

Appendix N

Greenhouse Gas Emission Impacts

N.1 Assessment Methods

This section describes the methodology used to develop the greenhouse gas (GHG) emission inventories and the comparison of the analysis results for the project site activities to the California Environmental Quality Act significance thresholds.

N.1.1 Emission Calculation Methodology

The GHG emission sources that were estimated as part of this analysis include the following:

- Exhaust from off-road (onsite) mobile construction equipment and stationary sources (e.g., generators)
- Exhaust from on-road (offsite) mobile vehicles, including haul trucks and construction worker commuting
- Methane (CH₄) emissions that could occur from impounded water at the reservoirs
- Possible emissions that could occur from replace the hydroelectric dams with non-renewable power

Emissions of carbon dioxide (CO₂), CH₄, and nitrous oxide (N₂O) were estimated to evaluate GHG impacts. Non-CO₂ pollutants have global warming potential (GWP) factors that reflect the degree to which these pollutants affect climate change, as compared to CO₂. The product of each GHG emissions and its GWP is known as Carbon Dioxide equivalent (CO₂e). The value of GWPs is continually being modified by the Intergovernmental Panel on Climate Change (IPCC) as climate change science is refined. Although the IPCC is currently working on the Fifth Assessment Report, most mandatory and voluntary reporting registries require the use of the GWPs published in the Second Assessment Report (IPCC 1996); therefore, the GWPs from the Second Assessment Report were used to maintain consistency with the international standard.

Annual emissions for each year of construction were estimated from appropriate emission factors, number of facilities and features being worked, and the associated schedules that were provided by the project consultants. The following sections provide additional discussion of emission estimation methodologies used for each source group.

N.1.1.1 On-Site (Off-Road) Equipment Engine Exhaust Emissions

Emissions would occur from the combustion of fuel during operation of the off-road construction equipment at each of the dams. As was previously stated, separate emission factor models (i.e., OFFROAD2007 and NONROAD2008a) are used to estimate emissions in California and Oregon.

Preliminary estimates of the type, size (horsepower), and quantity of construction proposed to be used at each of the dam locations was provided by the project consultants. Engine load factors are also incorporated into the emission factor models. Emission factors for each piece of equipment were then selected based on the equipment type (e.g., cranes, excavators, loaders, etc.) and the engine size. It was conservatively assumed that all equipment located at a dam site could operate simultaneously for the entire shift. Iron Gate would have a maximum operating schedule of 14 hours per day, Copco 1 would operate 16 hours per day, and Copco 2 and J.C. Boyle would operate eight hours per day. The total hours of operation for each piece of equipment was also provided with the equipment list provided by the project consultants. Annual emissions were then calculated from the total hours of operation.

In addition to the mobile construction equipment, several stationary generators would be present at each of the dam locations to provide power for electric-operated equipment. Emission factors from Chapter 3.3 (U.S. Environmental Protection Agency 1995) of AP-42 were used to estimate emissions from these generators.

N.1.1.2 Off-Site (On-Road) Haul Truck Engine Exhaust Emissions and Paved Road Dust

The haul truck engine exhaust emissions were calculated based on EMFAC2007 and MOBILE6.2 emission factors for heavy-duty diesel trucks in Siskiyou County, California and Klamath County, Oregon, respectively. Information on the project total round trips was provided by the project consultants. The total project trips were assumed to occur evenly throughout the project schedule. The total vehicle miles traveled was determined from the number of trips and estimated distance to haul each component (e.g., earth, concrete, metal, etc.).

Emission factors vary by year based on changes in the vehicle fleet mix by older engines retiring from service and improved emission control technologies and standards in newer engines joining the fleet. As a result, two different emission factors are provided by location (state) and pollutant to reflect these changes in the fleet mix.

N.1.1.3 Construction Worker Commuting

Emissions associated with construction workers commuting to and from the various dam locations were also estimated for each alternative. It was assumed that construction worker vehicles would consist of a mix of passenger cars and light-duty trucks. The combination of diesel and gasoline (catalyst and non-catalyst) vehicles from the various emission factor models was retained in the emission factor estimates. As explained in

Section N.1.1.2 for trucks, the EMFAC2007 and MOBILE6.2 emission factor models were used to estimate emissions.

N.1.1.4 Methane Emissions from Reservoirs

Methane emissions could also occur from impounded water at the reservoirs. The Karuk Tribe (2006) estimated the total amount of CH₄ released from Keno, J.C. Boyle, Copco, and Iron Gate reservoirs in its comments on the Draft Environmental Impact Statement (EIS) for relicensing and/or decommissioning of the Klamath Hydroelectric Project. The emissions estimation method presented by the Karuk Tribe was adapted for this analysis to estimate CH₄ emissions from impounded water. Emissions were estimated by multiplying the reservoirs' area by areal emissions rates from reservoirs around the world with similar characteristics (poor water quality).

N.1.1.5 Power Replacement

GHG emissions could also occur in the event of any changes in renewable power from the Four Facilities. Since the exact renewable power mix that could exist when the dams are removed, emissions were estimated in two ways: 1) assuming that the existing power mix would be in place and 2) assuming that PacifiCorp met the California Renewable Portfolio Standard (RPS) goal of 33 percent. Emission factors from Emissions & Generation Resource Integrated Database (eGRID) for the PacifiCorp Power Control Area were used to estimate a worst-case scenario assuming that the power grid would not change between now and 2020. Emission factors were then developed assuming that the renewable power mix would increase from approximately nine percent (current mix) to 33 percent by 2020.

The Federal Energy Regulatory Commission EIS (2007) provided power generation estimates for the different alternatives. These annual average power estimates were used in the analysis to estimate emissions that could occur from power replacement.

N.2 Emission Inventories

Emission inventories were completed for each of the dam locations and alternatives as described in the previous sections. Table N-1 summarizes emissions that could occur from dam removal activities or the construction of fish passage, as well as possible power replacement emissions. The table does not include CH₄ emissions that would occur from impounded water in the reservoirs.

Table N-1. Impact Summary Table (Without Methane Generation from Reservoirs)

Alternative	Emissions (metric tons CO ₂ e/year)		
	Deconstruction	Power Replacement	
		(Current Resource Mix)	(33% RPS)
2	8,747	396,575	341,539
3	7,840	396,575	341,539
4	1,600	87,525	75,431
5	7,789	139,644	120,320

Key:

CO₂e = carbon dioxide equivalent

Table N-2 summarizes power replacement emissions with CH₄ generation from the reservoirs. The Karuk Tribe (2006) estimated a range of emissions that could occur based on the conditions that could occur; therefore, Table N-2 shows the predicted range of emissions that could occur based on the amount of CH₄ that could be emitted from the reservoirs.

In Alternatives 2 and 3, the dams would be removed in their entirety and the reservoirs would cease to exist; therefore, the total expected impact from power replacement would be reduced by the amount of CH₄ that would no longer be emitted from the impounded water. Although the dams would remain in place in Alternative 4, the amount of power that could be produced would be reduced from current conditions because water would be needed to support fish passage. The amount of CH₄ emitted from the reservoirs is added to the emissions that could occur from the expected reduction in renewable power. In Alternative 5, the J.C. Boyle Reservoir would remain, but emissions from the other reservoirs would be eliminated. As with Alternative 4, CH₄ emissions from the reservoirs are added to the emissions that could occur from power replacement.

Table N-2. Impact Summary Table (With Methane Generation from Reservoirs)

Alternative	Power Replacement and CH ₄ from Impounded Reservoirs Emissions (metric tons CO ₂ e/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 CH₄ emissions predicted to be emitted by the reservoirs.

² High power replacement refers to maximum CH₄ emissions predicted to be emitted by the reservoirs.

Key:

CH₄ = methane

CO₂e = carbon dioxide equivalent

Detailed emission inventories for each of the alternatives are included as attachments to this appendix.

N.3 References

Federal Energy Regulatory Commission. 2007. Final Environmental Impact Statement for Hydropower License. Volume I. Klamath Hydroelectric FERC Project No. 2082-0278. November.

Intergovernmental Panel on Climate Change. 1996. Climate Change 1995: The Science of Climate Change. Contribution of Working Group I to the Second Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge, Great Britain: Press Syndicate of the University of Cambridge.

Karuk Tribe of California. 2006. Comments on Draft EIS in Klamath Hydroelectric Project Docket for Filing: P-2082-027 (Klamath). Submitted to FERC by the Karuk Tribe of California, Orleans, CA. 60 p. Accessed on July 7, 2011. Available online at: [http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040\(16445270\).pdf](http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040(16445270).pdf).

U.S. Environmental Protection Agency. 1995. Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources. AP-42, Fifth Edition. Accessed on January 31, 2011. Available at: <http://www.epa.gov/ttn/chief/ap42/>.

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Table N1A. Summary of Annual Emissions by Alternative (tons per one year)

	Annual Emissions (MT/yr)			2020 Annual Emissions (MTCO2e/yr)					Below Threshold
	CO2	CH4	N2O	CO2	CH4	N2O	Total	Amortized	
Alternative 2	8,551	0.31	0.00	8,551	6	0	8,558	285	1,442
Alternative 3	7,742	0.30	0.00	7,748	6	0	7,748	258	2,252
Alternative 4	1,599	0.06	0.00	1,600	1	0	1,600	53	8,400
Alternative 5	6,439	0.29	0.00	6,445	6	0	6,445	215	3,555

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

MT = metric tons

N2O = nitrous oxide

Project Lifetime 30 years **2020 Emissions Target** 427 million MTCO2e

Project Threshold 10,000 MTCO2e/yr

Global Warming Potential CO2 1 CH4 21 N2O 310

Table N1B. Alternative 2 Annual Emissions Summary (tons per one year)

	Annual Emissions (MT/yr)			2020 Annual Emissions (MTCO2e/yr)				
	CO2	CH4	N2O	CO2	CH4	N2O	Total	Amortized
Iron Gate				2020				
Construction Equipment	3,840.37	0.19	n/a	3,840	4	--	3,844	128
Haul Trucks	227.98	0.00	n/a	228	0	--	228	8
Employee Commuting	37.74	0.00	n/a	38	0	--	38	1
TOTAL	4,106.09	0.20	0.00	4,106	4	0	4,110	137
Copco 1				2020				
Construction Equipment	1,410.41	0.06	n/a	1,410	1	--	1,412	47
Haul Trucks	20.02	0.00	n/a	20	0	--	20	1
Employee Commuting	28.92	0.00	n/a	29	0	--	29	1
TOTAL	1,459.35	0.06	0.00	1,459	1	0	1,461	49
Copco 2				2020				
Construction Equipment	894.43	0.04	n/a	894	1	--	895	30
Haul Trucks	15.43	0.00	n/a	15	0	--	15	1
Employee Commuting	59.72	0.00	n/a	60	0	--	60	2
TOTAL	969.58	0.05	0.00	970	1	0	971	32
J.C. Boyle				2020				
Construction Equipment	1,974.35	0.00	n/a	1,974	0	--	1,974	66
Haul Trucks	12.28	n/a	n/a	12	0	--	12	0
Employee Commuting	29.75	n/a	n/a	30	0	--	30	1
TOTAL	2,016.37	0.00	0.00	2,016	0	0	2,016	67
Project Total	8,551.40	0.31	0.00	8,551	6	0	8,558	285
California Total	6,535.03	0.31	0.00	6,535	6	0	6,542	218
Oregon Total	2,016.37	0.00	0.00	2,016	0	0	2,016	67

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- MT = metric tons
- N2O = nitrous oxide

Global Warming Potential

CO2	1	CH4	21	N2O	310
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Table N1C. Alternative 3 Annual Emissions Summary (tons per one year)

	Annual Emissions (MT/yr)		
	CO2	CH4	N2O
Iron Gate			
Construction Equipment	3,840.37	0.19	n/a
Haul Trucks	237.58	0.00	n/a
Employee Commuting	35.85	0.00	n/a
TOTAL	4,113.80	0.20	0.00
Copco 1			
Construction Equipment	1,410.41	0.06	n/a
Haul Trucks	21.75	0.00	n/a
Employee Commuting	26.35	0.00	n/a
TOTAL	1,458.51	0.06	0.00
Copco 2			
Construction Equipment	742.58	0.03	n/a
Haul Trucks	26.60	0.00	n/a
Employee Commuting	59.72	0.00	n/a
TOTAL	828.90	0.04	0.00
J.C. Boyle			
Construction Equipment	1,280.87	0.00	n/a
Haul Trucks	32.96	0.00	n/a
Employee Commuting	27.10	n/a	n/a
TOTAL	1,340.93	0.00	0.00
Project Total	7,742.14	0.30	0.00
California Total	6,401.21	0.30	0.00
Oregon Total	1,340.93	0.00	0.00

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- MT = metric tons
- N2O = nitrous oxide

Global Warming Potential
CO2 1 CH4 21 N2O 310

	2020 Annual Emissions (MTCO2e/yr)			
	CO2	CH4	N2O	Amortized
	3,840	4	0	3,844
	238	0	0	238
	36	0	0	36
	4,114	4	0	4,118
	1,410	1	0	1,412
	22	0	0	22
	26	0	0	26
	1,459	1	0	1,460
	743	1	0	743
	27	0	0	27
	60	0	0	60
	829	1	0	830
	1,281	0	0	1,281
	33	0	0	33
	27	0	0	27
	1,341	0	0	1,341
	7,742	6	0	7,748
	6,401	6	0	6,408
	1,341	0	0	1,341

Table N1D. Alternative 4 Annual Emissions Summary (tons per one year)

	Annual Emissions (MT/yr)		
	CO2	CH4	N2O
	2023		
Iron Gate			
Construction Equipment	1,410.65	0.05	n/a
Haul Trucks	89.55	0.00	n/a
Employee Commuting	98.84	0.01	n/a
TOTAL	1,599.04	0.06	0.00
	2025		
Copco 1			
Construction Equipment	1,158.54	0.04	n/a
Haul Trucks	85.35	0.00	n/a
Employee Commuting	62.71	0.00	n/a
TOTAL	1,306.60	0.04	0.00
	2024		
Copco 2			
Construction Equipment	253.44	0.01	n/a
Haul Trucks	29.52	0.00	n/a
Employee Commuting	19.04	0.00	n/a
TOTAL	302.01	0.01	0.00
	2022		
J.C. Boyle			
Construction Equipment	666.90	0.00	n/a
Haul Trucks	102.82	0.00	n/a
Employee Commuting	50.35	n/a	n/a
TOTAL	820.08	0.00	0.00
Project Maximum	1,599.04	0.06	0.00
California Maximum	1,599.04	0.06	0.00
Oregon Maximum	820.08	0.00	0.00

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- MT = metric tons
- N2O = nitrous oxide

Global Warming Potential

CO2	1	CH4	21	N2O	310
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	2020 Annual Emissions (MTCO2e/yr)			
	CO2	CH4	N2O	Amortized
	2023			
	1,411	1	0	1,412
	90	0	0	90
	99	0	0	99
	1,599	1	0	1,600
	2025			
	1,159	1	0	1,159
	85	0	0	85
	63	0	0	63
	1,307	1	0	1,308
	2024			
	253	0	0	254
	30	0	0	30
	19	0	0	19
	302	0	0	302
	2022			
	667	0	0	667
	103	0	0	103
	50	0	0	50
	820	0	0	820
	1,599	1	0	1,600
	1,599	1	0	1,600
	820	0	0	820

Table N1E. Alternative 5 Annual Emissions Summary (tons per one year)

	Annual Emissions (MT/yr)		
	CO2	CH4	N2O
Iron Gate			
Construction Equipment	3,840.37	0.19	n/a
Haul Trucks	13.34	0.00	n/a
Employee Commuting	90.79	0.01	n/a
TOTAL	3,944.50	0.20	0.00
Copco 1			
Construction Equipment	1,410.41	0.06	n/a
Haul Trucks	3.53	0.00	n/a
Employee Commuting	59.72	0.00	n/a
TOTAL	1,473.67	0.07	0.00
Copco 2			
Construction Equipment	253.91	0.02	n/a
Haul Trucks	0.46	0.00	n/a
Employee Commuting	14.15	0.00	n/a
TOTAL	268.51	0.03	0.00
J.C. Boyle			
Construction Equipment	666.88	0.00	n/a
Haul Trucks	73.81	0.00	n/a
Employee Commuting	11.24	n/a	n/a
TOTAL	751.92	0.00	0.00
Project Total	6,438.60	0.29	0.00
California Total	5,686.68	0.29	0.00
Oregon Total	751.92	0.00	0.00

	2020 Annual Emissions (MTCO2e/yr)			
	CO2	CH4	N2O	Amortized
	3,840	4	0	128
	13	0	0	0
	91	0	0	3
	3,944	4	0	132
	1,410	1	0	47
	4	0	0	0
	60	0	0	2
	1,474	1	0	49
	254	1	0	8
	0	0	0	0
	14	0	0	0
	269	1	0	9
	667	0	0	22
	74	0	0	2
	11	0	0	0
	752	0	0	25
	6,439	6	0	215
	5,687	6	0	190
	752	0	0	25

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- MT = metric tons
- N2O = nitrous oxide

Global Warming Potential

CO2	1	CH4	21	N2O	310
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Table N2A. Summary of Alternative 2 Off-Road Construction Emissions

	(metric tons)		CO2e (metric tons)		
	CO2	CH4	CO2	CH4	Total
Iron Gate	3,840.4	0.2	3,840.4	4.0	3,844.4
Copco 1	1,410.4	0.1	1,410.4	1.3	1,411.7
Copco 2	894.4	0.0	894.4	0.9	895.3
J.C. Boyle	1,974.3	0.0	1,974.3	0.0	1,974.3
Total	8,119.6	0.3	8,119.6	6.2	8,125.8
California %	76%	100%	76%	100%	76%
Oregon %	24%	0%	24%	0%	24%

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

Table N2B. Off-Road Construction Emissions for Iron Gate Dam (Alternative 2)

Maximum Daily Work Hours 14 hours

Dam Removal Duration

Start Date 6/1/2020

End Date 9/23/2020

83 days (5 days/week)

99 days (6 days/week)

Global Warming Potential

CO2 1

CH4 21

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
					CO2	CH4	CO2	CH4	CO2	CH4
1	Crane - crawler, 150-200 ton	Cranes	335	Diesel	163.24	0.01	63.54	0.00	63.54	0.07
1	Crane - rough terrain hydraulic, 50 ton	Cranes	130	Diesel	208.07	0.02	31.43	0.00	31.43	0.05
4	Excavator - 180,000-240,000 lb, Hitachi ZX870 to EX1200	Excavators	646	Diesel	234.10	0.01	702.90	0.03	702.90	0.69
20	Dump truck - articulated, 35 ton, Cat 735	Off-Highway Trucks	435	Diesel	246.84	0.01	2,495.40	0.12	2,495.40	2.59
2	Dozer - D8	Rubber Tired Dozers	347	Diesel	240.08	0.02	193.60	0.02	193.60	0.32
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	191	Gasoline	6,624.02	0.50	18.47	0.00	18.47	0.03
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	160	Diesel	7,623.11	0.11	11.24	0.00	11.24	0.00
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Onroad	195	Diesel	7,623.11	0.11	13.70	0.00	13.70	0.00
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	323.94	0.02	65.87	0.00	65.87	0.08
1	Engine generator, 6.5 KW	N/A - Offroad diesel engine	13	Diesel	521.64	--	7.88	--	7.88	--
1	Engine generator, 10 KW	N/A - Offroad diesel engine	21	Gasoline	489.89	--	11.95	--	11.95	--
4	Submersible pump, 4" dia, 230 volt	Other Construction Equipment	175	Diesel	275.84	0.01	224.37	0.01	224.37	0.21

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	3,840.37	0.19	3,840.37	4.04
		Total CO2e	3,844.41	

Legend

Onroad vehicle - emissions estimated by EMFAC2007

Stationary source - emissions estimated by AP-42 for diesel engines

Table N2C. Off-Road Construction Equipment Emissions for Copco 1 (Alternative 2)

Maximum Daily Work Hours 8 hours/shift

Dam Removal Duration

Start Date 12/30/2019

End Date 4/15/2020

78 (5 days/week)

Global Warming Potential

CO2 1

CH4 21

Quantity		Equipment Description	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
Primary	Secondary				CO2	CH4	CO2	CH4	CO2	CH4
1	1	Crane - crawler, 150-200 ton	335	Diesel	163.24	0.01	68.25	0.00	68.25	0.08
1	1	Crane - rough terrain hydraulic, 50 ton	130	Diesel	208.07	0.02	33.76	0.00	33.76	0.05
1	0	Excavator - hydraulic ram	321	Diesel	211.85	0.01	42.44	0.00	42.44	0.04
1	1	Excavator - 45,000-60,000 lb, Komatsu 220-350	219.5	Diesel	287.66	0.01	78.80	0.00	78.80	0.08
3	0	Excavator - <20,000 lb	168	Diesel	290.62	0.02	91.40	0.01	91.40	0.11
1	0	Loader - WA250 IT	138	Diesel	275.32	0.02	23.71	0.00	23.71	0.03
1	0	Loader - WA450	273	Diesel	214.82	0.01	36.60	0.00	36.60	0.04
2	0	Dump truck - articulated, 30 ton, Cat 730	325	Diesel	246.84	0.01	100.12	0.00	100.12	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Gasoline	6624.02	0.50	60.21	0.00	60.21	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Diesel	7623.11	0.11	36.65	0.00	36.65	0.01
1	1	Pick-up truck, 1 ton, on-highway 4x4		Diesel	7623.11	0.11	44.66	0.00	44.66	0.01
1	1	Pick-up truck, 3/4 ton, on-highway 4x4		Gasoline	6624.02	0.50	89.90	0.01	89.90	0.14
1	1	Water tanker, off-highway, 5000 gal	175	Diesel	323.94	0.02	70.75	0.00	70.75	0.09
1	1	Engine generator, 6.5 KW	13	Diesel	521.64	--	8.46	--	8.46	--
1	1	Engine generator, 10 KW	21	Gasoline	489.89	--	12.84	--	12.84	--
4	4	Air compressor, 850-1200 cfm	106	Diesel	305.37	0.02	161.59	0.01	161.59	0.19
4	4	Drills - air/hydraulic track, jackleg, or sinker	291	Diesel	282.17	0.01	409.89	0.01	409.89	0.20
2	2	Submersible pump, 4" dia, 230 volt	53	Diesel	305.37	0.02	40.40	0.00	40.40	0.05

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	1,410.41	0.06	1,410.41	1.32
	Total CO2e		1,411.73	

Legend

Onroad vehicle - emissions estimated by EMFAC2007

Stationary source - emissions estimated by AP-42 for diesel engines

Table N2D. Off-Road Construction Emissions for Copco 2 (Alternative 2)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	12,111	1,096	8	163.24	0.01	59.94	0.00	59.94	0.07
2	Hydraulic yard crane, Grove 4x4x4, 13.6MT, 52' boom	Cranes	130	Diesel	7,749	1,904	8	208.07	0.02	51.50	0.00	51.50	0.08
2	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	24,408	1,808	8	211.85	0.01	122.95	0.01	122.95	0.12
2	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	29,548	2,192	8	211.85	0.01	149.07	0.01	149.07	0.15
2	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	17,361	2,192	8	270.06	0.01	145.63	0.01	145.63	0.16
1	Articulated wheel loader, Cat988, 8.2 cy	Rubber Tired Loaders	475	Diesel	1,946	128	8	214.82	0.01	13.06	0.00	13.06	0.01
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	11,686	1,408	8	246.84	0.01	144.23	0.01	144.23	0.15
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	4,677	504	8	301.16	0.02	36.12	0.00	36.12	0.05
2	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	4,209	2,192	8	7623.11	0.11	32.09	0.00	32.09	0.01
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	2,565	1,096	8	7623.11	0.11	19.55	0.00	19.55	0.01
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	191	32	8	323.94	0.02	1.81	0.00	1.81	0.00
3	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	2,302	3,288	8	521.64	--	22.30	--	22.30	--
2	Engine generator, 10 KW	N/A - AP42 3.3-1	21	Gasoline	3,968	2,192	8	489.89	--	22.55	--	22.55	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	2,367	1,096	8	305.37	0.02	20.08	0.00	20.08	0.02
2	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	6,313	2,192	8	305.37	0.02	53.55	0.00	53.55	0.06

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential

CO2	1
CH4	21

Total	894.43	0.04	894.43	0.88
	Total CO2e		895.32	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N2E. Off-Road Construction Emissions for JC Boyle (Alternative 2)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	Fuel Type	NONROAD Category	Rating (hp)	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Diesel	Diesel Cranes	335	23,603	2,136	8	228.13	--	163.24	--	163.24	--
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Diesel	Diesel Cranes	130	3,256	800	8	228.14	--	23.73	--	23.73	--
2	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Diesel	Diesel Excavators	321	57,672	4,272	8	316.47	--	433.98	--	433.98	--
2	Hydraulic excavator, 2.5 cy	Diesel	Diesel Excavators	321	57,587	4,272	8	316.47	--	433.98	--	433.98	--
1	Hydraulic excavator, 6 cy	Diesel	Diesel Excavators	513	11,014	488	8	316.47	--	79.23	--	79.23	--
2	Articulated wheel loader, Cat966, 5.0 cy	Diesel	Diesel Rubber Tire Loaders	246	11,912	1,504	8	316.46	--	117.09	--	117.09	--
5	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Diesel	Diesel Off-highway Trucks	415	16,600	2,000	8	316.48	--	262.68	--	262.68	--
1	Crawler dozer, Cat238	Diesel	Diesel Crawler Tractors	238	9,280	1,000	8	316.48	--	75.32	--	75.32	--
1	Pick-up truck, 1/2 ton, on-highway 4x4	Diesel	N/A - MOBILE	160	3,072	1,600	8	10,177.90	--	31.27	--	31.27	--
1	Pick-up trucks, 1 ton, on-highway 4x4	Diesel	N/A - MOBILE	195	3,744	1,600	8	10,177.90	--	38.11	--	38.11	--
1	Water tanker, off-highway, 5000 gal	Diesel	Diesel Off-highway Trucks	175	12,582	2,104	8	316.49	--	116.53	--	116.53	--
1	Engine generator, 6.5 KW	Diesel	N/A - AP42 3.3-1	13	1,495	2,136	8	521.64	--	14.48	--	14.48	--
1	Engine generator, 10 KW	Gasoline	N/A - AP42 3.3-1	21	3,446	1,904	8	489.89	--	19.59	--	19.59	--
1	Air compressor, 160 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	60	5,754	2,136	8	351.37	--	45.03	--	45.03	--
2	Air compressor, 250 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	80	12,303	4,272	8	351.37	--	120.09	--	120.09	--

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential	
CO2	1
CH4	21

Total	1,974.35	0.00	1,974.35	0.00
		Total CO2e	1,974.35	

Legend

- Onroad vehicle - emissions estimated by MOBILE6.2
- Stationary source - emissions estimated by AP-42 for diesel engines

**Table N2F. Construction Worker Commute Emissions
Alternative 2 - Full Facilities Removal (Proposed Action)**

Round-Trip Commute Distance: 30 miles

Dam	Peak Workers	Duration (Days)	State
J.C. Boyle	45	47	Oregon
Copco 1	56	78	California
Copco 2	40	69	California
Iron Gate	80	83	California

Dam	Annual Emissions, metric tons/year (2020)		
	CO2	CH4	N2O
J.C. Boyle	29.75	n/a	n/a
Copco 1	28.92	0.00	n/a
Copco 2	59.72	0.00	n/a
Iron Gate	37.74	0.00	n/a
Total	156.13	0.01	0.00
GWP	1	21	310
Dam	CO2e Emissions, MTCO2e/year		
J.C. Boyle	29.75	n/a	n/a
Copco 1	28.92	0.04	n/a
Copco 2	59.72	0.08	n/a
Iron Gate	37.74	0.05	n/a
Total	156.13	0.18	0.00
Total CO2e	156.30		
California Total	126.56		
Oregon Total	29.75		

81%
19%

Note:

Emission factors for N2O are not available in the EMFAC and MOBILE6 emission factor models.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

GWP = global warming potential

MTCO2e/year = metric tons CO2e per year

n/a = not available

N2O = nitrous oxide

**Table N2G. Annual Haul Truck Emissions
Alternative 2 - Full Facilities Removal (Proposed Action)**

Dam	Waste Material	Annual Trips	Round Trip Distance (mi)	Annual Emissions (tons per year) - 2020			CO2e Emissions (MTCO2e/year)					
				CO2	CH4	N2O	CO2	CH4	N2O	Total		
J.C. Boyle	Earth	8,500	1	11.86	n/a	n/a	12	n/a	n/a	n/a	12	
	Concrete	2,600	3	10.89	n/a	n/a	11	n/a	n/a	n/a	11	
	Metal	430	44	26.40	n/a	n/a	26	n/a	n/a	n/a	26	
	Building Waste	200	44	12.28	n/a	n/a	12	n/a	n/a	n/a	12	
	J.C. Boyle Subtotal	11,730	92	61.43	0.00	0.00	61	0.00	0.00	0.00	61	
Copco 1 (California)	Concrete	4,000	2	15.20	0.00	n/a	15	0.0044	n/a	n/a	15	
	Metal	170	62	20.02	0.00	n/a	20	0.0058	n/a	n/a	20	
	Building Waste	30	62	3.53	0.00	n/a	4	0.0010	n/a	n/a	4	
	Copco 1 Subtotal	4,200	126	38.76	0.00	0.00	39	0.011	0.00	0.00	39	
Copco 2 (California)	Earth	90	2	0.34	0.00	n/a	0	0.00010	n/a	n/a	0	
	Concrete (dam)	400	2	1.52	0.00	n/a	2	0.00044	n/a	n/a	2	
	Concrete (plant)	0	0	0.00	0.00	n/a	0	0	n/a	n/a	0	
	Metal (dam)	45	62	5.30	0.00	n/a	5	0.0015	n/a	n/a	5	
	Metal (plant)	145	56	15.43	0.00	n/a	15	0.0045	n/a	n/a	15	
	Building Waste	60	56	6.38	0.00	n/a	6	0.0019	n/a	n/a	6	
	Wood-stave planks	45	240	20.52	0.00	n/a	21	0.0060	n/a	n/a	21	
	Copco 2 Subtotal	785	418	49.49	0.00	0.00	49	0.014	0.00	0.00	50	
	Iron Gate (California)	Earth	60,000	2	227.98	0.00	n/a	228	0.066	n/a	n/a	228
		Concrete	750	2	2.85	0.00	n/a	3	0.00083	n/a	n/a	3
Metal		130	54	13.34	0.00	n/a	13	0.0039	n/a	n/a	13	
Building Waste		40	54	4.10	0.00	n/a	4	0.0012	n/a	n/a	4	
Iron Gate Subtotal		60,920	112	248.27	0.00	0.00	248	0.072	0.00	0.00	248	
	Grand Total	77,635	748	397.95	0.0047	0.00	398	0.10	0.00	0.00	398	
	California Total	65,905	656	337	0.0047	0.00	337	0.10	0.00	0.00	337	
	Oregon Total	11,730	92	61	0.00	0.00	61	0.00	0.00	0.00	61	
	California %	85%	88%	85%	100%	0%	85%	100%	0%	0%	85%	
	Oregon %	15%	12%	15%	0%	0%	15%	0%	0%	0%	15%	

Source: U.S. Department of the Interior, Bureau of Reclamation. 2011. Detailed Plan for Dam Removal - Klamath River Dams. Klamath Hydroelectric Project.

FERC License No. 2082, Oregon - California. June 15.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

mi = miles

MTCO2e/year = metric tons CO2e per year

n/a = not available

N2O = nitrous oxide

Global Warming Potential

CO2

CH4

N2O

1

21

310

Source:

IPCC 1996 - Second Assessment Report

Table N3A. Summary of Alternative 3 Off-Road Construction Emissions

	(metric tons)		CO2e (metric tons)		
	CO2	CH4	CO2	CH4	Total
Iron Gate	3,840.4	0.2	3,840.4	4.0	3,844.4
Copco 1	1,410.4	0.1	1,410.4	1.3	1,411.7
Copco 2	742.6	0.0	742.6	0.7	743.3
J.C. Boyle	1,280.9	0.0	1,280.9	0.0	1,280.9
Total	7,274.2	0.3	7,274.2	6.1	7,280.3
California %	82%	100%	82%	100%	82%
Oregon %	18%	0%	18%	0%	18%

Note:

Alternative 3 includes full removal of Iron Gate and Copco 1 and partial removal of Copco 2 and JC Boyle.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

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Table N3B. Off-Road Construction Emissions for Iron Gate Dam (Alternative 3)

Maximum Daily Work Hours 14 hours

Dam Removal Duration

Start Date 6/1/2020

End Date 9/23/2020

83 days (5 days/week)

99 days (6 days/week)

Global Warming Potential

CO2 1

CH4 21

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
					CO2	CH4	CO2	CH4	CO2	CH4
1	Crane - crawler, 150-200 ton	Cranes	335	Diesel	163.24	0.01	63.54	0.00	63.54	0.07
1	Crane - rough terrain hydraulic, 50 ton	Cranes	130	Diesel	208.07	0.02	31.43	0.00	31.43	0.05
4	Excavator - 180,000-240,000 lb, Hitachi ZX870 to EX1200	Excavators	646	Diesel	234.10	0.01	702.90	0.03	702.90	0.69
20	Dump truck - articulated, 35 ton, Cat 735	Off-Highway Trucks	435	Diesel	246.84	0.01	2,495.40	0.12	2,495.40	2.59
2	Dozer - D8	Rubber Tired Dozers	347	Diesel	240.08	0.02	193.60	0.02	193.60	0.32
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	191	Gasoline	6,624.02	0.50	18.47	0.00	18.47	0.03
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	160	Diesel	7,623.11	0.11	11.24	0.00	11.24	0.00
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Onroad	195	Diesel	7,623.11	0.11	13.70	0.00	13.70	0.00
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	323.94	0.02	65.87	0.00	65.87	0.08
1	Engine generator, 6.5 KW	N/A - Offroad diesel engine	13	Diesel	521.64	--	7.88	--	7.88	--
1	Engine generator, 10 KW	N/A - Offroad diesel engine	21	Gasoline	489.89	--	11.95	--	11.95	--
4	Submersible pump, 4" dia, 230 volt	Other Construction Equipment	175	Diesel	275.84	0.01	224.37	0.01	224.37	0.21

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	3,840.37	0.19	3,840.37	4.04
		Total CO2e	3,844.41	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N3C. Off-Road Construction Equipment Emissions for Copco 1 (Alternative 3)

Maximum Daily Work Hours 8 hours/shift

Dam Removal Duration

Start Date 12/30/2019

End Date 4/15/2020

78 (5 days/week)

Global Warming Potential

CO2 1

CH4 21

Quantity		Equipment Description	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
Primary	Secondary				CO2	CH4	CO2	CH4	CO2	CH4
1	1	Crane - crawler, 150-200 ton	335	Diesel	163.24	0.01	68.25	0.00	68.25	0.08
1	1	Crane - rough terrain hydraulic, 50 ton	130	Diesel	208.07	0.02	33.76	0.00	33.76	0.05
1	0	Excavator - hydraulic ram	321	Diesel	211.85	0.01	42.44	0.00	42.44	0.04
1	1	Excavator - 45,000-60,000 lb, Komatsu 220-350	219.5	Diesel	287.66	0.01	78.80	0.00	78.80	0.08
3	0	Excavator - <20,000 lb	168	Diesel	290.62	0.02	91.40	0.01	91.40	0.11
1	0	Loader - WA250 IT	138	Diesel	275.32	0.02	23.71	0.00	23.71	0.03
1	0	Loader - WA450	273	Diesel	214.82	0.01	36.60	0.00	36.60	0.04
2	0	Dump truck - articulated, 30 ton, Cat 730	325	Diesel	246.84	0.01	100.12	0.00	100.12	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Gasoline	6624.02	0.50	60.21	0.00	60.21	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Diesel	7623.11	0.11	36.65	0.00	36.65	0.01
1	1	Pick-up truck, 1 ton, on-highway 4x4		Diesel	7623.11	0.11	44.66	0.00	44.66	0.01
1	1	Pick-up truck, 3/4 ton, on-highway 4x4		Gasoline	6624.02	0.50	89.90	0.01	89.90	0.14
1	1	Water tanker, off-highway, 5000 gal	175	Diesel	323.94	0.02	70.75	0.00	70.75	0.09
1	1	Engine generator, 6.5 KW	13	Diesel	521.64	--	8.46	--	8.46	--
1	1	Engine generator, 10 KW	21	Gasoline	489.89	--	12.84	--	12.84	--
4	4	Air compressor, 850-1200 cfm	106	Diesel	305.37	0.02	161.59	0.01	161.59	0.19
4	4	Drills - air/hydraulic track, jackleg, or sinker	291	Diesel	282.17	0.01	409.89	0.01	409.89	0.20
2	2	Submersible pump, 4" dia, 230 volt	53	Diesel	305.37	0.02	40.40	0.00	40.40	0.05

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	1,410.41	0.06	1,410.41	1.32
	Total CO2e		1,411.73	

Legend

Onroad vehicle - emissions estimated by EMFAC2007

Stationary source - emissions estimated by AP-42 for diesel engines

Table N3D. Off-Road Construction Emissions for Copco 2 (Alternative 3)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	9,989	904	8	163.24	0.01	49.44	0.00	49.44	0.06
2	Hydraulic yard crane, Grove 4x4x4, 13.6MT, 52' boom	Cranes	130	Diesel	7,749	1,904	8	208.07	0.02	51.50	0.00	51.50	0.08
2	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	16,200	1,200	8	211.85	0.01	81.61	0.00	81.61	0.08
2	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	24,372	1,808	8	211.85	0.01	122.95	0.01	122.95	0.12
2	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	17,361	2,192	8	270.06	0.01	145.63	0.01	145.63	0.16
1	Articulated wheel loader, Cat988, 8.2 cy	Rubber Tired Loaders	475	Diesel	1,946	128	8	214.82	0.01	13.06	0.00	13.06	0.01
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	7,702	928	8	246.84	0.01	95.06	0.00	95.06	0.10
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	4,677	504	8	301.16	0.02	36.12	0.00	36.12	0.05
2	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	4,209	2,192	8	7623.11	0.11	32.09	0.00	32.09	0.01
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	2,565	1,096	8	7623.11	0.11	19.55	0.00	19.55	0.01
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	191	32	8	323.94	0.02	1.81	0.00	1.81	0.00
3	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	2,302	3,288	8	521.64	--	22.30	--	22.30	--
2	Engine generator, 10 KW	N/A - AP42 3.3-1	21	Gasoline	3,968	2,192	8	489.89	--	22.55	--	22.55	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	1,572	728	8	305.37	0.02	13.34	0.00	13.34	0.02
2	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	4,193	1,456	8	305.37	0.02	35.57	0.00	35.57	0.04

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential

CO2	1
CH4	21

Total	742.58	0.03	742.58	0.73
	Total CO2e		743.31	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N3E. Off-Road Construction Emissions for JC Boyle (Alternative 3)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	Fuel Type	NONROAD Category	Rating (hp)	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Diesel	Diesel Cranes	335	17,680	1,600	8	228.13	--	122.28	--	122.28	--
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Diesel	Diesel Cranes	130	3,256	800	8	228.14	--	23.73	--	23.73	--
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Diesel	Diesel Excavators	321	9,612	712	8	316.47	--	72.33	--	72.33	--
2	Hydraulic excavator, 2.5 cy	Diesel	Diesel Excavators	321	51,332	3,808	8	316.47	--	386.85	--	386.85	--
1	Hydraulic excavator, 6 cy	Diesel	Diesel Excavators	513	11,014	488	8	316.47	--	79.23	--	79.23	--
2	Articulated wheel loader, Cat966, 5.0 cy	Diesel	Diesel Rubber Tire Loaders	246	11,912	1,504	8	316.46	--	117.09	--	117.09	--
5	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Diesel	Diesel Off-highway Trucks	415	8,300	1,000	8	316.48	--	131.34	--	131.34	--
1	Crawler dozer, Cat238	Diesel	Diesel Crawler Tractors	238	9,280	1,000	8	316.48	--	75.32	--	75.32	--
1	Pick-up truck, 1/2 ton, on-highway 4x4	Diesel	N/A - MOBILE	160	3,072	1,600	8	10,177.90	--	31.27	--	31.27	--
1	Pick-up trucks, 1 ton, on-highway 4x4	Diesel	N/A - MOBILE	195	3,744	1,600	8	10,177.90	--	38.11	--	38.11	--
1	Water tanker, off-highway, 5000 gal	Diesel	Diesel Off-highway Trucks	175	12,582	2,104	8	316.49	--	116.53	--	116.53	--
1	Engine generator, 6.5 KW	Diesel	N/A - AP42 3.3-1	13	1,495	2,136	8	521.64	--	14.48	--	14.48	--
1	Engine generator, 10 KW	Gasoline	N/A - AP42 3.3-1	21	3,446	1,904	8	489.89	--	19.59	--	19.59	--
1	Air compressor, 160 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	60	2,888	1,072	8	351.37	--	22.60	--	22.60	--
1	Air compressor, 250 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	80	3,087	1,072	8	351.37	--	30.13	--	30.13	--

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential

CO2	1
CH4	21

Total	1,280.87	0.00	1,280.87	0.00
Total CO2e	1,280.87			

Legend

- Onroad vehicle - emissions estimated by MOBILE6.2
- Stationary source - emissions estimated by AP-42 for diesel engines

**Table N3F. Construction Worker Commute Emissions
Alternative 3 - Partial Facilities Removal**

Round-Trip Commute Distance: 30 miles

Dam	Peak Workers	Duration (Days)	State
J.C. Boyle	41	47	Oregon
Copco 1	56	78	California
Copco 2	38	69	California
Iron Gate	80	83	California

Dam	Annual Emissions, metric tons/year (2020)		
	CO2	CH4	N2O
J.C. Boyle	27.10	n/a	n/a
Copco 1	26.35	0.00	n/a
Copco 2	59.72	0.00	n/a
Iron Gate	35.85	0.00	n/a
Total	149.03	0.01	0.00
GWP	1	21	310
Dam	CO2e Emissions, MTCO2e/year		
J.C. Boyle	27.10	n/a	n/a
Copco 1	26.35	0.04	n/a
Copco 2	59.72	0.08	n/a
Iron Gate	35.85	0.05	n/a
Total	149.03	0.17	0.00
Total CO2e	149.20		
California Total	122.09		
Oregon Total	27.10		

82%
18%

Note:

Emission factors for N2O are not available in the EMFAC and MOBILE6 emission factor models.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

GWP = global warming potential

MTCO2e/year = metric tons CO2e per year

n/a = not available

N2O = nitrous oxide

**Table N3G. Annual Haul Truck Emissions
Alternative 3 - Partial Facilities Removal**

Dam	Waste Material	Annual Trips	Round Trip Distance (mi)	Annual Emissions (tons per year) - 2020			CO2e Emissions (MTCO2e/year)			
				CO2	CH4	N2O	CO2	CH4	N2O	Total
J.C. Boyle	Earth	8,500	1	11.86	n/a	n/a	12	n/a	n/a	12
	Concrete	1,300	3	5.44	n/a	n/a	5	n/a	n/a	5
	Metal	255	44	15.66	n/a	n/a	16	n/a	n/a	16
	J.C. Boyle Subtotal	10,055	48	32.96	0.00	0.00	33	0.00	0.00	33
Copco 1 (California)	Concrete	3,710	2	14.10	0.00	n/a	14	0.0041	n/a	14
	Metal	65	62	7.66	0.00	n/a	8	0.0022	n/a	8
	Copco 1 Subtotal	3,775	64	21.75	0.00030	0.00	22	0.0063	0.00	22
Copco 2 (California)	Earth	0	2	0.00	0.00	n/a	0	0	n/a	0
	Concrete	150	2	0.57	0.00	n/a	1	0.00017	n/a	1
	Metal	50	58	5.51	0.00	n/a	6	0.0016	n/a	6
	Wood-stave planks	45	240	20.52	0.00	n/a	21	0.0060	n/a	21
	Copco 2 Subtotal	245	302	26.60	0.00037	0.00	27	0.0077	0.00	27
Iron Gate (California)	Earth	60,000	2	227.98	0.00	n/a	228	0.066	n/a	228
	Concrete	500	2	1.90	0.00	n/a	2	0.00055	n/a	2
	Metal	75	54	7.69	0.00	n/a	8	0.0022	n/a	8
	Iron Gate Subtotal	60,575	58	237.58	0.0033	0.00	238	0.069	0.00	238
	Grand Total	74,650	472	318.89	0.0040	0.00	319	0.08	0.00	319
	California Total	64,595	424	286	0.0040	0.00	286	0.08	0.00	286
	Oregon Total	10,055	48	33	0.00	0.00	33	0.00	0.00	33
	California % Oregon %	87% 13%	90% 10%	90% 10%	100% 0%	0% 0%	90% 10%	100% 0%	0% 0%	90% 10%

Source: U.S. Department of the Interior, Bureau of Reclamation. 2011. Detailed Plan for Dam Removal - Klamath River Dams. Klamath Hydroelectric Project, FERC License No. 2082, Oregon - California. June 15.

Note:

Annual trips estimated from ratio of the quantity of waste disposed during Alternative 3 as compared to Alternative 2.

Key:

Global Warming Potential

CH4 = methane
CO2 = carbon dioxide
CO2e = carbon dioxide equivalent
mi = miles

MTCO2e/year = metric tons CO2e per year
n/a = not available
N2O = nitrous oxide

Source:

IPCC 1996 - Second Assessment Report

Table N4A. Summary of Alternative 4 Off-Road Construction Emissions

Location	Year	(metric tons)		CO2e (metric tons)		
		CO2	CH4	CO2	CH4	Total
Iron Gate	2023	1,410.7	0.1	1,410.7	1.1	1,411.8
Copco 1	2024	1,158.5	0.0	1,158.5	0.8	1,159.4
Copco 2	2025	253.4	0.0	253.4	0.2	253.6
J.C. Boyle	2022	666.9	0.0	666.9	0.0	666.9
Maximum		1,410.7	0.1	1,410.7	1.1	1,411.8

Note:

Since construction emissions at each location happen during different years, emissions are not additive. Maximum annual emissions used to evaluate significance.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

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Table N4B. Off-Road Construction Emissions for Iron Gate Dam (Alternative 4)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2023 Emission Factors (g/hp-hr or g/gal for on-highway)		2023 Emissions (metric tons per year)		2023 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	23,409	2,280	8	163.24	0.01	124.68	0.01	124.68	0.12
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Cranes	130	Diesel	13,936	3,424	8	208.07	0.01	92.61	0.01	92.61	0.11
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	7,668	568	8	211.85	0.01	38.63	0.00	38.63	0.03
1	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	23,078	1,712	8	211.85	0.01	116.42	0.00	116.42	0.10
1	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	13,559	1,712	8	270.06	0.01	113.74	0.00	113.74	0.10
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	18,990	2,288	8	246.84	0.01	234.38	0.01	234.38	0.21
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	5,271	568	8	301.16	0.02	40.71	0.00	40.71	0.05
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	191	Gasoline	8,276	2,280	8	6,642.21	0.42	54.97	0.00	54.97	0.07
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	4,378	2,280	8	7,623.11	0.11	33.37	0.00	33.37	0.01
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	5,335	2,280	8	7,623.11	0.11	40.67	0.00	40.67	0.01
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	6,841	1,144	8	323.94	0.02	64.85	0.00	64.85	0.07
5	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Other Construction Equipment	235	Diesel	36,975	4,560	8	230.44	0.01	246.94	0.01	246.94	0.16
1	Compactor, Cat, vibratory, self propelled, 84"	Rollers	138	Diesel	1,335	568	8	280.06	0.01	21.95	0.00	21.95	0.02
1	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	1,439	2,056	8	521.64	--	13.94	--	13.94	--
2	Portable generator 1 KW	N/A - AP42 3.3-1	2.75	Gasoline	576	4,112	8	489.89	--	5.54	--	5.54	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	1,227	568	8	275.84	0.01	9.40	0.00	9.40	0.01
1	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	1,636	568	8	275.84	0.01	12.53	0.00	12.53	0.01
1	Dump truck, on-highway 8x4, 18 cy	N/A - Emfac	450	Diesel	14,415	1,144	8	10,080.00	0.11	145.30	0.00	145.30	0.03

Key:
CH4 = methane
CO2 = carbon dioxide
CO2e = carbon dioxide equivalent
g/gal = grams per gallon
g/hp-hr = grams per horsepower-hour

Global Warming Potential
CO2 1
CH4 21

Total	1,410.65	0.05	1,410.65	1.13
		Total CO2e	1,411.78	

Legend
Onroad vehicle - emissions estimated by EMFAC2007
Stationary source - emissions estimated by AP-42 for diesel engines

Table N4C. Off-Road Construction Equipment Emissions for Copco 1 (Alternative 4)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2025 Emission Factors (g/hp-hr or g/gal for on-highway)		2025 Emissions (metric tons per year)		2025 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	20,951	1,896	8	163.24	0.01	103.68	0.00	103.68	0.09
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Cranes	130	Diesel	11,591	2,848	8	208.07	0.01	77.03	0.00	77.03	0.08
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	6,372	472	8	211.85	0.01	32.10	0.00	32.10	0.02
1	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	19,196	1,424	8	211.85	0.01	96.84	0.00	96.84	0.07
1	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	11,278	1,424	8	270.06	0.01	94.60	0.00	94.60	0.08
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	7,902	952	8	246.84	0.01	97.52	0.00	97.52	0.08
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	4,380	472	8	301.16	0.02	33.83	0.00	33.83	0.04
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	191	Gasoline	6,882	1,896	8	6650.13	0.39	45.77	0.00	45.77	0.06
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	3,640	1,896	8	7623.11	0.10	27.75	0.00	27.75	0.01
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	4,437	1,896	8	7623.11	0.10	33.82	0.00	33.82	0.01
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	5,693	952	8	323.94	0.01	53.97	0.00	53.97	0.05
5	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Other Construction Equipment	235	Diesel	43,151	5,320	8	230.44	0.01	288.09	0.01	288.09	0.17
1	Compactor, Cat, vibratory, self propelled, 84"	Rollers	138	Diesel	1,109	472	8	280.06	0.01	18.24	0.00	18.24	0.02
1	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	1,193	1,704	8	521.64	--	11.56	--	11.56	--
2	Portable generator 1 KW	N/A - AP42 3.3-1	2.75	Gasoline	477	3,408	8	489.89	--	4.59	--	4.59	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	1,020	472	8	275.84	0.01	7.81	0.00	7.81	0.01
1	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	1,359	472	8	275.84	0.01	10.42	0.00	10.42	0.01
1	Dump truck, on-highway 8x4, 18 cy	N/A - Emfac	450	Diesel	11,995	952	8	10080.00	0.10	120.91	0.00	120.91	0.02

Key:
CH4 = methane
CO2 = carbon dioxide
CO2e = carbon dioxide equivalent
g/gal = grams per gallon
g/hp-hr = grams per horsepower-hour

Global Warming Potential
CO2 1
CH4 21

Total	1,158.54	0.04	1,158.54	0.82
		Total CO2e	1,159.36	

Legend
Onroad vehicle - emissions estimated by EMFAC2007
Stationary source - emissions estimated by AP-42 for diesel engines

Table N4D. Off-Road Construction Emissions for Copco 2 (Alternative 4)

		Maximum Daily Work Hours		8 hours		Peak Daily		2024 Emission Factors (g/hp-hr or g/gal for on-highway)		2024 Emissions (metric tons per year)		2024 CO2e Emissions (metric tons per year)	
Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Hours	CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	4,862	440	8	163.24	0.01	24.06	0.00	24.06	0.02
2	Hydraulic yard crane, Grove 4x4x4, 13.6MT, 52' boom	Cranes	130	Diesel	2,670	656	8	208.07	0.01	17.74	0.00	17.74	0.02
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	1,512	112	8	211.85	0.01	7.62	0.00	7.62	0.01
1	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	4,421	328	8	211.85	0.01	22.31	0.00	22.31	0.02
1	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	2,598	328	8	270.06	0.01	21.79	0.00	21.79	0.02
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	3,718	448	8	246.84	0.01	45.89	0.00	45.89	0.04
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	1,039	112	8	301.16	0.02	8.03	0.00	8.03	0.01
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	845	440	8	7623.12	0.10	6.44	0.00	6.44	0.00
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	1,030	440	8	7623.12	0.10	7.85	0.00	7.85	0.00
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	1,340	224	8	323.94	0.02	12.70	0.00	12.70	0.01
4	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Other Construction Equipment	235	Diesel	5,709	704	8	230.44	0.01	38.12	0.00	38.12	0.02
1	Compactor, Cat, vibratory, self propelled, 84"	Rollers	138	Diesel	263	112	8	280.06	0.01	4.33	0.00	4.33	0.00
1	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	280	400	8	521.64	--	2.71	--	2.71	--
2	Portable generator 1 KW	N/A - AP42 3.3-1	2.75	Gasoline	112	800	8	489.89	--	1.08	--	1.08	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	242	112	8	275.84	0.01	1.85	0.00	1.85	0.00
1	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	323	112	8	275.84	0.01	2.47	0.00	2.47	0.00
1	Dump truck, on-highway 8x4, 18 cy	N/A - Emfac	450	Diesel	2,822	224	8	10080.01	0.10	28.45	0.00	28.45	0.01

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential	
CO2	1
CH4	21

Total	253.44	0.01	253.44	0.19
		Total CO2e	253.63	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N4E. Off-Road Construction Emissions for JC Boyle (Alternative 4)

Maximum Daily Work Hours 8 hours

Quantity	Equipment Description	Fuel Type	NONROAD Category	Rating (hp)	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2022 Emission Factors (g/hp-hr or g/gal for on-highway)		2022 Emissions (metric tons per year)		2022 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Diesel	Diesel Cranes	335	10,696	968	8	228.15	--	73.98	--	73.98	--
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Diesel	Diesel Cranes	130	5,926	1,456	8	228.16	--	43.19	--	43.19	--
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Diesel	Diesel Excavators	321	3,240	240	8	316.48	--	24.38	--	24.38	--
1	Hydraulic excavator, 2.5 cy	Diesel	Diesel Excavators	321	9,813	728	8	316.48	--	73.96	--	73.96	--
1	Articulated wheel loader, Cat966, 5.0 cy	Diesel	Diesel Rubber Tire Loaders	246	5,766	728	8	316.47	--	56.68	--	56.68	--
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Diesel	Diesel Off-highway Trucks	415	8,101	976	8	316.49	--	128.19	--	128.19	--
1	Crawler dozer, Cat238	Diesel	Diesel Crawler Tractors	238	2,227	240	8	316.48	--	18.08	--	18.08	--
1	Pick-up truck, 1/2 ton, on-highway 4x4	Diesel	N/A - MOBILE	160	1,859	968	8	10177.90	--	18.92	--	18.92	--
1	Pick-up trucks, 1 ton, on-highway 4x4	Diesel	N/A - MOBILE	195	2,265	968	8	10177.90	--	23.05	--	23.05	--
1	Water tanker, off-highway, 5000 gal	Diesel	Diesel Off-highway Trucks	175	2,918	488	8	316.49	--	27.03	--	27.03	--
4	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Diesel	Diesel Cement & Mortar Mixers	235	12,455	1,536	8	228.03	--	82.31	--	82.31	--
1	Compactor, Cat, vibratory, self propelled, 84"	Diesel	Diesel Rollers	138	564	240	8	316.47	--	10.48	--	10.48	--
1	Engine generator, 6.5 KW	Diesel	N/A - AP42 3.3-1	13	610	872	8	521.64	--	5.91	--	5.91	--
2	Portable generator 1 KW	Gasoline	N/A - AP42 3.3-2	2.75	244	1,744	8	489.89	--	2.35	--	2.35	--
1	Air compressor, 160 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	60	647	240	8	351.42	--	5.06	--	5.06	--
1	Air compressor, 250 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	80	691	240	8	351.42	--	6.75	--	6.75	--
1	Dump truck, on-highway 8x4, 18 cy	Diesel	N/A - MOBILE	450	6,149	488	8	10828.85	--	66.59	--	66.59	--

Key:

- CH4 = methane
- CO2 = carbon dioxide
- CO2e = carbon dioxide equivalent
- g/gal = grams per gallon
- g/hp-hr = grams per horsepower-hour

Global Warming Potential	
CO2	1
CH4	21

Total	666.90	0.00	666.90	0.00
		Total CO2e		666.90

Legend

- Onroad vehicle - emissions estimated by MOBILE6.2
- Stationary source - emissions estimated by AP-42 for diesel engines

**Table N4F. Construction Worker Commute Emissions
Alternative 4 - Fish Passage at Four Dams**

Round-Trip Commute Distance: 30 miles

Dam	Peak Workers	Duration (Days)	State
J.C. Boyle	20	179	Oregon
Copco 1	25	270	California
Copco 2	20	101	California
Iron Gate	30	344	California

Dam	Year	Annual Emissions, metric tons/year			
		CO2	CH4	N2O	Total
J.C. Boyle	2022	50	n/a	n/a	n/a
Copco 1	2025	63	0.0039	n/a	n/a
Copco 2	2024	19	0.0013	n/a	n/a
Iron Gate	2023	99	0.0071	n/a	n/a
Total		231	0.012	0.00	231
GWP		1	21	310	n/a
Dam	Year	CO2e Emissions, MTCO2e/year			
J.C. Boyle	2022	50	n/a	n/a	50
Copco 1	2025	63	0.083	n/a	63
Copco 2	2024	19	0.027	n/a	19
Iron Gate	2023	99	0.15	n/a	99
Total		231	0.15	0.00	231
Maximum		99	0.15	0.00	99

Note:

Emission factors for N2O are not available in the EMFAC and MOBILE6 emission factor models.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

GWP = global warming potential

MTCO2e/year = metric tons CO2e per year

n/a = not available

N2O = nitrous oxide

**Table N4G. Annual Haul Truck Emissions
Alternative 4 - Fish Passage at Four Dams**

Dam	Waste Material	Annual Trips	Round Trip Distance (mi)	Annual Emissions (tons per year)			CO2e Emissions (MTCO2e/year)			
				CO2	CH4	N2O	CO2	CH4	N2O	Total
J.C. Boyle 2022	Concrete	488	148	101	n/a	n/a	101	n/a	n/a	101
	Rebar	8	121	1	n/a	n/a	1	n/a	n/a	1
	Wood	4	121	1	n/a	n/a	1	n/a	n/a	1
	J.C. Boyle Subtotal	500	390	103	0.00	0.00	103	0.00	0.00	103
Copco 1 (California) 2024	Concrete	725	59	81	0.00081	n/a	81	0.017	n/a	81
	Rebar	13	120	3	0.000029	n/a	3	0.00062	n/a	3
	Wood	6	120	1	0.000014	n/a	1	0.00029	n/a	1
	Copco 1 Subtotal	744	299	85	0.00085	0.00	85	0.018	0.00	85
Copco 2 (California) 2025	Concrete	250	59	28	0.00026	n/a	28	0.0056	n/a	28
	Rebar	4	120	1	0.0000086	n/a	1	0.00018	n/a	1
	Wood	3	120	1	0.0000065	n/a	1	0.00014	n/a	1
	Copco 2 Subtotal	257	299	30	0.00028	0.00	30	0.0059	0.00	30
Iron Gate (California) 2023	Concrete	900	50	85	0.00091	n/a	85	0.019	n/a	85
	Rebar	16	90	3	0.000029	n/a	3	0.00061	n/a	3
	Wood	9	90	2	0.000016	n/a	2	0.00034	n/a	2
	Iron Gate Subtotal	925	230	90	0.0010	0.00	90	0.020	0.00	90
	Grand Total	2,426	1,218	307	0.0021	0.00	307	0.044	0.00	307
	Maximum	925	390	103	0.0010	0	103	0.020	0	103

Key: Global Warming Potential

CH4 = methane
CO2 = carbon dioxide
CO2e = carbon dioxide equivalent
mi = miles

MTCO2e/year = metric tons CO2e per year
n/a = not available
N2O = nitrous oxide

Source:

IPCC 1996 - Second Assessment Report

Table N5A. Summary of Alternative 5 Off-Road Construction Emissions

	(metric tons)		CO2e (metric tons)		
	CO2	CH4	CO2	CH4	Total
Iron Gate	3,840.4	0.2	3,840.4	4.0	3,844.4
Copco 1	1,410.4	0.1	1,410.4	1.3	1,411.7
Copco 2	253.9	0.0	253.9	0.5	254.4
J.C. Boyle	666.9	0.0	666.9	0.0	666.9
Total	6,171.6	0.3	6,171.6	5.9	6,177.4
California %	89%	100%	89%	100%	89%
Oregon %	11%	0%	11%	0%	11%

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

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Table N5B. Off-Road Construction Emissions for Iron Gate Dam (Alternative 5)

Maximum Daily Work Hours 14 hours

Dam Removal Duration

Start Date 6/1/2020

End Date 9/23/2020

83 days (5 days/week)

99 days (6 days/week)

Global Warming Potential

CO2 1

CH4 21

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
					CO2	CH4	CO2	CH4	CO2	CH4
1	Crane - crawler, 150-200 ton	Cranes	335	Diesel	163.24	0.01	63.54	0.00	63.54	0.07
1	Crane - rough terrain hydraulic, 50 ton	Cranes	130	Diesel	208.07	0.02	31.43	0.00	31.43	0.05
4	Excavator - 180,000-240,000 lb, Hitachi ZX870 to EX1200	Excavators	646	Diesel	234.10	0.01	702.90	0.03	702.90	0.69
20	Dump truck - articulated, 35 ton, Cat 735	Off-Highway Trucks	435	Diesel	246.84	0.01	2,495.40	0.12	2,495.40	2.59
2	Dozer - D8	Rubber Tired Dozers	347	Diesel	240.08	0.02	193.60	0.02	193.60	0.32
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	191	Gasoline	6,624.02	0.50	18.47	0.00	18.47	0.03
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Onroad	160	Diesel	7,623.11	0.11	11.24	0.00	11.24	0.00
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Onroad	195	Diesel	7,623.11	0.11	13.70	0.00	13.70	0.00
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	323.94	0.02	65.87	0.00	65.87	0.08
1	Engine generator, 6.5 KW	N/A - Offroad diesel engine	13	Diesel	521.64	--	7.88	--	7.88	--
1	Engine generator, 10 KW	N/A - Offroad diesel engine	21	Gasoline	489.89	--	11.95	--	11.95	--
4	Submersible pump, 4" dia, 230 volt	Other Construction Equipment	175	Diesel	275.84	0.01	224.37	0.01	224.37	0.21

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	3,840.37	0.19	3,840.37	4.04
		Total CO2e	3,844.41	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N5C. Off-Road Construction Equipment Emissions for Copco 1 (Alternative 5)

Maximum Daily Work Hours 8

Dam Removal Duration

Start Date 12/30/2019
End Date 4/15/2020

78 (5 days/week)

Global Warming Potential

CO2 1
CH4 21

Quantity		Equipment Description	Rating (hp)	Fuel Type	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
Primary	Secondary				CO2	CH4	CO2	CH4	CO2	CH4
1	1	Crane - crawler, 150-200 ton	335	Diesel	163.24	0.01	68.25	0.00	68.25	0.08
1	1	Crane - rough terrain hydraulic, 50 ton	130	Diesel	208.07	0.02	33.76	0.00	33.76	0.05
1	0	Excavator - hydraulic ram	321	Diesel	211.85	0.01	42.44	0.00	42.44	0.04
1	1	Excavator - 45,000-60,000 lb, Komatsu 220-350	219.5	Diesel	287.66	0.01	78.80	0.00	78.80	0.08
3	0	Excavator - <20,000 lb	168	Diesel	290.62	0.02	91.40	0.01	91.40	0.11
1	0	Loader - WA250 IT	138	Diesel	275.32	0.02	23.71	0.00	23.71	0.03
1	0	Loader - WA450	273	Diesel	214.82	0.01	36.60	0.00	36.60	0.04
2	0	Dump truck - articulated, 30 ton, Cat 730	325	Diesel	246.84	0.01	100.12	0.00	100.12	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Gasoline	6624.02	0.50	60.21	0.00	60.21	0.10
1	1	Pick-up truck, 1/2 ton, on-highway 4x4		Diesel	7623.11	0.11	36.65	0.00	36.65	0.01
1	1	Pick-up truck, 1 ton, on-highway 4x4		Diesel	7623.11	0.11	44.66	0.00	44.66	0.01
1	1	Pick-up truck, 3/4 ton, on-highway 4x4		Gasoline	6624.02	0.50	89.90	0.01	89.90	0.14
1	1	Water tanker, off-highway, 5000 gal	175	Diesel	323.94	0.02	70.75	0.00	70.75	0.09
1	1	Engine generator, 6.5 KW	13	Diesel	521.64	--	8.46	--	8.46	--
1	1	Engine generator, 10 KW	21	Gasoline	489.89	--	12.84	--	12.84	--
4	4	Air compressor, 850-1200 cfm	106	Diesel	305.37	0.02	161.59	0.01	161.59	0.19
4	4	Drills - air/hydraulic track, jackleg, or sinker	291	Diesel	282.17	0.01	409.89	0.01	409.89	0.20
2	2	Submersible pump, 4" dia, 230 volt	53	Diesel	305.37	0.02	40.40	0.00	40.40	0.05

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

g/gal = grams per gallon

g/hp-hr = grams per horsepower-hour

Total	1,410.41	0.06	1,410.41	1.32
		Total CO2e	1,411.73	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N5D. Off-Road Construction Emissions for Copco 2 (Alternative 5)

Quantity	Equipment Description	OFFROAD Category	Rating (hp)	Fuel Type	Fuel Amount (gal)	Total Hours	Peak Daily Hours	2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per year)		2020 CO2e Emissions (metric tons per year)	
								CO2	CH4	CO2	CH4	CO2	CH4
								Maximum Daily Work Hours					
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Cranes	335	Diesel	4,862	440	8	163.24	0.01	24.06	0.00	24.06	0.03
2	Hydraulic yard crane, Grove 4x4x4, 13.6MT, 52' boom	Cranes	130	Diesel	2,670	656	8	208.07	0.02	17.74	0.00	17.74	0.03
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Excavators	321	Diesel	1,512	112	8	211.85	0.01	7.62	0.00	7.62	0.01
1	Hydraulic excavator, 2.5 cy	Excavators	321	Diesel	4,421	328	8	211.85	0.01	22.31	0.00	22.31	0.02
1	Articulated wheel loader, Cat966, 5.0 cy	Rubber Tired Loaders	246	Diesel	2,598	328	8	270.06	0.01	21.79	0.00	21.79	0.02
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Off-Highway Trucks	415	Diesel	3,718	448	8	246.84	0.01	45.89	0.00	45.89	0.05
1	Crawler dozer, Cat238	Crawler Tractors	238	Diesel	1,039	112	8	301.16	0.02	8.03	0.00	8.03	0.01
1	Pick-up truck, 1/2 ton, on-highway 4x4	N/A - Emfac	160	Diesel	845	440	8	7623.11	0.11	6.44	0.00	6.44	0.00
1	Pick-up truck, 1 ton, on-highway 4x4	N/A - Emfac	195	Diesel	1,030	440	8	7623.11	0.11	7.85	0.00	7.85	0.00
1	Water tanker, off-highway, 5000 gal	Off-Highway Trucks	175	Diesel	1,340	224	8	323.94	0.02	12.70	0.00	12.70	0.02
4	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Other Construction Equipment	235	Diesel	5,709	704	8	230.44	0.01	38.12	0.00	38.12	0.03
1	Compactor, Cat, vibratory, self propelled, 84"	Rollers	138	Diesel	263	112	8	280.06	0.02	4.33	0.00	4.33	0.01
1	Engine generator, 6.5 KW	N/A - AP42 3.3-1	13	Diesel	280	400	8	521.64	--	2.71	--	2.71	--
1	Air compressor, 160 cfm, 100 psi	Other Construction Equipment	60	Diesel	242	112	8	305.37	0.02	2.05	0.00	2.05	0.00
1	Air compressor, 250 cfm, 100 psi	Other Construction Equipment	80	Diesel	323	112	8	305.37	0.02	2.74	0.00	2.74	0.00
1	Dump truck, on-highway 8x4, 18 cy	N/A - Emfac	450	Diesel	2,822	224	8	10080.00	0.14	28.45	0.01	28.45	0.30
2	Portable generator 1 KW	N/A - AP42 3.3-1	2.75	Gasoline	112	800	8	489.89	--	1.08	--	1.08	--

Key:
 CH4 = methane
 CO2 = carbon dioxide
 CO2e = carbon dioxide equivalent
 g/gal = grams per gallon
 g/hp-hr = grams per horsepower-hour

Global Warming Potential
 CO2 1
 CH4 21

Total	253.91	0.02	253.91	0.52
		Total CO2e	254.43	

Legend

- Onroad vehicle - emissions estimated by EMFAC2007
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N5E. Off-Road Construction Emissions for JC Boyle (Alternative 5)

Quantity	Equipment Description	Fuel Type	NONROAD Category	Rating (hp)	Fuel Amount (gal)	Total Hours	Maximum Daily Work Hours		2020 Emission Factors (g/hp-hr or g/gal for on-highway)		2020 Emissions (metric tons per)		2020 CO2e Emissions (metric tons per year)					
							8 hours		Peak Daily		CO2		CH4		CO2		CH4	
							Hours	Hours	CO2	CH4	CO2	CH4	CO2	CH4				
1	Lattice boom crane, Manitowoc Crawler, 150T(US), 160'boom	Diesel	Diesel Cranes	335	10,696	968	8	8	228.13	--	73.98	--	73.98	--				
2	Hydraulic yard crane, Grove 4x4x4, 52' boom, 13.6MT	Diesel	Diesel Cranes	130	5,926	1,456	8	8	228.14	--	43.18	--	43.18	--				
1	Hydraulic excavator, 2.5 cy, long reach, Cat H120 Hoe Ram (3000 flb)	Diesel	Diesel Excavators	321	3,240	240	8	8	316.47	--	24.38	--	24.38	--				
1	Hydraulic excavator, 2.5 cy	Diesel	Diesel Excavators	321	9,813	728	8	8	316.47	--	73.96	--	73.96	--				
1	Articulated wheel loader, Cat966, 5.0 cy	Diesel	Diesel Rubber Tire Loaders	246	5,766	728	8	8	316.46	--	56.67	--	56.67	--				
2	Dump truck, Cat740, 22.8-30 cy, 38.1 MT	Diesel	Diesel Off-highway Trucks	415	8,101	976	8	8	316.48	--	128.19	--	128.19	--				
1	Crawler dozer, Cat238	Diesel	Diesel Crawler Tractors	238	2,227	240	8	8	316.48	--	18.08	--	18.08	--				
1	Pick-up truck, 1/2 ton, on-highway 4x4	Diesel	N/A - MOBILE	160	1,859	968	8	8	10177.90	--	18.92	--	18.92	--				
1	Pick-up trucks, 1 ton, on-highway 4x4	Diesel	N/A - MOBILE	195	2,265	968	8	8	10177.90	--	23.05	--	23.05	--				
1	Water tanker, off-highway, 5000 gal	Diesel	Diesel Off-highway Trucks	175	2,918	488	8	8	316.49	--	27.03	--	27.03	--				
4	Concrete Mixer, 8 cy, rear discharge/Concrete pump truck	Diesel	Diesel Cement & Mortar Mixers	235	12,455	1,536	8	8	228.00	--	82.30	--	82.30	--				
1	Compactor, Cat, vibratory, self propelled, 84"	Diesel	Diesel Rollers	138	564	240	8	8	316.45	--	10.48	--	10.48	--				
1	Engine generator, 6.5 KW	Diesel	N/A - AP42 3.3-1	13	610	872	8	8	521.64	--	5.91	--	5.91	--				
1	Air compressor, 160 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	60	647	240	8	8	351.37	--	5.06	--	5.06	--				
1	Air compressor, 250 cfm, 100 psi	Diesel	Diesel Other Construction Equipment	80	691	240	8	8	351.37	--	6.75	--	6.75	--				
1	Dump truck, on-highway 8x4, 18 cy	Diesel	N/A - MOBILE	450	6,149	488	8	8	10828.85	--	66.59	--	66.59	--				
2	Portable generator 1 KW	Gasoline	N/A - AP42 3.3-1	2.75	244	1,744	8	8	489.89	--	2.35	--	2.35	--				

Key:
CH4 = methane
CO2 = carbon dioxide
CO2e = carbon dioxide equivalent
g/gal = grams per gallon
g/hp-hr = grams per horsepower-hour

Global Warming Potential

CO2 1
CH4 21

Total	666.88	0.00	666.88	0.00
		Total CO2e	666.88	

Legend

- Onroad vehicle - emissions estimated by MOBILE6.2
- Stationary source - emissions estimated by AP-42 for diesel engines

Table N5F. Construction Worker Commute Emissions
Alternative 5 - Fish Passage at Two Dams, Remove Copco 1 and Iron Gate

Round-Trip Commute Distance: 30 miles

Dam	Peak Workers	Duration (Days)	State
J.C. Boyle	17	47	Oregon
Copco 1	56	78	California
Copco 2	15	69	California
Iron Gate	80	83	California

Dam	Annual Emissions, metric tons/year (2020)		
	CO2	CH4	N2O
J.C. Boyle	11.24	n/a	n/a
Copco 1	59.72	0.00	n/a
Copco 2	14.15	0.00	n/a
Iron Gate	90.79	0.01	n/a
Total	175.90	0.01	0.00
GWP	1	21	310
Dam	CO2e Emissions, MTCO2e/year		
J.C. Boyle	11.24	n/a	n/a
Copco 1	59.72	0.08	n/a
Copco 2	14.15	0.02	n/a
Iron Gate	90.79	0.13	n/a
Total	175.90	0.23	0.00
Total CO2e	176.13		
California Total	164.90		
Oregon Total	11.24		

94%
6%

Note:

Emission factors for N2O are not available in the EMFAC and MOBILE6 emission factor models.

Key:

CH4 = methane

CO2 = carbon dioxide

CO2e = carbon dioxide equivalent

GWP = global warming potential

MTCO2e/year = metric tons CO2e per year

n/a = not available

N2O = nitrous oxide

**Table N5G. Annual Haul Truck Emissions
Alternative 5 - Fish Passage at Two Dams, Remove Copco 1 and Iron Gate**

Dam	Waste Material	Annual Trips	Round Trip Distance (mi)	Annual Emissions (tons per year) - 2020			CO ₂ e Emissions (MTCO ₂ e/year)				
				CO ₂	CH ₄	N ₂ O	CO ₂	CH ₄	N ₂ O	Total	
J.C. Boyle	Concrete (In)	350	148	72.29	n/a	n/a	72	n/a	n/a	n/a	72
	Rebar	6	121	1.01	n/a	n/a	1	n/a	n/a	n/a	1
	Wood	3	121	0.51	n/a	n/a	1	n/a	n/a	n/a	1
	J.C. Boyle Subtotal	359	390	73.81	0.00	0.00	74	0.00	0.00	0.00	74
Copco 1 (California)	Concrete (Out)	4,000	2	15.20	0.00	n/a	15	0.0044	n/a	n/a	15
	Metal	170	62	20.02	0.00	n/a	20	0.0058	n/a	n/a	20
	Building Waste	30	62	3.53	0.00	n/a	4	0.0010	n/a	n/a	4
	Copco 1 Subtotal	4,200	126	38.76	0.00	0.00	39	0.011	0.00	0.00	39
Copco 2 (California)	Concrete (In)	125	59	14.01	0.00	n/a	14	0.0041	n/a	n/a	14
	Rebar	2	120	0.46	0.00	n/a	0	0.00013	n/a	n/a	0
	Wood	2	120	0.46	0.00	n/a	0	0.00013	n/a	n/a	0
	Copco 2 Subtotal	129	299	14.92	0.00021	0.00	15	0.0043	0.00	0.00	15
Iron Gate (California)	Earth	60,000	2	227.98	0.00	n/a	228	0.066	n/a	n/a	228
	Concrete (Out)	750	2	2.85	0.00	n/a	3	0.00083	n/a	n/a	3
	Metal	130	54	13.34	0.00	n/a	13	0.00388	n/a	n/a	13
	Building Waste	40	54	4.10	0.00	n/a	4	0.00119	n/a	n/a	4
	Iron Gate Subtotal	60,920	112	248.27	0.00	0.00	248	0.072	0.00	0.00	248
	Grand Total	65,608	927	375.76	0.0042	0.00	376	0.09	0.00	0.00	376
	California Total	65,249	537	302	0.0042	0.00	302	0.09	0.00	0.00	302
	Oregon Total	359	390	74	0.00	0.00	74	0.00	0.00	0.00	74
	California %	99%	58%	80%	100%	0%	80%	100%	0%	0%	80%
	Oregon %	1%	42%	20%	0%	0%	20%	0%	0%	0%	20%

Key: Global Warming Potential

CH₄ = methane
CO₂ = carbon dioxide
CO₂e = carbon dioxide equivalent
mi = miles
MTCO₂e/year = metric tons CO₂e per year
n/a = not available
N₂O = nitrous oxide

Source: IPCC 1996 - Second Assessment Report

Table N6A. Generation Resource Mix for Electricity Emissions

NWPP			
Nonrenewable Resource	Fuel Mix %	MWh	
Coal	32.0%	86,260,263.9	
Oil	0.2%	602,465.1	
Gas	12.8%	34,485,140.6	
Other Fossil	0.3%	778,321.0	
Nuclear	3.0%	8,108,560.0	
Other Unknown / Purchased Fuel	0.1%	137,632.7	
Nonrenewable Total	48.3%	130,372,383.4	
<hr/>			
Grand Total	100.0%	269,912,352.3	

Renewable Resource	Fuel Mix %	MWh
Wind	1.9%	5,090,845.3
Solar	0.0%	0.0
Geothermal	0.3%	925,122.0
Biomass	1.1%	2,979,437.1
Hydro	48.4%	130,544,564.6
Renewable Total	51.7%	139,539,969.0
Nonhydro Renewable Total	3.3%	8,995,404.4

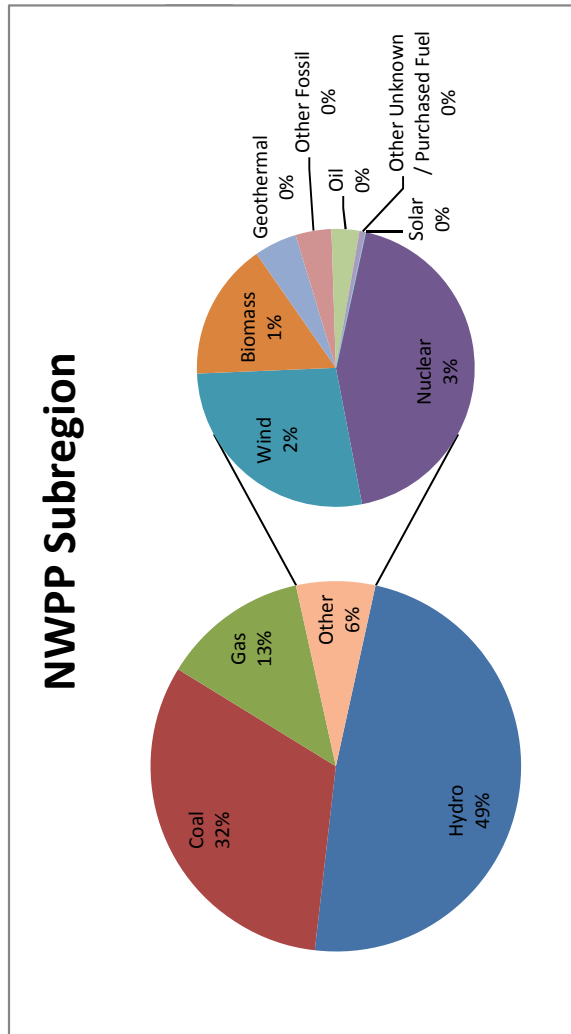


Table N6B. Electricity Emissions Profile – Base Load (Off-Peak)

PacifiCorp		Natural Gas	
Capacity (MW):	12,171.2	Capacity (MW):	437,528.6
Net Generation (MWh):	67,961,659.9	Net Generation (MWh):	894,494,854.6
Heat Input (MMBtu):	646,819,058.7	Heat Input (MMBtu):	7,049,211,251.1

Annual Emissions		Output Emission Rates			
Pollutant	Emissions	Units	Pollutant	Emission Rate	Units
CO2	62,507,461.8	tons	CO2	943.64	lb/MWh
CH4	1,790,449.1	lbs	CH4	38.53	lb/GWh
N2O	2,040,423.8	lbs	N2O	4.09	lb/GWh

Annual Emissions		Output Emission Rates			
Pollutant	Emissions	Units	Pollutant	Emission Rate	Units
CO2	1,839.49	lb/MWh	CO2	422,039,953.7	tons
CH4	26.34	lb/GWh	CH4	17,230,682.8	lbs
N2O	30.02	lb/GWh	N2O	1,829,313.3	lbs

Generation Capacity	
Dam	Capacity (MW)
Iron Gate	119,206.0
Copco 1	95,316.0
Copco 2	119,854.0
John C Boyle	279,767.0
Total	614,143.0
	163.7

Adjusted Emissions - Iron Gate, Copco 1, Copco 2, and Iron Gate Removed	
Net Generation (MWh):	67,347,516.9

Adjusted Emissions - Iron Gate, Copco 1, Copco 2, and Iron Gate Removed		
Pollutant	Emission Rate	Units
CO2	1,856.27	lb/MWh
CH4	26.59	lb/GWh
N2O	30.30	lb/GWh

Adjusted Emissions - Iron Gate and Copco 1 Removed	
Net Generation (MWh):	67,747,137.9

Adjusted Emissions - Iron Gate and Copco 1 Removed		
Pollutant	Emission Rate	Units
CO2	1,845.32	lb/MWh
CH4	26.43	lb/GWh
N2O	30.12	lb/GWh

Table N6C. Potential Emissions from Power Replacement (Alternatives 2 and 3)

Alt	Annual Total Output Emission Rates Base Load (Off-Peak)			
	CO2 (lb/MWh)	CH4 (lb/GWh)	N2O (lb/GWh)	
Off-Peak	1,856.27	26.59	30.30	(PacifiCorp PCA Resource Mix)
On-Peak	943.64	38.53	4.09	(Natural Gas)
33% RPS	1,363.68	19.53	22.26	

Iron Gate and Copco 1 Removed

Peaking Power (Natural Gas)

Pollutant	State	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
			CO2	CH4	N2O	CO2	CH4	N2O	Total
Iron Gate	California	74,571	31,919	1.3	0.1	31,919	27	43	31,989
Copco 1	California	68,143	29,167	1.2	0.1	29,167	25	39	29,232
Copco 2	California	86,786	37,147	1.5	0.2	37,147	32	50	37,229
JC Boyle	Oregon	211,500	90,529	3.7	0.4	90,529	78	122	90,729
Total		441,000	188,763	7.7	0.8	188,763	162	254	189,179
Total California		229,500	98,234	4.0	0.4	98,234	84	132	98,450
Total Oregon		211,500	90,529	3.7	0.4	90,529	78	122	90,729

Generation based on FERC EIS (Table 4-8), Average Annual Generation (MWh)

Off-Peak (PacifiCorp PCA Resource Mix)

Pollutant	State	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
			CO2	CH4	N2O	CO2	CH4	N2O	Total
Iron Gate	California	41,429	34,883	0.5	0.6	34,883	10	176	35,070
Copco 1	California	37,857	31,876	0.5	0.5	31,876	10	161	32,047
Copco 2	California	48,214	40,597	0.6	0.7	40,597	12	205	40,814
JC Boyle	Oregon	117,500	98,935	1.4	1.6	98,935	30	501	99,466
Total		245,000	206,291	3.0	3.4	206,291	62	1,044	207,396
Total California		127,500	107,355	1.5	1.8	107,355	32	543	107,931
Total Oregon		117,500	98,935	1.4	1.6	98,935	30	501	99,466

Generation based on FERC EIS (Table 4-8), Average Annual Generation (MWh)

Total Emissions (Existing Grid)

Pollutant	State	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
			CO2	CH4	N2O	CO2	CH4	N2O	Total
Iron Gate	California	116,000	66,802	1.8	0.7	66,802	38	219	67,059
Copco 1	California	106,000	61,043	1.6	0.6	61,043	35	200	61,278
Copco 2	California	135,000	77,744	2.1	0.8	77,744	44	255	78,043
JC Boyle	Oregon	329,000	189,465	5.1	2.0	189,465	107	622	190,194
Total		686,000	395,054	10.7	4.2	395,054	224	1,297	396,575
Total California		357,000	205,589	5.5	2.2	205,589	117	675	206,381
Total Oregon		329,000	189,465	5.1	2.0	189,465	107	622	190,194

Generation based on FERC EIS (Table 4-8), Average Annual Generation (MWh)

Table N6C. Potential Emissions from Power Replacement (Alternatives 2 and 3) (continued)

Off-Peak (33% RPS)

Pollutant	State	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
			CO2	CH4	N2O	CO2	CH4	N2O	Total
Iron Gate	California	41,429	25,626	0.4	0.4	25,626	8	130	25,764
Copco 1	California	37,857	23,417	0.3	0.4	23,417	7	118	23,543
Copco 2	California	48,214	29,824	0.4	0.5	29,824	9	151	29,983
JC Boyle	Oregon	117,500	72,681	1.0	1.2	72,681	22	368	73,071
Total		245,000	151,548	2.2	2.5	151,548	46	767	152,360
Total California		127,500	78,867	1.1	1.3	78,867	24	399	79,290
Total Oregon		117,500	72,681	1.0	1.2	72,681	22	368	73,071

Generation based on FERC EIS (Table 4-8), Average Annual Generation (MWh)

Total Emissions (33% RPS)

Pollutant	State	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
			CO2	CH4	N2O	CO2	CH4	N2O	Total
Iron Gate	California	116,000	57,545	1.7	0.6	57,545	35	173	57,753
Copco 1	California	106,000	52,585	1.5	0.5	52,585	32	158	52,774
Copco 2	California	135,000	66,971	1.9	0.6	66,971	41	201	67,212
JC Boyle	Oregon	329,000	163,210	4.7	1.6	163,210	99	489	163,799
Total		686,000	340,311	9.9	3.3	340,311	207	1,020	341,539
Total California		357,000	177,101	5.1	1.7	177,101	108	531	177,740
Total Oregon		329,000	163,210	4.7	1.6	163,210	99	489	163,799

Generation based on FERC EIS (Table 4-8), Average Annual Generation (MWh)

GWP

CO2	1
CH4	21
N2O	310

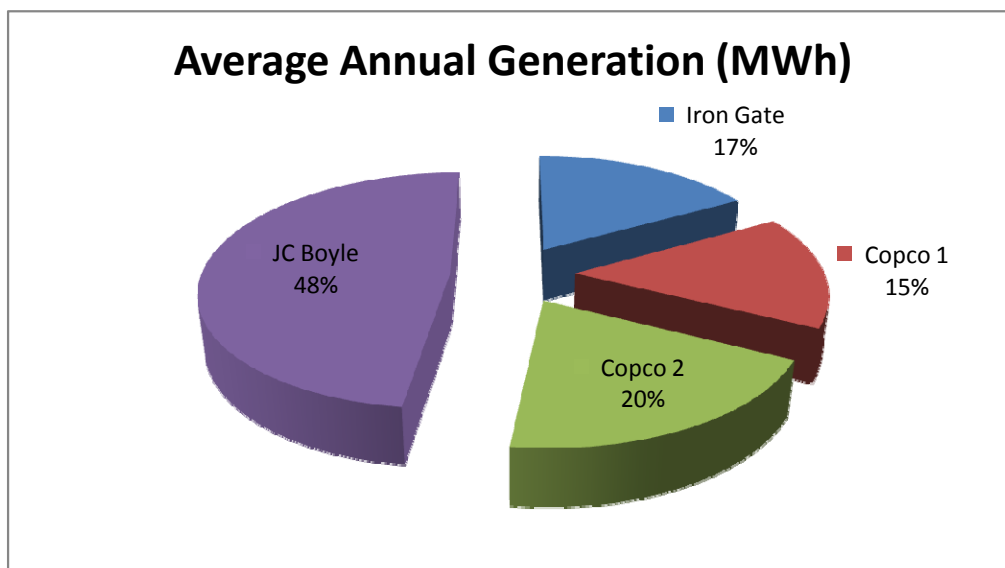


Table N6D. Potential Emissions from Power Replacement (Alternative 4)

Alt	Annual Total Output Emission Rates Base Load (Off-Peak)			
	CO2 (lb/MWh)	CH4 (lb/GWh)	N2O (lb/GWh)	
Off-Peak	1,839.49	26.34	30.02	(PacifiCorp PCA Resource Mix)
On-Peak	943.64	38.53	4.09	(Natural Gas)
33% RPS	1,351.35	19.35	22.06	

Fish Passage Alternative

Baseline (all dams)	686,000 MWh	(Includes Iron Gate, Copco, and JC Boyle)
Average Annual Electricity Generation	533,879 MWh	(FERC EIS, Section 4.4)
Difference	152,121 MWh	

Total Emissions (Existing Grid)

Pollutant	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
		CO2	CH4	N2O	CO2	CH4	N2O	Total
On-Peak	97,792	41,858	1.7	0.2	41,858	36	56	41,951
Off-Peak	54,329	45,332	0.6	0.7	45,332	14	229	45,575
Total	152,121	87,190	2.4	0.9	87,190	50	286	87,525

Total Emissions (33% RPS)

Pollutant	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
		CO2	CH4	N2O	CO2	CH4	N2O	Total
On-Peak	97,792	41,858	1.7	0.2	41,858	36	56	41,951
Off-Peak	54,329	33,302	0.5	0.5	33,302	10	168	33,481
Total	152,121	75,161	2.2	0.7	75,161	46	225	75,431

GWP

CO2	1
CH4	21
N2O	310

Table N6E. Potential Emissions from Power Replacement (Alternative 5)

Alt	Annual Total Output Emission Rates			
	Base Load (Off-Peak)			
	CO2 (lb/MWh)	CH4 (lb/GWh)	N2O (lb/GWh)	
Off-Peak	1,845.32	26.43	30.12	(PacifiCorp PCA Resource Mix)
On-Peak	943.64	38.53	4.09	(Natural Gas)
33% RPS	1,355.63	19.42	22.13	

Fish Passage Alternative

Baseline (all dams)	686,000 MWh	(Includes Iron Gate, Copco, and JC Boyle)
Average Annual Electricity Generation	443,694 MWh	(FERC EIS, Section 4.4)
Difference	242,306 MWh	

Total Emissions (Existing Grid)

Pollutant	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
		CO2	CH4	N2O	CO2	CH4	N2O	Total
On-Peak	155,768	66,674	2.7	0.3	66,674	57	90	66,821
Off-Peak	86,538	72,435	1.0	1.2	72,435	22	366	72,824
Total	242,306	139,109	3.8	1.5	139,109	79	456	139,644

Total Emissions (33% RPS)

Pollutant	Generation (MWh)	Annual Emissions (metric ton/year)			Annual CO2e Emissions (MTCO2e/yr)			
		CO2	CH4	N2O	CO2	CH4	N2O	Total
On-Peak	155,768	66,674	2.7	0.3	66,674	57	90	66,821
Off-Peak	86,538	53,213	0.8	0.9	53,213	16	269	53,499
Total	242,306	119,888	3.5	1.2	119,888	73	359	120,320

GWP

CO2	1
CH4	21
N2O	310

Table N7A. Power Replacement and CH4 from Impounded Reservoirs Emissions (With Methane Generation from Reservoirs)

Alternative	Power Replacement and CH4 from Impounded Reservoirs Emissions (MTCO2e/yr)		33 Percent RPS	
	Current Resource Mix		Low	High
	Low	High	Low	High
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

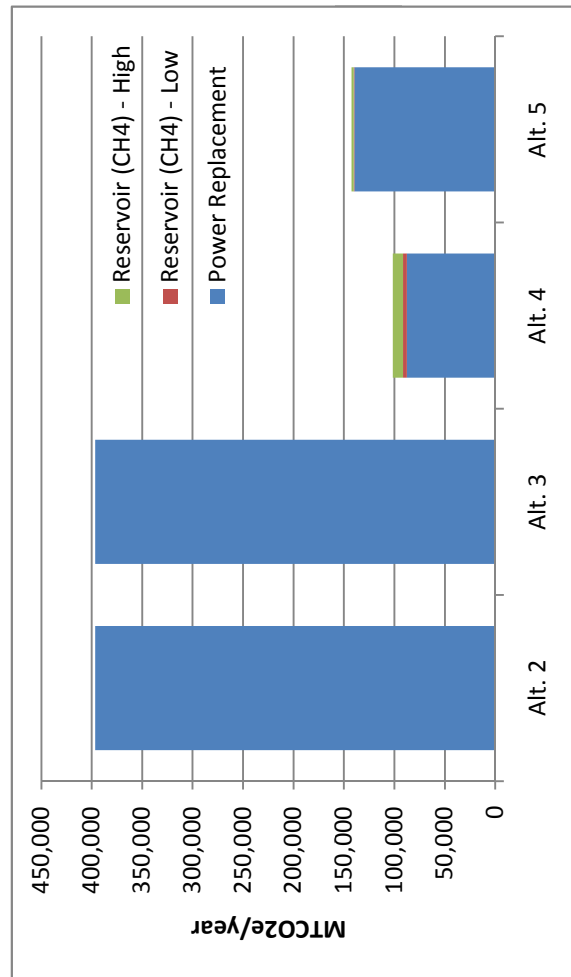


Table N7B. Estimated Methane Emissions from All Reservoirs

KHP Reservoir Area ¹ (m ²)	CH ₄ Flux		CH ₄ Mass Flow Rate ⁴ (MT CH ₄ /d)	CH ₄ Mass Flow Rate ⁵ (MT CH ₄ /yr)	GWP per Year ⁶ (MT CO ₂ e/yr)	KHP CO ₂ Displacement ⁷ (MT CO ₂ /yr)	GWP of CH ₄ Emissions as % of Displacement ⁸ (%)
	Source	(mg CH ₄ /m ² d)					
19,582,738	Lake Shasta ²	11	0.215	79	1,651	265,455	0.62%
19,582,738	Lake Mendota ³	50	0.979	357	7,505	265,455	2.83%
19,582,738	Priest Pot ³	100	1.958	715	15,010	265,455	5.65%
19,582,738	Flooded Rainforest Reservoir ²	193	3.779	1,380	28,970	265,455	10.91%
19,582,738		500	9.791	3,574	75,051	265,455	28.27%

Notes:

¹Area (m²) = Keno + JC Boyle + Copco + Iron Gate = 2475 + 420 + 1000 + 944 = 4389 acres, unit conversion to m² = 19582738

²Source: Soumis et al. (2004)

³Source: Bastviken et al. (2004)

⁴CH₄ mass flow rate (MT CH₄/d) = (CH₄ flux) * (Area)

⁵CH₄ mass flow rate (MT CH₄/yr) = (CH₄ mass flow rate) * (365 d/yr)

⁶GWP per year (MT CO₂e/yr) = (CH₄ mass flow rate) * (23) because CH₄ is 23 times more potent than CO₂ on a mass basis (IPCC 2001)

⁷KHP Carbon Displacement = Amount of carbon that would be released annually from a natural gas power plant that would replace KHP generation.

(101 kg C/MWh) * (KHP generation 716,800 MWh/yr) * (3.66666666666667 kg CO₂/kg C) / (unit conversion 1000 kg/MT) [Source: FERC DEIS and Table 3]

⁸GWP of CH₄ Emissions as % of Displacement = (GWP per year) / (KHP Carbon Displacement)

Table Source:

Karuk Tribe of California. 2006. Comments on Draft EIS in Klamath Hydroelectric Project Docket for Filing: P-2082-027 (Klamath). Submitted to FERC by the Karuk Tribe of California, Orleans, CA. 60 p. Available online at: <[http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040\(16445270\).pdf](http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040(16445270).pdf)>

Replacement Power Estimate (Current Grid)	396,575	MTCO ₂ e/year
Range of Replaced Power	2% to 7%	
Replacement Power Estimate (33% RPS)	341,539	MTCO ₂ e/year
Range of Replaced Power	2% to 8%	

Reservoir	Area (acres)
Keno	2,475
JC Boyle	420
Copco	1,000
Iron Gate	944
Total	4,839

CH₄ GWP 21

Table N7C. Estimated Methane Emissions from All Reservoirs Excluding Keno

KHP Reservoir Area ¹ (m ²)	CH ₄ Flux		CH ₄ Mass Flow Rate ⁴ (MT CH ₄ /d)	CH ₄ Mass Flow Rate ⁵ (MT CH ₄ /yr)	GWP per Year ⁶ (MT CO ₂ e/yr)	KHP CO ₂ Displacement ⁷ (MT CO ₂ /yr)	GWP of CH ₄ Emissions as % of Displacement ⁸ (%)
	Source	(mg CH ₄ /m ² d)					
9,566,769	Lake Shasta ²	11	0.105	38	807	265,455	0.30%
9,566,769	Lake Mendota ³	50	0.478	175	3,666	265,455	1.38%
9,566,769		100	0.957	349	7,333	265,455	2.76%
9,566,769	Priest Pot ³	193	1.846	674	14,153	265,455	5.33%
9,566,769	Flooded Rainforest Reservoir ²	500	4.783	1,746	36,665	265,455	13.81%

Notes:

¹Area (m²) = Keno + JC Boyle + Copco + Iron Gate = 2475 + 420 + 1000 + 944 = 4389 acres, unit conversion to m² = 19582738

²Source: Soumis et al. (2004)

³Source: Bastviken et al. (2004)

⁴CH₄ mass flow rate (MT CH₄/d) = (CH₄ flux)*(Area)

⁵CH₄ mass flow rate (MT CH₄/yr) = (CH₄ mass flow rate)*(365 d/yr)

⁶GWP per year (MT CO₂e/yr) = (CH₄ mass flow rate)*(23) because CH₄ is 23 times more potent than CO₂ on a mass basis (IPCC 2001)

⁷KHP Carbon Displacement = Amount of carbon that would be released annually from a natural gas power plant that would replace KHP generation.

(101 kg C/(MWh))*(KHP generation 716,800 MWh/yr)*(3.66666666666667 kg CO₂/kg C)/(unit conversion 1000 kg/MT) [Source: FERC DEIS and Table 3]

⁸GWP of CH₄ Emissions as % of Displacement = (GWP per year)/(KHP Carbon Displacement)

Table Source:

Karuk Tribe of California. 2006. Comments on Draft EIS in Klamath Hydroelectric Project Docket for Filing: P-2082-027 (Klamath). Submitted to FERC by the Karuk Tribe of California, Orleans, CA. 60 p. Available online at: <[http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040\(164445270\).pdf](http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040(164445270).pdf)>

Replacement Power Estimate (Current Grid) 396,575 MTCO₂e/year
Range of Replaced Power 1% to 4%

Replacement Power Estimate (Current Grid) 341,539 MTCO₂e/year
Range of Replaced Power 1% to 4%

Table N7C. Estimated Methane Emissions from All Reservoirs Excluding Keno (continued)

Scenario	Annual CO ₂ e Emissions (MTCO ₂ e/year)	CH ₄ Emissions from Reservoirs (MTCO ₂ e/year)		Adjusted Emissions (MTCO ₂ e/year)	
		Low	High	Low	High
<i>Alternative 2 and 3</i>					
Current Grid	396,575	4,000	14,000	392,575	382,575
33% RPS	341,539	4,000	14,000	337,539	327,539
<i>Alternative 4</i>					
Current Grid	87,525	4,000	14,000	91,525	101,525
33% RPS	75,431	4,000	14,000	79,431	89,431

Reservoir	Area (acres)
Keno	--
JC Boyle	420
Copco	1,000
Iron Gate	944
Total	2,364

CH₄ GWP 21

Table N7D. Estimated Methane Emissions from JC Boyle Reservoir

KHP Reservoir Area ¹ (m ²)	CH ₄ Flux		CH ₄ Mass Flow Rate ⁴ (MT CH ₄ /d)	CH ₄ Mass Flow Rate ⁵ (MT CH ₄ /yr)	GWP per Year ⁶ (MT CO ₂ e/yr)	KHP CO ₂ Displacement ⁷ (MT CO ₂ /yr)	GWP of CH ₄ Emissions as % of Displacement ⁸ (%)
	Source	(mg CH ₄ /m ² d)					
1,699,680	Lake Shasta ²	11	0.019	7	143	265,455	0.05%
1,699,680	Lake Mendota ³	50	0.085	31	651	265,455	0.25%
1,699,680		100	0.170	62	1,303	265,455	0.49%
1,699,680	Priest Pot ³	193	0.328	120	2,514	265,455	0.95%
1,699,680	Flooded Rainforest Reservoir ²	500	0.850	310	6,514	265,455	2.45%

Notes:

¹Area (m²) = Keno + JC Boyle + Copco + Iron Gate = 2475 + 420 + 1000 + 944 = 4389 acres, unit conversion to m² = 19582738

²Source: Soumis et al. (2004)

³Source: Bastviken et al. (2004)

⁴CH₄ mass flow rate (MT CH₄/d) = (CH₄ flux)*(Area)

⁵CH₄ mass flow rate (MT CH₄/yr) = (CH₄ mass flow rate)*(365 d/yr)

⁶GWP per year (MT CO₂e/yr) = (CH₄ mass flow rate)*(23) because CH₄ is 23 times more potent than CO₂ on a mass basis (IPCC 2001)

⁷KHP Carbon Displacement = Amount of carbon that would be released annually from a natural gas power plant that would replace KHP generation.

(101 kg C/MWh)*(KHP generation 716,800 MWh/yr)*(3.66666666666667 kg CO₂/kg C)/(unit conversion 1000 kg/MT) [Source: FERC DEIS and Table 3]

⁸GWP of CH₄ Emissions as % of Displacement = (GWP per year)/(KHP Carbon Displacement)

Table Source:

Karuk Tribe of California. 2006. Comments on Draft EIS in Klamath Hydroelectric Project Docket for Filing: P-2082-027 (Klamath). Submitted to FERC by the Karuk Tribe of California, Orleans, CA. 60 p. Available online at: <[http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040\(16445270\).pdf](http://www.klamathwaterquality.com/documents/karuk_comments_20061201-5040(16445270).pdf)>

Replacement Power Estimate (Current Grid) 139,644 MTCO₂e/year
Range of Replaced Power 0.5% to 2%

Replacement Power Estimate (Current Grid) 120,320 MTCO₂e/year
Range of Replaced Power 0.5% to 2%

Table N7D. Estimated Methane Emissions from JC Boyle Reservoir (continued)

Adjusted Power Replacement Emissions With Methane Emissions from Reservoirs					
Scenario	Annual CO₂e Emissions (MTCO₂e/year)	CH₄ Emissions from Reservoirs (MTCO₂e/year)		Adjusted Emissions (MTCO₂e/year)	
		Low	High	Low	High
<i>Alternative 5</i>					
Current Grid	139,644	700	3,000	140,344	142,644
33% RPS	120,320	700	3,000	121,020	123,320

Reservoir	Area (acres)
Keno	--
JC Boyle	420
Copco	--
Iron Gate	--
Total	420

CH₄ GWP 21

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Table N8A. Summary of EMFAC2007 Emission Factors

Emission Factors (g/mi) - 2019															
Source	ROG	TOG	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2	CH4
Construction Workers	0.551	0.588	4.680	0.487	0.004	0.041	0.021	0.008	0.013	0.027	0.019	0.002	0.005	351.872	0.033
Pick-up Trucks (Gasoline)	0.442	0.476	3.714	0.465	0.005	0.052	0.031	0.008	0.013	0.037	0.029	0.002	0.005	503.354	0.031
Pick-up Trucks (Diesel)	0.082	0.094	0.638	1.477	0.003	0.074	0.053	0.008	0.013	0.056	0.049	0.002	0.005	346.620	0.004
Heavy-Duty Diesel Trucks	0.628	0.715	2.737	7.691	0.018	0.317	0.253	0.036	0.028	0.254	0.233	0.009	0.012	1901.576	0.029
Emission Factors (g/mi) - 2020															
Construction Workers	0.506	0.539	4.201	0.439	0.004	0.041	0.021	0.008	0.013	0.026	0.019	0.002	0.005	337.274	0.030
Pick-up Trucks (Gasoline)	0.413	0.444	3.396	0.423	0.005	0.052	0.031	0.008	0.013	0.037	0.029	0.002	0.005	503.380	0.029
Pick-up Trucks (Diesel)	0.081	0.092	0.630	1.482	0.003	0.073	0.052	0.008	0.013	0.055	0.048	0.002	0.005	346.726	0.004
Heavy-Duty Diesel Trucks	0.566	0.645	2.498	6.793	0.018	0.283	0.219	0.036	0.028	0.223	0.202	0.009	0.012	1899.853	0.026
Emission Factors (g/mi) - 2023															
Construction Workers	0.387	0.412	2.867	0.312	0.004	0.040	0.020	0.008	0.013	0.026	0.018	0.002	0.005	319.237	0.023
Pick-up Trucks (Gasoline)	0.344	0.370	2.600	0.319	0.005	0.052	0.032	0.008	0.013	0.037	0.029	0.002	0.005	503.455	0.024
Pick-up Trucks (Diesel)	0.078	0.089	0.617	1.492	0.003	0.072	0.051	0.008	0.013	0.055	0.047	0.002	0.005	347.164	0.004
Heavy-Duty Diesel Trucks	0.434	0.494	1.984	4.916	0.018	0.213	0.148	0.036	0.028	0.158	0.137	0.009	0.012	1895.307	0.020
Emission Factors (g/mi) - 2024															
Construction Workers	0.352	0.375	2.554	0.278	0.004	0.040	0.019	0.008	0.013	0.025	0.018	0.002	0.005	314.182	0.021
Pick-up Trucks (Gasoline)	0.325	0.349	2.412	0.291	0.005	0.052	0.032	0.008	0.013	0.037	0.029	0.002	0.005	503.489	0.023
Pick-up Trucks (Diesel)	0.076	0.086	0.611	1.493	0.003	0.070	0.050	0.008	0.013	0.053	0.046	0.002	0.005	347.107	0.004
Heavy-Duty Diesel Trucks	0.407	0.463	1.880	4.544	0.018	0.198	0.134	0.036	0.028	0.144	0.123	0.009	0.012	1894.343	0.019
Emission Factors (g/mi) - 2025															
Construction Workers	0.322	0.343	2.297	0.248	0.004	0.040	0.019	0.008	0.013	0.025	0.018	0.002	0.005	309.680	0.019
Pick-up Trucks (Gasoline)	0.309	0.332	2.260	0.267	0.005	0.052	0.032	0.008	0.013	0.037	0.029	0.002	0.005	503.549	0.022
Pick-up Trucks (Diesel)	0.074	0.084	0.608	1.493	0.003	0.068	0.048	0.008	0.013	0.051	0.044	0.002	0.005	346.702	0.003
Heavy-Duty Diesel Trucks	0.386	0.439	1.800	4.261	0.018	0.187	0.122	0.036	0.028	0.134	0.113	0.009	0.012	1893.663	0.018

Emission Factors (g/gal) - 2019															
Source	ROG	TOG	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2	CH4
Pick-up Trucks (Gasoline)	3.099	3.675	64.564	8.089	0.085	0.903	0.546	0.139	0.218	0.635	0.506	0.035	0.093	6853.123	0.535
Pick-up Trucks (Diesel)	2.391	2.721	18.554	42.953	0.096	2.139	1.542	0.233	0.365	1.633	1.419	0.058	0.156	7895.515	0.111
Heavy-Duty Gasoline Vehicles	38.397	41.971	1079.229	102.086	0.085	0.651	0.179	0.141	0.331	0.343	0.166	0.035	0.142	7040.659	3.104
Heavy-Duty Diesel Trucks	3.329	3.790	14.509	40.768	0.096	1.683	1.342	0.191	0.150	1.347	1.235	0.048	0.064	10080.002	0.155
Emission Factors (g/gal) - 2020															
Pick-up Trucks (Gasoline)	2.765	3.302	59.094	7.358	0.085	0.904	0.547	0.139	0.218	0.636	0.507	0.035	0.094	6624.024	0.501
Pick-up Trucks (Diesel)	2.340	2.664	18.312	43.091	0.096	2.110	1.512	0.233	0.365	1.606	1.391	0.058	0.156	7623.113	0.109
Heavy-Duty Gasoline Vehicles	30.459	33.476	977.395	98.842	0.085	0.668	0.181	0.145	0.342	0.351	0.168	0.036	0.146	7226.011	2.641
Heavy-Duty Diesel Trucks	3.004	3.420	13.256	36.040	0.096	1.504	1.163	0.191	0.150	1.182	1.070	0.048	0.064	10080.002	0.140
Emission Factors (g/gal) - 2023															
Pick-up Trucks (Gasoline)	2.023	2.474	45.355	5.560	0.085	0.909	0.551	0.140	0.219	0.639	0.511	0.035	0.094	6642.214	0.424
Pick-up Trucks (Diesel)	2.279	2.594	17.903	43.325	0.096	2.084	1.487	0.232	0.364	1.583	1.368	0.058	0.156	7623.112	0.106
Heavy-Duty Gasoline Vehicles	20.409	22.792	813.006	91.566	0.085	0.696	0.187	0.152	0.357	0.364	0.174	0.038	0.153	7516.216	2.127
Heavy-Duty Diesel Trucks	2.306	2.626	10.551	26.147	0.096	1.131	0.789	0.191	0.150	0.838	0.726	0.048	0.064	10079.996	0.107
Emission Factors (g/gal) - 2024															
Pick-up Trucks (Gasoline)	1.820	2.249	42.095	5.076	0.085	0.910	0.552	0.140	0.219	0.641	0.512	0.035	0.094	6646.593	0.404
Pick-up Trucks (Diesel)	2.205	2.511	17.740	43.355	0.096	2.036	1.439	0.232	0.364	1.538	1.324	0.058	0.156	7623.115	0.102
Heavy-Duty Gasoline Vehicles	18.285	20.541	776.986	90.334	0.085	0.704	0.191	0.153	0.360	0.370	0.177	0.038	0.154	7579.538	2.025
Heavy-Duty Diesel Trucks	2.164	2.464	10.002	24.177	0.096	1.054	0.712	0.192	0.150	0.767	0.655	0.048	0.064	10080.007	0.101
Emission Factors (g/gal) - 2025															
Pick-up Trucks (Gasoline)	1.658	2.067	39.462	4.661	0.085	0.912	0.553	0.140	0.219	0.642	0.513	0.035	0.094	6650.133	0.387
Pick-up Trucks (Diesel)	2.150	2.448	17.664	43.395	0.096	1.989	1.392	0.233	0.365	1.495	1.281	0.058	0.156	7623.111	0.100
Heavy-Duty Gasoline Vehicles	14.981	17.039	710.425	89.275	0.085	0.717	0.196	0.155	0.365	0.377	0.182	0.039	0.157	7694.584	1.866
Heavy-Duty Diesel Trucks	2.055	2.339	9.581	22.680	0.096	0.993	0.652	0.192	0.150	0.712	0.599	0.048	0.064	10080.004	0.095

Notes:
Construction workers emissions only include LDA, LDT1, and LDT2 vehicle types, based on guidance from URBEMIS2007 User's Guide.
CO2 emission factors for construction workers adjusted to reflect the Pavley and LCFS using CARB's Pavley post-processor.
Pick-up trucks use LDT2 emission factors.

Table N8B. Summary of MOBILE 6.2 Emission Factors

Emission Factors (g/mi) - 2019													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	0.530	10.446	0.408	0.009	0.024	0.004	0.008	0.013	0.011	0.004	0.002	0.005	467.9
Pick-Up Trucks (Gasoline)	0.596	10.789	0.473	0.009	0.024	0.004	0.008	0.013	0.011	0.004	0.002	0.005	516.1
Pick-Up Trucks (Diesel)	0.228	0.486	0.295	0.006	0.039	0.018	0.008	0.013	0.024	0.017	0.002	0.005	598.7
Heavy-Duty Gasoline Vehicles	0.498	8.250	0.713	0.016	0.036	0.015	0.009	0.013	0.021	0.013	0.002	0.005	905.9
Heavy-Duty Diesel Trucks	0.271	0.517	1.921	0.013	0.072	0.033	0.026	0.013	0.042	0.030	0.007	0.005	1395.4
Emission Factors (g/mi) - 2020													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	0.504	10.304	0.396	0.009	0.024	0.004	0.008	0.013	0.011	0.004	0.002	0.005	468.8
Pick-Up Trucks (Gasoline)	0.564	10.613	0.459	0.009	0.024	0.004	0.008	0.013	0.011	0.003	0.002	0.005	516.1
Pick-Up Trucks (Diesel)	0.212	0.465	0.271	0.006	0.038	0.017	0.008	0.013	0.023	0.016	0.002	0.005	598.7
Heavy-Duty Gasoline Vehicles	0.459	8.206	0.637	0.016	0.035	0.014	0.009	0.013	0.020	0.012	0.002	0.005	905.6
Heavy-Duty Diesel Trucks	0.266	0.470	1.686	0.013	0.069	0.030	0.026	0.013	0.039	0.027	0.007	0.005	1395.6
Emission Factors (g/mi) - 2022													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	0.461	10.125	0.373	0.009	0.024	0.004	0.008	0.013	0.011	0.004	0.002	0.005	468.8
Pick-Up Trucks (Gasoline)	0.511	10.400	0.434	0.009	0.024	0.004	0.008	0.013	0.011	0.003	0.002	0.005	516.1
Pick-Up Trucks (Diesel)	0.184	0.429	0.229	0.006	0.035	0.014	0.008	0.013	0.021	0.013	0.002	0.005	598.7
Heavy-Duty Gasoline Vehicles	0.393	8.126	0.492	0.016	0.033	0.012	0.009	0.013	0.018	0.011	0.002	0.005	905.6
Heavy-Duty Diesel Trucks	0.257	0.396	1.312	0.013	0.063	0.024	0.026	0.013	0.034	0.022	0.007	0.005	1395.6

Emission Factors (g/gal) - 2019													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	10.379	204.664	7.998	0.168	0.477	0.075	0.157	0.245	0.213	0.070	0.039	0.104	9168.2
Pick-Up Trucks (Gasoline)	10.367	187.800	8.234	0.165	0.422	0.065	0.139	0.218	0.188	0.061	0.035	0.092	8983.0
Pick-Up Trucks (Diesel)	3.876	8.262	5.015	0.095	0.660	0.3111	0.136	0.213	0.410	0.286	0.034	0.090	10177.9
Heavy-Duty Gasoline Vehicles	4.893	81.036	7.008	0.161	0.351	0.143	0.085	0.123	0.203	0.130	0.021	0.052	8898.9
Heavy-Duty Diesel Trucks	2.102	4.017	14.910	0.101	0.559	0.257	0.204	0.097	0.329	0.236	0.051	0.041	10833.6
Emission Factors (g/gal) - 2020													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	9.860	201.489	7.742	0.168	0.476	0.075	0.156	0.244	0.211	0.069	0.039	0.104	9166.8
Pick-Up Trucks (Gasoline)	9.815	184.734	7.997	0.165	0.422	0.065	0.139	0.218	0.187	0.060	0.035	0.092	8983.0
Pick-Up Trucks (Diesel)	3.604	7.905	4.607	0.095	0.638	0.289	0.136	0.213	0.389	0.265	0.034	0.090	10177.9
Heavy-Duty Gasoline Vehicles	4.514	80.624	6.264	0.161	0.342	0.134	0.085	0.123	0.194	0.121	0.021	0.052	8898.2
Heavy-Duty Diesel Trucks	2.061	3.647	13.079	0.101	0.532	0.230	0.204	0.097	0.304	0.212	0.051	0.041	10828.8
Emission Factors (g/gal) - 2022													
Source	VOC	CO	NOx	SOx	PM10 Total	PM10 Exhaust	PM10 Tire Wear	PM10 Brake Wear	PM2.5 Total	PM2.5 Exhaust	PM2.5 Tire Wear	PM2.5 Brake Wear	CO2
Construction Worker	9.011	197.974	7.299	0.168	0.475	0.074	0.156	0.244	0.211	0.069	0.039	0.104	9167.5
Pick-Up Trucks (Gasoline)	8.890	181.029	7.557	0.165	0.421	0.064	0.139	0.218	0.187	0.060	0.035	0.092	8983.9
Pick-Up Trucks (Diesel)	3.128	7.293	3.893	0.095	0.593	0.245	0.136	0.213	0.349	0.224	0.034	0.090	10177.9
Heavy-Duty Gasoline Vehicles	3.859	79.841	4.830	0.161	0.326	0.119	0.085	0.123	0.181	0.107	0.021	0.052	8898.2
Heavy-Duty Diesel Trucks	1.997	3.072	10.181	0.101	0.488	0.186	0.204	0.097	0.264	0.172	0.051	0.041	10828.8