US Army Corps of Engineers®
Portland District

DESIGN DOCUMENTATION REPORT NO. 1
JOHN DAY DAM
KILCKITAT COUNTY, WASHINGTON

FY19 FISH ACCORDS LAMPREY PASSAGE JOHN DAY DAM

100% Design Documentation Report
June 2022

EXECUTIVE SUMMARY

1. INTRODUCTION

This Design Documentation Report (DDR) covers the alternatives evaluation and the selected plan for the north fish ladder lamprey collection system. This report describes the project background and outlines technical aspects of the selected plan.

The existing lamprey collection system at the John Day north fish ladder entrance has insufficient capacity. The collection box needs to be upgraded so that it can hold more fish for longer periods of time. Because a larger collection box will be installed, the water supply will also need to be upgraded to provide more recirculation.

The Product Development Team (PDT) considered alternatives for a gravity-fed watering system supplied by the fish ladder and a pumped system. The PDT’s first concept was a gravity-fed water source, although a pumped system was considered if sourcing from the fish ladder could not be guaranteed to have no effects on salmonid passage. The PDT decided that a gravity-fed water source could be installed without impacting salmonid passage through the north fish ladder. The existing lamprey collection system has a pumped water supply. The upgrades to the lamprey collection system will be made during the FY23 in-water work period.

In addition to lamprey collection at the north ladder, the PDT will design improvements to the south fish ladder entrance. The improvements will include a modification to an existing weir by adding a rounded weir crest and integrated fillers for unused weir slots at the south ladder fish entrance. No existing features at the south entrance will be removed.

2. PURPOSE

The purpose of this project is to improve lamprey collection at the north fish ladder and improve lamprey passage at the entrance to the south fish ladder.

3. PROJECT LOCATION

This project is located at the John Day Dam. The lamprey collection system is located at the north end of the spillway on the tailrace deck.

4. DESCRIPTION OF FACILITY

The John Day Dam has a fish ladder at the north side, where the dam meets the navigation lock, and at the south side on the riverbank. The north side lamprey collection box is located down on the tailrace deck at the base of the fish ladder. The flume leading into the lamprey collection box draws fish out of the north ladder entrance pool. Adjacent to this tailrace deck is the spillway.

On the south side, the fish ladder entrance is located at the end of the powerhouse. The entrance to the collection channel is located at the north end of the powerhouse, where the powerhouse and spillway meet. There is an existing lamprey collection box on the south fish ladder that was installed in 2013.

5. INSTALLATION

All procurement and installation will be handled by the John Day Project. No contract is required, so an independent government estimate from ENC-C is not needed. Installation will begin during the fall of 2022 with activities that propose little or no disturbance to the fish ladder (such as fabricating the collection tank and installing the new platform around the existing drainpipe). The Project will seek Fish Passage Operations and Maintenance (FPOM) clearance for work near the fish ladder outside of the winter de-watering period.

CONTENTS

TABLES

FIGURES

APPENDICES

PREVIOUS AND PLANNED REPORTS

Number	Title	Date
DDR 1	John Day Lock and Dam; Design Document Report North Fish Ladder Exit Section and Count Station Improvements	April 2009
DDR	John Day Lock and Dam; Design Document Report North Fish Ladder Entrance Improvements	September 2010
DDR	John Day Lock and Dam; Design Document Report Lamprey Passage Structure Development and Improvement (60% Draft - Phase III)	February 2018

ACRONYMS

Acronym	Description
AISC	American Institute of Steel Construction
APE	Area of Potential Effects
ASTM	American Society for Testing and Materials
BoR	Bureau of Reclamation
BPA	Bonneville Power Administration
CRFM	Columbia River Fish Mitigation Program
CRITFC	Columbia River Inter-Tribal Fish Commission
CRS	Columbia River System
CTLWG	Corps-Tribal Lamprey Work Group
DDR	Design Documentation Report
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FCRPS	Federal Columbia River Power System
FEIS	Final Environmental Impact Statement
FFDRWG	Lower Columbia River Fish Facility Design Review Work Group
FPOM	Fish Passage Operations and Maintenance
FPP	Fish Passage Plan
HECP	Hazardous Energy Control Program
HMI	Human-Machine Interface
HSS	Hydraulic Steel Structure
LPS	Lamprey Passage Structure
MOA	Memorandum of Agreement
MPH	Miles Per Hour
NGVD 29	National Geodetic Vertical Datum of 1929 (also Mean Sea Level)
NEPA	National Environmental Policy Act
NFPA	National Fire Protection Association
NMFS	National Marine Fisheries Service
O&M	Operations and Maintenance
OBE	Operational Basis Earthquake
PCF	Pounds Per Cubic Foot
PLC	Programmable Logic Controller
PPE	Personal Protective Equipment
PSF	Pounds Per Square Foot
PDT	Product Development Team
REC	Record of Environmental Consideration
RME	Research, Monitoring, and Evaluation
SCADA	Supervisory Control and Data Acquisition
SHPO	Oregon State Historic Preservation Officer
THPO	Tribal Historic Preservation Officers
USACE	United States Army Corps of Engineers
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey

SECTION 1 - PURPOSE AND INTRODUCTION

1.1 INTRODUCTION

The U.S. Army Corps of Engineers (USACE) FY2020 Work Plan included $20 million in the Columbia River Fish Mitigation Program (CRFM) to complete all lamprey work contemplated in the 2019-2023 Federal Columbia River Power System (FCRPS) Fish Accords. These are ‘no year’ funds and can be carried in to out-years as needed to implement the program.

The goal of the USACE Pacific Lamprey (Entosphenus tridentatus) passage improvement efforts is to improve both juvenile and adult lamprey passage and survival through the eight USACE multi-purpose dams on the lower Columbia and Snake rivers (CRS Project), contributing to a regional effort to arrest the decline of Pacific lamprey populations in the Columbia Basin and rebuild their populations to sustainable and harvestable levels.

1.2 BACKGROUND

1.2.1 2020 CRS Proposed Action

In September 2020, USACE signed a Record of Decision adopting the Preferred Alternative described in the Action Agencies’ (Bonneville Power Administration (BPA), Bureau of Reclamation (BoR), and USACE) Final Environmental Impact Statement (FEIS) for the long-term coordinated operation and management of the CRS Project. Several adult and juvenile lamprey passage improvement measures were considered in the EIS and integrated into the EIS’s Selected Alternative. The Selected Alternative included the following structural measures to improve lamprey survival:

- Bypass screen modifications for juvenile lamprey passage. USACE will replace existing extended-length bar screens with screens designed to reduce juvenile lamprey entanglement at Little Goose and Lower Granite dams. The upgrades would occur when existing screens need replacement.
- Bonneville ladder serpentine weir modifications. This measure would modify the serpentine-style flow control sections of Bonneville Dam’s Washington Shore and Bradford Island fish ladders to improve passage conditions for adult lamprey and likely reduce stress and delay for adult salmon, steelhead, and bull trout.
- Expand network of Lamprey Passage Structures (LPS) to bypass impediments in existing fish ladders. New structures may be installed at Bonneville Dam’s Bradford Island and Washington Shore fish ladders, The Dalles Dam’s east fish ladder, and/or John Day Dam’s south fish ladder.
- Modify turbine cooling water strainer systems to safely exclude Pacific lamprey and other juvenile fish.
- Modify existing fish ladders, incorporating lamprey passage features and criteria into ladder modifications at the lower Snake and Columbia River dams. Modifications may include ramps to submerged weir orifices, diffuser plating to

provide attachment surfaces, diffuser grating with smaller gaps, refuge boxes, wetted walls, rounded weir caps and closure of floating orifice gates.

1.2.2 Columbia Basin Fish Accords MOA

From 2008 to 2018, USACE addressed many adult, juvenile, and larval lamprey passage issues and Research, Monitoring, and Evaluation (RME) needs at its Columbia and Snake River dams using Columbia River Fish Mitigation program (CRFM) funding in accordance with commitments made through the 2008 Columbia Basin Fish Accords Memorandum of Agreement (MOA) between the Three Treaty Tribes and FCRPS Action Agencies.

In 2018, a new Columbia Basin Fish Accords MOA was negotiated then further extended in a 2020 MOA without change to the commitments within. The 2018/2020 Fish Accords extensions include commitments by USACE to:

- Continue coordinating and collaborating on Pacific Lamprey issues through participation in the Pacific Lamprey Conservation Agreement, interagency meetings, and technical workgroup meetings, including the U.S. Fish and Wildlife Service’s Lamprey Technical Workgroup.
- Continue counting adult lamprey that pass Lower Columbia and Snake River dams.
- Provide access to the Tribes to collect adult lamprey at USACE dams in support of tribal restoration actions.
- Operate and maintain existing lamprey passage facilities.
- Integrate lamprey design considerations into future Columbia River Basin plans for adult and juvenile salmonid passage facilities.
- <u>*Seek funding*</u> to finalize and implement a plan to continue to improve Pacific Lamprey passage conditions at USACE dams, to include:
    - Additional adult lamprey passage improvements at USACE dams.
    - Develop/implement a strategy to obtain more accurate adult counts at USACE dams.
    - Develop/implement an RM&E plan regarding adult lamprey migration behavior and fate above Bonneville.
    - Develop/implement a juvenile lamprey RM&E plan.

1.2.3 Pacific Lamprey Passage Improvements Implementation Plan

USACE coordinated with the Treaty Tribes and Columbia River Inter-Tribal Fish Commission (CRITFC) 2018-2020 to develop and prioritize a list of actions that could be accomplished should funding be received to implement the measures in the 2018/2020 Fish Accords extension. When Work Plan funding was received in 2020, the prioritized list of actions developed by the Corps-Tribal Lamprey Work Group (CTLWG) became the basis for the USACE Pacific Lamprey Passage Improvements Implementation Plan (Implementation Plan), finalized in May 2021.

The purpose of the Implementation Plan is to identify high priority passage improvements and research, monitoring and evaluation, and estimate program costs by fiscal year, to be implemented with the $20 million received. The Implementation Plan will be updated annually to adapt to changes in priorities and project budgets.

Adult lamprey passage improvements in the Implementation Plan are intended to meet the adult passage commitments in the 2020 CRS Proposed Action to modify the Bonneville ladder serpentine weirs, expand the network of lamprey passage structures, and incorporate other lamprey passage features in the existing ladders. All structural or operational changes intended to improve passage conditions for Pacific lamprey will be coordinated with the Services to ensure neutral to beneficial effects on Endangered Species Act (ESA) listed species.

At Bonneville Dam, the Washington Shore serpentine weirs will undergo a major redesign, converting them to an Ice Harbor-style vertical slot with submerged orifices configuration while the Bradford Island serpentine weirs will undergo extensive minor modifications, incorporating lamprey specific passage features into the existing configuration. New LPS will be constructed at Bonneville Dam's Bradford Island and Washington Shore ladders and The Dalles Dam's east fish ladder and improvements will be made to the existing LPS at Bonneville and John Day dams. The Implementation Plan also prescribes several modifications to the existing ladders at Bonneville, The Dalles, John Day, McNary, and Lower Monumental dams to incorporate lamprey passage features at the fishway entrances, salmon orifices, and diffuser grating.

1.3 PROJECT DESCRIPTION

The project scope includes the adult lamprey passage improvements identified in the Implementation Plan for John Day Dam and is divided into two parts:

- North Fish Ladder Lamprey Collection Improvements
    - Increase the capacity and reliability of the existing lamprey collection structure at the North Fish Ladder entrance with (a) gravity-fed water supply or alternative, more reliable pump configuration and (b) a larger collection box to hold more fish. This is a fish safety/health issue.
- South Fish Ladder Entrance Improvements
    - At the entrance of the south fish ladder, round the weir crest and construct guide slot fillers/covers attached to the weir.

1.4 PROJECT OBJECTIVES

The primary objective is to increase lamprey passage efficiency at the John Day Dam fishways.

1.5 PREVIOUS STUDIES AND REPORTS

The design of this project will be based on previous lamprey passage projects at John Day and at Bonneville. A gravity-fed water source for the north ladder lamprey collection system was partially designed in 2017 and will serve as a reference.

1.6 PROJECT CONSTRAINTS

1.6.1 Environmental

Any modifications to the existing fish ladders to benefit Pacific lamprey cannot be detrimental to salmon passage.

1.6.2 Construction

Construction in the fish ladder can only occur during the winter maintenance period, which occurs every year from 30 November through 27 February. The PDT's intent is to complete plans and specifications and award before winter 2022, so that construction can occur during the winter 22-23 dewatering period.

1.6.3 Cost

This project is funded by the FY2020 Work Plan budget and has been allocated $1.21 million. Any increases to that initial allocation will compete with the other concurrent lamprey passage projects along the lower Columbia River.

SECTION 2 - BIOLOGICAL DESIGN CONSIDERATIONS AND CRITERIA

2.1 DESIGN ASSUMPTIONS

All structural or operational changes intended to improve passage conditions for Pacific lamprey will be coordinated with the Services to ensure no adverse effects to ESA-listed species.

All in-water work will occur during the annual winter maintenance period (December to March) unless coordinated with regional forums.

All components of the fishway will operate normally in accordance with the Fish Passage Plan and within NMFS operation criteria between April and November.

Research, non-routine maintenance, fish-related activities, and construction will not be conducted within 100 feet of any fishway entrance or exit, within 50 feet of any other part of the adult fishway, or directly in, above, or adjacent to any fishway, unless coordinated with FPOM or Lower Columbia River Fish Facility Design Review Work Group (FFDRWG) by the Project, District Operations and/or Planning or Construction office. Alternate actions will be considered by District and Project biologists in conjunction with the regional fish agencies on a case-by-case basis.

2.2 DESIGN CRITERIA

The LPS flumes needs to accommodate the movements and physical abilities of lamprey associated with mode of swimming for which they were designed. Traversing ducts are designed for free anguilliform swimming for adult lamprey. This requires the flow velocity to be below the critical swim speed (an estimate of the swim speed that can be maintained without fatiguing) of adult Pacific lamprey, which has been estimated to be around 2.6 ft/s (Mesa et al. 2003). Additionally, the flow depth must be adequate to allow free swimming of lamprey.

The minimum recommended flow depth for anguilliform swimming has not been established; however, an analysis of the draft *Design Guidelines for Pacific Lamprey Passage Structures* (Zobott et al. 2015) shows that the flow depths should be 1.0 inches in 18-inch-wide flumes and 2.4 inches in 8-inch wide flume for best practice. The typical width of a traversing duct ranges from 8 to 18 inches and the minimum recommended turning radius is 1.6 feet (Zobott et al. 2015).

Climbing ducts are intended to allow “burst-and-attach” movement for partially submerged adult lamprey. Pacific lamprey can ascend vertical surfaces with sheeting flow and velocities of approximately 12 ft/s (Kemp et al. 2009). The recommend width of a climbing duct is 20 inches, the recommended slope is 45 degrees (1 ft/ft), and the recommended maximum elevation gain between resting boxes is 11.5 feet (Zobott et al. 2015). The recommended mean flow velocity is 7.9 to 11.8 ft/s (Zobott et al. 2015). The normal depths for these conditions vary between 0.13 to 0.20 inches depending on the discharge (62 to 124 gpm).

Rest boxes should be placed at key transitions within the LPS, particularly immediately upstream of climbing sections. Rest boxes should feature fykes to discourage downstream movement (fallback) of lamprey ascending the systems. The presence of fykes (preventing downstream movement) and the function of the rest box as a refuge for exhausted animals means that most lamprey that die within the LPS will eventually end up in a rest box.

Pacific lamprey are extremely sensitive to olfactory cues (Robinson et al. 2009) and researchers have noted immediate declines in LPS use preceding discovery of dead lamprey in refuge boxes. To facilitate regular inspection and removal of dead lamprey from rest boxes, boxes must be accessible to personnel. Though there are examples of rest boxes that can be flushed remotely using pneumatics, direct inspection and manual removal of dead fish is strongly recommended by John Day Project fisheries biologists and other LPS operators.

2.3 DESIGN METHODS

The LPS water supply, whether pumped from below or gravity fed from above, will come from a “fish free” source, appropriately screened to prevent adult and juvenile fish entrainment. An example of a fish free water source would be an area behind picketed leads.

2.4 DESIGN RECOMMENDATIONS

The recommended design is for a gravity fed system from a “fish free” water source either from the turning pool above the current LPS location in the fish ladder or from the area at or adjacent from the count station near the upper end of the overflow section of the ladder before the exit control section starts. The supply pipe should supply adequate volume and flow to fully turnover the upgraded holding tank at the rate of 30 minutes or less.

SECTION 3 - HYDRAULIC DESIGN

This chapter describes the hydraulic design of specific features pertinent to the proposed lamprey improvements at John Day North Fish ladder.

3.1 DESIGN ASSUMPTIONS

The following assumptions pertain the hydraulic design of key components of the proposed lamprey improvements.

3.1.1 Hydrologic Conditions

Lamprey systems must be able to function within the expected range of forebay and tailwater elevations. The following water elevations are provided in National Geodetic Vertical Datum (NGVD) 1929.

3.1.1.1 *Forebay Elevations*

The forebay elevations are controlled by the difference between Project inflow and discharge operations. The forebay usually runs near median forebay elevation (EL) 263.8 feet during the Lamprey passage season (June to September).

- Minimum: 257 feet.
- Maximum: 268 feet.
- Normal range: 262.8 to 267.4 feet.
  - Forebay is within the normal range 98 percent of time based on daily forebay data collected between 1990 to 2021.

3.1.1.2 *John Day River Flow Rates and Discharge Duration Curves*

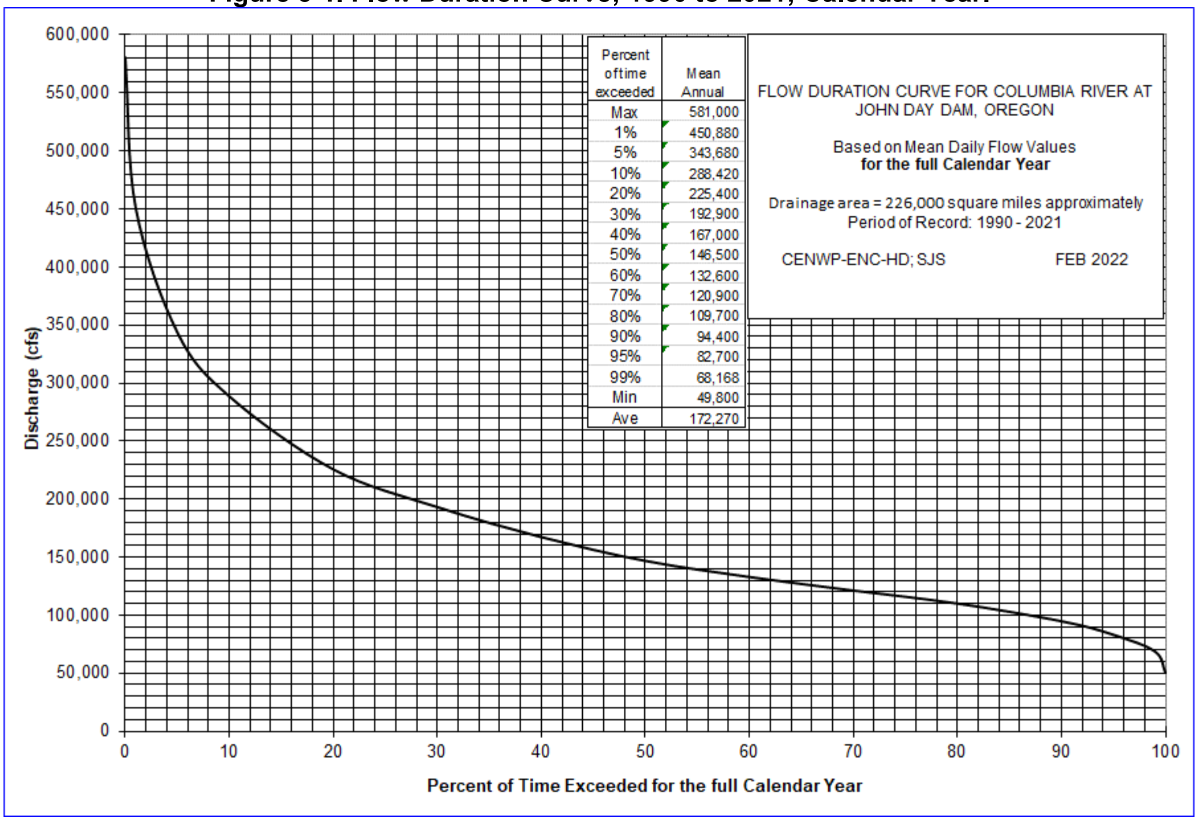
Daily discharge data at John Day Dam was assembled for an updated record from 1990 to 2021. The river flow duration curves are defined as the flow rate versus percent of time exceeded on a daily basis.

Pertinent mean daily river flow rates over the Calendar year include:

- Minimum 48.8 kcfs
- 95% exceedance 82.7 kcfs
- 90% 94.4 kcfs
- 70% 120.9 kcfs
- Median (50% exceedance) 146.5 kcfs
- Average annual flow 172.3 kcfs
- 30% 192.9 kcfs
- 10% 288.4 kcfs
- 5% exceedance 343.7 kcfs
- Maximum 581.0 kcfs

Error! Reference source not found. provides a chart showing daily discharge at John Day Dam versus percent of time (days) in which the project discharge was exceeded during the calendar year. This chart is based on a mean daily discharge record from 1990 to 2021.

Figure 3-1. Flow Duration Curve; 1990 to 2021; Calendar Year.



Peak lamprey passage times occurs at John Day Dam during June through September, partly when flow rates are historically higher than in the calendar year. The spring freshet usually occurs sometime in late May through early July. June is on average the highest flowing month.

Error! Reference source not found. provides a chart showing daily discharge versus percent of time (days) in which the project discharge was exceeded during the June through September. This chart is based on a mean daily discharge record from 1990 to 2021. Figure 3-3 **Error! Reference source not found.**shows the **Error! Reference source not found.** data in tabular form and includes the calendar year (annual) data for comparison.

Figure 3-2. Flow Duration Curve; 1990 to 2021; June to September.

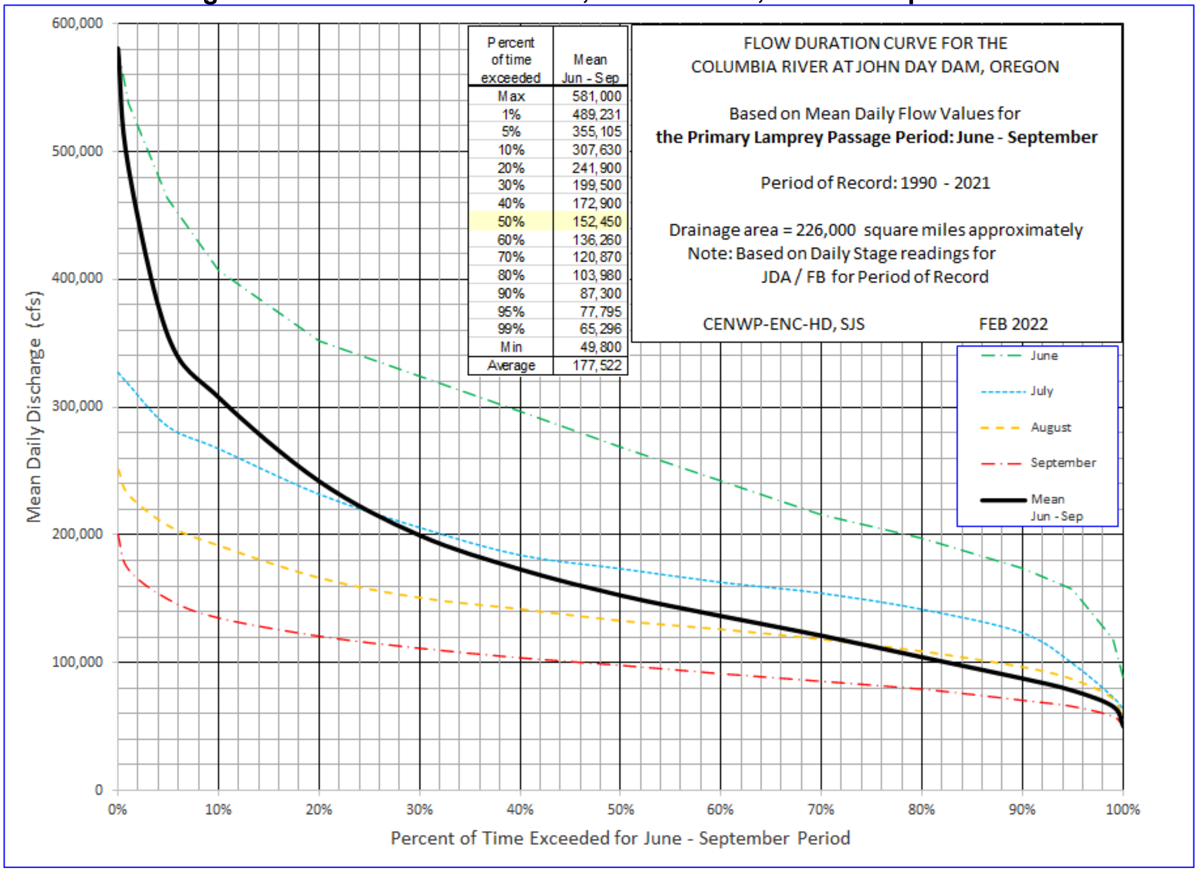


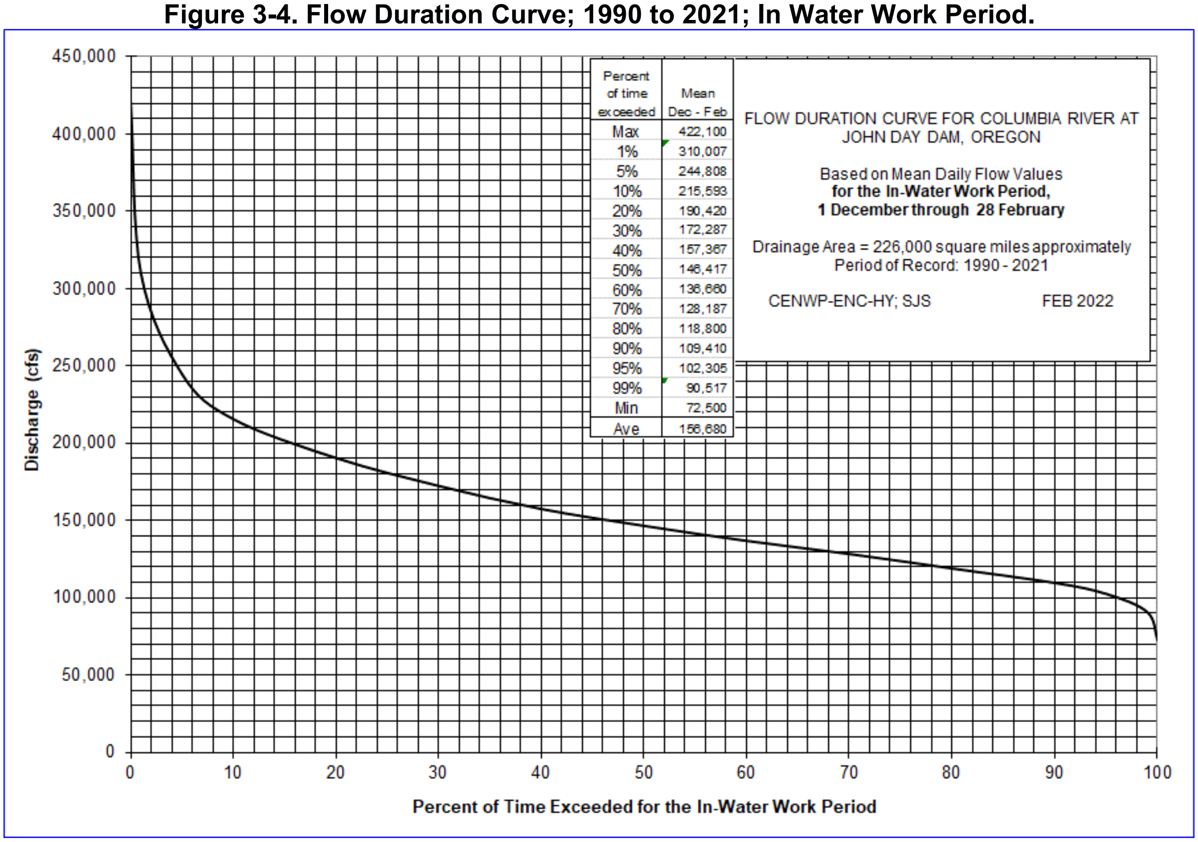
Figure 3-3. Discharge Duration Data; 1990 to 2021; June to September.

John Day Lock and Dam: Discharge Duration Data during June - September Mean Daily Project Flow Rates, June 1 Thru September 30 (Period of Record 1990 -2021)						
Percent of time exceeded	Annual	June - Mid Sept. (Peak Lamprey Passage Period)				
		June	July	August	September	Mean Jun - Sep
Max	581,000	581,000	327,400	251,000	200,600	581,000
1%	450,880	537,969	318,394	231,367	173,475	489,231
5%	343,680	463,165	284,750	206,960	149,545	355,105
10%	288,420	406,690	267,560	191,650	135,030	307,630
20%	225,400	352,120	231,920	166,380	120,700	241,900
30%	192,900	324,530	205,720	150,860	111,200	199,500
40%	167,000	297,000	184,100	142,000	103,700	172,900
50%	146,500	269,250	173,500	132,850	97,800	152,450
60%	132,600	242,720	162,780	126,200	91,200	136,260
70%	120,900	215,310	154,220	118,370	85,220	120,870
80%	109,700	197,020	141,560	108,900	79,040	103,980
90%	94,400	174,180	123,060	96,660	70,270	87,300
95%	82,700	157,100	98,780	87,175	65,385	77,795
99%	68,168	118,678	72,584	72,090	57,588	65,296
Min	49,800	88,000	63,100	54,800	49,800	49,800
Average	172,270	280,624	183,417	138,203	101,055	177,522

Construction inside or in near proximity to the fishladder must be completed during the in-water work period. The official in-water work period is between 01 December to 28 February. Figure 3-4 provides a chart showing daily discharge versus percent of time (days) in which the project discharge was exceeded during the in-water work period. This chart is based on a mean daily discharge record from 1990 to 2021.

Extensions of the in-water work period are sometimes permitted in coordination with the fishery agencies. If so, the extension is more likely to be granted in late November instead of earlier March, when more juvenile salmon are on the move.

Figure 3-4. Flow Duration Curve; 1990 to 2021; In Water Work Period.



3.1.1.3 *Tailwater Elevations*

John Day tailwater elevations are dependent on project discharge and the Dalles Dam operations. Based on hourly data collected between 1990 to 2021, the pertinent daily tailwater elevations include:

- Minimum 156.4 feet
- 95% exceedance 159.2 feet
- Median (50% exceedance) 160.5 feet
- 5% exceedance 164.5 feet
- Maximum 173.2 feet

The project minimum operating tailrace elevation is mandated to be 158 feet in the USACE 2021 Fish Passage Plan. This is done to maintain at least 8-feet of tailwater submergence above the multiple JDA fishladder entrance inverts at 150 feet. The tailwater has exceeded this minimum tailwater 99 percent (or fallen below it 1 percent) of the time between 1990 to 2021.

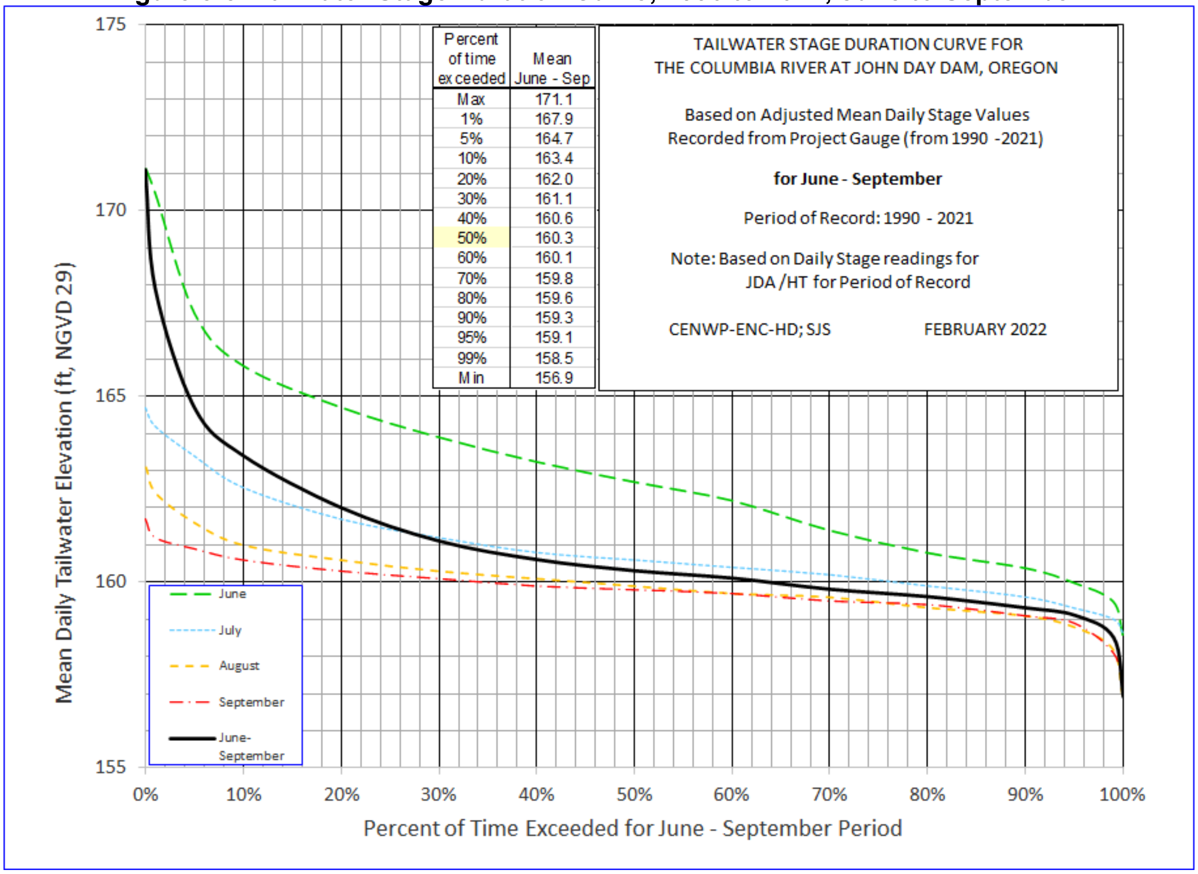
As noted previously, the peak lamprey passage period occurs between June and September. Daily tailwater elevations versus percent of time (days) in which the tailwater elevation was exceeded is shown in **Error! Reference source not found.** for the June to September period. This chart is based on a daily tailwater record from 1990 to 2021.

Pertinent daily tailwater elevations during the June to September time frame include:

- Minimum 156.9 feet
- 95% exceedance 159.1 feet
- Median (50% exceedance) 160.3 feet
- 5% exceedance 164.7 feet
- Maximum 171.1 feet

The 1 percent annual exceedance (100-year flow event) flow rate at John Day 680,000 cfs. Assuming a median forebay EL 158.3 feet at The Dalles Dam, the 1 percent annual exceedance tailwater will be EL 173.3 feet.

Figure 3-5. Tailwater Stage Duration Curve; 1990 to 2021; June to September.



3.1.2 Lamprey Passage System (LPS) Assumptions and Design Features

A LPS is the system devised to separately pass the adult lamprey outside of the fishladder and includes some or all of the following components: lamprey entrance unto the LPS, climbing ducts, traversing ducts, alternatives series of chutes and pools, rest boxes or rest areas, water supply intakes (pump or gravity), collection box or upwelling boxes with LPS exits.

There is an existing LPS system at the Entrance of the North Fish ladder that includes a LPS entrance, climbing duct, traversing duct, and an upwelling box with a Lamprey collection box. It has a pumped water supply drawn from the Auxiliary water supply conduit adjacent to the entrance.

The pumped water is supplied to the upwelling box. The majority on the flow into the upwelling box goes directly to the LPS (greater than 120 gpm) and small proportion of flow (18 to 20 gpm) goes to the Lamprey collection box. Drain valves at the bottom of the upwelling box and collection box release the excess or recirculation flow.

The current phase proposes to upgrade the water supply source (preferably gravity) and enlarge the collection box.

3.1.2.1 *LPS Water Supply Sources*

Pumped water sources are required for LPS systems where Lamprey are released to the Forebay. Otherwise, the feasibility of a gravity water supply should be explored.

Gravity water supplies are generally more reliable than pumped supplies and typically have lower Operations and Maintenance (O&M) costs. Where gravity water supplies are not feasible, a configuration with two pumps that run continuously to make up the required flow rate for the LPS is recommended.

For each standard 20-inch wide LPS, recommend a design flow of 124 gpm (0.28 cfs).

The water source should be sized about 20 to 40 percent higher than the computed LPS requirement to allow for adjustments. Tribal LPS operators recommend between 15 to18 gpm allocated for the Collection box to sustain the trapped lamprey.

The design flow rate is rounded up to at least 160 gpm (0.33 cfs) to account the combined LPS and tank requirement and allow room for flow adjustment and optimization.

Screening to exclude juvenile salmonid fish is often required at the intake of the water supply sources whether pumped or gravity source.

Pumped Water Supply

For each standard 20-inch wide LPS, two 62 gpm pumps are recommended. The two pump outputs would be combined through a manifold (with one-way valves) to achieve a target flow supply of 160 gpm, or 124 gpm down the LPS. The rationale is that if one pump fails, the LPS will still receive at least 62 gpm, which could sustain the lamprey already in the LPS while the pump is being repaired.

Pumps sizes are selected to exceed (by 20 percent to 40 percent) the anticipated required flow rate (124 gpm plus 18 gpm) and a throttle valve is used to adjust the flow rate down to an optimum level. Other control options include orifices or dump valves (for excess flow). Coordination with Mechanical Design is needed to assure the pump(s) are operating near optimum efficiency. Care must be taken if using variable frequency drive (VFD) controllers add noise to the power distribution system from which they are powered. This may disturb RFID antennas commonly in the same vicinity of the LPSs.

The existing pumped supply draws from the AWS conduit adjacent to the North Fishladder entrance. The pumps convey the water through two 40-foot-deep vertical pipes from the lower AWS conduit up to the tailrace deck (EL 185 feet). The lower portions and intakes of the pipes (at the bottom) are continually exposed to high velocity flow turbulence. Under higher flow ladder operation conditions, the pipes and pump system have been noted to vibrate violently as observed from the tailrace deck. In the initial (and different sump location), the initial PVC pipes became quickly fractured and the pumps were moved from the original design location to the current location. While the current system has thus far held, the system is increasingly subject to fatigue with continued use.

If pumps are to continue to be used as the LPS water supply source, either the pipes and intakes need to be secured more effectively, or a less turbulent sump location needs to be found. ENC-DM noted that an attempt to better secure pipes and intakes near the bottom of the AWS conduit present several obstacles due to physical constraints. Alternatively, the immediate tailrace with the entrance discharge and adjacent spillway bay does not offer a more tranquil hydraulic environment. For these reasons and the added O&M burden from pumps, gravity water supply is preferable at JDA North.

Gravity Water Supply

Similar to pump sources, the gravity water supply should be designed to exceed the required water supply be 20 to 40 percent to allow for adjustments. Based on the standard 20-inch wide LPS, the design LPS flow should be 124 gpm (0.28 cfs).

In addition, Tribal LPS operators recommend between 15 to18 gpm allocated for the Collection box to sustain the trapped lamprey.

The design flow rate is rounded up to at least 160 gpm (0.36 cfs) to account the combined LPS and tank requirement and allow room for flow adjustment and optimization.

A 4-inch diameter pipe has been estimated to be sufficient to pass the required flow.

3.1.2.2 *Collection Box*

Collection boxes are effectively end-of-the-run LPS rest boxes. The LPS terminates at the upwelling box, which in turn directs the lamprey into the collection box. Here Lamprey are trapped and collected for upstream outplanting. The volume of the collection box must be sized larger than the typical rest box depending on expected Lamprey traffic and transport frequencies. Tribal Lamprey operators recommend around 15 to18 gpm recirculation flow to maintain Lamprey while being held.

Fishladder Entrance. The project and Tribal biologists have deemed the existing collection box undersized. It is being enlarged based on their recommendations.

3.1.2.3 *LPS Drainage*

The LPS system must be designed to allow for maintenance, which may include drainage. Drainage is also used to fine tune the flow into the headboxes that feed the lamprey traversing ducts, as the pumps or gravity intakes must be somewhat oversized to assure the required discharge rates. Provisions will be provided to allow fish to be salvaged during the drainage operations (likely refuge pools in resting boxes).

3.1.3 Rounded Weir Crests

Rounded weir crests are proposed to be installed atop the upper most leaf of the existing weirs of the JDA South Fishladder. These radiused crests provide lamprey passage access through the high entrance velocities (8 to 12 ft/s) by means of attachment. The radii of the rounded crests are dependent on the girth of the currently flat weir top surface. However, they should not be less than 4-inches minimum.

There are three entrance weirs in the JDA South Fishladder:

- Two narrow weirs at the North entrance area (North end of Powerhouse Collections Channel).
  - North Entrance concrete sill elevation = 150 feet NGVD 29.
- One wider (12-foot) weir at the South Entrance (South end of Powerhouse).
  - South Entrance concrete sill elevation = 146 feet NGVD 29.

Specific weir drawings of the existing south fishladder entrance weirs could not located, but they have usually or always been designed so that the tops of the weirs match the adjacent concrete invert when bottomed out. Section 2.4.2.3 of Chapter 4 (JDA) of the USACE 2021 Fish Passage Plan mandates the following criteria for the fishladder entrance at JDA:

- Maintain main entrance weir depths at 8 feet or greater below tailwater. Maintain tailwater elevation above 158 feet mean-sea-level to stay within criteria operating range for entrance weirs.

The proposed rounded crest will raise the minimum invert of the weir top by the amount of the radius. This means the two weirs at the North entrance would no longer meet the 8-feet of tailwater submergence criteria at minimum operating tailwater elevation. The only way to avoid this would be to structurally modify the upper leaves of the north weirs so that the tops are lowered sufficiently to accommodate the radial increase. As this would be a time consuming and expensive endeavor, it is more probable that rounded crests will not be added to the north entrance weirs.

This complication does not exist at the South Entrance weir, assuming the top of the existing weir matches the 146-foot elevation concrete invert when the weir is bottomed out. There is ample elevation elbow room to add the rounded weir crest to the south entrance weir. It is anticipated that the addition of weir caps at this entrance location will provide significant Lamprey passage improvement benefits.

3.2 DESIGN CRITERIA

The following design criteria pertain the hydraulic design of key components of the proposed lamprey improvements.

3.2.1 Lamprey Passage System (LPS) Criteria

Most of the following LPS criteria are obtained from Zobott, et.al. 2015. Technical Report 2015-5, Design Guidelines for Pacific Lamprey Structures. Additional criteria are derived from engineering experience and judgement, and biological consultation.

3.2.1.1 *LPS Flow Rates*

- Design LPS flow rate = 124 gpm (0.28 cfs) for standard 20-inch wide LPS flumes.
    - Minimum interim operating flow rate = 62 gpm (0.14 cfs).
- Add 20 gpm for holding Lamprey in Collection Box.
    - Round up total to allow for flow adjustments.
- Total design water supply = 160 gpm (0.36 cfs).

3.2.1.2 *Intake Screens for LPS Water Supply Sources*

- Intake screens are required to meet fish passage facility requirements for juvenile salmon detailed in NMFS (2011).
- The applicable requirements indicate an approach velocity less than 0.2 ft/s and a maximum square screen mesh size of 3/32-inch to prevent impingement or entrapment of juvenile salmonids.
- Screen must be accessible for periodic cleaning.
- The above criteria might be waived if it can be shown that the risk of entraining juvenile fish is very low at the source.
    - This would have to be coordinated with the fishery agencies.

3.2.1.3 *Collection Box*

- Minimum recirculation flow = 20 gpm.
- Volume shall be coordinated with Project biologists.
- Drainage capability must be provided.

3.2.1.4 *LPS Drainage*

- Drainage must be adjustable by means of either valve or adjustable weir.

3.2.2 Rounded Weir Crests

- Minimum radius of round crest is 4 inches.
- Following installation of the rounded crest, the weir crest elevation at fully lowered setting shall not exceed 150 feet NGVD 29.

3.3 DESIGN METHODS

Normal one-dimensional calculations will be prepared in development of design features, operations, and PDT support.

3.4 DESIGN FEATURES

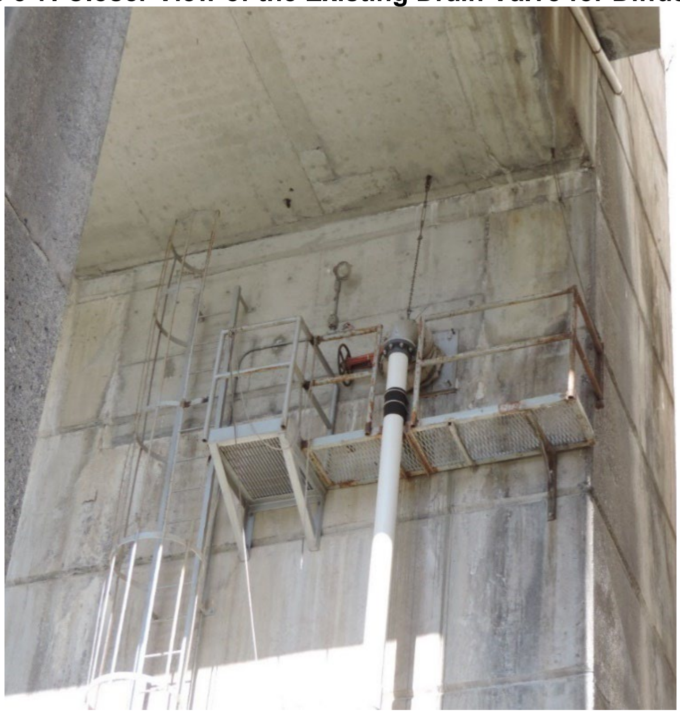
3.4.1 LPS Water Supply

The estimated design flow rate for a standard sized LPS is 160 gpm (0.36 cfs). There is ample flow supply to both allow for flow adjustment and provide for the collection box lamprey holding requirement (20 gpm).

The proposed water supply source is gravity fed from an existing Diffuser 16 drainage pipe, shown in Figure 3-7 and Figure 3-8. Note the breather device to release or supply the air in the pipe in Figure 3-7.

Figure 3-6. Drainage Pipe for Diffuser 16 on Upper North Fish Ladder

Figure 3-7. Closer View of the Existing Drain Valve for Diffuser 16.



3.4.2 Diffuser 16

Diffuser 16 is located between the Exit Section and Count Station and supplies auxiliary forebay water as needed to assure the upper fish ladder operates under design ladder head. The diffuser grating is 13 by 24 feet, or 312 square feet in area. Diffuser 16 is supplied from a 3-foot diameter auxiliary water pipe from the forebay. Normal diffuser flow is between 12 to 45 cfs, depending on ladder head (1.0 to 1.3 feet) assuming a typical forebay elevation of 263 feet.

Figure 3-8 shows an As-built Plan and Elevation View of Diffuser 16. The plan view is on the left and elevation view on the right. No drawings of the diffuser drainpipe could be found; however, the location and size of the diffuser 6-inch drainpipe intake was confirmed during a PDT site visit of the dewatered fish ladder during December 2021.

The diffuser drainpipe is located at near the bottom of the south side of an 8.5-foot-deep basin, as shown in the left figure of Figure 3-8. The 3-foot diameter AWS pipe from the Forebay discharges into the same basin from the opposite side. Flow and velocity vectors are shown in both views. The average velocity through the inflow portal from the basin into the diffuser basin is shown for a range of medium forebay levels and ladder head operations.

Assuming the normal operation of the Exit Section under 1-foot sills, Figure 3-9 shows Exit Channel flow rate, diffuser flow rate, and average net velocities going out of the inflow/drain portal as a function of Forebay elevation and ladder head. The portal velocities incorporate the deduction of the 0.36 cfs LPS supply. The upper part of the figure pertains to the normal 1-foot ladder head operations and the second part pertains to the typical shad operations that normally occurs in June and July when lamprey are passing. Likewise, Figure 3-10 shows the same information under operation of the Exit Section under high sills, needed for the highest forebay elevations.

If the forebay exceeds 264.5 feet, the Exit Channel sills needs to be raised to high sills, at which the Exit Channel Flow rates will be reduced and the diffuser rates increased. The Project staff report that the sills have not changed in at least 5 years.

Figure 3-8. As-built Plan and Elevation Views of Diffuser 16.

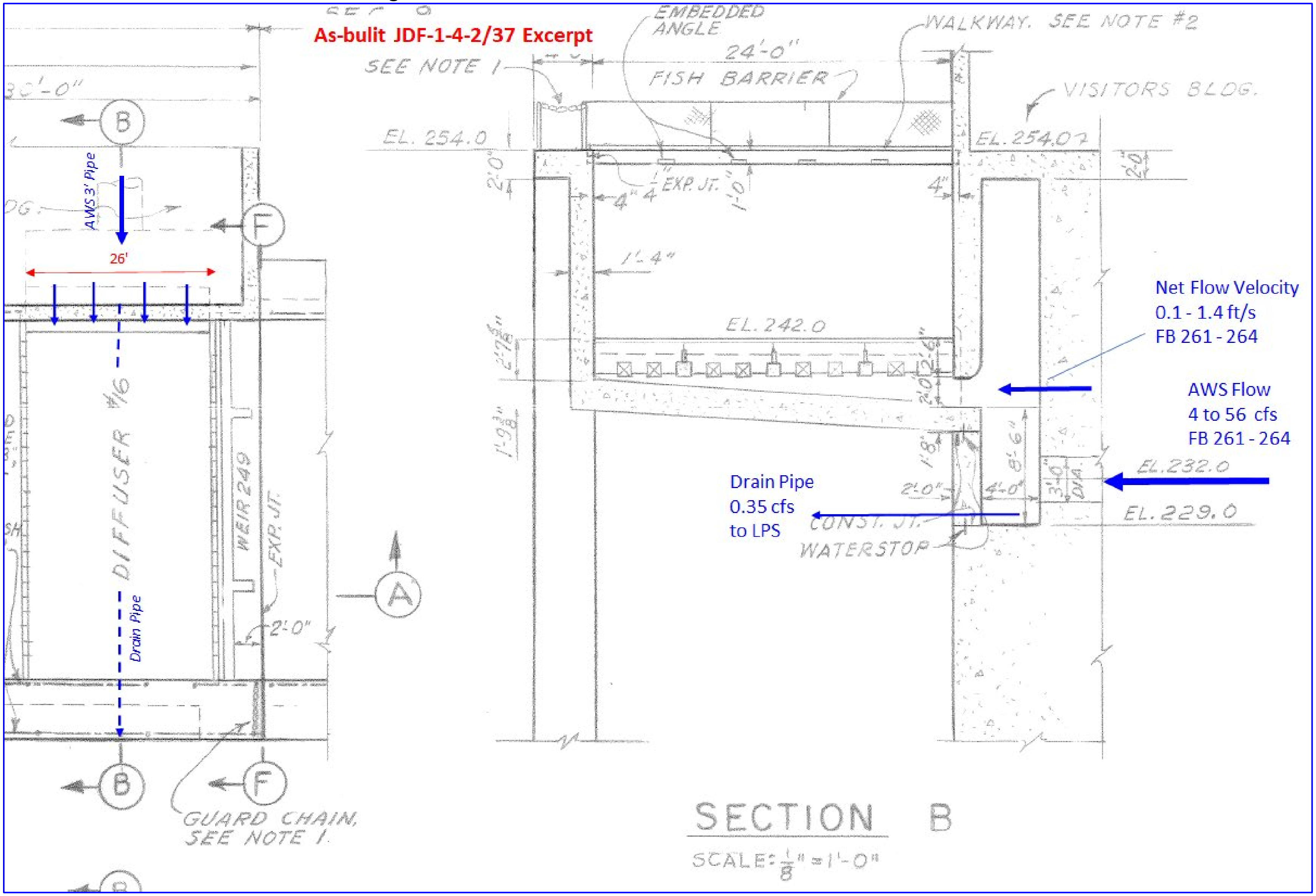


Figure 3-9. Diffuser 16 Flow Rates; Normal Low Sill Settings

Operational Conditions				Diffuser 16 Operation		
	Exit Channel	Upper Ladder OP				
Forebay (ft)	1' Sills Exit Channel Flow Rate (cfs)	Ladder Head (ft)	Ladder Flow (cfs)	Flow (cfs)	Screen Velocity (ft/s)	Net Inflow/Drain Portal Velocity
257	31.8	1.0	85.0	53.2	0.17	1.3
258	37.7	1.0	85.0	47.3	0.15	1.2
259	44.0	1.0	85.0	41.0	0.13	1.0
260	50.5	1.0	85.0	34.5	0.11	0.9
261	57.8	1.0	85.0	27.2	0.09	0.7
262	65.0	1.0	85.0	20.0	0.06	0.5
262.5	68.8	1.0	85.0	16.2	0.05	0.4
263	72.8	1.0	85.0	12.2	0.04	0.3
264	81.4	1.0	85.0	3.6	0.01	0.1
265	89.0	1.0	85.0	0.0	0.00	0.0

Operational Conditions				Diffuser 16 Operation		
	Exit Channel	Upper Ladder OP				
Forebay (ft)	1' Sills Exit Channel Flow Rate (cfs)	Ladder Head (ft)	Ladder Flow (cfs)	Flow (cfs)	Screen Velocity (ft/s)	Net Inflow/Drain Portal Velocity
257	31.8	1.3	113.4	81.6	0.26	2.0
258	37.7	1.3	113.4	75.7	0.24	1.9
259	44.0	1.3	113.4	69.4	0.22	1.7
260	50.5	1.3	113.4	62.9	0.20	1.6
261	57.8	1.3	113.4	55.6	0.18	1.4
262	65.0	1.3	113.4	48.4	0.16	1.2
262.5	68.8	1.3	113.4	44.6	0.14	1.1
263	72.8	1.3	113.4	40.6	0.13	1.0
264	81.4	1.3	113.4	32.0	0.10	0.8
265	89.0	1.3	113.4	24.4	0.08	0.6

Note. Diffuser 16 Flow Rates and Velocities as Function of Forebay and Ladder Operations. Part A: Normal Low Sill Settings for Medium to Low Forebay Elevations.

Figure 3-10. Diffuser 16 Flow Rates; High Sill Settings

Operational Conditions						
	Exit Channel	Upper Ladder OP		Diffuser 16 Operation		
	High Sills					
Forebay (ft)	Exit Channel Flow Rate (cfs)	Ladder Head (ft)	Ladder Flow (cfs)	Flow (cfs)	Screen Velocity (ft/s)	Inflow/Drain Portal Velocity (ft/s)
261	51.6	1.0	85.0	33.4	0.11	0.8
262	45.4	1.0	85.0	39.6	0.13	1.0
262.5	42.1	1.0	85.0	42.9	0.14	1.1
263	38.8	1.0	85.0	46.2	0.15	1.1
264	31.9	1.0	85.0	53.1	0.17	1.3
265	24.6	1.0	85.0	60.4	0.19	1.5
266	17.0	1.0	85.0	68.0	0.22	1.7
267	9.0	1.0	85.0	76.0	0.24	1.9
268	0.0	1.0	85.0	85.0	0.27	2.1

Operational Conditions						
	Exit Channel	Upper Ladder OP		Diffuser 16 Operation		
	High Sills					
Forebay (ft)	Exit Channel Flow Rate (cfs)	Ladder Head (ft)	Ladder Flow (cfs)	Flow (cfs)	Screen Velocity (ft/s)	Net Inflow/Drain Portal Velocity
261	51.6	1.3	113.4	61.8	0.20	1.5
262	45.4	1.3	113.4	68.0	0.22	1.7
262.5	42.1	1.3	113.4	71.3	0.23	1.8
263	38.8	1.3	113.4	74.6	0.24	1.9
264	31.9	1.3	113.4	81.5	0.26	2.0
265	24.6	1.3	113.4	88.8	0.28	2.2
266	17.0	1.3	113.4	96.4	0.31	2.4
267	9.0	1.3	113.4	104.4	0.33	2.6
268	0.0	1.3	113.4	113.4	0.36	2.8

Note. Diffuser 16 Flow Rates and Velocities as Function of Forebay and Ladder Operations. Part B: High Sill Settings for Medium to High Forebay Elevations

3.4.3 Juvenile Fish Screen

A juvenile fish screen under the Diffuser 16 grating has been a potential requirement pending consultation with the Fishery Agencies. The concern is potential entrainment of juvenile fish into the LPS supply pipeline. Based on the recent findings and analyses described in Section **Error! Reference source not found.**, the use of the 6-inch drain pipe for the LPS water supply has been deemed a very low risk of entraining juvenile fish and screening is not required, pending juvenile fish capture numbers from future operations. If juvenile fish are getting captured by the LPS supply pipe, they will be easily detected as they will turn up in the LPS upwelling box.

The existing pump system should remain in place as a backup system if unacceptable numbers of juvenile fish are detected in the proposed gravity supply system.

If screening were to be required, the minimum fish screen size is 2 square feet (rounded up) based on the maximum screen velocity of 0.2 ft/s. The estimated head loss through a typical fish screen under 50 percent blockage is only 0.01 feet under design LPS flow.

During the December 2021 site visit, no feasible location for a juvenile fish screen under Diffuser 16 could be determined. A screen located directly over the 6-inch drain intake would be deep in the 8.5-foot basin and would be difficult to access even when dewatered. Another possibility would be to place the screen over 2-foot-high by 20-foot-wide inflow/drain portal (See upper left flow arrow in **Error! Reference source not found.**).

While this would provide ample screen area, the primary drawback would the accumulation of debris from the inside of the 8.5-foot-deep basin from the normal operation of the 3-foot AWS pipe from the forebay. The clearance in the bars of the Forebay AWS intake trashrack is 5/8-inches. With the larger openings in the forebay trashrack, debris accumulation would be inevitable behind the 1.75-mm (0.068 inches, or 9 times smaller than 5/8 inches) fish screens. Cleaning the screens would require dewatering the ladder and temporary removal for cleaning.

Assuming the fish screen cannot be moved away from the drain intake prior to annual fish ladder drain operations, the fish screen would need to be large enough to accommodate the significantly higher drain flow. As the drainpipe is 6-inch diameter, the maximum drain flow rate is 6.2 cfs. Options for screen size versus various screen velocities under maximum drain flow are shown in **Error! Reference source not found.Error! Reference source not found.**. The upper row represents the minimum screen size as previously described. The right column shows the estimated headloss for a 50 percent blocked fish screen.

Table 3-1. Screen Size versus Screen Velocity (Vscr) at Maximum Drain Flow

Vcsr (ft/s)	Area (ft^2)	Square Dim (feet)	50% Block Headloss (feet)
3.1	2.0	1.5	2.58
0.2	40.0	6.4	0.01

As stated previously, a juvenile fish screen is not in the design plans due to the low risk of juvenile fish entrainment into the LPS water supply system.

3.4.4 Water Supply Pipe and Valves

The new LPS water supply pipe will wye off from the drainage pipe at the foot of the elevated ladder structure. From there, the pipe will either run alongside of the fish ladder columns or off the guard rail on the fish ladder. The pipe will then make a 90-degree turn under or around the turning pool and connect with the new Lamprey collection box and existing LPS flume.

Figure 3-11 shows a new air vent attached to the existing Diffuser 16 drainage pipe at a raised elevation compared to the existing vent. Valves were placed on the deck in order to more easily isolate the LPS supply pipe. Figure 3-12 shows the 3-inch control valve at the new collection box and a drain valve to release the excess and used recirculation flow from the box.

Figure 3-11. New Air Vent Attachment on Drainage Pipe

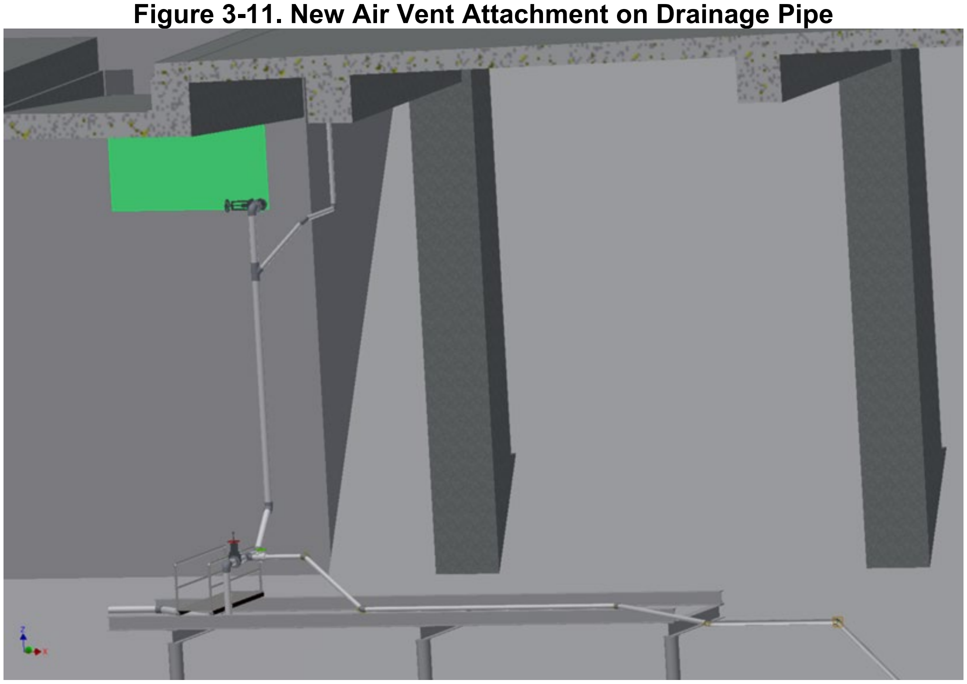
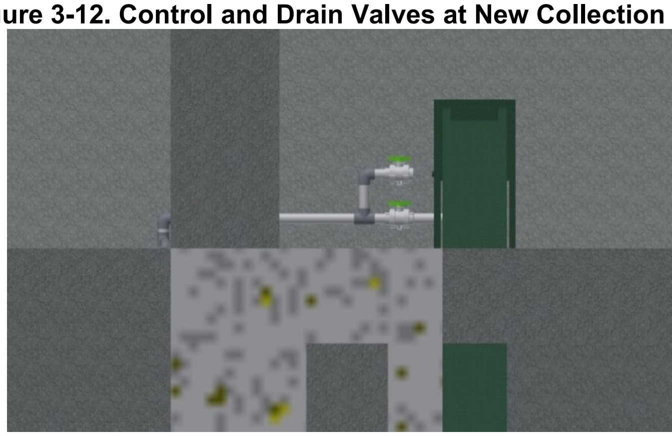


Figure 3-12. Control and Drain Valves at New Collection Box



The available total head to the water supply system is the normal ladder diffuser pool of EL 249 feet minus the collection box water surface EL 190 feet is 59 feet.

While the size of the upstream isolation valve should match the proposed 4-inch pipe size, the size of the initial downstream control valve should be downsized to 3-inches to assure the valve is operated between 20 to 70 degrees for more accurate and adjustable flow controllability.

3.4.5 Summary Design Bullets

- Design flow rate:
  - LPS + Collection Box: 160 gpm = 0.36 cfs
- Upstream Head:
  - Diffuser 16 Grating Invert Elevation: 243 feet, NGVD 29
  - Flow depth above grating: 6 feet
  - Total Available Upstream Head: 249 feet, NGVD 29
- Downstream Elevation
  - 185 Tailrace Deck: 185 feet, NGVD 29
  - Height of Collection Box: 5 feet
  - Downstream Collection Box Elevation: 190 feet, NGVD 29
- Available operating head: 59 feet
- Existing 6-inch pipeline to new LPS junction:
  - Pipe length ≈ 53 feet
  - Sum of minor loss coefficients: 1.24
  - Headloss under LPS flow rate 0.25 feet
  - New 6-inch isolation valve downstream of junction to LPS Pipe
- New LPS pipe to Upwelling Box
  - 4-inch Pipe length ≈ 320 feet
  - Sum of minor loss coefficients: 3.96
  - Pipe Diameter = 4-inches
  - Headloss under LPS flow rate 1.1 feet
- LPS Pipe Valves
  - Upstream isolation 4-inch gate, ball, or butterfly valve
  - Downstream control 3-inch butterfly, ball, or globe valve

The computations for LPS flow requirements, fish screen, pipe sizing and valve sizing for effective controllability are provided in Appendix B, Item B-1.

A new air vent is being added to the vertical section of the existing 6-inch drainpipe near the top of the pipe to better assure drainage and prevent excessively low subatmospheric pressures within the pipe. A new air vacuum valve will also be needed downstream of the new 6-inch isolation valve in the existing 6-inch pipe just downstream of the junction to the LPS pipe. This is to assure the remainder of the 6-inch pipe will drain when the 6-inch valve is closed.

In the LPS pipeline, a small combination air vacuum and air release valve will be included just downstream of the new 4-inch isolation valve after the wye off the main 6-inch drain pipe. Also, air release valves should be located at high points in the new pipe alignment and near vertical elbows where the pipe drops precipitously. Drain valves are to be included at the low points in the system.

The design drawings for the LPS supply pipe are shown sheets M-101 and M-501 of the DDR plan drawings.

SECTION 4 - STRUCTURAL DESIGN

The Lamprey Passage work at John Day North and South Fish Ladders, has new structural features that will be constructed using a combination of new and existing carbon steel as described in the following paragraphs.

4.1 DESIGN ASSUMPTIONS

The following design assumptions were made:

- Lampreys require rounded corners and smooth transition surfaces to navigate the fish ladder.
- Lamprey can fit into small spaces and cracks, anything larger than 3/4-inch.

4.2 DESIGN CRITERIA

The design criteria contain reference and material properties.

4.2.1 Material Properties

The material properties for the new and existing structures are as follows:

- Structural Steel
  - (ASTM A36) Bars, beams, plates, and angles: fy = 36,000 psi.
  - (ASTM A500, Grade B) HSS Square and rectangular shape: fy = 46,000 psi.
  - (ASTM A572, Grade 50) Plates, bars, and beams: fy = 50,000 psi.
- Grating
  - Galvanized carbon steel grating. 1-1/2 inches tall.
- Handrailing
  - Galvanized carbon steel railing.

4.3 DESIGN STANDARDS

This section describes the general building and design standards, as well as the design loads.

Concrete: Concrete, precast concrete, and prestressed concrete design will conform to EM 1110-2-2104 for hydraulic structures and ACI 318-19 for other structures. Concrete construction will also conform to EM 1110-2-2000.

Structural Steel and CRES: Designs for features made of these materials will conform to ETL 1110-2-584 for hydraulic steel structures and to AISC “Specifications for Structural Steel Buildings” for other structure features. All welding will conform to the American Welding Society Structural Welding Code, Current Edition, for the appropriate material.

Hydraulic Structures: For structural design, hydraulic structures are all permanent structures. Non-hydraulic structures include all temporary structures and features that are not submerged, like the maintenance platform at the north ladder and handrailing for the water pipe.

The hydraulic structures are the South Entrance Fishway Weir/Bulkhead Mod.

Lamprey Passage Structures: A new lamprey passage structural will be designed for this work. This will be designed by the mechanical engineer and is not considered a hydraulic structure.

4.3.1 Design Loads

Risk Category and Importance Factors: All structures as part of this project are designed as Risk Category II. Importance factors are selected accordingly.

Dead loads: The structural system for all features will be designed and constructed to safely support all dead loads, permanent or temporary, including but not limited to self-weight, concrete, metal, and fixed equipment. Concrete weight is assumed to be 150 pounds per cubic foot (PCF). Steel weight is assumed to be 490 PCF (0.283 PCF) per AISC manual. Aluminum unit weight of 0.098 pounds per cubic inch (170 PCF) will be used and is based on Aluminum Association values for structural shapes and plates.

Wind: Wind loading is determined in accordance with ASCE 7-16, Chapters 26 to 30. The design wind speed is 99 miles per hour (MPH).

Snow: Snow loading is determined in accordance with ASCE 7-16, Chapter 7. Ground snow load is 24 pounds per square foot (PSF).

Ice: Ice loading is determined in accordance with ASCE 7-16, Chapter 10.

Hydrostatic/Hydrodynamic: Permanent structural features exposed to flow of the stream shall be designed to resist static and hydrodynamic forces due to river flows of a 100-year event.

Seismic: Seismic loads will be based on requirements of the International Building Code 2018 and ASCE 07-16 documents. These loads are based on the operational basis earthquake (OBE). The inertial dynamic force due to water is determined using Westergaard's equation:

Equation 4-1. Westergaard's Equation

$$p = \frac{7}{8} * W * a_c * \sqrt{H * y}$$

Where:

- p = hydrodynamic pressure.
- W = unit weight of water.
- a_c = the maximum base acceleration of the dam (expressed as a fraction of gravitational acceleration).
- H = the reservoir height (to the bottom of the dam).
- y = the depth below the pool surface.

Inertial forces due to the self-weight and gravity loads are generally insignificant when compared to the force due to water and don't need to be considered for this project.

Ground motions for this region are:

- Site Class B (typical at John Day Dam)
- Risk Category II (conservatively assumed)
- S_s = 0.413, S_1 = .186 (USGS Ground Motions)
- S_{DS} = 0.248, S_{D1} = 0.099 (USGS Ground Motions)

Silt: Silt loads are based on a 1-inch thick layer of silt which shall be assumed to be acting in all areas where silt can accumulate without the ability to drain. The unit weight of silt is 90 lb/ft^3.

4.4 NEW STRUCTURAL FEATURES

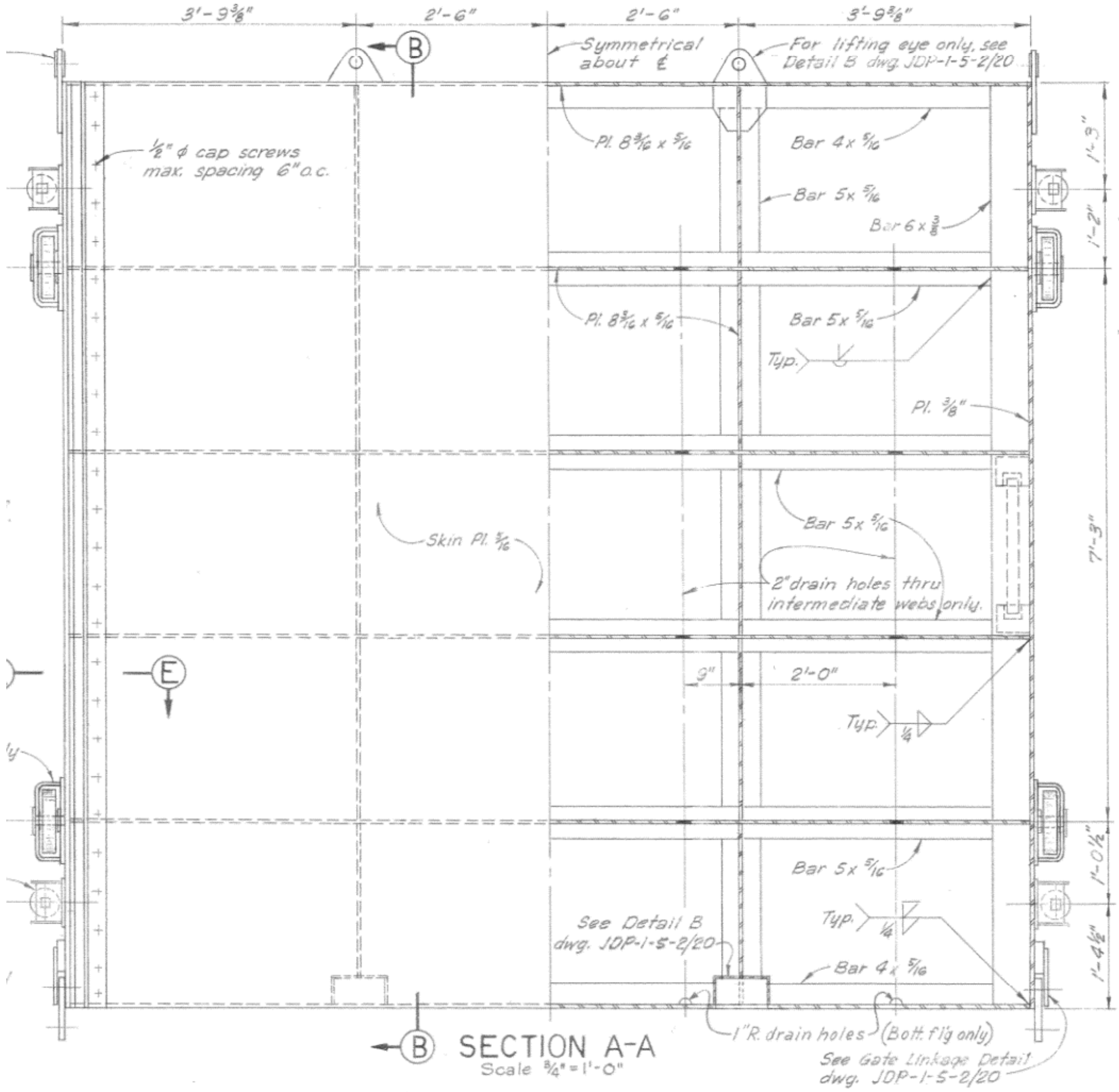
The following list includes the new structural features for this project:

- Weir Modification (South ladder)
- New Maintenance Platform (North ladder)
- Handrailing for Pipe route (North ladder)

4.4.1 Weir Modifications (South ladder)

The South ladder weir modification will consist of one modification, rounding the weir crest. This design has been used at The Dalles Dam on several different weirs. The Dalles weirs will be used as design guides and a baseline for this project. The existing weir is built of structural carbon steel with an upstream skin plate, shown in Figure 4-1.

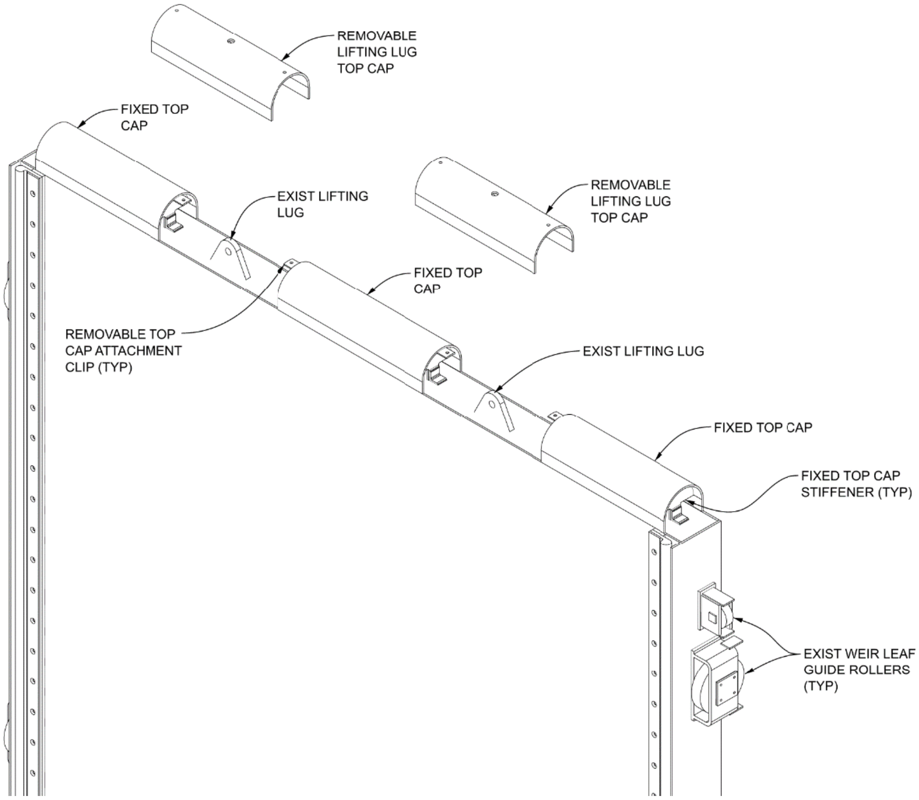
Figure 4-1. Existing Weir, Upstream (left), Downstream (right)



The rounded crests will be constructed from a rounded carbon steel plate attached to the top of weir. The purpose of this addition is to allow easier lamprey passage over the weir and into the ladder. The current weir has sharp edges on its crest, which is not conducive for lamprey passage. The rounded crest will have a 4-inch minimum radius (lamprey preferred). Only one entrance weir gate will require a rounded crest.

The rounded weir crests mod is shown in Figure 4-2.

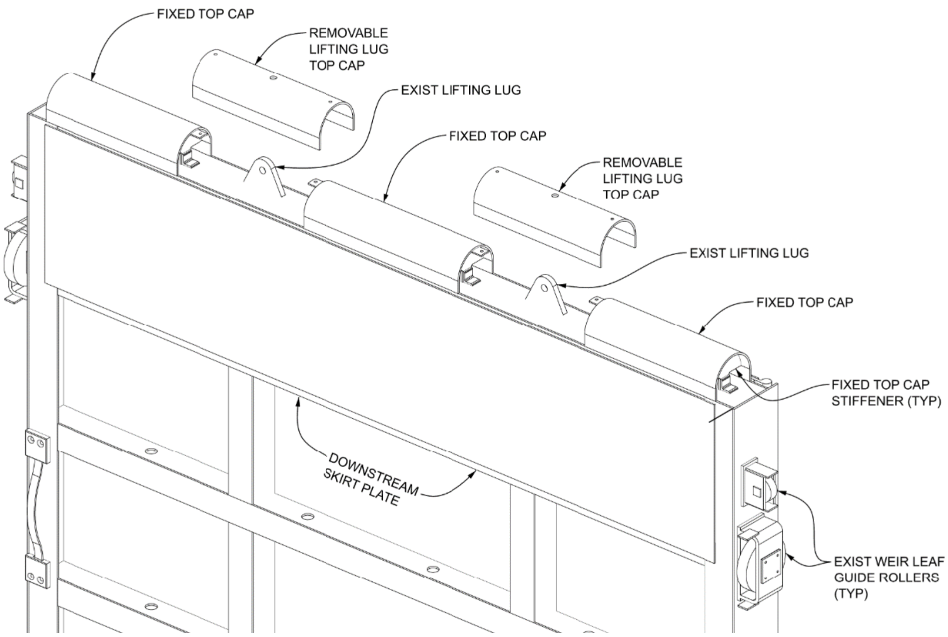
Figure 4-2. Upstream Side of Weir showing Rounded Top Cap Mod



Portions of the rounded cap can be removed to access the lifting lugs. The rest of the rounded cap will be permanent and welded to the top of the weir. The removable caps screw into place via tabs attached to the underside of the permanent caps. The lifting lugs are used to remove the weir from its slot. The weir moves up and down via extension arms, attached to the weir ends in its guide slot. These arms function as plate slot covers and will keep lamprey from getting stuck between the weir and the guide slot.

Figure 4-3 shows the downstream side of the weir. This is the direction lamprey will enter the ladder. An additional 2-1/2 foot skin plate has been added to allow lamprey to attach their way up and over the weir.

Figure 4-3. Downstream Side of Weir



4.4.2 New Maintenance Platform (North ladder)

A new maintenance platform is required for access to new mechanical piping, adjacent to the existing platform near the North ladder. The existing platform consists of a single 32.5-inch wide walkway spanning 11 feet. The new platform will increase the size of the existing platform to 55-inches wide. The added width will line up with an existing beam that the new mechanical pipe will use as support, allowing maintenance crews access to the new piping.

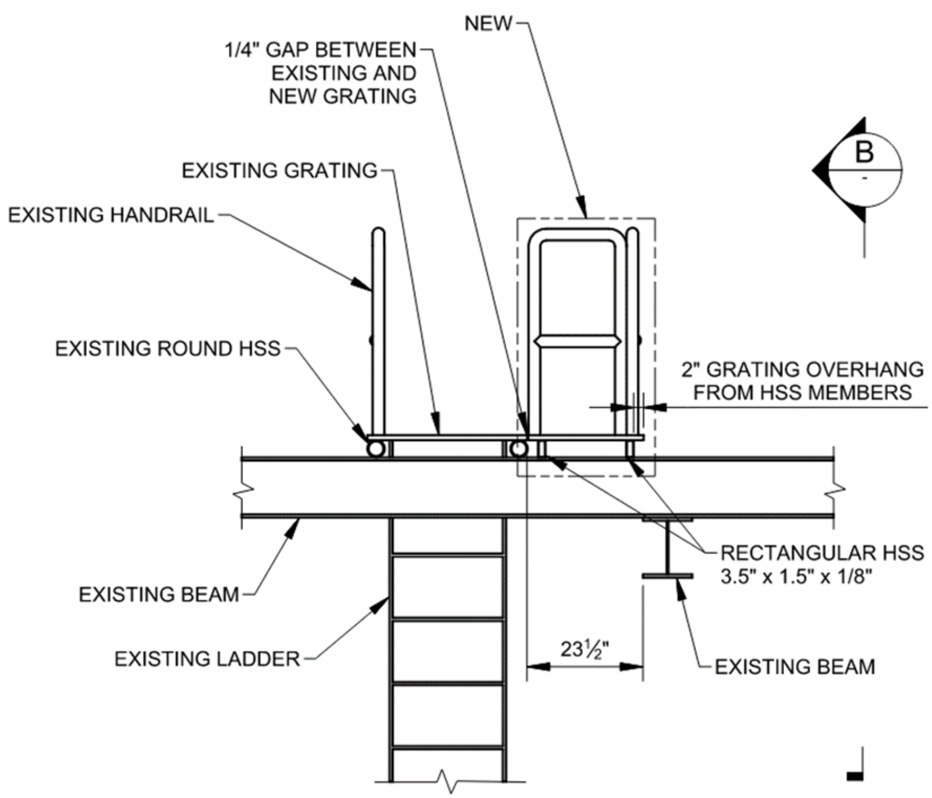
The new platform will be supported by two, 3.5-inch by 1.5-inch by 1/8-inch rectangular hydraulic steel structure (HSS) members fillet welded to the existing I beams.

New 1.5-inch tall, carbon steel grating will be used for the platform grating and will be fillet welded to the new rectangular HSS members.

Figure 4-4 shows the general location of the new platform. Figure 4-5 shows a schematic of the new platform next to the old platform.

Figure 4-4: General Location of New Platform

Figure 4-5: New Platform adjacent to Old Platform



The handrail on the existing platform will be shifted to the outside edge of the new platform. Project staff will need to order a new 22.5-inch long handrail for the portion of the platform adjacent to the ladder (shown above). The back edge of the platform butts against the dam and does not require handrailing.

The design team explored several alternatives to save the project funding on material costs. Existing grating was found in the boneyard at JDA; however, it was found to be aluminum and would not work welding with dissimilar metals. There were several sections of extra handrailing laying around the site; however, the maintenance manager informed us those would all be required for various dam work activities.

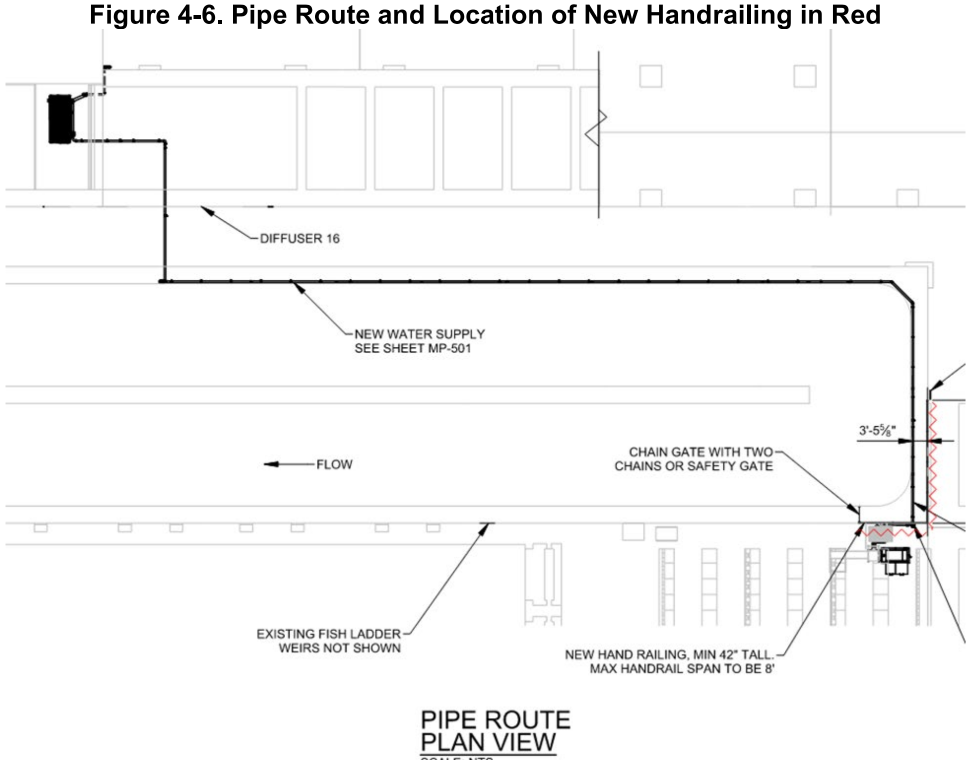
4.4.3 Handrailing for Pipe route (North ladder)

The LPS water supply pipe route runs up and along the length of the North fish ladder. A portion of this route currently requires fall protection to access the pipe. Additional handrailing will be added in this location to allow this area to not require fall protection. A minimum of 35 feet of handrailing is required. They will be anchored by concrete screws.

At the end of the railing, a safety gate or chain gate with signage saying, “Fall Protection required beyond this point” is required. This will keep staff from leaving the non-fall protection area. If a safety chain is used, two chains are required - one at 42-inches height and one below. Each chain must be strong enough to withstand a 200 pound point force in any direction.

Figure 4-6 shows the pipe route and location of handrailing.

Figure 4-6. Pipe Route and Location of New Handrailing in Red



Although it is not shown on Figure 4-6, the other portions of the pipe route already have the required handrailing.

4.5 REMOVAL OF STRUCTURAL FEATURES

No structural features will be removed.

4.6 DESIGN CALCULATIONS

See Appendix A for the design calculations for the new maintenance platform and weir cap.

4.7 DESIGN DECISIONS

The structural design has been finalized.

SECTION 5 - MECHANICAL DESIGN

5.1 GENERAL

5.1.1 Mechanical Scope

The mechanical scope for this project includes design of a new water supply system for the existing LPS and replacement of the existing LPS collection box.

5.1.2 Design Requirements

The key requirements of the mechanical design as of the 100% milestone are:

- Biological constraints.
  - The water supply does not need to be screened per Section 2.2.
- Hydraulic constraints.
  - The water supply must adhere to the hydraulic requirements outlined in Sections 3.2.1.1, 3.2.1.2, and 3.2.1.4.
  - The collection box must adhere to the requirements outlined in Section 3.2.1.3.

5.2 SELECTED ALTERNATIVE

5.2.1 Alternative 3: Gravity Feed from Diffuser 16 Drain

This system diverts the design flow required for the LPS from the drain pipe for diffuser 16, located at the fish counting station. This concept was selected due to low frequency of maintenance, ease of accessibility, high constructability, and low complexity relative to other alternatives described in Section 5.3.

Major features and modifications to existing features are described below. The existing diffuser 16 drainage pipe and its valve are shown in Figure 5-1 and Figure 5-2.

Figure 5-1. Diffuser 16 Drainage Pipe

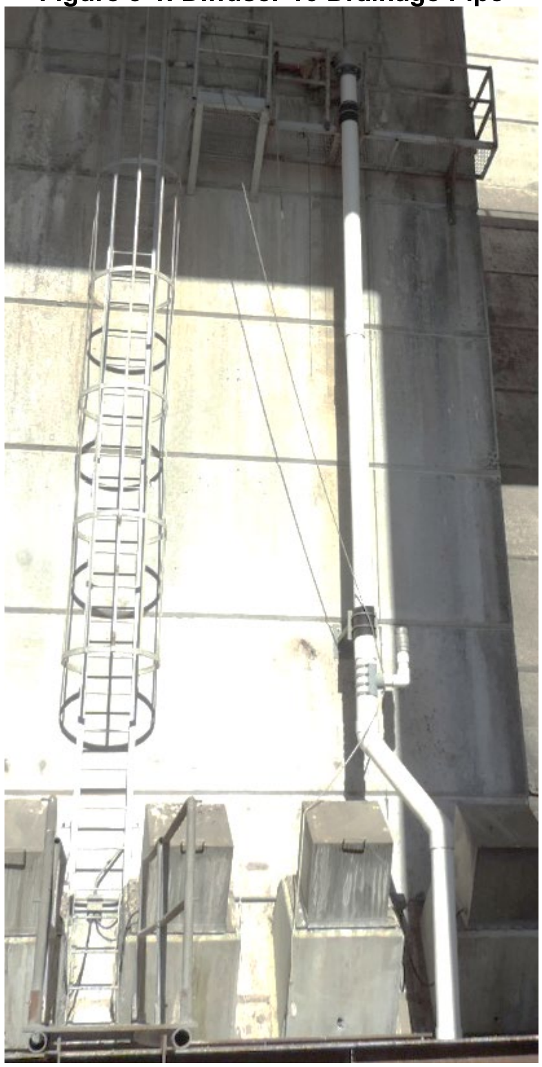
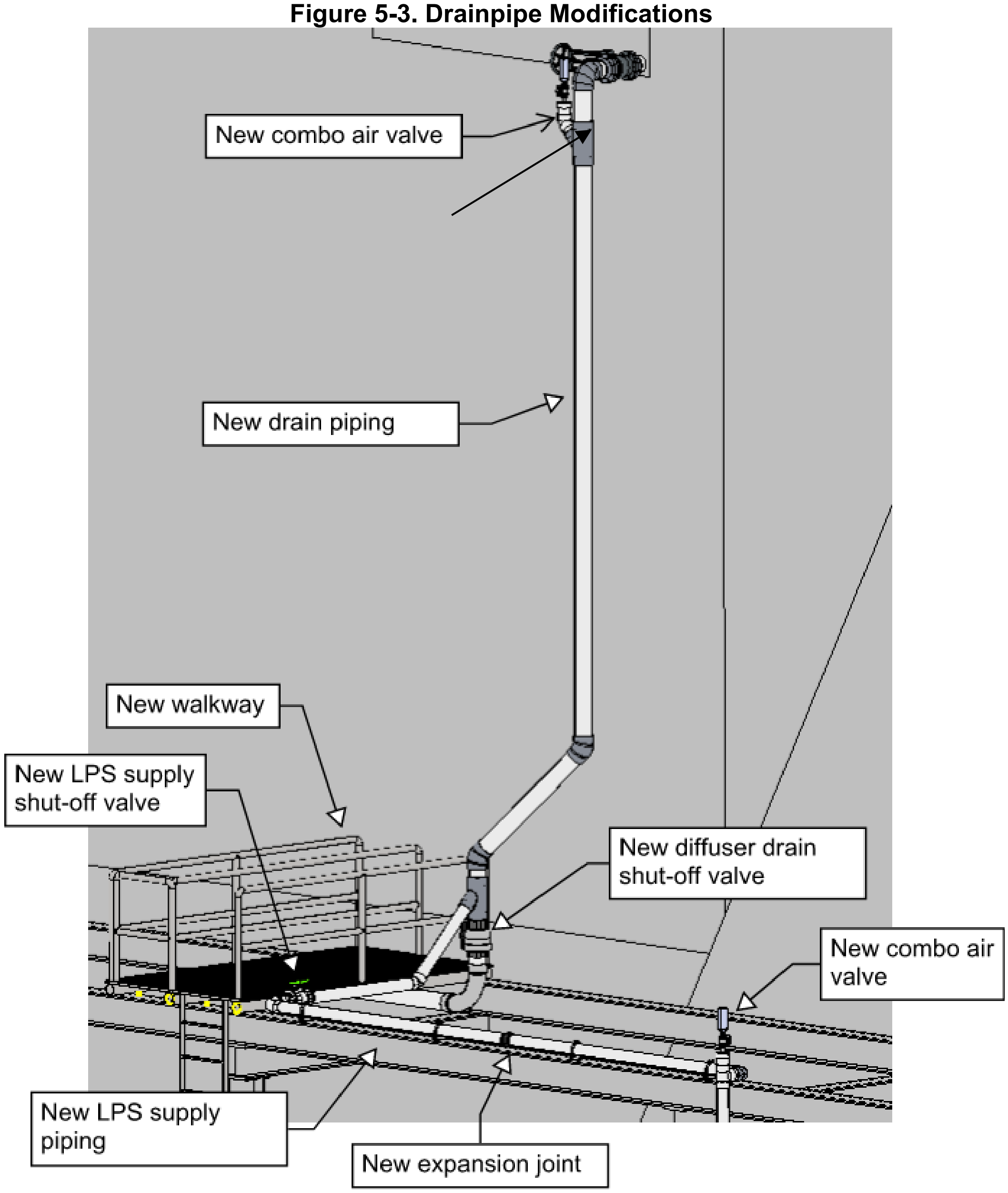


Figure 5-2. Diffuser 16 Existing Drainage Pipe Valve

The diffuser drain pipe is located near EL 229 feet. The lamprey trap is located at EL 185 feet. This provides around 83 feet of head for the system to overcome friction losses due to valves and fittings. The drain pipe will be replaced with schedule 80 PVC piping. The existing air valve will be replaced with a combination air release and vacuum valve and moved further up the drainage pipe. The existing pipe supports will be re-used for the new piping.

A new shut-off valve for the diffuser 16 drain will be located near the new walkway. The LPS water supply piping will connect to the drain pipe just above the new shut-off valve. The LPS water supply shut-off valve will be located next to the new walkway. The LPS supply piping will be supported on the access platform and includes a second combo air valve at the next vertical drop (see Figure 5-3).

Figure 5-3. Drainpipe Modifications

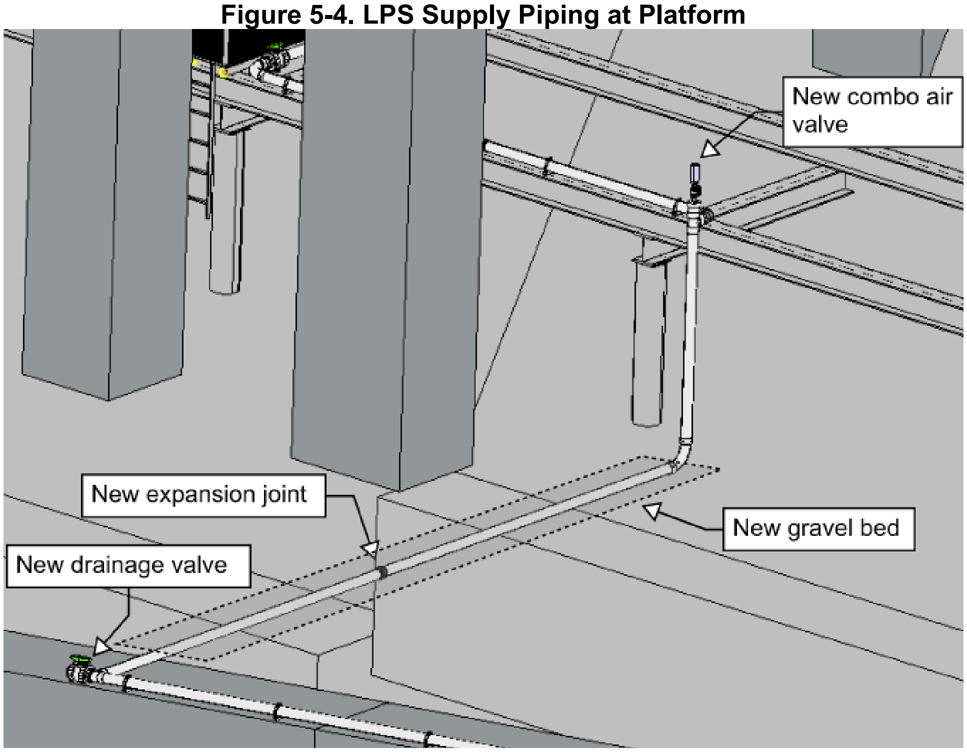


The pipe route will be supported by a new gravel bed between the access platform and the fish ladder. The gravel bed will be 1 foot wide around the centerline of the pipe and filled to a minimum depth of 4 inches using pea gravel with a nominal sieve size of 3/8-inch and the following sieve size gradation per ASTM D422: 100 percent of the pea gravel will be smaller than 1/2-inch, 95 to 100 percent will be 3/8-inch or smaller, 0 to 10 percent will be #8 or smaller, and 0 percent will be #200 or smaller.

Guarding will be installed to protect the pipe from foot traffic. Suggested locations are shown on the plan drawings.

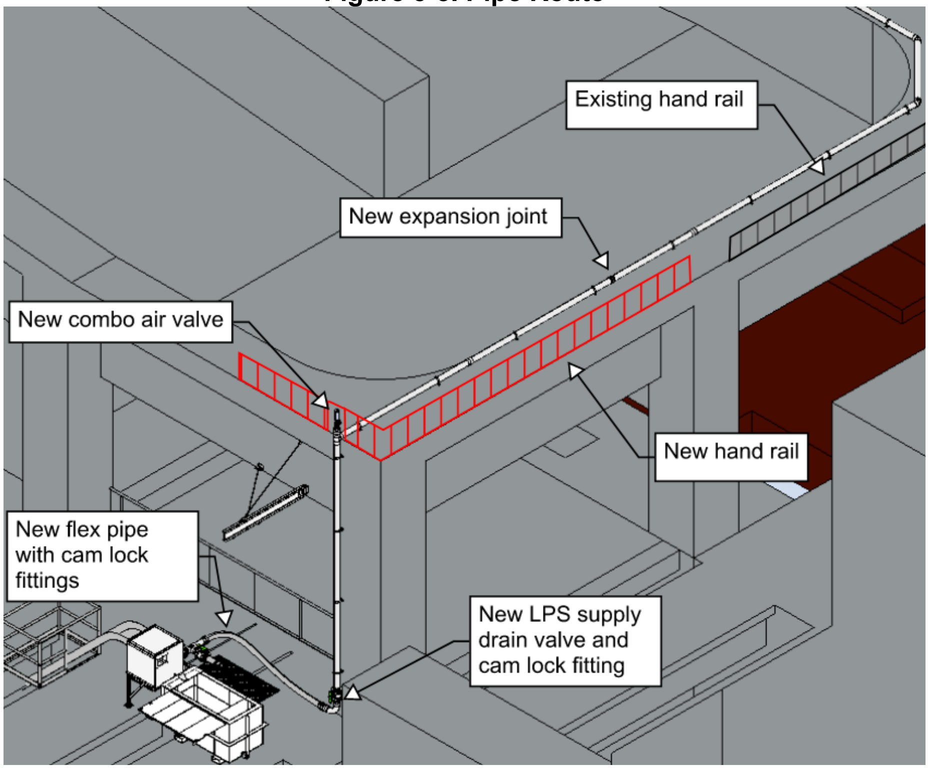
A new drain valve for the LPS supply piping is located at the fish ladder (Figure 5-4).

Figure 5-4. LPS Supply Piping at Platform



The piping will be supported on unistrut and follows the same slope as the fish ladder. The pipe is routed along the downstream side of the walkway and requires new safety railing to facilitate access. The vertical drop to the deck elevation includes a third combo air valve. A flexible pipe with cam lock fittings will be used to connect the LPS supply piping to the upwelling box manifold uses a flexible pipe. This allows workers to remove the piping and clear the walkway when the LPS is out of service (see Figure 5-5). The proposed safety rail location is shown in red.

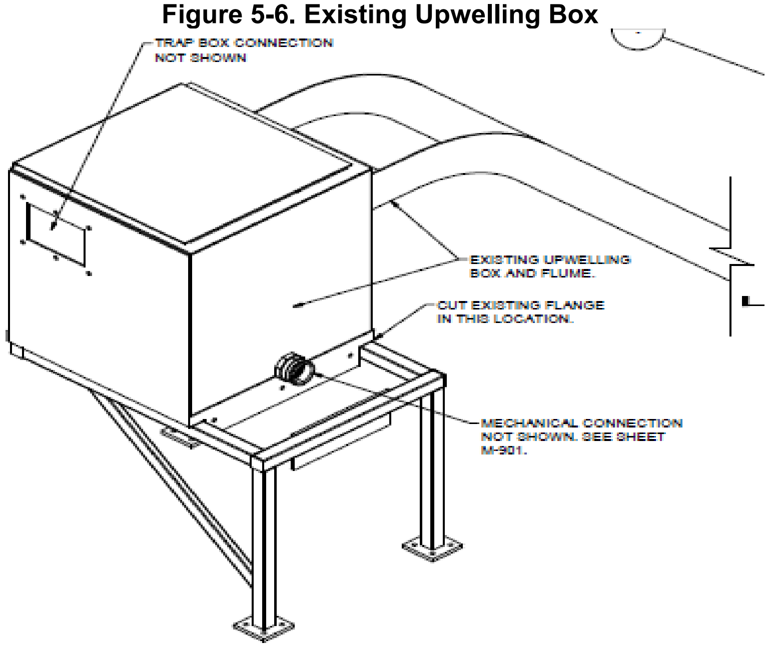
Figure 5-5. Pipe Route



5.2.2 Upwelling Box

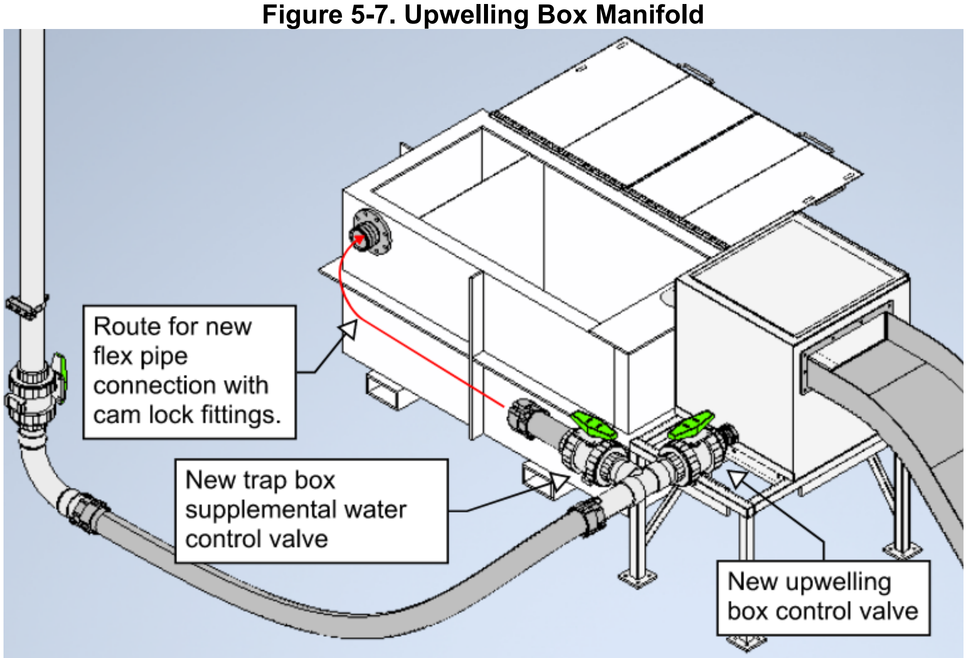
The existing LPS uses an upwelling box to provide water to the LPS flume and the collection box. The existing collection box will be replaced with a larger tank per the requirements of Sections 3.1.2.2 and 3.2.1.3. The existing upwelling box will remain in service (see Figure 5-6).

Figure 5-6. Existing Upwelling Box



A new manifold will connect the LPS supply piping to the upwelling box. The manifold will use two control valves. One valve will control flow into the upwelling box. A portion of the remaining flow will be diverted into the new trap box as supplemental supply water. This allows the system to eliminate heat transferred from the environment into the trap box (see Figure 5-7).

Figure 5-7. Upwelling Box Manifold



5.2.3 Collection Box

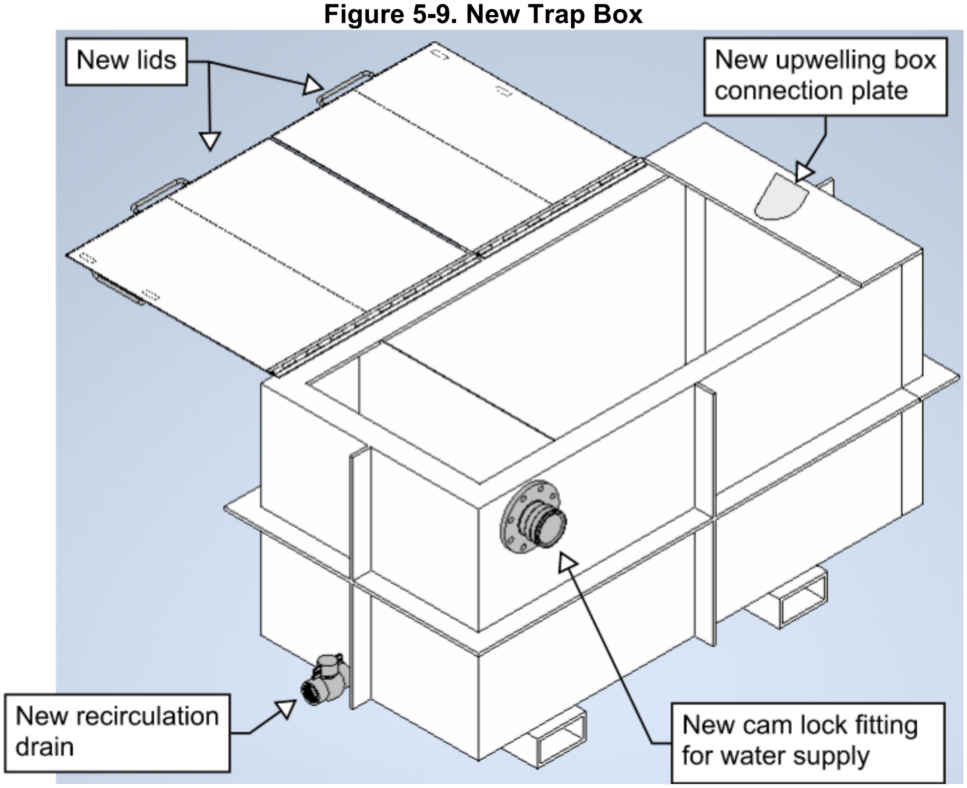
A new collection box will be fabricated using an existing collection tank. The existing collection tank is constructed of welded, 1/2-inch aluminum alloy plate. The type of alloy is unknown. See Figure 5-8 for the existing collection tank proposed for modification.

Figure 5-8. Existing Collection Tank

The existing collection tank will be reduced to a volume of 500 gallons. All existing piping will be removed. Existing holes will be sealed and welded water tight with the interior sides ground smooth, with the exception of a floor drain behind the interior perforated screen. The screen will remain in place to protect the new water supply connection, a new recirculation drain, and the existing floor drain.

The existing lid is split in two with each side weighing around 150 pounds. The existing lids require a counterbalance system to open. New lids will be fabricated from 1/8-inch 5052 aluminum plate. This will reduce the weight of each lid to around 20 lbs. Each lid will be connected to the trap box using piano style hinges. The lids will have weld-on handles and include 1/8-inch aluminum stiffeners to help maintain the shape of the lid. The upwelling box exit chute connection will be reused. See Figure 5-9 for the features of the new trap box. The existing perforated plate is shown without holes.

Figure 5-9. New Trap Box



5.3 WATER SUPPLY SYSTEM ALTERNATIVES

5.3.1 Alternative 1: Gravity Feed from Fish Ladder

This solution would divert the design flow required for the LPS from the fish ladder. It is based on a solution previously proposed during the Phase 3 LPS project for the John Day North Fish Ladder LPS (see Figure 5-10). This concept can be effectively screened per fry criteria at the inlet and outlet piping to prevent entry into the wet well, or screened at the wet well.

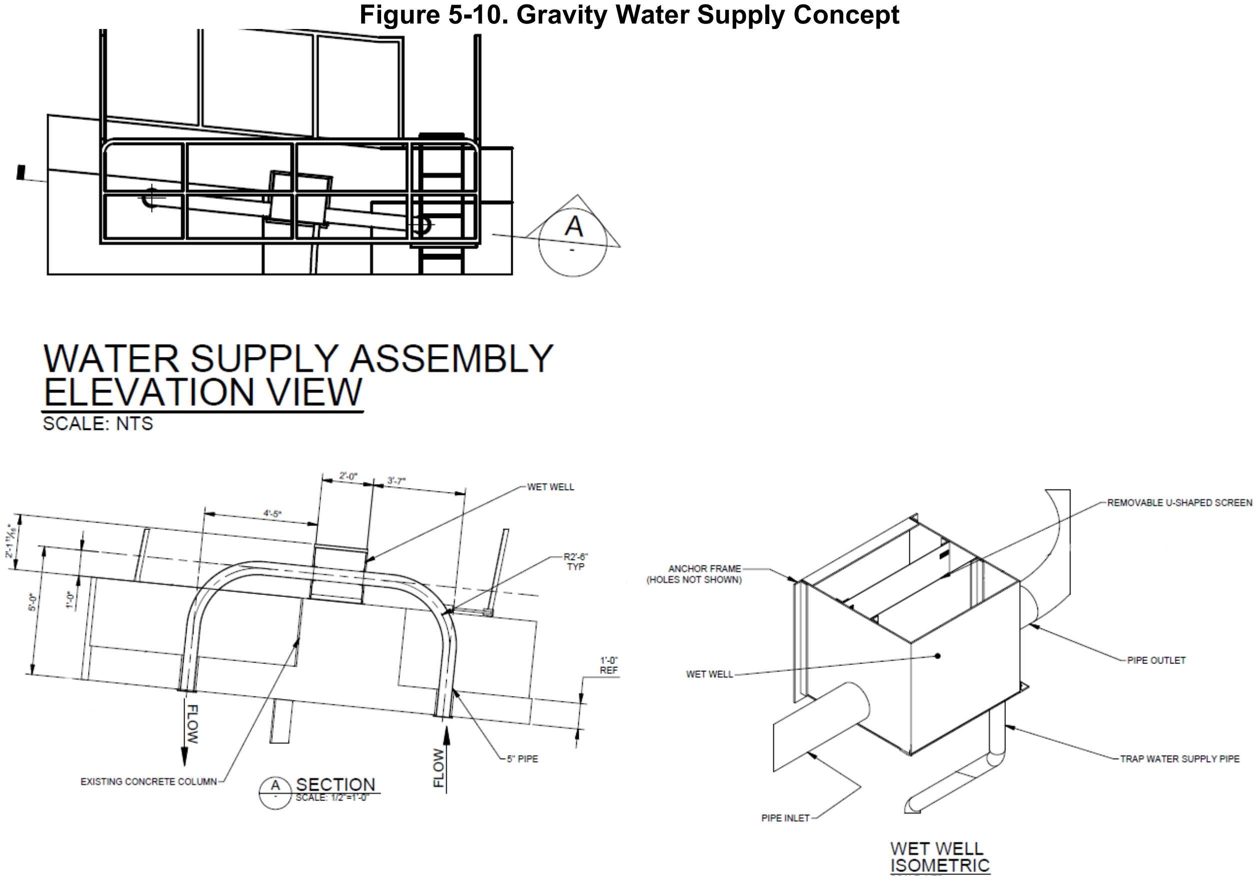
The wet well has a hinged lid to allow access. A barrier can be added to the wet well to stop flow during maintenance operations, allowing the screen to be removed and cleaned as needed. The flow rate of the gravity feed system will be designed to exceed the design flow rate and can be controlled by an adjustable weir.

A gravity fed water supply system requires less maintenance than a pumped system but requires a greater level of monitoring. Water is supplied by the fish ladder, meaning the LPS would be subject to the conditions of the fish ladder. Should flow through the fish ladder cease, flow through the LPS would also cease.

The location of the system is constrained by the slope of the pipe necessary to provide the design flow rate and the friction losses induced by the pipe length resulting from the slope of the pipe run.

This system was not selected due to concerns of impacts to adult fish passage times.

Figure 5-10. Gravity Water Supply Concept



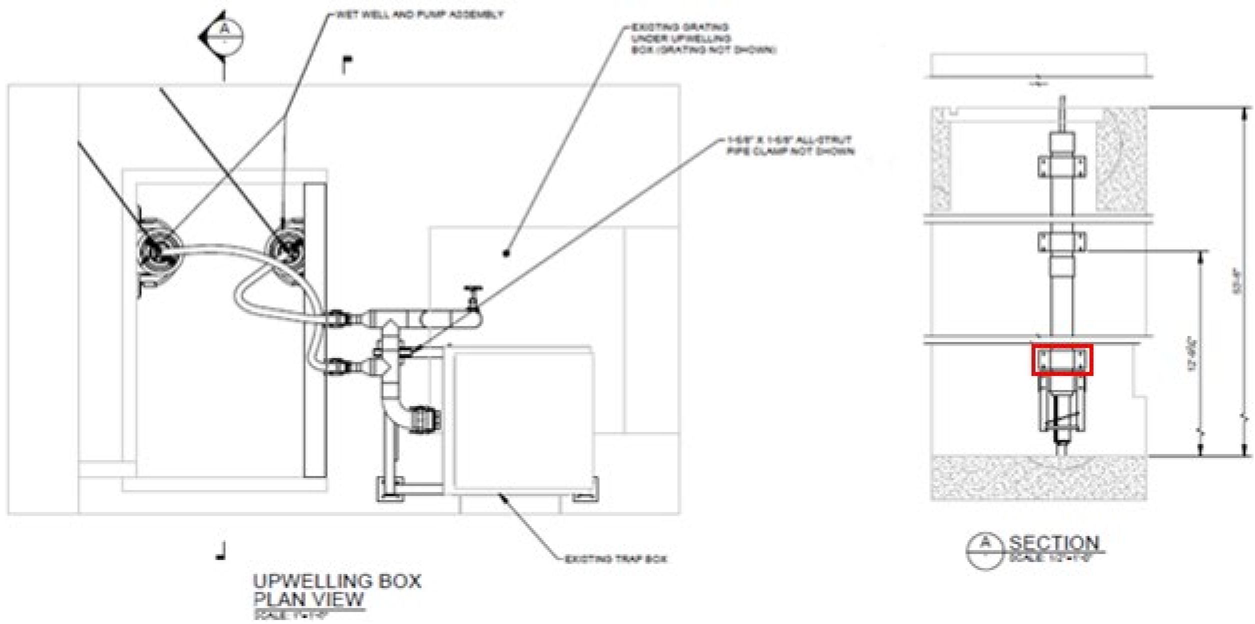
5.3.2 Alternative 2: Pumped Supply with Steel Pipe

A pumped supply system would use two pumps whose combined flow would be capable of exceeding the design flow rate. The use of two pumps creates a redundancy in the system, allowing flow to continue to the LPS should one pump fail. Pumped water supply solutions typically require more annual maintenance than a gravity-fed water supply system. A pumped system is generally considered less reliable than a gravity fed system. However, a pumped supply is more reactive and is not at the mercy of the source conditions to the extent that a gravity fed system is.

The existing pumped supply features a pair of PVC wet wells which failed during operation. This concept replaces the PVC piping used in the previous design with 8-inch diameter schedule 40 stainless steel piping for increased bending strength. A second support bracket is also installed 1-inch in elevation above the final pipe support bracket to reduce the amount of shear stress experienced by any given bolt in the assembly. The position of the second bracket is shown in Figure 5-11 with a red box.

This concept was not selected as it requires more frequent and more difficult maintenance than the diffuser 16 gravity fed alternative described in Section 5.2.

Figure 5-11. New Bracket Position



SECTION 6 - ELECTRICAL DESIGN

6.1 PURPOSE

This section serves as a discussion and presentation of the anticipated work for power and control systems in support of John Day Fish Accords Lamprey Project.

6.2 DESIGN ASSUMPTIONS

New electrical upgrades were considered as part of the new lamprey collection system at the north fish ladder. The scope of the upgrades was dependent on the alternative chosen by the PDT. The two alternatives considered consisted of a gravity fed option and an increased capacity to the existing pumped water supply system.

The gravity fed option would not require pumps or new power distribution but would require sensors and communications for monitoring and alarm. The modified pumped water option would include the monitoring and alarm functionality of the gravity fed option in addition to increasing the capacity of the existing pumping system, as it was determined to be undersized for the larger collection box and increased water circulation.

6.3 EXISTING PUMPED WATER SUPPLY SYSTEM

The existing LPS electrical system consists of the following equipment: an LPS duplex pump controller (LPSWSCG), responsible for control, and indication of the status of the two pumps; and Two 480V pump receptacles (PMR-1 and PMR-2) which can be used to power each of the pumps through cord and plug connections.

In the upwell box there is an existing level switch that provides a signal and alarm input to the Fishway PLC panel FCC1 (located in Cabinet FSC2). If the water level in the upwell box drops below a minimum allowable set point operations staff is notified of the low water level on the Fishway PLC HMI.

6.4 DESIGN CRITERIA

6.4.1 Code and Standards Requirements

Any new electrical design would be performed per USACE standards, engineering manuals, and regulations. In addition, all National Fire Protection Association (NFPA) 70 requirements would be met.

6.4.2 Electrical Design Constructability

Electrical design for any new control or power systems should consider constructability and ease of installation when determining new cable and conduit routing and the addition of any new electrical equipment.

6.5 DESIGN CONSTRAINTS

6.5.1 Load Center Capacity

The capacity of the existing 480V panel would need to be verified for any increase to the existing pump size.

6.6 SYSTEM LEVEL ALTERNATIVES AND RECOMMENDATIONS

6.6.1 Alternative 1 - Pumped Water Supply

This design option included an increase in power delivery from the 480V panel feeding the pumps due to the desired increased pump size. Verification of the new pump motor size is needed to ensure it is capable of meeting the new water flow requirements.

Verification of the panel's capacity to add the additional loading would also be needed before a determination could be made regarding reusing the existing panel. Any additional remote monitoring or alarm would require new connections to the existing IO panel. The functionality of the existing pump system would not be modified.

6.6.2 Alternative 2 - Gravity Fed Water Supply

This design option included implementing any new required sensors in the upwell or collection box. Water levels would be monitored and would notify operations staff though the Fishway programmable logic controller (PLC) human-machine interface (HMI) if certain low set points are met. Fishway PLC panel FCC1 would be used for any required additional digital inputs. The water level set points and location of required sensors would be determined by project staff and the product development team.

6.7 DESIGN CALCULATIONS

There were no required design calculations for this project. The PDT determined that the gravity fed system was the preferred option.

6.8 CONTROL AND INDICATING SYSTEM DESIGN

Design intent was to have water level monitoring and notification capability for any required sensors. Any new sensors would need to be integrated to the existing Fishway PLC and Supervisory Control and Data Acquisition (SCADA) system. There is an existing level switch in the upwell box that provides this functionality. Additional digital inputs would be required for water level detection in other locations and for any additional alarm functionality.

6.9 DESIGN DECISIONS

The PDT determined that the gravity fed option is more viable than the modified pumped water system. The gravity fed system requires less operation and maintenance while the lamprey collection box will need to be increased in size. The existing upwell box can be reused for a new gravity fed design. The existing level switch in the upwell box is sufficient for monitoring and notification purposes.

6.10 DESIGN RECOMMENDATIONS

The design recommendation is for there to be no electrical changes or modifications as part of this project. The existing level switch in the upwell box is sufficient to monitor water level. This sensor has an existing connection to the control cabinet FCC1 and can send a signal to project staff, through the existing SCADA system if a low water level is detected. There is also a spare sensor provided as part of a previous project in the event the existing level switch were to fail. Once the new gravity fed system is in place, the existing sensor signal can be reestablished with no additional electrical installation requirements.

SECTION 7 - ENVIRONMENTAL AND CULTURAL RESOURCES

7.1 CULTURAL RESOURCES

Compliance with all applicable cultural resources laws and regulations will be required. Per Section 106 of the National Historic Preservation Act of 1966 (implementing regulations 36 CFR 800), any federal undertakings that may directly or indirectly effect historic properties will require consultation with Oregon State Historic Preservation Officer (SHPO), tribes and Tribal Historic Preservation Officers (THPOs), and other interested parties, as appropriate. Any action involving ground disturbance could require an archaeology survey. Consultation with SHPO and any Tribes that ascribe cultural associations and significance within the Area of Potential Effects (APE) will be required.

John Day Lock and Dam is eligible for listing in the National Register of Historic Places. Both the north and south fish ladders are identified in the nomination as contributing resources. Certain actions might meet “Attachment 6: Routine Activities…that do not require Section 106 consultation” in the Systemwide Programmatic Agreement for the Federal Columbia River Power System. If these requirements are met, no separate consultation will be needed, and the project will be documented in an Annual Report.

Any alterations will diminish the characteristics that qualify the property for listing, beyond those rehabilitation and replacement actions that meet the Secretary of the Interior's Standards, will likely be considered an adverse effect. If adverse effects cannot be feasibly avoided, appropriate mitigation measures will need to be determined in consultation with SHPO, tribes and THPOs, and other interested parties, captured in an MOA, and then carried out by USACE within the agreed upon timeframe and funded by the project.

7.2 ENVIRONMENTAL COMPLIANCE

USACE projects must comply with numerous Federal environmental laws, rules, and regulations. Compliance with State or local environmental regulations may also be required. Typically, it is during the Plans and Specification phase (60% DDR) that USACE prepares environmental clearance documents, so that compliance is complete before construction. CENWP-PM-E coordinates the environmental compliance process, with the exception of the FPOM coordination, which is conducted by PME-F or OD-T.

All actions that are Federally funded, constructed, or permitted must comply with the National Environmental Policy Act (NEPA). The District Commander is the official responsible for compliance with NEPA for actions within the district boundaries.

The John Day Lamprey Passage project will probably require USACE to prepare a Record of Environmental Consideration (REC), which documents USACE compliance with NEPA through the use of a Categorical Exclusion. For this project it would be under the category of actions described in 33 CFR 230.9(b). The type of NEPA document may change if the design evolves in a manner that does not fit within any of USACE excluded categories.

The status of other key environmental clearances for this project are:

- ESA Section 7. Species under jurisdiction of National Marine Fisheries Service - addressed through CRSO BiOp routine maintenance provisions. Assumes that work will be done during routine annual dewatering period or gain a variance through the FPOM process. Compliance with the terms of the CRSO Biological Opinion will be documented in the REC.
- ESA Section 7 - Species under jurisdiction of US Fish and Wildlife Service - No effect. These species are not present in the action area.
- Marine Mammal Protection Act (MMPA) - Not applicable. Disturbance not likely to impact marine mammals because they do not occur at JDA.
- Fish and Wildlife Coordination Act (FWCA) - Not applicable. Not a water control project.
- Bald and Golden Eagle Protection Act (BGEPA) - Not applicable. Eagles not nesting in work area.
- Clean Water Act Section 401 water quality certification - not needed as long as work area is totally isolated from active flow, and work does not result in discharges to water bodies.
- Clean Water Act 404b1 analysis - not needed, as long as there is no fill into waters of the U.S.

SECTION 8 - OPERATIONS AND MAINTENANCE

8.1 SAFETY

All work should be completed following Hazardous Energy Control Program (HECP) protocols to ensure the health and safety of personnel. All necessary personal protective equipment (PPE) and safety pagers should be worn at all times while at the John Day Project. Safety meetings should be performed daily prior to working.

The lamprey passage system is about 100 feet below the entrance door. The access elevator is unreliable, so the primary access route is the stairs. To avoid injury, use handrails and avoid carrying heavy items up and down the stairs.

8.2 SECURITY

Security protocols should be followed while at the John Day Project. Doors should remain closed and locked when not in use. Only areas cleared for use should be accessed. Badges should be visible at all times while on project. When guest badges are needed, requests should be made through John Day personnel. All guest badges must be picked up and dropped off at the front gate daily.

8.3 DESIGN RECOMMENDATIONS

Any design decisions should be as simple as possible. John Day personnel have numerous daily tasks to tend to, and any operation or maintenance needs should be kept to a minimum.

The water supply design will tap into the diffuser drain valve, located near the north fish ladder count station, and use this new line to supply water to the LPS. The drain intake is located below diffuser grating and should not impact adult passage. This water will be diverted to the ground, cross to the fish ladder, and be mounted along the top of the fish ladder adjacent to the inner handrail. The piping will be out of the way for most of the route on top of the fish ladder. Where the pipe route crosses the walkway, yellow safety steps will be installed to reduce tripping hazard.

To monitor LPS water levels remotely, the existing water level sensor in the upwelling box will be reused. This is tied into the current SCADA system located in the fisheries building.

8.4 GENERAL

The north fish ladder at John Day is operated by following Fish Passage Plan (FPP) guidelines. Any deviations from the FPP must be coordinated in advance with John Day fisheries staff.

8.5 FEATURES

The John Day north fish ladder consists of 90 overflow weirs (crest ELs 158 feet to 248 feet). The exit is EL 250.5 feet (floor level) and the depth is regulated by 22-modulating weirs (7-single modulating, and 15-double modulating). There is a count station located near the exit at EL 243 feet (floor elevation).

The entrance elevation is EL 150 feet (floor elevation), and the differential is controlled by 6-auxillary water supply pumps. The entrance also contains a variable width weir, with a bollard field for lamprey passage. The lamprey passage system (LPS) entrance ramp is located just upstream of the variable width weir, and it leads to the LPS and holding tank (deck EL 185 feet).

8.6 MAINTENANCE

Winter maintenance is performed annually on the north fish ladder. Outage times vary but are typically 1 to 2 months long (depending on maintenance needs). The ability to perform LPS maintenance outside this window varies by component. Maintenance repairs are costly, and any modifications to the LPS should be performed using the simplest designs possible.

8.7 COMMISSIONING

Any LPS modifications should have low operation and maintenance (O&M) designs. Onsite personnel have numerous daily tasks, and as such the LPS should require minimal project oversight (both in and out of operation). Accessing the LPS can be extremely difficult. The elevation change from the entrance door to the LPS is about 100 feet. The elevator is outdated and extremely unreliable, so the primary access route is the stairs. John Day personnel will not be responsible for transporting fish.

8.8 SYSTEM OPERATION

The following pertains to the normal operations of the water supply and LPS system.

8.8.1 System Startup

The water supply pipeline needs to be filled to start up the LPS system. Inflow must be carefully regulated to avoid system transients caused by excessive initial inflows. As this startup operation occurs during active salmon fish passage season, the hazard of high or full drainage flow (greater than 6 cfs) must again be avoided.

- Close LPS pipe drain valves.
- Partially close 6-inch isolation valve (80 percent) at junction with LPS pipe at bottom of elevation ladder structure.
- Open 6-inch isolation valve at top of elevated ladder structure.
- Partially (50 percent) open downstream 3-inch LPS control valve at upwelling box.
- Fully open 4-inch LPS isolation valve.

- Monitor pipe exit into upwelling box for inflow.
- Gradually close 6-inch isolation valve to finish filling the LPS supply pipe.
- Adjust the 3-inch control valve to deliver the desired flow into the upwelling box.
- Adjust the collection box drain valve for final adjustments for flow into collection box and down LPS.

8.8.2 Normal Operation

Once adjusted, the water supply pipeline should deliver a constant continuous discharge to the upwelling box and collection box. A level senser will monitor the levels in the tank. An alarm will be triggered if the tank levels become too low.

The normal causes of tank drawdown (pump failure, plugged screens, etc.) are not present in the proposed gravity system. Potential causes are open drain valve(s), plugged forebay auxiliary watering system trashrack, or pipe breach.

8.8.3 System Shutdown

Flow down the LPS needs to be gradually terminated to prevent additional lamprey collection. Trapped Lamprey need to be removed from the collection box. Then the LPS pipeline needs to be drained. This shutdown occurs during active salmon fish passage season, so the hazard of high or full drainage flow (greater than 6 cfs) must again be avoided.

- Partially close/adjust 3-inch LPS control valve at upwelling box to reduce and gradually shut off flow to LPS.
- Adjust drain valves as needed to maintain depth in collection box until trapped Lamprey can be safely removed.
- Close upstream 4-inch Isolation valve.
- Open LPS supply pipe drain valves.
- Close 6-inch isolation valve at top of elevated ladder structure.
- Fully 6-inch isolation valve (80 percent) at junction with LPS pipe at bottom of elevation ladder structure.
- Winterize LPS supply pipeline as needed.

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