UNITED STATES OF AMERICA
BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Klamath River Renewal Corporation	**Project Nos. 14803-001;**
PacifiCorp	**2082-063**

AMENDED APPLICATION FOR SURRENDER OF LICENSE FOR MAJOR PROJECT AND REMOVAL OF PROJECT WORKS

EXHIBIT K (1 of 2)
Reservoir Drawdown and Diversion Plan

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project
FERC Project No. 14803

Reservoir Drawdown and Diversion Plan

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February 2021

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Table of Contents

List of Tables

List of Figures

Appendices

1.0 Introduction

The Lower Klamath Project (Project) (FERC No. 14803) consists of four hydroelectric developments on the Klamath River: J.C. Boyle, Copco No. 1, Copco No. 2, and Iron Gate (Figure 1-1). Specifically, the reach between J.C. Boyle dam and Iron Gate dam is known as the Hydroelectric Reach. In September of 2016, the Renewal Corporation filed an *Application for Surrender of License for Major Project and Removal of Project Works,* FERC Project Nos. 2082-063 & 14803-001 (License Surrender). The Renewal Corporation filed the License Surrender application as the dam removal entity for the purpose of implementing the Klamath River Hydroelectric Settlement (KHSA). In November of 2020, the Renewal Corporation filed its Definite Decommissioning Plan (DDP) as Exhibits A-1 and A-2 to its amended License Surrender application. The DDP is the Renewal Corporation's comprehensive plan to physically remove the Lower Klamath Project and achieve a free-flowing condition and volitional fish passage, site remediation and restoration, and avoidance of adverse downstream impacts (Proposed Action). The Limits of Work is a geographic area that encompasses dam removal related activities in the Proposed Action and may or may not expand beyond the FERC boundary associated with the Lower Klamath Project.

The Proposed Action includes the deconstruction of the J.C. Boyle Dam and Powerhouse (Figure 1-2), Copco No. 1 Dam and Powerhouse (Figure 1-3), Copco No. 2 Dam and Powerhouse (Figure 1-4), and Iron Gate Dam and Powerhouse (Figure 1-5), as well as associated features. Associated features vary by development, but generally include powerhouse intake structures, embankments, and sidewalls, penstocks and supports, decks, piers, gatehouses, fish ladders and holding facilities, pipes and pipe cradles, spillway gates and structures, diversion control structures, aprons, sills, tailrace channels, footbridges, powerhouse equipment, distribution lines, transmission lines, switchyards, original cofferdam, portions of the Iron Gate Fish Hatchery, residential facilities, and warehouses. Facility removal will be completed within an approximately 20-month period.

This Reservoir Drawdown and Diversion Plan describes the proposed drawdown methods, procedures, schedules, and monitoring efforts the Renewal Corporation will implement as part of the Proposed Action. The Renewal Corporation has prepared 16 Management Plans for FERC's review and approval as conditions of a license surrender order. These Management Plans were developed in consultation with federal, state and county governments and tribes.

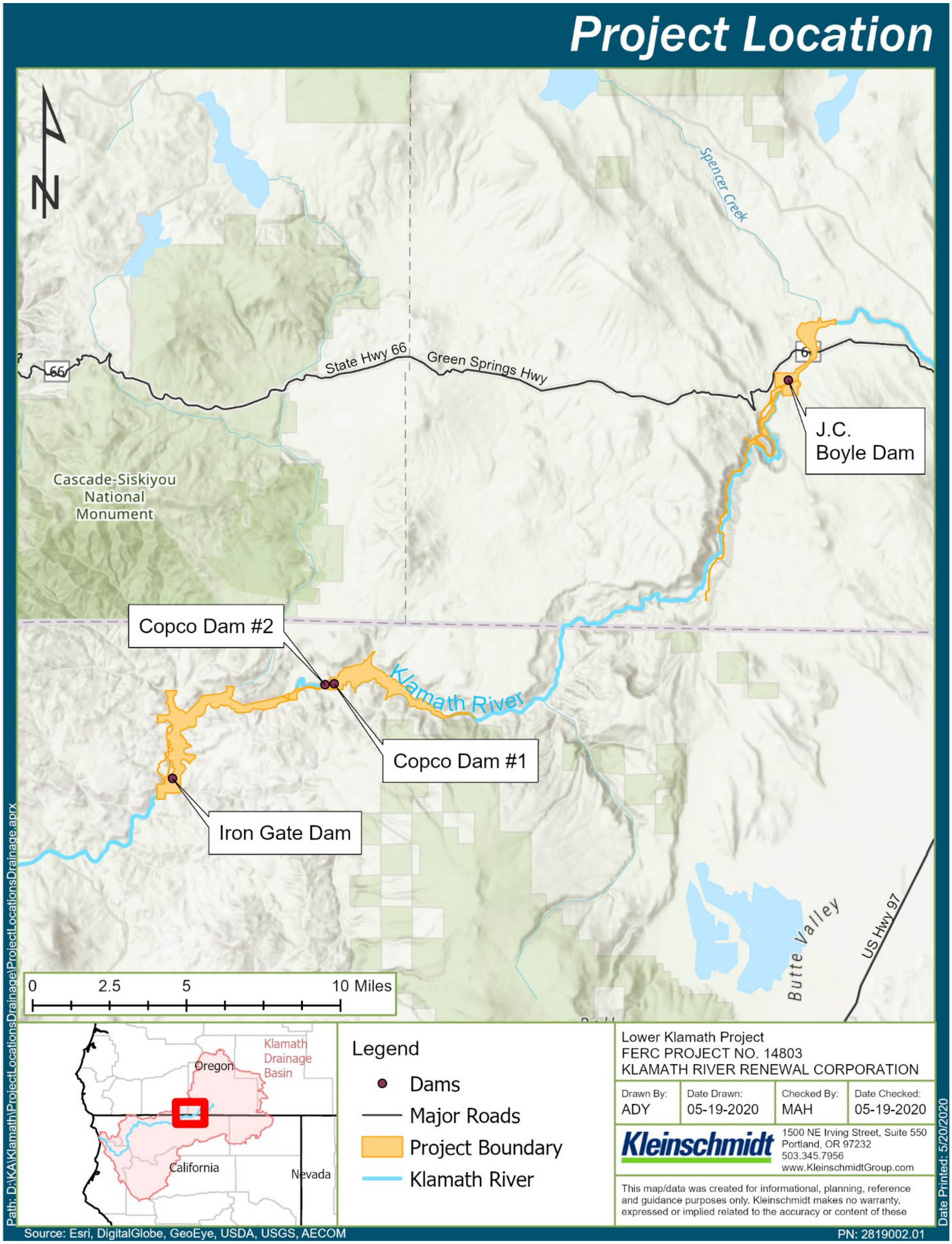

Figure 1-1. Lower Klamath Project Location

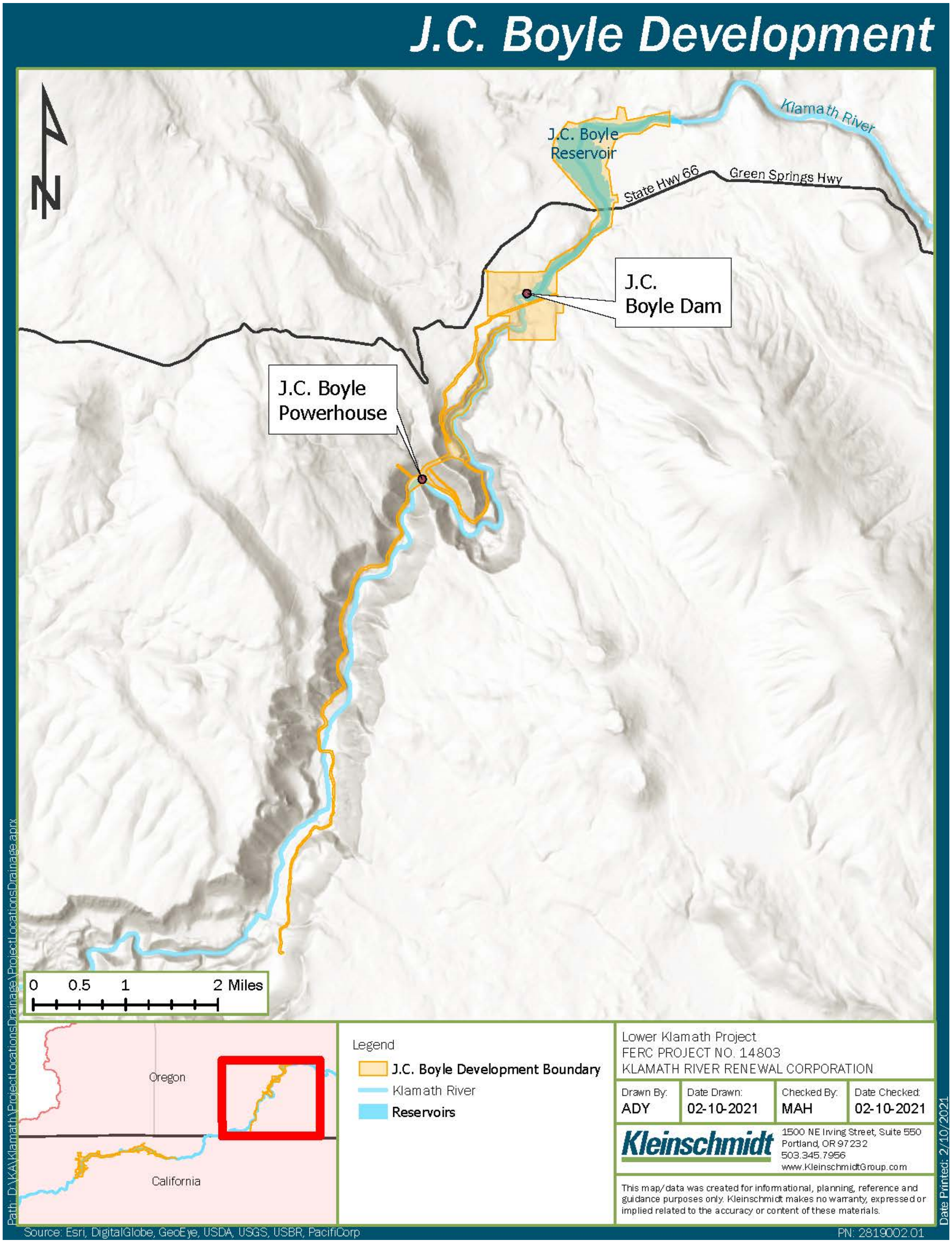

Figure 1-2. J.C. Boyle Development Facility Details

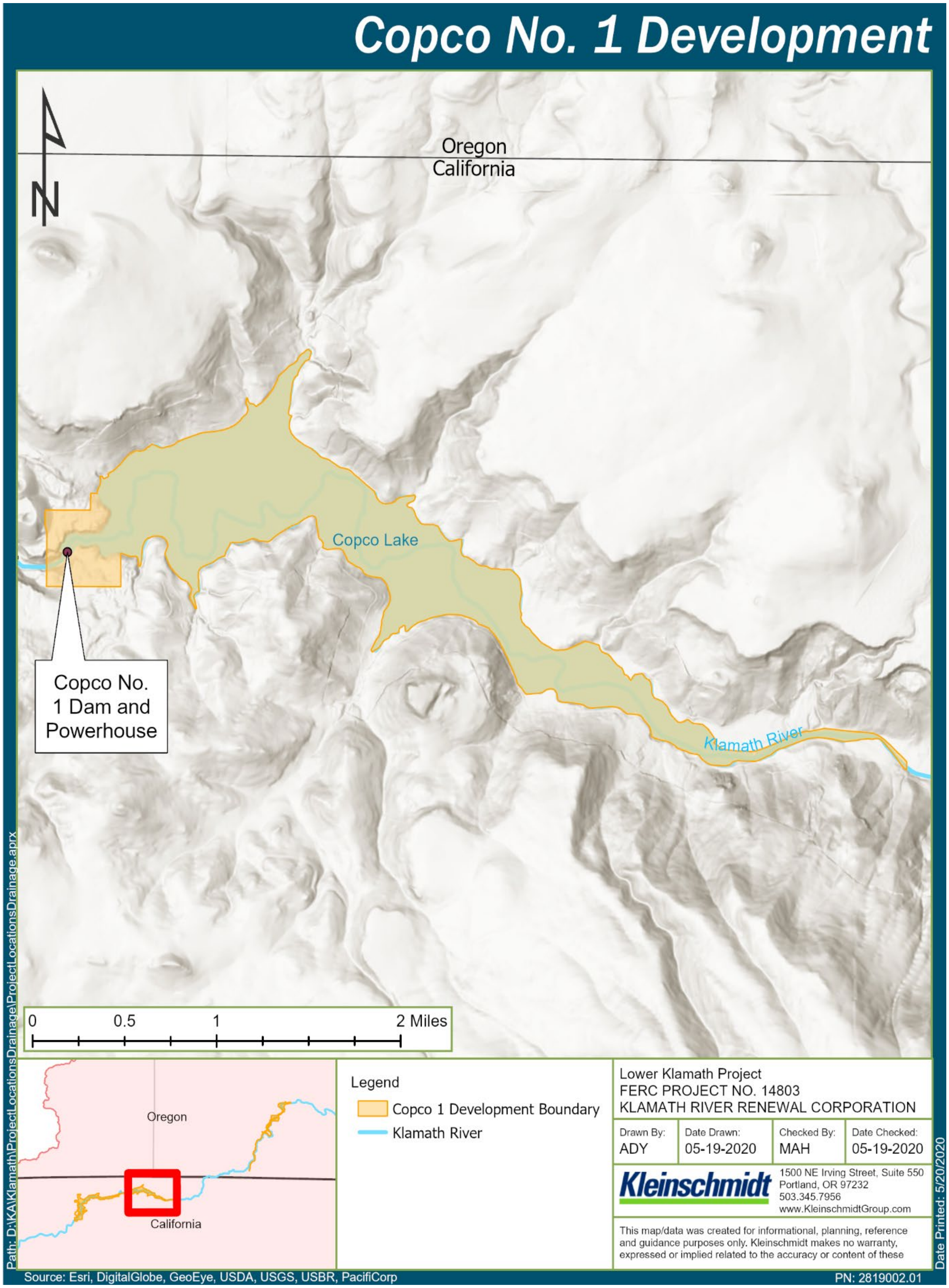

Figure 1-3. Copco No.1 Development Facility Details

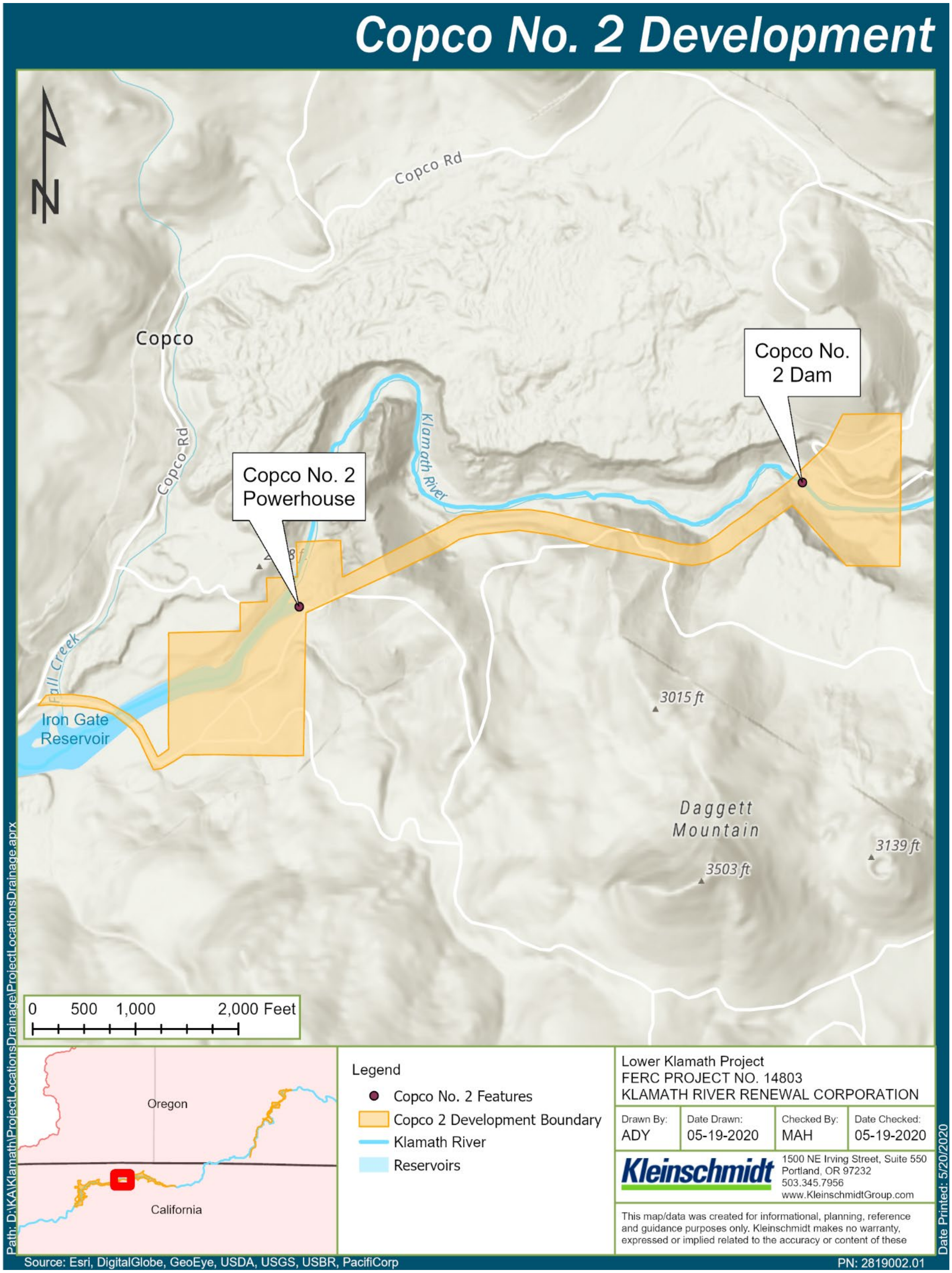

Figure 1-4. Copco No.2 Development Facility Details

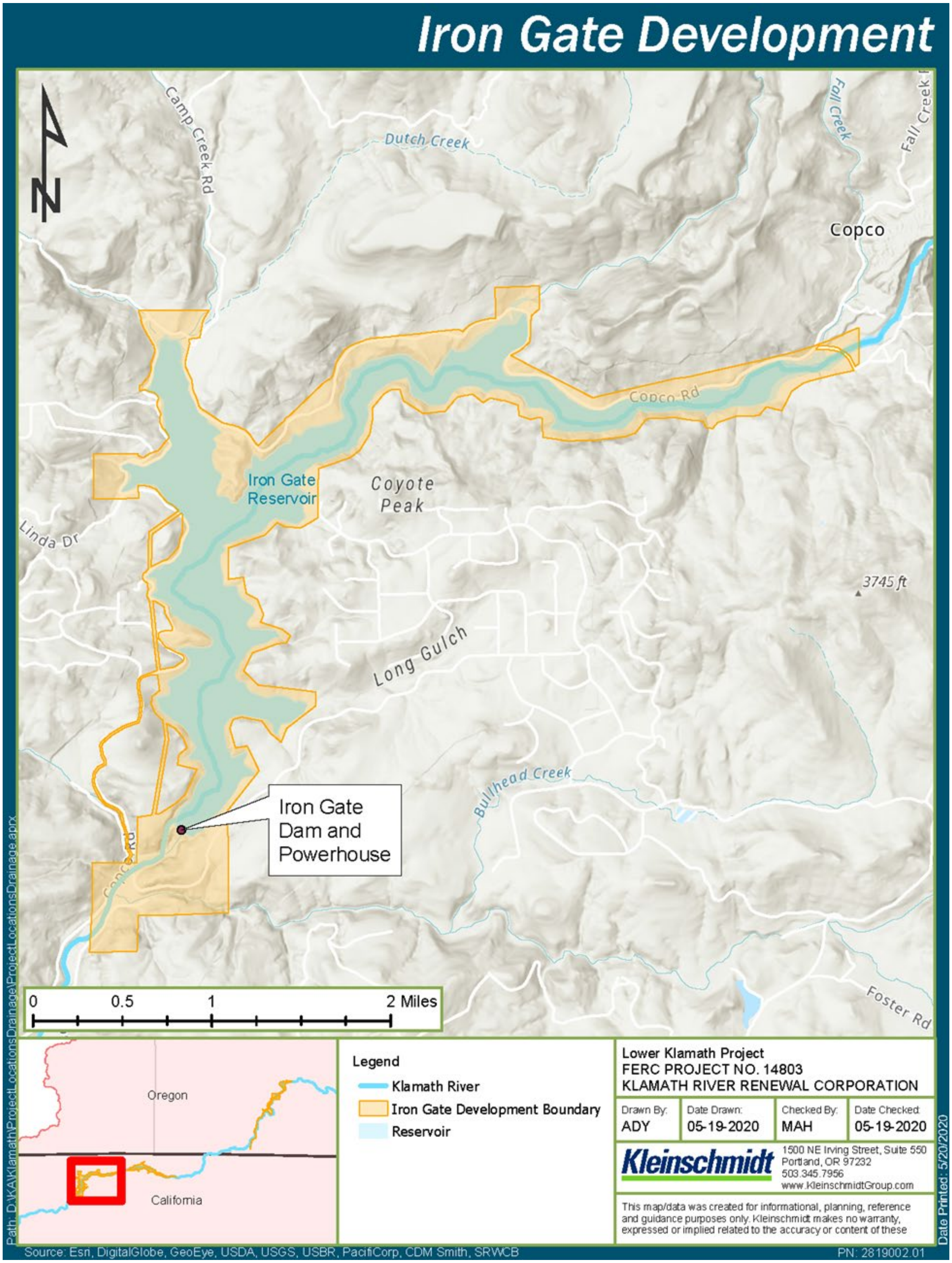

Figure 1-5. Iron Gate Development Facility Details

2.0 Regulatory Context

The Reservoir Drawdown and Diversion Plan is one of 16 Management Plans implementing the DDP.

Table 2-1. Lower Klamath River Management Plans

1. Aquatic Resources Management Plan	9. Remaining Facilities Plan
2. Construction Management Plan	10. Reservoir Area Management Plan
3. Erosion and Sediment Control Plan	11. Reservoir Drawdown and Diversion Plan
4. Hatchery Management and Operations Plan	12. Sediment Deposit Remediation Plan
5. Health and Safety Plan	13. Terrestrial and Wildlife Management Plan
6. Historic Properties Management Plan	14. Waste Disposal and Hazardous Materials Plan
7. Interim Hydropower Operations Plan	15. Water Quality Monitoring Management Plan
8. Recreation Facilities Plan	16. Water Supply Management Plan

2.1 Organizational Structure

The Reservoir Drawdown and Diversion Plan outlines the proposed drawdown methods, procedures, schedules, and monitoring efforts included as part of the Proposed Action. The Reservoir Drawdown and Diversion Plan includes the following sub-plans.

- Appendix A: California Reservoir Drawdown and Diversion Plan
- Appendix B: California Slope Stability Monitoring Plan
- Appendix C: Oregon Reservoir Drawdown and Diversion Plan

2.2 Specific Regulatory Interests

The Renewal Corporation considered the following regulatory interests in the development of the Reservoir Drawdown and Diversion Plan:

- California Section 401 Water Quality Certification
- Oregon Section 401 Water Quality Certification
- California Department of Fish and Wildlife MOU
- California Environmental Quality Act, Final Environmental Impact Report
- Oregon MOU

2.3 Regulatory Review Process

The Renewal Corporation will implement the Reservoir Drawdown and Diversion Plan upon FERC approval, including any changes required in the FERC License Surrender Order. A consultation record for the Reservoir Drawdown and Diversion Plan is included as Appendix D.

2.4 Reporting

The Renewal Corporation will prepare and submit an Annual Report by February 15th of each year which will include information pertaining to implementation of the Reservoir Drawdown and Diversion Plan.

Appendix A

California Reservoir Drawdown and Diversion Plan

KLAMATH RIVER RENEWAL CORPORATION

Lower Klamath Project FERC Project No. 14803

California Reservoir Drawdown and Diversion Plan

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Table of Contents

List of Tables

List of Figures

Appendices

1.0 Introduction

The California Reservoir Drawdown and Diversion Plan described herein is a subplan of the Reservoir Drawdown and Diversion Plan that will be implemented as part of the Proposed Action for the Lower Klamath Project (Project).

1.1 Purpose of California Reservoir Drawdown and Diversion Plan

The purpose of the California Reservoir Drawdown and Diversion Plan is to describe the proposed drawdown methods, procedures, schedules, and monitoring measures that the Renewal Corporation will implement as part of the Proposed Action.

The Renewal Corporation and PacifiCorp have entered into an Operations and Maintenance Agreement. Upon acceptance of the License transfer order and subsequently acceptance of the License Surrender Order, PacifiCorp will continue to operate the Project as the Renewal Corporation assignee, until such time operation is no longer required under decommissioning.

1.2 Relationship to Other Management Plans

The California Reservoir Drawdown and Diversion Plan is supported by elements of the following management plans for effective implementation: Reservoir Drawdown and Diversion Plan sub-plans, Erosion and Sediment Control Plan, Remaining Facilities, Waste Disposal, Health & Safety Plan, and the Reservoir Area Management Plan. So as not to duplicate information, elements from these other management plans are not repeated herein but are, where appropriate, referenced in this California Reservoir Drawdown and Diversion Plan.

2.0 Drawdown and Diversion Plan

2.1 Drawdown Criteria

Pertinent drawdown criteria for the Proposed Action are summarized in the below Table 2.1, which includes information from the Design Report (Knight Piésold, 2020b).

Table 2.1 Reservoir Drawdown Design Criteria

FEATURE/CONSIDERATION	CRITERIA	REMARKS	REFERENCE
OPERATING REQUIREMENTS			
Daily Minimum Downstream Flows	Downstream of Iron Gate: • September through November and March - 1,000 cfs • December through February - 950 cfs • April - 1,325 cfs • May - 1,175 cfs • June - 1,025 cfs • July and August - 900 cfs	• Minimum flows will be dictated by USBR requirements which may supersede the biological opinion flows as set out. Minimum flows only applicable up to completion of drawdown.	• USBR, BIOP 2019
Normal Maximum Operating Surface Elevation (ft msl)	• J.C. Boyle = 3,796.7 ft • Copco Lake = 2,611.0 ft • Copco No. 2 = 2,486.5 ft • Iron Gate = 2,331.3 ft		FERC License Application - Exhibit A (2004) - NAVD88 Elevations Copco No. 2 is not a high-hazard dam; therefore, operating surface elevations were supplied by PacifiCorp.
Normal Minimum Operating Surface Elevation (ft msl)	• J.C. Boyle = 3,791.7 ft • Copco Lake = 2,604.5 ft • Copco No. 2 = 2,486.1 ft • Iron Gate = 2,327.3 ft		

PRE-DRAWDOWN			
Pre-Drawdown Construction Activities (Downstream of Reservoirs)	• Construction and commissioning to occur prior to January 1 of the drawdown year		
	• All reservoirs to be operated at or below minimum operating water levels during early works construction; minimum operating water levels are specific to each facility	• Water levels to be defined through consultation with PacifiCorp	• PacifiCorp STID Section 4 Standard Operations Procedures
Pre-Drawdown Flow Regulation	• Regulate project operation flows at or below minimum operating levels to maintain construction safety • The reservoir lowering will begin prior to construction and will be accomplished through normal project power and water bypass operations on a site-specific basis	• Required for construction staging and work safety	• PacifiCorp STID Section 4 Standard Operations Procedures
DRAWDOWN			
Initial Drawdown	• To begin on or about January 1 of the drawdown year.		
Reservoir Drawdown Rate	• Target drawdown water surface level rate 5 ft/day	• Each facility is unique relative to reservoir area capacity and proposed drawdown. Actual drawdown will be based on the actual water year	
Drawdown Completion	• Water surface level at or below historic cofferdam level		• Knight Piésold Memo VA20-01231 - Klamath Drawdown Model

GEOTECHNICAL REQUIREMENTS			
SLOPE STABILITY OF RESERVOIR RIM			
Minimum Required FOS	• Drawdown FOS = 1.2	• Reservoir Drawdown criterion applies to existing dam, rim, and embankment slopes.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003
	• Long-term, Post Drawdown FOS = 1.5		• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003
Design Earthquake for Temporary Construction	• 10% Probability of Exceeding Operating Basis Earthquake in 50 Years (1/475-Year Event); 0.2% Probability in 1 Year • 2% Probability of Exceeding Maximum Design Earthquake in 50 Years (1/2,475- Year Event); 0.04% Probability in 1 Year		• Appendix A4 of the Design Report
SLOPE STABILITY OF TEMPORARY EMBANKMENT SLOPES			
Reservoir Drawdown	FOS = 1.3	• Reservoir Drawdown criterion applies to temporary embankment slopes during removal.	• USBR Design Standard No. 13 • USACE EM 1110-2-1902, 2003

Notes:

BIOP = Biological Opinion
CFS = Cubic feet per second
EM = Engineer Manual
FERC = Federal Energy Regulatory Commission
FOS = Factor of Safety
FT MSL = Feet above Mean Sea Level
NAVD88 = North American Vertical Datum of 1988
STID = Supporting Technical Information Document
USBR = United States Bureau of Reclamation
USACE = United States Army Corps of Engineers

2.1.1 Discharge Volumes and Rates

2.1.1.1 Copco No. 1 Facility

Discharges during the drawdown stage will be made through a newly constructed low-level outlet tunnel, through the exiting historic diversion tunnel, and by spillway releases. Low-level outlet tunnel discharge rating capacities are outlined in Appendix C of the Design Report (Knight Piésold, 2020b), and are summarized below. Relevant information is included in Appendix A of this subplan. The proposed discharge rating curves for Copco No. 1 are also presented in Appendix A (drawing C2056).

Table 2.2 Copco No. 1 Total Discharge Capacity for Low-Level Outlet Tunnel

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,609	4,197
2,604	4,099
2,599	3,998
2,594	3,894
2,589	3,789
2,584	3,680
2,579	3,568
2,574	3,453
2,569	3,334
2,564	3,211
2,559	3,084
2,554	2,951
2,549	2,813
2,544	2,667
2,540	2,546
2,539	2,515
2,538	2,483
2,537	2,451
2,536	2,419
2,535	2,386
2,534	2,353
2,533	2,319
2,532	2,285
2,531	2,250
2,530	2,215

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,529	2,179
2,528	2,143
2,527	2,106
2,526	2,069
2,525	2,031
2,524	1,653
2,523	1,264
2,522	934
2,521	659
2,520	500
2,519	268
2,518	144
2,517	63
2,516	18
2,515	0

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix C2 of the Design Report (Knight Piésold, 2020b).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.1.2 Copco No. 2 Facility

To allow for dam modifications works (i.e., removal of a portion of Spillway Bay No. 1), the Renewal Corporation will manage Copco No. 2 reservoir water surface levels during pre-drawdown by using the conveyance system to the powerhouse. The outlet works for reservoir drawdown will be comprised of discharge through the existing spillway gates and the removal of Spillway Bay No. 1. Discharge rating capacities for the spillway gates and removal of Spillway Bay No. 1 are outlined in Appendix D of the Design Report (Knight Piésold, 2020b), and are summarized below. Relevant information is included in Appendix A of this subplan. Discharge rating curves for Copco No. 2 are also presented in Appendix A (drawing C3057).

Table 2.3 Copco No. 2 Total Discharge Capacity77

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)	SPILLWAY 4 GATES RATES (CFS)	TOTAL RATES (CFS)
2,459.5	0	-	0
2,460	11	-	11
2,461	57	-	57

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)	SPILLWAY 4 GATES RATES (CFS)	TOTAL RATES (CFS)
2,462	123	-	123
2,463	204	-	204
2,464	298	-	298
2,465	402	-	402
2,466	517	-	517
2,467	641	-	641
2,468	773	-	773
2,469	1,345	-	1,345
2,470	2,170	-	2,170
2,471	3,045	-	3,045
2,472	3,490	-	3,490
2,473	3,962	-	3,962
2,474	4,464	-	4,464
2,475	4,969	-	4,969
2,476	5,496	-	5,496
2,476.5	5,768	0	5,768
2,477	5,991	172	6,163
2,478	6,393	895	7,288
2,479	6,789	1,926	8,715
2,480	7,314	3,190	10,504
2,481	8,038	4,651	12,690
2,482	8,801	6,285	15,086
2,483	9,603	8,074	17,678
2,484	10,445	10,008	20,452
2,485	11,327	12,075	23,401
2,486	12,249	14,267	26,516
2,487	13,123	16,578	29,701
2,488	13,846	19,002	32,847
2,489	14,581	21,533	36,114
2,490	15,328	24,168	39,496

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix D2 of the Design Report (Knight Piésold, 2020b).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.1.3 Iron Gate Facility

Discharges during drawdown will be made through the modified diversion tunnel using the existing outlet control gate, through the existing power intake and turbine/bypass, and by spillway releases. The Computation Fluid Dynamics (CFD) model developed for the diversion channel and existing outlet control gate confirmed that the hydraulic capacity is approximately 4,000 cfs, as was designed by J.C. Boyle, PE and PacifiCorp. Discharge rating capacities for the diversion tunnel with gate fully open are outlined in Appendix E of the Design Report (Knight Piésold, 2020b and are summarized below. Relevant information is included in Appendix A of this subplan. Discharge rating curves for Iron Gate are also presented in Appendix A (drawing C4050).

Table 2.4 Iron Gate Total Discharge Capacity

WATER SURFACE ELEVATION (FEET, NAVD88)	TOTAL DISCHARGE RATE CAPACITY (CFS)
2,331.3	3,930
2,291.3	3,380
2,251.3	2,530
2,211.3	1,650
2,188	0

Notes:

Source: Northwest Hydraulic Consultants computational fluid dynamics modeling in Appendix E2 of the Design Report (Knight Piésold, 2020b).
NAVD88 = North American Vertical Datum of 1988
cfs = cubic feet per second

2.1.2 Slope-Stability Analysis

The Reservoir Rim Stability Report (Knight Piésold, 2020a) provides analysis in support of this section of the California Reservoir Drawdown and Diversion Plan and describes the reservoir rim and associated properties (private vs. public) abutting the rim. The Reservoir Rim Stability Report summarized the findings of an analysis of the reservoir rim stability during and following drawdown. The analysis focused on the potential for large-scale deep-seated instabilities that could affect residences and other resources adjacent to the rim, such as transportation infrastructure. The reservoir rim is defined as the terrain that lies within the normal operating levels of the reservoir. The terrain downslope and upslope of the rim are defined as submarine slopes and upslope areas, respectively. Additional detail on slope stability can be found in the California Slope Stability Monitoring Subplan (Knight Piésold, 2020c).

2.1.2.1 Copco No. 1 Facility

Residential properties occur locally around the Copco No. 1 Reservoir rim, primarily at the southwest and east sectors of the shoreline. Copco Road follows the north side (e.g., right side looking in the downstream direction) of the Copco No. 1 Reservoir and Ager Beswick Road along the south side (e.g., left side looking in the downstream direction). The stability analysis results (Knight Piésold, 2020a) indicate the potential for slope instability impacts from the proposed reservoir drawdown near the southwest shoreline of the reservoir Figure 2-1, Appendix C of this sub-plan. This finding is consistent with the Renewal Corporation study (2019). Contingency measures are discussed in Section 4.7.

Steep shoreline slopes of weak, white diatomite are a prominent feature along the west part of the rim of the Copco No. 1 Reservoir. Shoreline slopes of diatomite are particularly prominent along the south (left) shore in the west part of the reservoir. Diatomite is a very fine-grained sedimentary rock most often used as a filter aid in commercial applications (SWRCB, 2020a). The presence of diatomaceous deposits and associated fluvio-lacustrine terrace deposits along the rim and below the reservoir water level present the greatest potential for slope instability during drawdown. The shoreline slopes show indications of active erosion undercut by wind-induced reservoir waves, two possible debris slides, a tension crack, slope retrogression, and slumped toe debris.

A natural terrain landslide was identified upslope, with the toe located beneath the reservoir shoreline. Past rock falls occur close to Copco No. 1 Reservoir, and two rockslides were identified in a cliff upslope from Ager Beswick Road. Terrain analysis identified three possible debris slides on the downslope side of Copco Road and a possible debris flood deposit within the reservoir (Knight Piésold, 2020a). Landslides were identified within the cut slopes along Copco Road and Ager Beswick Road, and a rock cut slope alongside Ager Beswick Road shows evidence of recent rock falls and rockslides. Minor sheet and gully erosion were identified on the natural slopes and south (left) side of the reservoir.

The Klamath River previously followed a sinuous meandering path in the west part of the reservoir footprint. Debris slides were identified in the steep slope on the outside of these former meander bends. It is interpreted these landslides occurred in terrace slopes that are comprised of alluvium and diatomaceous lacustrine deposits. These locations may be possible sites of terrain instability in the post-drawdown condition once the course of the Klamath River is re-established. Possible relict rockslides were identified in submarine rock slopes close to the dam in the south (left) part of the reservoir. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

2.1.2.2 Copco No. 2 Facility

There are no residential properties adjacent to the reservoir rim. The access roads to the Copco No. 1 Powerhouse and Copco No. 2 Reservoir are located adjacent to the rim on the north (right) side of the reservoir. Based on the low risk of identified potential instability areas, drawdown of the reservoir is not expected to result in large-scale slope instability affecting adjacent infrastructure or properties. No management measures are necessary.

Two shallow debris slides were identified in a steep slope at the left bank of the rim of Copco No. 2 Reservoir. The columnar jointed basalt cliffs upslope of the reservoir have open sub-vertical discontinuities and are susceptible to toppling, causing rock falls. Talus slopes exist from past rock falls adjacent to the downstream portion of the reservoir. A previously constructed rock fall protection barrier was observed on the southwest side of the reservoir. The terrain analysis also identified a debris slide in the cut slope along the access road to the Copco No. 1 Powerhouse at a switch-back of the road alignment. The surficial geology at the site of this landslide comprises an unwelded pyroclastic deposit, which developed before 1991, and there appears to have been no significant change between 1991 and 2016.

The Copco No. 2 Reservoir is relatively shallow, with valley side slopes intersecting the gently sloping terrain of the former riverbed. The submarine slopes are gently inclined, and no submarine landslides have been identified. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

For Copco No. 2, terrain analysis indicates that although there are areas of potentially unstable terrain around the rim of the reservoir, any slope instability is expected to be relatively small due to the interpreted shallow depth of the bedrock and the fact that the colluvium generally comprises coarse talus (Knight Piésold, 2020a). There is also a potential for local instability of the colluvial slopes in the upstream area at the left bank where the colluvium is finer grained and the two recent debris slides were identified.

2.1.2.3 Iron Gate Facility

Copco Road follows the north (right) side of the reservoir. No known residential properties were identified adjacent to the rim of the Iron Gate Reservoir in the Reservoir Rim Stability Report (Knight Piésold, 2020a). Slope instability at these areas caused by the drawdown is likely small-scale and will not affect Copco Road. No management measures are necessary.

One structure was subsequently identified adjacent to the east side of the reservoir rim. The terrain hazard analysis completed by Knight Piésold (2020a) identified no slope hazards were present in this area. Additionally, the slopes below this property are relatively gentle; therefore, this property was not included in the stability analysis.

The terrain analysis completed by Knight Piésold (2020a) confirmed the presence of slope instability at the rim of the Iron Gate Reservoir as previously identified in both the PanGeo (2008) and the Renewal Corporation (2019) reports Figure 2-2, Appendix C of this sub-plan. A debris slide was identified at a former meander bend of the Klamath River and, upslope of this, a possible relict debris slide. The terrain analysis also identified two recent debris slides in colluvium or weathered bedrock at the reservoir rim, as well as two additional debris slides that occurred at the site of a former meander bend of the Klamath River. It is possible that undercutting at the former meander bend was a contributory cause of slope instability. The presence of over-steepened bare soil slopes, slumped debris, and inclined trees along the reservoir rim provide evidence of active erosion by wind-generated reservoir waves.

The Klamath River followed a sinuous meandering path in the footprint area of the reservoir. Over-steepened slope segments are present on the outside of meander bends and are potential sites of terrain instability in the post-drawdown condition once the course of the Klamath River is re-established. Submarine talus slopes have accumulated from rock falls locally around the reservoir rim, in particular in the east part of the south shore of the reservoir. Soft sediment that has accumulated on the floor of the reservoir will likely be susceptible to erosion upon drawdown.

For Iron Gate, there is the potential for local instability to affect Copco Road, in particular where possible historic landslides were identified between the road and the reservoir rim and where existing cracks were identified on the road pavement. Previous slope instability was identified at the reservoir rim down slope from Copco Road; however, it was relatively small-scale and did not affect the road. It is likely that any slope instability at these areas caused by the drawdown is similarly small-scale and will not affect Copco Road. The terrain analysis identified previous slope instability at an area between the road and reservoir rim; however, it is unlikely that slope instability will be reactivated at the same location by the drawdown (Knight Piésold, 2020a).

2.2 Drawdown and Diversion Procedures

The Renewal Corporation will initiate the release of sediment to the Klamath River from the three larger reservoirs (J.C. Boyle, Copco No. 1, and Iron Gate) with reservoir drawdown. Proposed pre-January 1 reservoir releases will be accomplished with the facilities' existing structures to bring the reservoirs at or near their minimum allowable operating levels. Then, starting January 1 of the drawdown year, the Renewal Corporation will allow regulated releases to draw down the reservoirs and release associated sediment in a controlled manner. Drawdown will continue until removal of the four dams. The following reservoir drawdown and diversion approach described in this section is from the Design Report (Knight Piésold, 2020b).

2.2.1 Cofferdams

The Renewal Corporation will install work pads at the base of Copco 1 and Irongate dam to allow for construction equipment access. Work pads serve the function of a cofferdam by establishing a dry working environment. Construction of the work pads include installing clean rock into the wetted area allowing equipment to then extend further into the wetted area in the dry. The equipment then installs more clean rock further into the wetted area allow the construction equipment to roll further out into the area in the dry. This process continues until the entire pad is constructed. A cofferdam is not used in these applications as there is more active stream channel work required to install the coffer dam, and then the work pad would be constructed after. The coffer dam method is not economically practical nor is it time efficient. By installing the work pad it functions like a dike allowing for the dry access above the water elevation. Please refer to the Klamath River Renewal Project 100% Design Completion Drawings (Knight Piésold and Kiewit. 2020) Sheets 2501 and 2501 for Copco and Sheet 4500 for Iron Gate. The work pads will be removed in reverse succession as their installation.

Work pads will be inspected daily to make sure that no fish or other aquatic or terrestrial species are trapped on the inside and cannot return to the river. There will be short term turbidity increases during their installation as the river bottom is agitated by placed rock. At Copco the turbidity will be limited to the bypass reach or will be directed through the Copco tunnel. At Iron Gate turbidity will occur in the mainstem Klamath River.

Construction at Copco will take approximately 13 days and Iron Gate will take approximately 18 days.

2.2.2 J.C. Boyle Facility

2.2.2.1 Existing Facility Components

The J.C. Boyle facility construction is well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report. Supporting Technical Information Documents (STIDs) are provided in Appendix J of the Design Report.

2.2.2.2 Pre-Drawdown Works

The Renewal Corporation will utilize existing facility features to assist with pre-drawdown and drawdown at the J.C. Boyle facility. The Renewal Corporation will use two existing diversion culverts under the current spillway to facilitate reservoir drawdown and flow passage during dam removal. The historic cofferdam and earthfill dam embankment divert water into the diversion culverts. No new cofferdams will be installed.

The dam site is accessible without additional access improvements. The Renewal Corporation can commence site preparation, equipment mobilization, and construction access improvements to other parts of the facility after drawdown is complete.

The J.C. Boyle Reservoir operation during the pre-drawdown period will follow the PacifiCorp STID operating levels (PacifiCorp, 2015a). The reservoir operation elevations are defined as follows:

- Normal maximum reservoir operation level: 3,796.7 ft (NAVD88)
- Normal minimum reservoir operation level: 3,791.7 ft (NAVD88)

2.2.2.3 Reservoir Operation

After the License transfer order is accepted, the Renewal Corporation will lower the reservoir and maintain it at a targeted level just below the spillway crest by controlled spillway releases or by using normal power operations prior to the commencement of drawdown (January 1 of the drawdown year).

2.2.2.4 Drawdown Works

The Renewal Corporation will commence initial drawdown when the J.C. Boyle Reservoir is at or about the normal minimal operating level (elevation 3,791.7 ft). The Renewal Corporation will commence drawdown operations at J.C. Boyle on or about January 1 of the drawdown year. No special provisions for pre-drawdown are needed for J.C. Boyle; however, the Renewal Corporation will drawdown the reservoir to the normal minimum operating level prior to January 1, as inflows allow. The proposed drawdown occurs in four stages, the first utilizes the spillway gates, the second utilizes the power facilities, and the third and fourth utilizes a sequenced removal of the diversion culvert stoplogs (shown on drawing C1050 in Appendix A).

The Renewal Corporation will maintain a reservoir water surface level of 3,783.2 ft (2 ft below the spillway crest) to initiate both Stage 3 and Stage 4. This level allows workers to safety access the downstream side of the diversion culverts. River forecasting and coordination with the Upper Klamath River Basin is required so the reservoir water level will remain below the spillway crest while crews are actively working on the downstream side of the diversion culverts. The maximum rate of drawdown varies from stage to stage due to inflow, the geometry of the reservoir, and the nature of the outflow (free-flowing) through the diversion culverts. The Renewal Corporation will achieve final drawdown when water flowing through the two diversion culverts reaches open channel flow and the water surface is at or below elevation 3,763.1 ft.

The design analysis completed to support the Design (Knight Piésold, 2020b) compared steady-state inflows to culvert rating curves to determine the maximum flow allowable for crews to safely access the downstream side of the diversion culverts. These are presented in the Stage 2 and Stage 3 drawdown sections below. In years when inflows exceed these flows, it is anticipated that the Keno Dam and Upper Klamath Lake can be used to temporarily manipulate inflows into the reservoir to allow for initiation of Stages 3 and 4 through coordination with the United States Bureau of Reclamation (USBR). The Renewal Corporation is in discussions with the USBR to allow for temporary flow control measures. Control measures can be finalized prior to the drawdown year when actual base and hydrologic information is available and flow forecasts are prepared by the USBR.

Drawdown sequencing is shown on drawing C1050, and steady state water surface elevations are provided on drawing C1055, both in Appendix A. The proposed reservoir area capacity curve, various rating curves, and drawdown modeling results are summarized on drawing C1056 (Appendix A). The proposed drawdown process is discussed below.

2.2.2.4.1 Stage 1 Drawdown

The Renewal Corporation will commence Stage 1 drawdown no earlier than January 1 of the drawdown year, with the reservoir at or above the minimum operating elevation of 3,791.7 ft. The Renewal Corporation will achieve this stage of drawdown by using the gated spillway bays to lower reservoir levels at a target rate of 5 ft per day (ft/day). The Renewal Corporation will achieve reservoir drawdown rate control by varying spillway openings according to actual reservoir inflow rates. The power intake can be closed during Stage 1 except in the case of extreme wet conditions (high inflow rates), when the additional capacity of the power facilities is required to achieve drawdown.

The Renewal Corporation will undertake to complete Stage 1 drawdown within 48 to 72 hours of commencement, when the water level in the reservoir has stabilized above the spillway crest (spillway crest elevation 3,785.2 ft). The stabilized elevation marking completion of Stage 1 will depend on the reservoir inflows at the time of drawdown.

2.2.2.4.2 Stage 2 Drawdown

The Renewal Corporation may initiate Stage 2 drawdown by continued power operations once Stage 1 is completed, and with the use of the spillways during wet year inflows. With power operations, outflow rates will initially increase and then quickly subside as water levels recede (ranging up to 2,850 cfs). The diversion culverts can remain closed during Stage 2.

Stage 2 drawdown may be complete when the water level in the reservoir has stabilized at least 2 ft below the spillway crest (spillway crest elevation 3,785.2 ft). The stabilized elevation marking completion of Stage 2 may depend on the reservoir inflows at the time of drawdown. A reservoir water level which is 2 ft below the spillway crest is associated with a reservoir inflow of 1,260 cfs and may require river forecasting and coordination with the Upper Klamath River Basin to achieve this flow release. The Renewal Corporation is in discussions with the USBR to allow for temporary flow control measures. Control measures can be finalized when actual base and hydrologic information is available and flow forecasts are prepared by the USBR.

A concrete stoplog needs to be removed from diversion culvert #1 to initiate Stage 3 drawdown. The explosives required to remove the culvert stoplog and initiate Stage 3 can only be set when there is no flow coming over the spillway. The Renewal Corporation may complete culvert stoplog removal work at the end of Stage 2 when reservoir water surface elevations are below the spillway invert and reservoir outflows are passing through power operations. The Renewal Corporation will close the spillway gates when work is being performed on the downstream side of the low-level diversion culverts. The Renewal Corporation will prepare and remove the diversion culvert #1 stoplog over a period of about 24 hours.

2.2.2.4.3 Stage 3 Drawdown

The Renewal Corporation will initiate Stage 3 drawdown once Stage 2 is completed by removing one of the diversion culvert concrete stoplogs. The Renewal Corporation will remove the diversion culvert #1 stoplog by controlled blasting. Diversion culvert #1 is located below the gated spillways and provides a 9.5 ft by 10 ft opening with an invert elevation of 3,755.2 ft. With diversion culvert #1 opened, outflow rates will initially increase and then subside as reservoir water levels recede (ranging up to 3,786 cfs). The Renewal Corporation will close the power intake wheel gate simultaneously with (or immediately prior to) the removal of the diversion culvert #1 stoplog. Once the power intake is closed, it will remain closed for the duration of the drawdown period.

The J.C. Boyle reservoir is narrow and does not have a large storage capacity below the spillway crest elevation. As a result, the culvert outflow rate will quickly equalize with the reservoir inflow rates over a 48- to 72-hour period. The maximum anticipated drawdown rate for Stage 3 is 10 ft per day. The stabilized elevation marking completion of Stage 3 will depend on the reservoir inflows at the time of drawdown. Similarly, to Stage 2, a reservoir water level that is 2 ft below the spillway crest is required for access to the downstream side of diversion culvert #2 to prepare for Stage 4. While water is flowing from diversion culvert #1, the Renewal Corporation will cut an access hole in the roof of diversion culvert #2 to gain access to the diversion culvert #2 stoplog. This process will allow the Renewal Corporation to conduct diversion culvert #2 concrete stoplog demolition work in the dry (i.e., isolated from diversion culvert #1 outflows, to the greatest extent possible). This reservoir elevation is associated with a reservoir inflow of about 2,120 cfs and will require river forecasting and coordination with the Upper Klamath River Basin to achieve this flow release. The Renewal Corporation is in discussions with the USBR to allow for temporary flow control measures. Control measures can be finalized when actual base and hydrologic information is available and flow forecasts are prepared by the USBR.

2.2.2.4.4 Stage 4 Drawdown

The Renewal Corporation will initiate Stage 4 drawdown on or about June 10 of the drawdown year by removing the diversion culvert #2 concrete stoplog. Evaluation of the inflow rates and water levels at the time will help determine the optimal time to remove this stoplog.

The Renewal Corporation will remove the diversion culvert #2 stoplog by controlled blasting, if required. Diversion culvert #2 is located below the gated spillways and provides a 9.5 ft by 10 ft opening with an invert elevation of 3,755.2 ft. The outflow rate will initially increase and then equalize with the reservoir inflow rates over approximately 12 to 24 hours as the reservoir water level drops (ranging up to 7,572 cfs). The maximum anticipated drawdown rate for Stage 4 is 10 ft per day. Completion of the Stage 4 drawdown may provide the lowest possible drawdown of the reservoir based on reservoir inflow.

The drawdown is considered completed when both diversion culverts are operating, the J.C. Boyle reservoir is substantially dewatered, and reservoir inflows and outflows equalize (water levels are relatively stable). The diversion culverts will remain open and will pass all river flows until the historic cofferdam breach is conducted.

2.2.3 Copco No. 1 Facility

2.2.3.1 Existing Facility Components

The Copco No. 1 facility construction has been well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report. STIDs are provided in Appendix J of the Design Report.

2.2.3.2 Pre-Drawdown Works

The Renewal Corporation will construct a new low-level outlet tunnel under spillway bay 3, which will be used to draw down the reservoir. The construction of the low-level outlet tunnel will require temporary construction access from the right bank through the powerhouse to develop a work platform beside the spillway plunge pool. This spillway plunge pool work platform will also provide access to the historic diversion tunnel outlet, which is required to reopen the tunnel and complete drawdown. The proposed work includes dredging of the low-level outlet tunnel approach channel and the historic diversion tunnel approach channel.

The Renewal Corporation will conduct dredging of deposited sediment and debris in the reservoir at the low-level outlet tunnel approach channel to remove obstructions and facilitate the safe passage of river flows and sediment during drawdown. Dredging of the historic diversion tunnel approach channel is also required to facilitate its usage during dam demolition and removal. Design drawings C2160, C2210, and C2272 (Appendix A) show the extents of the dredging location and material disposal.

The Renewal Corporation will excavate a low-level outlet tunnel through the center of the concrete dam during the pre-drawdown construction works period to allow for reservoir drawdown. The outlet will be excavated as a 10.5-ft high and 10.5-ft wide D-shaped tunnel with vertical sides, a 10-ft concrete plug orifice to the reservoir, and a 10.5-ft diameter steel outlet conduit (drawings C2205 and C2225 in Appendix A). When opened, the outlet will connect the reservoir to the spillway plunge pool and drain the reservoir. The Renewal Corporation will accomplish excavation of the low-level outlet tunnel by first constructing a work platform at the toe of the dam to access the proposed adit. Then the concrete at the base of the dam will be drilled, blasted, and excavated in sections (vertically and horizontally) until the final section/plug is reached. The final section will terminate in the upper cut-off wall, leaving a concrete plug separating the dry tunnel and the reservoir, as shown on drawing C2225 (Appendix A). The concrete plug is designed to provide the plug length required for structural strength, and includes additional contingency length to account for possible fractures in the concrete mass induced by vibration during excavation of the tunnel. The tunnel plug design will allow normal power operations to continue until reservoir drawdown.

The low-level outlet terminates in a narrow canyon with an existing spillway plunge pool. The Renewal Corporation will embed a 10.5-ft diameter pipe into the concrete tunnel section to extend the outlet into the spillway plunge pool. The outlet pipe will direct outflow into the spillway plunge pool and allow access to a spillway work platform while flow is discharging through the outlet and pipe.

2.2.3.3 Reservoir Operations

During the pre-drawdown construction period, the Renewal Corporation will operate the Copco No. 1 facility to comply with the procedures set out below.

2.2.3.3.1 Normal Flow Condition

The Renewal Corporation will keep the Copco No. 1 reservoir level at or below the spillway ogee crest level (elevation 2,597.1 ft), to as low as the minimum operating level (elevation 2,592 ft) during and after pre-drawdown construction. The Renewal Corporation will bypass reservoir inflows through the powerhouse turbine generator units 1 and 2, which provide a combined discharge capacity of 3,000 cfs (PacifiCorp, 2016).

The Renewal Corporation will lock out spillway gates to comply with dam safety requirements during the pre-drawdown construction period and to allow safe access below the spillway to construct the new low-level outlet tunnel. Proposed reservoir operation under this procedure will provide a freeboard height of at least 12 ft to the normal maximum reservoir operating level

(2,611 ft), equal to at least 6,900 acre-ft of storage capacity. This will provide attenuation capacity and time to monitor inflows and vacate the downstream area in the event of large reservoir inflows that exceed the powerhouse capacity, causing reservoir levels to rise.

The Renewal Corporation will maintain the operating water level (as described in the previous paragraph) for reservoir inflow rates up to 3,000 cfs, which exceeds the average flow conditions during the pre-drawdown dam modification construction works period (ranging up to 2,110 cfs). However, average flow rates and flood risks do increase through the fall. By November and December average flows are estimated to be 1,230 cfs and 1,490 cfs, respectively. To address flood risks, the Renewal Corporation will complete low-level outlet tunnel works prior to November of the pre-drawdown year.

2.2.3.3.2 Flood Condition

Reservoir inflow rates greater than 3,000 cfs exceed the powerhouse flow capacity and will cause reservoir water levels to rise. The Renewal Corporation will stop work at the downstream construction area if reservoir water levels exceed the minimum freeboard criteria (i.e., result in less than 12 ft of freeboard).

A work stoppage may require the removal of all personnel from the downstream construction area and the unlocking of the spillway gates, as defined in the Emergency Response Plan (Kiewit, 2020) and STIDs. The facility will continue to discharge through powerhouse units 1 and 2. Work will be resumed when water levels recede below the minimum freeboard criteria. In the event that water levels rise to above the spillway ogee level (2,597.1 ft), the Renewal Corporation will lower the reservoir level by release of water through the spillway gates. Damage to the temporary spillway downstream work platform is expected if spillway operation occurs. In this event, the Renewal Corporation will re-establish the work area to facilitate ongoing construction of the low-level outlet tunnel works after flood water levels have receded.

2.2.3.4 Drawdown Works

The Renewal Corporation will maintain the lowered Copco Lake reservoir level for pre-drawdown construction until drawdown begins on or around January 1 of the drawdown year. The proposed drawdown operation will be governed by two main events: opening of the low-level outlet tunnel for primary reservoir lowering, and subsequent opening of the historic diversion tunnel to divert flows around the dam and facilitate dam removal works. Initial drawdown occurs when the concrete plug is opened to the low-level outlet tunnel.

The Renewal Corporation will achieve final drawdown through the historic diversion tunnel and when the water surface elevation is maintained below elevation 2,515 ft (crest of the historic cofferdam). The proposed drawdown process is discussed below and included on drawings C2055, C2056, and C2057 in Appendix A.

2.2.3.4.1 Opening of the Low-Level Outlet Tunnel

The shape and profile of the low-level outlet tunnel was selected to facilitate construction, reduce stresses acting on the crown of the tunnel, and provide the internal cross-section necessary to discharge design flows (Table 2.2). The Renewal Corporation will commence drawdown on or about January 1 of the drawdown year when the low-level outlet tunnel is opened to the reservoir. This will be achieved by precision blasting the concrete plug left in place during the pre-drawdown tunnel excavation works. Access to remove the concrete plug is only possible from the dry downstream side of the outlet conduit vent pipe and will require predrilling of the blast holes at the time of the tunnel construction. Upon removal of the plug, the surge of water from the reservoir will remove concrete debris that will settle in the plunge pool.

The low-level outlet tunnel is designed to lower the reservoir without addition of power operations. The reservoir level range expected for normal hydrologic conditions (50th percentile) during drawdown, using only the low-level outlet tunnel, is at elevations between 2597.1 ft to 2530 ft. The maximum drawdown rate of the reservoir for normal hydrologic conditions is approximately 5 ft/day and occurs between January 1 and January 8.

The 10.5-ft low-level outlet tunnel orifice inlet diameter provides an initial discharge capacity of about 3,680 cfs at a reservoir elevation of 2,592 ft. The outflow capacity decreases to approximately 2,115 cfs at a reservoir elevation of 2,530 ft., which is the water level at or below which the historic diversion tunnel will be opened. The proposed rating curve for the low-level outlet tunnel is provided on drawing C2056 (Appendix A).

The design of the 10.5 ft diameter tunnel orifice and high discharge velocity of the outlet allows the passage of sediment and reduce the risk of blockages. Concentrated flow velocities upstream of the dam promote sediment mobilization in the original river channel and sediment transport downstream. The energy of the outflowing water dissipates within the spillway plunge pool.

The Renewal Corporation will implement measures to address potential debris blockage during drawdown. In advance of drawdown, the Renewal Corporation will conduct dredging on the upstream side of the adit and historic diversion tunnel intake to create a depression for collection of sediment and/or debris materials. If sediment and/or debris materials accumulate in the adit or tunnel, the Renewal Corporation will use mechanical means or controlled blasting to remove the obstruction. In addition to these measures, the low-level outlet tunnel slopes downward at a 10% grade, from the intake to the outlet. This slope allows for the clearing of the concrete plug debris and sediment passage of bed material during reservoir drawdown, and debris materials will end up in the plunge pool at the end of the pipe (see drawings C2210 and C2225).

The low-level outlet tunnel functions as an uncontrolled hydraulic structure and drawdown rates and the overall drawdown period will depend on the reservoir inflow rates during the drawdown period. Partial reservoir refilling can occur due to large inflow events that exceed low-level outlet tunnel capacity.

2.2.3.4.2 Left Bank Access

Access to the historic diversion tunnel inlet structure is required to open the historic tunnel during the late stages of drawdown when water levels have receded to 2,530 ft or lower. The Renewal Corporation will lower equipment down the left bank to the concrete inlet structure. Two methods are proposed for lowering the equipment. Under the first method, and after initial removal of the top off the dam that will leave a wider passage, equipment will traverse the dam to the south side (i.e., left abutment looking downstream) and then track-walked down the abutment using an anchoring system that will winch the excavator down to the intake elevation. If equipment is not able to traverse the top of the dam, the Renewal Corporation will bring equipment through private property to the south side.

2.2.3.4.3 Opening of the Historic Diversion Tunnel

The Renewal Corporation will complete opening of the historic diversion tunnel when reservoir water surface elevations have subsided to 2,530 ft or lower. The invert elevation of the historic diversion tunnel is assumed as 2494.8 ft. The initial step is to remove the concrete inlet structure to elevation 2,505.8 ft or lower, followed by removal of the existing concrete plug by drilling and blasting from the downstream side of the plug. Re-establishing flow in the historic diversion tunnel results in the lowering of water levels to at or below the historic cofferdam crest elevation (2,515 ft), thereby routing river flows around the dam site and facilitating dam demolition and removal. The Renewal Corporation will complete the removal of the remaining intake structure and embedded items to elevation 2,494.8 ft once the reservoir level is lowered to an approximate elevation 2,515 ft to fully open the diversion tunnel. The additional diversion capacity reduces the risk of reservoir refilling during the dam removal period.

The historic diversion tunnel provides a flow capacity of 4,200 cfs when water levels are at approximately 2,515 ft, which exceeds normal flows during the summer period when dam removal will occur. The historic diversion tunnel originally functioned as the diversion tunnel during construction of Copco No. 1. The range of diversion flows are the same as the flows expected after the diversion tunnel is reopened. The proposed diversion tunnel reopening is shown on drawing C2100 in Appendix A.

2.2.4 Copco No. 2 Facility

2.2.4.1 Existing Facility Components

The Copco No. 2 facility construction has been well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report. STIDs are provided in Appendix J of the Design Report.

2.2.4.2 Pre-Drawdown Works

The Renewal Corporation will use the existing diversion dam structure to pass the river flows and avoid the use of cofferdams or the need to develop new large structures in the river channel. The base-case design involves removing a portion of a spillway bay and preparing the remaining spillway ogee section for initiation of drawdown. After drawdown, the dam will be progressively removed laterally. The proposed removal of the elements of the diversion dam and intake structure are shown on drawings C3200 to C3232 in Appendix A.

During the pre-drawdown period, the Renewal Corporation will remove the downstream portion of the left-most spillway bay (Spillway Bay No. 1), extending down to the concrete apron (elevation 2,459.5 ft). The Renewal Corporation will remove all concrete, except for the upstream 17 ft of the ogee spillway, which will be left in place. The ogee spillway provides support to the left bank wing wall, which is required to remain stable after the ogee crest is removed to prevent erosion of the bank during drawdown. Results of a structural analysis conducted for the spillway left wing wall indicated it should be stable when the entire ogee structure is removed for the diversion of river flows.

The Renewal Corporation will build a temporary construction work platform from the right bank onto the spillway apron, which will function as a work platform for the pre-drawdown works, as shown on drawing C3210 (Appendix A). The spillway apron work platform will be built to elevation 2,462.5 ft, above expected tailwater elevations, to provide a competent dry working surface. Additionally, concrete between the two piers of Spillway Bay No. 1 will be removed using blasting techniques or mechanical demolition. Concrete will be removed to elevation 2,459.5 ft during the pre-drawdown works to match the top of the spillway apron. The spillway apron, sill, and left bank retaining wall will be left in place to provide erosion protection for the riverbed, since high flows may pass through the confined opening during the drawdown year. The work platform material will be removed following concrete removal to the target elevation.

2.2.4.3 Reservoir Operations

To complete pre-drawdown construction works, the Renewal Corporation will close the spillway gates, and all water will be diverted through the intake to the powerhouse. After pre-drawdown dam modifications are complete, the Copco No. 2 facility will continue to operate as a power generating station under normal operating conditions until drawdown begins the following year. The reservoir will be lowered and maintained at the normal minimum reservoir operation level (elevation 2,486.1 ft) prior to the commencement of drawdown (January 1 of the drawdown year). Section 2.3 outlines alternative drawdown procedures and reservoir operations.

2.2.4.4 Drawdown Works

The Renewal Corporation anticipates no restrictions regarding Copco No. 2 drawdown, except that it must not be initiated prior to January 1 of the drawdown year. The Renewal Corporation will initiate drawdown of the reservoir by opening the spillway gates and increasing the flow through the conveyance system to the powerhouse. The average monthly flow at Copco No. 2 is less than 2,000 cfs in January and the capacity of the conveyance system and turbines is 3,200 cfs. The drawdown below the spillway crest can therefore be completed entirely through the intake, provided inflows to Copco No. 2 are not substantially higher than average during drawdown. Drawdown of the reservoir and the spillway bay removal will occur over a short timeframe, so high-flow events are not anticipated to affect the drawdown period. Drawdown will reduce the head pond to a minimum level below the spillway crest, which is controlled by the hydraulics of the tunnel and inflows from the river. By using the conveyance system to lower the reservoir, removal of the final 17 ft of dam at Spillway Bay No. 1 can occur under a lower head.

The Renewal Corporation will remove the Spillway Bay No. 1 concrete plug to elevation 2,459.5 ft through a controlled blast or by mechanical methods. The intake caterpillar gate will be closed permanently after Spillway Bay No. 1 is opened and the reservoir level can then become limited by the constriction at the spillway bay. The rating curve for the reservoir with Spillway Bay No. 1 excavated to elevation 2,459.5 ft and the four remaining spillway gates open is shown on drawing C3057.

An alternative option for Copco No. 2 drawdown and removal is discussed in Section 2.3.3, which uses Copco No. 1 to block flow to the Copco No. 2 reservoir and complete removal in the dry.

2.2.5 Iron Gate Facility

2.2.5.1 Existing Facility Components and Preconstruction Inspections

The Iron Gate facility construction is well documented in historic design drawings and construction photographs. Historic drawings are provided in Appendix K of the Design Report. STIDs are provided in Appendix J of the Design Report.

The existing low-level outlet control at Iron Gate Dam consists of a hydraulically actuated, gravity-close, reinforced concrete bulkhead gate. The outlet control is installed at the bottom of a 160 ft-long shaft and is comprised of two sections of concrete bulkhead, the lower of which has not been moved since original construction. The gate slot and concrete bulkheads close a waterway opening that is horseshoe-shaped and is 15 ft – 6 inches wide by 16 ft – 9 inches high. A concrete collar and 9-ft diameter blind flange were installed downstream of the control gate during a 2007 construction program, to allow isolation and underwater inspection of the control gate.

A detailed underwater inspection and survey was completed for the concrete-lined upstream tunnel from the intake structure to the control gate using a Remote Operating Vehicle (ROV) in late August 2020. ASI Marine (ASI) used an ROV to investigate the configuration and condition of the Iron Gate diversion tunnel upstream of the control gate and intake structure, and control gate and operator. Using multibeam profiling sonar equipment, a 3-dimensional model of the gate structure, gate, and diversion tunnel was developed. The diversion tunnel gate and associated components appear to be in good condition with only minor spalling observed in several areas. On average, the height of the tunnel profiles along the vertical center of the profile from Station 3+06 to Station 6+66 is approximately 172 inches, which differs approximately 26 inches from the height indicated in historic drawings (G-8862 in Appendix A).

ASI also conducted an underwater inspection of the Iron Gate diversion gate. The inspection identified debris build-up that will need to be cleared; the gate rollers and guides will also need to be cleared of debris. This work will be scheduled in the pre-drawdown period. Additionally, a

9-ft diameter steel head will be attached to an existing flange located just downstream of the gate. The 9-ft diameter steel head will be installed during pre-drawdown work to create a balanced head condition, followed by a partially unbalanced head condition, across the diversion tunnel gate. Once all debris is removed, the gate and its hydraulic power unit (hoist) will be cycled up and down. Components will be lubricated, maintained, and replaced as necessary. The gate will be raised to its fully open position and then closed three times to demonstrate its ability to open and close. Once confirmed, the diversion tunnel gate and hoist will be considered ready for the scheduled opening to begin drawdown on January 1.

The downstream tunnel from the control gate to the outlet portal currently features a concrete-lined segment for approximately 90 ft immediately downstream of the gate. The rest of the tunnel downstream of the gate (approximately 500 ft long) is unlined, except for a 25 ft long concrete-lined segment at the outlet. This section of the diversion tunnel has been visually inspected above the water line, and surveyors from the Yurok Tribe Design and Construction Division surveyed the Iron Gate low-level diversion tunnel in November 2020 from the control gate to the downstream tunnel outlet. This survey was completed to corroborate the information, configuration, and dimensions of the downstream portion of the diversion tunnel provided in as-constructed drawings. Subaqueous and aqueous 3-dimensional model data were collected and are being processed as of December 7, 2020. Preliminary results from the survey indicate that the existing concrete is of sound quality and the concrete is in good condition.

2.2.5.2 Pre-Drawdown Works

Pre-drawdown works at Iron Gate will involve developing access to the low-level outlet tunnel, installing a new concrete liner system in a portion of the tunnel, and installing an air vent. The sections below describe the pre-drawdown construction activities at Iron Gate.

2.2.5.3 Reservoir Operations

During the pre-drawdown construction period, the Iron Gate facility will need to be operated at minimum levels. This will be achieved by directing maximum flows through the powerhouse. The discharge capacity of the powerhouse is 1,735 cfs (PacifiCorp, 2016). The minimum operating water level is at elevation 2,327.3 ft, as set out in the design criteria in Table 2.1.

Average flow rates and flood risks increase through the fall, and by December, average flows are estimated to be 1,580 cfs. The construction risk for in-water work will increase with increased flows.

2.2.5.4 Drawdown Works

Initial drawdown will begin when the reservoir surface water level is at or about the spillway level. The existing diversion tunnel reinforced concrete bulkhead control gate will be utilized as the main drawdown control mechanism. A preliminary assessment of the gate and hoist system has been completed and results indicate the existing capacity of the hoist is adequate to operate the gate during drawdown. The Renewal Corporation will initiate drawdown of Iron Gate reservoir by opening the existing outlet control gate to its maximum opening height of 57 inches.

The penstock and powerhouse bypass valve will be used to supplement initial drawdown flows. The maximum outflow rate, at full reservoir with the control gate fully open, is estimated to be 4,000 cfs and the flow rate will decrease as the reservoir level lowers. The gate will remain fully open for the period of reservoir drawdown. The maximum drawdown rate (12 ft/day) was visually assessed and defined based on the steepest part of the slope from the power intake invert (elevation 2,295.3 ft) to the historic cofferdam crest (elevation 2,212 ft). The upgraded tunnel concrete invert and sidewall liner will provide erosion protection to safely pass outflows throughout drawdown and dam removal. The Renewal Corporation determined use of the existing gate in the fully open position to be an acceptable drawdown method. In making this determination, the Renewal Corporation considered:

- Embankment stability;
- Reservoir rim stability;
- Downstream erosion; and
- Tunnel integrity.

Reservoir pre-drawdown operations will begin in November and December to bring the reservoir water surface level to the normal minimum operating surface elevation of 2,327.3 ft, as permitted by inflows at the time. The Renewal Corporation will commence drawdown on or about January 1 of the drawdown year and drawdown will continue concurrently with embankment removal until water levels are low enough to initiate the final dam breach, as discussed further in Section 4.4. The penstock and powerhouse bypass may be used to supplement drawdown flows while the reservoir level remains high enough to allow for flow through the penstock. Final drawdown is achieved when the reservoir water surface level is at or below the historic cofferdam level.

2.3 Alternative Drawdown Procedures

2.3.1 J.C. Boyle Facility

The Renewal Corporation does not have alternative drawdown procedures for this facility.

2.3.2 Copco No. 1 Facility

The alternative drawdown procedures planned for this facility are directly tied to Copco No. 2, as discussed in the section below.

2.3.3 Copco No. 2 Facility

The Renewal Corporation is considering an option that involves using Copco No. 1 to fully dewater the Copco No. 2 reservoir, allowing for Copco No. 2 Dam removal in the dry and without the need for staged diversion. Current Copco No. 1, Copco No. 2, and Iron Gate operations allow the river channel between Copco No. 1 and Copco No. 2 dams to be dewatered for short periods of time. Construction activities can proceed directly to removal of the entire concrete diversion dam, and a portion of the intake structure, during the pre-drawdown year to the final excavation limits shown on drawing C3221 (Appendix A), without having to follow the Spillway Bay No. 1 removal activities described in Section 4.3.

There are certain benefits to demolishing the Copco No. 2 Dam in the dry, including that it is a quicker and safer means and method for removal, and it provides a safer working condition for personnel, reduces potential river water contamination by eliminating the use of equipment within the water system, and eliminates the need for special erosion measures required for in-water work. In addition, it will be easier and quicker to install the fish passage in the dry, which also allows fish to be accommodated immediately.

The Renewal Corporation is evaluating two factors that will determine whether this alternative is viable. First, the Renewal Corporation will need to empty Copco No. 1 Reservoir to provide the greatest capacity for water retention upstream when flows from that reservoir are shut off to prevent flows to Copco No. 2. Additionally, the Renewal Corporation is in discussions with the USBR to allow for temporary flow control measures to minimize flows upstream at Keno Dam and Upper Klamath Lake. Second, the Renewal Corporation will need to fill Iron Gate Reservoir with enough water to provide at least 5 to 7 days of required downstream environmental flows for fish preservation.

2.3.4 Iron Gate Facility

There are currently no alternative drawdown procedures planned for this facility.

2.4 Flood Frequency and Hydrological Evaluation

This section of the California Reservoir Drawdown and Diversion Plan is informational and discusses the results of the drawdown model and implications to the Proposed Action. The section does not contain specific measures to be implemented by the Renewal Corporation as part of the Proposed Action.

2.4.1 Copco No. 1 Facility

The Renewal Corporation has designed the reservoir drawdown outlet works and its operation to achieve the following:

- Outlet facilities for reservoir drawdown will be designed to discharge reservoir drawdown flows and natural inflows during the drawdown period up to flow events with 25% chance of exceedance between January 1 and June 15 of the drawdown year.
    - Drawdown outlet discharge capacity is designed to lower the reservoir levels at a reasonable rate for elevations above 50% of the hydraulic height of the dam. A reasonable drawdown rate of the reservoir water surface above elevation 2555 ft (50% of the hydraulic height of the dam) for normal hydrologic conditions (50th percentile) is approximately 7 ft/day and occurs between January 1 and January 6.
    - Reservoir refill can occur when natural inflows exceed the drawdown outflows.

- The reservoir drawdown will occur when the capacity of the drawdown discharge outlet exceeds the natural inflow and drawdown discharge. This condition is achieved when:
    - The reservoir volume is equal to the average inflow multiplied by one day (inactive storage).
    - Storage capacity is less than 10% of the capacity of the long-term normal reservoir operation level.

2.4.1.1 Reservoir Conditions During Drawdown

Hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle Reservoir and drawdown regulation and outflows through the J.C. Boyle Dam are included in Appendix A. Appendix A also shows the hydrologic simulations of the reservoir drawdown inflows into the Copco No.1, Copco No. 2, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

Operation of the Copco No. 1 reservoir during drawdown will achieve successful evacuation of the reservoir impoundment. The Renewal Corporation will complete reservoir drawdown and river diversion utilizing the spillway, newly constructed low-level outlet tunnel, and the historic diversion tunnel. The drawdown model was developed to assess drawdown sequencing in terms of reservoir water surface levels under a range of hydrologic conditions for the 2019 Biological Opinion (2019 BiOp [National Marine Fisheries Service, 2019]) flows. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. These drawdown sequencing assessments were performed to provide the magnitude and timing of expected reservoir water surface elevations, inflows, and outflows, which were important for the design and staging of drawdown.

Reservoir water surface levels were simulated in the drawdown model for the full record of inflows available for the 2019 BiOp dataset. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Copco No. 1 Simulated Drawdown. These plots indicate the following:
    - Reservoir water surface levels.
    - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway, low-level outlet tunnel, and flows through the historic diversion tunnel).
- Maximum daily reservoir water surface level non-exceedance percentiles (percentiles) are shown on Figure 2-1. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the results on any given day of the simulations. These results do not represent a single simulation and are based on all the model simulations.
- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-2. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

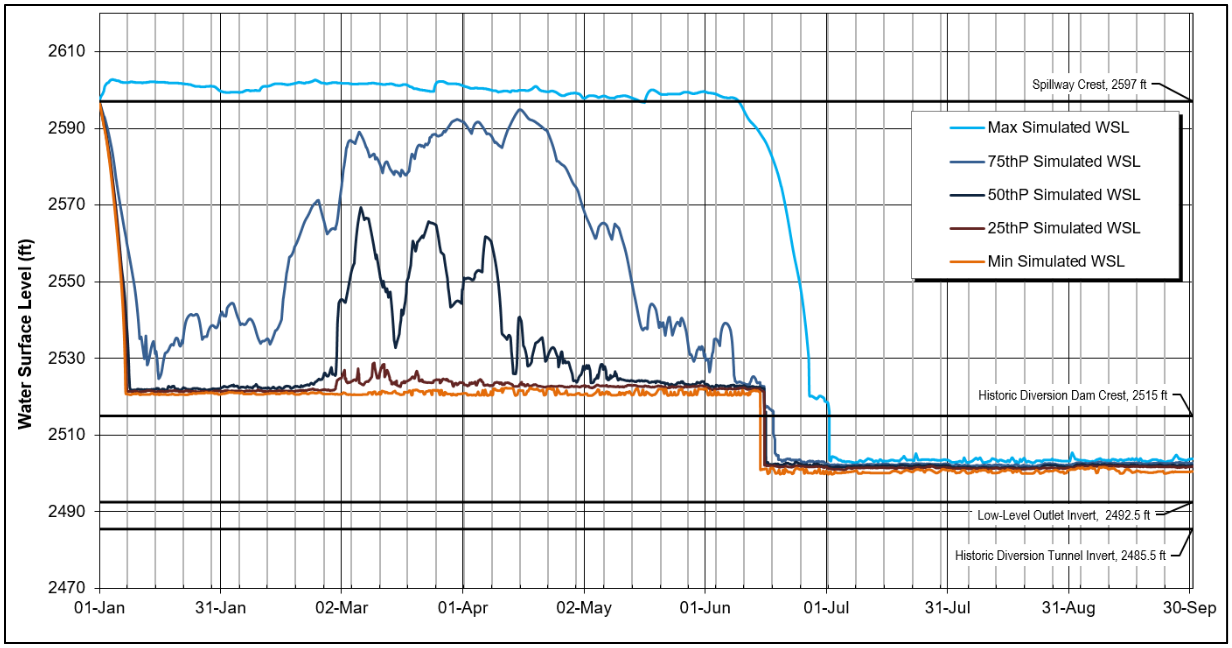

Figure 2-1 Copco No. 1 Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

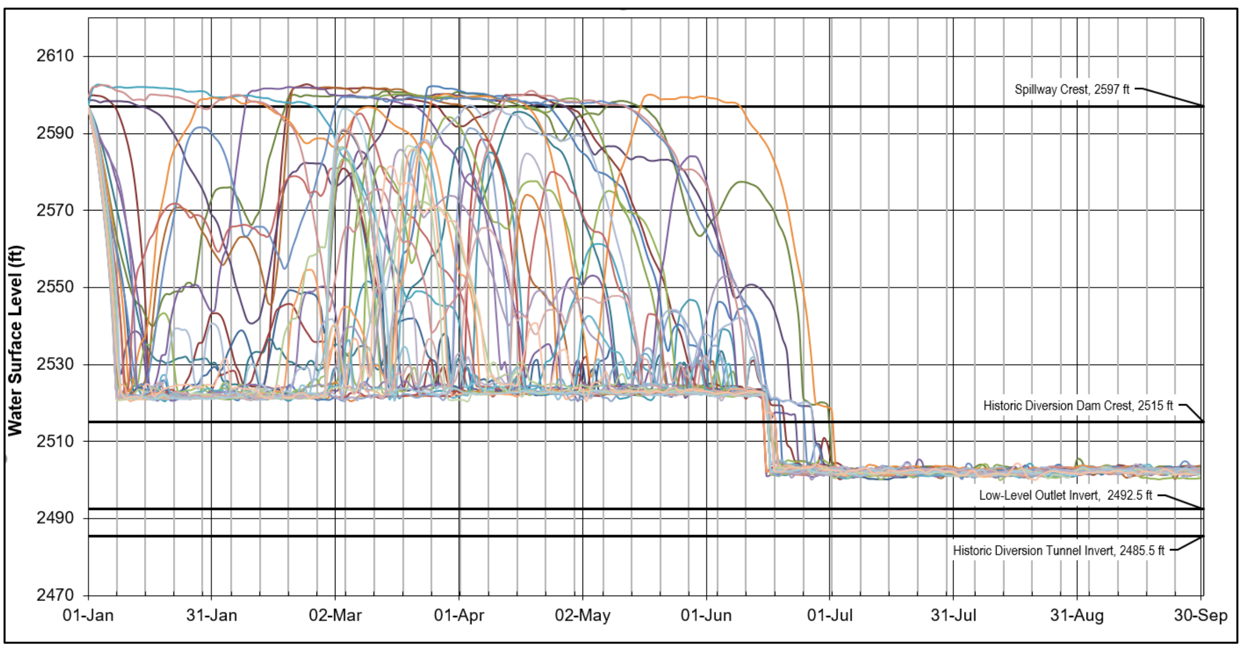

Figure 2-2. Copco No. 1 Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-1**.** show that the reservoir water levels drop below the crest of the historic diversion dam in mid-June for the 75th percentile, while the remaining model simulations achieve a lowered reservoir water level by the beginning of July.

Figure 2-2 shows that approximately 80% of the model simulations draw down to a water surface elevation of approximately 2,520 ft in January, which is the lowest water surface elevation achievable using the low-level outlet tunnel prior to the historic diversion tunnel opening. However, the reservoir refills in the higher flow months of February through May. There can be large fluctuations in the reservoir water surface levels from March through June. Spillway flows are observed after January for 31% of the simulations.

The reservoir water surface level can rapidly rise in March, April and May resulting from large inflow events. Examples of this are seen in simulation years 1981, 1989, and 1993, where the reservoir water surface level was at approximately 2,520 ft in January but then rapidly rises in response to the high inflows. These inflows may be a function of the refilling of Klamath Lake as described in USBR (2018) or are influenced by the flows from unregulated tributaries entering the Copco No. 1 reservoir.

Figure 2-3 shows the cumulative percent of model simulations and both the date when the reservoir water surface level is at or below the highest water surface elevation at which the historic diversion tunnel can be opened (2,530 ft) and the date when the water surface elevation is sustained below the crest of the historic diversion dam. Currently in the drawdown model, the historic diversion tunnel opens after June 15 once the reservoir water surface elevation is at or below 2,530 ft, which is approximately 20 ft above the top of the historic diversion tunnel intake. Initially, a 5-ft diversion tunnel opening is assumed and once the water surface elevation drops below 2,516 ft an 18 ft opening is assumed. The drawdown model indicates that approximately 50% of the simulations have reservoir water levels below the 2,530 ft by June 1, with approximately 30% of the simulations achieving this as early as May 1. The drawdown model indicates that 100% of the simulations achieve this by the end of June. There is potential to open the historic diversion tunnel earlier in the year based on the drawdown model results, but this will be dependent on the hydrological conditions in the drawdown year. River forecasting will be required as the reservoir levels need to be maintained below 2,530 ft for 3 weeks, once the historic diversion tunnel is opened, to perform plug removal.

Drawdown is achieved when the water surface elevation is maintained below the crest of the historic cofferdam (2,515 ft) and can only be achieved after the historic diversion tunnel is opened. The drawdown model indicates that approximately 80% of the simulations have reservoir water surface elevations sustained below the crest of the historic diversion dam within a few days (June 19) of the historic diversion tunnel opening on June 15, with 100% of the simulations achieving this by July 2. Note that the water level results shown on Figure 2-3 are based on average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

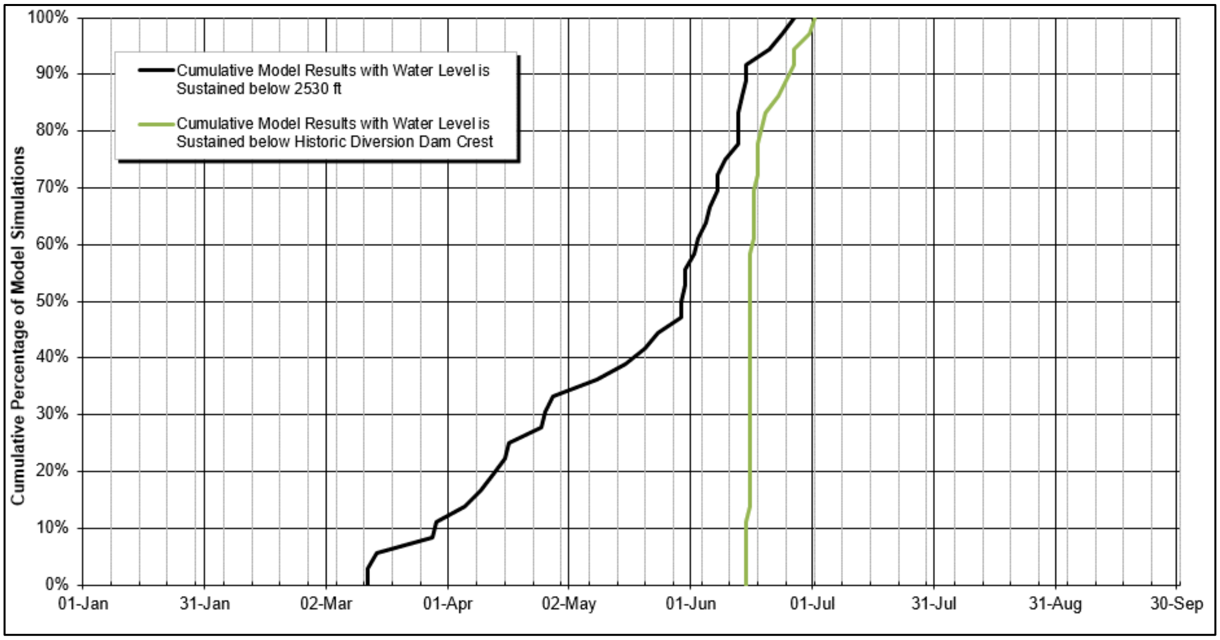

Figure 2-3. Copco No. 1 Reservoir Drawdown Cumulative Model Simulation Dates to Achieve and Sustain Reservoir Water Surface Levels below the 2,530 ft and below the Crest of the Historic Diversion Dam Crest

2.4.1.2 Post-Drawdown/ River Diversion

Bypass through historic diversion tunnel: the historic diversion tunnel can be opened when the reservoir water surface elevation of 2,530 ft is reached on or after June 15 of the drawdown year. The discharge capacity of the tunnel will depend on the opening size and the reservoir water level:

- The diversion tunnel partially opened to elevation 2,505.85 ft has a capacity greater than 1,775 cfs for reservoir level of 2,530 ft.
- The diversion tunnel fully opened (i.e., inlet structure removed to provide inlet conditions at least equal to the nominal tunnel dimensions of 16 ft wide by 18 ft high) has a capacity greater than 3,885 cfs for reservoir level of 2,514 ft, (elevation of the abandoned diversion dam with 1-ft freeboard).
- The fully opened diversion tunnel can bypass all inflows during June 15 to October under all hydrological years evaluated.

At the first opening of the diversion tunnel, outflow of up to 5,675 cfs will occur. The diversion tunnel flow becomes free-flowing, or open channel flow, shortly after opening. The water level upstream of the diversion tunnel intake matches the water surface corresponding to the open channel flow.

River diversion is achieved when all the inflows pass through the diversion tunnel. The outflows are roughly equal to the inflows in the post-drawdown period. The drawdown model and Figure 2-1 and Figure 2-2 indicate that the post-drawdown water surface levels will range between

2,500 ft and 2,505 ft for average daily conditions evaluated in the drawdown model. These levels do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

2.4.2 Copco No. 2 Facility

Operation of the Copco No. 2 reservoir during drawdown and post-drawdown will achieve successful evacuation of the reservoir impoundment. The Renewal Corporation will initiate drawdown of the reservoir by removing Spillway Bay No. 1 in January of the drawdown year.

The drawdown model was developed to assess the reservoir water surface levels during drawdown and post-drawdown under a range of hydrologic conditions. Copco No. 2 is operated as a run-of-river facility with minimal storage volume; therefore, evacuation of the reservoir will occur quickly. During drawdown, the operating characteristics of the reservoir will be a reflection of upstream conditions, particularly conditions at Copco No. 1.

2.4.2.1 Reservoir Conditions during Drawdown

Hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle Reservoir and drawdown regulation and outflows through the J.C. Boyle Dam are included in Appendix A. Appendix A also shows the hydrologic simulations of the reservoir drawdown inflows into the Copco No.1, Copco No. 2, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

Reservoir water surface levels were simulated in the drawdown model for the full record of inflows available for the 2019 Biological Opinion (2019 BiOp) dataset. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Copco No. 2 Simulated Drawdown. These plots indicate the following:
    - Reservoir water surface levels, and
    - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway and power intake).
- Maximum daily reservoir water surface level daily non-exceedance percentiles (percentiles) are shown on Figure 2-4. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the all the results on any given day of the simulations. These results to not represent a simple simulation and are based on all the model simulations.
- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-5. This figure overlaps the simulated reservoir water surface levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

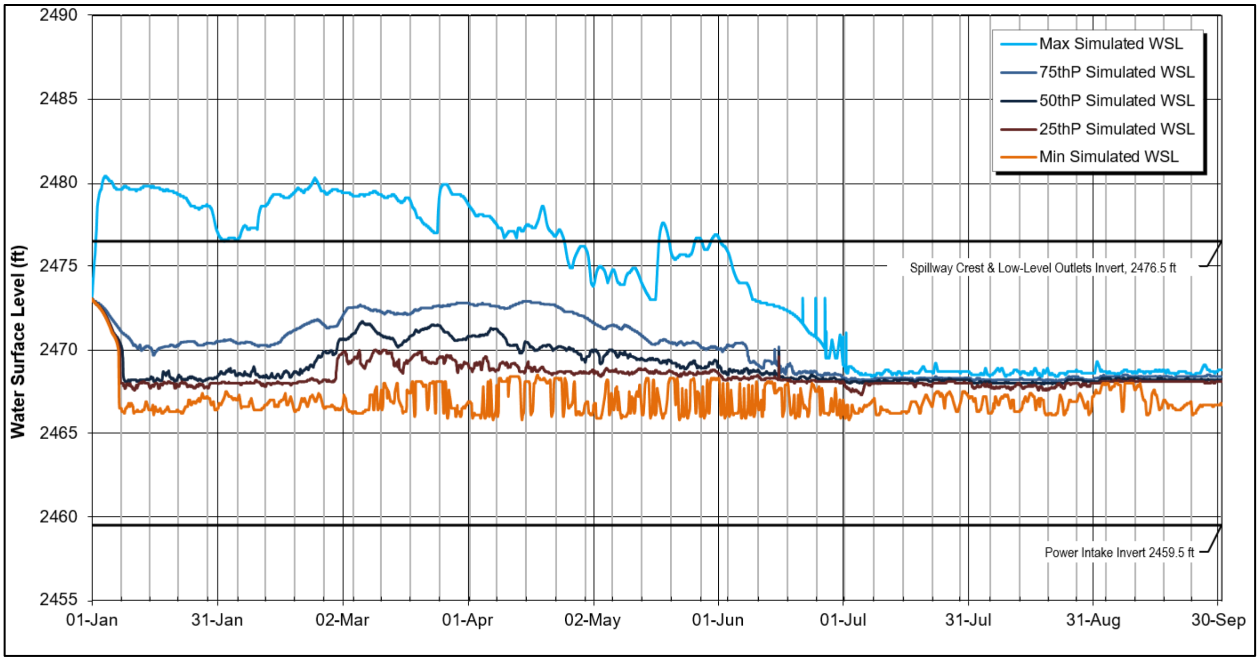

Figure 2-4. Copco No. 2 Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

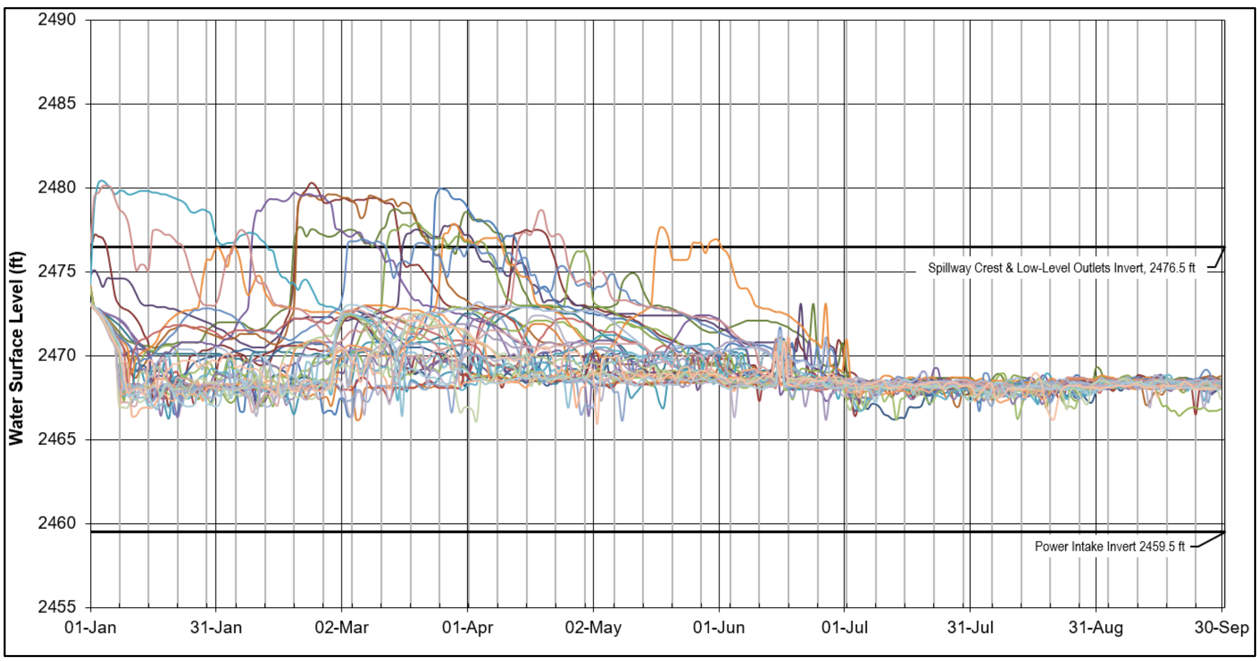

Figure 2-5. Copco No. 2 Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-4 and Figure 2-5 show that there is a reduction in the reservoir water levels in mid-June with the majority of the simulated years achieving sustained low level water levels by the end of July. This is a function of inflow hydrology, which indicates a reduction in streamflow for the second half of June (Appendix A6 of the Design Report, Knight Piésold 2020b) and the timing of when the historic diversion tunnel is fully opened at Copco No. 1, which is targeted to be around June 15.

Figure 2-4 shows that there are large fluctuations in the reservoir water surface levels from January through June. Copco No. 2 is operated as a run-of-river facility with minimal storage volume; therefore, the reservoir water levels reflect the outflow conditions at Copco No. 1. The drawdown model results show that the flows can be discharged over the Copco No. 2 spillway between January through mid-June.

Lower reservoir levels will be sustained after July 1 depending on the hydrologic conditions and when the Copco No. 1 historic diversion tunnel is opened. The post-drawdown water surface levels are within the range of 2,466.0 ft to 2,469.5 ft for all of the drawdown model simulations. Note that these water levels are for average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

2.4.3 Iron Gate Facility

Hydrologic simulations of the reservoir drawdown inflows into the J.C. Boyle Reservoir and drawdown regulation and outflows through the J.C. Boyle Dam are included in Appendix A. Appendix A also shows the hydrologic simulations of the reservoir drawdown inflows into the Copco No.1, Copco No. 2, and Iron Gate Reservoirs and drawdown regulation and outflows from the upstream dam.

The Renewal Corporation will complete reservoir drawdown utilizing the spillway, power intake and turbine/bypass, and the existing outlet control gate in the diversion tunnel. The power intake will be used to assist with reservoir drawdown using the existing turbines or bypass valve. The Renewal Corporation will remove the power intake structure concurrently with embankment removal when the appropriate embankment elevation is reached. The drawdown model was developed to assess the drawdown sequencing in terms of reservoir water surface levels under a range of hydrologic conditions.

Reservoir water surface levels are simulated in the drawdown model for the full record of inflows available for the 2019 Biological Opinion (2019 BiOp) dataset. The 2019 BiOp flows reflect 36 years of river flows, from October 1980 through September 2016. The results of the drawdown model are summarized in three ways:

- Individual year simulations were produced for the Gate Simulated Drawdown. These plots indicate the following:
  - Reservoir water surface levels, and
  - Daily average inflows, total outflows, and outflows for each outlet structure (i.e., spillway, power intake and bypass, and flows through the diversion tunnel).
- Maximum daily reservoir water surface level daily non-exceedance percentiles (percentiles) are shown on Figure 2-6. This figure represents the results from all 36 model simulations as non-exceedance percentiles to summarize the distribution of the all the results on any given day of the simulations. These results do not represent a simple simulation and are based on all the model simulations, and
- Ensemble figures with each line representing a single model simulation for a different year are shown on Figure 2-7. This figure overlaps the simulated reservoir water surface

levels on a common x-axis that spans January 1 to September 30. Each line represents a single model simulation.

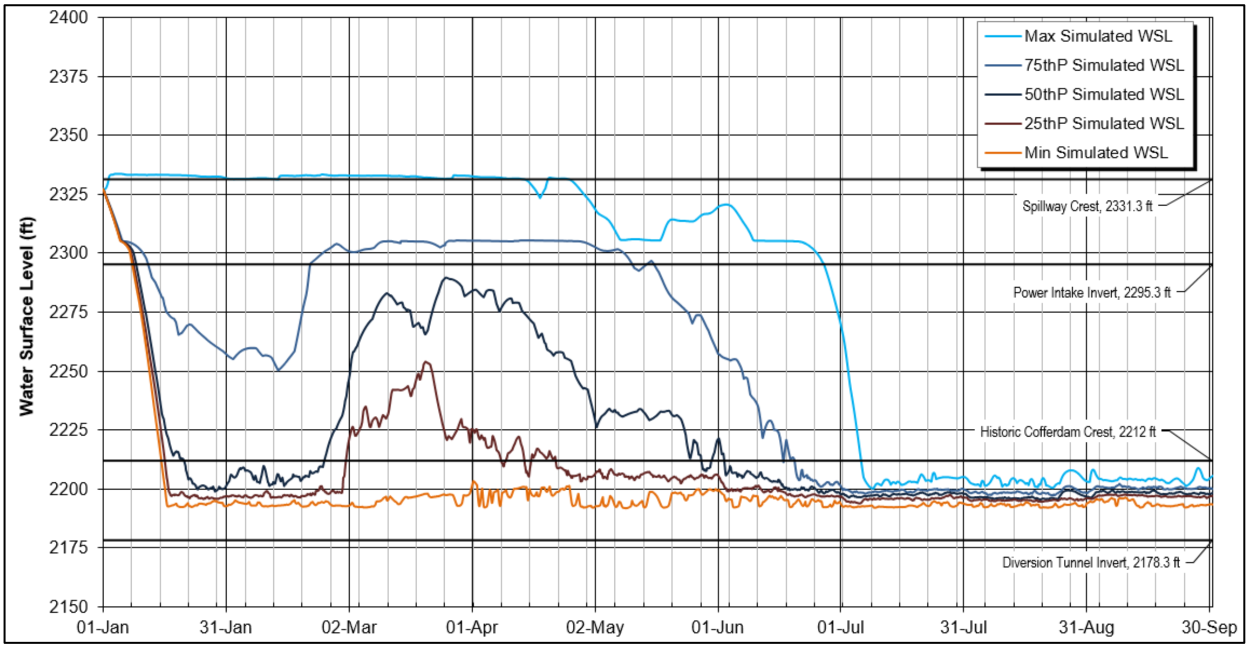

Figure 2-6. Iron Gate Reservoir Drawdown Simulated Water Surface Levels Non-Exceedance Percentiles

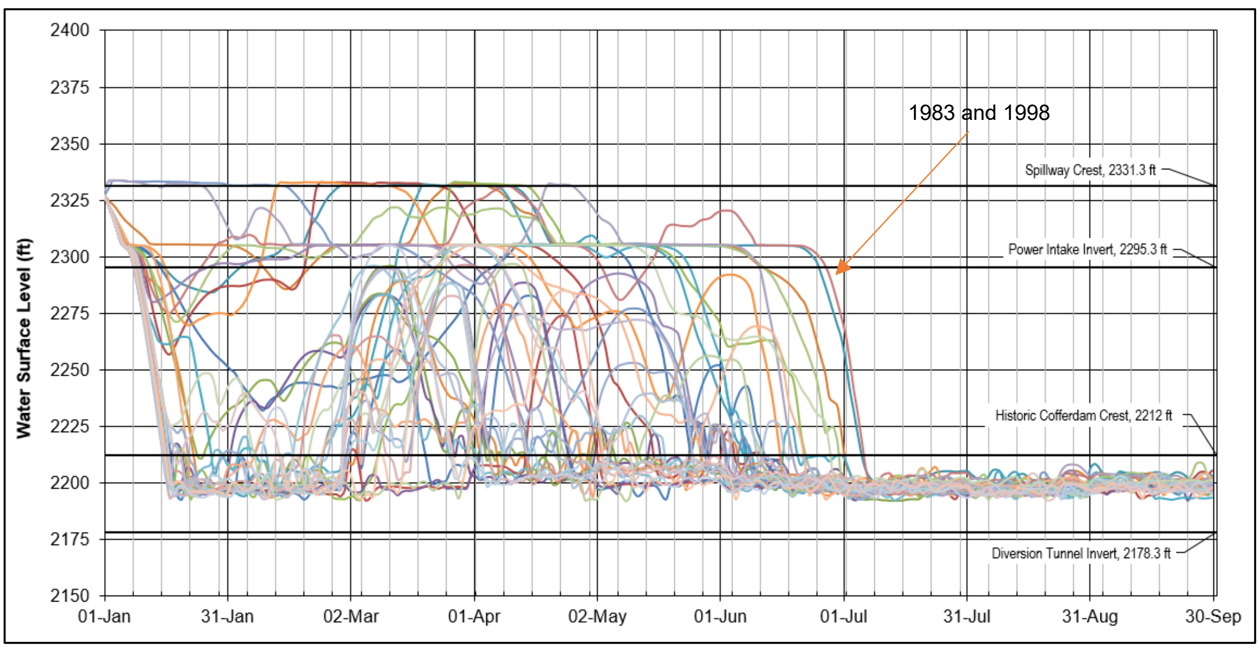

Figure 2-7. Iron Gate Reservoir Drawdown Simulated Water Surface Levels Ensemble Plot

The simulated water surface levels on Figure 2-6 show that the reservoir water levels drop below the crest of the historic cofferdam in mid-June for the 75th percentile, while the remaining model simulations achieve a lowered reservoir water level in early July. There are two model years (1983 and 1998) indicated on Figure 2-7 that show elevated reservoir water surface levels past July 1. In these years, the reservoir water surface levels drop below the crest of the historic cofferdam prior to July 10.

Figure 2-7 shows that many of the model simulations achieve reservoir drawdown in January; however, the reservoir refills in the higher flow months of February through May. There can be large fluctuations in the reservoir water surface levels from March through June. Spillway flows are observed after January for 28% of the simulations, and for power intake and bypass valve for an additional 25% of the simulations. The reservoir water surface level does not rise above the power intake invert in the remaining 55% of the simulations.

The reservoir water surface level can rapidly rise in March, April and May resulting from large inflow events. Examples of this are seen in simulation years 1981, 1989, and 1993, where the reservoir water surface level was below the historic cofferdam crest in January but then rapidly rises in response to the high inflows. These inflows may be a function of the refilling of Klamath Lake as described in USBR (2018), or are influenced by the flows from unregulated tributaries entering the Iron Gate reservoir, such as Jenny Creek.

Figure 2-8 shows the cumulative percent of model simulations and the date when the reservoir water surface level is lower, and sustained, below the crest of the historic cofferdam. The drawdown model indicates that approximately 40% of the simulations have reservoir water levels sustained below the crest of the historic cofferdam by June 1, with 100% of the simulations by July 7. Note that these water levels are for average daily conditions and do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

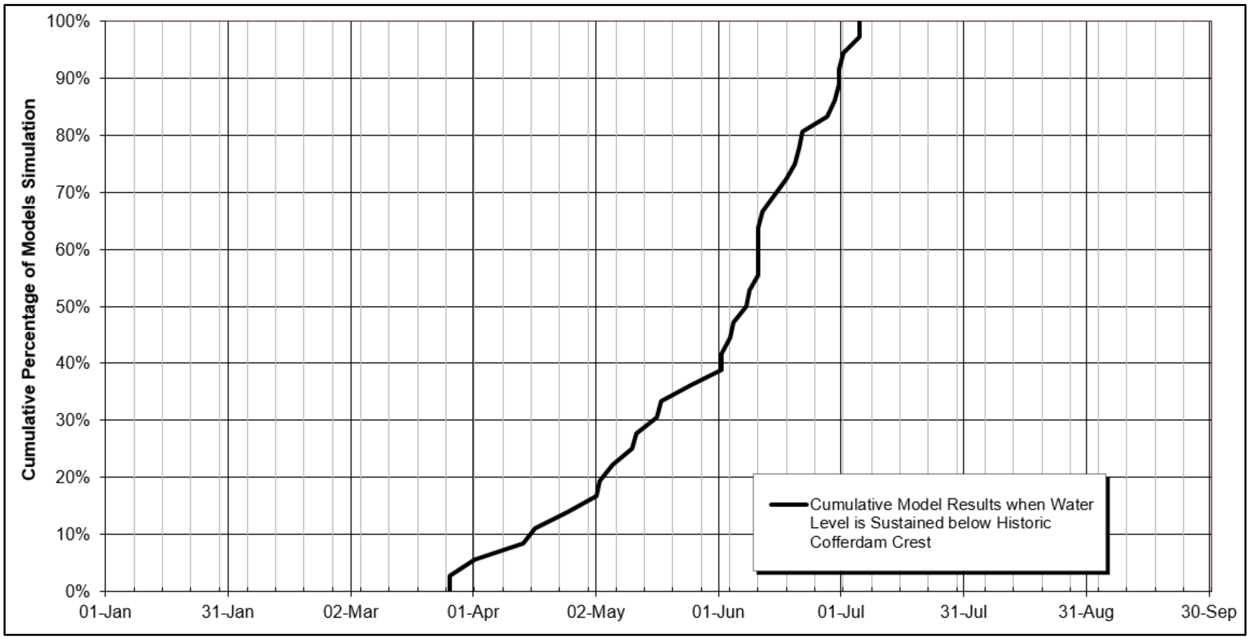

Figure 2-8. Iron Gate Reservoir Drawdown Cumulative Model Simulation Dates to Achieve and Sustain Reservoir Water Surface Levels below the Crest of the Historic Cofferdam Crest

2.4.3.1 Post-Drawdown River Diversion

River diversion is achieved when all the inflows will be passed through the diversion tunnel with negligible attenuation in the post-drawdown period (i.e., the outflows are roughly equal to the inflows). The drawdown model and Figure 2-6 and Figure 2-7 indicate that the post-drawdown water surface levels will range between 2,192 ft and 2,209 ft for average daily conditions evaluated in the drawdown model. These levels do not account for the low probability flood flows (i.e., the 1% and 5% probable flood flows).

3.0 Monitoring Plan

3.1 Reservoir Level Monitoring

Reservoir levels for Iron Gate and Copco No. 1 are currently continuously monitored through the powerhouse control room and Hydro Control Center (HCC) at Merwin Dam on the Lewis River in Washington (PacifiCorp, 2015). Flows can increase the amount of debris deposited against facility components during potentially high-flow storm events. Erosion, back cutting, sloughing, or obstruction in the spillway or tailrace channels might occur as a result of these high-flow conditions. Special attention to these areas is included in the monitoring and surveillance of the facilities during or after high-flow events.

In accordance with the requirements in the STIDs, the Proposed Action will comply with high-flow event monitoring. If obstructions occur, the Renewal Corporation can implement measures to remove obstructions, such as mechanical means of removal and controlled blasting. The Renewal Corporation will monitor reservoir levels during drawdown by level sensors and staff gauge, per the PacifiCorp STIDs for each facility. If readings are approaching a level that could cause concern regarding stability of the reservoir rim or embankment areas, the Renewal Corporation will implement the contingency measures discussed in Section 4.7 and, if necessary, take remedial actions described in the Emergency Response Plan (Kiewit, 2020) for the Project and the California Slope Stability Monitoring Subplan.

3.2 Embankment and Reservoir Rim Monitoring

Slope stability monitoring for the Iron Gate, Copco No. 1, and Copco No. 2 reservoir rims and applicable embankment structures is addressed in the California Slope Stability Monitoring Subplan. The Slope Stability Monitoring Subplan presents the Renewal Corporation's proposed monitoring and evaluates practices to avoid and minimize potential water quality impacts related to slope stability. The subplan also includes proposed measures to mitigate instability that may affect residential structures. Proposed monitoring activities include visual monitoring and inspections for evidence of potential slumping, cracking, and other signs of slope instability during drawdown and dam removal and after storm events, and implementation of any necessary repairs, replacements, and/or additional measures to minimize potential slope instability effects on water quality based on inspection information.

3.3 Sediment Monitoring

The Renewal Corporation will conduct the sediment monitoring as described in the California Reservoir Area Management Plan (RAMP) (RES, 2020). Per the RAMP, the Renewal Corporation will use aerial data capture methods and ground-based surveying to inform design progression following drawdown and assist sediment evacuation at the priority tributary restoration sites. Refer to the RAMP for additional information regarding sediment and vegetation monitoring and associated adaptive management approaches.

4.0 Implementation Plan

4.1 J.C. Boyle Facility

The subsections below describe the post-drawdown decommissioning and removal measures. Water surface elevations based on steady state flood flows and with both low-level outlets (diversion culverts #1 and #2) open, are provided on drawing C1055.

4.1.1 Dam and Intake Concrete Removal

With the diversion culverts operating as described above, the Renewal Corporation will remove the concrete components at the dam and intake. Dam and intake structure removals are described in the subsections below.

4.1.1.1 Concrete Removal

The Renewal Corporation will remove spillway gates and hoisting equipment after drawdown is complete. Partial removal of the concrete spillway can occur in the low flow summer period coinciding with the decline in flood water surface elevations. The Renewal Corporation will remove the fish ladder, concrete cut-off wall, and power intake concrete in conjunction with dam embankment removal. The phased removal elevations are shown on drawings C1234 and 1239. The final removal elevation at the intake is about 3,785.2 ft. Removal methods include mechanical demolition, drilling, and controlled blasting. Following use as an access road to the left bank, the Renewal Corporation will bury concrete below this elevation in place. The Renewal Corporation will place excavated concrete rubble in the scour hole. The top-down concrete removal process will confirm structural stability criteria are met throughout the entire concrete structure removal process.

4.1.2 Earthfill Embankment Removal

The Renewal Corporation will commence embankment removal and demolition work following reservoir drawdown. The removal plan allows for the majority of the dam removal to occur in the dry, by leaving the upstream portion of the dam embankment and historic cofferdam in place and removing the dam embankment in phases (as shown in Table 5.1). The Renewal Corporation will remove the embankment in Phases 1 to 7, remove the historic cofferdam in Phase 8, and bury the diversion culvert channel and remaining concrete in Phase 9. Additional detail is provided in the following subsections.

Proposed stability requirements for the embankment through drawdown and embankment removal are provided in Table 2.1, and embankment removal drawings (C1230 to C1232, and C1234 to C1239) are included in Appendix A.

4.1.2.1 Stability, Freeboard, and Removal Phases

Removal of the J.C. Boyle earthfill dam embankment and concrete structures is planned and proposed in a manner that maintains the current stability criteria. This is achieved by removing the embankment in a sequence that does not result in narrowing of the crest or steepening of the downstream embankment slopes (drawing C1050 in Appendix A). The embankment removal work is broken into multiple phases related to flood water surface elevations. The phased embankment removal, historic cofferdam, and downstream rockfill grading, including historic cofferdam breach and removal are shown on the design drawings in Appendix A.

In addition to meeting the stability criteria discussed above, the Renewal Corporation will remove the dam in a manner that provides a 3-ft freeboard for a reservoir water level corresponding to a 1% flood event (100-year instantaneous flood flow), as shown on the design drawings in Appendix A.

4.1.2.2 Final Embankment Removal

The Phase 5 embankment crest will be at elevation 3,770.7 ft. The Renewal Corporation will complete the majority of embankment dam fill removal in the dry, as the historic cofferdam upstream is anticipated to route flows to the diversion culverts. The Renewal Corporation will excavate the final river channel footprint to approximately 3,739 ft at the dam embankment centerline based on the anticipated bedrock depth. This river bottom elevation is lower than the diversion culvert invert elevation of 3,755.2 ft. The Renewal Corporation will complete visual inspection of the historic cofferdam and remaining sediment prior to removal of the Phase 6 embankment. The Renewal Corporation will complete the removal of the Phase 6 embankment in conjunction with the riverbank slope protection installation, as shown on drawing C1230 in Appendix A.

4.1.3 Historic Cofferdam and Sediment Removal

The Renewal Corporation will use the historic cofferdam that is located about 450 ft upstream of the dam embankment centerline. No historic design or construction cofferdam details are available. The Renewal Corporation will assess the condition of the historic cofferdam after the reservoir is lowered and make any repairs needed for the cofferdam to function as originally intended. This may include:

- Adding earthfill to the crest to restore original crest elevation and freeboard.
- Lining the upstream portion of the historic cofferdam with impervious material.
- Mechanically removing sediment from the diversion culvert approach channel.

Following use of the historic cofferdam to divert flows to the diversion culverts, the Renewal Corporation will remove the cofferdam as well as accumulated sediment between the embankment dam and the cofferdam. This is required to restore the river channel and achieve volitional fish passage.

The Renewal Corporation will cut the cofferdam embankment back towards the right bank (drawing C1239 in Appendix A). Once the cofferdam is breached, flow will naturally erode and remove portions of the historic cofferdam. The Renewal Corporation will remove material remaining and place this material in the disposal area. This removal will return flows to the historic channel and allow for in-water removal of the remaining fill.

4.1.4 Final River Channel

The Renewal Corporation will remove the embankment, historic cofferdam, and soft sediment to an elevation that provides channel width and grade suitable for volitional fish passage. No bedrock or rockfill will be excavated. The Renewal Corporation will install erosion protection prior to historic cofferdam breach. The Renewal Corporation will line areas along the final river channel that are expected to be inundated during the 1% flood with a layer of bedding material, to provide the appropriate filter relationship with the subgrade material, and rock material to mitigate scour. Proposed gradations and appropriate thicknesses are detailed in the Design Report (Knight Piésold, 2020b), and the final grading plan of the channel through J.C. Boyle is shown on drawing C1230 in Appendix A.

4.2 Copco No. 1 Facility

The demolition and removal works will include removal of the dam, water conveyance, powerhouse, and electrical infrastructure. It will also involve establishment of the final river channel for volitional fish passage through the former dam and reservoir inundation area. Water surface elevations based on steady state flows and with the low-level outlet tunnel and historic diversion tunnel open, are provided on drawings C2056 and C2057 in Appendix A.

4.2.1 Concrete Dam Removal

When the Klamath River flows are routed through the historic diversion tunnel, the Renewal Corporation can demolish and remove the concrete dam. Dam removal is shown on drawings C2250 and C2255 through C2258 (Appendix A) and is described in the subsections below.

4.2.1.1 Concrete Removal (Crest to Elevation 2,515 ft)

The Renewal Corporation will remove the concrete dam after the historic diversion channel is reopened and the reservoir is lowered. Concrete removal methods include mechanical demolition, drilling and controlled blasting to break up and remove the concrete in lifts from the top down. The blasted concrete rubble will be moved to the downstream face of the spillway and on to the spillway work platform. The concrete will be loaded at the base of the spillway and hauled to the right bank disposal area.

The top-down concrete removal will enable the Renewal Corporation to remove the dam while the work platform level is above the 5% probable flood level.

4.2.1.2 Concrete Foundation Removal (Elevation 2,515 ft to 2,472 ft)

The Renewal Corporation will remove dam concrete to establish the final river channel configuration through the former dam footprint.

The Renewal Corporation proposes to remove the concrete foundation in August or September (depending on the water year) when river flows will be at seasonal lows. Bypass of inflows through the diversion tunnel and seepage reduction at the existing historic cofferdam will limit the need to dewater the work site once the removal line progresses lower than elevation 2,515 ft. However, the Renewal Corporation will conduct pumping as necessary to keep the work site dewatered if seepage were to occur.

The Renewal Corporation will complete this work by constructing work platforms into the former dam footprint area (above the dam foundation) and drilling, blasting, and excavating riverbed concrete. The work platforms will elevate the construction equipment to above water level and allow for much of this work to be conducted in the dry.

4.2.2 Final River Channel

The final river channel will be established through final riverbed and foundation concrete excavation and shaping so future scour and migration of the riverbed will not create a fish barrier at the former Copco No. 1 Dam site. The Renewal Corporation's proposed concrete removal elevation takes into account historic channel elevations upstream and downstream of the dam site. The Renewal Corporation will line areas along the final river channel that are expected to be inundated during the 1% flood with a layer of bedding material, to provide the appropriate filter relationship with the subgrade material, and rock material to mitigate scour. Required gradations and appropriate thicknesses are detailed in the Design Report (Knight

Piésold, 2020b), and the final grading plan of the channel through Copco No. 1 and the erosion protection lining is shown on drawing C2230 in Appendix A.

4.2.3 Historic Cofferdam Removal

After the dam foundation is removed at the dam site and the final channel is established downstream, the Renewal Corporation will remove the historic cofferdam to restore flow through the former dam site. The cofferdam will only be accessible in periods of low flow and will be removed by drilling and blasting during the excavation and grading of the upstream portion of the river channel. Concrete and spoil from the cofferdam will be disposed at the disposal area.

4.2.4 Diversion Tunnel Closure

Following removal of the concrete dam and foundation concrete, including the historic cofferdam and diversion tunnel inlet structure, the Renewal Corporation will permanently block the diversion tunnel by backfilling and burying the inlet and outlet portals with earthfill barriers. Blocking the diversion tunnel will prevent access and the possibility of Klamath River flows passing through the historic tunnel. Portal barriers will be comprised of compacted earthfill with sufficient length to prevent piping and downstream erosion of the tunnel plug and erosion protection on the exposed face of the earthfill plug. The outlet portal plug is designed with a filter layer at the base to allow drainage and prevent hydrostatic pressure build-up, as shown on drawing C2175 in Appendix A.

4.3 Copco No. 2 Facility

The Renewal Corporation's proposed construction works after the reservoir is drawn down will involve dam removal and other facility removal activities. The subsections below detail the Renewal Corporation's proposed decommissioning and removal activities. Water surface elevations based on variable flow conditions and water years are provided on drawing C3057 in Appendix A.

4.3.1 Dam Removal

The Renewal Corporation will complete dam removal with the river flowing through the removed Spillway Bay No. 1. The Renewal Corporation will construct a temporary work platform to elevation 2,465.0 ft on the spillway apron to elevate the construction equipment above the river diversion flow level. The elevation of the work platform is dependent on the construction of a temporary channel excavation, as shown on drawing C3520 in Appendix A. The base case design of Copco No. 2 involves excavating the downstream river channel to reduce anticipated water levels that will be experienced at the dam during removal. If the temporary channel is not constructed, the work platform elevation may need to be higher to keep the work surface above water. The Renewal Corporation may need to regrade the temporary channel excavation after the dam is removed to maintain the desired final channel geometry.

The Renewal Corporation will remove concrete down to elevation 2,453.5 ft. The excavation will remove the spillway apron, the remaining ogee crest, both abutment wing walls, and part of the intake structure. The limits of the excavation are shown on drawings C3221 and C3232 in Appendix A.

4.3.2 Historic Cofferdam Removal

The Renewal Corporation will complete removal of the historic cofferdam upstream of the Copco No. 2 Dam during the low-flow summer period. An excavator will traverse the river from the right bank and notch out a portion of the left bank side of the historic cofferdam at a natural low point in the riverbed to provide an alternative flow path for river flow. This alternate flow path will allow the current opening to be backfilled to facilitate construction equipment access for the removal of the entire cofferdam (drawing C3240 in Appendix A). The Renewal Corporation will drain the Copco No. 2 reservoir to allow the concrete diversion dam and the historic cofferdam to be removed after the Copco No. 2 reservoir is dewatered, as previously discussed in Section 2.3.3. Another proposed option involves the removal of Copco No. 2 and the historic cofferdam in the pre-drawdown period only. If removal of Copco No. 2 and the historic cofferdam needs to occur during the drawdown year, activities outlined in the design report and drawings will proceed (Knight Piésold, 2020b). These activities include, but are not limited to, demolition of a portion of Spillway Bay No. 1 in the pre-drawdown year as in-water work. After drawdown, the Renewal Corporation will remove the remaining Copco No. 2 Dam structure and historic cofferdam, also as in-water work.

4.3.3 Earthfill Embankment Removal

The Renewal Corporation will partially remove the earthfill embankment with 1.5 horizontal to 1 vertical (1.5H:1V) excavation side slopes. Partial removal of the right abutment retaining wall is shown on drawing C3400 in Appendix A. This temporary excavation will be backfilled to the final channel grade. The Renewal Corporation will permanently leave in place the portion of the earthfill embankment and gunite wall that is not within the footprint of the temporary excavation.

4.3.4 Final River Channel

The Renewal Corporation will backfill the final river channel banks with a combination of erosion protection material and riverbed material. The riverbed material specification is unique to Copco No. 2 and will be comprised of a well graded material ranging from 36 inches to the No. 200 Standard sieve with less than 10% fines and is intended to be a visual specification. The material will be similar to the natural material found in the river between Copco No. 1 and Copco No. 2 and can be sourced from in-river, the historic diversion cofferdam, or one of the erosion protection borrow sources at the Copco area. The final grading plan of the channel through Copco No. 2 is shown on drawing C3234 in Appendix A.

4.4 Iron Gate Facility

Demolition and removal work at Iron Gate will involve the decommissioning and removal of the dam and all facility components. The subsections below detail proposed deconstruction activities. Water surface elevations based on steady state flows are provided on drawings C4050 and C4051 in Appendix A.

4.4.1 Embankment Removal

After reservoir water levels have been lowered, the Renewal Corporation will remove the embankment dam at a rate that will provide a required 3 ft of freeboard on the monthly 1% probable flood event until the extended work platform at the upstream toe of the dam is established. Maximum removal limits that provide the required freeboard are shown on the removal sequence drawings C4203 through C4209 in Appendix A. The crest of the extended cofferdam will be established at 3 ft above the controlling 1% probable flood from August 1 to September 15 or until the controlled breach is prepared and implemented during the low flow summer period. The final breach will occur when the reservoir level corresponds to expected average monthly flows. The planned controlled breach avoids downstream flood impacts and public risk. Stability requirements for the embankment through drawdown and embankment removal are provided in Table 2.1.

4.4.2 Final Dam Breach

The Renewal Corporation anticipates that flow rates in the Klamath River will decrease (normal hydrologic cycle) through the dam removal period, which will result in the lowest possible reservoir levels occurring around the time of the final dam breach (August / September). The primary goal of the final breach design is to release the final remaining pond or stored reservoir volume without causing overbank flooding or property damage in the downstream reaches. Based on inundation mapping completed for flood magnitudes of 6,000 cfs and 10,980 cfs (Yurok Tribe / USBR, 2020), there is no overbank flooding expected at 6,000 cfs, and limited overbank flooding expected at 10,980 cfs. The monthly 50% probable floods of approximately 6,500 cfs occur in March and December based on observed flows. Therefore, breach peak outflows in the range of 6,000 to 7,000 cfs are considered acceptable for this one-time reservoir release condition, given appropriate planning and advanced warning (and as per the public notice) to protect the safety of the downstream population.

The Renewal Corporation will maintain a minimum of 1,000 cfs, or the flow in the Klamath River if it is less than 1,000 cfs at the time, throughout the final breach. The existing diversion tunnel will remain open and continue to pass flows. As the water level drops and the capacity of the diversion tunnel is reduced, the Renewal Corporation will augment these flows with outflows resulting from the breach formation. Natural flow in the Klamath River will be restored at the completion of the final breach, with all flows diverted through the breach channel, while the remaining embankment materials in the extended cofferdam are removed.

4.4.3 Breach Channel Design

Once the Renewal Corporation establishes the extended cofferdam at elevation 2,228 ft, it will excavate a breach channel along the right rock abutment, with a breach plug retaining the remaining reservoir at the upstream end of the breach channel. The breach channel and plug are designed to initiate progressive erosion once notched, while limiting breach widening and slowing the rate of erosion, so the risk of peak outflows potentially leading to overbank flooding is considered negligible. The Renewal Corporation will employ the following channel design characteristics to achieve this goal, as shown in drawings C4250 and C4255 (Appendix A):

The breach channel will be excavated along the right abutment of the extended cofferdam to a base channel width of 20 ft. The channel sides will be excavated to a slope of 2H:1V, which are shallower than the slopes typically seen in a breach when a dam fails by overtopping.

The breach plug will have a crest elevation of 2,202 ft, just above the recommended maximum water surface at the time of breach (elevation 2,201 ft), which is consistent with flows that are exceeded 25% of the time in the first half of September. This plug elevation will limit the amount of stored volume that could possibly be released in the event of an unplanned breach to approximately 516 acre-ft.

The downstream slope of the breach plug will be excavated, at a slope of 5H:1V, from the native materials within the footprint of the historic cofferdam. This slope is consistent with USBR recommendations (USBR, 1998 and 2010) for downstream embankment slopes where riprap may be considered suitable for overtopping protection. A 5H:1V slope will limit the energy of overtopping flows when compared to more typical embankment slopes of 3H:1V.

The side boundary of the downstream face of the plug that leads to a 20-ft base width will be protected with riprap (minimum D50 = 34 inches) to limit the breach channel widening beyond 20 ft. This riprap size is consistent with recommended sizes for preventing channel flows from laterally eroding side slopes.

Once outflows transition into the channel downstream of the plug where the channel gradient is reduced 0.5%, side boundary riprap will reduce in size due to the reduction in local velocities (minimum D50 = 18 inches), but still sufficiently sized to prevent lateral erosion and widening of the breach channel.

The downstream plug face will be lined with riprap that is sized to be mobile but will also slow the rate of progressive erosion (minimum D50 = 18 inches).

Once the Renewal Corporation excavates and prepares the breach channel, the remaining plug will be progressively notched, from a safe access point on the right abutment, according to the following sequence:

The first notch cut will be 1 ft below water surface at the time of breach, and no greater than 10-ft wide, beginning from the rock on the right abutment.

Outflow behavior will be observed and if they begin to increase, the plug crest will be evacuated to the extended cofferdam crest. If progressive erosion is not initiated, the notch will be further excavated to 3 ft below the existing water surface at the time.

The above process will be repeated until progressive erosion is initiated. At no point will cuts be excavated deeper than 3 ft or wider than 20 ft.

4.4.4 Final River Channel

The Renewal Corporation will establish the final river channel through final riverbed excavation and shaping. The final channel has an average slope of 0.7% from where it intersects the reservoir bottom at the upstream end of the excavation to where the excavation daylights naturally near the current powerhouse tailrace. The Renewal Corporation will leave final channel side slopes untreated where embankment excavation is to bedrock. The Renewal Corporation will protect the channel from erosion, when the excavation is bound by fill slopes, with riprap for up to and including the 1% flood event plus 3 ft of freeboard excavation. Additionally, the Renewal Corporation will assess excavated side slopes not in bedrock, or other channel side slopes that put foundation materials for disposal sites at risk, once the reservoir is drawn down and native materials can be assessed for erodibility. The final grading plan of the channel through Iron Gate is shown on drawing C4210 in Appendix A.

4.5 Drawdown Implementation Timeline

The following subsections summarize key dates and associated work activities with respect to the drawdown schedule for each facility. A complete implementation schedule for the California Reservoir Drawdown and Diversion Plan is provided in Appendix B.

4.5.1 J.C. Boyle Facility

Table 4.1 summarizes key dates and associated work activities with respect to the drawdown of the J.C. Boyle Reservoir.

Table 4.1 J.C. Boyle – Key Intake and Embankment Elevations and Removal Timing

REMOVAL ITEM	ELEVATION (FT)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Spillway Gates and Trunnions	3,790.0	January 1	-	Trunnions and spillway gates are not necessary for spillway operation and can be removed after drawdown.
Diversion Culvert #1 (Drawdown Stage 3)	3,755.2 ft	Varies	-	See drawdown section (Stage 3).
Embankment Removal **Phase 1**	-	March 15	1% Probable Flood + 3ft freeboard	Remove erosion protection material from downstream face of the dam.
Embankment Removal **Phase 2**	3,792.1	June 1	1% Probable Flood + 3ft freeboard	Remove embankment to June 1 1% probable flood with 3 ft freeboard
Diversion Culvert #2 (Drawdown Stage 4)	3,755.2	Varies	-	See drawdown section (Stage 4).

REMOVAL ITEM	ELEVATION (FT)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Embankment Removal **Phase 3**	3,784.7	June 15	1% Probable Flood + 3ft freeboard	Remove embankment to June 15 1% probable flood with 3 ft freeboard
Spillway Structure	3,785.2	July 1	1% Probable Flood + 3ft freeboard	Remove spillway and intake structure to max removal elevation – maintain 15 ft width for access to left bank
Abutment Left Wall Phase 1	3,785.2	July 1	1% Probable Flood + 3ft freeboard	Match left wall elevation to spillway and elevation.
Embankment Removal **Phase 4**	3,776.7	July 1	1% Probable Flood + 3ft freeboard	Remove embankment to July 1 1% probable flood with 3 ft freeboard
Embankment Removal **Phase 5**	3,770.4	July 15	1% Probable Flood + 1ft freeboard	Criteria changes from 1% probable flood with 3 ft freeboard to 1% probable flood with 1 ft freeboard. Remove embankment to July 15 1% probable flood with 1 ft freeboard.
Embankment Removal **Phase 6** and Erosion Protection installation	-	Aug 1	1% Probable Flood + 1ft freeboard	Remove remaining embankment and silt. Excavate final channel to lines and grades shown on drawing C1230, followed by installation of erosion protection and bedding material. Stockpile material for eventual placement in diversion culvert channel and to bury intake concrete (Phase 9).
Evaluate/Grade Downstream Rockfill **Phase 7**	-	Aug 1	1% Probable Flood + 1ft freeboard	Evaluate rockfill for use in final channel following removal Phase 6 and grade as required.
Historic Cofferdam Breach **Phase 8**	3,755.2 (min)	September 1	-	To start no earlier than September 1 and be completed no later than September 30. Breaching of the historic cofferdam must take place after the final channel excavation is substantially complete.
Intake Cover **Phase 9**	-	September 1	-	To occur after historic cofferdam breach and substantial completion of the final river channel. Place material in diversion culvert channel and bury intake concrete.

4.5.2 Copco No. 1 Facility

The Renewal Corporation determined the earliest proposed dates for key work items in relation to the post drawdown reservoir level and the tailwater level based on the variability of the inflows and assume that work can occur up to the 5% probable inflow with freeboard. Table 4.2 presents the earliest dates.

Table 4.2 Copco No. 1 – Key Structure Elevations and Removal Timing

WORK ITEM	LOWEST ELEVATION (FT)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Removal of spillway gates and ancillary items	2,597.1	-	1% max. monthly flood	Spillway gates can be removed in the dry after drawdown is complete to elevation 2,530 ft.
Removal of concrete dam and intake structure	2,472.1	-	5% max. monthly flood	Allow impoundment of the 1% probable flood level with 3 ft freeboard
Removal of gatehouses and intake mechanical items	+/-2,570	After low-level outlet tunnel operation	1% max. monthly flood	Can be removed in the dry after drawdown is complete, 5% probable flood level with 3 ft freeboard after June 1 is 2,534 ft
Removal of penstock #1, #2 and #3	2,575	-	1% max. monthly flood	Can be removed at any time after the flow diversion through the turbine and generator unit is no longer required. Intake gates to be in the closed position and leakage controlled if the removal of the penstock exposes the downstream area to uncontrolled release of water
Re opening of the diversion tunnel	2,488	-	After freshet flows	Final opening to occur when reservoir level is at or below elevation 2,530 ft.
Removal of upstream historic construction spoil materials	+/-2,490	-	-	Can be removed any time where water level allows access or alternatively by dredging.
Removal of the powerhouse	2,465	-	-	Can be removed at any time after the flow diversion through the turbine and generator unit is no longer required. In-water work to occur after the California in-water work date (June 1).
Removal of in-river concrete	2,472	June 16	-	Drawdown is complete and all flows are diverted through the diversion tunnel.

WORK ITEM	LOWEST ELEVATION (FT)	EARLIEST REMOVAL DATE	DESIGN FLOOD EVENT	COMMENTS
Removal of spillway work platform and river channel final grading	2,477	-		In-water work is required, lowest water levels occur during August and September
Construction of tunnel portal plugs	2,494 (inlet) / 2,475 (outlet)	August		In-water work is required, lowest water levels occur during August and September

Notes:

1. Removal of the facility's WATER RETAINING structures including the dam, intake gates and the spillway gates before June 1 and when the reservoir water surface level is above elevation 2,538 ft exposes the work site and downstream area to the 1% probable flood.
2. Should the diversion tunnel be reopened before June 15, the design water levels and earliest removal date should be reevaluated.

4.5.3 Copco No. 2 Facility

Copco No. 2 has no restrictions regarding drawdown, except that the Renewal Corporation will not initiate drawdown prior to January 1 of the drawdown year. Timing associated with powerhouse operations is tied to demolition of the dam and will be taken offline as soon as is possible. Other removal work items, timing, and elevations are described in Section 4.3 above.

4.5.4 Iron Gate Facility

During the pre-drawdown construction period, PacifiCorp will operate the Iron Gate facility at minimum levels. This will be achieved by directing maximum flows through the powerhouse whenever possible. The discharge capacity of the powerhouse is 1,735 cfs (PacifiCorp, 2016). The minimum operating water level is 2,327.3 ft. Other removal work items, timing, and elevations are included in Section 4.4 above, and approximate embankment removal volumes by sequence are shown in Table 4.3 below (Knight Piésold, 2020b). The removal sequence is governed by the applicable flood probability and the need to maintain a 3-ft freeboard for the associated flood level.

Table 4.3 Iron Gate – Embankment Cut Volumes by Sequence

SEQUENCE DESCRIPTION	DRAWING NUMBER	FLOOD PROBABILITY	START DATE	END DATE	MINIMUM CREST ELEVATION (FT)	APPROXIMATE SEQUENCE CUT VOLUME (CY)
1	C4203	1%	1-Apr	31-May	2,340.0	50,800
2	C4204	1%	1-Jun	15-Jun	2,335.4	5,800
3	C4205	1%	16-Jun	30-Jun	2,308.4	71,000

SEQUENCE DESCRIPTION	DRAWING NUMBER	FLOOD PROBABILITY	START DATE	END DATE	MINIMUM CREST ELEVATION (FT)	APPROXIMATE SEQUENCE CUT VOLUME (CY)
4	C4206	1%	1-Jul	15-Jul	2,297.5	89,000
5	C4207	1%	16-Jul	31-Jul	2,243	341,000
6	C4208	5%	1-Aug	31-Aug	2,228	103,100
7	C4209	5%	Sequence 6 Completion	31-Aug	2,228	175,200
Breach Channel	C4250	Not Applicable	Sequence 7 Completion	15-Sep	2,202.0	42,500
Final Grade	C4210	Not Applicable	Breach Completed	1-Oct	Not Applicable	59,300

4.6 Potential Failure Mode Analysis (PFMA)

Potential Failure Modes (PFMs) were determined as part of the December 11 and 14, 2020 informal PFMA workshop.

4.7 Contingency Measures

Proposed contingency measures identifying, evaluating, and addressing potential issues that may occur during reservoir drawdown and removal include procedures for assessing and responding to:

- Reservoir discharge obstructions caused by physical blockages, mechanical failure, or other conditions that may restrict outflow;
- Embankment stability, slumping, or loss of erosion protection; and
- Other events that may directly or indirectly affect the reservoir drawdown schedule.

The above measures are further discussed in the following paragraphs. Adaptive management strategies related to potential corrective measures for erosion, sedimentation, or a reduction in water quality are included in the California Reservoir Area Management Subplan.

The California Slope Stability Monitoring Subplan contains measures for slope stability. Section 10 and Attachment C of that Slope Stability Monitoring Subplan proposes measures for responding to various emergency situations. Specific contingency measures to be implemented by the Renewal Corporation (if and as needed) during drawdown and removal of the reservoirs are described below.

If excess flows are identified during drawdown of the Iron Gate Reservoir, the Renewal Corporation will continue to use the spillway as a fail-safe to accommodate overflow situations. If water levels rise, excess flows will go over the existing spillway. During post-drawdown dam demolition, and dependent on the water year conditions, the Renewal Corporation can notch a portion of the dam to act as a temporary spillway to accommodate raised water levels. The Renewal Corporation will use either a liner or riprap for this potential notched temporary spillway to prevent erosion and protect the core of the dam from instability.

If excess flows are identified during drawdown of the Copco No. 1 and No. 2 Reservoirs, the Renewal Corporation will continue to use the spillway as a fail-safe for overflow situations. During post-drawdown dam demolition, and dependent on the water year conditions, the Renewal Corporation can vacate the site during excess flow conditions. Water will spill over the dam wherever things stand at that point in the removal. The Renewal Corporation will continue dam removal activities once conditions return to a safe and normal flow situation.

After reservoir water levels have been lowered, the Renewal Corporation will remove embankment dams at a rate that will provide a required 3 ft of freeboard on the monthly or semi-monthly 1% probable flood event to maintain safety, up to the point of breach then the 5% probable flood event will govern safety requirements. The Renewal Corporation will implement these measures if adverse conditions are observed.

5.0 References

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Federal Energy Regulatory Commission (FERC), 2018 Order Amending License and Deferring Consideration of Transfer Application FERC Project Nos. 2082-062 and 14803-000. 162 FERC ¶ 61,236. Washington, DC, Federal Energy Regulatory Commission, Office of Energy Projects, Division of Hydropower Licensing.

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Kleinschmidt, 2020. Lower Klamath Project, FERC No. 14803, Definite Decommissioning Plan. Prepared for Klamath River Renewal Project. July.

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Knight Piésold, 2020b. Design Report. Prepared for Klamath River Renewal Project. November.

Knight Piésold, 2020c. Slope Stability Monitoring Subplan. Prepared for Klamath River Renewal Corporation. December.

National Marine Fisheries Service. 2019. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response: Klamath Project Operations from April 1, 2019 through March 31, 2024. Available online: https://www.fisheries.noaa.gov/resource/document/2019-klamath-project-biological-opinion. Accessed April 4, 2020.

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PacifiCorp, 2015a. J.C. Boyle Development, Klamath River Project, Supporting Technical Information Document (STID). April.

PacifiCorp, 2015b. Klamath Hydroelectric Project FERC No. P-2082 Iron Gate Hydroelectric Development, Supporting Technical Information Document (STID). April 30.

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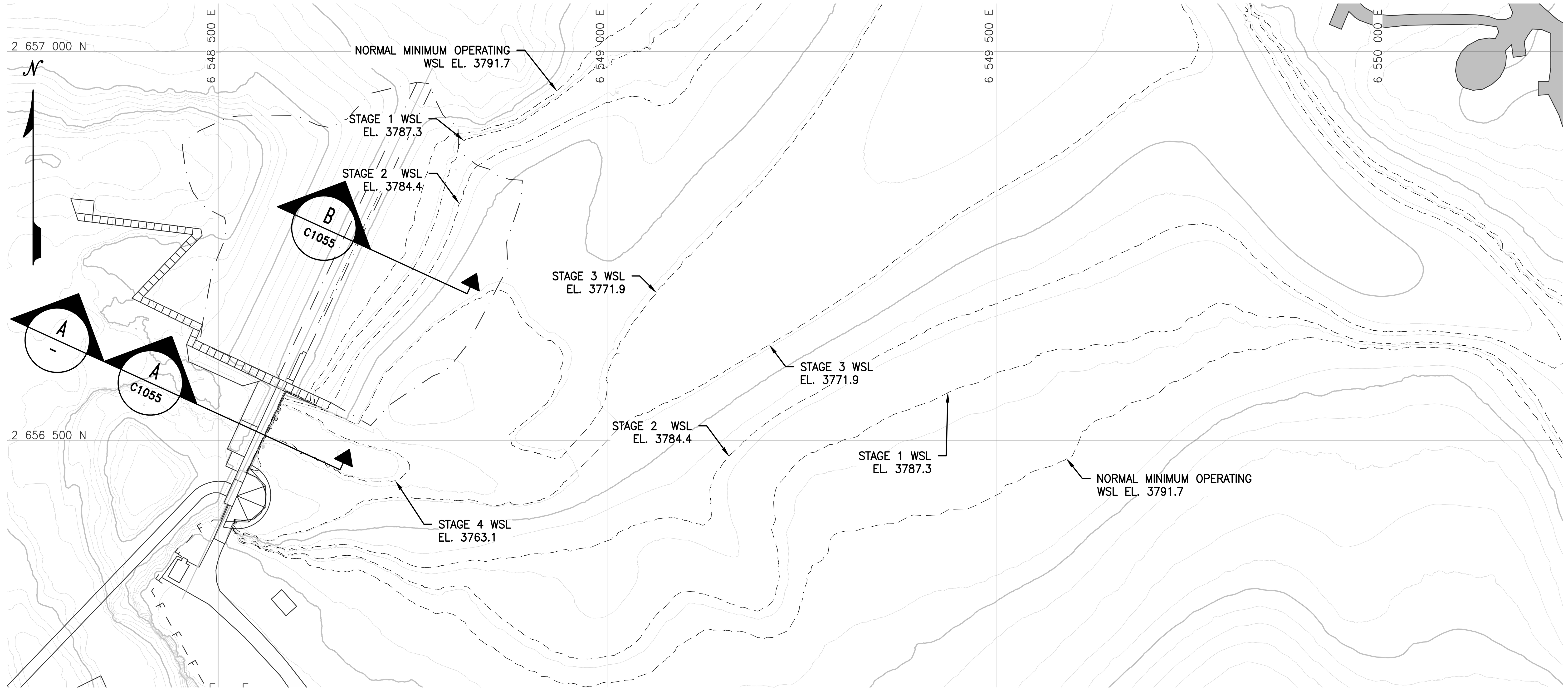
PanGEO, 2008. Geotechnical Report – Klamath River Dam Removal Project – California and Oregon. Project No. 07-153. Prepared for Philip Williams & Associates, Ltd. And California State Coastal Conservancy. August.

RES, The Yurok Tribe, and Stantec Consulting Services Inc. (RES), 2020. Reservoir Area Management Plan. Prepared for Klamath River Renewal Corporation. December.

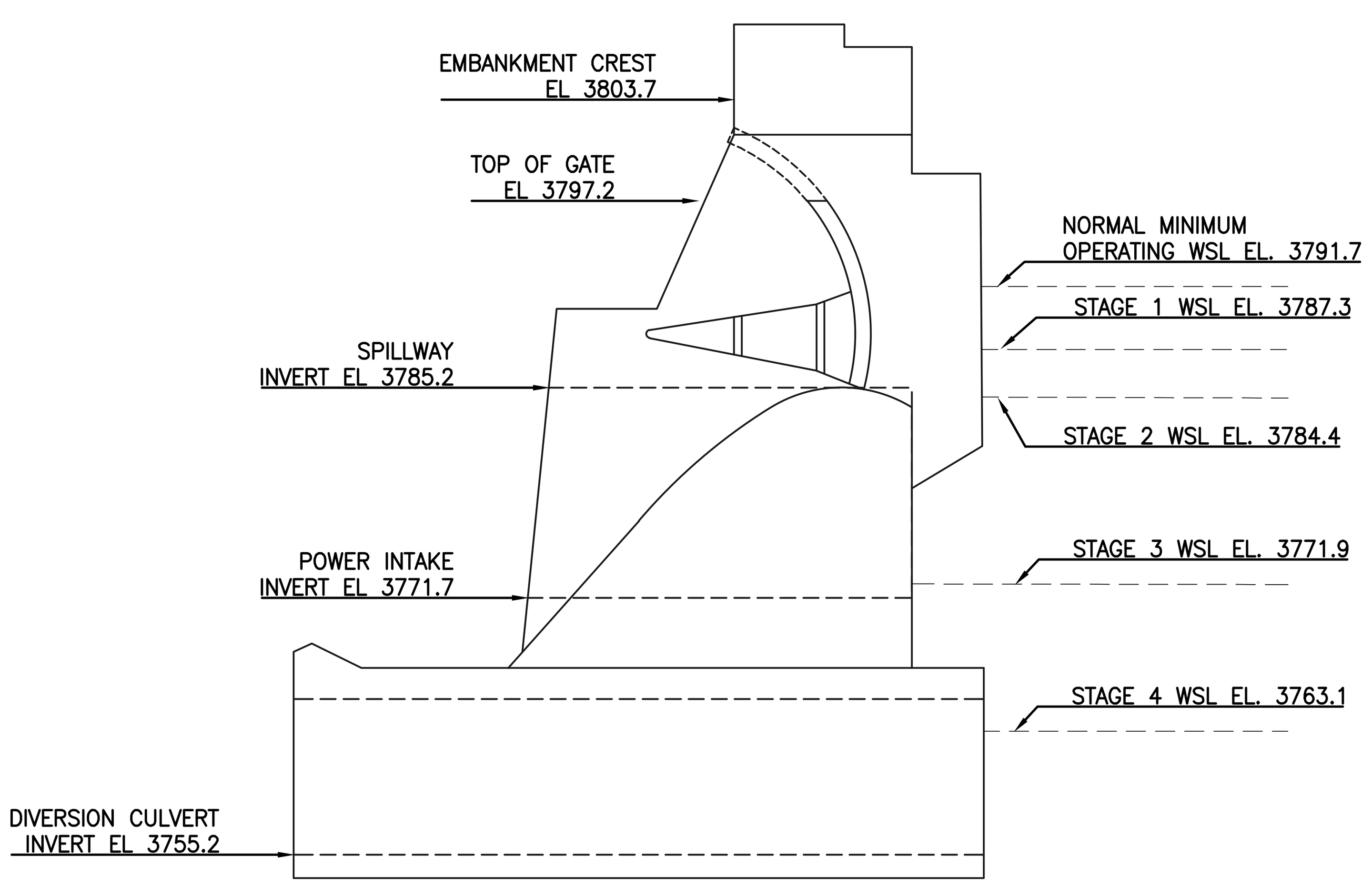
Appendix A

Design Report Excerpt



PLAN

1" = 100'



A – SECTION – INTAKE STRUCTURE

1" = 10'

PRE–DRAWDOWN PRODEDURE:

1. OPERATE THE FACILITY BETWEEN RESERVOIR WATER SURFACE LEVELS AS PER FERC APPROVAL.
   1.1. NORMAL MAXIMUM RESERVOIR OPERATING SURFACE LEVEL: 3796.7 ft.
   1.2. NORMAL MINIMUM RESERVOIR OPERATING SURFACE LEVEL: 3791.7 ft.
2. LOWER RESERVOIR TO NORMAL MINIMUM OPERATING LEVEL PRIOR TO JANUARY 1 OF THE DRAWDOWN YEAR BY CONTROLLED SPILLWAY RELEASES OR BY UTILIZING THE POWER INTAKE, AND MAINTAIN AT THIS LEVEL UNTIL DRAWDOWN IS INITIATED.

DRAWDOWN PRODEDURE:

1. STAGE 1 – DRAWDOWN USING SPILLWAY GATES:
   1.1. DRAWDOWN IS INITIATED ON JANUARY 1.
   1.2. THE SPILLWAY GATES ARE TO BE UTILIZED TO DRAWDOWN THE RESERVOIR WATER LEVEL AT A TARGET RATE OF 5 ft/DAY.
2. STAGE 2 – DRAWDOWN USING POWER INTAKE TO LOWER THE RESERVOIR LEVEL TO BELOW THE SPILLWAY CREST.
   2.1. STAGE 2 IS INITIATED ON JANUARY 2. THE POWER INTAKE OPENS TO DRAW THE RESERVOIR LEVEL TO 2 ft BELOW THE SPILLWAY CREST.
   2.2. SET CHARGES ON DIVERSION CULVERT #1 STOPLOG FROM DOWNSTREAM SIDE OF DIVERSION CULVERT #1 ONCE THE RESERVOIR WATER LEVEL IS 2 ft BELOW THE SPILLWAY CREST. RIVER FORECASTING AND COORDINATION WITH THE UPSTREAM PROJECT IS REQUIRED TO VERIFY THAT THE RESERVOIR WATER LEVEL WILL REMAIN BELOW THE SPILLWAY CREST WHILE CREWS ARE ACTIVELY WORKING ON THE DOWNSTREAM SIDE OF THE DIVERSION CULVERTS. THE RESERVOIR WATER LEVEL 2 ft BELOW THE SPILLWAY CREST IS ASSOCIATED WITH A STEADY–STATE INFLOW OF 1260 cfs.
3. STAGE 3 – REMOVE DIVERSION CULVERT #1 STOPLOG:
   3.1. STAGE 3 CAN BEGIN ONCE STAGE 2 CHARGES HAVE BEEN SET AND STAGE 2 IS COMPLETE.
   3.2. BLAST DIVERSION CULVERT #1 STOPLOG TO INITIATE FLOW THROUGH DIVERSION CULVERT #1.
   3.3. THE POWER INTAKE IS CLOSED ONCE DIVERSION CULVERT #1 IS OPENED. ONCE THE POWER INTAKE IS CLOSED, IT IS TO REMAIN CLOSED TO ISOLATE THE DOWNSTREAM FACILITY COMPONENTS.
   3.4. SET CHARGES ON DIVERSION CULVERT #2 STOPLOG FROM DOWNSTREAM SIDE OF DIVERSION CULVERT #2 ONCE THE RESERVOIR WATER LEVEL IS 2 ft BELOW THE SPILLWAY CREST AND BEFORE JUNE 10 OF THE DRAWDOWN YEAR. RIVER FORECASTING AND COORDINATION WITH THE UPSTREAM PROJECT IS REQUIRED TO VERIFY THAT THE RESERVOIR WATER LEVEL WILL REMAIN BELOW THE SPILLWAY CREST WHILE CREWS ARE ACTIVELY WORKING ON THE DOWNSTREAM SIDE OF THE DIVERSION CULVERT. THE RESERVOIR WATER LEVEL 2 ft BELOW THE SPILLWAY CREST IS ASSOCIATED WITH A STEADY–STATE INFLOW OF 2120 cfs.
4. STAGE 4 – REMOVE DIVERSION CULVERT #2 STOPLOG:
   4.1. STAGE 4 CAN BEGIN ONCE STAGE 3 CHAGES HAVE BEEN SET ONCE STAGE 3 IS COMPLETE. STAGE 4 INITIATION CAN BE DELAYED UNTIL JUNE 10 AT THE LATEST.
   4.2. BLAST DIVERSION CULVERT #2 STOPLOG TO INITIATE FLOW THROUGH DIVERSION CULVERT #2.

POST–DRAWDOWN/RIVER DIVERSION PRODEDURE:

1. RIVER DIVERSION IS ACHIEVED ONCE THE INFLOWS INTO THE RESERVOIR ARE EQUAL TO THE DISCHARGE CAPACITY WITH NO RESERVOIR IMPOUNDMENT.
2. DIVERSION OF ALL INFLOWS THROUGH THE DIVERSION CULVERTS REQUIRE RE–ESTABLISHMENT OF THE HISTORIC COFFERDAM.

FOR INFORMATION ONLY

LEGEND:

– – – – – – WATER SURFACE LEVEL

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. THE STAGED ELEVATIONS REPRESENT FINAL ELEVATIONS AFTER COMPLETION OF EACH STAGE ASSUMING AVERAGE INFLOWS AND THE CORRESPONDING WATER SURFACE ELEVATIONS HIGHLIGHTED ON DRAWING C1055.
3. RESERVOIR DRAWDOWN MONITORING SHALL BE ESTABLISHED BY THE CONTRACTOR TO MEASURE WATER SURFACE LEVELS AS REQUIRED BY THE JCB STID AND TECHNICAL SPECIFICATIONS.

0 100 200 300

1" = 100'

0 10 20 30

1" = 10'

REV	DESCRIPTION	BY	CHK	APP	DATE
E	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
D	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
C	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20
B	ISSUED WITH 60% DESIGN REPORT	CBN	NB	SRM	02/07/20
A	ISSUED WITH DRAFT 60% DESIGN REPORT	CBN	NB	SRM	12/17/19

WARNING

0 1/2 1

IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: Knight Piésold CONSULTING / Kiewit

DESIGNED	C. NIAMIR
DRAWN	A. NASIRI
REVIEWED	H. ELWIN
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR: KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE: J.C. BOYLE FACILITY DRAWDOWN STAGES AVERAGE INFLOW - PLAN AND SECTION

PROJ #: VA103-640/1

DATE: 11/13/2020

DWG: C1050

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Flow Condition		Discharge (cfs)															
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	14,000	14,200	14,200	13,600	9,900	7,300	4,400	3,200	1,800	1,800	2,500	3,000	3,800	4,600	5,500	7,200	10,500
	5% Probable Flood	8,000	9,700	10,900	9,400	6,800	4,400	2,800	2,100	1,700	1,700	2,100	2,400	2,900	3,300	3,800	4,400	6,300
	20% Probable Flood	4,400	4,900	8,000	6,800	4,300	2,800	1,800	1,400	1,500	1,500	1,700	1,900	2,200	2,400	2,600	2,900	3,900
	50% Probable Flood	2,600	2,700	6,300	4,500	2,700	1,800	1,400	1,000	1,400	1,400	1,400	1,500	1,700	1,700	1,800	2,000	2,500
Monthly Flow Duration 25% of Time Equaled or Exceeded		1,850	2,540	3,880	3,390	2,330	1,670	1,020	810	830	810	880	880	890	950	1,020	820	1,240
Mean Monthly Flow		1,500	1,900	2,800	2,370	1,760	1,330	960	740	760	760	800	790	810	890	980	950	1,110
Monthly Flow Duration 75% of Time Equaled or Exceeded		600	630	1,220	1,040	980	820	730	660	670	630	730	710	750	760	780	650	590
Flow Condition		Water Surface Levels at Intake Structure - Stage 2 (Spillway and Power Intake Open) (ft)																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	3793.6	3793.7	3793.7	3793.4	3791.4	3789.8	3787.9	3787.0	3785.4	3785.4	3786.3	3786.8	3787.5	3788.1	3788.7	3789.7	3791.7
	5% Probable Flood	3790.2	3791.3	3792.0	3791.1	3789.5	3787.9	3786.6	3785.9	3785.3	3785.3	3785.9	3786.2	3786.7	3787.1	3787.5	3787.9	3789.2
	20% Probable Flood	3787.9	3788.3	3790.2	3789.5	3787.9	3786.6	3785.4	3783.9	3784.4	3784.4	3785.3	3785.6	3786.0	3786.2	3786.4	3786.7	3787.6
	50% Probable Flood	3786.4	3786.5	3789.2	3788.0	3786.5	3785.4	3783.9	3781.8	3783.9	3783.9	3783.9	3784.4	3785.3	3785.3	3785.4	3785.8	3786.3
Monthly Flow Duration 25% of Time Equaled or Exceeded		3785.5	3786.3	3787.5	3787.1	3786.1	3785.2	3782.0	3780.7	3780.9	3780.7	3781.1	3781.1	3781.2	3781.6	3782.0	3780.8	3783.1
Mean Monthly Flow		**3784.4**	3785.6	3786.6	3786.2	3785.4	3783.6	3781.6	3780.3	3780.4	3780.4	3780.7	3780.6	3780.7	3781.2	3781.7	3781.6	3782.5
Monthly Flow Duration 75% of Time Equaled or Exceeded		3779.3	3779.6	3783.0	3782.1	3781.7	3780.8	3780.2	3779.8	3779.8	3779.6	3780.2	3780.1	3780.3	3780.4	3780.5	3779.7	3779.3
Flow Condition		Water Surface Levels at Intake Structure - Stage 3 (Diversion Culvert #1 Open, Power Intake Closed) (ft)																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	3793.7	3793.8	3793.8	3793.5	3791.6	3790.0	3787.9	3786.8	3776.8	3776.8	3785.8	3786.5	3787.4	3788.1	3788.8	3790.0	3791.9
	5% Probable Flood	3790.5	3791.5	3792.1	3791.3	3789.7	3787.9	3786.3	3782.8	3775.1	3775.1	3782.8	3785.7	3786.4	3786.9	3787.4	3787.9	3789.4
	20% Probable Flood	3787.9	3788.3	3790.5	3789.7	3787.8	3786.3	3776.8	3770.4	3771.9	3771.9	3775.1	3778.7	3784.9	3785.7	3786.0	3786.4	3787.5
	50% Probable Flood	3786.0	3786.1	3789.4	3788.0	3786.1	3776.8	3770.4	3765.8	3770.4	3770.4	3770.4	3771.9	3775.1	3775.1	3776.8	3780.7	3785.8
Monthly Flow Duration 25% of Time Equaled or Exceeded		3777.8	3785.9	3787.5	3787.0	3785.5	3774.6	3765.9	3764.3	3764.4	3764.3	3764.8	3764.8	3764.9	3765.3	3765.9	3764.3	3768.3
Mean Monthly Flow		**3771.9**	3778.7	3786.3	3785.6	3776.1	3769.5	3765.4	3763.7	3763.9	3763.9	3764.2	3764.1	3764.3	3764.9	3765.6	3765.3	3766.8
Monthly Flow Duration 75% of Time Equaled or Exceeded		3762.6	3762.9	3768.1	3766.1	3765.6	3764.3	3763.7	3763.1	3763.2	3762.9	3763.7	3763.5	3763.8	3763.9	3764.0	3763.0	3762.5
Flow Condition		Water Surface Levels at Intake Structure Diversion - Stage 4 (Culverts #1 and #2 Open, Power Intake Closed) (ft)																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	[redacted]					3788.4	3784.9	3773.4	3765.0	3765.0	3768.4	3771.9	3778.7	3785.6	3786.8	3788.3	3790.5
	5% Probable Flood						3784.9	3770.4	3766.2	3764.6	3764.6	3766.2	3767.8	3771.1	3774.2	3778.7	3784.9	3787.6
	20% Probable Flood						3770.4	3765.0	3763.4	3763.8	3763.8	3764.6	3765.3	3766.7	3767.8	3769.1	3771.1	3779.7
	50% Probable Flood						3765.0	3763.4	3761.8	3763.4	3763.4	3763.4	3763.8	3764.6	3764.6	3765.0	3765.8	3768.4
Monthly Flow Duration 25% of Time Equaled or Exceeded							3764.5	3761.9	3760.9	3761.0	3760.9	3761.2	3761.2	3761.3	3761.6	3761.9	3761.0	3762.8
Mean Monthly Flow							**3763.1**	3761.6	3760.6	3760.7	3760.7	3760.9	3760.8	3760.9	3761.3	3761.7	3761.6	3762.2
Monthly Flow Duration 75% of Time Equaled or Exceeded							3761.0	3760.5	3760.2	3760.2	3760.0	3760.5	3760.4	3760.6	3760.7	3760.8	3760.1	3759.8

TABLE 1: MONTHLY INFLOWS AND STEADY–STATE WATER LEVELS AT INTAKE STRUCTURE FOR DRAWDOWN AND POST–DRAWDOWN

Flow Condition		Discharge (cfs)																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	14,000	14,200	14,200	13,600	9,900	7,300	4,400	3,200	1,800	1,800	2,500	3,000	3,800	4,600	5,500	7,200	10,500
	5% Probable Flood	8,000	9,700	10,900	9,400	6,800	4,400	2,800	2,100	1,700	1,700	2,100	2,400	2,900	3,300	3,800	4,400	6,300
	20% Probable Flood	4,400	4,900	8,000	6,800	4,300	2,800	1,800	1,400	1,500	1,500	1,700	1,900	2,200	2,400	2,600	2,900	3,900
	50% Probable Flood	2,600	2,700	6,300	4,500	2,700	1,800	1,400	1,000	1,400	1,400	1,400	1,500	1,700	1,700	1,800	2,000	2,500
Monthly Flow Duration 25% of Time Equaled or Exceeded		1,850	2,540	3,880	3,390	2,330	1,670	1,020	810	830	810	880	880	890	950	1,020	820	1,240
Mean Monthly Flow		1,500	1,900	2,800	2,370	1,760	1,330	960	740	760	760	800	790	810	890	980	950	1,110
Monthly Flow Duration 75% of Time Equaled or Exceeded		600	630	1,220	1,040	980	820	730	660	670	630	730	710	750	760	780	650	590
Flow Condition		Water Surface Level at Embankment - Stage 4 (Culverts #1 and #2 Open, Power Intake Closed) (ft)																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 -15	Jul 16 - 30	Aug	Sep 1 - 15	Sep 16 - 30	Oct 1 -15	Oct 16 - 31	Nov 1 - 15	Nov 16 - 30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	[redacted]					3789.1	3781.7	3773.7	3768.0	3768.0	3769.7	3771.1	3777.4	3784.6	3787.7	3789.0	3791.4
	5% Probable Flood						3781.7	3769.8	3768.1	<3768	<3768	3768.1	3768.7	3770.2	3774.8	3777.4	3781.7	3788.0
	20% Probable Flood						3769.8	3768.0	<3768	<3768	<3768	<3768	3768.0	3768.2	3768.7	3769.7	3770.2	3777.8
	50% Probable Flood						3768.0	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	3768.0	3768.1	3769.7
Monthly Flow Duration 25% of Time Equaled or Exceeded							<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768
Mean Monthly Flow							<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768
Monthly Flow Duration 75% of Time Equaled or Exceeded							<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768	<3768

SEE NOTE 9

TABLE 2: MONTHLY INFLOWS AND STEADY–STATE WATER LEVELS AT UPSTREAM EMBANKMENT FOR DRAWDOWN AND POST–DRAWDOWN

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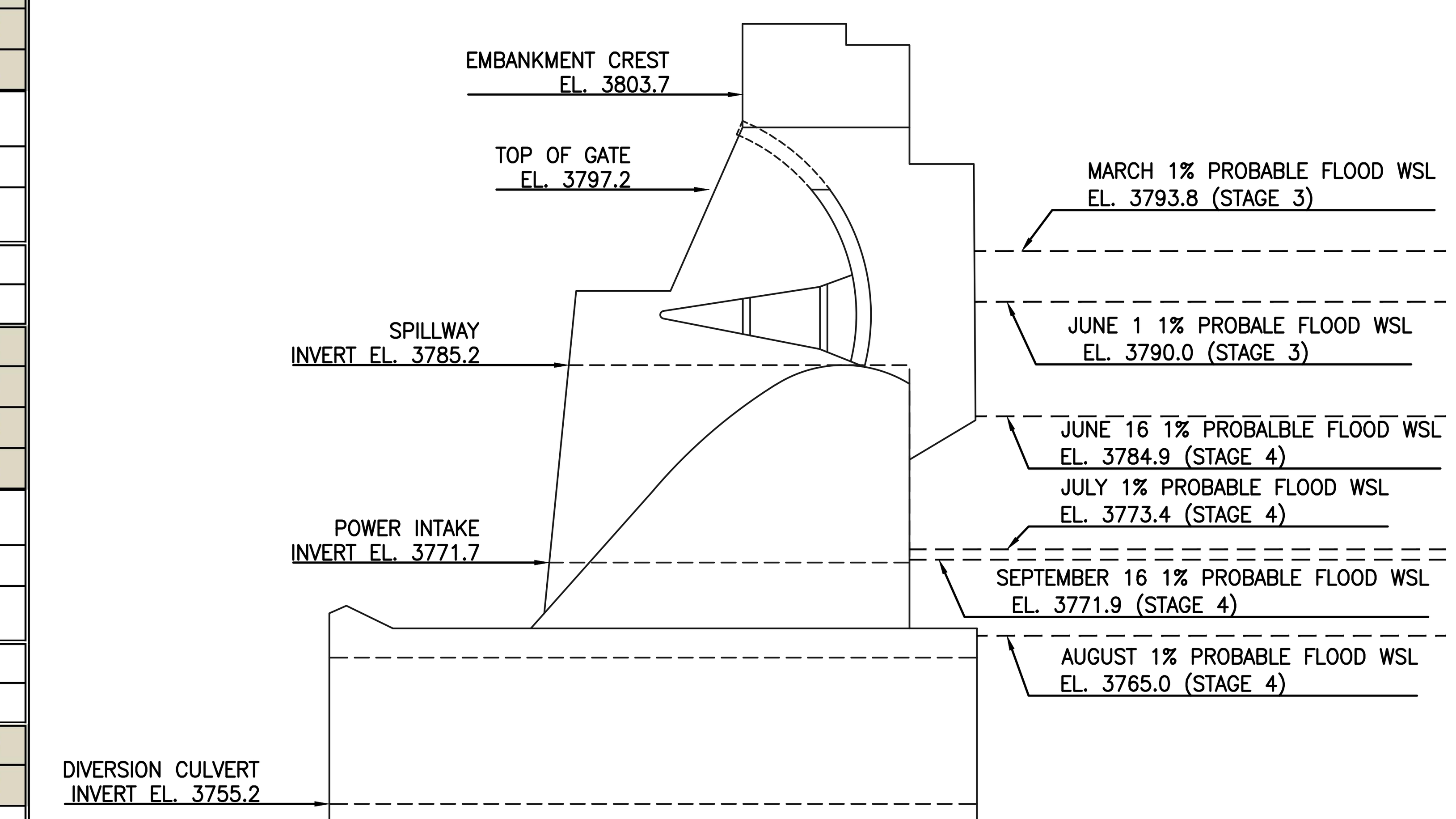
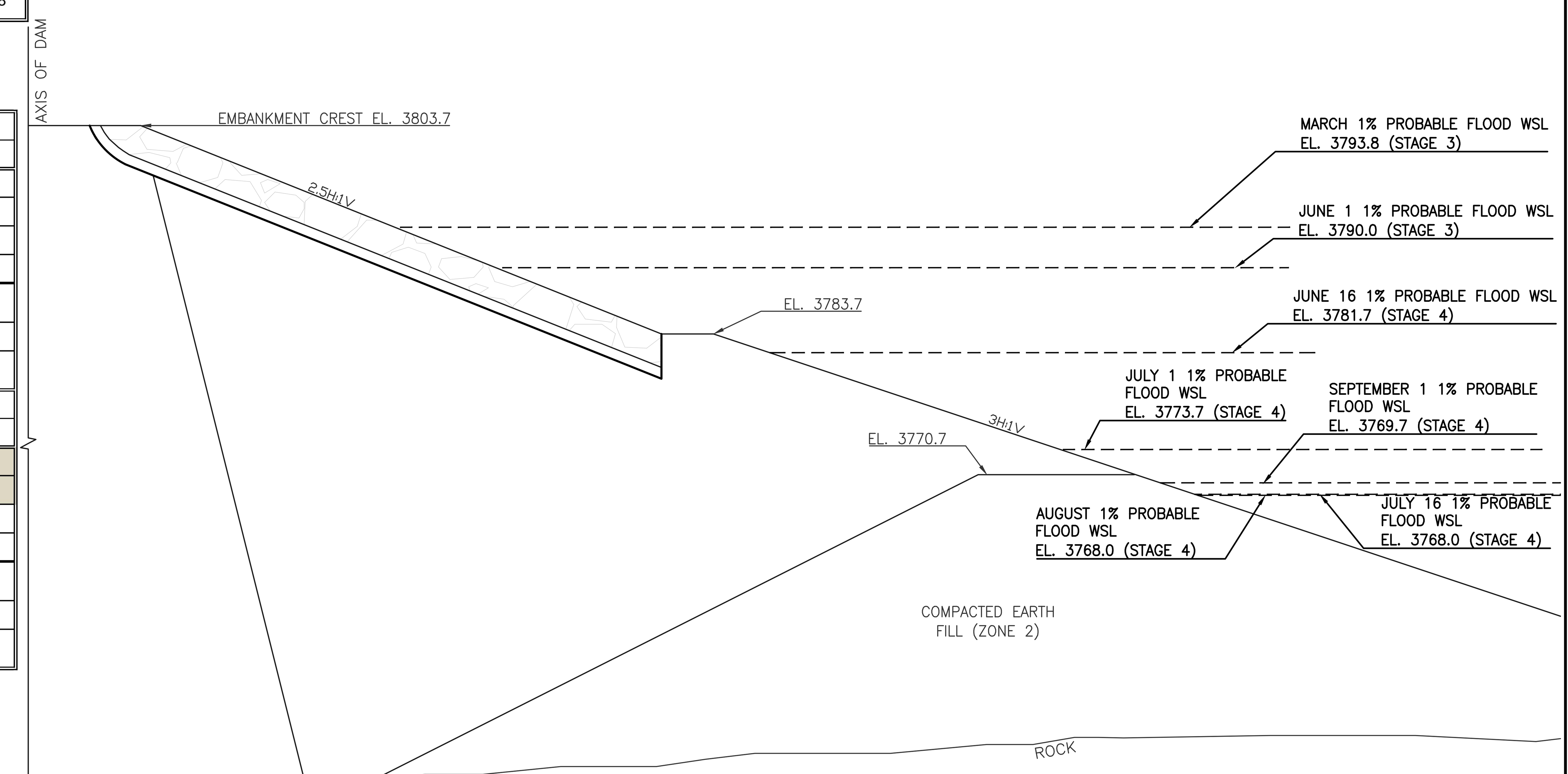


A SECTION – INTAKE STRUCTURE
C1050
1" = 10'



B SECTION – UPSTREAM EMBANKMENT
C1050
1" = 10'

0 10 20 30
1" = 10'

LEGEND:

– – – – – WATER SURFACE LEVEL

NOTE:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. WATER SURFACE LEVELS SHOWN IN TABLE 2 AND SECTION B CORRESPOND TO LEVELS AT THE UPSTREAM FACE OF THE EMBANKMENT.
3. SELECT LEVELS SHOWN ON SECTIONS. ADDITIONAL LEVELS SHOWN ON TABLE 1.
4. THE WATER LEVELS IN TABLE 1 AND TABLE 2 ARE DETERMINED USING STEADY–STATE FLOWS IN TABLE 1 AND THE RATING CURVES SHOWN ON DRAWING C1056.
5. SHADED VALUES IN TABLE 1 AND TABLE 2 REPRESENT WATER SURFACE LEVELS WITH SPILLWAY FLOW.
6. BOLDED CELLS CORRESPOND TO RESERVOIR ELEVATIONS SHOWN ON DRAWING C1050.
7. STARTING JUNE 1 OF THE DRAWDOWN YEAR, EMBANKMENT MATERIALS CAN BE REMOVED ACCORDING TO THE STAGING DRAWINGS SHOWN ON C1234 TO C1239, SUCH THAT:
   7.1. 3 ft FREEBOARD IS MAINTAINED ON THE RELEVANT FLOOD EVENT PRIOR TO JULY 16.
   7.2. 1 ft FREEBOARD IS MAINTAINED ON THE RELEVANT FLOOD EVENT POST JULY 16.
8. CONTRACTOR TO ASSESS THE FLOOD RISK BASED ON USBR FORECAST REPORT AND CURRENT WATER CONDITIONS WHICH WILL INFLUENCE REMOVAL SCHEDULE.
9. ALL WATER LEVELS DENOTED BY <3768 INDICATE THAT THE INFLOW IS FULLY DIVERTED BY THE HISTORIC COFFERDAM. IN THESE CASES, THERE IS NO WATER SURFACE ELEVATION AT THE EMBANKMENT BUT ONLY AT THE INTAKE STRUCTURE.
10. WATER LEVELS SHOWN ON THIS DRAWING ARE NO LONGER VALID ONCE THE CONTROL IS REVISED AND THE INTAKE/SPILLWAY STRUCTURE IS DEMOLISHED.

REV	DESCRIPTION	BY	CHK	APP	DATE
C	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
B	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
A	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED V. MARTIN
DRAWN A. NASIRI
REVIEWED H. ELWIN
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

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KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
J.C. BOYLE FACILITY
HYDROLOGIC AND HYDRAULIC INFORMATION
POST-DRAWDOWN WATER SURFACE LEVELS

PROJ # VA103-640/1
DATE 11/13/2020
DWG C1055

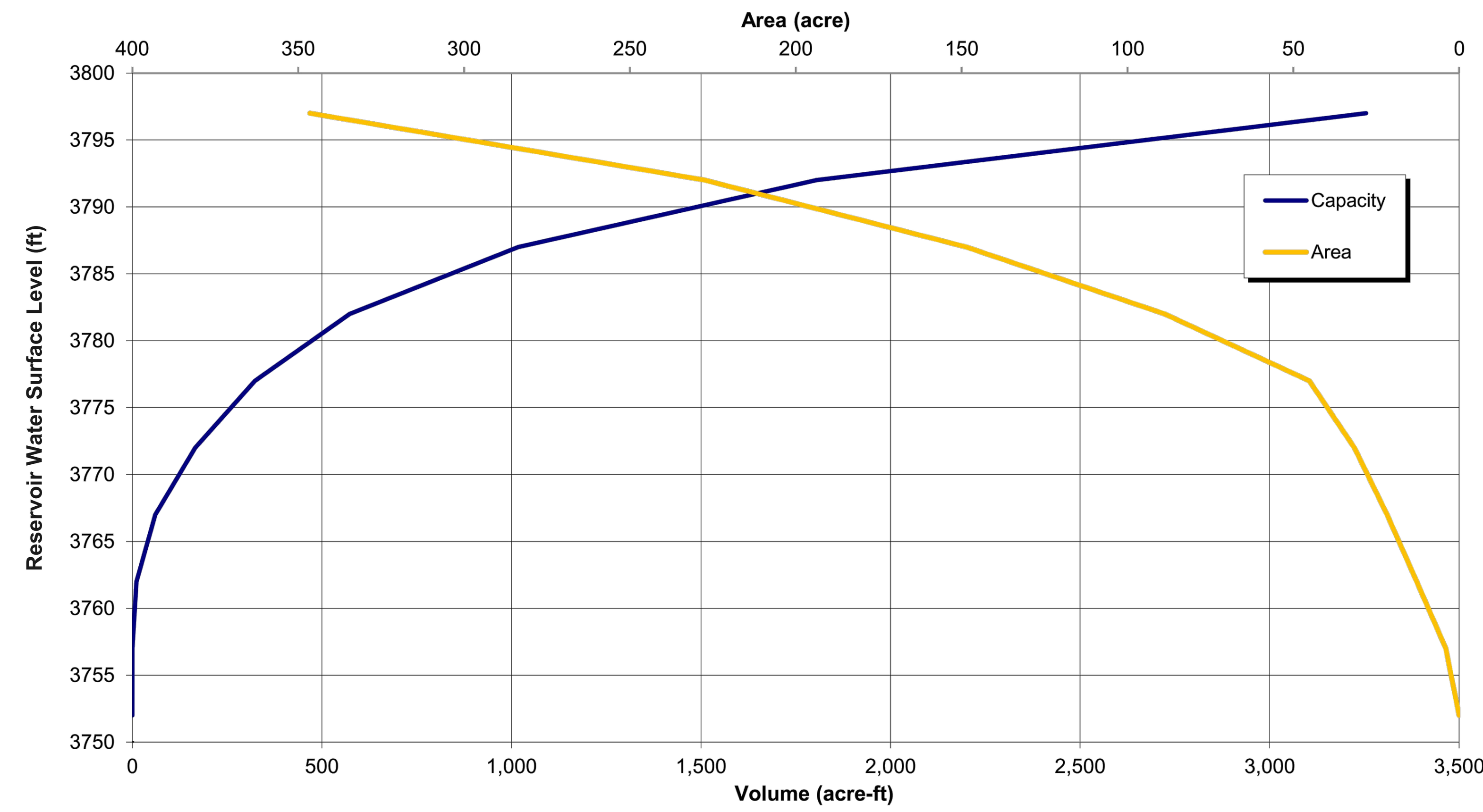

FIGURE 1: J.C. BOYLE DEPTH AREA CAPACITY CURVE

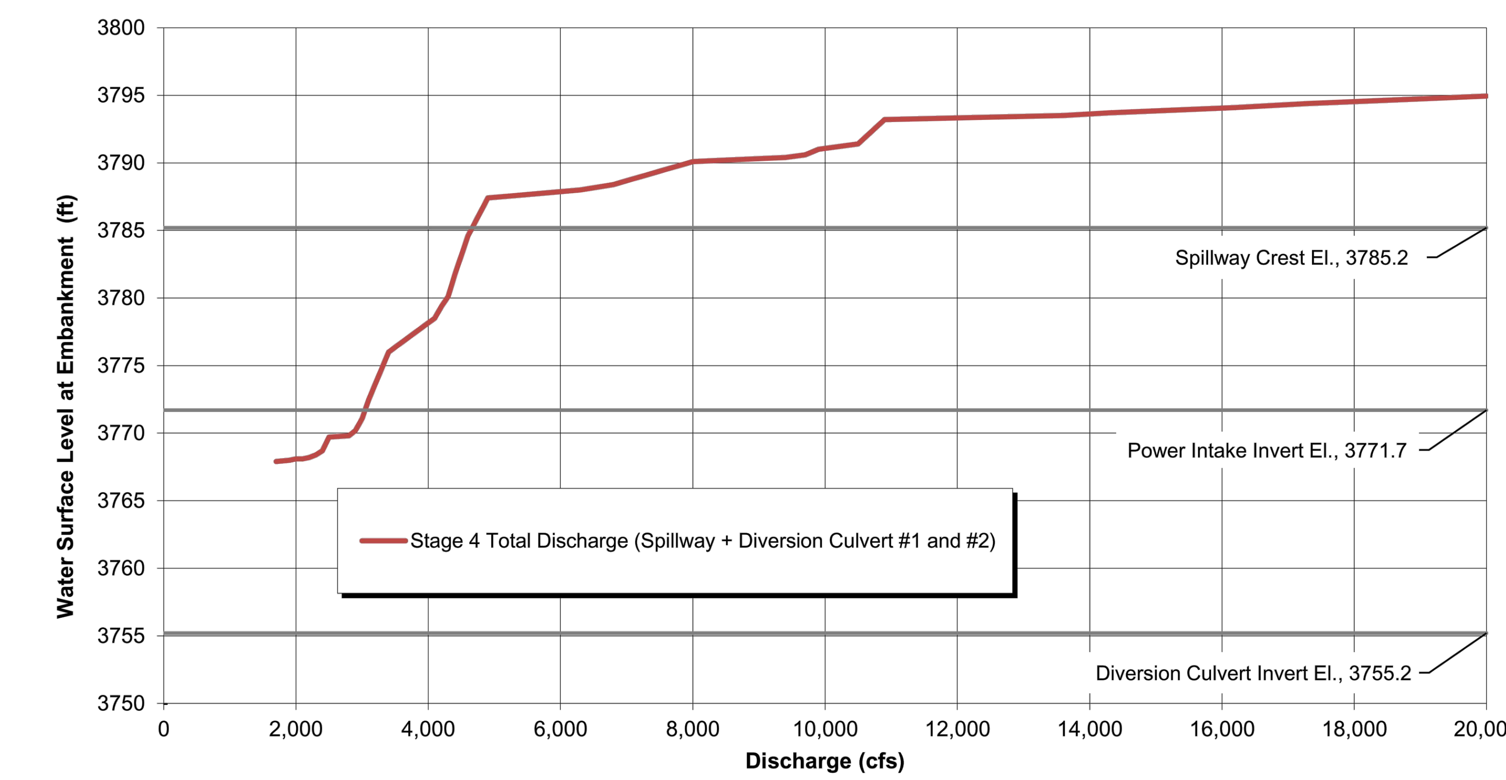

FIGURE 3: J.C. BOYLE RESERVOIR DISCHARGE RATING CURVE (EMBANKMENT)

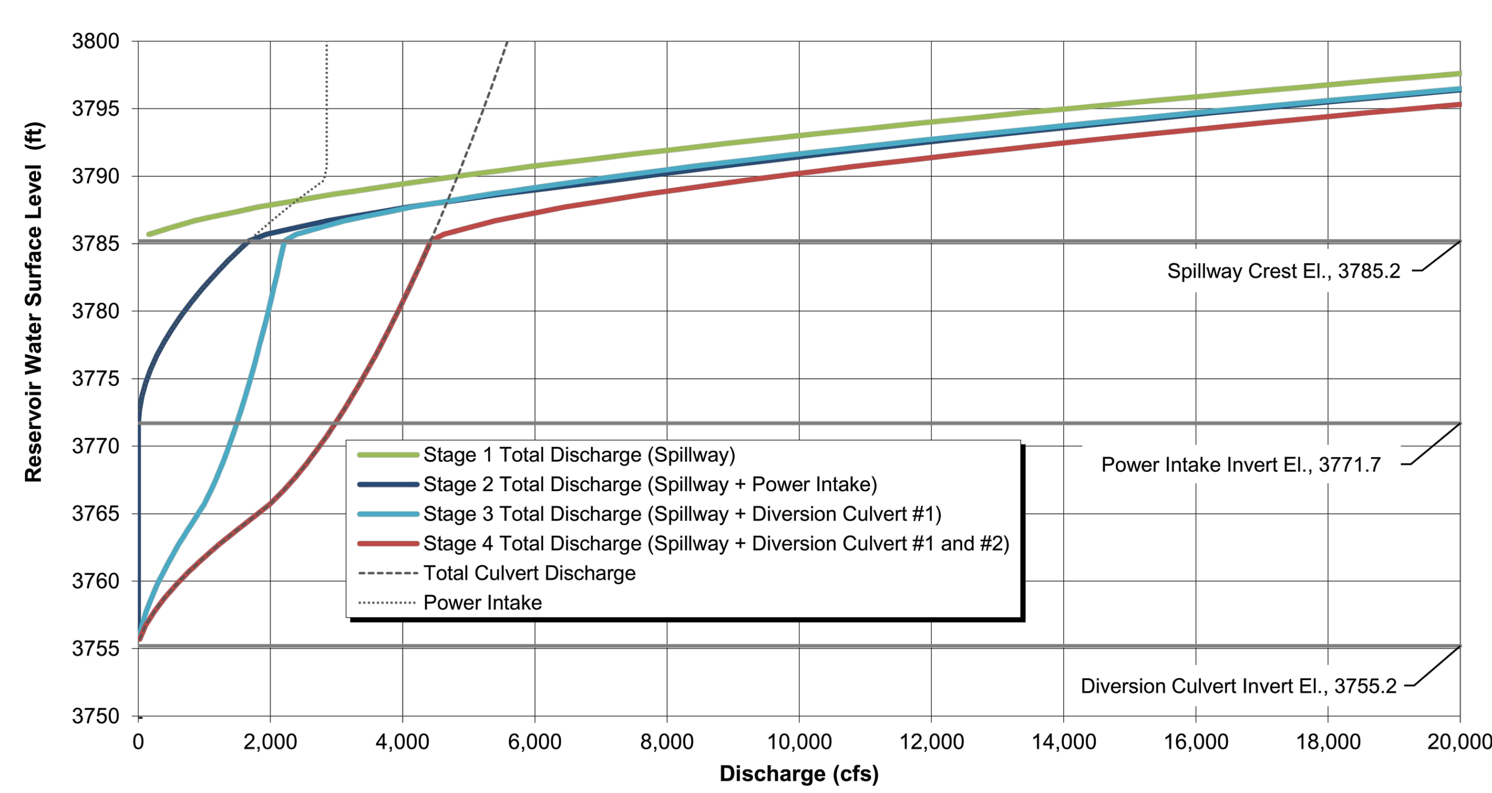

FIGURE 2: J.C. BOYLE RESERVOIR DISCHARGE RATING CURVE (INTAKE STRUCTURE)

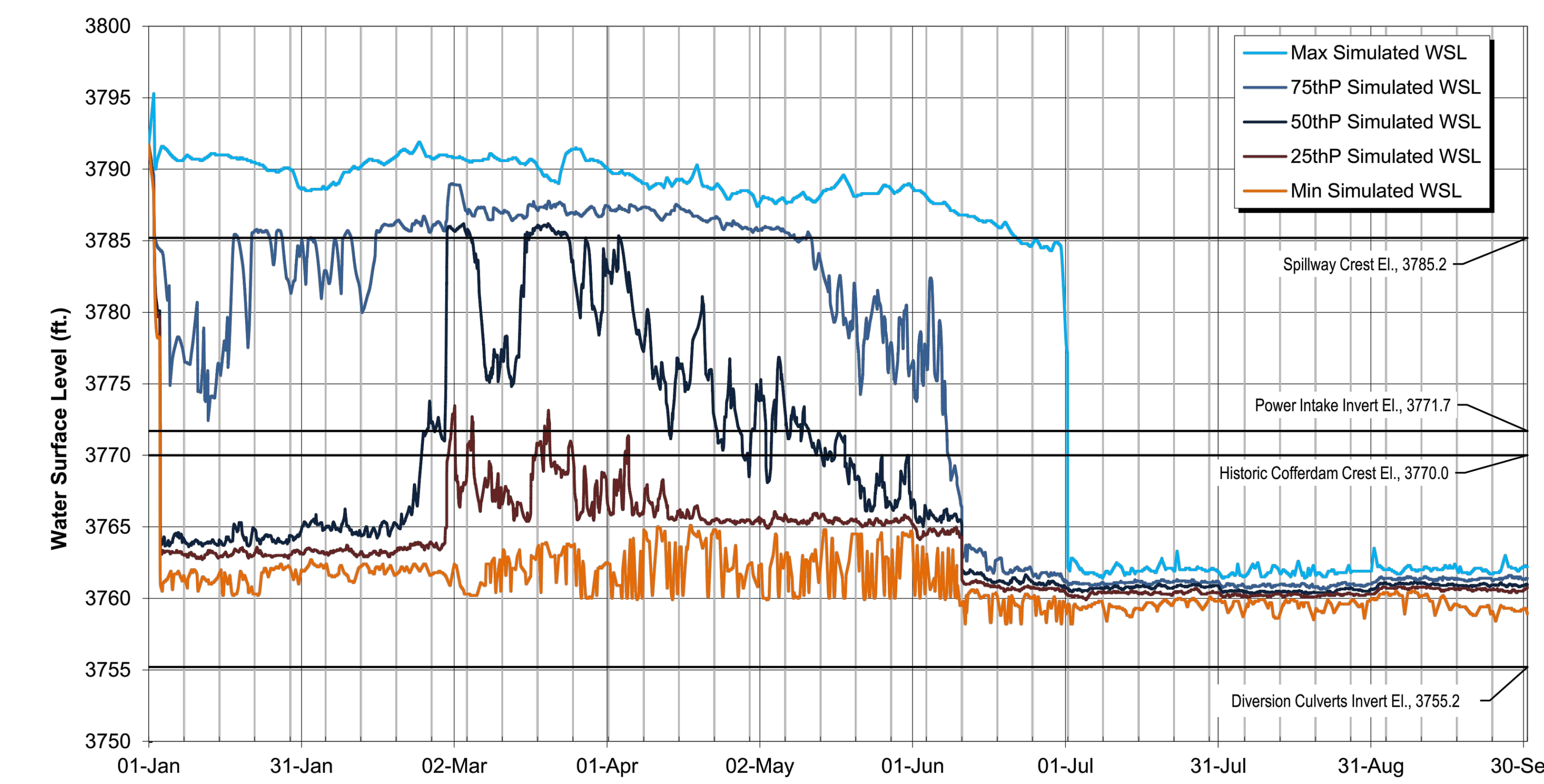

FIGURE 4: J.C. BOYLE RESERVOIR DRAWDOWN PERCENTILE WATER SURFACE LEVELS

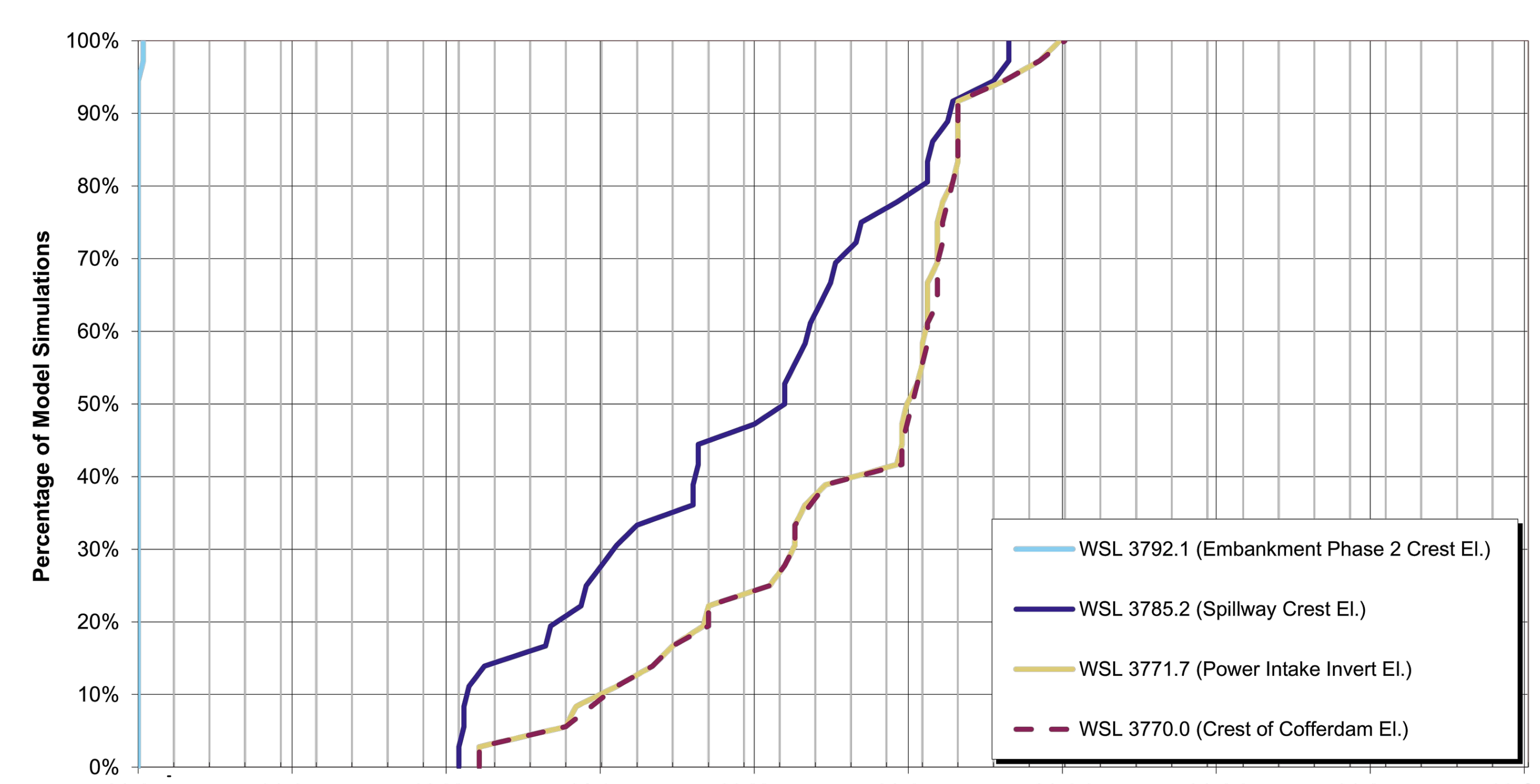

FIGURE 5: J.C. BOYLE SUSTAINED RESERVOIR DRAWDOWN AT SELECTED ELEVATIONS OVER PERIOD OF RECORD MODEL RUNS BY DATE

NOTES:

1. FOR RESERVOIR DRAWDOWN OPERATIONS NOTES SEE DRAWING C1050.
2. RESERVOIR STORAGE AREA CAPACITY CURVE (FIGURE 1) IS BASED ON THE 2018 BATHYMETRIC SURVEY AS NOTED ON DRAWING G0006.
3. DISCHARGE CAPACITY OF SPILLWAY ON FIGURE 2 IS FOR ALL THREE GATES OPEN.
4. DISCHARGE CAPACITY OF DIVERSION CULVERTS ON FIGURE 2 ARE FOR FREE DISCHARGE CONDITIONS. DIVERSION CULVERT #1 AND #2 HAVE THE SAME INVERT ELEVATION AND DISCHARGE RATING CURVE CAPACITY. A SINGLE DISCHARGE RATING CURVE IS SHOWN THAT REPRESENTS THE CAPACITY OF A SINGLE CULVERT.
5. DISCHARGE RATING CURVE ON FIGURE 2 IS FOR WATER LEVELS IMMEDIATELY UPSTREAM OF THE INTAKE STRUCTURE.
6. DISCHARGE RATING CURVE ON FIGURE 3 IS FOR WATER LEVELS AT THE CENTER OF THE UPSTREAM EMBANKMENT UNDER STAGE 4 OF DRAWDOWN CONDITIONS (THREE SPILLWAY GATES OPEN AND DIVERSION CULVERTS OPEN).
7. RESERVOIR WATER LEVELS SHOWN IN FIGURE 4 ARE THE RESERVOIR WATER SURFACE LEVEL MODEL RUN RESULTING PERCENTILES IMMEDIATELY UPSTREAM OF THE DAM USING DRAWDOWN MODEL. THE PERCENTILES ARE CALCULATED BASED ON THE ENTIRE 36 YEAR RECORD OF 2019 JOINT BIOLOGICAL OPINION FLOWS FOR THE USBR'S KLAMATH PROJECT. THE RESERVOIR WATER LEVELS ARE SIMULATED USING THE RESERVOIR DRAWDOWN OPERATIONS ON DRAWING C1055. WATER LEVELS CAN BE OUTSIDE OF THE VALUES DEPENDING ON THE HYDROLOGICAL CONDITIONS DURING THE DRAWDOWN YEAR.
8. THE CURVES SHOWN ON FIGURE 5 REPRESENT THE PERCENTAGE OF MODEL SIMULATIONS AT WHICH RESERVOIR DRAWDOWN WATER SURFACE LEVELS ARE SUSTAINED BELOW SELECTED ELEVATIONS BASED ON THE DRAWDOWN MODEL USING THE ENTIRE 36 YEAR RECORD OF 2019 JOIN BIOLOGICAL OPINION FLOWS FOR THE USBR'S KLAMATH PROJECT. THE ACTUAL DATE A WATER SURFACE LEVEL IS SUSTAINED AT A CERTAIN ELEVATION CAN BE DIFFERENT THAN SHOWN DEPENDING ON THE HYDROLOGICAL CONDITIONS DURING THE DRAWDOWN YEAR AND THE DRAWDOWN SEQUENCING SHOWN ON DRAWING C1055.

FOR INFORMATION ONLY

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C	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
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A	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20

WARNING
0 1/2 1
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PROJECT
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SHEET TITLE
J.C. BOYLE FACILITY
HYDROLOGIC AND HYDRAULIC INFORMATION
FIGURES

PROJ # VA103-640/1
DATE 11/13/2020
DWG C1056

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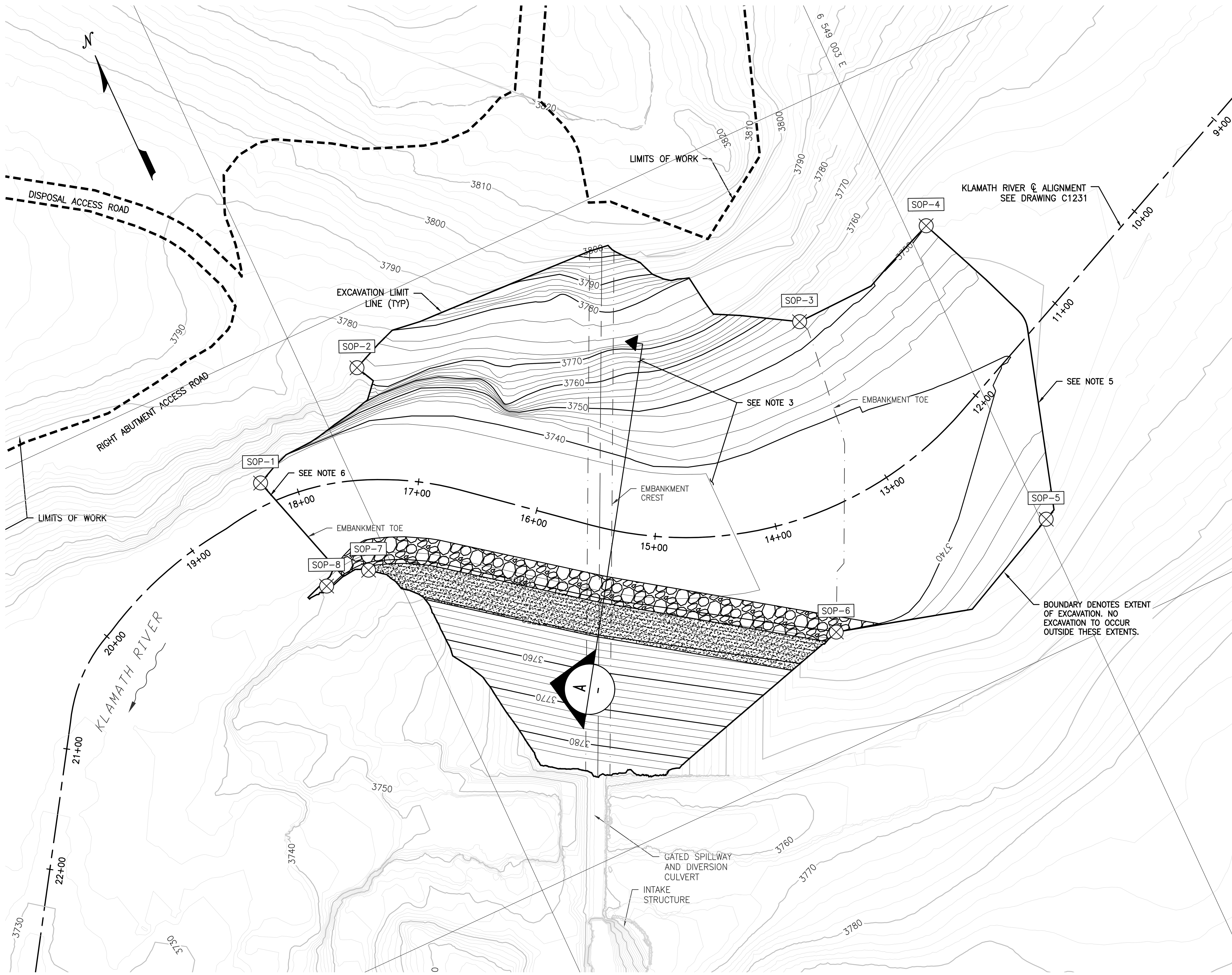


PLAN
1" = 50'

NOTES:

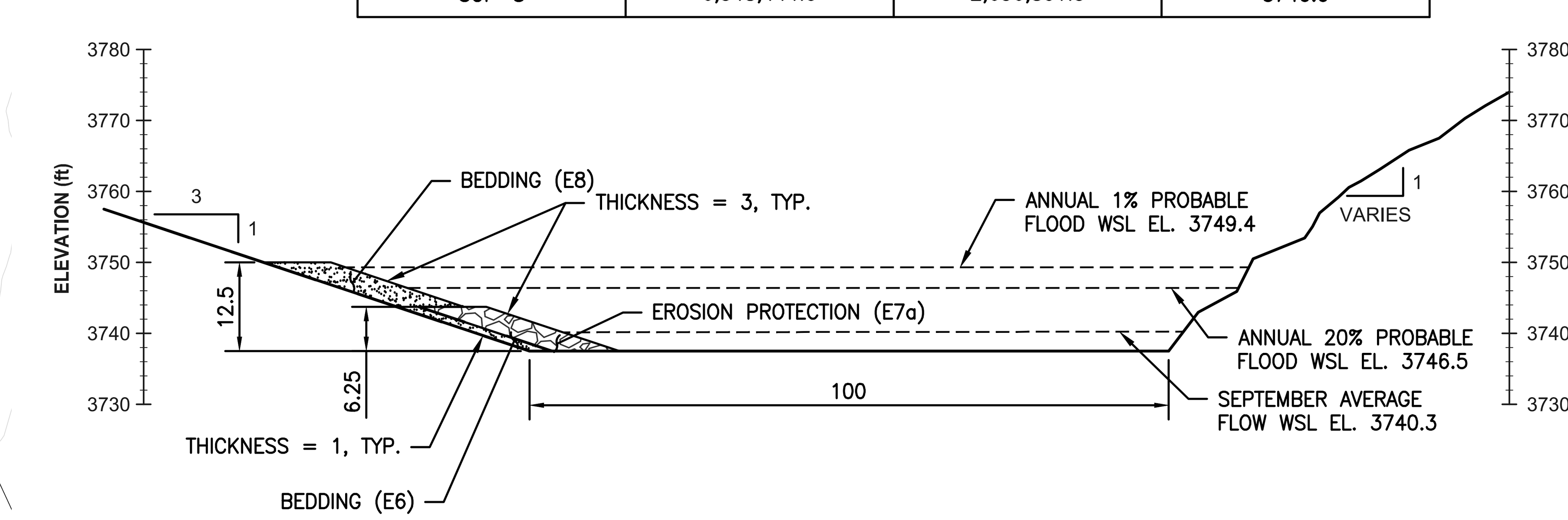
1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. REMOVE DAM EMBANKMENT FILL TO LINES AND GRADES SHOWN. EROSION PROTECTION AND BEDDING MATERIALS TO BE PLACED PRIOR TO COFFERDAM BREACH.
3. FINAL RIVER CHANNEL EXCAVATED TO BEDROCK ALONG THE RIGHT BANK AND BOTTOM. DO NOT EXCAVATE INTO BEDROCK SURFACE.
4. EXCAVATED FILL TO BE PLACED IN DISPOSAL AREAS SHOWN ON C1240 OR USED AS COVER MATERIAL.
5. EXTENT OF REMAINING SEDIMENT AND DEBRIS TO BE EVALUATED FOLLOWING DRAWDOWN. REMOVAL LIMIT CORRESPONDS TO HISTORIC COFFERDAM UPSTREAM TOE. ADDITIONAL SEDIMENT AND DEBRIS REMOVAL MAY BE NECESSARY TO ACCESS THIS POINT. REMOVAL OF MATERIAL UPSTREAM OF THIS POINT, UNLESS TO ACCESS TO THE HISTORIC COFFERDAM TOE, WILL BE COMPLETED BY OTHERS AND IS OUTSIDE THE SCOPE OF THIS DESIGN.
6. FOLLOWING EMBANKMENT REMOVAL, EVALUATE ROCKFILL AT DOWNSTREAM TOE AND GRADE AS REQUIRED.
7. CHANNEL SECTIONS BY STATION SHOWN ON C1232.
8. THE ANTICIPATED WATER SURFACE LEVELS AT SECTION A FOR VARIOUS FLOW CONDITIONS DURING CONSTRUCTION ARE SUMMARIZED IN APPENDIX B1.
9. EXCAVATION EXTENTS ARE INTERPRETED BASED ON THE HISTORIC DRAWINGS AND ARE INTENDED TO ILLUSTRATE THE GROUND SURFACE ONCE THE EMBANKMENT IS REMOVED. HOWEVER, ADDITIONAL EXCAVATION MAY BE REQUIRED. BEDROCK DEPTH MAY VARY.

LEGEND:

- EROSION PROTECTION (E7a)
- BEDDING (E6/E8)
- WATER SURFACE LEVEL
- LIMITS OF WORK

WORK POINTS TABLE

WORK POINTS	EASTING	NORTHING	ELEVATION
SOP–1	6,548,430.0	2,656,901.0	3736.5
SOP–2	6,548,542.0	2,656,954.0	3773.0
SOP–3	6,548,888.5	2,656,835.5	3774.5
SOP–4	6,549,016.0	2,656,864.0	3777.5
SOP–5	6,549,004.5	2,656,603.0	3770.5
SOP–6	6,548,808.5	2,656,591.5	3765.0
SOP–7	6,548,480.7	2,656,798.9	3744.0
SOP–8	6,548,444.0	2,656,801.5	3740.0



A SECTION
1" = 20'

0 20 40 60
1" = 20'

0 50 100 150
1" = 50'

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REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	CBN	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	CBN	NB	SRM	12/17/19

WARNING
0 1/2 1
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PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
J.C. BOYLE FACILITY
EMBANKMENT REMOVAL
PLAN

PROJ # VA103-640/1
DATE 11/13/2020
DWG C1230

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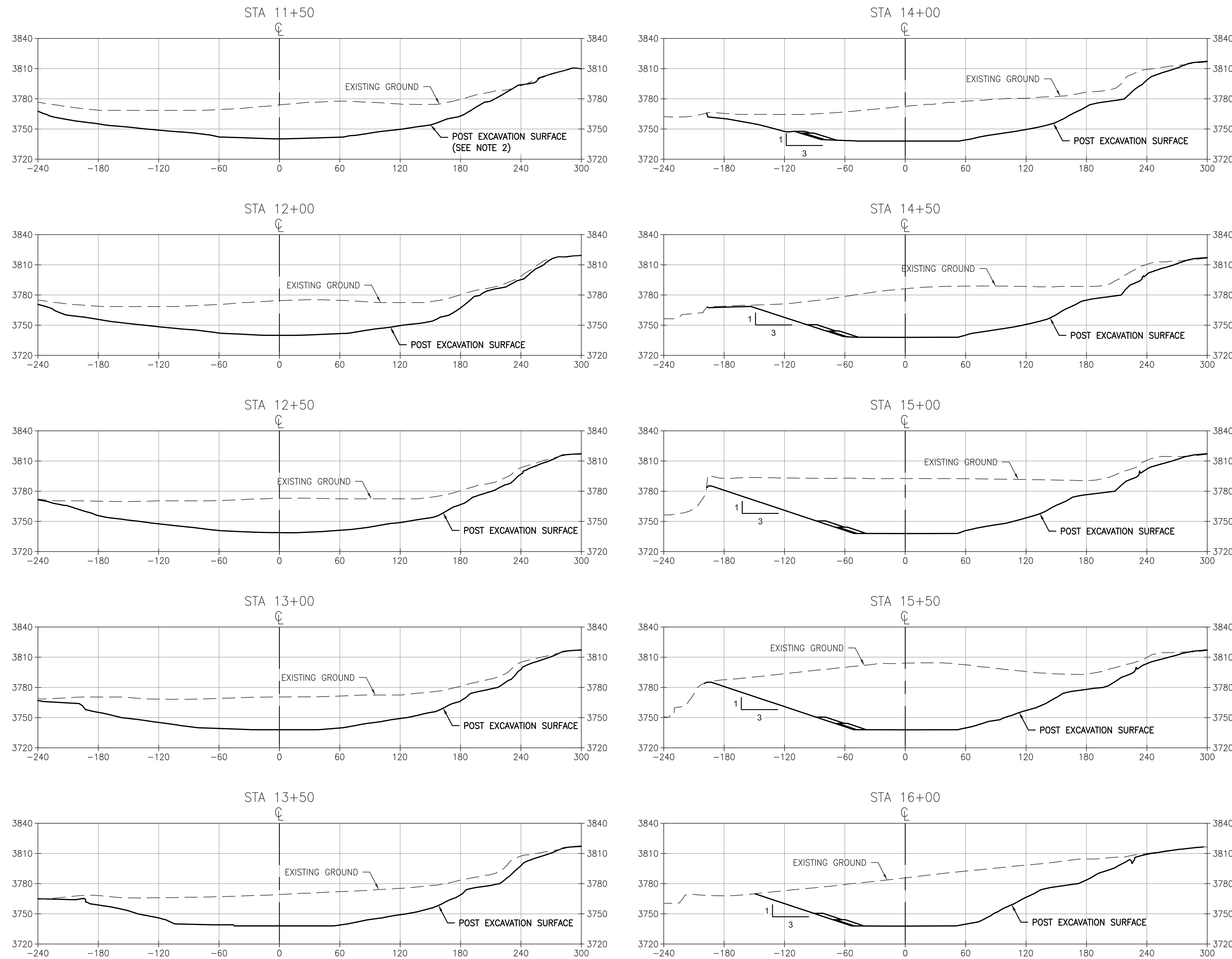

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. ACTUAL BEDROCK ELEVATION TO DETERMINE POST EXCAVATION SURFACE. NO EXCAVATION IS TO OCCUR INTO BEDROCK OR ROCKFILL.
3. REMOVE DAM EMBANKMENT FILL TO LINES AND GRADES SHOWN OR UNTIL BEDROCK/ROCKFILL IS ENCOUNTERED. EROSION PROTECTION AND BEDDING MATERIALS TO BE PLACED ON LEFT BANK POST EXCAVATION SURFACE.
4. FINAL RIVER CHANNEL ROCK SURFACE BOTTOM WIDTH AND RIGHT BANK ERODIBLE FILLS TO BE REMOVED PRIOR TO HISTORIC COFFERDAM BREACH.
5. EXCAVATION EXTENTS ARE INTERPRETED BASED ON THE HISTORIC DRAWINGS AND ARE INTENDED TO ILLUSTRATE THE GROUND SURFACE ONCE THE EMBANKMENT IS REMOVED. HOWEVER, ADDITIONAL EXCAVATION MAY BE REQUIRED. BEDROCK DEPTH MAY VARY.

0 60 120 180
1" = 60'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	CBN	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	CBN	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	CBN	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
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DESIGNED	C. NIAMIR
DRAWN	R. McLELLAN
REVIEWED	H. ELWIN
IN CHARGE	N. BISHOP
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KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
J.C. BOYLE FACILITY
EMBANKMENT REMOVAL
EXCAVATION SECTIONS

PROJ # VA103-640/1
DATE 11/13/2020
DWG C1232

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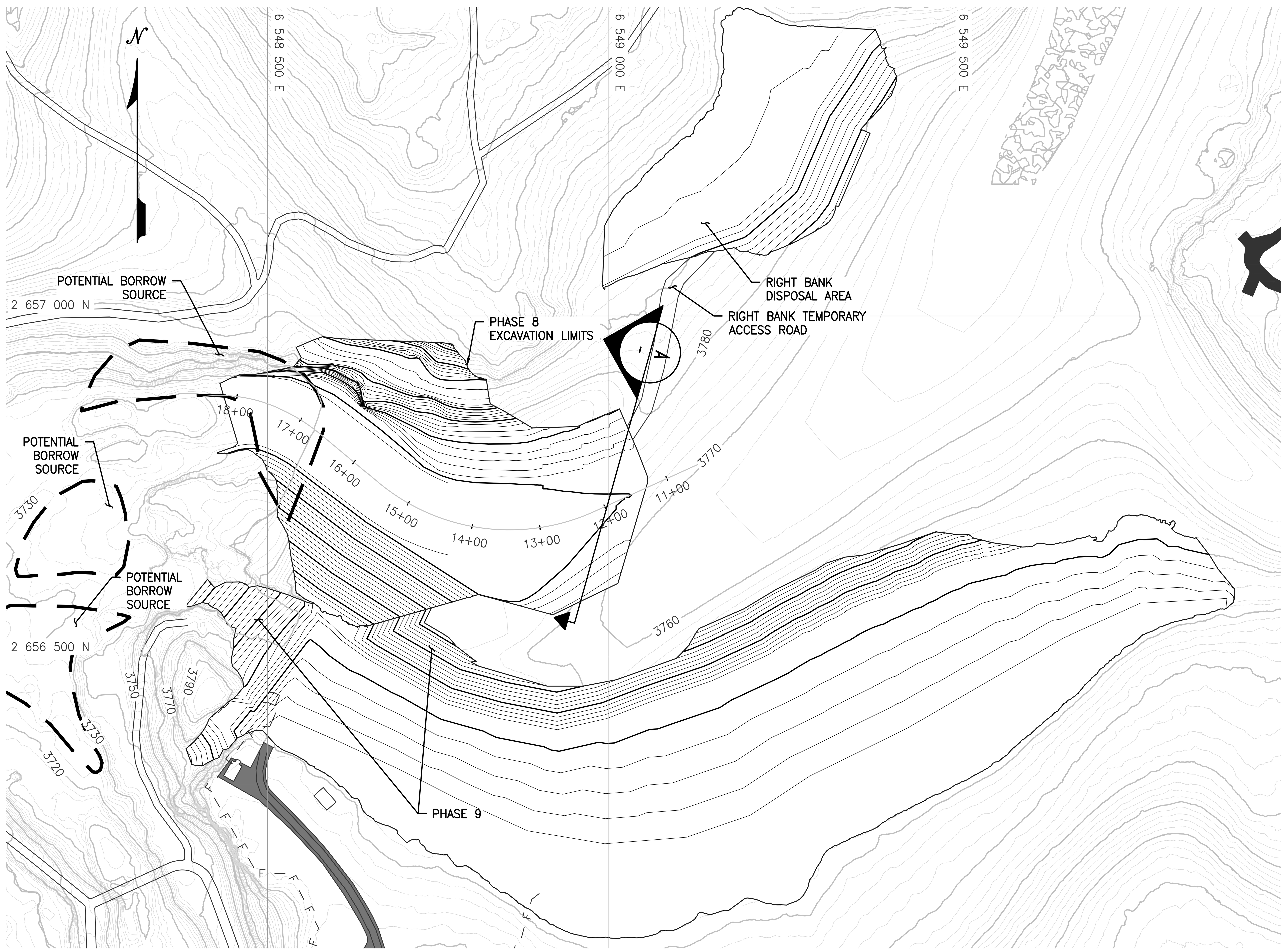
CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

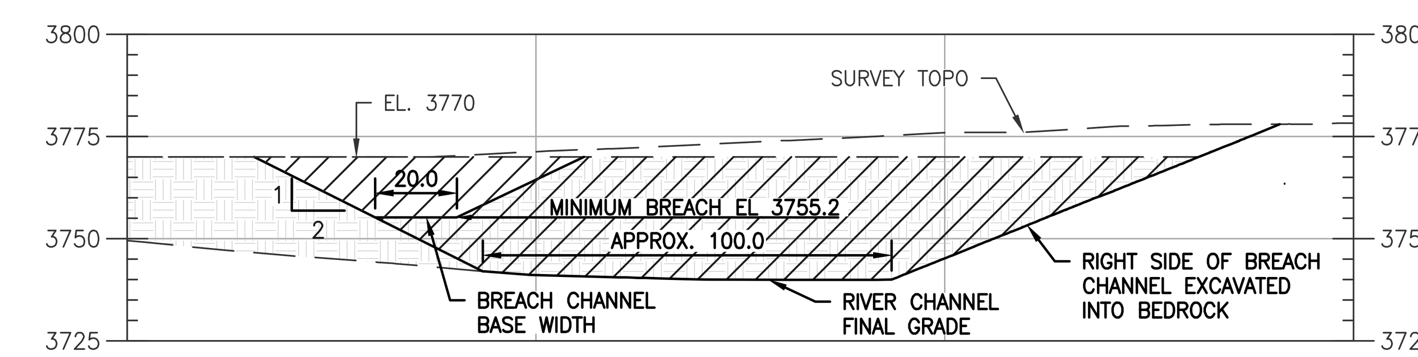
(CEII)

REDACTED

DESIGN SHEET C1234: EMBANKMENT REMOVAL



PLAN
1" = 120'



A SECTION – HISTORIC COFFERDAM BREACH
NTS

REMOVAL SEQUENCE NOTES – GENERAL ARRANGEMENT SEQUENCE NOTES (SEE DRAWINGS C1234 TO C1239):

1. PHASE 8 BREACH TO MATCH FINAL CHANNEL SLOPE ONCE FINAL RIVER CHANNEL IS SUBSTANTIALLY COMPLETE.
2. PHASE 9 PLACE STOCKPILED MATERIAL IN DIVERSION CULVERT CHANNEL AND BURY LEFT–IN–PLACE CONCRETE.

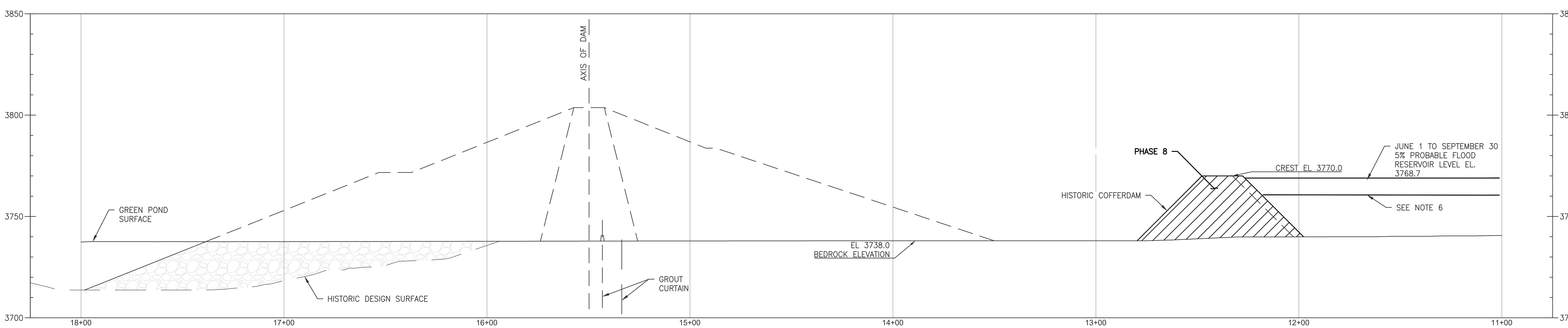
NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. LOCATION AND EXTENT OF HISTORIC COFFERDAM IS BASED ON HISTORIC PHOTOS AND MAY VARY. THE CONTRACTOR SHALL LOCATE AND ASSESS THE HISTORIC COFFERDAM PRIOR TO COMMENCING EXCAVATION SO EXCAVATION LIMITS CAN BE UPDATED AS REQUIRED.
3. HISTORIC COFFERDAM REMOVAL EXTENTS AS SHOWN ON SECTION A ARE APPROXIMATE AND WILL BE FIELD FIT BASED ON ENCOUNTERED CONDITIONS DURING REMOVAL.
4. BREACH DEPTH OF 3755.2 ft REQUIRED TO DIVERT FLOWS FROM THE DIVERSION CULVERTS TO THE FINAL RIVER CHANNEL.
5. EXCAVATE TO BREACH FROM RIGHT BANK. AVOID HAVING EXCAVATOR WORK FROM ERODIBLE FILLS
6. RESERVOIR ELEVATION AT TIME OF BREACH WILL DEPEND ON DIVERSION CULVERT INFLOW HYDRAULICS. TO BE EVALUATED POST DRAWDOWN.

LEGEND:

DEMOLITION / REMOVAL

(E) RIPRAP



PROFILE – EMBANKMENT REMOVAL MAXIMUM
1" = 30'

0 30 60 90
1" = 30'

0 120 240 360
1" = 120'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
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A	ISSUED WITH 90% DESIGN REPORT	CBN	NB	SRM	08/05/20

WARNING
0 1/2 1
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PREPARED BY
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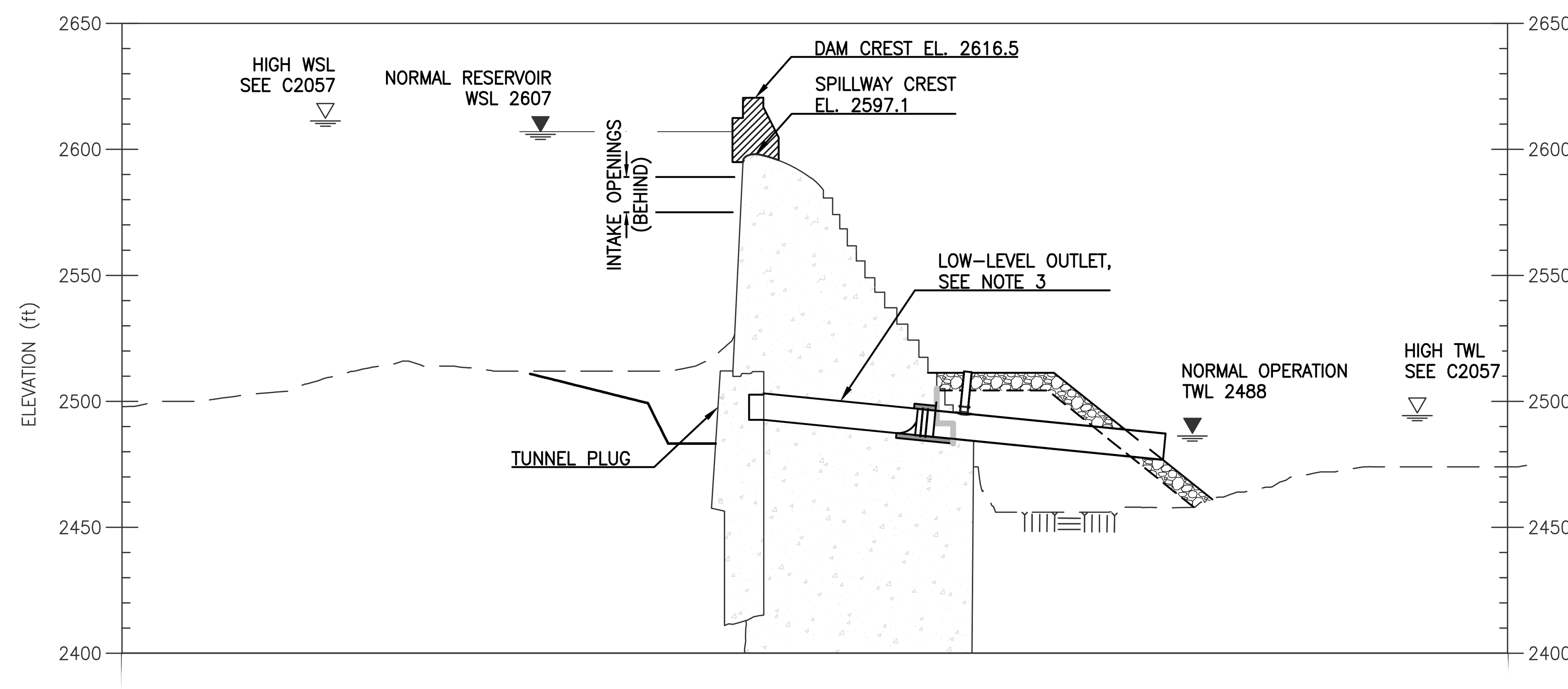
PROJECT
KLAMATH RIVER RENEWAL PROJECT

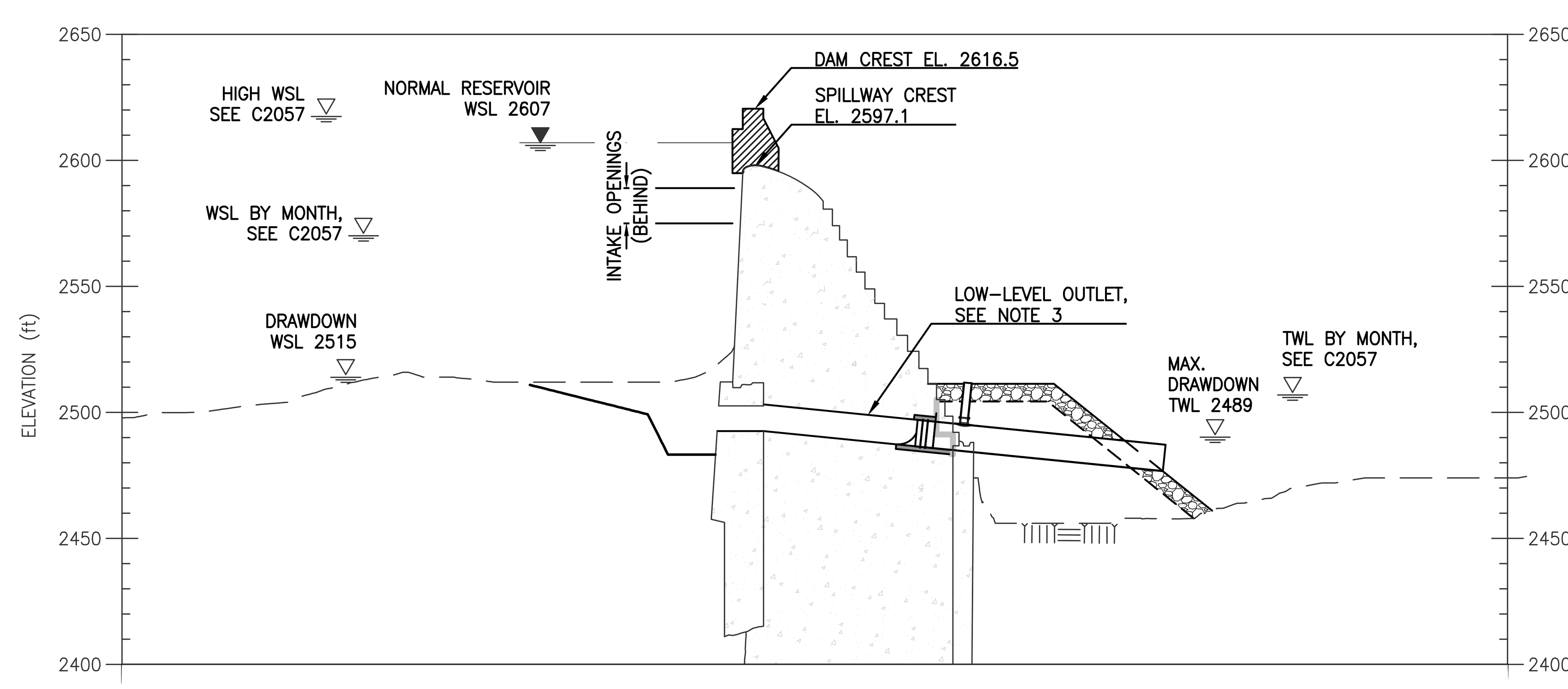
SHEET TITLE
J.C. BOYLE FACILITY
EMBANKMENT REMOVAL
GENERAL ARRANGEMENT SEQUENCE - (SHEET 6 OF 6)

PROJ # VA103-640/1
DATE 11/13/2020
DWG C1239



ELEVATION – PRE-DRAWDOWN

1" = 50'



ELEVATION – RESERVOIR DRAWDOWN

1" = 50'

NOTES:

1. SEE DRAWING C2057 FOR FLOW AND WATER SURFACE ELEVATIONS VALUES.
2. FOR DAM MODIFICATIONS NOTES SEE DRAWING C2200.
3. LOW-LEVEL OUTLET WITH STEEL CONDUIT IS PROVIDED FOR USE OF PLUNGE POOL AREA DURING DRAWDOWN WHEN LOW-LEVEL OUTLET DISCHARGE DOES NOT ALLOW THE DIVERSION TUNNEL TO BE ACCESSED OR FULLY OPENED FOR DIVERSION OF ALL INFLOWS. (75 PERCENTILE AND HIGHER FLOW YEAR). CONTRACTOR TO EVALUATE NEED FOR OUTLET CONDUIT.
4. RESERVOIR OPERATING WATER SURFACES:
   - 4.1. MAXIMUM RESERVOIR SURFACE EL. 2611 ft.
   - 4.2. NORMAL MAXIMUM RESERVOIR OPERATING SURFACE EL. 2609 ft.
   - 4.3. NORMAL MINIMUM RESERVOIR OPERATING SURFACE EL. 2605 ft.
   - 4.3 MINIMUM RESERVOIR OPERATING SURFACE EL. 2596 ft.

PRE-DRAWDOWN PROCEDURE:

1. OPERATE FACILITY AT LOWEST RESERVOIR WATER SURFACE ELEVATION POSSIBLE.
2. LOWER RESERVOIR TO MINIMUM RESERVOIR OPERATING LEVEL OF 2596 ft BY CONTROLLED SPILLWAY RELEASES OR BY BYPASS OF FLOWS THROUGH THE TURBINE-GENERATOR UNITS 01 AND 02 (DESIGN DISCHARGE OF 3,000 cfs).
3. MAINTAIN RESERVOIR AT MINIMUM WATER SURFACE ELEVATION BY CONTROLLED BYPASS OF FLOWS THROUGH THE TURBINE-GENERATOR UNITS DURING DAM MODIFICATIONS AND DOWNSTREAM WORKS.

RESERVOIR DRAWDOWN PROCEDURE:

1. RESERVOIR DRAWDOWN TO START NO EARLIER THAN JANUARY 1 OF THE DRAWDOWN YEAR BY THE OPENING OF THE LOW-LEVEL OUTLET.
2. UNDER JANUARY MEAN MONTHLY INFLOWS AND THE INITIAL RESERVOIR DRAWDOWN PROCEDURES DESCRIBED ABOVE, IT WILL TAKE APPROXIMATELY 10 DAYS TO LOWER THE RESERVOIR LEVEL TO THE TARGET DRAWDOWN ELEVATION OF 2530 ft. THE RESERVOIR WATER LEVELS CAN INCREASE FOLLOWING THIS PERIOD DEPENDING ON THE HYDROLOGICAL CONDITIONS DURING THE DRAWDOWN YEAR.
3. OPEN AND OPERATE THE EXISTING DIVERSION TUNNEL AFTER THE FRESHET SEASON AND WHEN THE RESERVOIR WATER LEVEL IS AT OR BELOW 2530 ft.
4. DRAWDOWN COMPLETION IS DETERMINED WHEN THE RESERVOIR LEVEL FIRST REACHES THE ELEVATION WHERE THE HISTORIC DIVERSION DAM CONTROLS THE UPSTREAM WATER SURFACE LEVEL AT OR BELOW 2515 ft.

POST – DRAWDOWN/RIVER DIVERSION:

1. RESERVOIR DRAWDOWN IS COMPLETE ONCE THE INFLOWS INTO THE RESERVOIR ARE EQUAL TO THE DISCHARGE CAPACITY WITH NO RESERVOIR IMPOUNDMENT.
2. DIVERSION OF ALL INFLOWS THROUGH THE DIVERSION TUNNEL REQUIRES RE-ESTABLISHMENT OF THE HISTORIC DIVERSION DAM.

FOR INFORMATION ONLY

0 50 100 150
1" = 50'

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REV	DESCRIPTION	BY	CHK	APP	DATE
C	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/09/20
B	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
A	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20

WARNING
0 1/2 1
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PREPARED BY
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REVIEWED	H. ELWIN
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

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KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
HYDROLOGIC AND HYDRAULIC INFORMATION
WATER SURFACE ELEVATIONS

PROJ # VA103-640/1
DATE 11/09/2020
DWG C2055

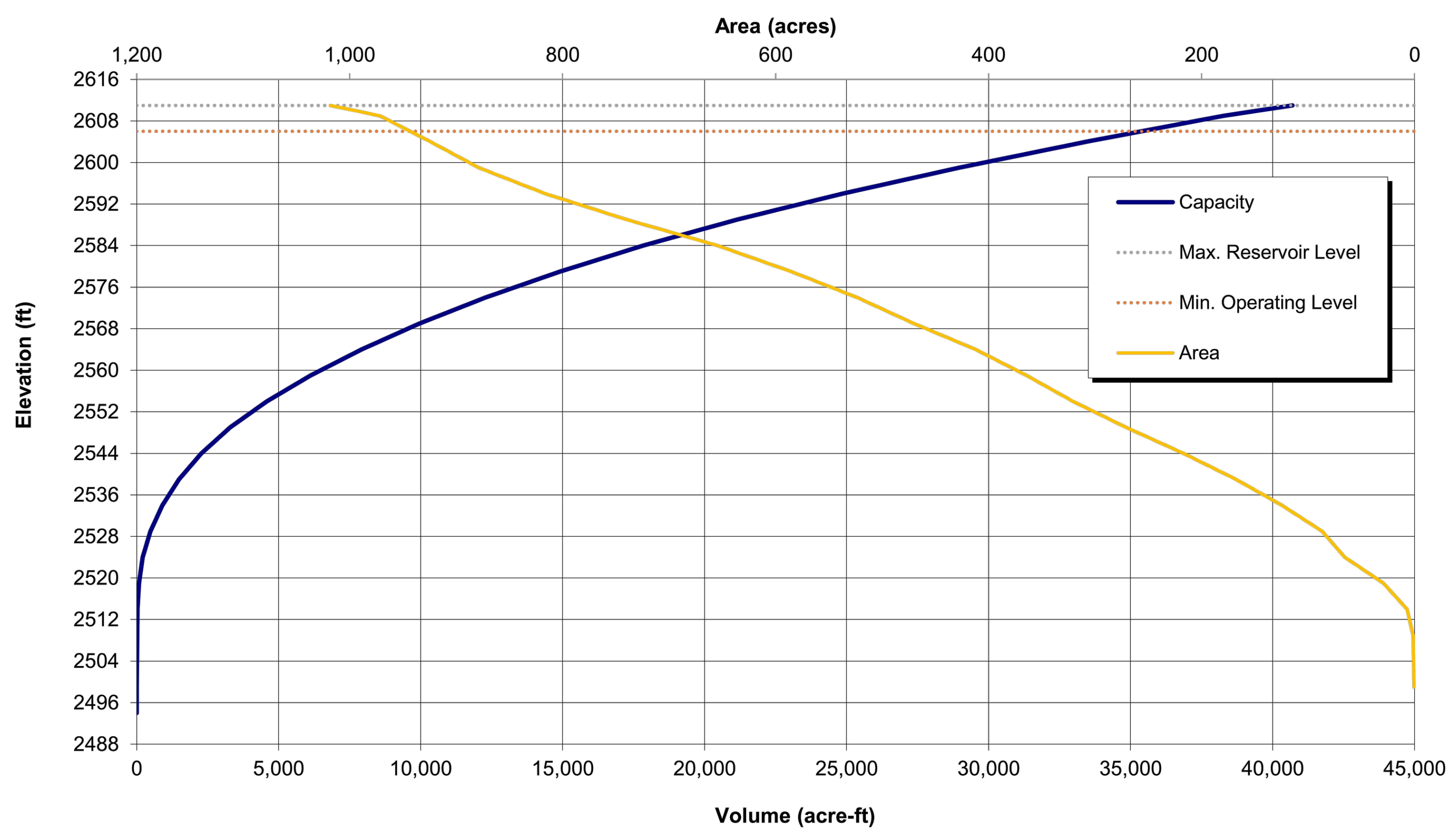

FIGURE 1 – RESERVOIR DEPTH AREA CAPACITY CURVE

NOT TO SCALE

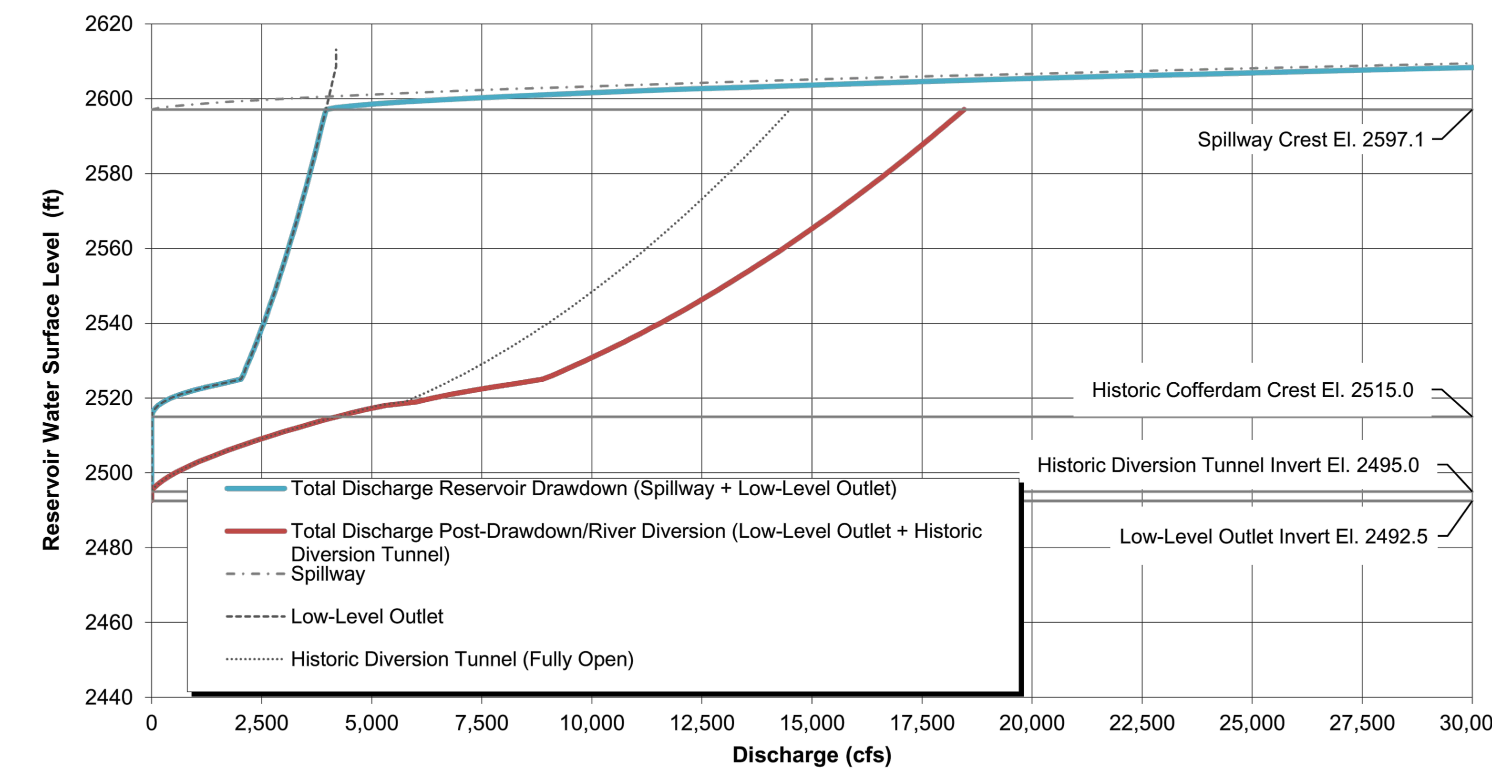

FIGURE 2 – RESERVOIR RATING CURVES

NOT TO SCALE

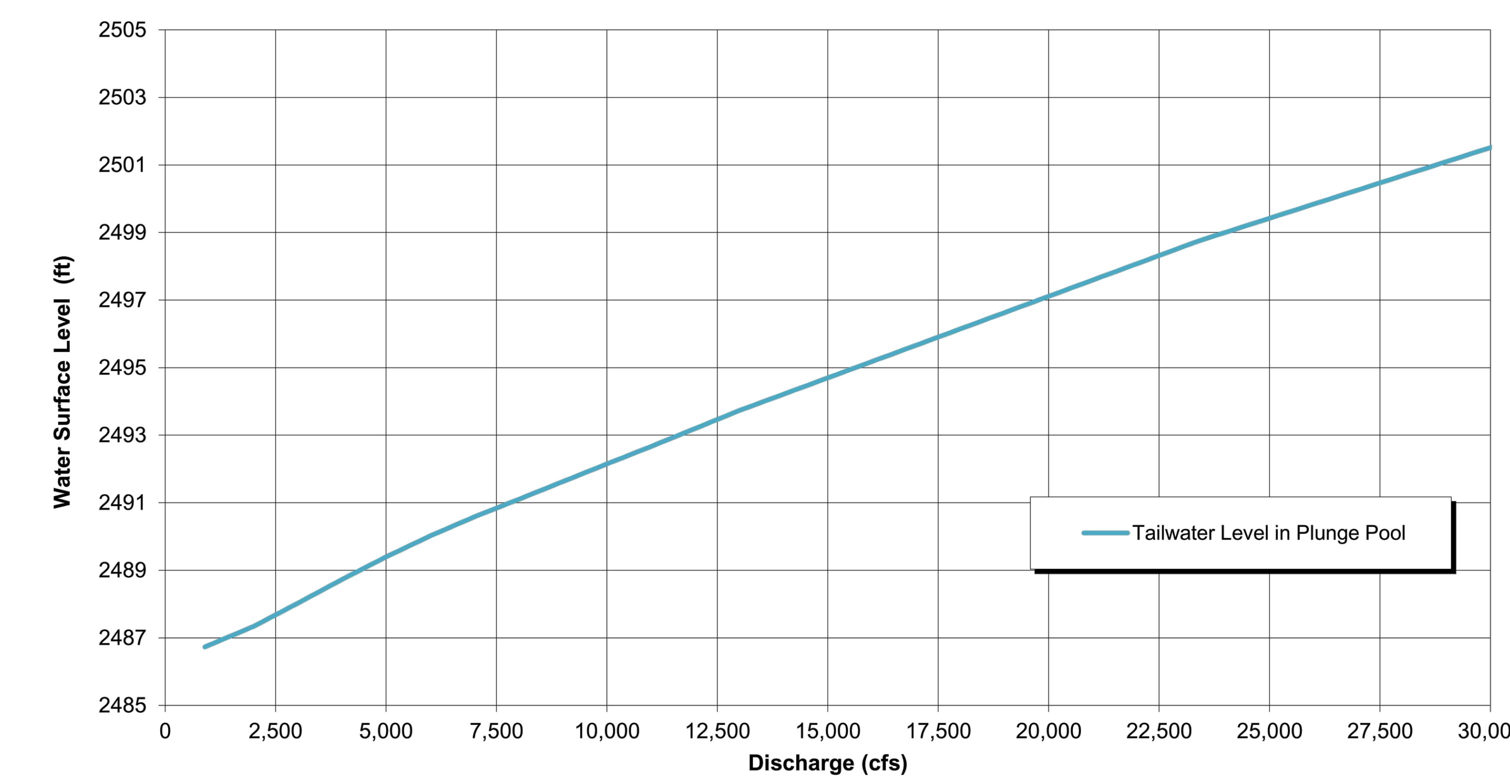

FIGURE 3 – TAILWATER SURFACE ELEVATIONS – VARIOUS FLOWS

NOT TO SCALE

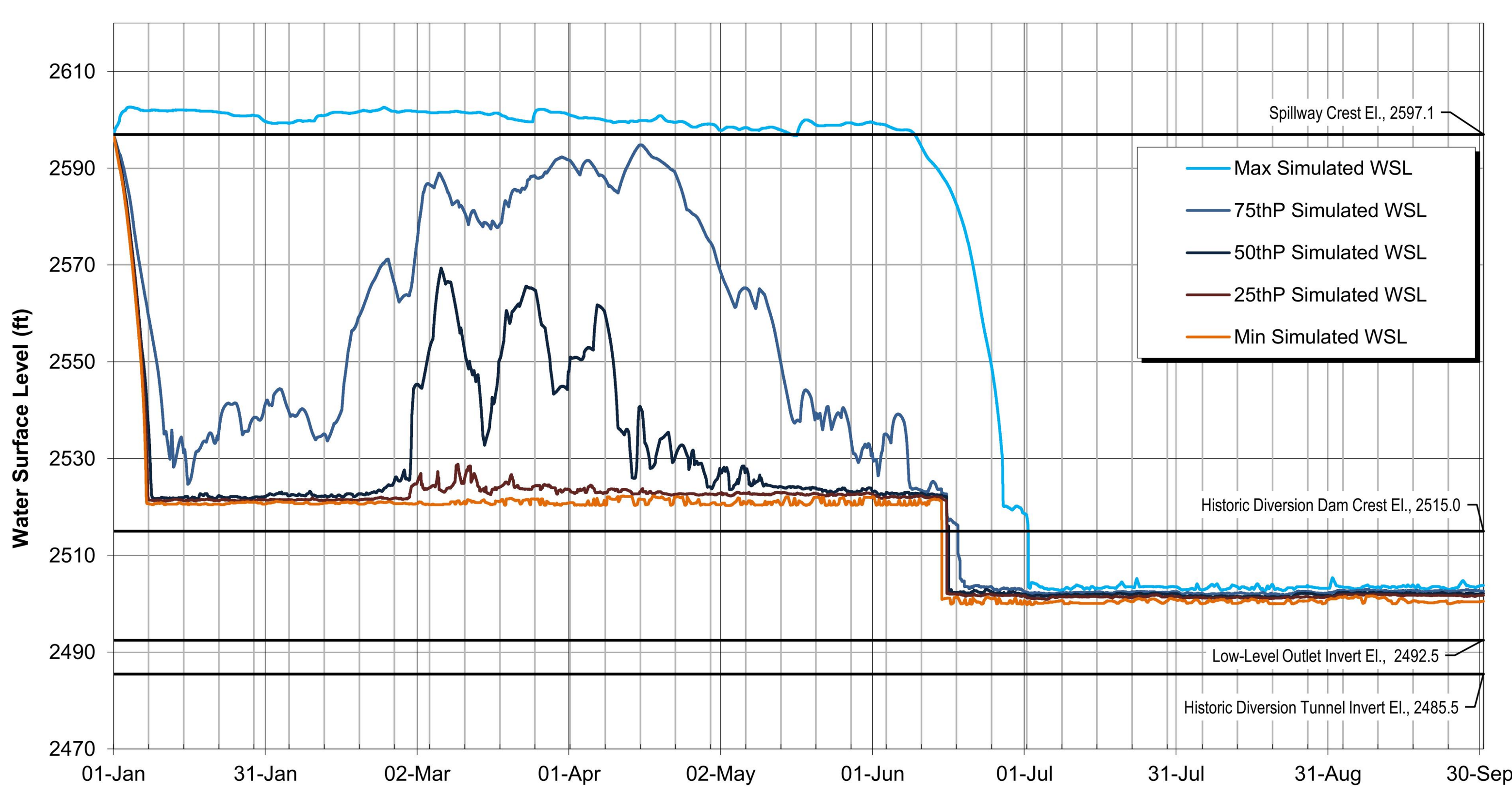

FIGURE 4 – SIMULATED DRAWDOWN – RESERVOIR WATER SURFACE LEVELS – PERCENTILES

NOT TO SCALE

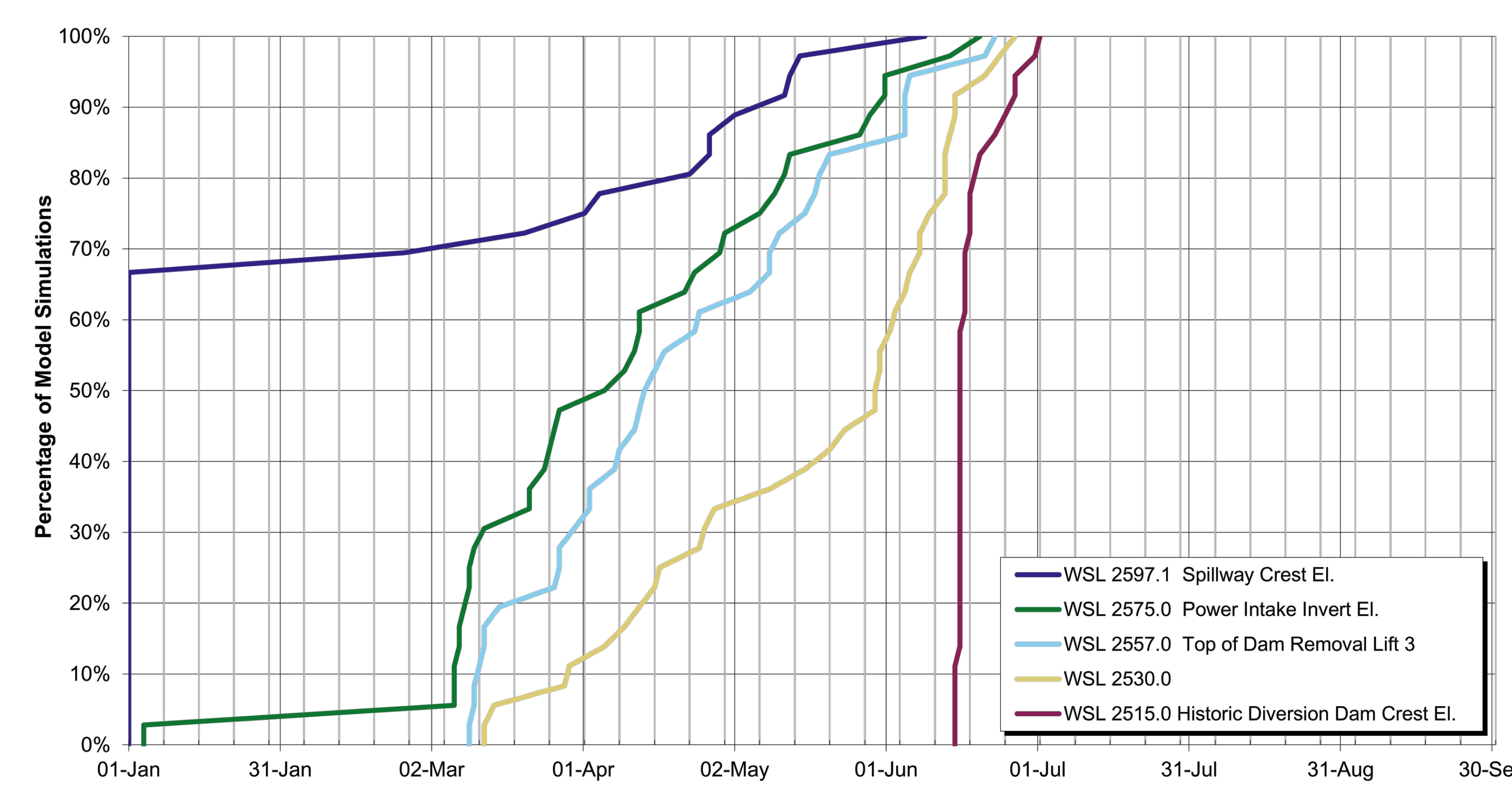

FIGURE 5 – RESERVOIR DRAWDOWN DISTRIBUTION BY DATE

NOT TO SCALE

NOTES:

1. FOR RESERVOIR DRAWDOWN OPERATIONS NOTES SEE DRAWING C2055.
2. RESERVOIR STORAGE AREA CAPACITY CURVE (FIGURE 1) IS BASED ON THE 2018 BATHYMETRIC SURVEY.
3. DISCHARGE CAPACITY OF THE SPILLWAY, LOW–LEVEL OUTLET, AND HISTORIC DIVERSION TUNNEL ON FIGURE 2 ARE FOR FREE DISCHARGE CONDITIONS. THE DISCHARGE CAPACITY FOR THE SPILLWAY IS FOR ALL 13 TAINTER (RADIAL) SPILLWAY GATES FULLY OPENED.
4. DISCHARGE RATING CURVES ON FIGURE 2 ARE FOR WATER LEVELS IMMEDIATELY UPSTREAM OF THE INTAKE STRUCTURE.
5. WATER SURFACE LEVELS ON FIGURE 3 ARE FOR TAILWATER LEVELS AT THE EXISTING PLUNGE POOL FOR VARIOUS FLOWS.
6. RESERVOIR WATER LEVELS SHOWN IN FIGURE 4 ARE THE SIMULATED RESERVOIR WATER SURFACE LEVEL PERCENTILES IMMEDIATELY UPSTREAM OF THE DAM USING THE DRAWDOWN MODEL. THE PERCENTILES ARE CALCULATED BASED ON THE ENTIRE 36 YEAR RECORD OF 2019 JOINT BIOLOGICAL OPINION FLOWS FOR THE USBR'S KLAMATH PROJECT. THE RESERVOIR WATER LEVELS ARE SIMULATED USING THE RESERVOIR DRAWDOWN OPERATIONS ON DRAWING C2055. WATER LEVELS CAN BE OUTSIDE OF THESE VALUES DEPENDING ON THE HYDROLOGICAL CONDITIONS DURING THE DRAWDOWN YEAR.
7. RESERVOIR DRAWDOWN DISTRIBUTIONS BY DATE FOR VARIOUS ELEVATIONS SHOWN ON FIGURE 5 ARE BASED ON THE SIMULATED RESERVOIR WATER SURFACE LEVEL USING THE DRAWDOWN MODEL FOR THE ENTIRE 36 YEAR RECORD OF 2019 JOINT BIOLOGICAL OPINION FLOWS FOR THE USBR'S KLAMATH PROJECT. THE ACTUAL DATE A WATER SURFACE LEVEL IS SUSTAINED AT A CERTAIN ELEVATION CAN BE DIFFERENT THAN SHOWN DEPENDING ON THE HYDROLOGICAL CONDITIONS DURING THE DRAWDOWN YEAR AND THE DRAWDOWN SEQUENCING SHOWN ON DRAWING C2055.

FOR INFORMATION ONLY

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C	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/09/20
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A	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20

WARNING
0 1/2 1
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PREPARED BY
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DRAWN	A. TSENG
REVIEWED	H. ELWIN
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
HYDROLOGIC AND HYDRAULIC INFORMATION
FIGURES

PROJ #	VA103-640/1
DATE	11/09/2020
DWG	C2056

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Flow Condition		Discharge (cfs), SEE NOTE 3																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	23,400	23,400	20,500	17,000	11,000	8,200	4,400	3,200	2,000	2,000	2,200	2,500	6,900	8,100	10,300	12,000	28,200
	5% Probable Flood	11,800	11,800	13,000	11,100	7,400	4,500	2,900	2,000	1,600	1,600	1,900	2,100	6,300	6,000	6,600	7,800	15,900
	20% Probable Flood	5,800	5,800	8,500	6,900	4,500	2,900	1,900	1,300	1,300	1,300	1,600	1,600	6,100	6,300	6,400	6,300	8,000
	50% Probable Flood	3,000	3,000	6,500	4,600	2,900	1,900	1,400	1,100	1,200	1,200	1,300	1,300	5,200	5,200	5,600	5,900	6,400
Monthly Flow Duration 25% of Time Equaled or Exceeded		2,280	2,920	4,430	3,920	2,700	1,840	1,230	1,080	1,060	1,050	1,100	1,110	1,100	1,190	1,260	1,080	1,600
Mean Monthly Flow		1,910	2,360	3,230	2,790	2,110	1,620	1,210	990	990	980	1,030	1,030	1,050	1,140	1,230	1,240	1,490
Monthly Flow Duration 75% of Time Equaled or Exceeded		900	940	1,630	1,410	1,290	1,080	970	860	870	850	940	940	960	990	1,040	940	900
Flow Condition		Reservoir Water Surface Levels (ft) - Drawdown Phase (Low-Level Outlet Open), SEE NOTES 4 AND 5																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	2606.5	2606.5	2605.6	2604.4	2602.1	2600.7	2597.9	2563.6	2524.9	2524.9	2529.6	2538.5	2599.9	2600.6	2601.7	2602.5	2607.9
	5% Probable Flood	2602.4	2602.4	2602.9	2602.1	2600.2	2598.0	2552.2	2524.9	2523.9	2523.9	2524.7	2526.8	2599.5	2599.3	2599.7	2600.5	2604.0
	20% Probable Flood	2599.2	2599.2	2600.8	2599.9	2598.0	2552.2	2524.7	2523.1	2523.1	2523.1	2523.9	2523.9	2599.4	2599.5	2599.6	2599.5	2600.6
	50% Probable Flood	2555.8	2555.8	2599.7	2598.1	2552.2	2524.7	2523.3	2522.5	2522.8	2522.8	2523.1	2523.1	2598.7	2598.7	2599.0	2599.3	2599.6
Monthly Flow Duration 25% of Time Equaled or Exceeded		2531.9	2552.9	2597.9	2595.2	2545.1	2524.5	2522.9	2522.4	2522.4	2522.4	2522.5	2522.5	2522.5	2522.8	2523.0	2522.4	2523.9
Mean Monthly Flow		2524.7	2534.2	2564.8	2548.2	2527.1	2523.9	2522.8	2522.2	2522.2	2522.1	2522.3	2522.3	2522.4	2522.6	2522.9	2522.9	2523.6
Monthly Flow Duration 75% of Time Equaled or Exceeded		2521.9	2522.0	2523.9	2523.4	2523.1	2522.4	2522.1	2521.7	2521.8	2521.7	2522.0	2522.0	2522.1	2522.2	2522.3	2522.0	2521.9
Flow Condition		Reservoir Water Surface Levels (ft) - Post-Drawdown Phase (Low-Level Outlet and Historic Diversion Tunnel Open), SEE NOTE 6																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	[redacted]						2515.6	2511.7	2507.1	2507.1	2508.0	2509.1	2521.2	2523.6	2532.5	2543.0	2603.0
	5% Probable Flood							2510.6	2507.1	2505.4	2505.4	2506.7	2507.6	2519.8	2519.0	2520.5	2523.0	2572.9
	20% Probable Flood							2506.7	2504.1	2504.1	2504.1	2505.4	2505.4	2519.2	2519.8	2520.0	2519.8	2523.4
	50% Probable Flood							2504.5	2503.1	2503.6	2503.6	2504.1	2504.1	2517.7	2517.7	2518.4	2518.8	2520.0
Monthly Flow Duration 25% of Time Equaled or Exceeded								2503.8	2503.0	2502.9	2502.9	2503.1	2503.2	2503.1	2503.6	2503.9	2503.0	2505.4
Mean Monthly Flow								2503.7	2502.6	2502.6	2502.5	2502.8	2502.8	2502.9	2503.3	2503.8	2503.8	2505.0
Monthly Flow Duration 75% of Time Equaled or Exceeded								2502.4	2501.9	2501.9	2501.8	2502.3	2502.3	2502.4	2502.6	2502.8	2502.3	2502.1

TABLE 1 – MONTHLY INFLOWS AND STEADY-STATE WATER SURFACE LEVELS

Flow Condition		Discharge (cfs), SEE NOTE 7																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	23,400	23,400	20,500	17,000	11,000	8,200	4,400	3,200	2,000	2,000	2,200	2,500	4,300	5,100	6,600	7,800	22,600
	5% Probable Flood	11,800	11,800	13,000	11,100	7,400	4,500	2,900	2,000	1,600	1,600	1,900	2,100	2,900	3,300	4,100	4,900	10,700
	20% Probable Flood	5,800	5,800	8,500	6,900	4,500	2,900	1,900	1,300	1,300	1,300	1,600	1,600	2,000	2,200	2,500	3,000	5,000
	50% Probable Flood	3,000	3,000	6,500	4,600	2,900	1,900	1,400	1,100	1,200	1,200	1,300	1,300	1,500	1,500	1,700	1,900	2,500
Monthly Flow Duration 25% of Time Equaled or Exceeded		2,280	2,920	4,430	3,920	2,700	1,840	1,230	1,080	1,060	1,050	1,100	1,110	1,100	1,190	1,260	1,080	1,600
Mean Monthly Flow		1,910	2,360	3,230	2,790	2,110	1,620	1,210	990	990	980	1,030	1,030	1,050	1,140	1,230	1,240	1,490
Monthly Flow Duration 75% of Time Equaled or Exceeded		900	940	1,630	1,410	1,290	1,080	970	860	870	850	940	940	960	990	1,040	940	900
Flow Condition		Reservoir Water Surface Levels (ft) - Pre-Drawdown Phase, SEE NOTES 8 AND 9																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	2611.0	2611.0	2611.0	2611.0	2609.8	2604.3	2595.6	2592.5	2592.0	2592.0	2592.0	2592.0	2595.3	2597.3	2600.7	2603.4	2611.0
	5% Probable Flood	2611.0	2611.0	2611.0	2610.0	2602.5	2595.8	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.8	2594.9	2596.8	2609.3
	20% Probable Flood	2599.0	2599.0	2604.9	2601.4	2595.8	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2597.0
	50% Probable Flood	2592.0	2592.0	2600.5	2596.1	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0
Monthly Flow Duration 25% of Time Equaled or Exceeded		2592.0	2592.0	2595.6	2594.4	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0
Mean Monthly Flow		2592.0	2592.0	2592.6	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0
Monthly Flow Duration 75% of Time Equaled or Exceeded		2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0	2592.0
Flow Condition		Tailwater Surface Levels (ft) - Existing Plunge Pool [6], SEE NOTES 10																
		Jan	Feb	Mar	Apr	May	Jun 1 - 15	Jun 16 - 30	Jul 1 - 15	Jul 16 - 31	Aug	Sep 1-15	Sep 16-30	Oct 1-15	Oct 16-31	Nov 1-15	Nov 16-30	Dec
Statistical High Water (Flood Conditions)	1% Probable Flood	2498.8	2498.8	2497.4	2495.7	2492.7	2491.2	2489.0	2488.2	2487.3	2487.3	2487.5	2487.7	2488.9	2489.5	2490.4	2491.0	2498.4
	5% Probable Flood	2493.1	2493.1	2493.7	2492.7	2490.8	2489.1	2488.0	2487.3	2487.1	2487.1	2487.3	2487.4	2488.0	2488.2	2488.8	2489.3	2492.5
	20% Probable Flood	2489.9	2489.9	2491.4	2490.5	2489.1	2488.0	2487.3	2487.0	2487.0	2487.0	2487.1	2487.1	2487.3	2487.5	2487.7	2488.0	2489.4
	50% Probable Flood	2488.0	2488.0	2490.3	2489.1	2488.0	2487.3	2487.0	2486.8	2486.9	2486.9	2487.0	2487.0	2487.1	2487.1	2487.2	2487.3	2487.7
Monthly Flow Duration 25% of Time Equaled or Exceeded		2487.5	2488.0	2489.0	2488.7	2487.8	2487.2	2486.9	2486.8	2486.8	2486.8	2486.8	2486.8	2486.8	2486.9	2486.9	2486.8	2487.1
Mean Monthly Flow		2487.3	2487.6	2488.2	2487.9	2487.4	2487.1	2486.9	2486.8	2486.8	2486.8	2486.8	2486.8	2486.8	2486.9	2486.9	2486.9	2487.1
Monthly Flow Duration 75% of Time Equaled or Exceeded		2486.7	2486.8	2487.1	2487.0	2486.9	2486.8	2486.8	2482.2	2482.2	2482.2	2486.8	2486.8	2486.8	2486.8	2486.8	2486.8	2486.7

TABLE 2 – PRE-DRAWDOWN MONTHLY INFLOWS AND STEADY-STATE WATER SURFACE LEVELS

NOTES:

1. WATER SURFACE LEVELS IN TABLE 1 CORRESPOND TO THE WATER LEVELS IMMEDIATELY UPSTREAM OF THE DAM.
2. RESERVOIR WATER SURFACE LEVELS ARE DETERMINED USING THE STEADY-STATE INFLOWS SHOWN IN TABLE 1 AND THE DISCHARGE RATING CURVES ON FIGURE 2 ON DRAWING C2056.
3. THE PROBABLE FLOOD DISCHARGES SHOWN IN TABLE 1 ASSUME THAT THE J.C. BOYLE FACILITY PROVIDES FLOW ATTENUATION FROM JANUARY TO JUNE 15TH. ONCE RIVER DIVERSION HAS BEEN ACHIEVED AT J.C. BOYLE THE FLOOD FLOWS WILL NO LONGER BE ATTENUATED. NO FLOW ATTENUATION IS ASSUMED FOR THE PROBABLE FLOOD DISCHARGES IN TABLE 1 BETWEEN JUNE 16TH AND DECEMBER.
4. SHADED VALUES IN TABLE 1 REPRESENT WATER SURFACE LEVELS WITH SPILLWAY FLOW. (13 TAINTER (RADIAL) GATES FULLY OPEN)
5. RESERVOIR WATER SURFACE LEVELS DO NOT INCLUDE THE RECOMMENDED 3 ft FREEBOARD.
6. WATER SURFACE LEVELS HIGHER THAN ELEVATION 2515 ft REQUIRE THE DIVERSION TUNNEL AND THE LOW-LEVEL OUTLET TO BE FULLY OPEN TO MAINTAIN THE STATED WATER LEVELS.
7. THE PROBABLE FLOOD DISCHARGES SHOWN IN TABLE 2 ASSUME THAT THE J.C. BOYLE FACILITY PROVIDES FLOW ATTENUATION IN ALL MONTHS.
8. FOR WATER SURFACE LEVELS INDICATED AS 2611 ft, THE SPILLWAY GATES NEED TO BE OPEN TO MAINTAIN THE STATED WATER LEVEL.
9. SPILLWAY FLOWS IN TABLE 2 THAT ARE LESS THAN OR EQUAL TO 3000 cfs ARE DIVERTED THROUGH THE POWER INTAKE AND THE RESERVOIR WATER SURFACE LEVEL IS KEPT STEADY AT 2596 ft.
10. TAILWATER SURFACE LEVELS IN TABLE 2 CORRESPOND TO THE WATER LEVELS IN THE PLUNGE POOL AND ARE DETERMINED USING THE STEADY-STATE INFLOWS SHOWN IN TABLE 2 AND THE DISCHARGE RATING CURVE ON FIGURE 3 ON DRAWING C2056.

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
C	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/09/20
B	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
A	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

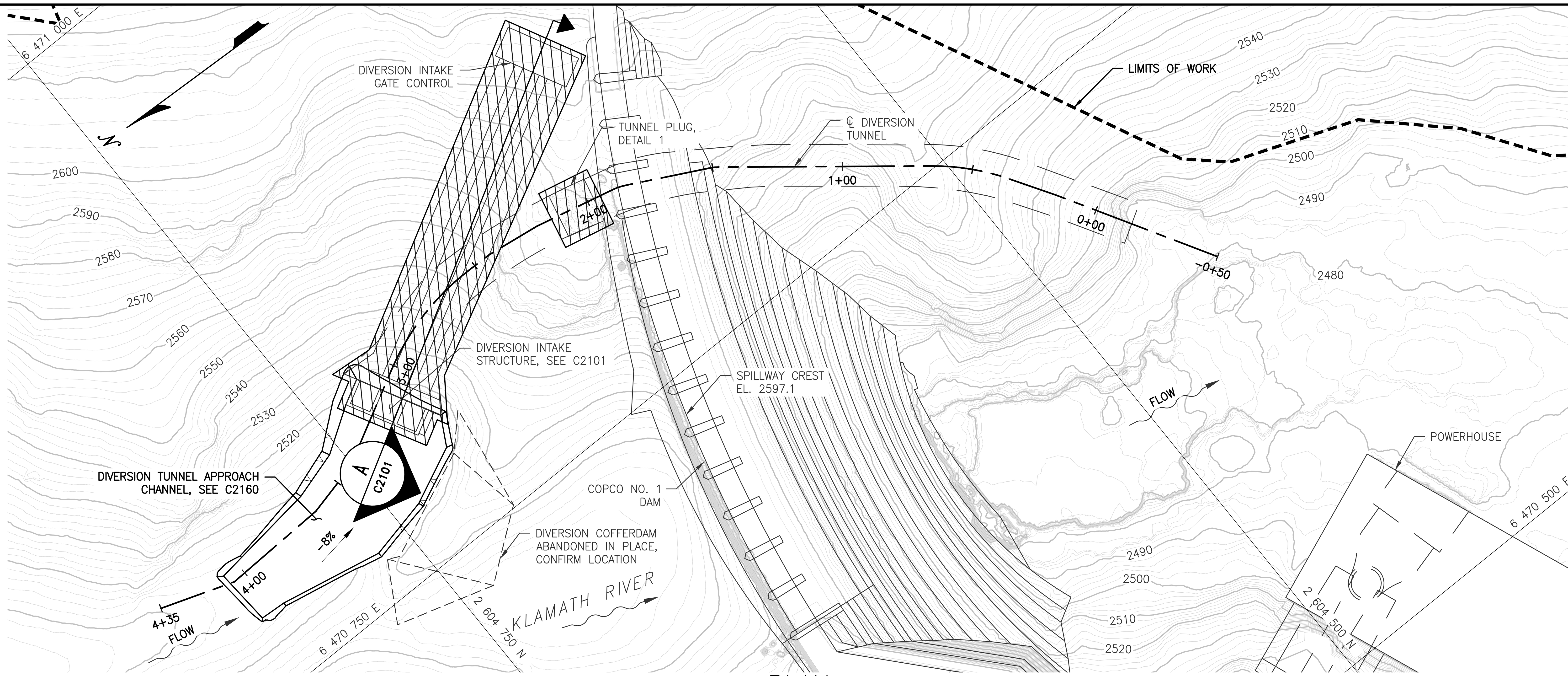
DESIGNED B. OTIS
DRAWN A. TSENG
REVIEWED H. ELWIN
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

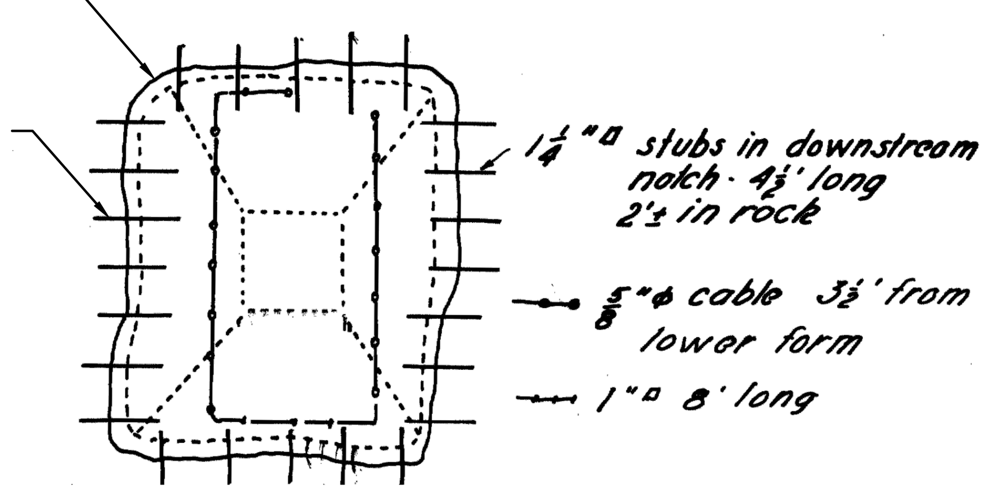
SHEET TITLE
COPCO NO. 1 FACILITY
HYDROLOGIC AND HYDRAULIC INFORMATION
TABLES

PROJ # VA103-640/1
DATE 11/09/2020
DWG C2057



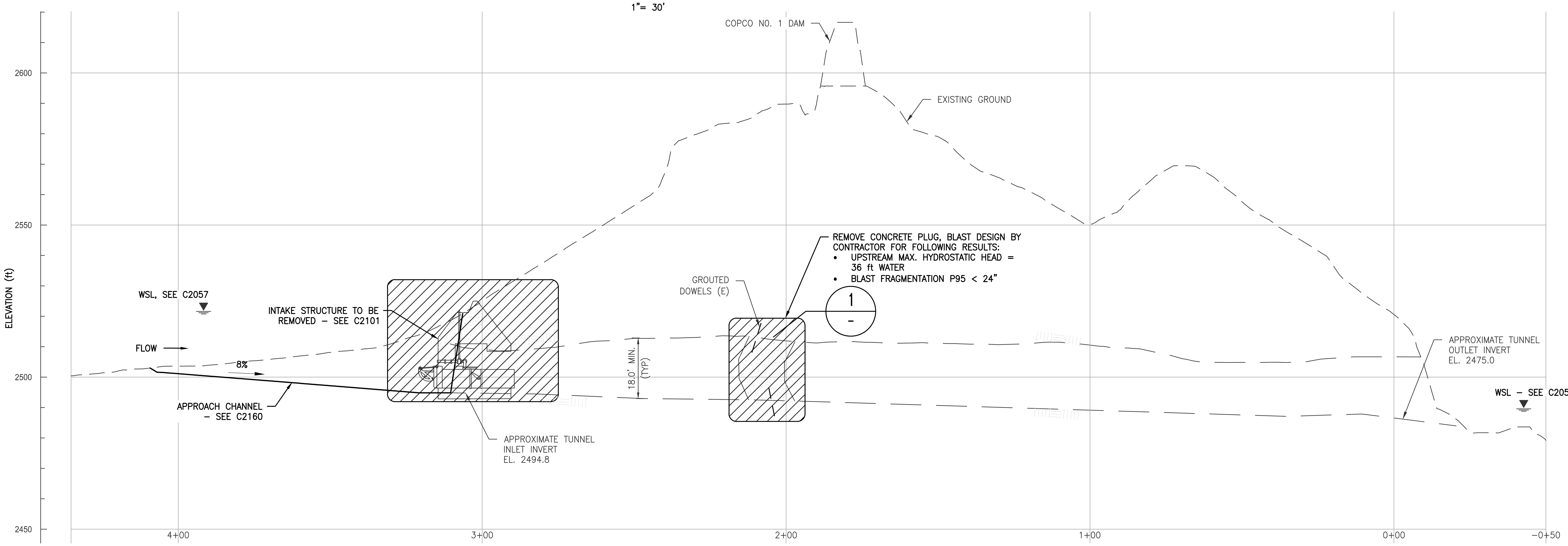
PLAN

1"= 30'



1 DETAIL

1"= 10'



PROFILE TUNNEL PROFILE

1"= 20'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. LINES AND GRADES OF THE DIVERSION TUNNEL ARE INTERPRETED FROM THE HISTORIC DRAWINGS AND ARE THEREFORE APPROXIMATE. CONTRACTOR TO CONFIRM ALL EXISTING STRUCTURES.
3. REQUIREMENTS FOR REMOVAL OF TUNNEL PLUG:
   - 3.1. INTAKE STRUCTURE IS REMOVED TO ELEVATION 2505.8 ft AT MINIMUM AND APPROACH CHANNEL IS CLEARED OF DEBRIS.
   - 3.2. TUNNEL PLUG IS REMOVED AFTER RESERVOIR WATER SURFACE HAS BEEN DRAWN DOWN AT OR BELOW ELEVATION 2530 ft.
   - 3.3. REMOVE REMAINDER OF INTAKE STRUCTURE TO FULLY OPEN THE DIVERSION TUNNEL ONCE RESERVOIR LEVELS ARE LOWERED.
4. TUNNEL PLUG SHOWN AS PER HISTORIC DRAWING F-1439.
5. DIVERSION COFFERDAM CREST ELEVATION IS INTERPRETED FROM THE BATHYMETRIC SURVEY AND IS THEREFORE APPROXIMATE. CONFIRM THE CONDITION AND CREST ELEVATION OF THE COFFERDAM ONCE RESERVOIR IS DRAWN DOWN. WHEN DIVERSION TUNNEL IS FULLY OPENED, HYDRAULIC CONTROL WILL BE THE DIVERSION COFFERDAM FOR ALL INFLOWS LESS THAN 3,700 cfs, EQUIVALENT TO WATER SURFACE ELEVATION OF 2515 ft.

LEGEND:

DEMOLITION / REMOVAL

FOR INFORMATION ONLY

0 30 60 90 — 1" = 30'

0 20 40 60 — 1" = 20'

0 10 20 30 — 1" = 10'

REV	DESCRIPTION	BY	CHK	APP	DATE
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/09/20
D	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
A	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED B. OTIS
DRAWN R. PENG
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APPROVED S. MOTTRAM

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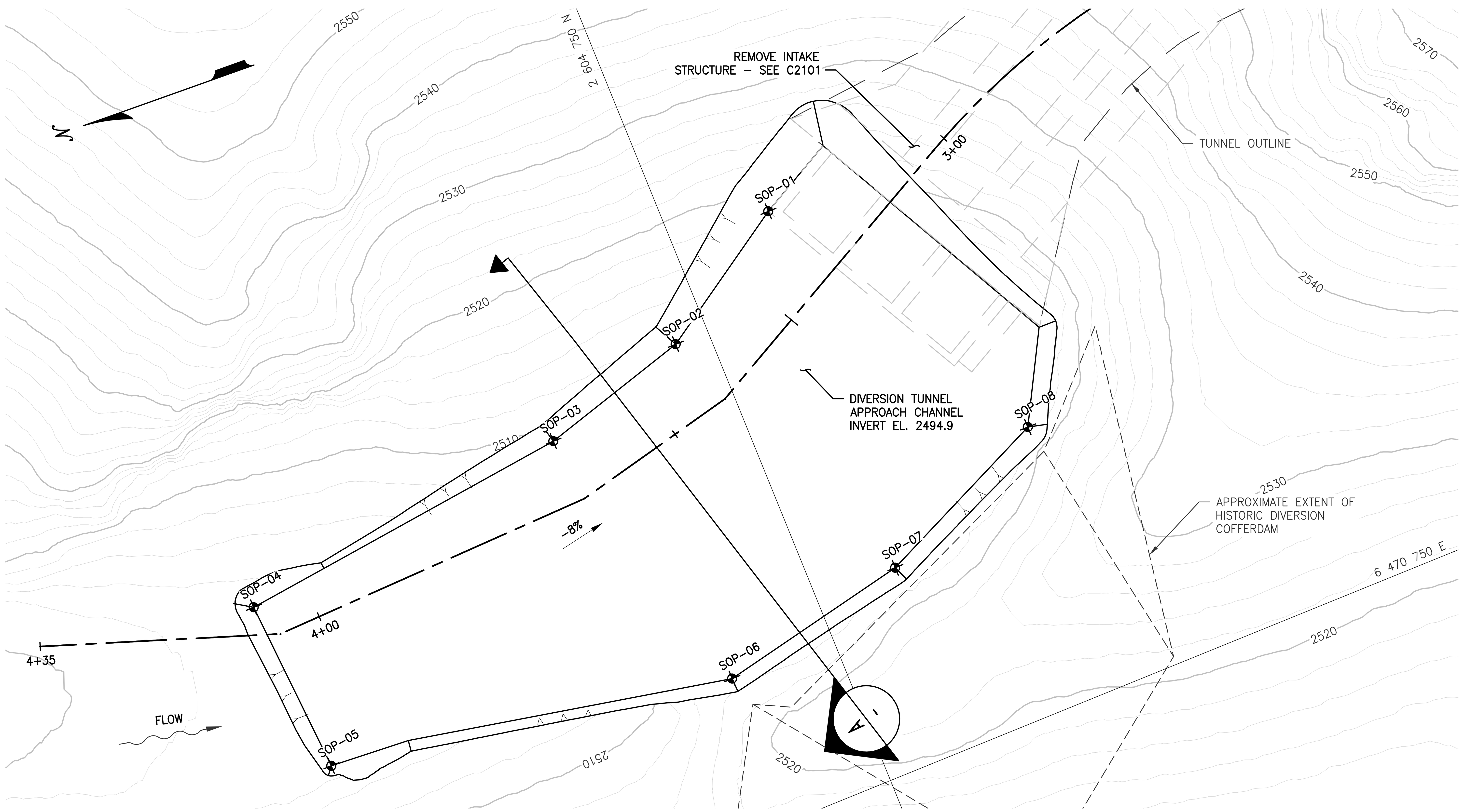
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

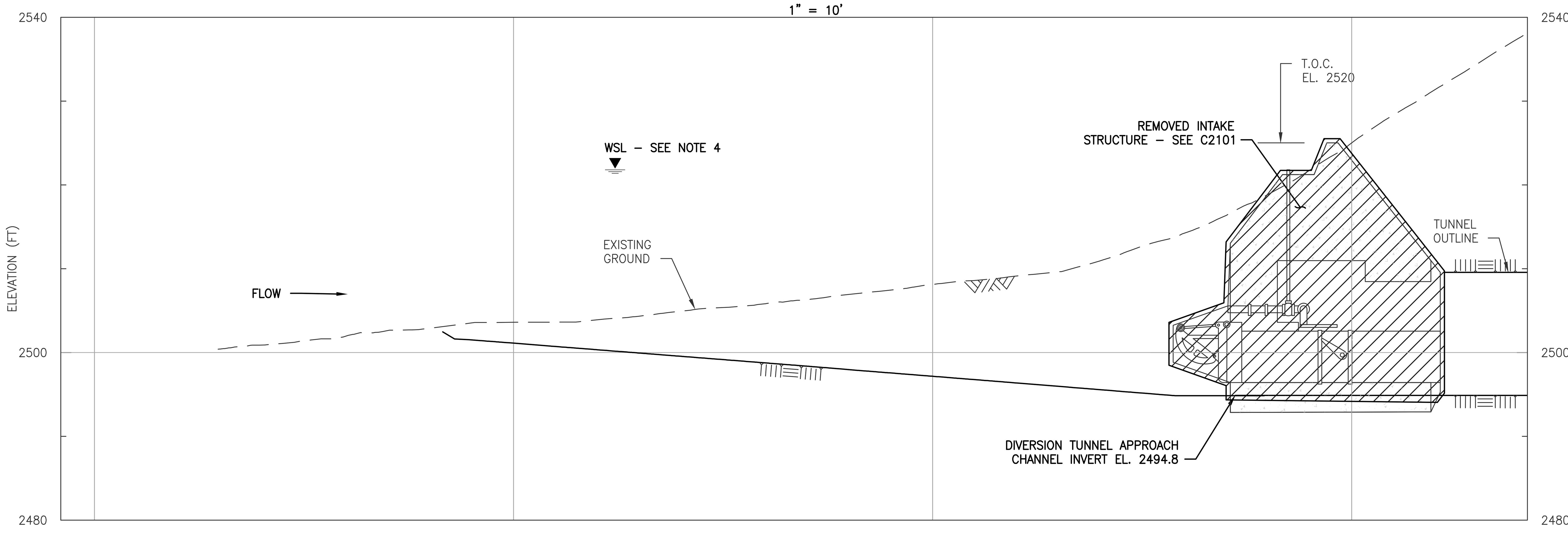
SHEET TITLE
COPCO NO. 1 FACILITY
DIVERSION TUNNEL MODIFICATIONS
PLAN AND PROFILE

PROJ # VA103-640/1
DATE 11/09/2020
DWG C2100



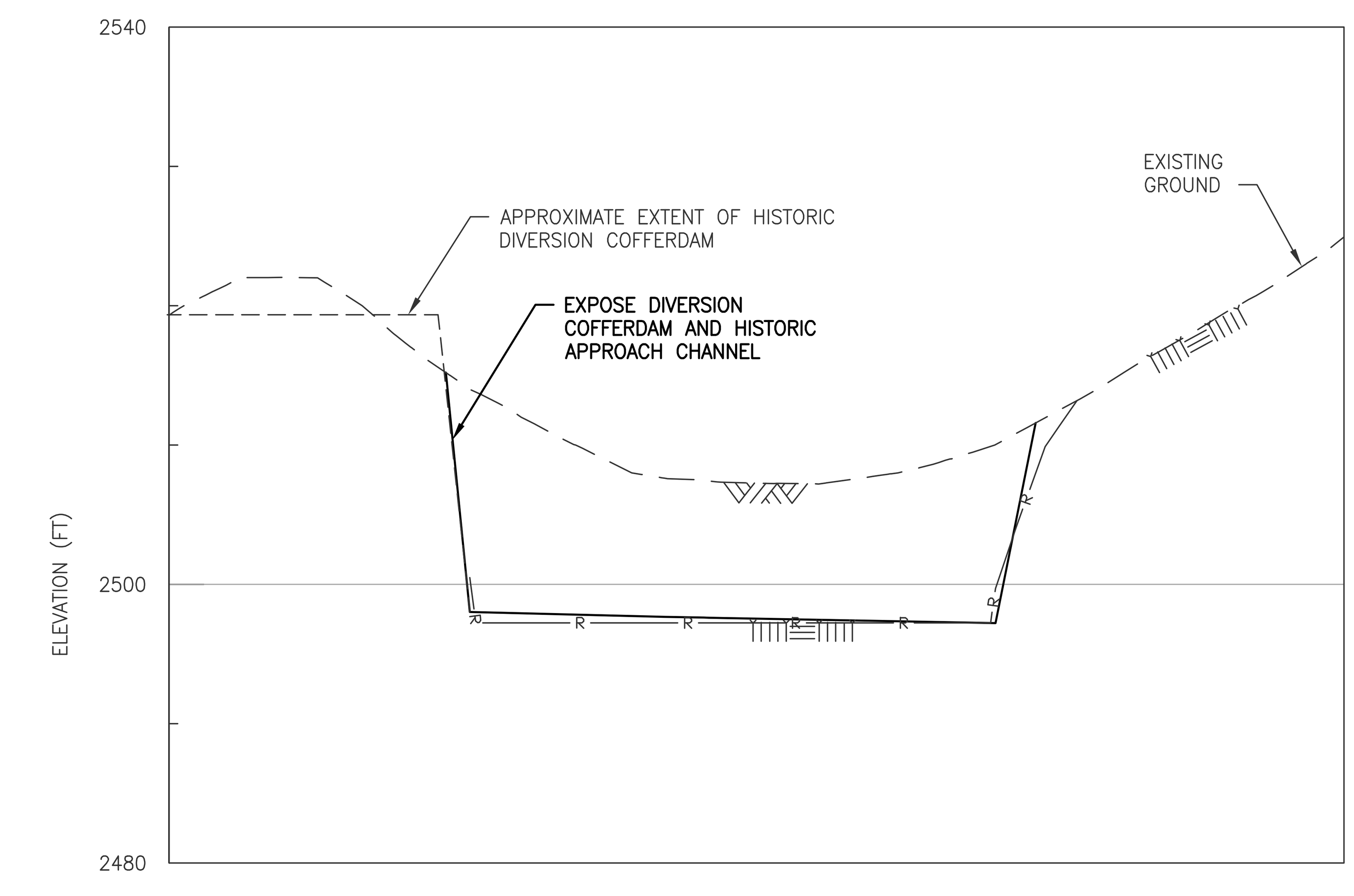
PLAN

1" = 10'



PROFILE

1" = 10'



A SECTION

1" = 10'

WORK POINTS TABLE			
WORK POINTS	EASTING	NORTHING	ELEVATION
SOP-01	6470821.427	2604737.376	2494.850
SOP-02	6470810.435	2604754.308	2496.465
SOP-03	6470804.989	2604772.966	2498.020
SOP-04	6470799.870	2604815.334	2501.434
SOP-05	6470777.939	2604813.822	2502.514
SOP-06	6470769.204	2604763.479	2498.741
SOP-07	6470774.352	2604739.464	2496.776
SOP-08	6470784.362	2604717.573	2494.850

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. GROUND CONDITION AND ARRANGEMENT OF DIVERSION COFFERDAM ARE ASSUMED BASED ON THE HISTORIC PHOTOS AND BATHYMETRY. BASED ON HISTORIC OPERATION OF THE DIVERSION TUNNEL THE APPROACH CHANNEL FOUNDATION MATERIAL IS ASSUMED TO BE RESISTANT TO EROSION FROM OPERATION BELOW UPSTREAM WATER LEVEL OF 2530 ft.
3. EXTENT OF EXCAVATION TO EXPOSE BEDROCK, WHERE BEDROCK IS ENCOUNTERED WITHIN THE FOOTPRINT OF APPROACH CHANNEL THE EXCAVATION SHALL BE TERMINATED.
4. WATER LEVEL UPSTREAM OF EXISTING DIVERSION COFFERDAM AS PER DRAWING C2057.
5. INSTALLATION OF A DEBRIS BOOM UPSTREAM OF THE DIVERSION TUNNEL INLET TO PREVENT DIVERSION TUNNEL BLOCKAGE TO BE EVALUATED ONCE RESERVOIR IS LOWERED. BOOM DESIGN AND LOCATION OF BOOM ANCHORS TO BE EVALUATED BY THE ENGINEER.
6. THE APPROACH CHANNEL EXCAVATION IS TO BE COMPLETED IN ADVANCE OF THE DIVERSION TUNNEL RE-OPENING.

LEGEND:

DEMOLITION / REMOVAL

ANTICIPATED BEDROCK

0 10 20 30

1" = 10'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
D	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	07/16/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
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REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
DIVERSION TUNNEL APPROACH CHANNEL EXCAVATION
PLAN, PROFILE AND SECTION

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2160

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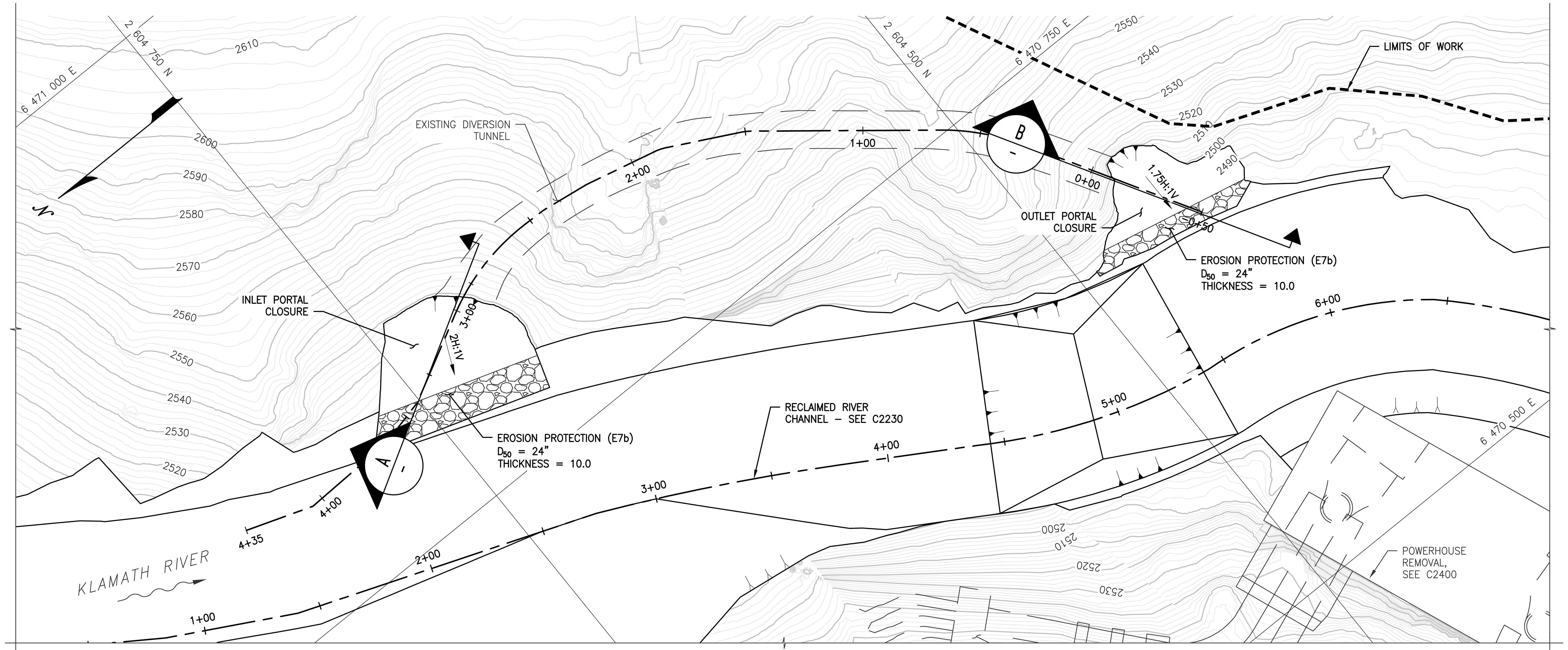


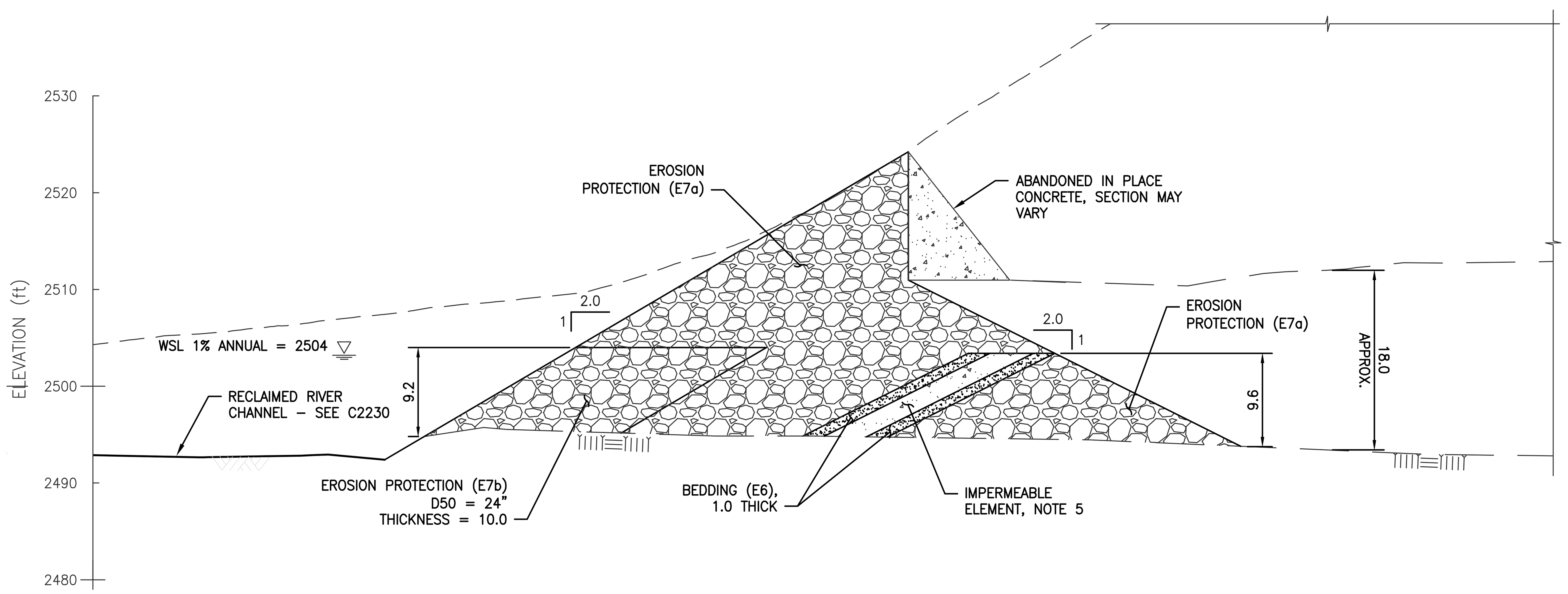
PLAN
1" = 30'

NOTES:

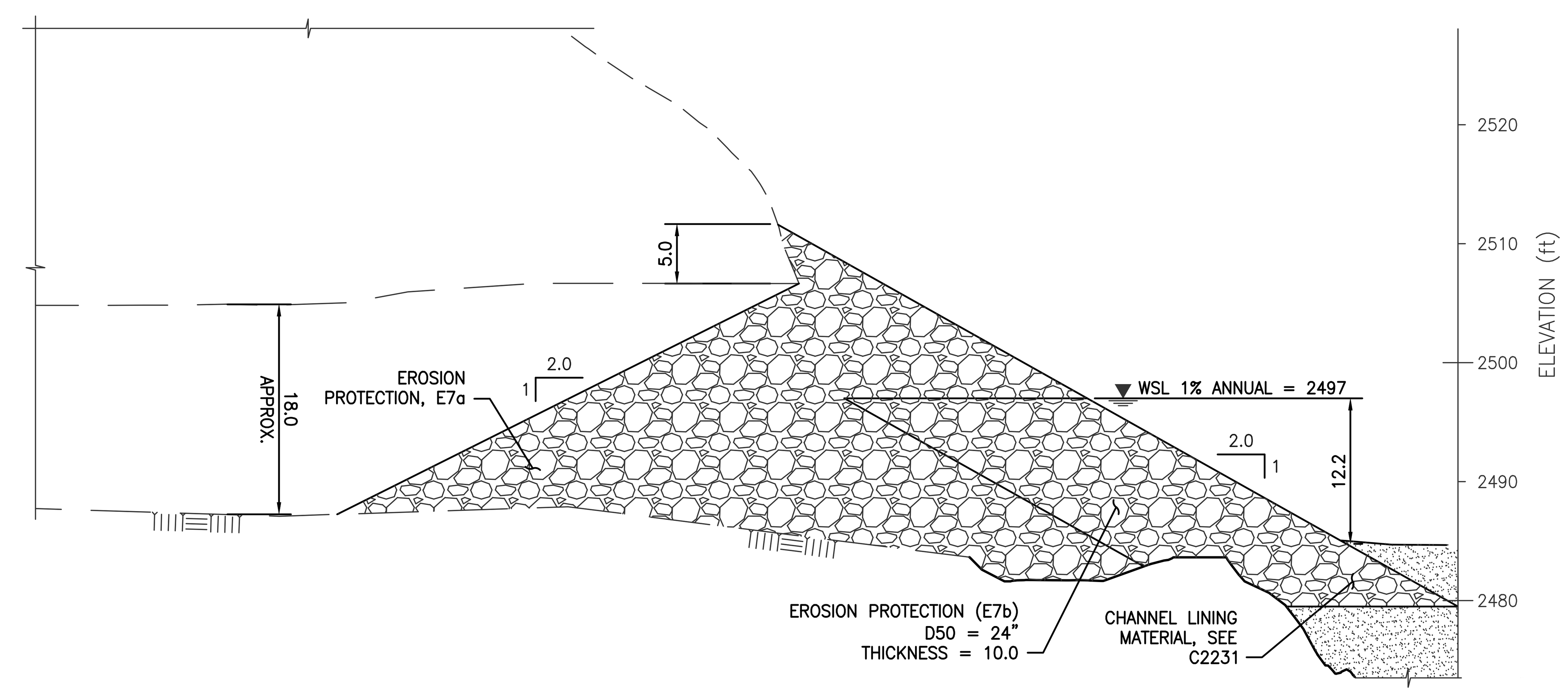
1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. THE PROFILE OF THE TUNNEL IS APPROXIMATE.
3. EROSION PROTECTION STONE SIZE TO MEET OR EXCEED THE INDICATED D50 DIMENSIONS/WEIGHT CLASS. STONE SIZE SPECIFIED ON THE STONE INTERMEDIATE DIMENSIONS (SECONDARY AXIS), I.E. EROSION PROTECTION SPECIFIED WITH A D50 OF 12 in WILL MEASURE NO LESS THAN 12 in ON THE SECOND AXIS OF THE STONE THREE PRIMARY AXIS, WITH 50 PERCENT OF THE EROSION PROTECTION GRADATION MEASURING NO SMALLER THAN THE SPECIFIED D50 STONE SIZE.
4. EROSION PROTECTION TO BE PLACED ON STABLE AND NON ERODIBLE FOUNDATION. DOWNSTREAM PORTAL CLOSURE TO ALLOW UNOBSTRUCTED DRAINAGE OF DIVERSION TUNNEL TO RIVER CHANNEL.
5. IMPERMEABLE ELEMENT TO PROVIDE HYDRAULIC CUTOFF FROM NORMAL RIVER WATER LEVEL AND EXTEND TO THE 1% ANNUAL FLOOD WATER LEVEL. MATERIAL TO BE PLACED ON CLEANED AND SUITABLE FOUNDATION SURFACE.
   - 5.1. PRE-MIXED CONCRETE BAG LINING IS ACCEPTABLE.
   - 5.2. ALTERNATIVE IMPERMEABLE MEMBRANE MAY BE ACCEPTABLE, SUBMIT FOR REVIEW AND APPROVAL BY THE ENGINEER.
   - 5.2. ALTERNATIVE PORTAL CLOSURE ARRANGEMENT INCLUDING REINFORCED CONCRETE CUTOFF MAY BE ACCEPTABLE, SUBMIT FOR REVIEW AND APPROVAL BY THE ENGINEER.
   - 5.3. LOCATION OF IMPERMEABLE ELEMENT TO BE SELECTED IN THE FIELD AFTER DRAWDOWN IS COMPLETED. SUITABLE INTERFACE WITH IMPERMEABLE ELEMENT AND GROUND SURFACE SHALL BE SELECTED TO PROVIDE ADEQUATE SURFACE FOR OVERLAP OF THE IMPERMEABLE ELEMENT.

LEGEND:

- LIMITS OF WORK
- GENERAL FILL (E9a)
- EROSION PROTECTION (E7a/E7b)
- BEDDING (E6)
- CONCRETE (E)



A SECTION – INLET PORTAL
1" = 10'



B SECTION – OUTLET PORTAL
1" = 10'

0 30 60 90
1" = 30'

0 10 20 30
1" = 10'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
D	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
A	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
DIVERSION TUNNEL PORTAL
PLAN AND SECTIONS

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2175

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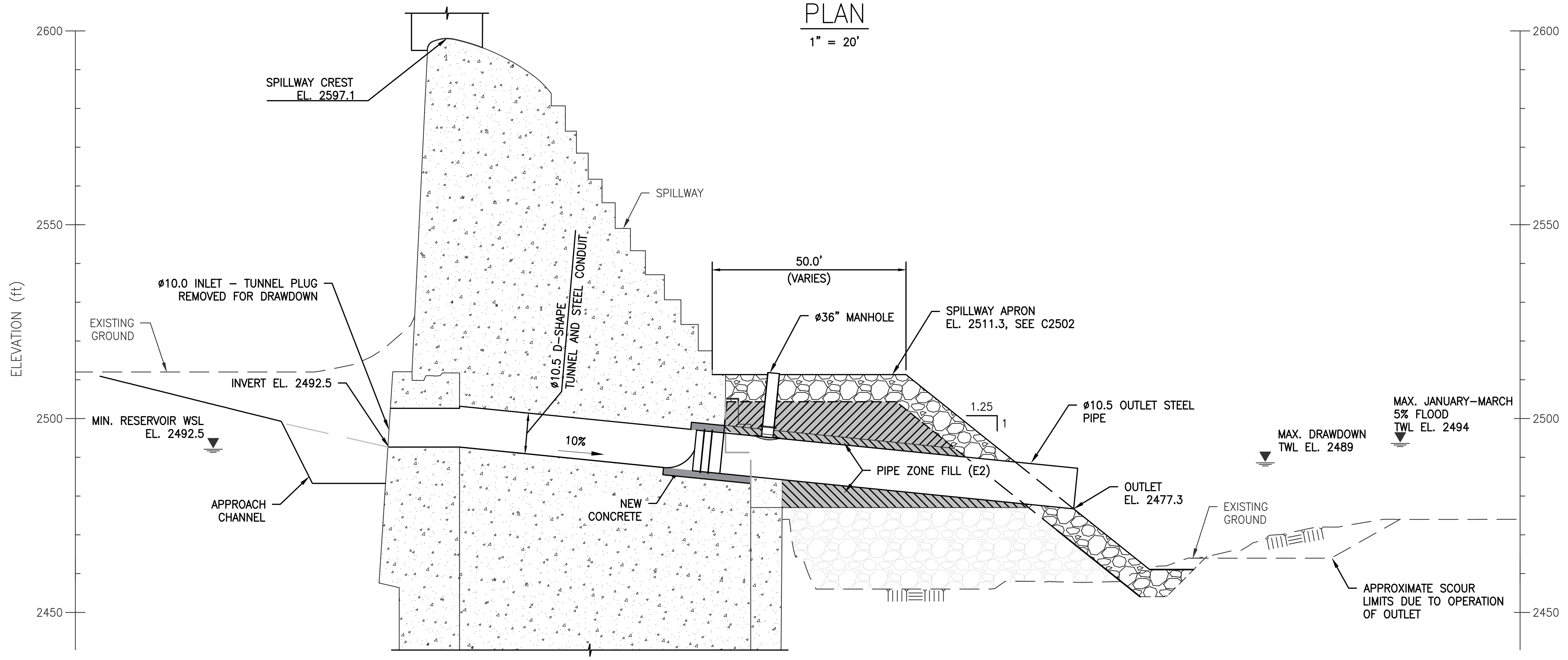
PLAN
1" = 20'



A SECTION
1" = 20'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. THIS DRAWING SHOWS THE COMPLETED ARRANGEMENT FOR THE RESERVOIR DRAWDOWN.
3. FOR WATER LEVEL DURING PRE-RESERVOIR DRAWDOWN AND AFTER DRAWDOWN AS PER DRAWING C2057.
4. FOR ACCESS TO THE SPILLWAY, DIVERSION TUNNEL AND LEFT RIVER BANK, REFER TO DRAWING C2500.
5. UPSTREAM SAFETY BOOM AND INTAKE DEBRIS BOOM TO BE REMOVED BEFORE DRAWDOWN IS INITIATED.

LEGEND:

- SELECT FILL (E4)
- PIPE ZONE (E2)
- EROSION PROTECTION (E7)
- EXISTING CONCRETE
- ROCKFILL

0 20 40 60
1" = 20'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
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PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
DRAWDOWN - GENERAL ARRANGEMENT
PLAN AND SECTION

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2205

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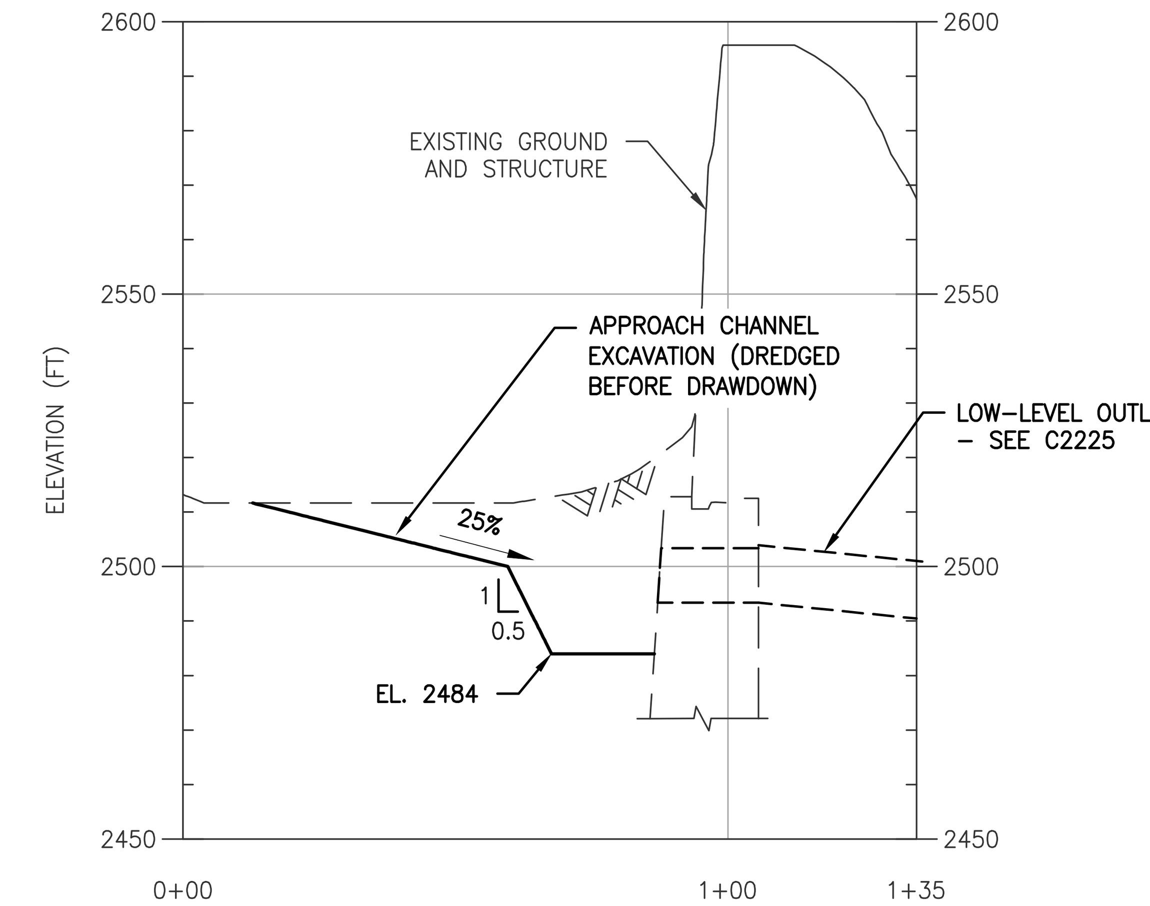
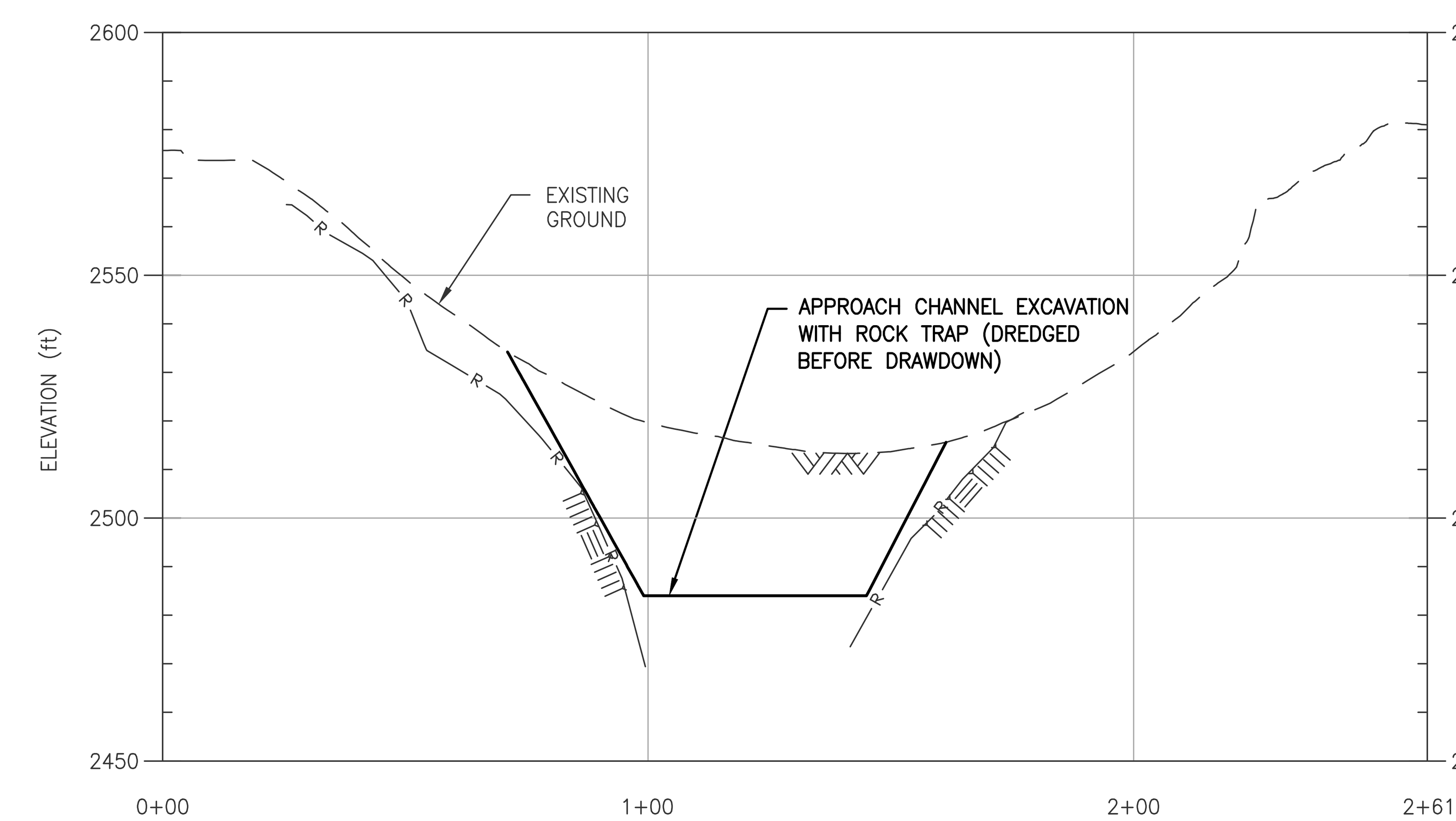
PLAN
1" = 30'



A SECTION
1" = 30'



B SECTION
1" = 30'

WORK POINTS TABLE

WORK POINTS	EASTING	NORTHING	ELEVATION
SOP-01	6470719.273	2604650.860	2484.000
SOP-02	6470720.611	2604673.161	2484.000
SOP-03	6470678.607	2604683.188	2484.000
SOP-04	6470665.320	2604662.504	2484.000
SOP-05	6470734.657	2604723.420	2511.647
SOP-06	6470698.694	2604732.021	2511.647

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. GROUND CONDITION AND ARRANGEMENT OF THE APPROACH CHANNEL ARE ASSUMED BASED ON THE HISTORIC PHOTOS AND INTERPOLATION OF THE BATHYMETRY. EXTENT OF EXCAVATION TO EXPOSE BEDROCK, WHERE BEDROCK IS ENCOUNTERED WITHIN THE FOOTPRINT OF THE APPROACH CHANNEL THE EXCAVATION SHALL BE TERMINATED.
3. THE APPROACH CHANNEL EXCAVATION IS TO BE COMPLETED IN ADVANCE OF THE LOW-LEVEL OUTLET OPENING.

LEGEND:

- LIMITS OF WORK
- ANTICIPATED BEDROCK
- WATER SURFACE LEVEL

FOR INFORMATION ONLY

0 30 60 90
1" = 30'

REV	DESCRIPTION	BY	CHK	APP	DATE
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
D	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	07/15/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED B. OTIS
DRAWN A. TSENG
REVIEWED S. YONG
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
PRE-DRAWDOWN WORKS - APPROACH CHANNEL EXCAVATION - PLAN AND SECTIONS

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2210

ppetkovic Nov 13, 2020 - 9:35am
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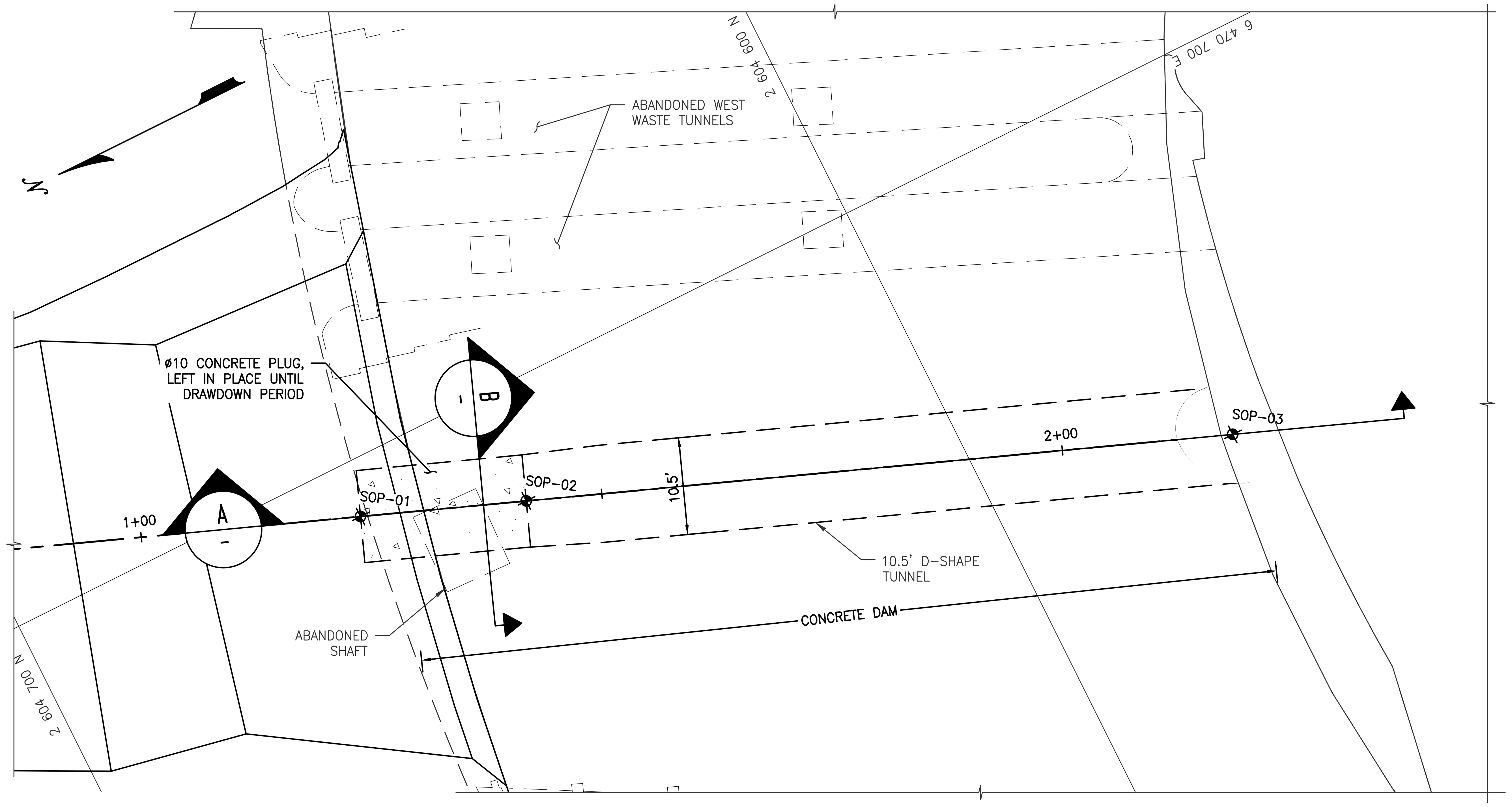
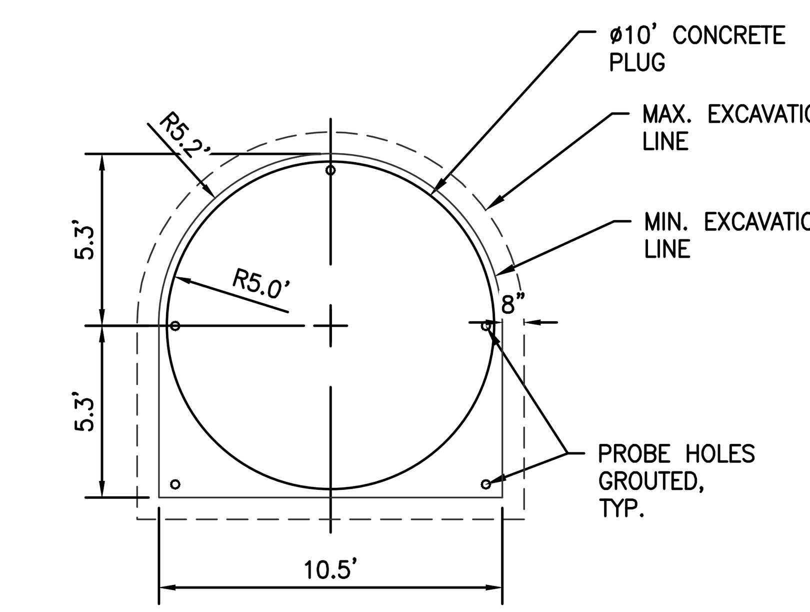


PLAN AT EL. 2512

1" = 10'



B SECTION

1" = 5'

WORK POINTS TABLE

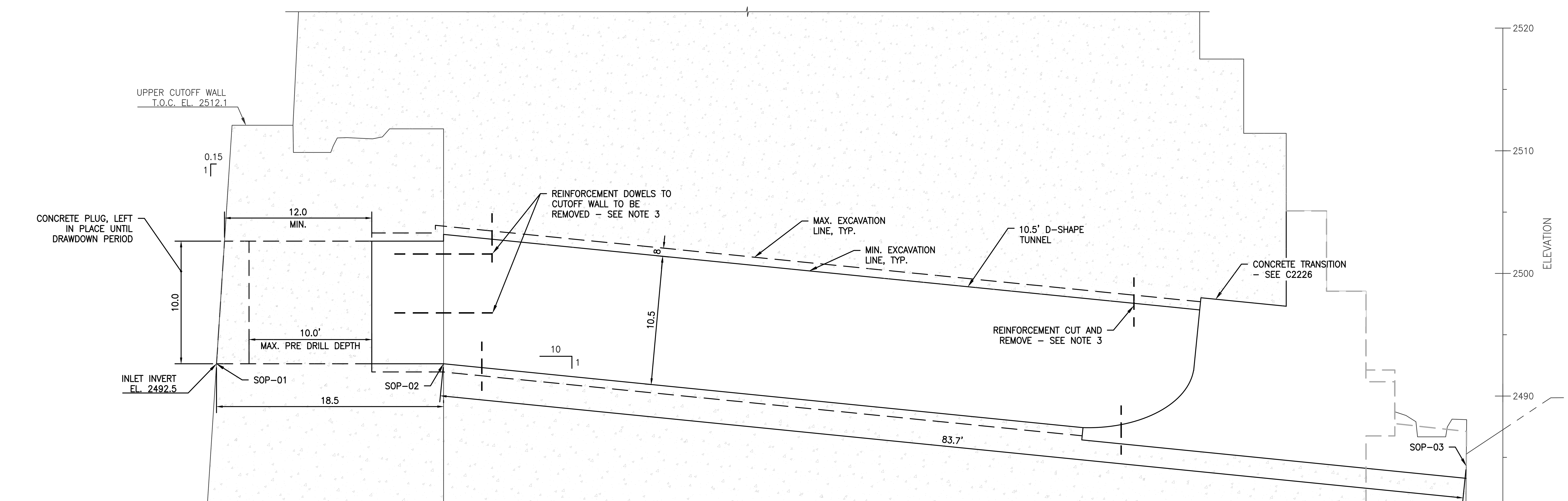
WORK POINTS	EASTING	NORTHING	ELEVATION
SOP-01	6470694.120	2604661.639	2497.630
SOP-02	6470687.629	2604644.850	2512.000
SOP-03	6470659.969	2604573.314	2497.630

NOTES:

1. CONCRETE PLUG DESIGNED FOR UPSTREAM WATER SURFACE ELEVATION OF 2607 ft.
2. CONTRACTOR TO CONFIRM THE DISTANCE TO THE UPSTREAM DAM FACE BY DRILLING PROBE HOLES ON EACH CORNERS AND SEALING THE PROBE HOLES WITH MECHANICAL PLUGS AND NON-SHRINK GROUT.
3. EXISTING REINFORCEMENT COMPRISES OF 30 lb RAIL SECTIONS, CONTRACTOR TO CUT AND REMOVE REINFORCEMENT WITHIN TUNNEL EXCAVATION. DRILL HORIZONTAL DOWELS AT UPPER CUT OFF WALL TO REMOVE BEFORE FINAL PLUG REMOVAL. RAIL SECTIONS MAY BE ENCOUNTERED AT ANY LOCATION ALONG THE EXCAVATION ALIGNMENT, DENSITY IS UNKNOWN.
4. PRE DRILL BLAST HOLES FOR DRY LAKE TAP PLUG REMOVAL (DESIGN BY CONTRACTOR) TO BE COMPLETED IN ADVANCED OF THE DRAW DOWN PERIOD.
5. REMOVE ALL LOOSE OR DETACHED CONCRETE FROM EXCAVATION SURFACE, ENGINEER DIRECTED SCALING OR ADDITIONAL SUPPORT (GROUTED DOWELS, ROCK BOLTS) MAY BE REQUIRED.
6. IT IS EXPECTED THAT DURING SCALING MATERIAL CAN BE REMOVED BEYOND THE MAXIMUM EXCAVATION LINE.

LEGEND:

EXISTING CONCRETE



A SECTION

1" = 5'

0 5 10 15
1" = 5'
0 10 20 30
1" = 10'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
D	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
A	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED B. OTIS
DRAWN A. TSENG
REVIEWED S. YONG
IN CHARGE N. BISHOP
APPROVED S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT
PROJ #: VA103-640/1
DATE: 11/13/2020
SHEET TITLE: COPCO NO. 1 FACILITY
PRE-DRAWDOWN WORKS - LOW-LEVEL OUTLET
TUNNEL EXCAVATION - PLAN AND SECTIONS
DWG: C2225

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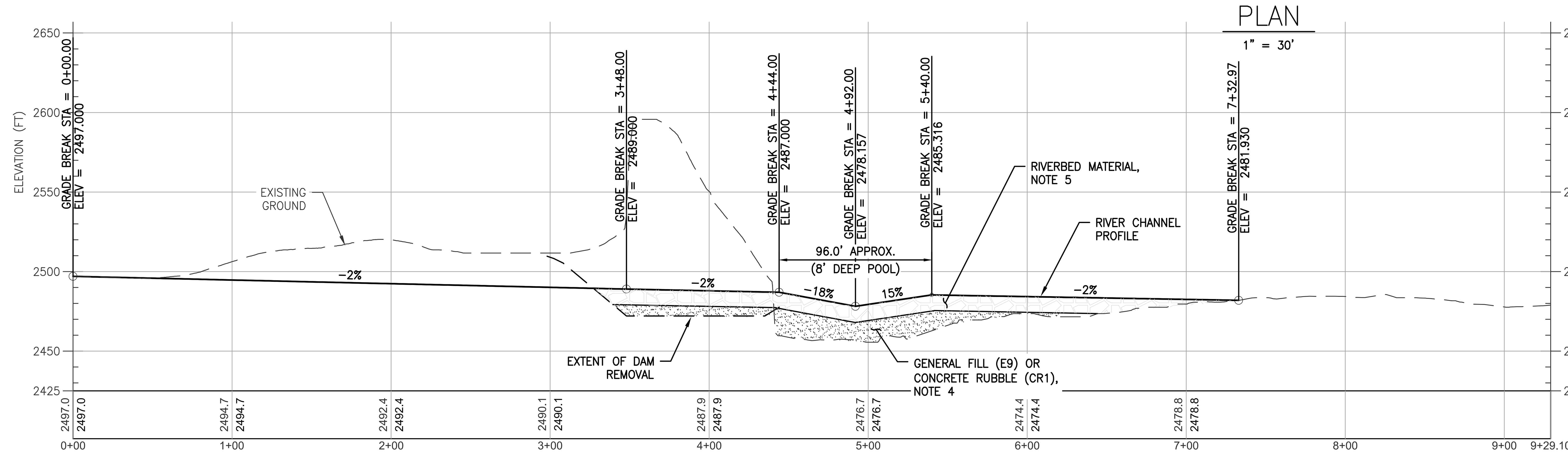
PLAN

1" = 30'



PROFILE

1" = 50'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. GROUND CONDITION AND ARRANGEMENT OF FINAL RIVER CHANNEL ARE ASSUMED BASED ON THE HISTORIC PHOTOS AND BATHYMETRY.
3. FINAL CHANNEL DESIGNED FOR THE POST DAM REMOVAL ANNUAL PEAK INSTANTANEOUS FLOOD WITH 1% CHANCE OF EXCEEDANCE = 32,700 cfs (KP REF. VA103-640/1-9). FLOW DEPTH WILL BE APPROXIMATELY 11 ft WITH FLOW VELOCITY OF APPROXIMATELY 25 ft/s.
4. ABANDONED IN PLACE CONCRETE OR CONCRETE RUBBLE FILL BELOW THE 1% ANNUAL FLOOD WATER LEVEL TO BE COVERED BY A 10 ft. THICK CAPPING LAYER OF RIVERBED MATERIAL.
5. MATERIAL STOCKPILED ON THE RIGHT BANK UPSTREAM OF THE COPCO NO. 1 DAM ORIGINATES FROM THE HISTORIC COPCO NO. 1 DAM EXCAVATION AND IS ASSUMED TO BE SUITABLE FOR DIRECT PLACEMENT AS RIVERBED MATERIAL. RIVERBED MATERIAL NOT SOURCED FROM THIS AREA MUST BE WELL GRADED MATERIAL WITH AN UPPER PARTICLE SIZE OF APPROXIMATELY 36 in, AND A 15% MAXIMUM OF MATERIAL SMALLER THAN 6 in (BY VOLUME).

LEGEND:

- LIMITS OF WORK
- EROSION PROTECTION MATERIAL (E7b)
- GENERAL FILL – (E9)
- RIVERBED MATERIAL

0 50 100 150
1" = 50'

0 30 60 90
1" = 30'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
E	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
D	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
C	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	07/15/20
B	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
Knight Piésold CONSULTING
Kiewit

DESIGNED	B. OTIS
DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
FINAL RIVER CHANNEL GRADING
PLAN AND PROFILE

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2230

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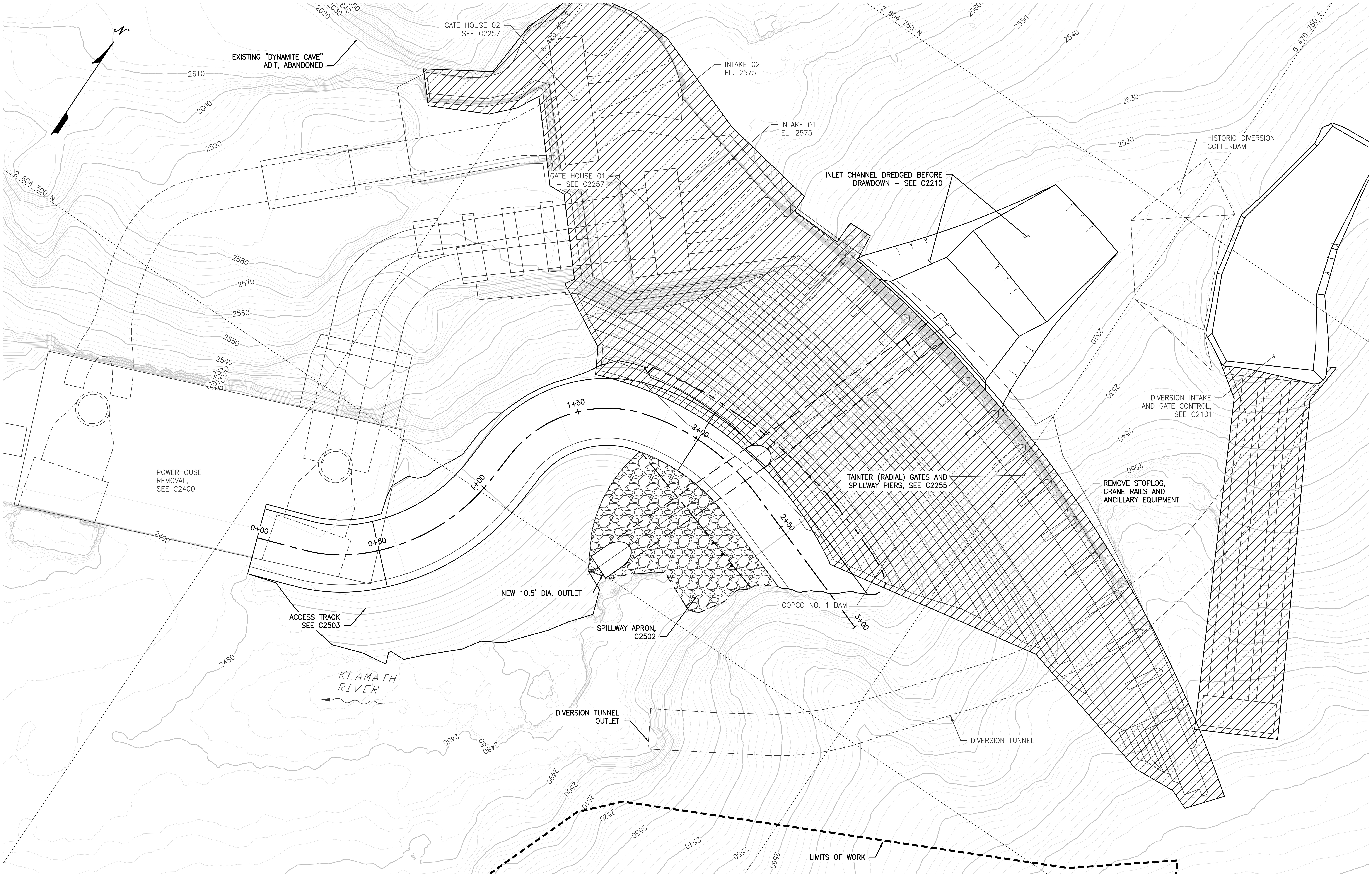

PLAN
1" = 20'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. FOR DRAWDOWN PROCEDURE SEE DRAWING C2055.
3. FOR DIVERSION TUNNEL MODIFICATIONS SEE DRAWING C2100.
4. UPSTREAM AND DOWNSTREAM WATER LEVELS AS PER DRAWING C2057.

LEGEND:

- DEMOLITION / REMOVAL
- LIMITS OF WORK
- EROSION PROCTETION (E7c)

0 20 40 60
1" = 20'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY: Knight Piésold CONSULTING; Kiewit

DESIGNED	B. OTIS
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REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR: KLAMATH RIVER RENEWAL CORPORATION

PROJECT: KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE: COPCO NO. 1 FACILITY DAM REMOVAL - GENERAL ARRANGEMENT PLAN

PROJ #	VA103-640/1
DATE	11/13/2020
DWG	C2250

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEET C2255: COPCO NO. 1 SPILLWAY CREST

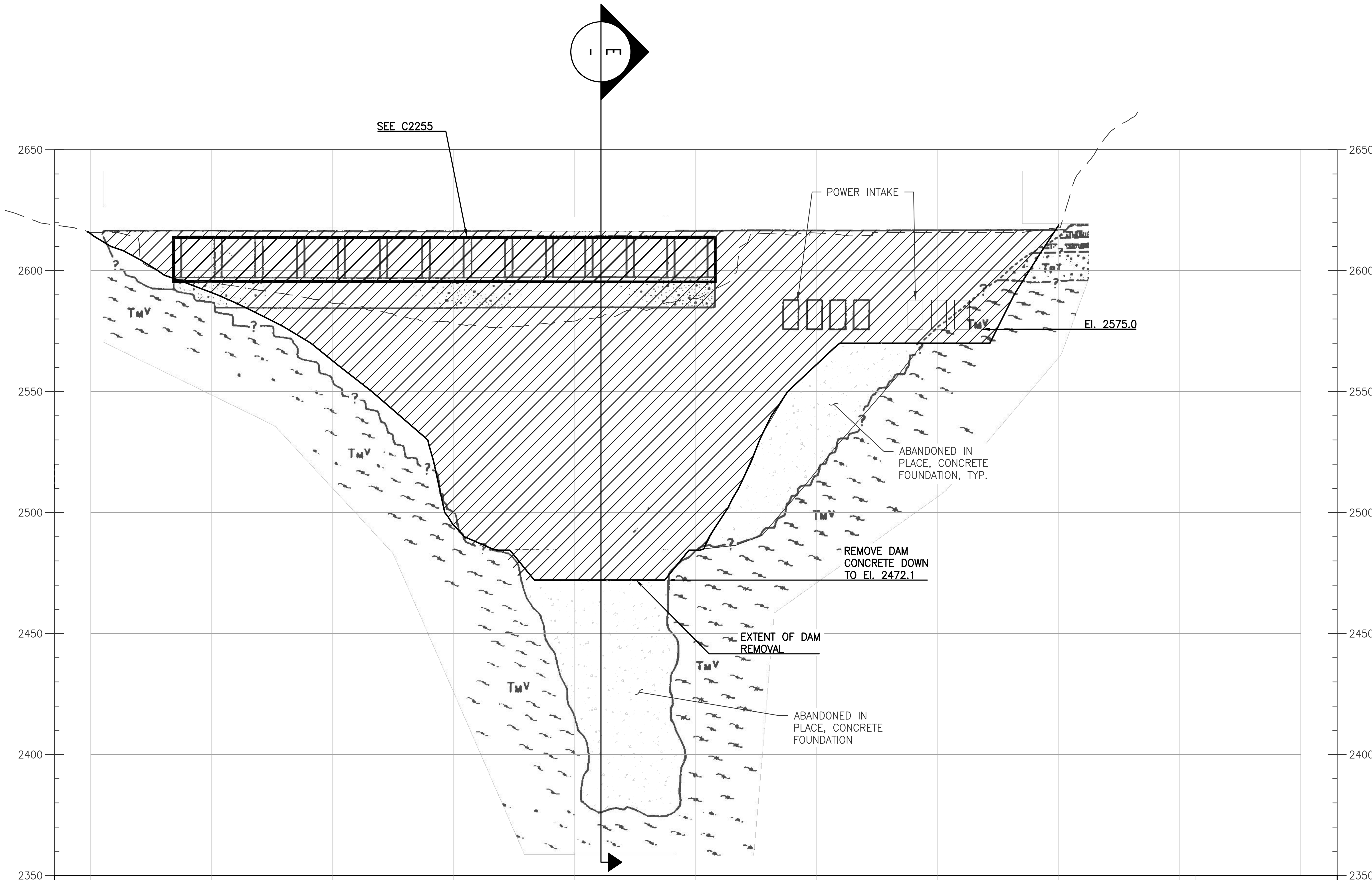
LEGEND:

DEMOLITION / REMOVAL

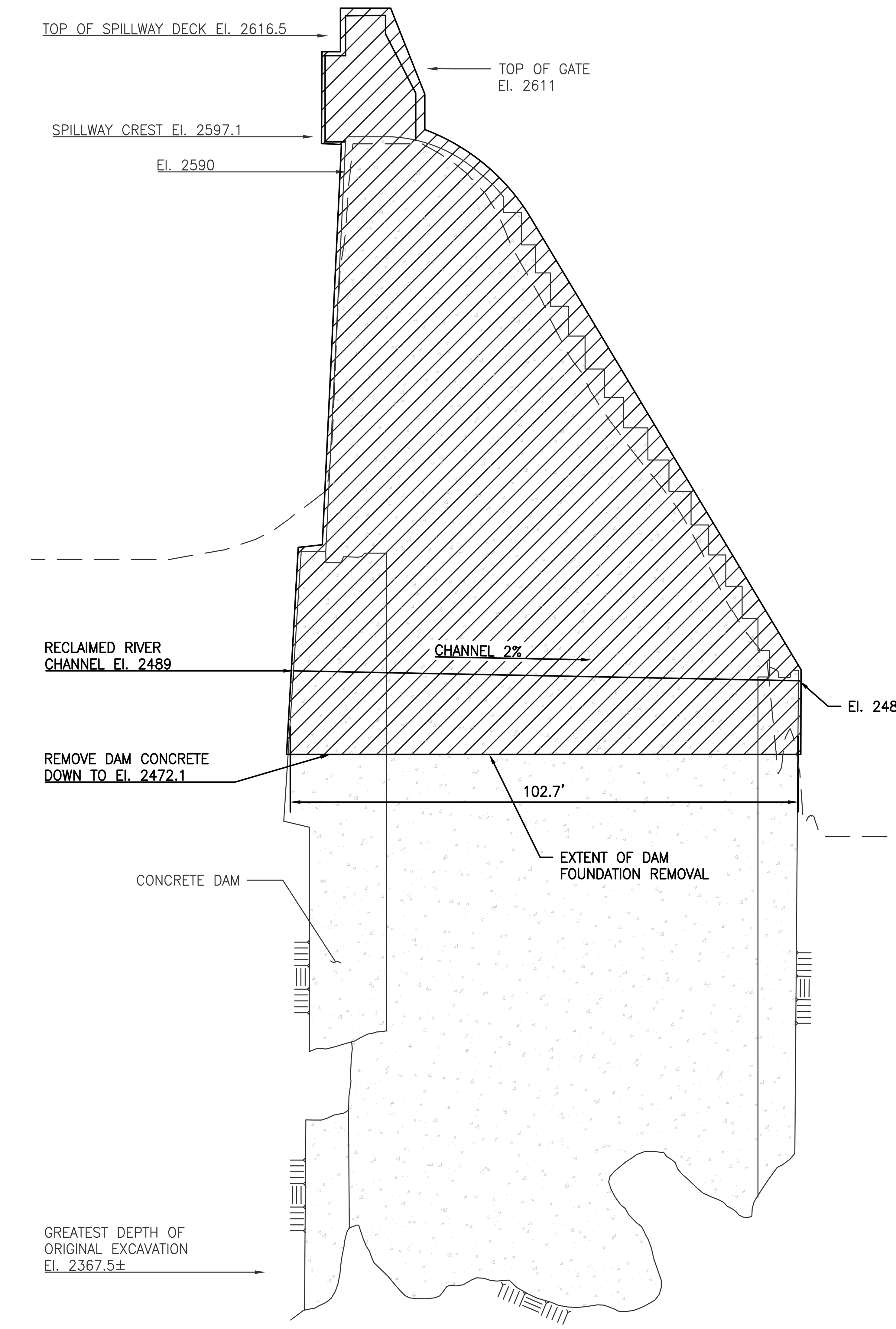
EXISTING CONCRETE (ABANDONED IN PLACE)

NOTES:

1. FOR DAM REMOVAL NOTES SEE DRAWING C2250.
2. REMOVE CONCRETE DAM TO NATURAL BEDROCK CONTOUR LINE.
3. REMOVE CONCRETE DAM FOUNDATION WITHIN THE RIVER CHANNEL WITH FINISHED SURFACE FREE OF SHARP EDGES.
4. FOR RESERVOIR WATER LEVELS DURING REMOVAL SEE DRAWING C2055.
5. OPERATION OF DIVERSION TUNNEL OR DEWATERING IS REQUIRED TO REMOVE THE DAM FOUNDATION BELOW ELEVATION 2525 ft.
6. WATER SURFACE ELEVATION UPSTREAM OF DAM ARE SHOWN ON DRAWING C2057.



UPSTREAM ELEVATION
1" = 30'



E C2258 E - SECTION
NTS

0 30 60 90
1" = 30'

FOR INFORMATION ONLY

REV	DESCRIPTION	BY	CHK	APP	DATE
G	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
F	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
E	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20
D	ISSUED WITH 60% DESIGN REPORT	BO	NB	SRM	02/07/20
C	ISSUED WITH DRAFT 60% DESIGN REPORT	BO	NB	SRM	12/17/19

WARNING
0 1/2 1
IF THIS BAR DOES NOT MEASURE 1" THEN DRAWING IS NOT TO SCALE

PREPARED BY
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Kiewit

DESIGNED	B. OTIS
DRAWN	A. NASIRI
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
DAM REMOVAL
PROFILE AND SECTION

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2256

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CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

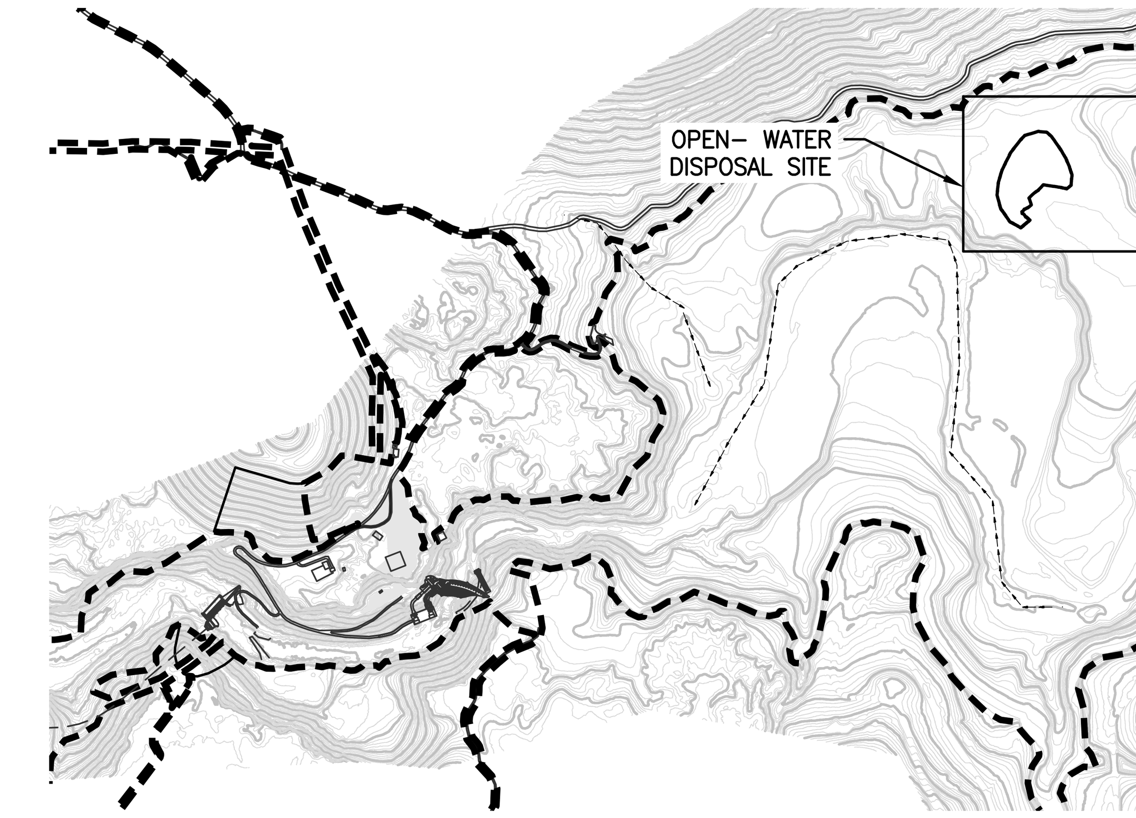
DESIGN SHEET C2257: COPCO NO. 1 INTAKE

CRITICAL ENERGY/ELECTRIC INFRASTRUCTURE INFORMATION

(CEII)

REDACTED

DESIGN SHEET C2258: COPCO NO. 1 FINAL GRADE



KEY PLAN
NTS

PLAN
1" = 100'

NOTES:

1. REFER TO GENERAL NOTES ON DRAWING G0006 FOR INFORMATION REGARDING TOPOGRAPHIC AND BATHYMETRIC DATA SOURCES.
2. NORMAL RESERVOIR LEVEL IS 2607 ft. REFER TO C2055 FOR PRE-DRAWDOWN RESERVOIR OPERATION.

LEGEND:

- - - - - LIMITS OF WORK

WORK POINTS TABLE

WORK POINTS	EASTING	NORTHING
SOP 1	6474286.577	2607418.774
SOP 2	6474066.604	2607064.690
SOP 3	6474481.498	2607132.897

FOR INFORMATION ONLY

0 100 200 300
1" = 100'

REV	DESCRIPTION	BY	CHK	APP	DATE
C	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	11/13/20
B	ISSUED WITH DRAFT 100% DESIGN REPORT	BO	NB	SRM	10/07/20
A	ISSUED WITH 90% DESIGN REPORT	BO	NB	SRM	08/05/20

WARNING
0 1/2 1
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PREPARED BY
Knight Piésold CONSULTING
Kiewit

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DRAWN	A. TSENG
REVIEWED	S. YONG
IN CHARGE	N. BISHOP
APPROVED	S. MOTTRAM

PREPARED FOR
KLAMATH RIVER RENEWAL CORPORATION

PROJECT
KLAMATH RIVER RENEWAL PROJECT

SHEET TITLE
COPCO NO. 1 FACILITY
OPEN-WATER DISPOSAL SITE
PLAN

PROJ # VA103-640/1
DATE 11/13/2020
DWG C2272

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