Attachment E

Dive Report

United States Department of the Interior

BUREAU OF RECLAMATION
Pacific Northwest Regional Office
1150 North Curtis Road, Suite 100
Boise, ID 83706-1234

IN REPLY REFER TO:
PN-3425
PRJ-14.00

JUN 15 2011

MEMORANDUM

To: Civil Engineering Division
Attn: 86-68130 (Hepler)

From: Dennis L. Hawkins, P.E.
Pacific Northwest (PN) Regional Diving Officer (PN-3425)

Subject: Submission of Dive Report

Attached is the Dive Report for the Underwater Examination of the Structures and Collection of Sediment Samples at Iron Gate, Copco 1, and JC Boyle Dams which was performed by the PN Regional Underwater Inspection Team from April 12 through 16, 2010.

This electronic copy supersedes the earlier version mailed on June 6, 2011. The cover letter distribution was revised and the dive report header and footer were updated with the omission of "FOR OFFICIAL USE ONLY."

If you have any questions, please contact Mr. Dennis Hawkins at 208-378-5211.

Attachment

cc: PN-3425 (Hawkins) (w/att)

General

Iron Gate Dam, Copco 1 Dam, and JC Boyle Dam are three facilities owned and operated by PacifiCorp, a subsidiary of MidAmerican Energy Holdings Company, that were examined by the Bureau of Reclamation Pacific Northwest Underwater Inspection Team members from April 12 through 16, 2010.

The underwater inspections were requested by Mr. Thomas Hepler (86-68130) from the Technical Service Center, Denver, Colorado. Underwater examinations were performed in support of future dam removal efforts being studied for these facilities. Site-specific access assistance, as-built drawings, and examination requirements were coordinated with PacifiCorp personnel.

Participating in the underwater inspections were Walt Heyder (86-68130), and Dave Godaire (86-68130) from the Technical Service Center (TSC), Denver, Colorado; Jesse Chan (PN-3435) from the PN Regional Office, Boise, Idaho; and Ryan Hedrick (MSFO-6213) from the Middle Snake Field Office, Boise, Idaho. Mr. Godaire was divemaster and author of this report. Topside support was provided by Mr. Chauncey Anderson, U.S. Geological Survey (USGS), Oregon Water Science Center, and Mr. Paul Zedonis, U.S. Fish & Wildlife Service (USFWS), and Arcata Fish and Wildlife Office. Additional personnel from PacifiCorp were available as needed but are not identified due to confidentiality agreements. The inspections were performed using SCUBA equipment.

Iron Gate Dam, Klamath Hydroelectric Project, California

Iron Gate Dam included six sediment sample collection dives within the reservoir and one Remotely Operated Vehicle (ROV) dive on the intake structure. For Copco 1, divers performed four sediment sample collection dives, along with inspecting the powerplant intake structure, and the abandoned diversion tunnel. Divers also attempted to locate and inspect the diversion tunnel guide cables and intake structure by ROV. Following upstream operations at Copco 1, divers launched a boat on Copco 2 reservoir in order to inspect the downstream portion of the diversion tunnel and concrete plug. The diversion tunnel downstream required no underwater inspection; however, a boat was required for entry. At JC Boyle Dam, divers inspected the powerplant intake structure and surveyed the diversion conduit stoplogs used during construction. The diversion conduit is located below the right side spillway pier looking downstream. In addition, divers entered, in the dry, the upstream portion of the diversion conduit. No sediment sampling was required at JC Boyle Dam.

Weather was mostly overcast and mild with a surface air temperature between 40˚F to 50˚F. Water temperature was generally around 45˚F to 50˚F for all three days of diving operations. Underwater visibility ranged from 0.5 to 1 foot at all locations. Reservoir water surface (RWS) elevation at Iron Gate was 2326.0 feet, at Copco 1 the reservoir elevation was at 2605.0 feet, and the reservoir elevation at JC Boyle dam was at 3793.0 feet.

Background

Iron Gate Dam

The Iron Gate facility consists of a reservoir, an earth embankment dam, an ungated side-channel spillway, intakes for the diversion tunnel and penstock, a steel penstock from the dam to the powerhouse, and the powerhouse. It is located on the Klamath River between approximately RM 196.8 and RM 190, approximately 20 miles northeast of Yreka, California. The dam was completed in 1962 at RM 190.1. It is the farthest downstream hydroelectric facility of the Klamath Hydroelectric Project. The purpose of the Iron Gate facilities is to generate hydroelectric power.

The reservoir formed upstream of Iron Gate Dam is approximately 944 surface acres and contains approximately 53,000 acre-feet of total storage capacity at RWS elevation 2328.0 feet. The normal maximum and minimum operating levels are between RWS elevations 2328.0 feet and 2324.0 feet, a range of 4 feet.

The dam is a zoned earthfill embankment with a structural height of 194 feet from the rock foundation to the dam crest at elevation 2348.0 feet. The dam crest is 20-feet-wide and approximately 740-feet-long. It has a central, vertical-asymmetrical clay core. The dam is founded on a sound basalt rock foundation. There is a grout curtain in the bedrock beneath the impervious core. In 2003, modifications were made to Iron Gate Dam to raise the dam crest five feet from elevation 2343.0 feet to elevation 2348.0 feet. This was accomplished by over steepening the upstream and downstream slopes and decreasing the crest width from 30 feet to 20 feet. A sheet pile wall was also driven along the centerline at the crest with three feet of stick up to provide freeboard, in addition to the 5-foot crest raise. Additional riprap materials were

placed on the upstream face of the dam to protect those areas inundated by the higher reservoir elevations.

There are fish trapping and holding facilities located on the random fill area at the dam toe. The top of the random fill area is at elevation 2189.0 feet. High- (elevation 2310.0 feet) and low- (elevation 2250.0 feet) level intakes for the fish facility water are incorporated in the dam.

The spillway is excavated in rock at the right abutment. It is an ungated chute spillway with a side channel entrance. The spillway crest is at elevation 2328.0 feet, 20 feet below the raised dam crest. The spillway crest is 727-feet-long and consists of a concrete ogee and slab placed over the excavated rock ridge. The upper part of the channel is partly lined with concrete. At the end of the chute, a flip-bucket terminal structure is located approximately 2,150 feet downstream of the toe of the dam. The spillway has a design discharge capacity of 32,000 cfs at RWS elevation 2333.0 feet. The modifications completed in 2003 included shotcrete protection at the top of the spillway crest and chute.

The diversion tunnel used during construction was driven through bedrock in the right abutment and is still in place. The tunnel terminates in a reinforced concrete outlet structure at the downstream toe of the dam. Control of the flow in the tunnel is provided by a slide gate approximately 112 feet upstream of the dam axis. The gate is housed in a reinforced concrete tower accessible by bridge from the dam crest. The intake is a reinforced concrete structure equipped with trashracks and is submerged on the floor of the reservoir approximately 480 feet upstream from the dam axis. Operation of the gate controlling flow through the tunnel is limited to emergency use during high flow events. If needed for such purposes, the tunnel can pass up to approximately 2,700 cfs. The intake structure for the powerhouse is a 45-foot-high, free-standing, reinforced-concrete tower, located in the reservoir immediately upstream of the left dam abutment and is accessed by a foot bridge from the abutment. It houses a 14- by 17-foot slide gate, which controls the flow into a 12-foot-diameter, welded-steel penstock. The penstock is concrete-encased where it penetrates the dam approximately 35 feet below the normal maximum reservoir level. The penstock is supported on concrete supports down the dam abutment. There is a 17.5- by 45-foot trashrack at the penstock entrance with 4-inch bar spacing.

The powerhouse is located at the base of the dam on the left bank, and consists of a single vertical Francis turbine with a rated discharge capacity of 1,735 cfs. In the event of a turbine shutdown, a synchronized Howell-Bunger bypass valve located immediately upstream of the turbine diverts water around the turbine to maintain flows downstream of the dam. The turbine has a rated output of 25,000 hp at a rated net head of 154 feet. The synchronous generator is rated 18.975 kVA with a 0.95 power factor (18 MW). There is a single three-phase, 19 MVA, 6,600/69,000-V step-up transformer at the powerhouse to interconnect the PacifiCorp transmission system. The Iron Gate powerplant has one associated 69-kV transmission line. Line No. 62 runs along the north side of Iron Gate reservoir for approximately 6.55 miles, to the Copco No. 2 switchyard.

The Iron Gate fish hatchery was constructed in 1966 and is located downstream of Iron Gate Dam, adjacent to the Bogus Creek tributary. The hatchery complex includes an office, incubator building, rearing ponds, fish ladder with trap, visitor information center, and employee

residences. Up to 50 cfs is diverted from the Iron Gate reservoir to supply the 32 raceways and fish ladder. The hatchery produces Chinook salmon, steelhead trout, and coho salmon. Annual production goals are 6 million Chinook, 200,000 steelhead, and 75,000 coho. The hatchery is **operated by the California Department of Fish and Game with operations and maintenance costs** funded by PacifiCorp.

Copco No. 1 Dam

The Copco No. 1 Facility consists of a reservoir, concrete dam, spillway, diversion tunnel, outlet works, and powerhouse, located on the Klamath River between approximately RM 204 and RM 198, near the Oregon-California border. Copco No. 1 Dam was constructed between 1911 and 1922 at RM 198.6, and is downstream of JC Boyle Dam and upstream of Copco No. 2 Dam. The purpose of the facility is to generate hydroelectric power.

Copco 1 Dam

The Copco No. 1 reservoir is approximately 1,000 surface acres and contains approximately 40,000 acre-feet of total storage capacity at RWS elevation 2607.5 feet. The normal maximum and minimum operating levels are between RWS elevations 2607.5 feet and 2601.0 feet, with a range of 6.5 feet.

The dam is a concrete gravity arch structure with a 492-foot radius at the upstream face. As originally designed, the spillway crest was approximately 115 feet above the original river bed. After construction began, the river gravel was found to be over 100 feet deep at the damsite, and was excavated and then backfilled with concrete, making the total height of the dam 230 feet, measured from the lowest depth of excavation to the spillway crest, and 250 feet to the top of the

spillway deck. The crest length between the rock abutments is approximately 410 feet. The upstream face of the dam is vertical at the top, then battered at 1 horizontal to 15 vertical. The downstream face is stepped, with risers generally about 6 feet in height. The ogee-type spillway is located on the crest of the dam. It is divided into 13 bays controlled by 14- by 14-foot radial (Tainter) gates, with a spillway crest at elevation 2593.5 feet. The normal operating reservoir water level is 1.5 feet below the top of the gates at RWS elevation 2606.0 feet. The estimated spillway discharge capacity at water surface elevation 2607.5 feet with all 13 gates fully open is 34,000 cfs. The normal tailwater is maintained at elevation 2483.0 feet by Copco No. 2 Dam located approximately ¼ miles downstream.

Two intake structures are located at approximately invert elevation 2575.0 feet in the dam near the right abutment, each containing four vertical lift gates. Two 10-foot-diameter (reducing to 8-foot-diameter) steel penstocks feed Unit No. 1 in the powerhouse; while a single, 14-foot-diameter (reducing to two 8-foot-diameter) steel penstock feeds Unit No. 2. Additional facilities were provided at the right intake structure for future expansion of the powerhouse. There are two side-by-side trashracks in front of each intake which measure 44 feet wide and 12.5 feet high, with bar spacing of 3 inches.

A 16- by 18-foot tunnel was excavated through the left abutment for streamflow diversion during construction, but was later sealed by a concrete plug. A gated concrete intake structure was provided upstream of the dam for flow regulation during construction, but no information on the structure was available prior to the dive inspection.

The Copco No. 1 powerhouse is a reinforced-concrete substructure with a concrete and steel superstructure located at the base of Copco No. 1 Dam on the right bank. The two turbines are double-runner, horizontal-Francis units, with a total rated discharge of 2,360 cfs. There are no turbine bypass valves. The two turbines are each rated at 18,600 hp with a net head of 125 feet. The generators are rated at 12,500 kVA with a 0.8 power factor (10 MW). Unit 1 has three single-phase, 5,000-kVA, 2,300/72,000-V transformers to step-up the generator voltage for transmission interconnection. Unit 2 has three single-phase, 4,165-kVA, 2,300/72,000-V transformers to step-up the generator voltage for transmission interconnection. Copco No. 1 plant has four associated 69-kV transmission lines. PacifiCorp Line No. 15 connects the Copco No. 1 switchyard to Copco No. 2, approximately 1.23 miles to the west; Line No. 3 is approximately 1.66 miles long and connects the Copco No. 1 switchyard to the Fall Creek powerhouse. PacifiCorp Line Nos. 26-1 and 26-2, each approximately 0.07 miles in length, connect Copco No. 1 powerhouse to the Copco No. 1 switchyard.

JC Boyle Dam

The JC Boyle Facility consists of a reservoir, a combination embankment and concrete dam, a gated spillway, a water conveyance system, and a powerhouse, located on the Klamath River between about RM 228 and RM 220, downstream of Keno Dam and upstream of Copco No. 1 Dam. JC Boyle Dam was completed in 1958 at RM 224.7. The purpose of the facility is to generate hydroelectric power.

JC Boyle Dam

JC Boyle Dam impounds a narrow reservoir of 420 surface acres (JC Boyle Reservoir). The normal maximum and minimum operating levels are between RWS elevations 3793.0 feet and 3788.0 feet, a range of 5 feet. The reservoir contains approximately 2,629 acre-feet of total storage capacity.

The embankment dam is a 68-foot-high (at its maximum height above the original streambed) earthfill structure with a 15-foot-wide crest and a length of 413.5 feet at elevation 3800.0 feet. The concrete portion of the dam is 279-feet-long and is composed of a spillway section, an intake structure, and a 115-foot-long gravity section with a maximum height of 23 feet between the intake structure and the left abutment.

The spillway is a concrete gravity overflow section with three 36-foot-wide by 12-foot-high radial gates. The spillway crest is at elevation 3781.5 feet and normal pool is 0.5 feet below the top of the gates (elevation 3793.5 feet). The spillway discharges onto a 13-foot-long concrete apron stepped at three elevations generally following the profile of the bedrock surface. Below the apron is a vertical drop of 15 feet to the discharge channel, which was excavated in rock. The discharge channel is generally unlined. The estimated spillway discharge capacity at RWS elevation 3793.0 feet with all three gates open is 16,000 cfs.

The intake structure is located to the left of the spillway and consists of a 40-foot-high reinforced concrete tower. It has four 11-foot, 2-inch-wide openings to the reservoir, each of which has a steel trashrack followed by a vertical traveling screen (0.25-inch mesh) with high pressure spray cleaners. Spray water from cleaning along with any screened fish are collected and diverted downstream of the dam. A 24-inch-diameter fish screen bypass pipe provides approximately 20 cfs of instream flow below the dam. A fabricated metal building was added to the intake

structure in 1989. Beyond the intake traveling screens is an entrance to the 14-foot-diameter steel pipeline, the downstream end of which is equipped with a 14- by 14-foot automated fixed-wheel gate within a concrete headgate structure. A bulkhead gate is provided at the upstream end of the 14-foot pipeline.

A pool and weir concrete fish ladder is located at the dam for upstream fish passage and is approximately 569-feet-long with a total of 63 pools. The fishway operates over a gross head range of approximately 55- to 60-feet.

The water conveyance system between the dam and the powerhouse has a total length of 2.56 miles. From the intake structure, the water flows through a 638-foot-long, 14-foot-diameter steel pipeline. The pipeline is supported on steel frames where it spans the Klamath River and discharges into an open power canal. The power canal is 2 miles long and located along a bench cut in the face of the river canyon. Depending on the terrain, the canal is either a double- or single-walled concrete flume approximately 17-feet-wide and 12-feet-high. The power canal is provided with overflow structures at the upstream and downstream ends and terminates in a forebay. The forebay overflow section is equipped with float-operated automatic spill gates, which release water during the hydraulic surge from the canal following any load rejection at the powerhouse. The released water discharges through a short, concrete-lined chute and returns to the bypass reach of the Klamath River. Water for power generation is drawn from the forebay through a 60-foot-wide and 17.9-foot-high trashrack with 2-inch bar spacing before entering a 15.5-foot-diameter, concrete-lined, horseshoe-section tunnel, which is 1,660 feet long. The last 57-foot length of the tunnel before the downstream portal is steel-lined with the liner bifurcating into two 10.5-foot-diameter steel penstocks. The bifurcation is encased in a concrete anchor block, and a steel surge tank is mounted on the thrust block. Descending to the powerhouse, the penstocks reduce in two steps to 9 feet in diameter. Each penstock is 956 feet in length and is supported by ring girders seated on concrete footings.

The conventional outdoor-type reinforced concrete powerhouse is located on the right bank of the river and approximately 4.3 river miles downstream of the dam. There are two vertical-Francis turbines with a total rated discharge of 2,850 cfs, and with 440 feet of net head. The rated capacity of the Unit 1 turbine is 75,700 hp with a generator rating of 53 MVA and the rated capacity of the Unit 2 turbine is 63,900 hp with a generator rating of 50 MVA. Two three-phase transformers step-up the generator voltage for transmission interconnection. The power from the powerhouse is transmitted a very short distance to the JC Boyle substation. There is also a second line that pre-dates the substation. The 0.24-mile 69-kV transmission line (PacifiCorp Line No. 98) connects the plant to a tap point on PacifiCorp's Line No. 18, which is currently unenergized.

Examination Results

Iron Gate Dam

Sediment sampling of the reservoir bottom was requested in order to determine the short-term oxygen demand of the sediment for dam removal studies. Coordinates and mapping for each of the sampling site locations can be found on Figures 1 and 2. Only primary site locations were

utilized for this work. Divers performed six dives to retrieve sediment samples from the reservoir bottom, refer to Photograph Nos. 1 through 3. Each dive consisted of a buddy pair team and therefore two sediment samples were produced for each dive. Each buddy team rotated shifts in the water in order to allow for safe dive operations. The first dive was a familiarization dive to determine the best methodology for collection. The first sediment collection was wasted in order to determine that the proper amount of sediment was able to be collected. Therefore, from six dives, a total of 10 samples were delivered to shore support personnel. Divers reached maximum depths that ranged from 17 feet to 62 feet to collect the samples. Collection of the samples required divers to descend to the bottom and insert a 3-inch diameter poly-vinyl chloride (PVC) tube into the reservoir bottom. Divers would then place and secure the top cap on the plastic tube. By gently rocking the tube, divers were able to raise the tube high enough to secure the bottom of the tube. Once secured, the divers maintained the tube in the upright position and ascended to the surface. Proper care in maintaining the tube in the vertical position was essential in determining accurate short-term oxygen demand of the reservoir bottom material.

The team then moved downstream to conduct the intake structure inspection. The dive team located the intake structure by boat using bottom scanning sonar in conjunction with "fishing" for the metallic trashracks with a large magnet. Refer to Photograph No. 4 and Drawing G-8692. Once located, the intake structure coordinates were recorded to be 122˚ 26.1219' N, 41˚ 56.1462' W. The trashracks protecting the intake structure were inspected with an ROV, (refer to Photograph Nos. 5 through 8) due to depth limitations of divers on SCUBA equipment. The trashracks are all covered with ¼-inch of organic matter, refer to Photograph No. 9. Approximately 15 feet of the upper portion of the intake structure is free of sediment and debris. The lower section is silted in with fine organics and sediments. A very small amount of woody debris, up to 3 inches, was observed. The trashracks had minor rust nodules covering 5 to 10 percent of their surface. Some nodules looked to be 2 to 3 inches in diameter and up to 1 inch in height, refer to Photograph No. 10. The concrete appeared to be in very good condition with no spalling or scaling. The top of the intake structure had approximately 3 to 4 inches of fine sediment and debris. Photograph No. 11 shows the "fishing" magnet secured to the side of the intake structure.

Copco 1 Dam

Sediment sampling of the river bottom was also requested at Copco 1 Dam. Coordinates and mapping for each of the sampling site locations can be found on Figures 1 through 3. Divers performed four dives to retrieve sediment samples from the reservoir bottom. From four dives, a total of 8 samples were delivered to shore support personnel. Divers reached maximum depths that ranged from 27 feet to 71 feet to collect the samples. Sample collection techniques were the same as those that were collected at Iron Gate Dam detailed above.

Divers moved downstream to the face of the dam and performed an inspection of the powerplant intake structure to the right of the radial gates. Refer to Photograph Nos. 12 and 13 and Drawing G-8692. Divers reached a maximum depth of 21 feet on the power intake structure. The limited visibility did not allow the divers to take photographs of the structure. Woody debris up to 3-inches in diameter and approximately 12-foot deep was encountered by divers. The second bay looking downstream had a slightly higher amount of woody debris collected. The concrete had

minor spalling on leading edges that was felt by hand. A ¼-inch deep covering of algae was noted on all concrete surfaces. The trashracks were 100 percent covered with rust and rust nodules up to ½-inch in diameter and ¼-inch high were noted. A steel L-bracket was found across bay 2 from pier to pier with no apparent purpose.

The diversion intake was surveyed by divers to a maximum depth of 42 feet. Refer to Photograph Nos. 14 through 16 and Drawing F-1370. Divers encountered very limited visibility and were only able to survey the structure by touch. Divers found what appeared to be the cables used to open and close the abandoned intake structure valves. The cables are 100 percent covered in rust and buried in silt. As divers proceeded deeper they encountered increasing amounts of gravel up to 4 inches in diameter and boulders that ranged from 12- to-18-inches in diameter. A large amount of woody debris was also discovered up to 6-inches in diameter. Due to the deep depths the ROV was dispatched in an attempt to survey the intake structure on the bottom. Due to the limited visibility adequate references for driving the ROV were not possible. Therefore, the intake structure was not found and no further information could be collected.

The dive team proceeded downstream to Copco 2 reservoir. The team launched a boat to survey the diversion tunnel and concrete plug in Copco 1 Dam. Refer to Photograph Nos. 17 through 19 and Drawing F-1439. The boat was able to float approximately 95 feet up the tunnel before requiring an on-foot approach to the concrete plug, refer to Photograph No. 20. The total length of the tunnel is approximately 189 feet. The concrete plug is approximately 14.5-feet wide and 20-feet high. The concrete plug is concave in the middle approximately 18 inches upstream and the center square is approximately 7-feet by 7-feet, refer to Photograph No. 19. On the centerline at the bottom is a 3-foot-by 3-foot opening in the concrete. Inside the opening is a rusted steel valve, refer to Photograph No. 21. On top of the concrete plug is what appears to be a grout pipe that is now flowing water. Flows from the grout pipe are estimated to be approximately 15-20 gallons per minute, refer to Photograph No. 22. There is a significant amount of leakage at the concrete-rock interface along the outer sides of the concrete plug, refer to Photograph No. 23.

JC Boyle Dam

No sediment sampling was required at JC Boyle Dam. The power intake structure was the first structure to be inspected. Divers reached a maximum depth of 33 feet to access the bottom sill of the intake structure, refer to Drawing AA78085A. Looking upstream the dive team labeled the four intakes 1 through 4 from left to right. At Intake 1 there is 100 percent covering of surface rust on the trashrack with 50 percent coverage of rust nodules. Rust nodules measured ½-inch to 1-inch in diameter on the leading edge of the bars. Divers were able to access all the way to the sill. At the sill a large amount of grassy weed was present and one 12-inch diameter log was found. The log was removed by divers and it was placed on the shore. Visibility at the trashracks was down to 3-inches. Intake 2 was found to be similar to Intake 1. Gravel and sand were discovered to be 6-inches below the sill. Intake 3 was also similar to Intake 1 and 2 with the exception that “slop” concrete was encountered at the base of the sill and transitioned down to the gravel layer. It was also noted that the rusting seemed to be greater than found at Intake 1 and 2. Intake 4 had a large amount of woody debris and was covered approximately 25 percent

with grassy weed. It did not appear to be limiting the flow into the intake structure. Rusting of the trashrack was greater than found in the other three intakes.

Divers located the abandoned double barrel diversion conduit used during construction reaching a maximum depth of 41 feet, refer to Drawing AA78087A. Looking downstream this structure is approximately centered under the right spillway pier. Visibility was limited; however, divers were able to confirm that the structure is clear of debris down to the sill. At the sill just below is a covering of volcanic type gravel that extends approximately 10 feet out. At 10 feet out the gravel transitions to a sloping silt layer that continues to rise in the upstream direction. The concrete stoplogs in place do not have any lifting eyes or other mechanical means for removal. The concrete appeared to be sharp with no spalling or exposed rebar found. The upper stoplogs in the right conduit looking downstream are slightly racked and leaking. Measurements from the drawing seem to be consistent with what the divers were able to feel by hand.

The dive team proceeded downstream to perform a topside inspection of the downstream portion of the double barrel diversion conduit, refer to Photograph No. 24. The conduit measurements are approximately 9½-feet-wide, 10-feet-high, and 40-feet to the stoplogs face. Looking downstream the left side conduit shows signs of very little leakage, refer to Photograph Nos. 25 through 27. The right side conduit has significant leakage as also discovered by divers underwater due to the stoplogs being racked in the guide channel, refer to Photograph Nos. 28 through 31. Flows through the right side are approximately 20 gallons per minute. Measurements of the racked stoplogs show there is a 1¾-inch offset from the top of the second stoplog. A probe of the gap allowed a plumbers rule to enter the gap by as much as 21 inches before significant resistance was noted.

Conclusions and Recommendations

Sediment sampling from Iron Gate and Copco 1 reservoir were successfully delivered to the topside support personnel and lab. Details of the laboratory findings will be contained in another report written by others.

The intake structure at Iron Gate Dam should be periodically inspected by ROV to determine if the rust nodules and algae growth are increasing with time, possibly reducing the structure's capacity to release flows. At this time it did not appear the capacity of the intake structure is reduced. The intake concrete appeared to be in satisfactory condition.

The power intake structure at Copco 1 Dam is severely clogged with woody debris. The woody debris should be removed so this material is not ingested by the turbines. In addition, if the debris is not removed it may significantly reduce the facility's ability to generate power. Overall the concrete structure is in good condition with no spalling or exposed rebar noted.

At JC Boyle Dam the grassy weed material in front of the power intake structure is apparently a constant problem. PacifiCorp has in place and should maintain their current procedure for removal of this material on a regular basis. The concrete was found to be in good condition with no spalling or exposed rebar noted. Divers in future diving operations, in and around the right

side of the double barrel diversion conduit, should be briefed on the leakage and possible P-Delta effects of working in this area.

Attachments:

Photograph Nos. 1 through 31

Figures 1 through 3

Reference drawings:

- AA78085A – Diversion Dam Intake & Spillway General Arrangement – JC Boyle Dam
- AA78087A – Diversion Dam Diversion Culvert, Forms, Reinforcement, & Embedded Steel – JC Boyle Dam
- F-1370 - Headgates to Tunnel – Copco 1 Dam
- F-1439 – Elevation & Sections of By-Pass Tunnel Plug Copco Development No. 1 A – Copco 1 Dam
- G-8692 – Diversion Tunnel – Outlet-Intake Detail – Iron Gate Dam
- S-2596 – General Arrangement – Copco 1 Dam

Photograph No. 1. Paul Zedonis (USFWS) showing arrangement and orientation required for proper delivery of sediment sampling tubes to the surface. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 2. Chauncey Anderson (USGS) providing divers with pre-dive briefing to go over requirements for adequate sampling of river bottom. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 3. Diver with sediment sampling tube in hand preparing to descend for sediment retrieval. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

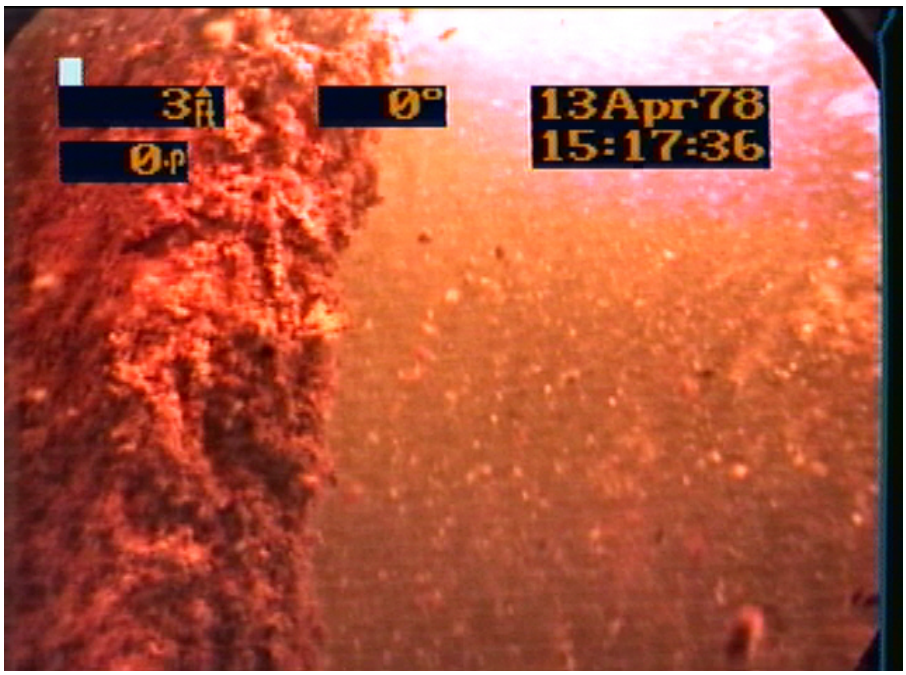
Photograph No. 4. Right abutment of Iron Gate dam at approximate location for deployment of ROV used to survey intake structure. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 5. PN Dive Team Deep Ocean Engineering ROV. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

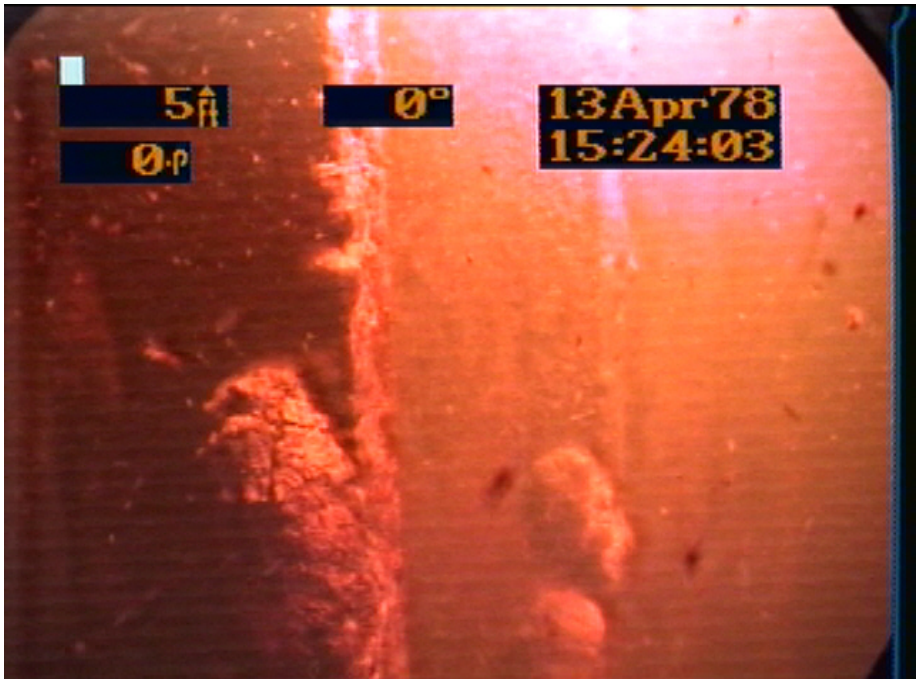
Photograph No. 6. ROV on surface with surface support personnel tending descent and ascent of vehicle. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 7. Hunting blind used for ROV video monitor. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

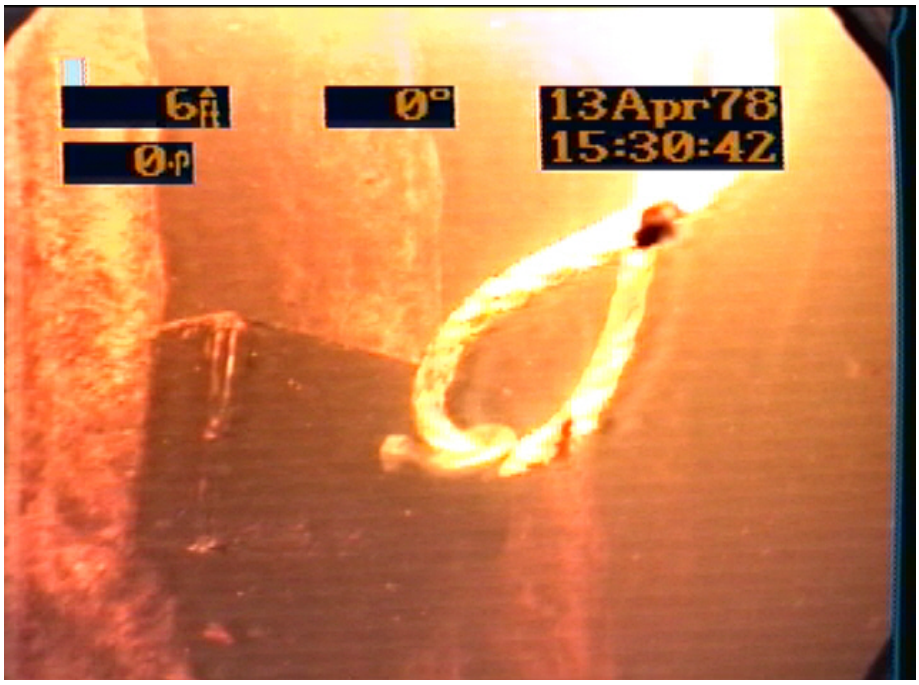
Photograph No. 8. View of ROV controls and video display unit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**



Photograph No. 9. ROV captured video image showing example of organic debris coating the trashrack bars on the outlet intake structure at Iron Gate Dam (Note: Date, time, and depth readings are not accurate). **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**



Photograph No. 10. ROV captured video image showing example of rust nodules found on trashrack surface. (Note: Date, time, and depth readings are not accurate). **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**



Photograph No. 11. ROV captured video image of fishing magnet attached to steel trashrack bars of outlet intake at Iron Gate Dam (Note: Date, time, and depth readings are not accurate). **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 12. Dive team securing boat for dive inspection of powerplant intake structure at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 13. Divers on surface relaying findings of dive inspection of the powerplant intake at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 14. Dive boat secured at right abutment near abandoned low-level intake control structure at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 15. Cable roller device for abandoned low-level intake structure at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

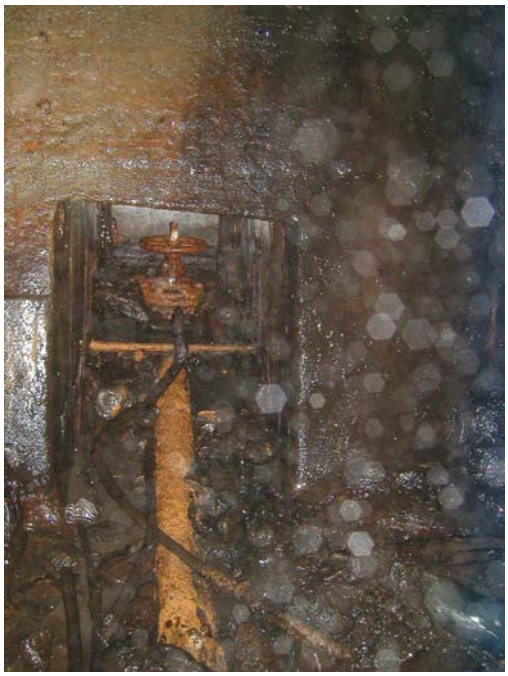
Photograph No. 16. Close-up of roller for abandoned low-level intake structure at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 17. Upstream view of Copco 1 Dam. On left side is powerplant generator structure. On right side (red arrow) shows abandoned low-level outlet tunnel. Divers made a boat assisted surface inspection of concrete plug. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 18. Divers standing at furthest most point accessible next to concrete plug, making field measurements.. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 19. Close-up view of concrete plug in the abandoned low-level outlet tunnel at Copco 1 Dam.. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 20. View of low-level outlet tunnel looking downstream to portal. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**



Photograph No. 21. Rusted gate valve located at bottom of concrete plug in the abandoned low-level outlet tunnel at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 22. View at top of concrete plug. Pipe at top of plug releasing water at approximately 15 to 20 gpm. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 23. Concrete plug interface with rock tunnel in the abandoned low-level outlet tunnel at Copco 1 Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 24. View looking upstream at double barrel diversion conduit (red arrow) used during construction of JC Boyle Dam. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 25. View looking upstream at left double barrel diversion conduit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

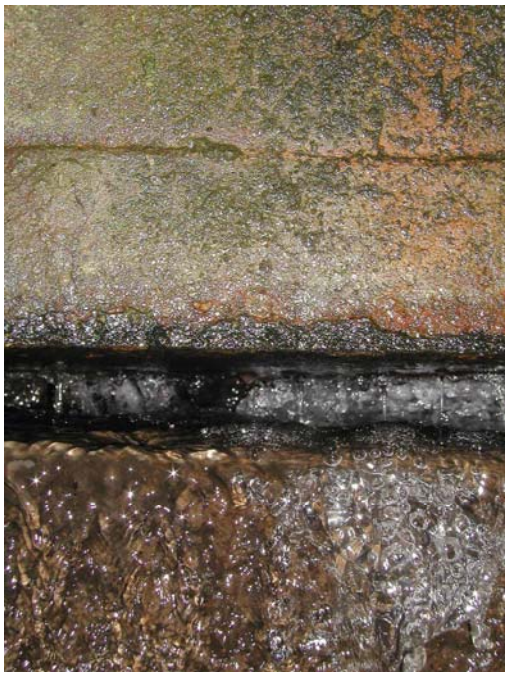
Photograph No. 26. Upstream view of stoplogs in the left side of the double barrel diversion conduit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 27. Finger pointing to seepage through horizontal lift line of the stoplogs in the left side of the double barrel diversion conduit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 28. Close-up view of double barrel diversion conduit exit. Note surface flow exiting right side conduit (red arrow). Stoplogs on right side are racked in the guide slot causing leakage. Significant P-Delta effects were noted by divers at this location. Extreme caution and distance should be maintained by any future dive team to this area. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 29. Upstream view on right side of double barrel diversion conduit showing flow through the concrete stoplog. P-Delta effects were noted by divers on the upstream side of this structure. **PN Regional Underwater Inspection Team – JC Boyle Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

Photograph No. 30. Flow through the stoplogs on the right side of the double barrel diversion conduit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**



Photograph No. 31. Close-up of flow through the stoplogs on the right side of the double barrel diversion conduit. **PN Regional Underwater Inspection Team – JC Boyle, Copco 1, and Iron Gate Dams, Klamath Hydroelectric Project, Oregon – California – April 12-16, 2010.**

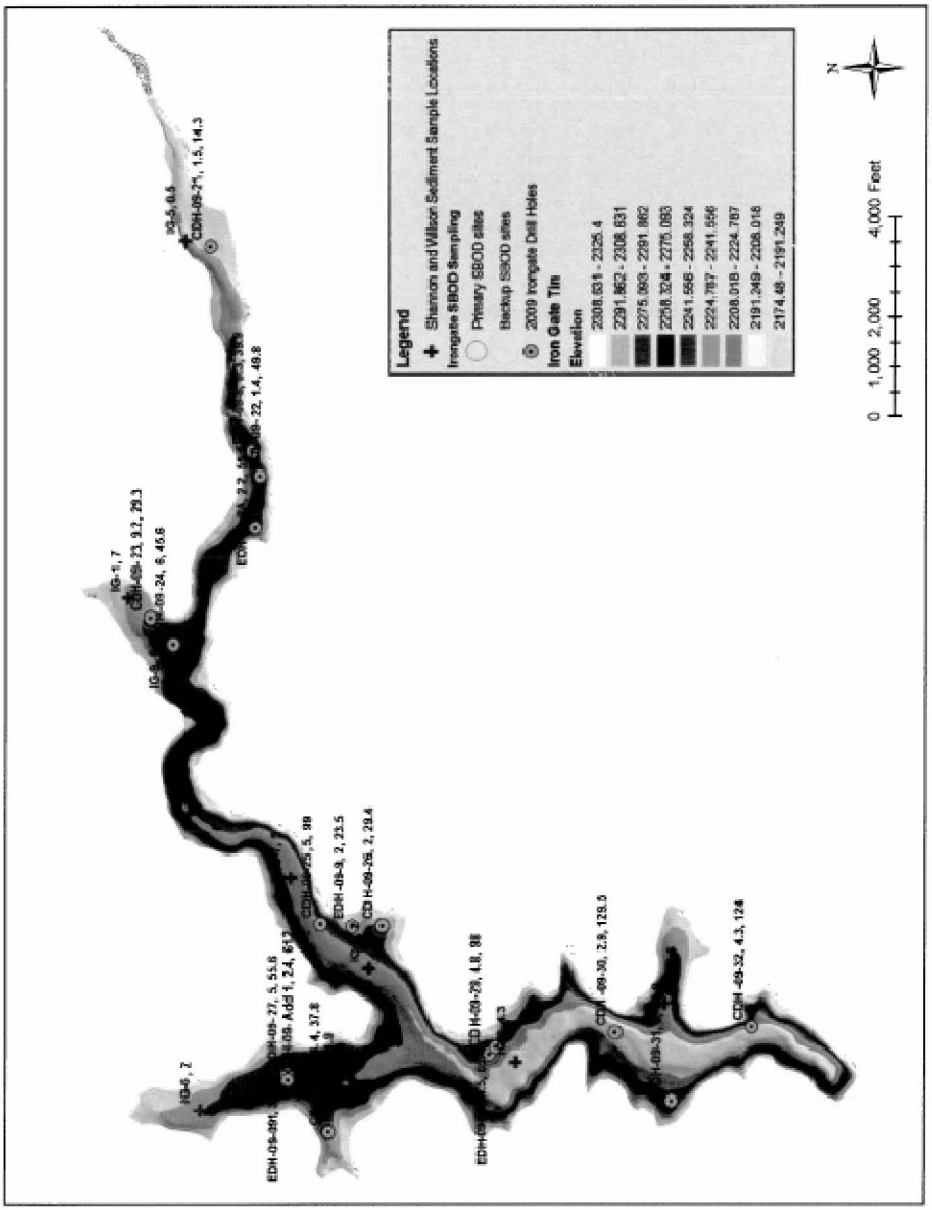
Sediment Sampling Site Locations, Copco and Iron Gate Reservoirs

Client Sample ID	Latitude	Longitude	Thalweg / NonThalweg	Sediment Depth	Water depth
Copco Reservoir Immediate Oxygen Demand Sampling Sites:					
Primary Locations:			Thalweg		
CDH-S-12	N41 58.629	W 122 17.440		5.4	5.4
CDH-S-14	N41 58.889	W 122 18.268	Non Thalweg	5.3	24
CDH-S-16	N41 58.888	W 122 19.025	Thalweg	7.5	74
CDH-S-19	N41 59.053	W 122 19.704	Non Thalweg	7.5	50.4
Backup Locations:			Thalweg		
CDH-S-13 (0.0-5.7)	N41 58.892	W 122 18.031		5.7	37.2
CDH-S-15A	N41 59.052	W 122 18.634	Thalweg	9.7	69.2
CDH-S-10	N41 58.251	W 122 16.896	Thalweg	7.9	26.4
CDH-S-09A	N41 58.096	W 122 16.460	Thalweg	4.6	16
Iron Gate Reservoir Immediate Oxygen Demand Sampling Sites:					
Primary Locations:			Thalweg (Jenny Creek)		45.6
CDH-S-24	N41 58.31	W 122 24.212		6	
CDH-S-27	N41 57.93	W 122 26.102	Thalweg	5	55.6
CDH-S-29	N41 57.262	W 122 26.006	Non Thalweg	4.8	98*
CDH-S-31	N41 56.662	W 122 26.208	Non Thalweg	4.8	50.9
Backup Locations:			Non Thalweg		29.4
CDH-S-26	N41 57.615	W 122 25.447		2	
CDH-S-28	N41 57.79	W 122 26.353	Non Thalweg	4.4	37.8
CDH-S-23	N41 58.388	W 122 24.092	Non Thalweg	9.2	23

* - Collect dive sample in shallower water as close as possible to this location.

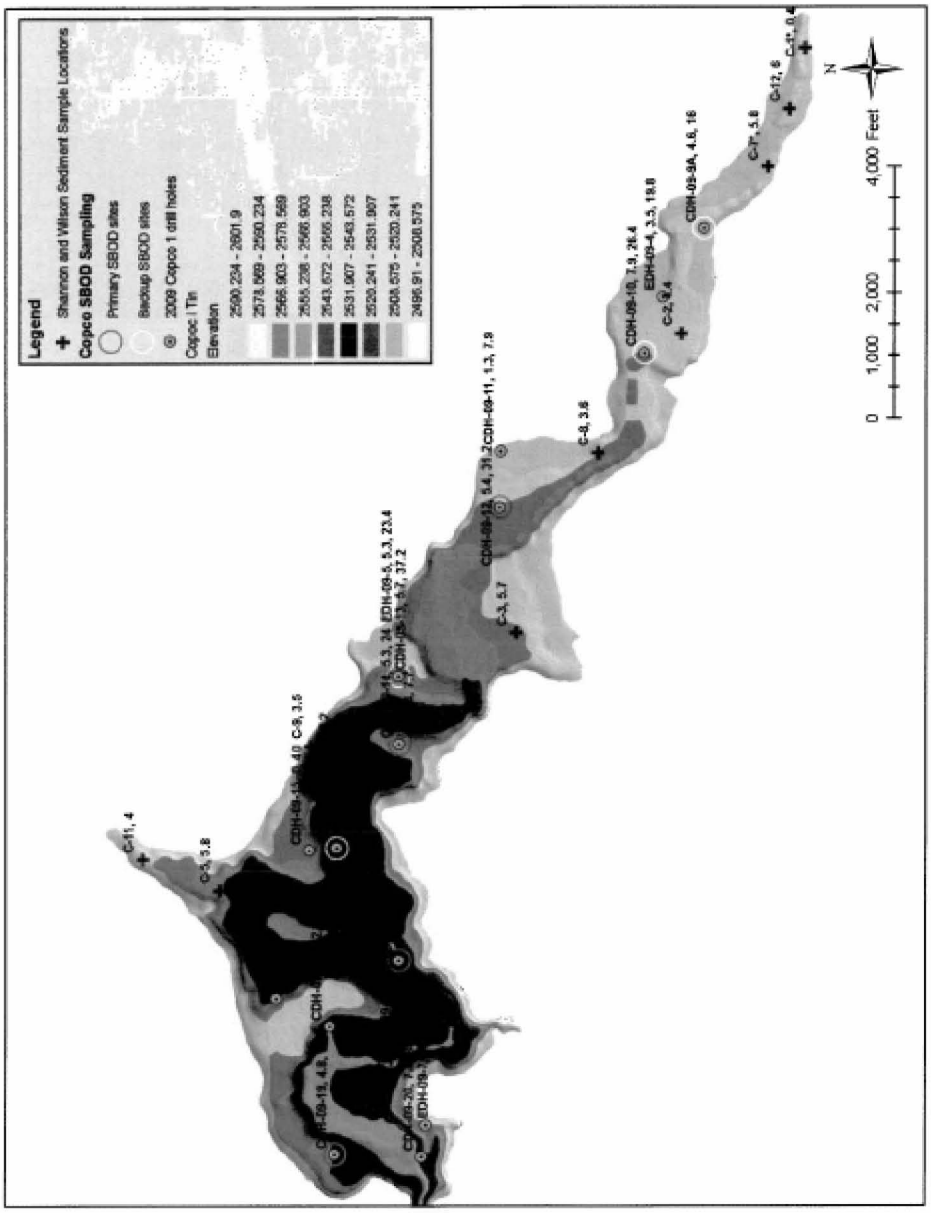
Dive samples to be collected in order from deeper to shallower sites.

FIGURE 1



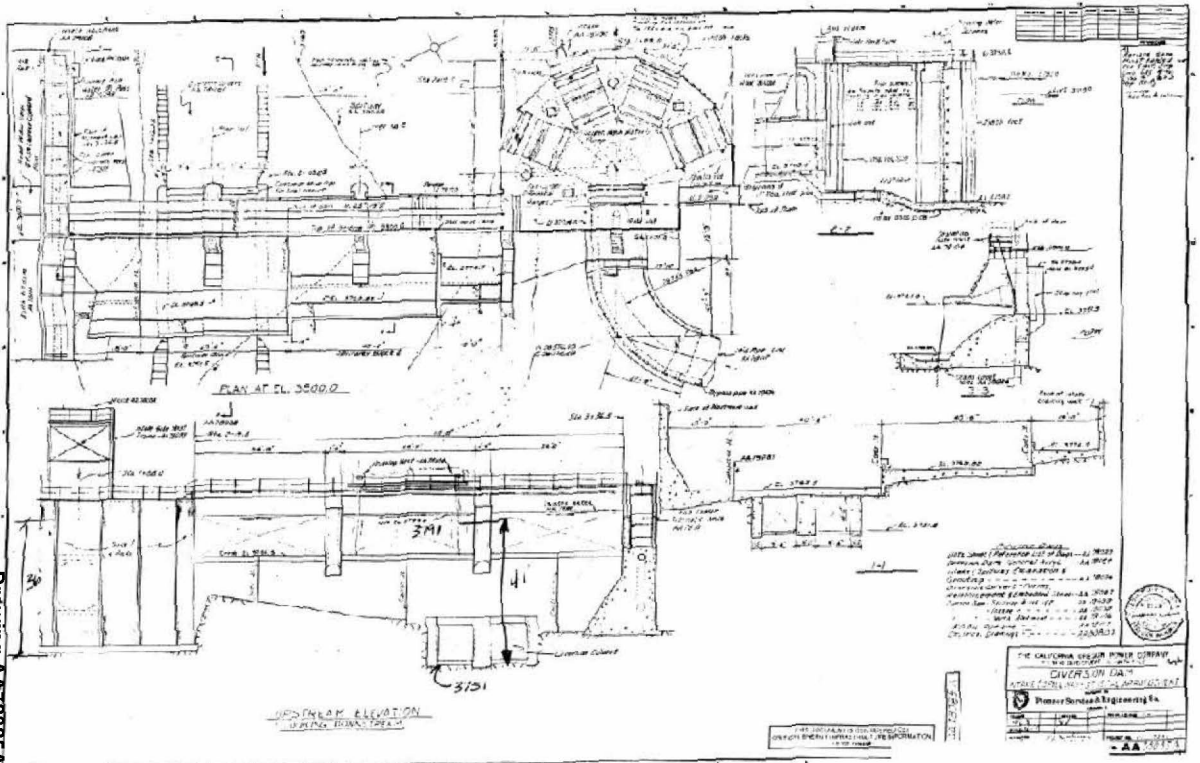
Iron Gate Reservoir map showing approximate locations of sampling sites.

FIGURE 2

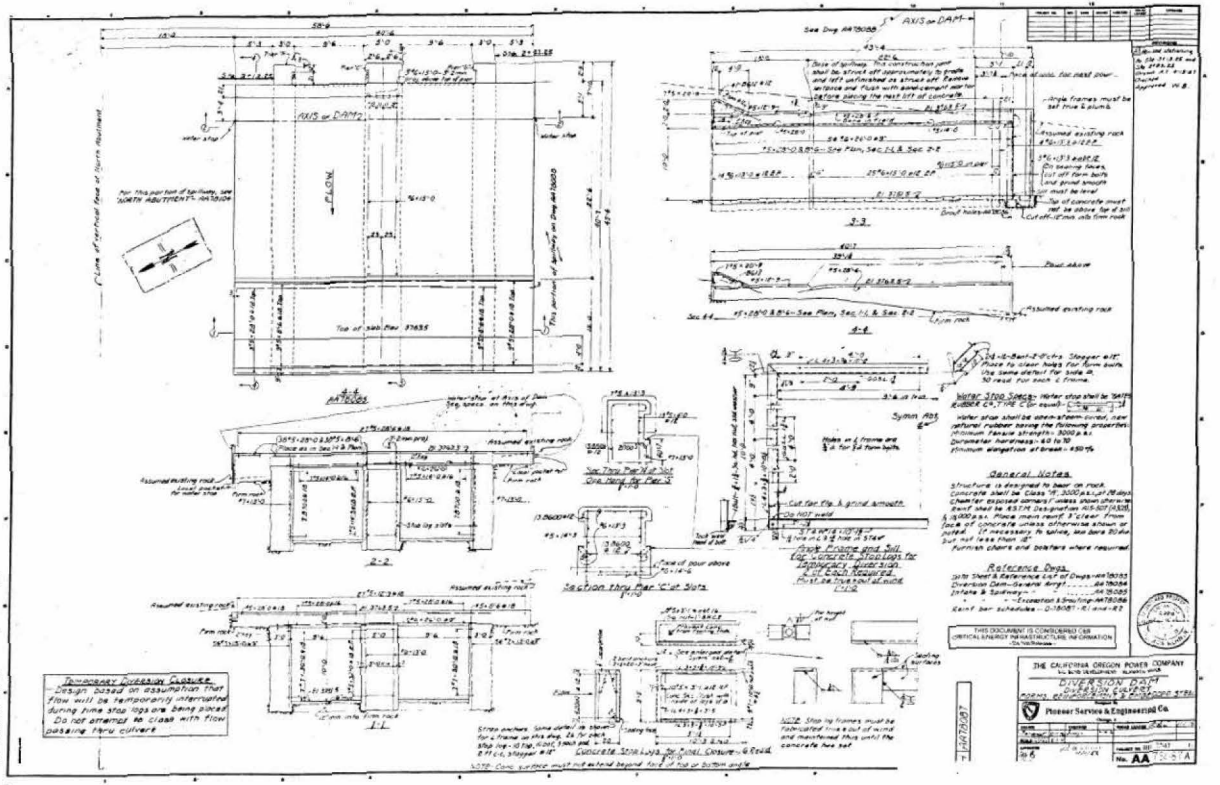


Copco Reservoir map showing approximate locations of sampling sites.

FIGURE 3



Drawing AA738085A



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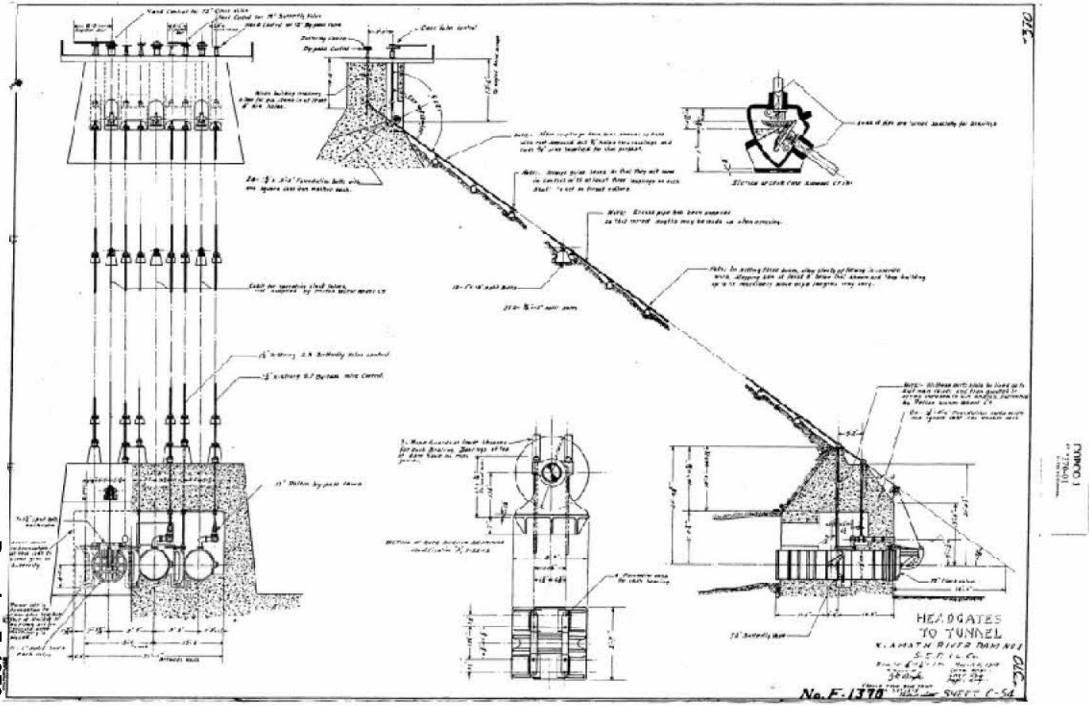
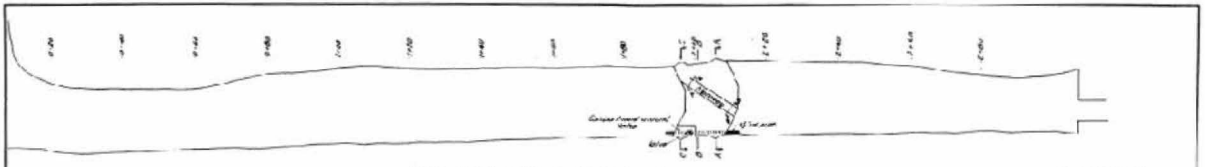


Drawing F-1370



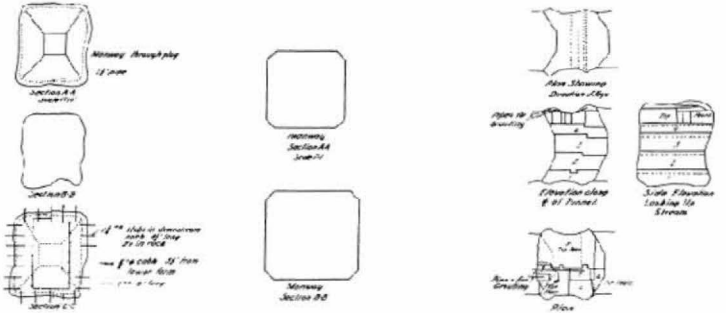
VERTICAL SECTION OF BY-PASS TUNNEL ALONG ℄

CONCRETE QUOTED

Item	Grade	Mark	Nos.	Wts.	Location
1					
2					
3					
4					
5					
6					
7					
8					

STEEL QUOTED

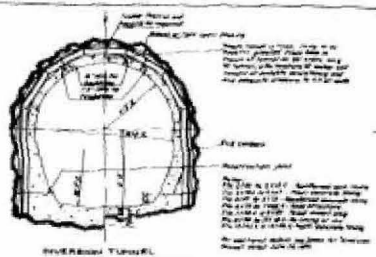
Size	Length	Wt.



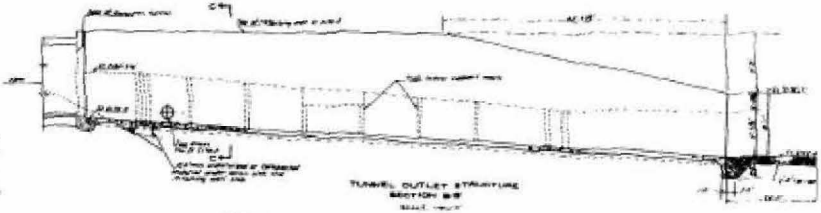
CRITICAL INFRASTRUCTURE INFORMATION

4		ELEVATION & SECTIONS OF BY-PASS TUNNEL PLUG CCPDO DEVELOPMENT NO. 1 A
3		
2		
1	DOC. CONTROL NUMBER	THE CALIFORNIA OREGON POWER COMPANY
	DRAWN BY CHK'D	ISSUED BY
	TRACED BY	APPROVED BY
	DATE	SCALE DRAWING NO. F-1439

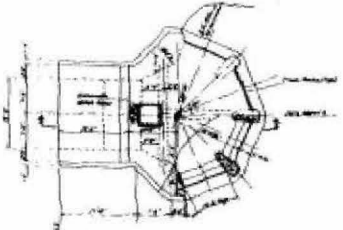
Drawing F-1439



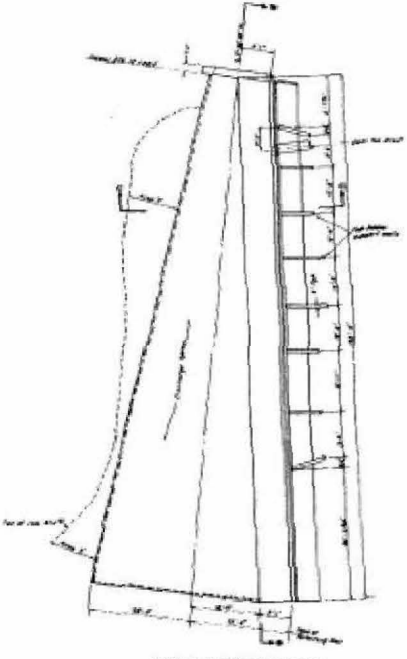
RIVERSIDE TUNNEL



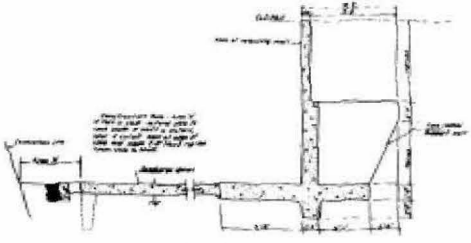
TUNNEL OUTLET STRUCTURE
SECTION B-B



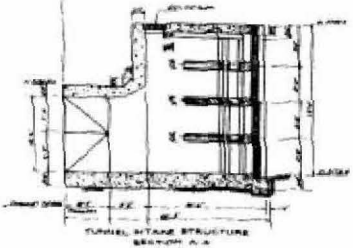
TUNNEL INTAKE STRUCTURE
PLAN



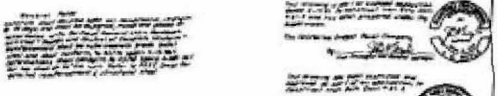
TUNNEL OUTLET STRUCTURE
PLAN

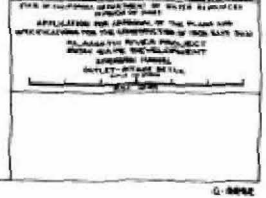


TUNNEL OUTLET STRUCTURE
SECTION CC-TYPICAL



TUNNEL INTAKE STRUCTURE
SECTION A-A



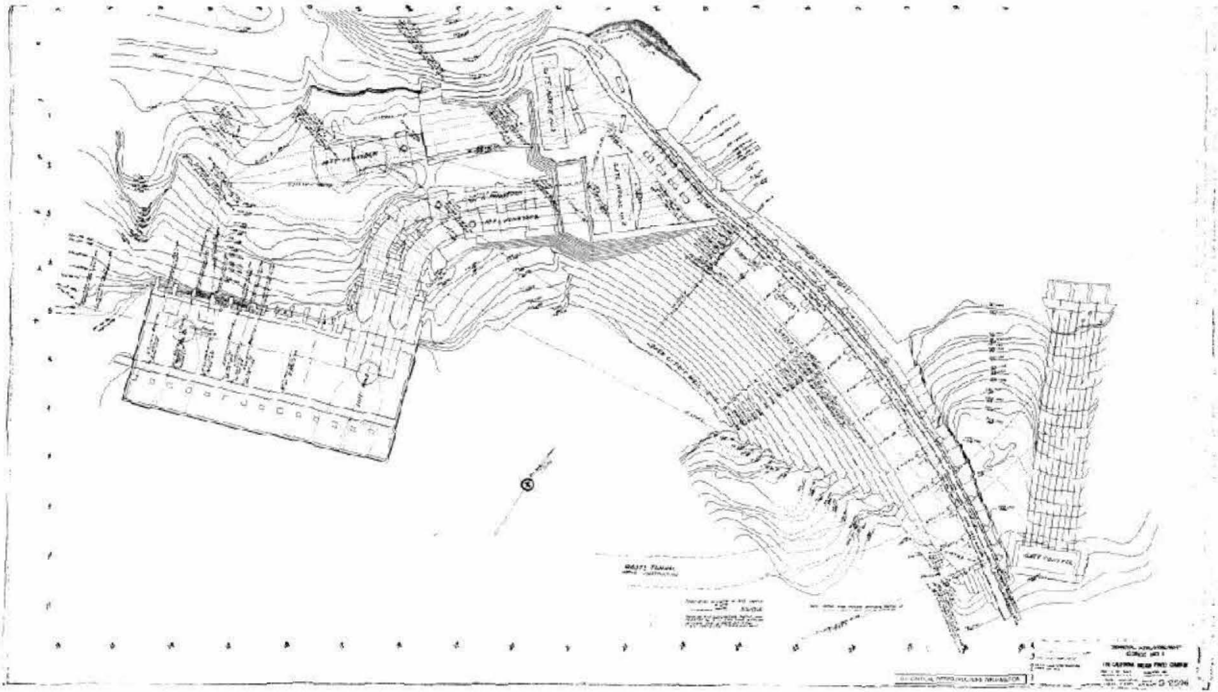


APPLICATION FOR APPROVAL OF THE PLANS AND SPECIFICATIONS FOR THE CONSTRUCTION OF THIS ELEC TRIC

ALAMATH RIVER PROJECT
KLAMATH RIVER DEVELOPMENT
SISKIYOU COUNTY
OUTLET STRUCTURE DETAILS

Drawing G-8692

G-8692



Drawing S-2596