath Falls, Oregon or the City of Yreka, California. In this case, the estimated 18 daily vehicle trips accounting for concrete delivery would not only access the local roadways, but would be added to traffic on the other major roadways, as shown in Appendix T, 2020 Traffic Volume Projections. The addition of an additional 18 daily vehicle trips to the AADT volumes would not cause deterioration in levels of service.

No long-term or permanent traffic volume increases or long-term changes in traffic patterns would occur as a result of this alternative. Any incremental transportation impacts associated with this alternative would be temporary and would occur during the one-year construction period. The number of construction days at J.C. Boyle and Copco 2 Dams would both be less than 130 days; Copco 1 and Iron Gate Dams would have fewer than 290 construction days.

Traffic associated with this alternative would cause none of the roads in the area of analysis to have a LOS worse than A or a v/c ratio greater than 0.25. The combined total of the projected baseline traffic volumes and the traffic that would result from implementation of this alternative would not exceed the significance criteria for traffic flow impacts. **Traffic flow effects on I-5, OR66, US97, access roads, and on-site roads would be a less than significant impact.**

Implementation of the prescriptions provided by the U.S. Fish and Wildlife Service (USFWS), U.S. Department of the Interior (DOI), and Department of Commerce (DOC) in the Federal Energy Regulatory Commission (FERC) 2007 EIS and seasonal trap and haul operations implemented at Keno Dam could result in temporary traffic flow effects on OR66 and US97, access roads, and on-site roads. Following construction of fishways to provide for volitional fish passage, interim seasonal trap and haul operations would be implemented below Keno Dam to avoid poor water quality conditions in Keno Impoundment/Lake Euwana. As vehicle trips associated with trap and haul operations would take place following fishway construction, there would be no overlap between these trips and peak construction traffic. These activities would be similar to those described above under the Proposed Action in the KBRA Fisheries Reintroduction and Management Plan. **Thus, traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant.**

Traffic Safety Effects

Activities associated with the Fish Passage at Four Dams Alternative would cause traffic safety effects at each construction site, on Copco Road, Topsy Grade/Ager-Beswick Road, and on OR66. Traffic safety effects for the Fish Passage at Four Dams alternative would be almost exactly the same as those for the Proposed Action, with two differences: 1) the recreation sites along Copco Road from Iron Gate Dam to Copco Dams would remain open; and 2) construction related traffic would be much lighter than that of the Proposed Alternative. While the traffic volume under this alternative would be lower than under the Proposed Action, the safety impacts would be the same. Installation of signage, dust abatement and proper construction traffic management would minimize impacts. **This impact would be less than significant.**

Activities associated with the implementation of the prescriptions and seasonal trap and haul operations could cause traffic safety effects on OR66 and US97, access roads, and on-site roads. As described under the analysis of traffic flow effects, vehicle trips associated with trap and haul operations would take place following fish passage construction. There would be no overlap between these trips and peak construction traffic. These activities would be similar to those described under the Proposed Action in the KBRA Fisheries Reintroduction and Management Plan. **Thus, traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant.**

Road Condition Effects

Road condition effects for the Fish Passage at Four Dams Alternative would be the same as those for the Proposed Action. As part of the development of the construction plan, an in-depth analysis of bridge and road capacity and state of repair would be conducted by

the Hydropower Licensee, with remedial actions taken prior to the commencement of construction. Following completion of construction, additional analysis of road condition would be completed and where needed, as a result of wear generated by construction repairs and or replacement actions would be completed. **Construction traffic could have significant impacts on roads and bridges in the project area. Analysis of road and bridge condition and repair prior to and following construction would reduce any impacts to a less than significant level.**

Public Transit Effects

Public transit effects for the Fish Passage at Four Dams Alternative would be the same as those for the Proposed Action. **Implementation of Alternative 4 would be less than significant.**

Non-motorized Transportation Effects

Non-motorized transportation effects for the Fish Passage at Four Dams Alternative would be the same as those for the Proposed Action. Development of appropriate signage to notify of potential conflicts within the area would reduce this impact by warning drivers and non-motorized users. **The safety hazard for non-motorized transportation would be a less than significant impact.**

Trap and Haul – Programmatic Measures

Operation of trap and haul measures could result in temporary traffic effects. Haul trucks would be required to seasonally relocate anadromous fish species around the Keno Impoundment/Lake Ewauna during periods of poor water quality. Haul trucks would carry upstream-migrating fish from the downstream from Keno Dam to areas in Upper Klamath Lake and its tributaries. They would also carry -migrating fish from Link River Dam to areas downstream from Keno Dam. Haul trucks would increase traffic on the roads between these sites. Haul trucks may travel on OR66 and US97, access roads, and on-site roads. As shown in Table 3.22-2, area roads carry substantially fewer vehicles in the Fish Passage at Four Dams Alternative than the Planning Capacity; adding additional truck trips for trap and haul operations would not substantially change traffic conditions. **The traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant.**

3.22.4.2.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate

Because Copco 1 and 2 Dams are adjacent to one another, they share local access roads, and the greatest traffic effects at either of the dams would apply to both. Under this alternative, the traffic and transportation effects at Iron Gate, Copco 1 and Copco 2 Dams would be the same as Proposed Action and would be less than significant after mitigation, and the traffic and transportation effects at J.C. Boyle Dam would be similar to that of the Fish Passage at Four Dams Alternative and would be less than significant.

Activities associated with the implementation of the prescriptions and seasonal trap and haul operations could cause traffic safety effects on OR66 and US97, access roads, and on-site roads. As described under the analysis of traffic flow effects, vehicle trips

associated with trap and haul operations would take place following dam deconstruction and fishway construction. There would be no overlap between these trips and peak construction-related traffic. These activities would be similar to those described under the Proposed Action in the KBRA Fisheries Reintroduction and Management Plan. **Thus, traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant.**

Trap and Haul – Programmatic Measures

Operation of trap and haul measures could result in temporary traffic effects. The trap and haul measures around Keno Impoundment/Lake Euwana would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. **The traffic flow effects on OR66 and US97, access roads, and on-site roads would be less than significant.**

City of Yreka Water Supply Pipeline Relocation – Programmatic Measures

The effects of relocating the City of Yreka Water Supply Pipeline would be the same as those described for the Proposed Action.

3.22.4.3 Mitigation Measures

3.22.4.3.1 Mitigation Measures by Consequence Summary

Mitigation Measure TR-1 – Relocate Jenny Creek Bridge and relocate or modify in place as appropriate culverts located along Copco Road away from sediment deposits potentially susceptible to down cutting as a result of reservoir drawdown to prevent bridge foundation failure.

3.22.4.3.2 Effectiveness of Mitigation in Reducing Consequences

All of the mitigation strategies indentified herein would reduce potential impacts to less than significant. Other actions that mitigate potential impacts would be standard, best management practices incorporated into project design activities. Such practices include construction zone signing and dust abatement, coupled with the periodic grading of roadways during construction. Implementation of these during project design and construction would reduce potential impacts to less than significant.

3.22.4.3.3 Agency Responsible for Mitigation Implementation

The DRE would be responsible for implementing mitigation measure TR-1.

3.22.4.3.4 Remaining Significant Impacts

Mitigation measures TR-1 would reduce traffic and transportation impacts to less than significant levels.

3.22.4.3.5 Mitigation Measures Associated with Other Resource Areas

Implementation of Mitigation Measure AR-1 could result in temporary traffic flow, traffic safety, and road condition effects on access roads and on-site roads. Mitigation measure AR-1 would relocate mussels in the Hydroelectric Reach and in the Lower Klamath River, downstream from Iron Gate Dam, to tributary streams or upstream of the Hydroelectric Reach. Relocation would take place prior to dam deconstruction activities and reservoir drawdown. Following dam deconstruction, mussels would be moved back

to their approximate location or to other suitable habitat in the river. Given the timing of vehicle trips associated with relocation activities, there would be no overlap with peak construction traffic during dam removal. **Thus, the impact to traffic flow, traffic safety, and road conditions on access roads and on-site roads would be less than significant.**

Implementation of Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. Recreation facility construction would take place following dam deconstruction activities and reservoir drawdown. Given the timing of vehicle trips associated with replacement activities, there would be no overlap with peak construction traffic during dam removal. **Thus, the impact to traffic flow, traffic safety, and road conditions on access roads and on-site roads would be less than significant.**

Several other mitigation measures may require construction, including mitigation measures H-2 (move or elevate structures with flood risk), GW-1 (deepen or replace wells), and WRWS-1 (modify water intakes). These measures could produce vehicle trips associated with construction activities. These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed Action and other alternatives; therefore, they would not add to these construction traffic impacts. These construction activities are generally smaller efforts that would not cause a substantial increase in vehicle trips. **Thus, the impact to traffic flow, traffic safety, and road conditions on access roads, on-site roads, and on roads would be less than significant.**

3.22.5 References

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3.23 Noise and Vibration

This section addresses the noise and vibration impacts of the Proposed Action and alternatives. It includes a description of the area of analysis, the affected environment, and existing conditions. This section also describes the criteria used to define and determine noise and vibration impact significance and the assessment methods. The potential impact from noise and vibration are evaluated for each alternative, and possible mitigation measures are listed. Appendix U describes basic noise and vibration concepts, detailed methods and calculations, and modeling results.

3.23.1 Area of Analysis

The area of analysis for noise and vibration effects associated with the Klamath Hydroelectric Settlement Agreement (KHSA) includes areas near the Four Facilities and the haul routes in Klamath and Jackson Counties, Oregon, and Siskiyou and Shasta Counties, California. Figure 3.23-1 shows the locations of the Four Facilities and haul routes. The area of analysis for the Klamath Basin Restoration Agreement (KBRA) constitutes the entirety of the Klamath Basin.

3.23.2 Regulatory Framework

Noise and Vibration levels in the area of analysis are regulated by local laws and policies. There are no Federal or State regulations applicable to noise and vibration levels from construction activity in the area of analysis.

3.23.2.1 Local Authorities and Regulations

3.23.2.1.1 Siskiyou County General Plan Noise Element (1978)

The Siskiyou County General Plan Noise Element contains criteria for maximum allowable noise levels from construction equipment. Table 3.23-1 lists the maximum allowable noise levels in A-weighted decibels (dBA) for construction equipment applicable to the Proposed Action. There are no other applicable State or local regulatory levels for noise or vibration in the area of analysis.

Although the Proposed Action does not involve highway construction, Federal and State highway traffic noise criteria provide a basis for analyzing project traffic noise impacts. The Federal Highway Administration (FHWA) requires highway agencies to define a "substantial" noise increase as an increase of 5 to 15 dBA over existing noise levels (23 CFR Part 772). The California Department of Transportation (Caltrans) defines "substantial" as a predicted increase greater than or equal to 12 dBA over existing 1-hour equivalent noise levels (L_{eq}) (Caltrans 2006). The Oregon Department of Transportation (ODOT) defines substantial noise increase as greater than or equal to 10 dBA above the existing 1-hour Leq (ODOT 2009).

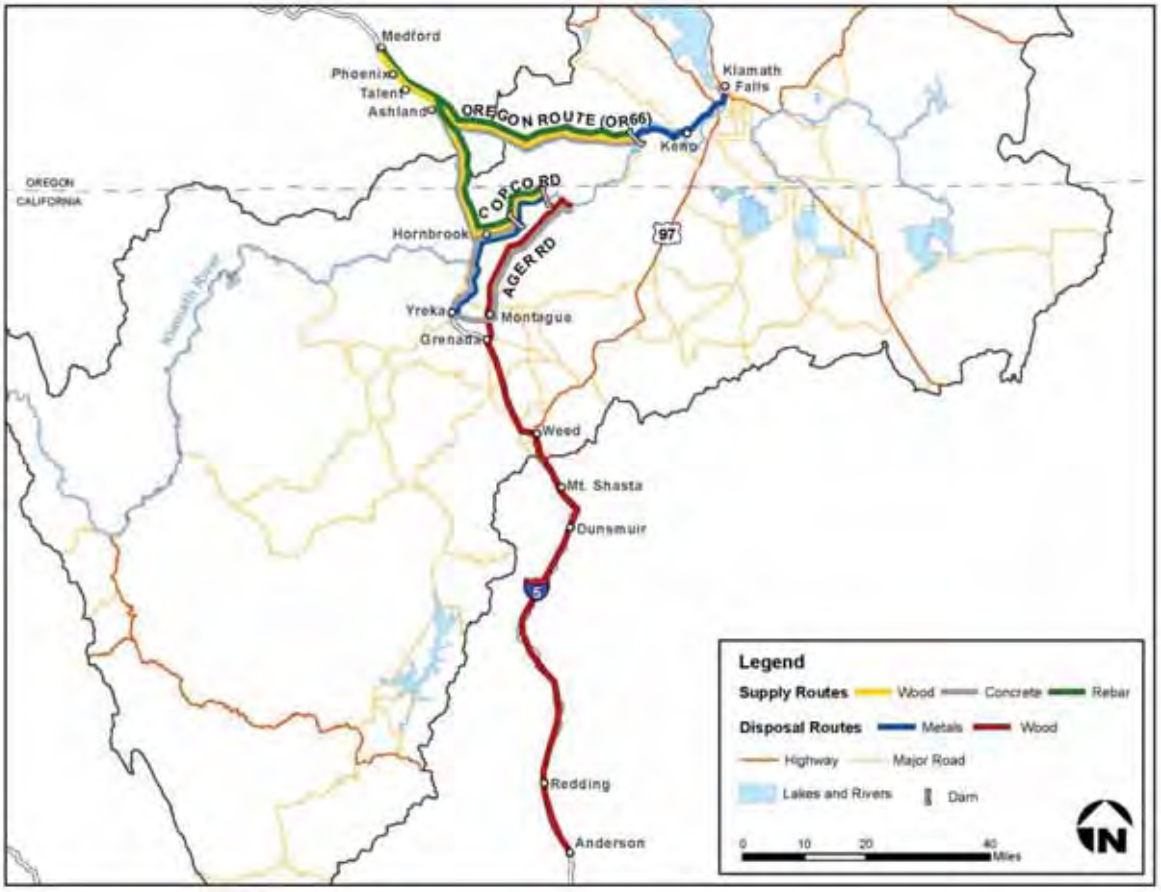

Figure 3.23-1. Primary Haul Routes from Dam Sites.

Table 3.23-1. Maximum Allowable Noise Levels from Construction Equipment in Siskiyou County, CA

Equipment Type	Peak Noise Level (dBA at 50 feet)[1]
Compressors	81
Concrete Mixers	81
Concrete Pumps	81
Cranes	81
Dozers	81
Front Loaders	81
Generators	81
Pneumatic Tools	86
Pumps	81
Tractors	81
Trucks	81

Source: Siskiyou County 1978.

Notes:

[1] *Maximum allowable noise levels from construction equipment at 100 ft from Siskiyou County's General Plan converted to noise levels at 50 ft.*

3.23.3 Existing Conditions/Affected Environment

The Lead Agencies identified noise-sensitive human receptor locations (i.e. residences) based on a review of current topographic, aerial, and land use maps. Existing outdoor ambient noise levels at affected sensitive receptor locations were estimated using published average ambient noise levels for various land uses. Siskiyou County presents average noise levels for various land use categories in the Noise Element of their General Plan (Siskiyou County 1978). However these median ambient noise levels for different land use categories were developed based on a one-time field survey in the 1970s and none of the measurements were taken in the project area. Therefore, the Lead Agencies used average daytime L_{eq} and nighttime outdoor L_{eq} noise levels from U.S. Environmental Protection Agency's (USEPA's) *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (1974) to estimate ambient noise levels at selected receptor locations. Noise levels for rural residential areas in the USEPA document are lower than the levels presented in the Siskiyou County General Plan; it is more conservative to analyze the impacts using the USEPA levels. Because noise and vibration impacts would not occur without a receptor, the Affected Environment includes the rural residential areas closest to the proposed construction sites. The following paragraphs describe the sensitive receptors in the Affected Environment. Another sensitive receptor is terrestrial wildlife, such as nesting birds. Potential affects to terrestrial wildlife are analyzed in Section 3.5, Terrestrial Resources.

3.23.3.1 Existing Noise Levels near Construction Sites

The land surrounding the J.C. Boyle Dam is primarily undeveloped, and land use is primarily recreational. Recreational sites would be closed to visitors during construction and demolition activities; therefore, no impact analysis was conducted for campgrounds. No residential areas are within a mile of the dam. Because of this, noise and vibration impacts to humans would not occur from construction and deconstruction activities at the J.C. Boyle Dam. Trucks from J.C. Boyle Dam would most likely travel on Oregon Route 66 (OR66), approximately 2,500 feet west of the dam, reached via Topsy Grade Road to access Interstate 5 (I-5) or U.S. Route 97 (US97). Figure 3.23-2 shows the locations of J.C. Boyle Dam, Topsy Campground, Topsy Recreation Site, and Topsy Grade Road.

Copco 1 Dam and Powerhouse are approximately 2,200 feet west of a rural residential area (see Figure 3.23-3). Residences on Janice Avenue are the closest sensitive receptors, and the estimated existing daytime and nighttime outdoor L_{eq}, based on the USEPA information as noted above are 40 and 30 dBA, respectively. The 2,200-foot distance between the dam and the receptor would provide 34 decibels (dB) of noise reduction, based on basic noise propagation calculation as described in Appendix U. The line of sight from the dam to the Janice Avenue receptor is blocked by a hill, the top of which is about 60 feet higher in elevation than the top of Copco 1 Dam at the hill's highest point along the line of sight between the dam and the receptor. The terrain may provide up to 5 dB of additional noise attenuation from the construction site to the Janice Avenue receptors. Copco Road and Topsey Grade Road are the main off-site haul routes from

this construction site. The Lead Agencies estimated traffic noise for trucks transporting materials in and out of the Copco 1 Dam and Powerhouse site via Copco Road and Topsey Grade Road.

Figure 3.23-2. J.C. Boyle Noise Receptors (Closest Receptors to J.C. Boyle Dam).

The closest sensitive receptor to Copco 2 Dam is the residential area on Janice Avenue described above for Copco 1 Dam. From Copco 2 Dam, the receptor is approximately 3,700 feet to the east. The line of sight from the dam to the receptor is blocked by two hills that have elevations approximately 180 feet higher than the top of the dam. Because of this natural topography surrounding the dam and distance between the dam and the receptor, noise from onsite construction activities at Copco 2 Dam would be reduced by 44 dB. No further analysis was conducted on noise from construction equipment and on-site hauling at Copco 2 Dam. The Lead Agencies estimated traffic noise for trucks

transporting materials in and out of Copco 2 Dam via Copco Road and Ager-Beswick Road. Figure 3.23-3 shows the Copco 1 Dam, Copco 1 Powerhouse, and Copco 2 Dam locations as well as the closest sensitive receptor on Janice Avenue.

Figure 3.23-3. Copco 1 and 2 Noise Receptor (Closest Receptor to Copco 1 and Copco 2 Dams).

The Iron Gate Dam area is approximately 1,100 feet east of Copco Road, its main haul route. The closest sensitive receptor to Iron Gate Dam is on Tarpon Drive, approximately 4,500 feet southwest of the dam, as shown on Figure 3.23-4. Based upon the rural residential land use category, the existing daytime outdoor L_{eq} on Tarpon Drive is likely 40 dBA. The existing nighttime outdoor L_{eq} at this receptor is approximately 30 dBA. At its highest point along the line of sight between the receptor and the dam, the hill on river left just upstream of Iron Gate Fish Hatchery is approximately 20 feet lower in elevation than the top of Iron Gate Dam. At the receptor, the hill would provide up to

3 dBA of noise reduction, in addition to the 43 dBA reduction due to distance from the construction site, for a total reduction of 46 dBA. Although this reduction is greater than that for Copco 2 Dam, there would be nighttime construction activities at Iron Gate Dam which may result in significant impact; the Lead Agencies estimated onsite construction and hauling noise levels.

Figure 3.23-4. Iron Gate Noise Receptors (Closest Receptor to Iron Gate Dam).

Section 3.5, Terrestrial Resources, shows the presence of special-status bird and other animal species near each of the dam sites and describes potential impacts and possible mitigation measures related to noise.

Table 3.23-2 summarizes the existing noise levels for the residential receptors selected to assess the noise and vibration impacts from each construction site. Daytime is defined as hours between 7:00 a.m. and 10:00 p.m., and nighttime is defined as 10:00 p.m. to 7:00 a.m. PacifiCorp's residential properties were assumed to be unoccupied during the transfer of ownership to Reclamation and were not considered in this analysis.

Table 3.23-2. Existing Noise Levels at Residential Receptors near Construction Sites

Construction Site [1]	Receptor Description	Distance from Construction Site (feet)	Estimated Existing Daytime L_{eq} (dBA)	Estimated Existing Nighttime L_{eq} (dBA)
Copco 1 Dam	Residential Area on Janice Ave, East of Copco 1 Dam.	2,200	40	30
Copco 2 Dam [2]	Residential Area on Janice Ave, East of Copco 1 Dam.	3,700	N/A	N/A
Iron Gate Dam	Residential Area on Tarpon Dr, SW of Iron Gate Dam.	4,500	40	30

Sources: Google Earth; USEPA 1974.

Notes:

[1] There are no applicable receptors at the J.C. Boyle Dam.

[2] Copco 2 Dam was not analyzed for noise impacts because the reduction in noise level due to distance and terrain between the receptor and the construction site would result in less than significant noise increase at the receptor.

Key:

dBA = A-weighted decibels

L_{eq} = 1-hour equivalent noise level

N/A = not applicable

3.23.3.2 Existing Noise Levels along the Haul Routes

The Lead Agencies used the FHWA Traffic Noise Model, Version 2.5 (TNM2.5) to estimate the existing daytime peak hour L_{eqs} along proposed haul routes. Peak-hour traffic was estimated by multiplying the average daily traffic by 10 percent based on a review of Caltrans and ODOT 2009 average daily and peak hourly traffic data (Caltrans 2010; ODOT 2010). Average daily traffic values published by ODOT (2010) and Caltrans (2010) were used to estimate the existing noise levels on OR66, US97, and I-5. Traffic volumes for I-5 between the City of Yreka and Anderson, California are higher than those for north of the City of Yreka; therefore, for conservative analysis, the lower volumes in the northern portion were used for the baseline. Field observations conducted for the preparation of the Klamath Facilities Removal Environmental Impact Statement/Environmental Impact Report (EIS/EIR) provided the basis for estimating existing 1-hr L_{eq} along Topsy Grade Road, Copco Road, and Ager-Beswick Road.

This analysis uses peak-hour noise level results from TNM2.5 for generic receptors 50 and 500 feet from the edge of the road. Fifty feet represents the minimum distance for a receptor along any roadway and 500 feet is the maximum recommended receptor distance for traffic noise models (Caltrans 2006). Table 3.23-3 summarizes the existing peak hour L_{eq} for project haul routes at 50 feet and 500 feet from the edge of the roadway.

Table 3.23-3. Existing Peak Hour L_{eq} Along Proposed Haul and Commute Routes

Haul Route/Commute Segment	Existing Daytime Peak hour L_{eq} (dBA)[1]	
	50 feet	500 feet
Topsy Grade County Road / Ager-Beswick Road	53	42
US97	75	64
OR66	60	49
Copco Road	58	46
I-5: Between Medford, OR and OR66	77	66
I-5: Between OR66 and the City of Yreka, CA	76	66

Source: Caltrans 2010. ODOT 2010. USEPA 1974.

Notes:
Daytime 1-hour L_{eq} estimated by modeling traffic counts using TNM2.5.
Key:
dBA = A-weighted decibels
L_{eq} = 1-hour equivalent noise level

3.23.3.3 Environmental Consequences

Potential sources of noise from implementation of the KHSA include construction equipment and construction-related traffic noise. Impact determination methods, criteria, and effects determination are presented below.

3.23.3.4 Environmental Effects Determination Methods

This analysis compared the impacts of the Proposed Action and alternatives to the baseline existing conditions. This analysis assumes that no considerable changes in land use would occur in the next 10 years and therefore, existing conditions and the No Action/No Project ambient noise levels would be the same. The Lead Agencies determined noise and vibration levels from construction equipment in the project area and construction-related traffic for each action alternative using the methods described below. A more detailed method description, analysis results, and data supporting the analysis are included in Appendix U.

3.23.3.4.1 On-site Construction Noise

The construction impact analysis focused on outdoor receptors in residential areas near the construction sites. Anticipated sources of construction noise include cranes, excavators, loaders, dozers, concrete trucks, water tankers, pick-up trucks, generators, air compressors, and pavement breakers.

Principles and methods described in FHWA's Roadway Construction Noise Model User's Guide (2006) were the basis for predicting noise impacts associated with construction equipment for the action alternatives. Table 3.23-4 presents noise levels of common construction equipment operating at full power (L_{max}) measured 50 feet from the source, the percentage of time the equipment would be operated at full power (usage factor), and the L_{eq} over a single shift (FHWA 2006). For equipment whose L_{max} in the Roadway Construction Noise Model exceeds the maximum allowable noise levels from construction equipment in the Siskiyou County General Plan Noise Element (1978), the upper limits from Siskiyou County were used.

Table 3.23-4. Construction Operations, Equipment Types, and Their Noise Levels

Equipment Types	Usage Factor	L_{max} at 50 feet (dBA)	L_{eq} at 50 feet (dBA)
Air Compressor	40%	78	74
Backhoe	40%	78	74
Blasting	1%	94	74
Compactor	20%	83	76
Concrete Mixer Truck	40%	79	75
Concrete Pump Truck[1]	20%	81	74
Crane	16%	81	73
Dozers[1]	40%	81	77
Dump Truck	40%	77	73
Excavator	40%	81	77
Front End Loader	40%	79	75
Generator	50%	81	78
Grader	40%	85	81
Jackhammer[1]	20%	81	74
Mounted Impact Hammer (hoe ram)	20%	90	83
Pickup Truck	40%	75	71
Pumps	50%	81	78
Scraper	40%	84	80
Tractor[1]	40%	81	77

Source: FHWA 2006. Siskiyou County 1978.

Notes:

[1] Maximum allowable noise levels from construction equipment at 100 ft from Siskiyou County's General Plan converted to noise levels at 50 ft.

Key:

dBA = A-weighted decibels

L_{eq} = 1-hour equivalent noise level

L_{max} = noise levels of equipment operating at full power

Detailed equipment lists for each phase of construction were not available at the time of this analysis. Therefore, the analysis conservatively assumed that the dam removal phase would involve the greatest amount of construction equipment. Attenuation due to sound travel from the source to the receptor was applied to the combined L_{eq} at 50 feet from all equipment, and the approximate noise level from construction at the receptor was added to existing outdoor ambient levels. Noise levels for each dam were analyzed separately because the facilities are spread out. Other phases, such as road and/or bridge improvement, the City of Yreka pipeline construction, implementation of the interim measures, cofferdam construction, drawdown, and removal of recreational facilities, would cause less noise and vibration impacts than on the peak day.

Vibration from Construction Sites

In addition to producing noise, construction activities have the potential to produce vibration that is annoying to humans and may cause damage to structures. Blasting, drilling, and demolition cause the highest levels of vibration from construction projects. Table 3.23-5 presents the peak particle velocity (PPV) in inches per second (in/sec) and

vibration velocity level (L_v) in vibration decibels (VdB) for typical construction equipment (Federal Transit Administration [FTA] 2006). The Lead Agencies applied these levels to each construction site as appropriate and calculated the equivalent PPV and L_v at the receptor. As was done for noise, the PPV and L_v are based on all construction equipment operating simultaneously on peak construction days.

Table 3.23-5 Vibration Levels for Construction Equipment

Equipment Types	PPV at 25 feet (in/sec)	L_v at 25 feet (VdB)
Clam Shovel Drop	0.202	94
Vibratory Roller	0.210	94
Large Bulldozer / Hoe Ram	0.089	87
Caisson Drilling	0.089	87
Loaded Trucks	0.076	86
Jackhammer	0.035	79

Source: FTA 2006.
Key:
in/sec = inches per second
L_v = vibration velocity level
PPV = peak particle velocity
VdB = vibration decibels

Construction-Related Traffic Noise

Transportation noise impacts include noise generated from an increase in local vehicle traffic due to construction workers commuting and trucks hauling waste and construction materials. Details regarding the roadways affected by this Proposed Action are presented in Section 3.22, Traffic and Transportation. Trucks for onsite waste disposal were included in the construction equipment analysis.

Under the Proposed Action, trucks would haul recyclable metal waste to the City of Yreka, California for waste originating in California and to Klamath Falls, Oregon for waste originating in Oregon. Wood waste from Copco 2 Dam would likely be hauled to a hazardous waste landfill in Anderson, California. For construction of fish passages, rebar and wood would be supplied from Medford, Oregon, and concrete would be transported from the City of Yreka, California. The haul routes would likely be I-5, US97, OR66, Copco Road, Ager-Beswick/Ager Road, and Topsy Grade Road. Communities potentially affected by project-related traffic include unincorporated areas of Siskiyou (California) and Klamath (Oregon) Counties and the following cities: the City of Yreka, Montague, Grenada, Weed, Dunsmuir, Mt. Shasta, Redding, and Anderson in California and Klamath Falls, Ashland, Talent, Phoenix, and Medford in Oregon. Figure 3.23-1 shows, for each supplied or removed material type, the haul route and the communities along the haul routes.

Like the trucks, construction workers would commute to the sites using the major highways and roads (I-5, OR66, US97, Copco Road, Ager-Beswick, and Topsy Grade Road). Based on the impact analysis in Section 3.17, Population and Housing, the analysis assumed that workers at facilities in California (Copco 1, Copco 2, and Iron Gate) would commute from Medford, Oregon or the City of Yreka, California and workers at J.C. Boyle Dam would commute from Keno, Oregon and Klamath Falls, Oregon.

This analysis bases the off-site traffic noise impact assessment on the sum of likely existing noise levels near the haul routes, as described in the Affected Environment/ Environmental Setting section, and additional traffic noise from the project. Results from TNM2.5 were used for predicting noise levels 50 feet and 500 feet from roadways. This analysis assumes that off-site hauling to suppliers and landfills would only occur during the daytime. Although the worker commute may not overlap with off-site hauling, the number of cars and trucks from worker commute and hauling were added to the baseline traffic counts for a conservative analysis. Nighttime construction at Copco 1 and Iron Gate would have less impact (i.e., only worker commute) than daytime commute and offsite hauling.

3.23.3.5 Significance Criteria

For the purpose of this analysis, a project action would be significant if it resulted in any the following:

- A greater than 10 dBA increase in the daytime or nighttime outdoor 1-hour L_{eq} at the receptor from on-site construction operations
- A PPV greater than 0.3 in/sec at the receptor
- An L_v greater than 72 VdB at the receptor
- A greater than 12 dBA (in California) or 10 dBA (in Oregon) increase above existing 1-hour L_{eq} for traffic-related noise

The criteria above were based on the characteristics of noise, published studies on vibration effects, and established regulations. Although Siskiyou County does not have local significance criteria for noise and vibration levels, the significance criteria itemized above is expected to provide a conservative analysis of noise and vibration levels. Daytime is defined as the hours between 7:00 am and 10:00 p.m., and nighttime is defined as the hours between 10:00 p.m. to 7:00 a.m. A 10 dBA increase in noise level is perceived as a doubling of noise (FHWA 2011). A PPV of 0.3 in/sec or greater can damage old residential structures from continuous or frequent vibration sources (Jones and Stokes 2004). The annoyance level for vibration is 72 VdB in residential areas (FTA 2006). Caltrans (2006) and ODOT (2009) define a substantial increase in noise levels from traffic as an increase of 12 dBA or 10 dBA, in California and Oregon, respectively, above existing 1-hour L_{eq}.

3.23.3.6 Effects Determinations

The following sections describe the noise and vibration impacts for each alternative.

3.23.3.6.1 Alternative 1: No Action/No Project

The Four Facilities would not be removed and fish passages would not be constructed. This analysis assumes that ambient noise levels under the No Action/No Project Alternative would be the same as existing conditions. **Therefore, implementation of the No Action/No Project Alternative would cause no change from existing conditions from construction noise impacts.**

Several ongoing resource management actions could cause noise and vibration impacts. There may be some noise and vibration effects due to the use of construction equipment throughout the basin associated with ongoing resource management actions, including the Fish Habitat Restoration Program. These activities may include mechanical thinning of vegetation, gravel augmentation, and breaching levees. Although sufficient information is currently not available to estimate noise and vibration impacts, the quantity of equipment required to complete these restoration activities are expected to be less than the required equipment for dam removal and fish ladder construction activities. **Noise and vibration impacts from ongoing resource management actions are therefore assumed to be less than significant.**

3.23.3.6.2 Alternative 2: Full Facilities Removal of Four Dams (Proposed Action)

This section summarizes the noise and vibration effects that would be caused by removing the dams, powerhouses, and other associated structures. J.C. Boyle Dam was not analyzed relative to impacts to human receptors because there are no applicable human sensitive receptors within a 1-mile radius. Copco 2 Dam was also not analyzed for human receptor noise impacts because the line of sight between the dam and the receptor is completely blocked by the terrain, and the nearest sensitive receptor is 3,700 feet from the dam. Impacts to special-status bird species identified near J.C. Boyle Dam and Copco 2 Dam are discussed in further detail below, as well as in Section 3.5, Terrestrial Resources. The Proposed Action impacts are expected to occur between January and September 2020 for approximately four to six months during the scheduled peak dam removal at each site. There are no long-term noise and vibration impacts due to the Proposed Action.

Construction Equipment Noise and Vibration

Two shifts of construction workers are expected to carry out deconstruction of Copco 1 and Iron Gate Dams. Both work shifts overlap with daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) existing levels defined in the previous section. The shifts are described further below. Table 3.23-6 lists the predicted average 1-hour L_{eq} at each construction site and receptor, the increase in noise level at the receptor that would occur as a result of the Proposed Action, and the times of day when the significant impact is expected to occur.

Table 3.23-6. Summary of Noise Levels from Deconstruction Activities for the Proposed Action

Location[1]	L_{eq} (dBA)		
	At Construction Site (50 feet)	At Receptor with Proposed Action	Increase in L_{eq} Caused by Proposed Action
Copco 1 Dam			
Daytime[2]	88-91	50-52	10-**12**
Nighttime[3]	88-91	49-52	10-**22**
Iron Gate Dam			
Daytime[2]	91	46	6
Nighttime[3]	91	44-46	6-**14**

Source: FHWA 2006.

Notes:

1 J.C. Boyle Dam removal was not analyzed because there are no receptors within 1 mile. Copco 2 Dam removal was not analyzed because the line of sight to the closest receptor is completely blocked.

2 Daytime is defined as between the hours of 7:00 a.m. to 10:00 p.m.

3 Nighttime is defined as between the hours of 10:00 p.m. to 7:00 a.m.

Key:

dBA = A-weighted decibels

L_{eq} = 1-hour equivalent noise level

Deconstruction activities at the Four Facilities could cause a temporary increase in noise levels at Copco 1 Dam that could affect residents in the area. The predicted shift-period L_{eq} from all construction equipment on a peak construction day at Copco 1 is 91 dBA at 50 feet during the first shift (6:00 a.m. to 3:00 p.m.) and 88 dBA during the second shift (3:00 p.m. to midnight). Attenuation due to distance, topography, and the atmosphere would reduce these construction site L_{eq} by approximately 39 dBA at the nearest receptor. Compared to the daytime (7:00 a.m. to 10:00 p.m.) and nighttime (10:00 p.m. to 7:00 a.m.) existing outdoor noise levels of 40 and 30 dBA, the resulting increases range from less than 10 to 22 dBA, depending on the time of day. The first shift exceeds the significance criteria at all times because of the high source noise level. The second shift only exceeds the significance criteria after 10:00 p.m. when the background noise levels are expected to be very low. **This increase in outdoor noise levels would have a temporary significant noise impact on the residential area near Copco 1 Dam. Mitigation Measure NV-1 would be implemented but would not reduce outdoor noise impacts to less than significant levels at sensitive receptors; therefore noise impacts would remain significant and unavoidable for outdoor receptors during Copco 1 Dam deconstruction.**

Deconstruction activities at the Four Facilities could cause a temporary increase in nighttime noise levels at Iron Gate Dam. The predicted shift-period L_{eq} from the Iron Gate facilities removal is 91 dBA at 50 feet during both shifts (7:00 a.m. to 4:00 p.m. and 4:00 p.m. to 11:00 p.m.). The combination of existing noise, distance divergence, topographic attenuation, and atmospheric attenuation would result in a shift-period L_{eq} of 46 dBA during the daytime (7:00 a.m. to 10:00 p.m.) and 44 dBA during the nighttime (10:00 p.m. to 11:00 p.m.) at the nearest receptor. The estimated noise level at the receptor exceeds the significance criterion for nighttime noise. **Deconstruction noise**

would cause a temporary significant noise impact on the residential area near Iron Gate Dam at night. Mitigation Measure NV-1 would be implemented but would not reduce nighttime outdoor noise impacts to less than significant levels at sensitive receptors. Nighttime noise impacts would remain significant and unavoidable for outdoor receptors during Iron Gate nighttime deconstruction.

Reservoir restoration activities could result in short-term increases in noise levels in the project vicinity. Additional equipment, including hydro seeding barges, trucks, and helicopters, would be used for reservoir restoration at the same time as dam deconstruction. This reservoir restoration activity would add to the noise levels generated by dam deconstruction activities in and around the dam sites described above. Additionally residential areas along Copco and Iron Gate Reservoirs away from the dam deconstruction sites may experience temporary increased noise levels due to passing hydro seeding vessel or vehicle along the embankment. Aerial hydro seeding is scheduled to begin on March 15 and last for 10 days at Iron Gate and 20 days at Copco. The helicopter would make 30 trips per day between the hours of 7:30 a.m. and 7:00 p.m. All other hydro seeding would be accomplished by barges and trucks. **Helicopters and other equipment noise from embankment restoration would cause a temporary significant noise impact on the residential areas near Copco and Iron Gate Reservoirs and increase the significant noise levels generated by dam deconstruction in and around the dam sites. Mitigation Measure NV-1 would be implemented but would not reduce outdoor noise impacts to less than significant levels at these sensitive receptors.**

Blasting activities at Copco 1 Dam could increase vibration levels. Table 3.23-7 summarizes the Proposed Action's vibration levels at sensitive receptors. Because of blasting, during the first shift at Copco 1 Dam, the PPV and L_v at the nearest receptor are 0.065 in/sec and 84 VdB, respectively. For reference, vibration levels without blasting are shown in Table 3.23-7. The first shift at Copco 1 Dam would therefore exceed the significance criteria for L_v and this is because of the substantial amount of blasting required. During the second shift, the maximum PPV for this alternative would be 0.001 in/sec at the receptors and the L_v at the receptors would be approximately 48 VdB. The vibration levels from Iron Gate Dam and Copco 2 Dam or during the second shift from Copco 1 Dam would not exceed the significance criteria of 0.3 in/sec and 72 VdB. **Deconstruction activities would result in significant human annoyance levels for vibration impacts at receptors near Copco 1 Dam during blasting operations in the first shift. Mitigation Measure NV-1 would be implemented but would not reduce vibration impacts to less than significant levels; therefore, vibration impacts to humans would remain significant and unavoidable during blasting at Copco 1.**

Deconstruction-Related Traffic Noise

Transporting waste to off-site landfills and construction worker commutes could cause increases in noise along haul routes. Noise effects from transporting waste and construction worker commute were evaluated for receptors at 50 feet and 500 feet from the road. Table 3.23-8 shows the results of the TNM2.5 modeling for this potential impact. The TNM2.5 results showed only minor increases in existing L_{eq} for receptors

50 feet or more from all haul routes analyzed. Increases in traffic from construction worker commutes for the second shift at Copco 1 and Iron Gate would result in less noise impact than that presented in Table 3.23-8. **Transporting waste off-site and construction worker commutes would result in less than significant noise impacts for receptors 50 feet or more from all local roadways.**

Table 3.23-7. Summary of Vibration from Construction Activities for the Proposed Action

Source[1]	PPV at Receptor (in/sec)	L_v at Receptor (VdB)
Copco 1 Dam		
Shift 1	0.065 (0.002 without blasting)	**84** (53 without blasting)
Shift 2	0.001	47
Copco 2 Dam	0.001	48
Iron Gate Dam		
Shift 1	0.001	48
Shift 2	0.001	48

Source: FTA 2006.
Notes:
[1] J.C. Boyle was not analyzed because there are no receptors within 1 mile.
Key:
L_v = vibration velocity level
PPV = peak particle velocity
VdB = vibration decibels
in/sec = inches per second

Table 3.23-8. Summary of Construction-Related Traffic Noise from Off-site Hauling and Construction Worker Commute for the Proposed Action

Haul Route/Commute Segment	Peak 1-hour L_{eq} (dBA)		Increase in L_{eq} Caused by Proposed Action (dBA)[1]	
	50 ft	500 ft	50 ft	500 ft
Topsy Grade Road	56	45	3	3
OR66	62	51	2	2
US97	76	64	0	0
I-5: Between OR66 and Medford, OR	77	66	0	0
Ager-Beswick Road	54	43	1	1
Copco Road	63	51	5	5
I-5: Between OR66 and the City of Yreka, CA	77	66	0	0

Notes:
[1] The increase in L_{eq} may appear different when subtracting the existing 1-hour L_{eq} from peak 1-hour L_{eq} values due to rounding.
Key:
dBA = A-weighted decibels
L_{eq} = 1-hour equivalent noise level
ft = feet

Keno Transfer

The transfer of Keno Facility to the United States Department of the Interior (DOI) could have adverse effects on noise and vibration. The Keno Transfer is a transfer of title for the Keno Facility from PacifiCorp to the DOI. This transfer would not result in the generation of new impacts on noise and vibration compared with existing facility operations. Following transfer of title, DOI would operate Keno in compliance with applicable law and would provide water levels upstream of Keno Dam for diversion and canal maintenance in accordance with agreements and historic practice (KHSA Section 7.5.4). **Therefore, the Keno Transfer would have no change from existing conditions for noise and vibration.**

East and Westside Facility Decommissioning – Programmatic Measures

The decommissioning of the East and Westside Facilities could have adverse effects on noise and vibration. Decommissioning of the East and Westside canals and hydropower facilities of the Link River Dam by PacifiCorp as a part of the KHSA will eliminate the need to divert water at Link River Dam in to the two canals. The decommissioning and deconstruction activities could create noise and vibration in excess of applicable standards depending on the location of nearby sensitive receptors. Surveys of receptors and specific decommissioning activities will need to be completed prior to the decommissioning in order to prevent adverse impacts to sensitive receptors. **Therefore, the decommissioning of the East and Westside Facilities would have a less than significant effect on noise and vibration.**

KBRA – Programmatic Measures

The KBRA has several programs that could cause temporary increases in noise and vibration level. The following KBRA programs may cause some noise and vibration impacts from the use of heavy equipment:

- Phases I and II Fisheries Restoration Plans
- Fisheries Reintroduction and Management Plan
- Wood River Wetland Restoration
- On-Project Plan
- Water Use Retirement Program
- Fish Entrainment Reduction
- Power for Water Management Program
- Additional Water Conservation and Storage

Construction activities associated with the KBRA could cause temporary increases in noise and vibration levels. Construction activities associated with the above KBRA programs include channel construction, mechanical thinning of trees, road decommissioning, fish passage and facilities construction, breaching levees, and fish hauling. While the exact geographic location and timing of these programs is not known, it is assumed that some could occur at the same time and in the same area as the hydroelectric facility removal actions analyzed above and could contribute to the effects of facility removal on noise and vibration. **Due to the potentially large amount of**

construction activities that would occur for the various KBRA programs, it is anticipated that the effects from noise and vibration could be potentially significant on sensitive receptors. Mitigation Measure NV-1 would be expected to reduce noise and vibration impacts to less than significant levels; therefore, noise vibration impacts to humans would be expected to be reduced to a less than significant impact. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.

Operational activities associated with the Fisheries Reintroduction and Management Plan could result in temporary increases in noise and vibration levels from vehicles associated with trap-and-haul activities. Haul trucks relocating anadromous fish species around Keno Impoundment /Lake Eauwna could produce noise and vibration. Seasonal trap and haul operations would occur below Keno Dam and near Link River Dam during periods of poor water quality. Hauling activities would occur after the peak noise-generating period of facility removal because fish cannot access Keno Dam until after removal of the Four Facilities; however, some noise and vibration associated with completing removal activities and reservoir restoration may occur at the same time as hauling operations. Construction noise and vibration related to dam removal and hauling operations, taken together, could increase the severity of the effects, but the combined noise and vibration would likely still be less than the peak levels during dam deconstruction. The timing of these trap and haul operations from the hydroelectric facility removal actions analyzed above reduce the potential for any negative noise and vibration effects generated by these trap and haul actions from contributing to the effects of facility removal actions. **Although the exact extent and timing of these hauling activities is not known, it is anticipated that the effects from noise and vibration could be potentially significant on sensitive receptors (including the Topsy Campground near Keno Dam). Mitigation Measure NV-1 would be expected to reduce noise and vibration impacts to less than significant levels; therefore, noise vibration impacts to humans would be expected to be reduced to a less than significant impact. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.**

3.23.3.6.3 Alternative 3: Partial Facilities Removal of Four Dams

Under this alternative, short-term demolition activities and drawdown of reservoirs would still occur; however, only in-stream facilities and select ancillary facilities would be demolished. Although there would be less total construction work and material hauling, peak day operations would be similar to those of the Proposed Action.

Deconstruction activities at the Four Facilities could increase noise and vibration levels. Noise and vibration impacts would be the same as for the Proposed Action and would be significant for construction noise and vibration impacts. **Mitigation Measure NV-1 would be implemented but would not reduce outdoor noise impacts to less than significant levels at sensitive receptors. Noise impacts would remain significant and unavoidable for outdoor receptors near Copco 1 and Iron Gate. Equipment noise from embankment restoration would cause a temporary significant noise impact on the residential areas near Copco Lake and Iron Gate Reservoir. Vibration impacts**

to humans would remain significant and unavoidable during blasting at Copco 1. Transporting waste to off-site landfills and construction worker commutes would result in a less than significant noise impact for receptors 50 feet or more from all local roadways.

Keno Transfer

The effects of the Keno Transfer would be the same as those for the Proposed Action.

East and Westside Facility Decommissioning – Programmatic Measures

The effects of the East and Westside Facilities removal would be the same as those described for the Proposed Action.

KBRA – Programmatic Measures

The Partial Facilities Removal Alternative would include full implementation of the KBRA. Therefore, impacts related to KBRA actions would be the same as under the Proposed Action, discussed above.

3.23.3.6.4 Alternative 4: Fish Passage at Four Dams

This section summarizes the potential noise and vibration impacts from constructing a fish passage at the Four Facilities. J.C. Boyle Dam was not analyzed for this alternative because there are no applicable sensitive receptors within a 1-mile radius. Copco 2 Dam was also not analyzed because the line of sight between the dam and the receptor is completely blocked by hills.

Construction Equipment Noise and Vibration

Construction activities at the Four Facilities could cause a temporary increase in noise levels at Copco 1 and Iron Gate receptor sites. Table 3.23-9 summarizes the predicted average 1-hour L_{eq} at each construction site and receptor, and the temporary increase in noise level at the receptor that would occur as a result of the Fish Passage at Four Dams Alternative. There are no long-term noise and vibration impacts due to this alternative.

Table 3.23-9. Summary of Noise Levels from Construction Activities for the Fish Passage at Four Dams Alternative

Location[1]	1-Hour L_{eq} (dBA)		
	At Construction Site (50 feet)	At Receptor with Fish Passage Construction	Increase in Existing L_{eq} Caused by Fish Passage Construction
Copco 1 Dam	90	52	**12**
Iron Gate Dam	90	45	5

Source: FHWA 2006.

Notes:

[1] J.C. Boyle was not analyzed because there are no receptors within 1 mile. Copco 2 Dam was not analyzed because the line of sight to the closest receptor is completely blocked.

Key:

dBA = A-weighted decibels

L_{eq} = 1-hour equivalent noise level

Fish passage construction activities could cause a temporary increase in noise levels at Copco 1 Dam. The predicted shift-period L_{eq} from construction activities at Copco 1 Dam is 90 dBA at 50 feet. Attenuation offered by distance, topography, and the atmosphere would reduce this L_{eq} to approximately 52 dBA at the nearest receptor. The resulting increase in ambient noise levels at the receptor would be 12 dBA. **This increase in ambient noise levels would represent a significant noise impact on the residential area near Copco 1 Dam. Mitigation Measure NV-1 would be implemented but would not reduce outdoor noise impacts to less than significant levels at sensitive receptors. Noise impacts would remain significant and unavoidable for outdoor receptors during construction.**

Fish passage construction activities could cause a temporary increase in noise levels at Iron Gate Dam. The predicted shift period L_{eq} from construction activities at Iron Gate Dam is 90 dBA at 50 feet. Attenuation offered by distance, topography, and the atmosphere would reduce this 1-hour L_{eq} to approximately 45 dBA at the nearest receptor. The resulting increase in ambient noise levels at the receptor would be 5 dBA. **This increase in ambient noise levels would result in a less than significant noise impact on the residents near Iron Gate Dam.**

Construction activities could increase vibration levels. Table 3.23-10 summarizes vibration levels at the receptors for the Fish Passage at Four Dams Alternative. The maximum PPV for this alternative would be 0.003 in/sec at the receptor near Copco 1 Dam. The L_v at the receptors would range from 46 to 57 VdB for different vibration source locations; these vibration levels would not exceed the 0.3 in/sec and 72 VdB significance criteria. **Construction activities would result in less than significant vibration impacts.**

Table 3.23-10. Summary of Vibration Levels at Receptors from Construction Activities for the Fish Passage at Four Dams Alternative

Location[1]	Peak Particle Velocity (in/sec)	Vibration Velocity Level (VdB)
Copco 1 Dam	0.003	57
Copco 2 Dam	0.001	48
Iron Gate Dam	0.001	46

Source: FTA 2006.
Notes:
[1] J.C. Boyle was not analyzed because there are no receptors within 1 mile.
Key:
VdB = vibration decibels
in/sec = inches per second

Construction-Related Traffic

Transporting construction materials from off-site suppliers and construction worker commute could cause increases in noise along haul routes. The Lead Agencies evaluated

the noise effects of transporting materials to the construction sites for receptors at 50 feet and 500 feet from the road. Table 3.23-11 shows the results of the TNM2.5 modeling for this potential impact. The TNM2.5 results showed only minor increases in existing L_{eq} for receptors 50 feet or more from all haul routes analyzed. **Transporting construction materials from off-site suppliers and construction worker commute would have a less than significant impact on receptors 50 feet or more from all local roadways.**

Table 3.23-11. Summary of Construction-Related Traffic Noise from Off-site Hauling for the Fish Passage at Four Dams Alternative

Haul Route/Commute Segment	Peak 1-hour L_{eq} (dBA)		Increase in Existing L_{eq} Caused by Fish Passage Construction (dBA)[1]	
	50 ft	500 ft	50 ft	500 ft
Topsy Grade Road	56	44	3	3
OR66	62	50	1	1
US97	76	64	0	0
I-5: Between Medford, OR and OR66	77	66	0	0
Ager-Beswick Road	54	43	3	3
Copco Road	60	49	2	2
I-5: Between OR66 and the City of Yreka, CA	77	66	0	0

Notes:
[1] The increase in L_{eq} may appear different when subtracting the existing 1-hour L_{eq} from peak 1-hour L_{eq} values due to rounding.
Key:
dBA = A-weighted decibels
L_{eq} = existing 1-hour equivalent noise level
ft = feet

Trap and Haul – Programmatic Measures

Trap and Haul operations could result in temporary increases in noise and vibration levels from vehicles used to relocate fish. Haul trucks relocating anadromous fish species around Keno Impoundment/Lake Euwana could produce noise and vibration. Seasonal trap and haul operations would occur below Keno Dam and near Link River Dam during periods of poor water quality. Although the exact extent and timing of these hauling activities is not known, it is anticipated that the effects from noise and vibration could be potentially significant on sensitive receptors (including the Topsy Campground near Keno Dam). Mitigation Measure NV-1 would be expected to reduce noise and vibration impacts to less than significant levels; therefore, noise vibration impacts to humans would be expected to be reduced to a less than significant impact. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.

3.23.3.6.5 Alternative 5: Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Dams

This section summarizes the noise and vibration impacts that would be caused by constructing a fish passage at J.C. Boyle and Copco 2 Dams and removing the facilities at

the Copco 1 and Iron Gate Dams. The analysis for this alternative does not predict construction impacts at J.C. Boyle Dam because there are no applicable receptors. Copco 2 Dam was also not analyzed for noise impacts because the line of sight between the dam and the receptor is completely blocked by hills.

Construction Equipment Noise and Vibration

Construction and deconstruction activities could cause a temporary increase in noise and vibration levels at receptor sites. Noise and vibration impacts at Copco 1 and Iron Gate Dams would be the same as for the Proposed Action. Vibration impacts near Copco 2 would be the same as for the Fish Passage at Four Dams Alternative. Increased noise and vibration levels would occur only during the construction/deconstruction period; no long-term noise and vibration impacts would occur. **Deconstruction at Copco 1 and Iron Gate Dams would have a temporary significant noise impact on outdoor receptors near the dam. Vibration impact to humans would be significant near Copco 1 Dam during blasting. Vibration impacts would be less than significant at receptors near Iron Gate and Copco 2 Dams. Equipment noise from embankment restoration would have a temporary significant noise impact on the residential areas near Copco and Iron Gate Reservoirs. Mitigation Measure NV-1 would be implemented but would not reduce outdoor noise and/or vibration impacts to less than significant levels at sensitive receptors near Copco 1 and Iron Gate Dams. Noise impacts would remain significant and unavoidable for outdoor receptors. Vibration impacts would also remain significant and unavoidable to humans near Copco 1.**

Construction-Related Traffic

Transporting waste to off-site landfills, hauling construction materials from off-site suppliers, and construction worker commute could cause increases in noise along haul routes. Noise impacts from haul trucks and worker commute were evaluated for receptors at 50 feet and 500 feet from the road. Table 3.23-12 shows the results of the TNM2.5 modeling for this alternative. The TNM2.5 results showed only minor increases in existing L_{eq} for receptors 50 feet or more from all haul routes analyzed. The second shift at Copco 1 and Iron Gate would not impact the roads in Oregon and would cause less impact on the California roads than what is presented in Table 3.23-12. **Transporting waste and construction materials and construction worker commute would have a less than significant impact on receptors 50 feet or more from all local roadways.**

Trap and Haul – Programmatic Measures

Trap and Haul operations could result in temporary increases in noise and vibration levels from vehicles used to relocate fish. The trap and haul measures around Keno Impoundment/Lake Euwana would have the same impacts under the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative as the Fish Passage at Four Dams Alternative. Although the exact extent and timing of these hauling activities is not known, it is anticipated that the effects from noise and vibration could be potentially significant on sensitive receptors (including the Topsy Campground near Keno Dam). Mitigation Measure NV-1 would be expected to reduce noise and vibration

impacts to less than significant levels; therefore, noise vibration impacts to humans would be expected to be reduced to a less than significant impact. Implementation of specific plans and projects described in the KBRA will require future environmental compliance as appropriate.

Table 3.23-12. Summary of Construction-Related Traffic Noise from Off-site Hauling for the Fish Passage at J.C. Boyle and Copco 2, Remove Copco 1 and Iron Gate Alternative

Haul Route/Commute Segment	Peak 1-hour L_{eq} (dBA)		Increase in Existing L_{eq} Caused by Fish Passage Construction or Facilities Removal (dBA)[1]	
	50 ft	500 ft	50 ft	500 ft
Topsy Grade Road	56	44	3	3
OR66	62	50	1	1
US97	76	64	0	0
I-5: Between Medford, OR and OR66	77	66	0	0
Ager-Beswick Road	53	42	0	0
Copco Road	62	51	4	4
I-5: Between OR66 and the City of Yreka, CA	77	66	0	0

Notes:
[1] The increase in L_{eq} may appear different when subtracting the existing 1-hour L_{eq} from peak 1-hour L_{eq} values due to rounding.
Key:
ft = feet
dBA = A-weighted decibels

3.23.3.7 Mitigation Measures

The following sections describe the recommended noise and vibration mitigation measures for each alternative.

3.23.3.7.1 Mitigation Measure by Consequences Summary

Mitigation Measure NV-1 – The Dam Removal Entity (DRE) will develop a Noise and Vibration Control Plan (NVCP) to address increased day and night time noise levels as a result of the Proposed Action. The NVCP will identify the procedures for predicting construction noise levels at sensitive receptors prior to performing construction activities and will describe the reduction measures required to meet the target noise level. The NVCP will be based on planned construction activities. Noise and vibration mitigation measures will include, but will not be limited to the following:

- The DRE will ensure that the Construction Contractor is maintaining equipment to comply with noise standards (e.g., exhaust mufflers, acoustically attenuating shields, shrouds, or enclosures).
- For nighttime or after-hour construction, the DRE will coordinate with the local jurisdictions to minimize noise. Nearby residents will be notified of hours and duration of construction activities.

- Schedule truck loading, unloading, and hauling operations so as to reduce daytime and nighttime noise impacts to less than noticeable levels.
- The blasting schedule will be coordinated with local jurisdictions to minimize noise. Nearby residents will be notified of blasting schedules.
- Appropriate blasting techniques will be employed to minimize noise and vibration.
- Noise and vibration complaints will be addressed promptly by the DRE and high impact activities rescheduled or alternate means of demolition and construction implemented, when feasible.

3.23.3.7.2 Effectiveness of Mitigation in Reducing Consequences

Implementation of mitigation measure NV-1 would manage noise and vibration impacts but would not reduce to less than significant levels. Because of the large construction areas and the long distances between the construction site and the receptors, conventional methods to reduce noise source, such as constructing barriers, would not provide a substantial reduction in noise levels and would not reduce noise and vibration to less than significant levels.

3.23.3.7.3 Agency Responsible for Mitigation Implementation

The DRE will be responsible for implementing mitigation measure NV-1.

3.23.3.7.4 Remaining Significant Impacts

Mitigation measures presented in Section 3.23.5 would not reduce noise impacts to less than-significant levels for outdoor receptors. This is because of the very low existing noise levels at the receptor compared to the high noise levels at the construction site. However, actual existing daytime and nighttime ambient noise levels may be higher than those used in this analysis and construction noise levels may be lower and therefore the impact may be less. This analysis calculated outdoor noise levels at residential properties. A review of the parcel lots near each dam site indicated that the following parcels are located within a one-mile radius of each dam site, as shown in Figures 3.23-5 and 3.23-6, and may be affected by noise:

- Iron Gate: 40 parcels, excluding Federal, county, and PacifiCorp Properties
- Copco 1 and 2: 135 parcels, excluding Federal, county, and Pacific Power and Light Properties

It is not known at this time how many parcels would be occupied during construction and demolition activities; therefore it is assumed all parcels would contain residents and would be affected. The majority of parcels, however, are located farther from the construction sites than the peak sensitive receptor, so any potential impacts would be less than what was estimated for the peak receptor.

As described earlier, all calculated noise levels are for outdoor human receptors. Buildings with an open window would reduce the noise levels indoors by 10 dB. A light frame building with a closed ordinary sash would reduce the outdoor noise level by

20 dB. Depending on the building and window types, up to 35 dB reduction in indoor levels may be achieved (FHWA 2011), substantially reducing impacts for indoor receptors.

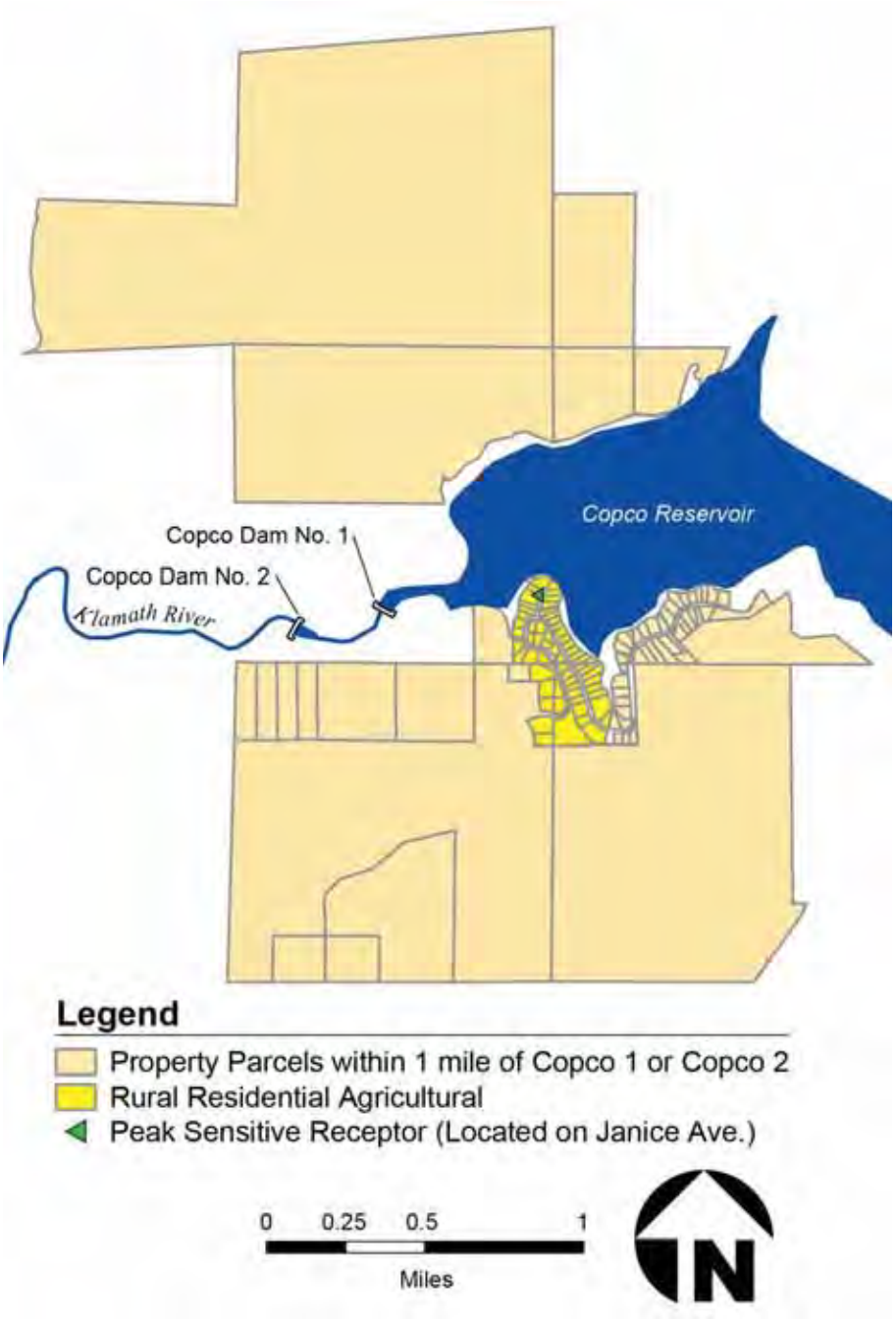

Figure 3.23-5. Parcel Lots within One-Mile of Copco 1 and 2 Dams.

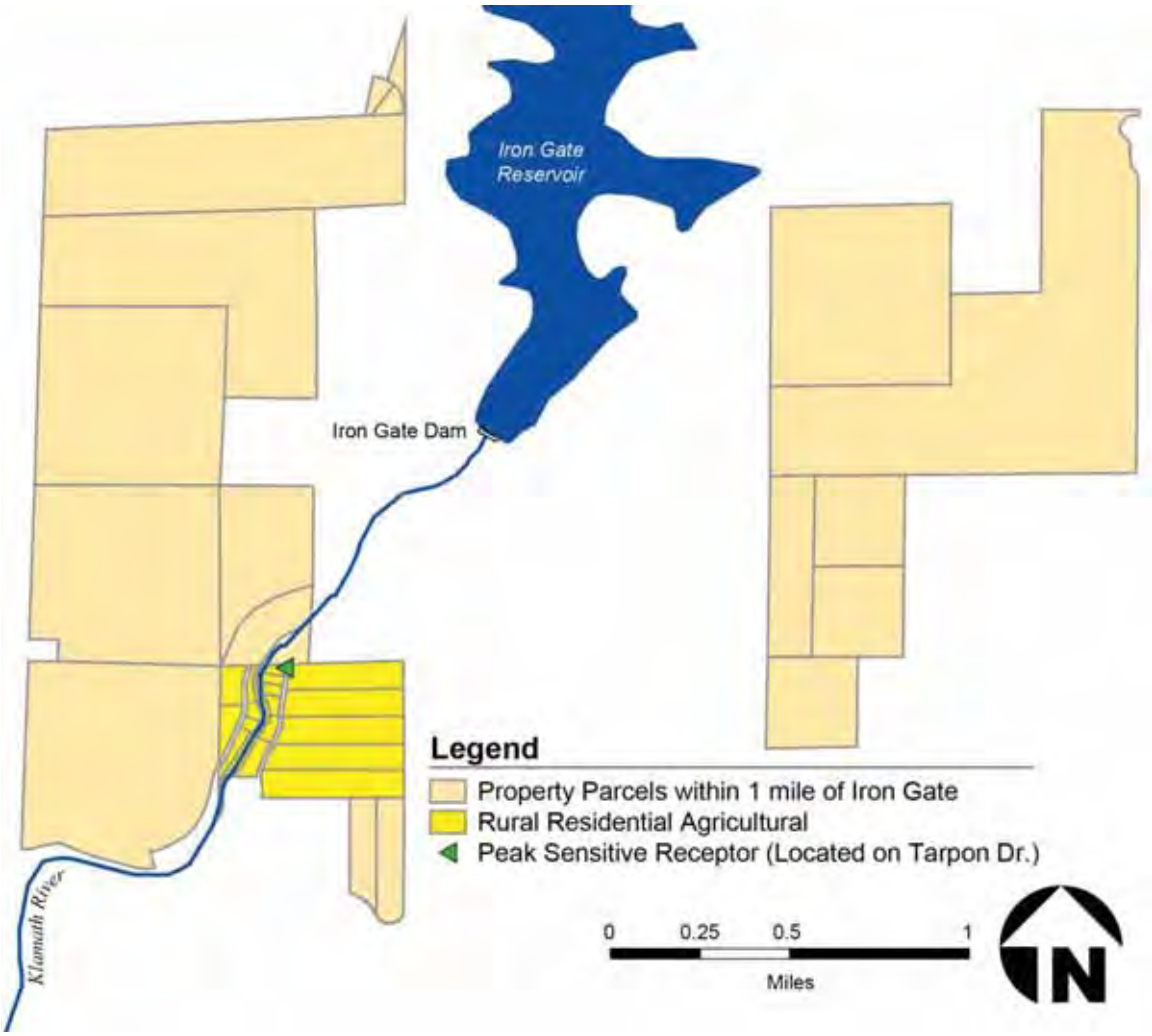

Figure 3.23-6. Parcel Lots within One-Mile of Iron Gate Dam.

Mitigation Measures Associated with Other Resource Areas

Transporting fish and mollusks under Mitigation Measures AR-1, 2, 5-7 could cause temporary increases in traffic noise. These mitigation measures involve trap and haul of fish and mollusks to protect them from the reservoir drawdown and dam deconstruction activities. It is anticipated that as many as 150 truck trips may be required to transport juvenile fish from areas downstream from Iron Gate Dam to the confluence of Klamath and Trinity Rivers between February and April of 2020. On average, the traffic volume during peak construction times would increase by two trucks due this mitigation measure. As a rule of thumb, for traffic noise levels to increase significantly, hourly traffic volume must multiply by approximately a factor of 10. **The noise and vibration impacts of these measures would be less than significant.**

Construction activities under Mitigation Measure TR-1 could cause a temporary increase in noise and vibration levels. Relocation of Jenny Creek Bridge and culverts near Iron Gate Reservoir would occur before the other construction phases of dam removal. In comparison to the dam removal, equipment and time required for this construction would be minimal. No sensitive receptors were identified near the bridge and therefore, noise and vibration from construction would not impact human receptors. **Construction noise and vibration due to TR-1 would be less than significant.**

Construction activities under Mitigation Measure REC-1 could cause a temporary increase in noise and vibration levels. Mitigation REC-1 would create a plan to develop recreational facilities and access points along the newly formed river channel between J.C. Boyle Reservoir and Iron Gate Dam. Recreation facilities, such as campgrounds and boat ramps, currently located on the edge of the reservoir would need to be replaced in appropriate areas near the new river channel once the reservoir is removed. In comparison to the dam removal, equipment and time required for this construction would be minimal. Recreation facility replacement would occur following dam removal and would not generate noise levels that exceed levels anticipated for the peak day. **Construction noise and vibration due to REC-1 would be less than significant.**

Several other mitigation measures may require construction, including mitigation measures H-2 (move or elevate structures with flood risk), GW-1 (deepen or replace wells), and WRWS-1 (modify water intakes). These measures could produce noise and vibration associated with construction activities. These activities would take place before or after the primary construction and deconstruction activities associated with the Proposed Action and action alternatives; therefore, they would not add to these noise and vibration impacts. The construction activities are generally smaller efforts that would not cause a substantial increase in noise to sensitive receptors. **Construction-related mitigation measures would cause a less than significant noise and vibration impact to sensitive receptors.**

3.23.4 References

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