FISH PASSAGE TECHNICAL STUDIES INTERIM REPORT

ATTACHMENT F

FINAL DRAFT FISH PASSAGE CONCEPTUAL DESIGN CRITERIA DOCUMENT

FA-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

SKAGIT RIVER HYDROELECTRIC PROJECT
FERC NO. 553

February 2022

This page intentionally left blank.

TABLE OF CONTENTS

Section No.	Description	Page No.

List of Figures

List of Tables

List of Attachments

List of Acronyms and Abbreviations

°C .... degrees Celsius
°F.......................... degrees Fahrenheit
7-DADMax............ 7-day average of the daily maximum temperatures
AWS...................... Agency Work Session
CEII....................... Critical Energy/Electric Infrastructure Information
CFR .... Code of Federal Regulations
cfs .... cubic feet per second
City Light............... Seattle City Light
CoSD .... City of Seattle Datum
CPUE..................... catch per unit effort
DCD .... Design Criteria Document
DIP .... demographically independent populations
DPS .... distinct population segment
EDF .... energy dissipation factor
ELC .... Environmental Learning Center
EPA .... Environmental Protection Agency
ESA .... Endangered Species Act
ESU .... Evolutionarily Significant Unit
FCC .... Flow Plan Coordinating Committee
FERC..................... Federal Energy Regulatory Commission
FIC .... Fixed Inlet Collector
FSA .... Fisheries Settlement Agreement
FSC........................ Floating Surface Collector
FSS .... Floating Screen Structure
ft/s .... feet per second
HSC....................... habitat suitability criteria
ISR .... Initial Study Report
kV .... kilovolt
LiDAR................... Light Detection and Ranging
LP.......................... licensing participant
MHz .... megahertz

mm .... millimeter
MP......................... milepost
MPG .... major population group
MWh .... megawatt hour
NAVD 88 .... North American Vertical Datum of 1988
NMFS.................... National Marine Fisheries Service
NPS .... National Park Service
PAD....................... Pre-Application Document
PFMC .... Pacific Fishery Management Council
PRM .... Project River Mile
Project .... Skagit River Hydroelectric Project
PSE........................ Puget Sound Energy
PSP .... Proposed Study Plan
RLNRA .... Ross Lake National Recreation Area
RM .... river mile
RSP........................ Revised Study Plan
RWG .... Resource Work Group
sq. mi..................... square miles
SR.......................... State Route
USACE.................. U.S. Army Corps of Engineers
USFS .... U.S. Forest Service
USFWS.................. U.S. Fish and Wildlife Service
USGS..................... U.S. Geological Survey
WDFW .... Washington Department of Fish and Wildlife
WQ........................ Water Quality
WSDOT................. Washington State Department of Transportation
WWTIT .... Western Washington Treaty Indian Tribes

EXECUTIVE SUMMARY

The Skagit River Hydroelectric Project (Project), licensed by the Federal Energy Regulatory Commission (FERC) to the City of Seattle, Washington, and operated through its publicly owned electric power utility Seattle City Light (City Light). The current FERC license for the Project expires on April 30, 2025. As part of the relicensing process, City Light engaged agencies and other licensing participants (LP). During these reviews, several LPs requested studies to assess the feasibility of implementing fish passage at the Project. In response, City Light is conducting the FA-04 Fish Passage Technical Studies Program (Fish Passage Study). The Fish Passage Study includes two discreet elements. The first element evaluates fish passage alternatives at the Project (i.e., Fish Passage Facilities Alternatives Assessment), while the second element assesses conditions in the Gorge bypass reach to determine fish passage potential for target species under various flow regimes (i.e., Fish Passage Assessment of Existing Features in the Bypass Reach [Bypass Reach Assessment]). The Bypass Reach Assessment is being conducted in parallel with the Fish Passage Facilities Alternatives Assessment, and a report on the findings will be developed in 2022. This document has been prepared to support the Fish Passage Facilities Alternatives Assessment and represents the first stage of that element of the study.

As part of the Fish Passage Facilities Alternatives Assessment, and in consultation with LPs, City Light proposed a three-stage process for assessing the feasibility of upstream and downstream fish passage at the Project. The three-stage process for assessment includes the development of: (1) fish passage conceptual design criteria, (2) fish passage concept-level designs, and (3) a fish passage feasibility assessment. The previous iterations of this document, the preliminary and revised draft Fish Passage Conceptual Design Criteria Documents (DCD), or the Preliminary Draft DCD and Revised Draft DCD, respectively, were the first documents prepared for the first stage of the fish passage feasibility process. Consistent with the Revised Study Plan (RSP) and City Light's commitment to work collaboratively with LPs during study implementation, the Preliminary and Revised Draft DCDs were shared with LPs for review and comment. Comments on these drafts were considered, in concert with additional data synthesis, to develop this document, the Final Draft DCD.

This Final Draft DCD summarizes key physical, biological, and technical criteria that will be considered during development of Project fish passage concept-level designs. The information presented in this document will provide the foundation for the discussion of biological performance standards and the design basis to develop concept-level upstream and downstream passage alternatives. This document describes existing conditions at the Project that may influence each fish passage strategy and alternative, including reservoir rule curves and operating limits, historical operations data, and biological and physical data for each reservoir, as currently available. This document also provides a preliminary list of conceptual alternatives that may be considered for further evaluation during the second stage of the Fish Passage Facilities Alternatives Assessment and summarizes empirical performance data from existing fish passage facilities implemented elsewhere. Following the Introduction (Section 1.0 of this document), components of the Final Draft DCD include the following sections and content:

- Section 2.0 of this document summarizes the salient physical and operational considerations that will be used to describe the operating environment of potential fish passage strategies and facility concepts. This section provides an overview of each dam and reservoir, with aerial and profile illustrations; defines specific information on intakes, spillways, and reservoirs; and provides a general assessment of the availability of land to construct passage infrastructure along with existing access routes for each development.

- Section 3.0 of this document describes biological considerations that influence the type, size, and complexity of fish passage strategies and facility concepts. This section provides a summary of known information on the fish species in the Skagit River that have been considered for passage as well as existing information relative to abundance, life history, and migration timing for both upstream and downstream migrants. The target list of species considered for this assessment includes those fish presented in the Fish Passage Study RSP, as well as several additional species requested for consideration by LPs (in the Notice of Certain Agreements on Study Plans for Skagit Relicensing [June 9, 2021 Notice][1]) for the related Bypass Instream Flow Model Development Study (City Light 2021b). These species include Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), Sockeye Salmon (*O. nerka*), steelhead (*O. mykiss*), Bull Trout (*Salvelinus confluentus*), Chum Salmon (*O. keta*), Pink Salmon (*O. gorbuscha*), sea-run Cutthroat Trout (*O. clarkii*), Dolly Varden (*S. malma*), Pacific Lamprey (*Entosphenus tridentatus*), and Salish Sucker (*Catostomus catostomus*).
- Section 4.0 of this document lists the engineering and ecohydraulic design guidelines established by fisheries agencies such as the National Marine Fisheries Service (NMFS) and Washington Department of Fish and Wildlife (WDFW) that will be used for fish facility concept formulation. These criteria relate to general passage guidelines for fishways, fish screening criteria, trapping and holding guidelines, and debris rack criteria.
- Section 5.0 of this document describes the process and integration of physical, operational, and biological factors to formulate site-specific design criteria unique to the Project for both upstream and downstream fish passage concept development. These include data to be provided from concurrent relicensing studies (e.g., Reservoir Tributary Habitat Assessment), surface water residence times in each reservoir, surface hydraulics, intake and forebay configuration, and biological factors related to target species swimming abilities, migration rates and periods, predation, foraging, entrainment, and residualization.
- Section 6.0 of this document provides an overview of typical regulatory performance standards and an overview of performance metrics at other Pacific Northwest fish passage facilities. This list was refined by NMFS during review of the Preliminary Draft DCD, and additional facilities were added.
- Section 7.0 of this document describes the range of upstream and downstream fish passage strategies and potential technologies considered for future fish passage facility concept development. These passage technologies can be applied to each of the Project developments upon selection of preferred fish management strategies by co-managers and resource agencies in the future. Example technologies include:
    - Upstream passage: trap and transport, fish ladders/fishways, and fish passes
    - Downstream passage (juvenile and adult): forebay collectors, head of reservoir collection, turbine passage, surface spill, bypass systems, and project operational changes

[1] Referred to by FERC in its July 16, 2021, Study Plan Determination as the "updated RSP."

- Section 8.0 of this document summarizes the range of potential fish passage options identified by the City Light study team and LPs during three "Agency Working Session" (AWS) engagements and identifies recommended options to be advanced to the next stage of the study for concept-level design and cost estimating.
- Section 9.0 of this document provides a document conclusion and communicates the arc of the Fish Passage Study as presented in the RSP, including next steps to inform future, LP-led policy decisions that will be needed to move forward into the next stages of fish passage design following the completion of this study.

A key premise of the Fish Passage Study is City Light's close coordination with LPs to provide a consistent forum for collaboration on all elements of the study. This frequent collaboration has provided a forum for the full and active involvement of resource agency and tribal biologists and engineers who have specific fish passage or related experience or have co-management responsibilities for fish resources in the Skagit River basin. City Light established bi-weekly AWS, which include representatives from City Light, its technical consultant team, and a small group of fish passage experts and interested LPs from NMFS, the UU.S. Fish and Wildlife Service (USFWS), WDFW, the National Park Service (NPS), the Upper Skagit Indian Tribe, the Swinomish Tribe, and the Skagit River System Cooperative. AWS participants have been encouraged to engage in these sessions to provide insights and opinions regarding ongoing and future elements of the Fish Passage Study. A summary of study progress to date, including AWS meetings, workshops, deliverables, and future key steps that will be taken to formulate passage alternatives is included below (Figure ES-1).

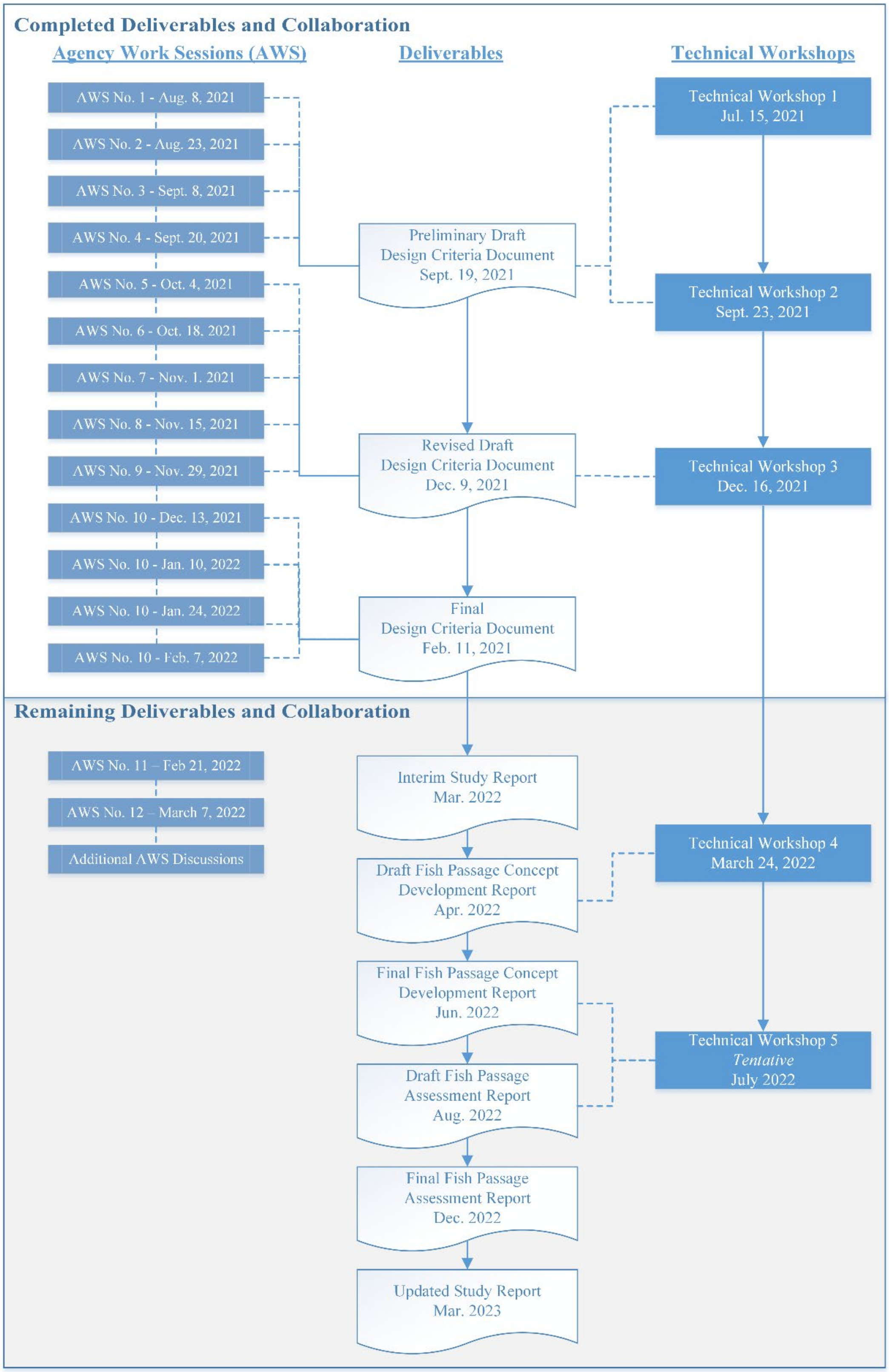


Figure ES-1. **Summary of Fish Passage Study progress to date, including meetings, workshops, and deliverables, with collaborative milestones.**

The Revised Draft DCD was shared with LPs in December 2021 prior to Workshop 3. During Workshop 3, the City Light consultant team led a robust discussion on fish passage technologies and preliminary discussions on feasibility. Following Workshop 3 and subsequent discussions with AWS participants during AWS meeting No. 11 (January 10, 2022), LPs concurred on the list of fish passage options to be carried forth into the next stage of the Fish Passage Facilities Alternatives Assessment, which will present concept-level designs for selected passage options. The options selected to advance to the concept design stage are presented in Section 8.5 of this Final DCD.

As the Fish Passage Study progresses through 2022, City Light will continue to track concurrent relicensing studies discussed in Section 1.4 of this document to ensure that the most current data is synthesized into the next stages of the Fish Passage Study. Per the RSP Section 2.6.1.2, next stages include the development of fish passage concept-level designs and development of a fish passage feasibility assessment. For the concept-level design stage, City Light will develop conceptual upstream and downstream fish passage alternatives and their estimated costs. City Light will develop functional site layouts, process descriptions and diagrams, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable costs for select fish passage alternatives.

The status of this information will be summarized in the next deliverable defined in the RSP, the draft Fish Passage Concept Development Report, which will be submitted to LPs for review in April 2022. At that time, a list of potential fish passage options for all three developments, by fish passage strategy, will be available for review. The Fish Passage Concept Development Report will be finalized in July 2022.

Following completion of the Fish Passage Development Report, City Light will identify fish passage concepts that appear viable and are consistent with the requirements of the DCD. Each technical option for facilitating fish passage above Gorge Dam will be evaluated in four ways: (1) its ability to be engineered, constructed, and operated in the context of site geology, existing Project and non-Project structures, site hydrology, reservoir and riverine operations, and safety requirements (i.e., technical feasibility); (2) its ability to operate without significantly interfering with existing Project and non-Project uses; (3) the facility's ability to meet customary performance standards established for similar facilities, such as facility collection efficiency, survival through the passage facility, and overall Project-wide passage effectiveness; and (4) its ability to accommodate a foreseeable range of future operational conditions, biological objectives, and population management strategies, and its capability of adapting as lessons learned are experienced through years of operation. Habitat availability and quality upstream of the Project, based on the results of the Reservoir Tributary Habitat Assessment, when available, will also influence evaluations of benefits to anadromous fish populations.

As a final step to this study and based on the outcome of the technical engineering assessment described above, City Light, in consultation with LPs, will identify any next steps or additional studies that may be needed in accordance with planning recommendations put forward in Anderson et al. (2014) and McClure et al. (2018), and the results of concurrent relicensing studies that may influence passage designs and strategies (e.g., Reservoir Tributary Habitat Assessment).

This page intentionally left blank.

1.0 INTRODUCTION

1.1 Background

The Skagit River Hydroelectric Project (Project), licensed by the Federal Energy Regulatory Commission (FERC) to the City of Seattle, Washington, and operated through its publicly owned electric power utility Seattle City Light (City Light), is located in northern Washington State and consists of three power generating developments on the Skagit River—Ross, Diablo, and Gorge – and associated lands and facilities. The current FERC license for the Project expires on April 30, 2025, and City Light will apply for a new license no later than April 30, 2023. City Light formally initiated the relicensing process by filing a Notice of Intent and Pre-Application Document with FERC by April 27, 2020 (City Light 2020a). The Pre-Application Document includes detailed descriptions of the Project facilities, operations, license requirements, and Project lands as well as a summary of the extensive existing information available on Project vicinity resources and early consultation on potential resource issues to be addressed during the relicensing.

1.2 Study Plan Development

In 2019-2020, City Light convened a series of Resource Work Groups (RWG) to engage agencies and other licensing participants (LP) in the Study Plan Development Process. As part of the Study Plan Development Process, the National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), the Washington Department of Fish and Wildlife (WDFW), the National Park Service (NPS), and the Upper Skagit Indian Tribe requested studies to assess the feasibility of implementing fish passage at Gorge, Diablo, and Ross dams. In response, City Light proposed to conduct the FA-04 Fish Passage Technical Studies Program (Fish Passage Study) as part of the original Proposed Study Plan (PSP) (City Light 2021a), with updates in the Revised Study Plan (RSP) and the June 9, 2021 Notice of Certain Agreement on Study Plans for Skagit Relicensing (June 9, 2021 Notice).[2]

This Fish Passage Study addresses two discreet elements that respond to LP study requests:

(1) An assessment of upstream passage potential for specific species under varying flow regimes at two existing features in the Gorge bypass reach, defined as the 2.5-mile section of the Skagit River from Gorge Dam to the Gorge Powerhouse (i.e., Fish Passage Assessment of Existing Features in the Bypass Reach); and

(2) An assessment to determine the feasibility of providing upstream and downstream passage for certain fish species at the Project, including conceptual designs and preliminary cost estimates for selected alternatives (i.e., Fish Passage Facilities Alternatives Assessment).

This DCD addresses the second element of the Fish Passage Study[3], which includes the development and study of fish passage facility options at the Project (i.e., Fish Passage Facilities Alternatives Assessment). The Fish Passage Assessment of Existing Features in the Gorge Bypass

2 Referred to by FERC in its July 16, 2021, Study Plan Determination as the "updated RSP."

3 Note that the Fish Passage Facilities Alternatives Assessment will include options for upstream passage at both the Gorge Dam and the Powerhouse to account for all outcomes of the Fish Passage Assessment of Existing Features in the Gorge Bypass Reach, which will be informed by analyses completed under both FA-04 Fish Passage Study and FA-05 Bypass Instream Flow Model Development Study in 2022.

Reach is being conducted in parallel with the Fish Passage Facilities Alternatives Assessment, and a report on those findings will be developed in 2022.

The Fish Passage Facilities Alternatives Assessment is a technical feasibility assessment to identify and provide cost opinions for passage solutions at the Project. This study element is not intended to provide a recommended passage solution but will investigate all solutions deemed technically feasible. The future formulation of fish passage strategies requires an assessment of other factors contributing to the biological value of access to each Project reservoir, which is currently being informed through concurrent relicensing studies discussed in Section 1.4 of this document. Fish passage strategies may be assembled based on the technically feasible passage methodology/technology but will not be considered prior to exploration of passage facility assessments.

1.3 Document Purpose and Scope

As part of the Fish Passage Facilities Alternatives Assessment, and in consultation with LPs, City Light is implementing a three-stage process for assessing the feasibility of upstream and downstream fish passage at the Project. The three-stage process for assessment includes the development of: (1) fish passage conceptual design criteria, (2) fish passage concept-level designs, and (3) a fish passage feasibility assessment.

The previous iterations of this document, the preliminary and revised draft Fish Passage Conceptual Design Criteria Documents (DCD), or the Preliminary Draft DCD and Revised Draft DCD, represented the first documents prepared in the first stage of the fish passage feasibility process. Consistent with the RSP, the Preliminary and Revised Draft DCDs were shared with LPs for review and comment. Comments on the preliminary and revised drafts were considered, in concert with additional data synthesis, to develop the final iteration of this document, the Final Draft DCD. The Final Draft DCD summarizes key physical, biological, and technical criteria that will be considered during development of conceptual fish passage facility design alternatives at the Project. The information presented in this document will provide the foundation for the discussion of biological performance standards and the design basis to develop concept-level upstream and downstream passage alternatives. This document describes existing conditions at the Project that may influence each fish passage strategy and alternative, including reservoir rule curves and operating limits, historical operations data, and biological and physical data for each reservoir, as currently available. This document also provides a list of fish passage options to be considered for further evaluation during the second stage of the Fish Passage Facilities Alternatives Assessment and summarizes empirical performance data from existing fish passage facilities implemented elsewhere. Following the Introduction (Section 1.0 of this document), components of the Final Draft DCD include the following sections and content:

- Section 2.0 of this document summarizes the salient physical and operational considerations that will be used to describe the operating environment of potential fish passage strategies and facility concepts. This section provides an overview of each dam and reservoir, with aerial and profile illustrations; defines specific information on intakes, spillways, and reservoirs; and provides a general assessment of the availability of land to construct passage infrastructure along with existing access routes for each development.

- Section 3.0 of this document describes biological considerations that influence the type, size, and complexity of fish passage strategies and facility concepts. This section provides a summary of known information on the fish species in the Skagit River that have been considered for passage as well as existing information relative to abundance, life history, and migration timing for both upstream and downstream migrants. The target list of species considered for this assessment includes those fish presented in the Fish Passage Study RSP, as well as several additional species requested for consideration by LPs (in the NOA) for the related Bypass Instream Flow Model Development Study (City Light 2021b). These species include Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), Sockeye Salmon (*O. nerka*), steelhead (*O. mykiss*), Bull Trout (*Salvelinus confluentus*), Chum Salmon (*O. keta*), Pink Salmon (*O. gorbuscha*), sea-run Cutthroat Trout (*O. clarkii*), Dolly Varden (*S. malma*), Pacific Lamprey (*Entosphenus tridentatus*), and Salish Sucker (*Catostomus catostomus*).
- Section 4.0 of this document lists the engineering and ecohydraulic design guidelines established by fisheries agencies such as NMFS and WDFW that will be used for fish facility concept formulation. These criteria relate to general passage guidelines for fishways, fish screening criteria, trapping and holding guidelines, and debris rack criteria.
- Section 5.0 of this document describes the process and integration of physical, operational, and biological factors to formulate site-specific design criteria unique to the Project for both upstream and downstream fish passage concept development. These include data to be provided from concurrent relicensing studies (e.g., Reservoir Tributary Habitat Assessment), surface water residence times in each reservoir, surface hydraulics, and intake and forebay configuration.
- Section 6.0 of this document provides an overview of typical regulatory performance standards and an overview of performance metrics at other Pacific Northwest fish passage facilities. This list was refined by NMFS during review of the Preliminary Draft DCD, and additional facilities were added.
- Section 7.0 of this document describes the range of upstream and downstream fish passage strategies and potential technologies considered for future fish passage facility concept development. These passage technologies can be applied to each of the Project developments upon selection of preferred fish management strategies by co-managers and resource agencies in the future. Example technologies include:
  - Upstream passage: trap and transport, fish ladders/fishways, and fish passes
  - Downstream passage (juvenile and adult): forebay collectors, head of reservoir collection, turbine passage, surface spill, bypass systems, and project operational changes
- Section 8.0 of this document summarizes the range of potential fish passage options identified by the City Light study team and LPs during three "Agency Working Sessions" (AWS) engagements, and identifies recommended options to be advanced to the next stage of the study for concept-level design and cost estimating.
- Section 9.0 of this document provides a document conclusion and communicates the arc of the Fish Passage Study by presenting next steps to inform future, LP-led policy decisions that will be needed to move forward into the next stages of fish passage design following the completion of this study.

1.4 Linkages to Other Studies

City Light is conducting several studies concurrent with the Fish Passage Study that are anticipated to inform conceptual designs, passage criteria, facility sizing and location, and biological and physical constraints. While information from these ongoing studies is not yet available to incorporate into this Final Draft DCD, new information will be included in future deliverables under the Fish Passage Study, as available and applicable. Therefore, the information presented herein will be adapted as more information is integrated into study activities, including but not limited to information from the following studies:

- OM-01: Operational Model Study – May provide additional information on future reservoir operations, spill procedures, and instream flow availability that may influence the fish passage facility operating environment.
- FA-01a: Water Quality (WQ) Monitoring Study – May provide additional information on reservoir hydrology, residence time, available nutrients, and temperatures that may influence assumptions relative to reservoir transit and navigability by anadromous adult upstream migrants, anadromous juvenile downstream migrants, and resident adfluvial migrants.
- FA-01b: Hydrodynamic, Temperature, and Water Quality Model[4] (WQ Model Development Study) – May provide additional information for operational scenarios and reservoir temperatures that could influence design concepts and assumptions. City Light is developing a water quality model of the Project vicinity that will be capable of simulating water balance at each reservoir, water surface elevations and temperatures below Gorge Dam to the confluence with the Sauk and Skagit Rivers, and temperature in each of the Project reservoirs.
- FA-02: Instream Flow Model Development Study – Information on target fish species periodicities will inform the timing of juvenile, adult upstream, and adult downstream migrations for the Fish Passage Study. The study may also inform flows and water surface elevations below the Gorge Powerhouse.
- FA-03: Reservoir Fish Stranding and Trapping Risk Assessment – May provide information influencing the viability of fish passage strategies (e.g., tributary collection) or facilities (e.g., surface water elevations associated with operations).
- FA-05: Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development Study (Bypass Instream Flow Model Development Study) – Will provide significant information, data, and conclusions informing the assessment of fish passage and identification of flow conditions that may provide fish passage through the existing bypass reach.
- FA-06: Reservoir Native Fish Genetics Baseline Study – Will provide additional insight on the potential need for management and fish passage of resident or adfluvial fish populations that currently exist within Project reservoirs and their tributaries and downstream of Project facilities. Any new information may also inform the goals and objectives of potential fish passage strategy implementation methodologies.
- FA-07: Reservoir Tributary Habitat Assessment – Will provide information on available habitat in reservoir tributaries and their potential to support target fish species. Any new

[4] The Fish Passage Study will consider temperature data from FA-01a; other WQ data from FA-01a is to be determined.

information may also inform the goals and objectives of potential fish passage strategy implementation methodologies. Note that reservoir habitat is being addressed through City Light's ongoing Food Web Study (not part of relicensing studies), which will address reservoir bioenergetics.

- FA-08: Entrainment Study – Will provide information on potential entrainment at each Project development for target species known to occur upstream of Project reservoirs, which may inform design criteria for downstream juvenile and adult (e.g., kelts) passage designs.

1.5 Collaboration with Licensing Participants

From the outset of this study, City Light and its consultant team have coordinated with LPs through several types of engagement opportunities to facilitate frequent communication and collaboration. Engagement opportunities have included the review and comment on the Preliminary Draft DCD (and all subsequent drafts), co-development of agendas for technical workshops, participation in technical workshops as defined in the RSP, and participation in bi-weekly AWS with a technically based group of LPs (Figure 1.5-1). Feedback and shared information obtained from LPs during these collaborative engagements will continue to be incorporated into this, and subsequent, study reports under the Fish Passage Study.

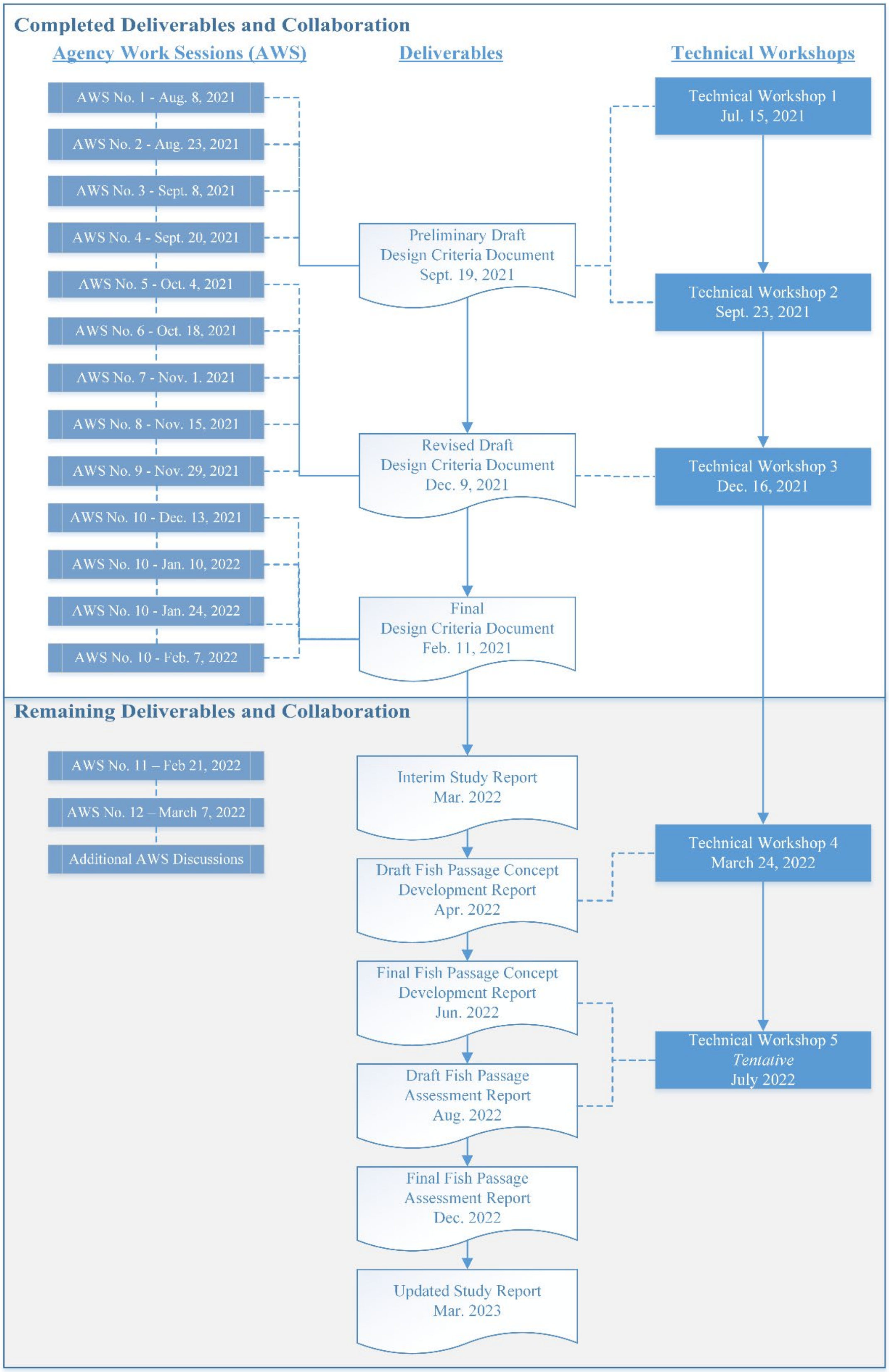


Figure 1.5-1. Summary of deliverables and licensing participants collaboration process.

1.5.1 Review of Preliminary and Revised Draft DCDs

The Preliminary and Revised draft DCDs were submitted to LPs prior to the Fish Passage Study Technical Workshop 2 and Workshop 3, held, respectively, on September 23, 2021, and December 16, 2021. Comments and information received following each workshop were considered and incorporated into the Final Draft. Comments received for the preliminary and revised drafts that required additional discussion or clarification were discussed among a smaller group of fish passage experts and interested LPs during bi-weekly AWS engagements that have been established as part of this study (see Section 1.5.4 of this document for details).

1.5.2 Agenda-Setting Participation

A small group of LPs has been invited to attend the co-development of agendas (agenda-setting meetings) prior to each technical workshop outlined in the RSP for this study. This engagement allows for input on the agenda and topics of most pertinence to the study, as aligned with the workshop content presented in the RSP. As of this writing (February 2022), LPs have participated in the agenda-setting exercise for Workshops 1, 2, and 3.

1.5.3 Technical Workshops

From the initiation of this study in June 2021 through issuance of the Final Draft DCD in February 2022, City Light hosted three fish passage technical workshops, the contents of which aligned with those presented in the RSP and are summarized in the subsections below. The workshops were well-attended by LPs, who actively participated to provide input on all elements of the study. Meeting agendas, summaries, and presentations for these three workshops are included as an attachment to this document.

1.5.3.1 Workshop 1, July 15, 2021

Prior to Workshop 1, City Light prepared a draft agenda, which was refined and finalized with LPs during an agenda-setting discussion conducted on July 7, 2021. During the discussion, City Light and participating LPs determined that the following elements would be discussed during the workshop:

- NOA commitments for the Fish Passage Study
- An overview of the RSP and detailed schedule
- A list of target species to be selected for passage for each element of the study, with a request for concurrence
- The development of the AWS as a mechanism to establish a frequent collaboration and communication channel
- The fish passage criteria to be applied to the Fish Passage Assessment of Existing Features in the Bypass Reach
- The status of the related Bypass Instream Flow Model Development Study and how it will inform development of the Fish Passage Assessment of Existing Features in the Bypass Reach

1.5.3.2 Workshop 2, September 23, 2021

Prior to Workshop 2, City Light prepared a draft agenda, which was refined and finalized with LPs during an agenda-setting discussion conducted on September 7, 2021. In addition to the draft agenda, the Consultant Team also prepared the first deliverable for the Fish Passage Study, the Preliminary Draft DCD, which was distributed to LPs approximately one week prior to Workshop 2. Workshop 2 agenda topics included the following:

- An overview of the Preliminary Draft DCD, including content, data sources, and resulting considerations to be used to formulate fish passage strategies and facility alternatives
- A review of the DCD milestones, including a request for LP comments by October 7, 2021
- A discussion of biological data obtained to date, primarily from publicly available information, and the identification of data gaps and potential data sources required to progress to the next stage of the Fish Passage Facilities Alternatives Assessment
- A review of potential fish passage strategies and technologies that may be considered for future evaluation and alternatives assessment
- Existing Biological Performance Information at PNW Fish Passage Facilities and Discussion on the Development of Performance Criteria for Project requirements

1.5.3.3 Workshop 3, December 16, 2021

Prior to Workshop 3, the study team prepared and submitted the Revised Draft DCD. Workshop 3 agenda topics included the following:

- An overview of changes incorporated into the Revised Draft DCD, based on LP comments on the Preliminary Draft DCD
- A proposed list of upstream and downstream passage options for each development as discussed with LPs during several AWS that took place in November 2021
- A discussion with the intention of concurrence on the list of fish passage options to be carried forward into the next stage of the Fish Passage Facilities Alternatives Assessment

Meeting notes for Workshop 3 were not available prior to the finalization of this document.

1.5.4 Agency Work Sessions Discussions

During the first Fish Passage Study technical workshop, held on July 15, 2021, the Fish Passage Study team introduced a new element of the study to increase LP engagement and the frequency at which LPs were consulted, were informed, and participated in study discussions. The new element established bi-weekly AWS, which are discussions hosted by City Light and its Fish Passage Study consultant team and attended by a small group of fish passage experts and interested LPs from NMFS, USFWS, WDFW, the NPS, the Upper Skagit Indian Tribe, the Swinomish Tribe, and the Skagit River System Cooperative.

The AWS discussions are intended to provide a consistent forum for frequent collaboration among the AWS participants on all elements of the Fish Passage Study. This communication will allow for a rigorous assessment of the factors influencing the viability and potential effectiveness of fish passage at the Project developments and will provide a forum for the full and active involvement of resource agency and tribal biologists and engineers who have specific fish passage or related experience or have co-management responsibilities for fish resources in the Skagit River basin. Meeting participants have been encouraged to engage in these sessions as frequently as possible to provide insights and opinions regarding ongoing and future elements of the Fish Passage Study.

The inaugural AWS discussion was held on August 8, 2021, and meetings have taken place every other week since the inception date through the release of this Final Draft DCD (February 2022). LP attendance has been robust and consistent. Summary notes for each AWS discussion are included as an attachment to this document, and a brief overview of the discussion content for each meeting held through January 10, 2022, is provided below.

1.5.4.1 AWS Discussion No. 1

August 9, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Allowed for participant introductions and background.
- Defined goals and objectives of AWS.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements and Outcomes

- Fish Passage Study team will provide a review of fish passage study development in detail in next meeting.
- Outline for Preliminary Draft DCD will be presented in next meeting.
- Group agreed that meeting notes will be made available to LPs and posted to Triangle Associates' SharePoint site.
- Agendas for each subsequent meeting will be sent to LPs in advance of the next call.

1.5.4.2 AWS Discussion No. 2

August 23, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Discussed data needs and linkages to development of fish passage strategies and conceptual designs.
- Discussed approach for filling data gaps.
- Discussed general strategy for developing passage strategies and concepts.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- City Light consultant team will provide list of data needs and distribute to LPs prior to next AWS call, for future discussion.
- AWS members will serve as liaisons for the greater LP group, including co-managers.

- Linkages to how other studies will influence this study will continue to be refined and identified.

1.5.4.3 AWS Discussion No. 3

September 8, 2021, via WebEx virtual platform (delayed due to Labor Day holiday)

Summary of Discussion Topics

- Provided LPs with high-level Request for Information tracking table for data needs.
- Discussed development of table and provided a summary of data collected to date.
- Discussed need for more specific data on fish abundance, timing, peak migration timing, reservoir transit behavior, and survival of juvenile outmigrants.
- Discussed periodicity and information to be obtained from Habitat Suitability Criteria (HSC) technical working group.
- Presented examples of how data is used to inform fish passage design.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- Subsequent meetings will continue to discuss data needs.
- Request for Information tracking table will include cultural resources.
- Pacific Lamprey will be added to periodicity considerations for passage.

1.5.4.4 AWS Discussion No. 4

September 20, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Continued discussion of Request for Information tracking table and data needs.
- Discussed refinement of target species list for passage considerations and the preferred use of the word "target" versus "focal."
- Consultant team requested information for Pacific lamprey and Salish Sucker (*Catostomus* sp.) occurrence and periodicity.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- Progress on Preliminary DCD comments will be discussed at next AWS meeting.
- City Light consultant team will update periodicity table per HSC refinements.

1.5.4.5 AWS Discussion No. 5

October 4, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Held high-level discussion on Preliminary DCD comments and reminder that comments are requested by October 7, 2021.
- Reviewed facilities assessment process and LP study request comments, and the need to review biological goals and engineering feasibility.
- Discussed typical process for establishing fish passage programs at barriers (including high dams), which includes the establishment of goals and objectives, along with benefits, risks, and constraints per McClure et al. (2018). A range of alternatives can be developed following the establishment of these parameters.
- Decided that subsequent AWS meetings will focus on a determination of goals, objectives, benefits, risks, and constraints for fish passage, as desired by LPs.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- Next meeting agenda will focus on goal setting, including a brainstorming event to encourage LP participation using a web-based platform.

1.5.4.6 AWS Discussion No. 6

October 18, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Brief discussion on NMFS' comments on Preliminary Draft DCD (received October 14, 2021), including request to LPs for information on fish sizes as requested by NMFS.
- Initiated discussion on Goal setting, including refresher on general definitions of Goals and how they are used to inform fish passage concepts and designs.
- Initiated brainstorming session on Mural, which was paused based on feedback from LPs. The consensus among AWS participants was that establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of the Fish Passage Study, but rather will be informed by concurrent studies and agency/tribal discussions in the future with consideration of recovery planning targets and current and future harvest objectives.
- Discussion on goals pivoted to discussion on fish passage strategies and proposed that future AWS discussions will look at range of facilities that might meet each strategy, per Project development.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- Various LPs agreed to explore their data sources for information on Skagit River-specific fish sizes.
- This study will not establish biological goals and objectives for fisheries resource management but will rather consider biological requirements of target species within the anticipated

operating environments of the Gorge, Diablo, and Ross developments. These factors will inform a range of upstream and downstream passage facility alternatives that may be evaluated as part of the study.

1.5.4.7 AWS Discussion No. 7

November 1, 2021, via WebEx virtual platform

Summary of Discussion Topics

- City Light consultant team reiterated the request for Skagit River-specific data on fish weights.
- Held brief discussion of comments on Preliminary Draft DCD from USFWS (received October 21, 2021) and acknowledgement of receipt of comments from Upper Skagit Indian Tribe (received October 29, 2021).
- Initiated brainstorming session on upstream and downstream passage alternatives, constraints, issues, for the Gorge Dam.
- Brainstorming session focused on technical options, criteria, and design considerations for passage; however, potential fisheries management options were considered as applicable to how and where fish would be transported (e.g., reservoir transit and tributary collection strategies).
- LPs expressed desire for full range of all feasible passage considerations – everything should be considered now, and feasibility will determine which options might progress to the next stage of the Fish Passage Study.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up front and eliminated in subsequent stages as feasibility is assessed.
- LPs will explore data on Skagit River-specific fish sizes.
- Diablo Dam fish passage alternatives will be discussed during the next AWS discussion.

1.5.4.8 AWS Discussion No. 8

November 15, via WebEx virtual platform

Summary of Discussion Topics

- Fish Passage Study team reiterated the request for Skagit River-specific data on fish weights.
- Held brief discussion of comments on Preliminary Draft DCD and preparation of comment response matrix that will be provided with the Revised Draft DCD.
- Initiated brainstorming session on upstream and downstream passage alternatives, constraints, and issues for the Diablo Dam.

- Brainstorming session focused on technical options, criteria, and design considerations for passage, and included volitional and non-volitional options (e.g., trap and haul), as well as tributary collection strategies.
- Identified initial constraints for several options that will be considered in future AWS and workshop discussions.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up front and eliminated in subsequent stages as feasibility is assessed.
- Consultant Team will prepare next meeting's agenda to include:
  - Review results of alternatives setting exercise and discussion for the Diablo Development
  - Fish Passage Options brainstorming exercise and discussion for the Ross Development

1.5.4.9 AWS Discussion No. 9

November 29, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Study team reiterated the request for Skagit River-specific data on fish weights.
- Held brief discussion of comments on Preliminary Draft DCD and preparation of comment response matrix that will be provided with the Revised Draft DCD.
- Reviewed results of the Diablo Dam fish passage options discussed during previous AWS.
- Initiated brainstorming session on upstream and downstream passage alternatives, constraints, and issues for the Ross Dam.
- Brainstorming session focused on physical conditions, technical options, criteria, and design considerations for passage, and included volitional and non-volitional options (e.g., trap and haul), as well as tributary collections.
- Identified initial constraints for several options that will be considered in future AWS and technical workshop discussions.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up front and eliminated in subsequent stages as feasibility is assessed.
- Study team will prepare next meeting's agenda to include:
  - Review results of alternatives-setting exercise and discussion for the Ross Development.

- Discuss factors that influence the technical feasibility of fish passage options and inform alternative selection.
- Discuss methods for option development and selection that will be discussed in more detail during Workshop 3.

1.5.4.10 AWS Discussion No. 10

December 13, 2021, via WebEx virtual platform

Summary of Discussion Topics

- Study team reiterated the request for Skagit River-specific data on fish weights.
- Held brief discussion of Revised Draft DCD, submitted to LPs on December 9, 2021, and requested comments on the DCD by January 6, 2022.
- Reviewed brainstorming session for fish passage options at Ross Development as discussed during the previous AWS meeting.
- Discussed factors that influence the technical feasibility of fish passage options and inform alternative selection.
- Discussed methods for option development and selection that will be discussed in more detail during Workshop 3.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up front and eliminated in subsequent stages as feasibility is assessed.
- Study team will prepare next meeting's agenda to include:
  - Discuss Revised Draft DCD comments received to date.
  - Review fish passage options and discussions from Workshop 3, held December 16, 2021.
  - Refine fish passage options to be carried into Stage 2 of the Fish Passage Facilities Alternatives Assessment.

1.5.4.11 AWS Discussion No. 11

January 10, 2022, via WebEx virtual platform

Summary of Discussion Topics

- Held brief discussion of comments received to date on Revised Draft DCD and stated that a revised comment response matrix will be provided with the Final Draft.
- Reviewed fish passage options discussed during Workshop 3, held December 16, 2021.

- Presented reformulation of fish passage options, including Options 1A, 1B, and 1C, and held discussion on each option. Requested concurrence from LPs on recommended list of options to advance to next stage of the Fish Passage Facilities Alternatives Assessment.
- Discussed options not recommended to advance to the next stage of the study, and rationale for elimination.
- Provided Fish Passage Study progress and schedule of future milestones.

Agreements

- Options 1A–C are to move forward and be evaluated as part of the Concept Development Report (Stage 2 of the Fish Passage Facilities Alternatives Assessment).
- Options and technologies that were eliminated from further consideration will be documented with explanations in the Final DCD.
- Study team will prepare next meeting's agenda to include:
  - Review of fish passage options selected for advancement to Stage 2 of the Fish Passage Facilities Alternatives Assessment, per previous AWS meeting.
  - Review of outline and schedule for Stage 2 deliverable – Concept Development Report.
  - Progress report on Fish Passage Assessment of Existing Features in Bypass Reach.

2.0 PHYSICAL SETTING

This section describes salient physical and operational considerations that contribute to an overall understanding of potential operating environments within which fish passage strategies and concept facilities may be implemented. Most of the information presented herein is paraphrased from the FERC Pre-Application Document (City Light 2020a) for context; however, pertinent supplemental information has been updated in this document and may continue to be updated in other deliverables to be prepared for this element of the Fish Passage Study. Pertinent information contained in this section includes but is not limited to descriptions of Project infrastructure, facility locations, reservoir operations, and existing reservoir temperature data.

Biological data, currently available for each of the selected target species (Section 3.0 of this document), is further combined with the physical and operational environment of each Project development in Section 5.0 of this document to establish key site-specific factors that directly influence the suitability and formulation of potential fish passage facility alternatives. Although technical feasibility is mentioned herein, a more in-depth analysis of feasibility for selected passage alternatives will not be developed until future stages of this study are issued in early 2022, as outlined in the Final FA-04 RSP.

Elevation data presented herein are provided in a City of Seattle Datum (CoSD) and the North American Vertical Datum of 1988 (NAVD 88) as available. City Light is in the process of converting Project information from its older vertical elevation datum (CoSD) to the more current and standardized elevation datum (NAVD 88). To the extent practicable, this document indicates the applicable corresponding datum for each data presented. In some cases, translation between CoSD and NAVD 88 datums are still in progress. Future study deliverables will endeavor to present all elevations consistently in NAVD 88 as accurately as possible. The conversion factor between CoSD and NAVD 88 varies depending on location and ranges between +5.96 and +6.72 feet.

2.1 Project Location

The Project consists of three power generating developments on the Skagit River—Ross, Diablo, and Gorge—and associated lands and facilities. The Project generating facilities are in the Cascade Mountains of the upper Skagit River watershed, between Project River Miles (PRM) 94.7 and 127.9 (U.S. Geological Survey [USGS] RMs 94.2 and 127).[5] Power from the Project is transmitted via two 230-kilovolt (kV) powerlines that span over 100 miles and end just north of Seattle at the Bothell Substation. The Project also includes two City Light-owned towns, an Environmental Learning Center (ELC), several recreation sites, and several parcels of fish and wildlife habitat mitigation lands.

Project generating facilities are all in Whatcom County, although Ross Lake, the most upstream reservoir, crosses the U.S.-Canada border and extends for about one mile into British Columbia at

[5] City Light has developed a standard Project centerline and river mile system to be used throughout the relicensing process, including the study program, to replace the outdated USGS RM system. Given the long-standing use of the USGS RM system, both it and the Project River Mile (PRM) system are provided throughout this document.

normal maximum water surface elevation.[6] Gorge Powerhouse, the most downstream facility, is approximately 120 miles northeast of Seattle and 60 miles east of Sedro-Woolley, the nearest large town. The closest town is Newhalem, which is part of the Project and just downstream of Gorge Powerhouse. The primary transmission lines are in Whatcom, Skagit, and Snohomish counties.

The boundary of the Skagit River Project (Project Boundary) is extensive, spanning over 133 miles and 32,773 acres from the U.S.-Canadian border to the Bothell Substation just north of Seattle, Washington. In addition, there are "islands" of fish and wildlife habitat lands and recreation sites within the Skagit, Sauk, and South Fork Nooksack watersheds that are also within the Project Boundary. Project generating facilities are entirely within the Ross Lake National Recreation Area (RLNRA), which is managed by the NPS as part of the North Cascades National Park Complex. RLNRA was established in 1968 in the enabling legislation for North Cascades National Park to provide for the "public outdoor recreation use and enjoyment of portions of the Skagit River and Ross, Diablo, and Gorge lakes." The legislation also mandated continued FERC jurisdiction over the Skagit River Hydroelectric Project, FERC No. 553 and the Newhalem Creek Hydroelectric Project, FERC No. 2705 within RLNRA and existing hydrologic monitoring stations necessary for the proper operation of the hydroelectric projects (Public Law 90-544, Section 505 dated October 2, 1968, as amended by Public Law 100-668, Section 202 dated November 16, 1988).

The Skagit River downstream of the Project from Bacon Creek to Sedro-Woolley is part of the Skagit River Wild and Scenic River System, which is managed by the Mt. Baker-Snoqualmie District of the U.S. Forest Service (USFS). The NPS has deemed the Skagit River from Gorge Powerhouse to Bacon Creek eligible for status as wild and scenic, with the "recreational" classification, but this segment of the river is not yet designated (NPS 2012).

An overview map of the Project facilities, displaying the Project Boundary in proximity to generation facilities, township/range/section, state, county, river, and river mile are provided in Figure 2.1-1. Access to most of the Project is via State Route (SR) 20, commonly referred to as the North Cascades Highway.

[6] All elevations cited in this document are City of Seattle Datum unless otherwise noted. City Light is in the process of transitioning over to use of North American Vertical Datum of 1988 (NAVD 88) for representation of vertical datum, which will be completed no later than filing of the license application. A table converting elevation values of key Project features from City of Seattle Datum to NAVD 88 and map of the features is appended to the Final Study Plan.

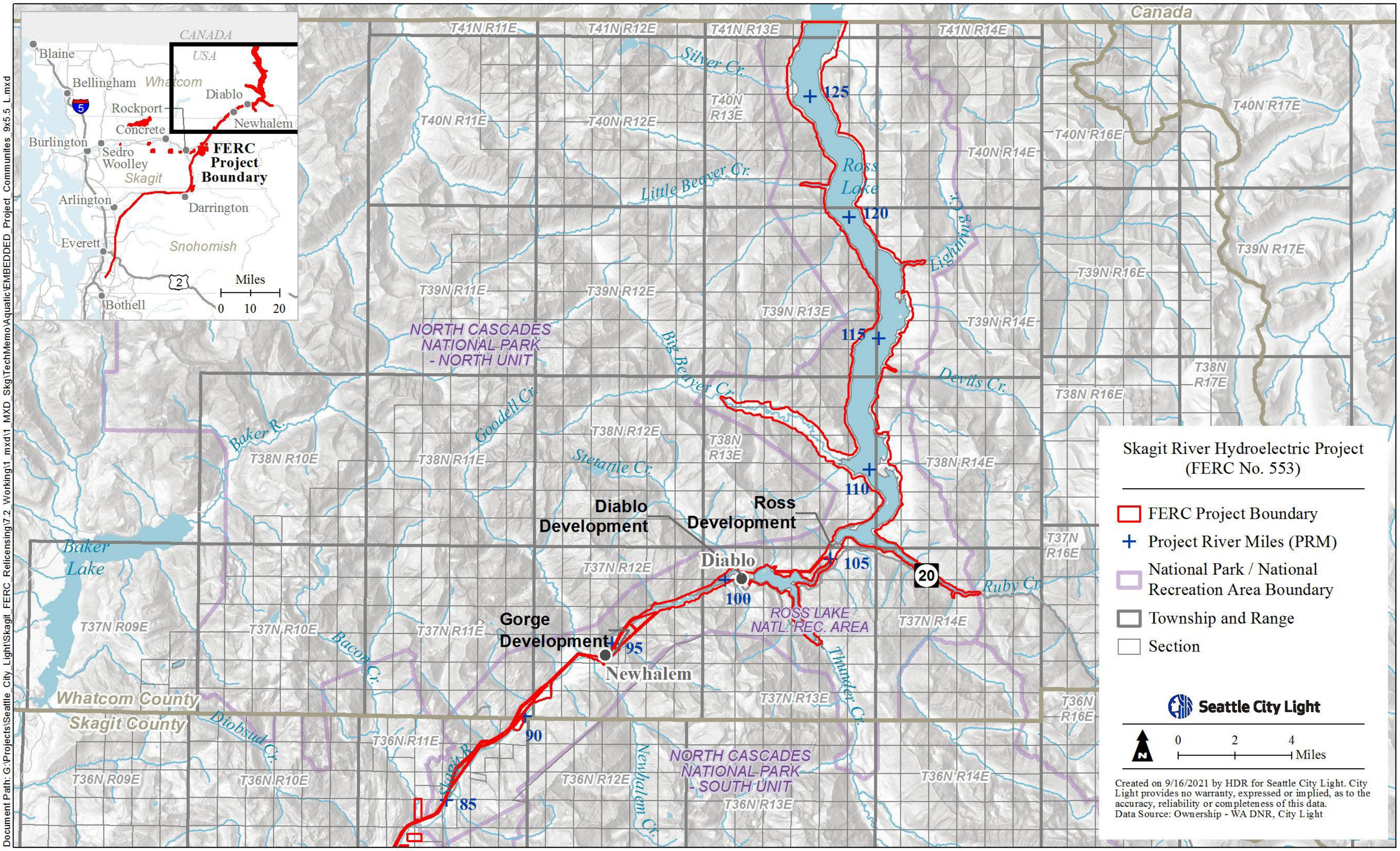


Figure 2.1-1. Skagit River Project and surrounding communities near Project generation facilities.

2.2 Existing Facilities

The following subsections provide more detailed information related to the three specific Project developments—Gorge, Diablo, and Ross—that include a dam, powerhouse, and reservoir, operations of which are hydraulically coordinated. The physical, operational, and accessibility information presented herein informs numerous considerations relative to the selection of potential fish passage technologies, facility location, engineering and constructability constraints, and transportation from each Project development to another. The general layout of the developments relative to each other and components of each are shown in Figure 2.1-1. Specifications for each development are summarized in Table 2.2-1 and described below in the following subsections. Engineering plans, profiles, and elevations of each development are included as an attachment to this document.[7]

Table 2.2-1. Specifications for the three developments of the Skagit River Project.

Project Component	Development		
	Gorge	Diablo	Ross
Dam			
Composition and configuration	concrete arch gravity diversion	concrete arch	concrete arch
Structural height of dam	300 ft	389 ft	540 ft
Length of crest (including spillways)	670 ft	1,180 ft	1,300 ft
Dam thickness at base	170 ft	146 ft	208 ft
Dam thickness at roadway	70 ft	16 ft	33 ft
Elevation of crest of dam (at roadway)	886.3 ft[1] (880.5 ft CoSD)	1,224.65 ft (1,218 ft CoSD)	1,621.2 ft (1,615 ft CoSD)
Concrete volume:	Unknown	350,000 cubic yards	909,214 cubic yards
Spillway			
Number of spillways	1	2	2
Spillway gates: Number Type Dimensions	 2 Fixed wheel 50 ft high by 47 ft wide	 19 Radial Tainter 19 ft high by 20 ft wide	 12 Radial Tainter 20 ft high[2] by 19.5 ft wide
Spillway crest elevation	831.3 ft (825 ft CoSD)	1,193.65 ft (1,187 ft CoSD)	1,588.2 ft (1,582 ft CoSD)
Maximum spillway capacity (at normal maximum water surface elevation)	120,000 cfs	98,500 cfs	124,800 cfs
Reservoir			
Normal maximum water surface elevation	881.51 ft (875 ft CoSD)	1,211.36 ft (1,205 ft CoSD)	1,608.76 ft (1,602.5 ft CoSD)

[7] Per guidance from the Federal Energy Regulatory Commission (FERC), Attachment A contains Critical Energy/Electric Infrastructure Information (CEII) and has therefore been omitted from general distribution. This information will be provided to the Fish Passage Study Licensing Participants via email and SharePoint posting. Procedures for obtaining access to CEII may be found at 18 Code of Federal Regulations (CFR) § 388.113. Requests for access to CEII should be made to the Commission's CEII coordinator. In addition to Fish Passage Licensing Partner submittal, this information will be included in the Final Draft DCD, which will be included as an appendix to the Initial Study Report (ISR) for the Fish Passage Study. It will be filed with FERC with a CEII designation as part of the ISR submittal in March 2022.

Project Component	Development		
	Gorge	Diablo	Ross
Maximum drawdown (authorized by current Project license)	831.51 ft (825 ft CoSD)	1,204.36 ft (1,198 ft CoSD)	1,480.76 ft (1,474.5 ft CoSD)
Length of reservoir	4.5 miles	4.5 miles	24 miles[3]
Surface area at normal maximum water surface elevation	240 acres	770 acres	11,680 acres[3]
Shoreline length at normal maximum water surface elevation[4]	11 miles	20 miles	84 miles[5]
Gross storage	8,500 acre-ft	50,000 acre-ft	1,435,000 acre-ft[6]
Usable storage	6,600 acre-ft	8,820 acre-ft	1,052,000 acre-ft
Intake			
Intake structure	1 bifurcated intake with 2 openings, each 20 ft wide and 88.9 ft long (4:1 vertical:horizontal incline)	2 bifurcated intakes with 4 openings, each 16.75 to 18.75 ft wide and 153.17 ft long (approximate 2.6:1 vertical:horizontal incline)	2 bifurcated intakes with 4 openings, each 20 ft wide and 198.13 ft long (4:1 vertical:horizontal incline)
Trashrack opening	3.5 inches by 2 ft and 2.5 inches	2.5 inches by 2 ft and 0.3 inches	3.5 inches by 2 ft and 1 inch for three rows per panel and 3.5 inches by 2 ft and 5.5 inches for one row per panel
Intake ("power") tunnel:			
Number	1	1	2
Invert elevation	801.3 ft (795 ft CoSD)	1,086.65 ft (1,080 ft CoSD)	1,429.2 ft (1,423 ft CoSD)
Length of concrete-lined section (gate slot to steel liner)	11,000 ft	1,800 ft	1,800 ft/1,634 ft
Length of steel-lined section	NA	190 ft	NA
Diameter of concrete-line section	20.5 ft	19.5 ft	24.5 ft
Diameter of steel-lined section	NA	19.5 ft	NA
Penstocks:			
Number	4	3	4
Length	1,600 ft	290 ft	350 ft
Diameter of turbine inlet	10 ft (Units 21, 22, 23); 15 ft (Unit 24)	15 ft (Units 31, 32); 5 ft (Units 35, 36)	16 ft (all units)
Penstock centerline elevation at turbine inlet	503.21 ft (497 ft CoSD)	887.38 ft (881 ft CoSD)	1,217.65 ft (1,211.5 ft CoSD)
Powerhouse			
Total plant capability[7]	207.58 MW	182.4 MW	450 MW
	839.98 MW total		
Total authorized installed capacity[7,8,9]	173 MW	182.4 MW	450 MW
	805.4 MW total		
Annual capacity factor	51.83%	47.99%	13.35%
Normal tailwater elevation at dam	501.34 ft (495 ft CoSD)	881.26 ft (875 ft CoSD)	1,210.96 ft (1,205 ft CoSD)

Project Component	Development		
	Gorge	Diablo	Ross
Normal gross head	380 ft	330 ft	374 ft
Turbines: Turbine type Number of units Ratings (hp=horsepower; RPM=rotations per minute)	 Francis vertical 4 Units 21, 22: 42,242 hp at 380 ft head, 257 RPM Unit 23: 43,180 hp at 380 ft head, 257 RPM Unit 24: 139,400 hp at 380 ft head, 150 RPM	 Francis vertical 4 Units 31, 32: 117,200 hp at 330 ft head, 171.5 RPM Units 35, 36: 1,650 hp at 330 ft head, 720 RPM	 Francis vertical 4 140,000 hp at 337 ft head, 150 RPM
Hydraulic capacity (at maximum plant output)	7,440 cfs	7,130 cfs	16,000 cfs
Generators: Generator manufacturer Ratings Plant factor (average)	 Westinghouse U21 36.86 MW U22 36.86 MW U23 36.86 MW U24 97.00 MW 107.59 MW	 Westinghouse U31 90 MW U32 90 MW U35 1.2 MW U36 1.2 MW 87.53 MW	 Westinghouse U41 112.5 MW U42 112.5 MW U43 112.5 MW U44 112.5 MW 60.10 MW

Source: Power System Engineering Information 2019 (City Light 2019).
Note: cfs = cubic feet per second; ft = feet; MW = megawatt(s).

1 All elevations in the table are in North American Vertical Datum 1988 (NAVD 88) with City of Seattle Datum (CoSD) value in parentheses.
2 2.5-foot risers installed on top of each gate to increase storage capacity by 30,000 acre-feet and annual energy capability by 10,700 megawatt hours (MWh).
3 Approximately 23 miles and 11,180 acres in the U.S. and 1 mile and 500 acres in Canada.
4 Shoreline length calculated from Light Detection and Ranging (LiDAR) data collected in 2018 that is in North American Vertical Datum of 1988 (NAVD 88) datum.
5 Approximately 369,315 feet (69.9 miles) in U.S. and 75,742 feet (14.3 miles) in Canada. Shoreline length in Canada includes small channels and inlets with shallow water.
6 USGS uses 1,440,700 acre-feet as the capacity of Ross Lake.
7 These numbers are consistent with a revised Exhibit M, in the Pre-Application Document, filed with FERC in March 2020. At the time of publication, FERC approval has not been received. The authorized installed capacity is 650.25 MW (FERC 1997).
8 Generating capacity is limited to 173 MW at Gorge by head loss from tunnel capacity. In addition, Units 21, 22, and 23 at Gorge are restricted to a combined maximum of 96 MW due to water and generator bus limitations.
9 The small "house" units (35 and 36) at Diablo provide power to only the town, the powerhouse, and the ELC.

2.2.1 Ross Development

The Ross Development is the farthest upstream of the three Skagit River Project developments. The powerhouse (PRM 105.5, USGS RM 104.9) and nearby dam (PRM 105.7, USGS RM 105.1) are located about 11 miles north of Newhalem (Figure 2.1-1). Figure 2.2-1 provides an aerial map of the Ross Development. Ross Lake (Reservoir) spans a total of 24 miles long, with the most upstream mile of reservoir (at full pool) extending into Canada. Most of the water used for Skagit

River Project power generation originates in high mountain basins surrounding Ross Lake and upstream along the Skagit River in British Columbia.

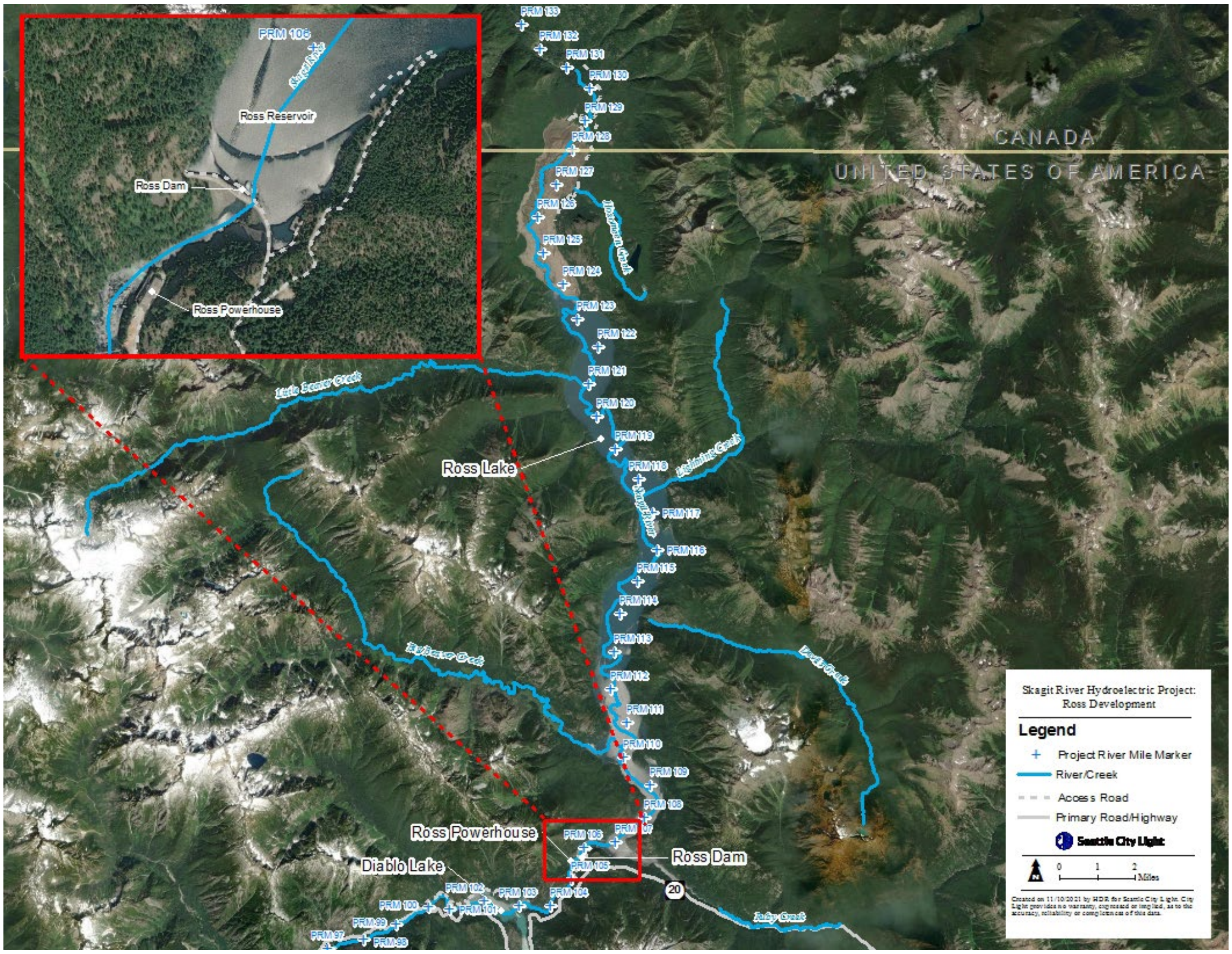


Figure 2.2-1. Ross Development aerial map.

Figure 2.2-2 provides a schematic profile representation of the Ross development and reservoir with the normal maximum water surface elevation and typical maximum drawdown. Information from Table 2.2-1 is reproduced in the figure for ease of reference. The typical water surface elevation range for Ross Lake operations is approximately 67 feet. Water surface elevations are typically maintained between a normal maximum of 1,608.76 feet NAVD 88 (1,602.5 feet CoSD) during summer and 1,541.26 feet NAVD 88 (1,535 feet CoSD) during fall and winter. The anticipated range of stage fluctuation with respect to implementation of fish passage facility technologies and alternatives is discussed in greater detail in Sections 2.3.1.1 and 5.4.1 of this document.

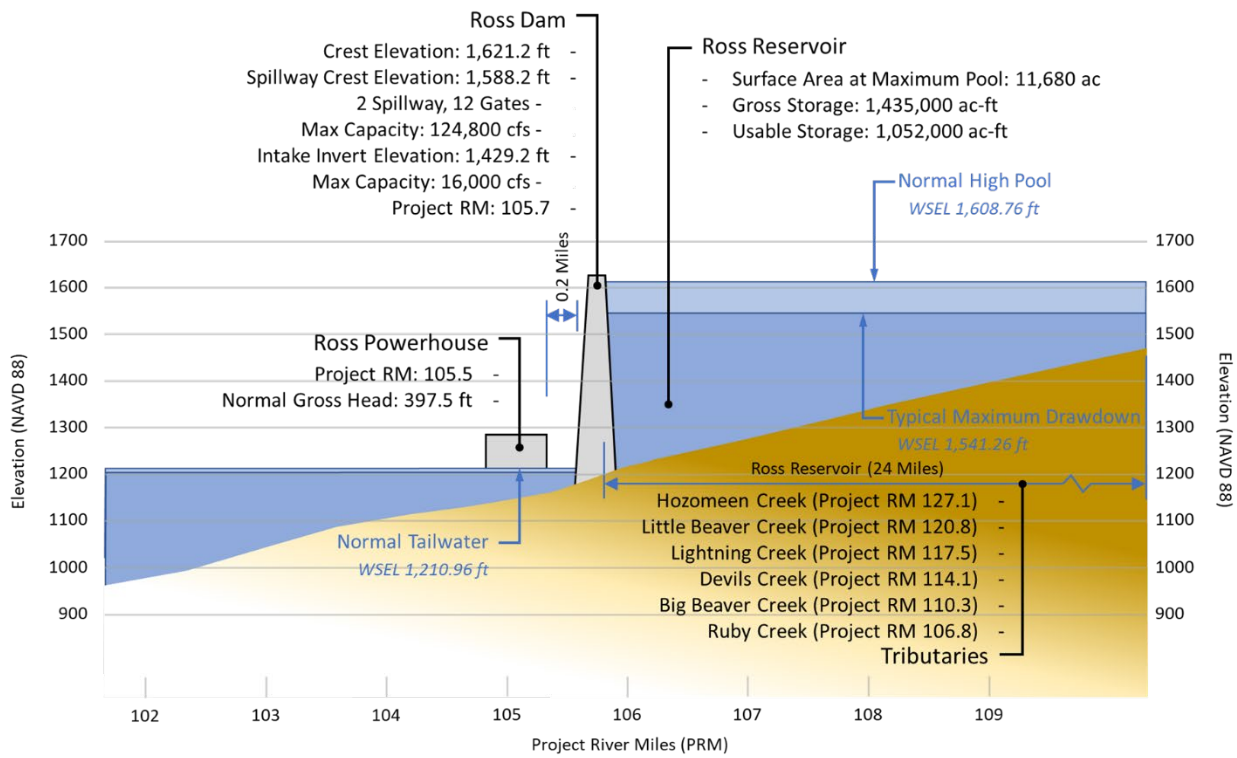


Figure 2.2-2. Ross development profile schematic. All elevations reported in NAVD 88.

Ross Powerhouse is located at PRM 105.5 (USGS RM 104.9) and is about 1,100 feet downstream of Ross Dam on the left bank at the eastern end of Diablo Lake (Figure 2.2-3 and Figure 2.2-4). Two concrete-lined power tunnels deliver water from the reservoir to four penstocks and into the powerhouse. Diablo Lake backs up to the base of Ross Dam, and there is no bypass reach or section of free-flowing river between the two developments.

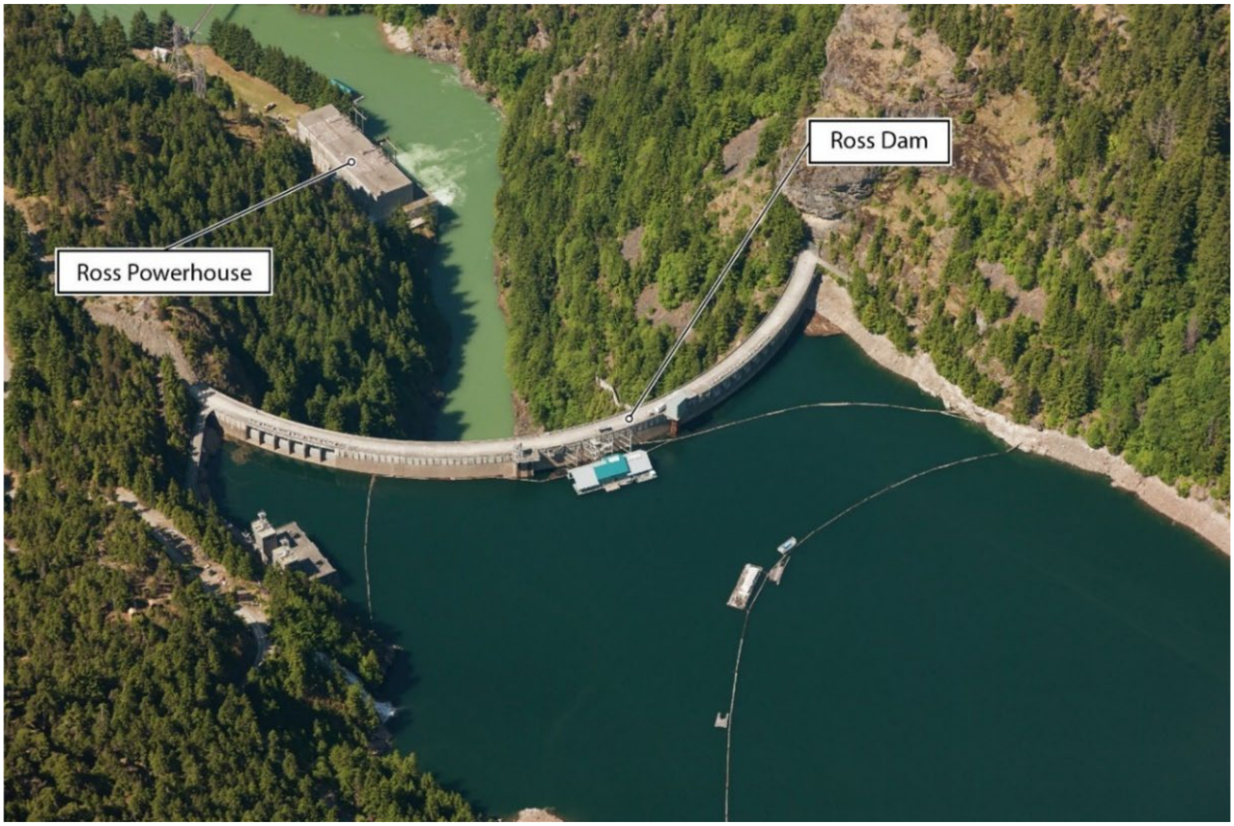


Figure 2.2-3. Aerial view of Ross Development and Powerhouse.

Figure 2.2-4. Ross Powerhouse.

Ross Dam is located at PRM 105.7 (USGS RM 105.1), just upstream of Ross Powerhouse. At 540 feet from bedrock to crest, it is the highest of the three Project dams. The crest of the dam is at elevation 1,621.2 feet NAVD 88 (1,615 feet CoSD). Ross Dam has two spillways, one on each side and each with six gates operated by an electric hoist (Figure 2.2-5 and Figure 2.2-6). The spillway crest is at elevation 1,588.2 feet NAVD 88 (1,582 feet CoSD). Two of the spill gates can be controlled remotely; the others are operated locally at the dam. In addition to the spillways, Ross Dam has two power tunnel intake structures with inverts at elevation 1,429.2 feet NAVD 88 (1,423 feet CoSD), two butterfly valves at elevation 1,346.26 feet NAVD 88 (1,340 feet CoSD) and two hollow jet valves near the base at elevation 1,275.26 and 1,260.26 feet NAVD 88 (1,269 feet and 1,254 feet CoSD). The two sets of valves can be opened to evacuate the reservoir once water levels drop below the level of the spill gates. On the top of the dam, a shed houses two hoists, one for each of the broome gates that close off the six-foot-diameter water supply pipes to the hollow jet valve. There is also a gantry that is used to raise and lower the broome gates that isolate the six-foot pipes for the butterfly valves. The road on top of the dam is used by City Light and NPS vehicles and is open to pedestrian use by the public. Engineering plans, profiles, and elevations of Ross Dam are included as an attachment to this document.[8]

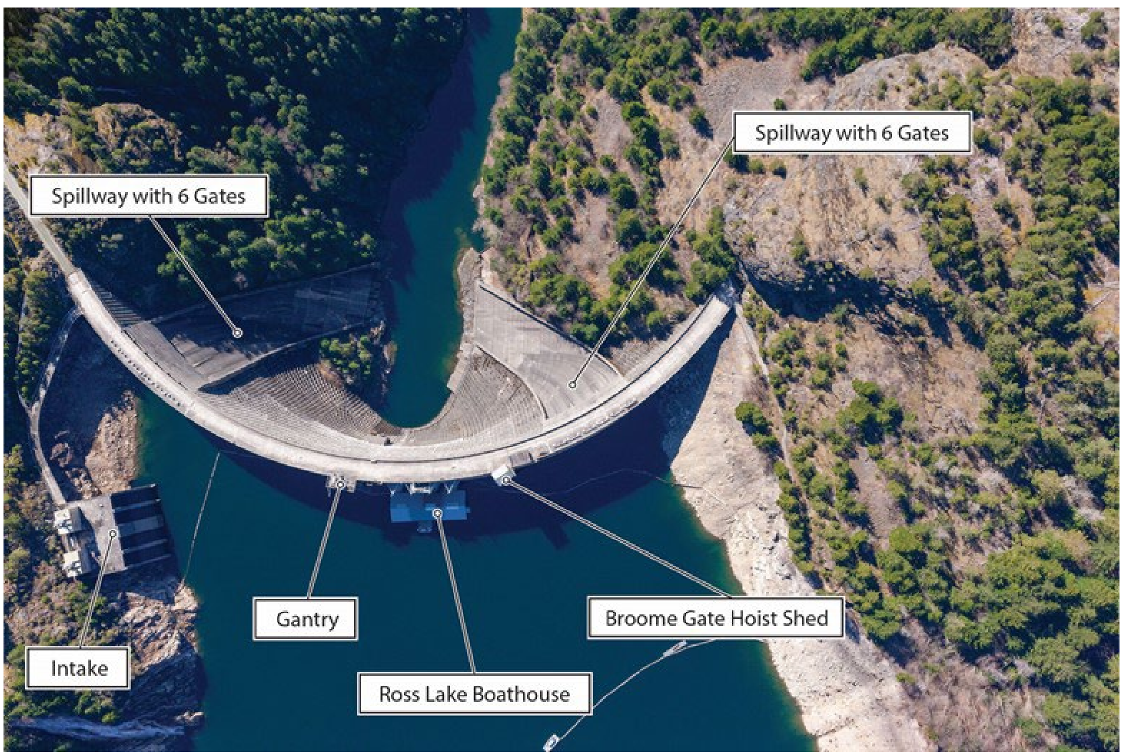


Figure 2.2-5. Aerial view of Ross Dam and associated facilities.

[8] Per guidance from FERC, Attachment A contains CEII and has therefore been omitted from general distribution. This information will be provided to the Fish Passage Study Licensing Participants via SharePoint posting. Procedures for obtaining access to CEII may be found at 18 CFR § 388.113. Requests for access to CEII should be made to the Commission's CEII coordinator. In addition to Fish Passage Licensing Partner submittal, this information will be included in the Final Draft DCD, which will be included as an appendix to the ISR for the Fish Passage Study. It will be filed with FERC with a CEII designation as part of the ISR submittal in March 2022.

Figure 2.2-6. Ross Dam.

At nearly 23 miles long, Ross Lake is the largest reservoir in western Washington. At full pool, Ross Lake extends into Canada approximately another 1 mile (24 miles total), with about 500 acres in British Columbia. The reservoir has a surface area of 11,680 acres and storage volume of 1,435,000 acre-feet at the normal maximum water surface elevation of 1,608.76 feet NAVD 88 (1,602.5 feet CoSD). With a drainage basin of 381 square miles (sq. mi.) in British Columbia (USGS 2019), the Skagit River provides the greatest inflow into Ross Lake. There are, however, several other tributary streams that make significant contributions. These include Ruby, Lightning, and Big Beaver creeks, which drain 209, 133, and 64 sq. mi., respectively (USGS 2019). Several other smaller streams contribute as well, including Happy Creek, which was diverted (circa 1962) via a tunnel into the reservoir from its original confluence with the Skagit River below the powerhouse.

Ross Lake is relatively inaccessible, especially by vehicle. The only vehicle access is via a 40-mile-long gravel road from Hope, British Columbia, to Hozomeen at the very north end of the reservoir (Figure 2.2-7). The boat ramps at Hozomeen provide the only public launches for motorized boats. The reservoir can also be accessed by foot via the Ross Dam Trail, which is one mile long and drops 700 feet from a parking lot along SR 20 at Milepost (MP) 134. Another trail to the lake, the East Bank Trail, leaves SR 20 from the upper end of Ruby Arm.

Figure 2.2-7. Ross Lake near Hozomeen looking north into British Columbia.

Figure 2.2-8 depicts Project infrastructure for potential fish passage facility locations for the Ross Development. These locations include the Skagit River by Ross Powerhouse, and the upstream and downstream faces of Ross Dam. Additional potential facility locations include within Ross Lake at the confluence of significant tributaries such as Hozomeen, Little Beaver, Lightning, Devils, Big Beaver, and Ruby creeks.

Figure 2.2-8. Aerial of Ross Dam and associated infrastructure for potential fish passage facilities.

The Ross Development has no direct road access; all materials, equipment, and staff are transported by boats and barges from a boathouse/dock/landing area at the western side of Diablo Lake (Figure 2.2-9) to a dock/landing near Ross Powerhouse (Figure 2.2-10). A steep gravel "haul" road (Ross Haul Road) connects the powerhouse and dock/landing to the dam. This road continues upstream of Ross Dam for approximately 1.6 miles, providing access to a landing used by Ross Lake Resort and other activities. The only other access to the development is via 2-foot trails: one off SR 20 at MP 134 and another that runs along the north side of Diablo Lake, crosses via a suspension bridge, and connects to the Ross Haul Road.

Figure 2.2-9. Barge transporting vehicles and equipment between Diablo Lake and Ross Powerhouse.

Figure 2.2-10. Barge landing and boat launch on Diablo Lake near Ross Powerhouse.

2.2.2 Diablo Development

The Diablo Development is located between the Ross and Gorge developments (Figure 2.1-1).In addition to generating power, it also reregulates flows between the Ross and Gorge developments. Figure 2.2-11 provides an aerial map of the Diablo Development. The powerhouse is located at PRM 100.8 (USGS RM 100.2) in the town of Diablo and the dam is located at PRM 101.6 (USGS RM 101.2). Diablo Lake (Reservoir) extends approximately 4.5 miles to the base of Ross Dam.

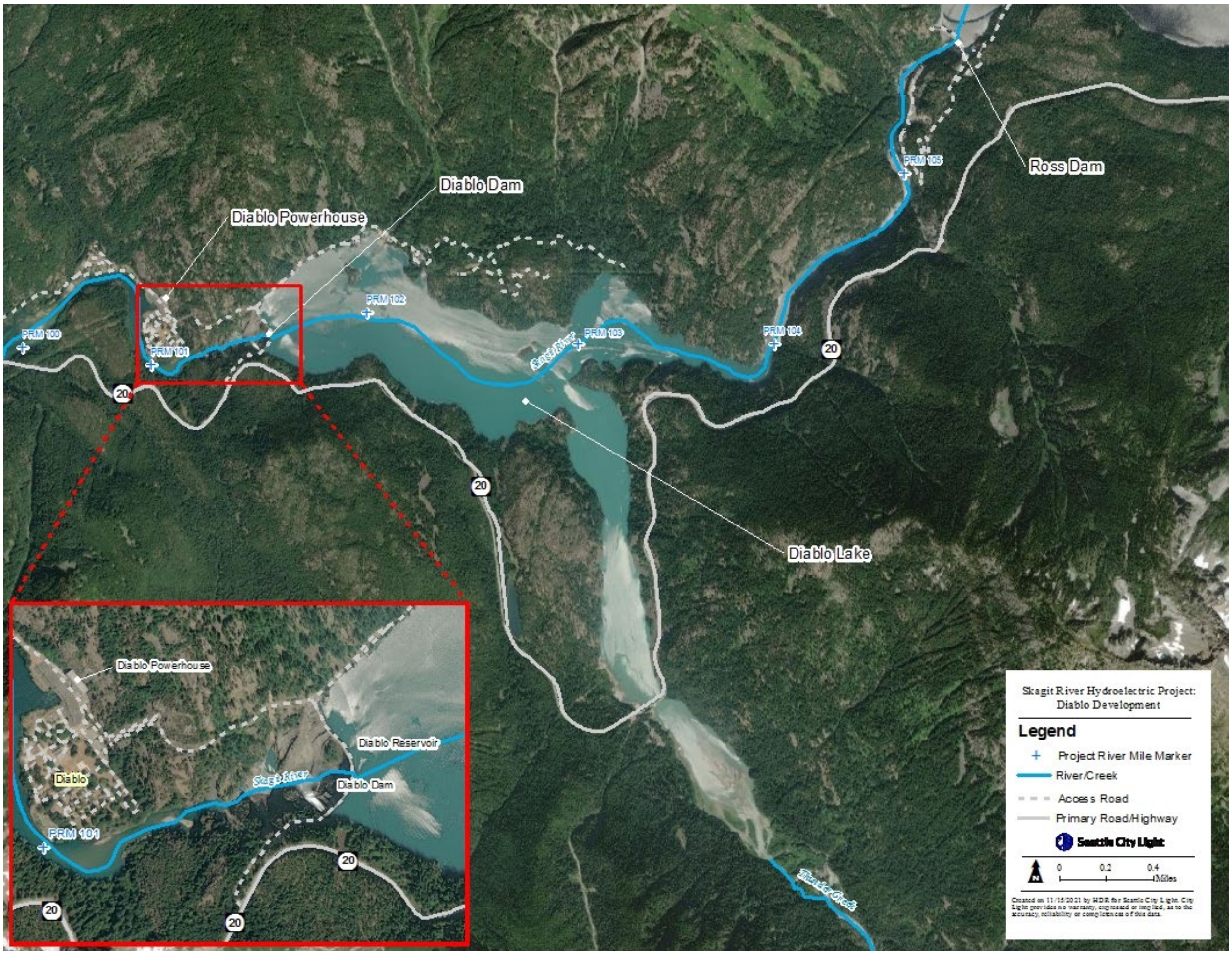


Figure 2.2-11. Diablo Development aerial map.

Figure 2.2-12 provides a schematic profile representation of the Diablo development and reservoir with the normal maximum water surface elevation and typical maximum drawdown. Information from Table 2.2-1 is reproduced in the figure for ease of reference. The typical water surface elevation range for Diablo Lake operations is approximately 4 to 5 feet, between about 1,206 and 1,211 feet NAVD 88 (1,199.64 and 1,204.64 feet CoSD).[9] The anticipated range of stage fluctuation with respect to implementation of fish passage facility technologies and alternatives is discussed in greater detail in Sections 2.3.1.2 and 5.4.2 of this document.

[9] Per the PAD (City Light 2020), the FERC-authorized range for Diablo is 7 feet.

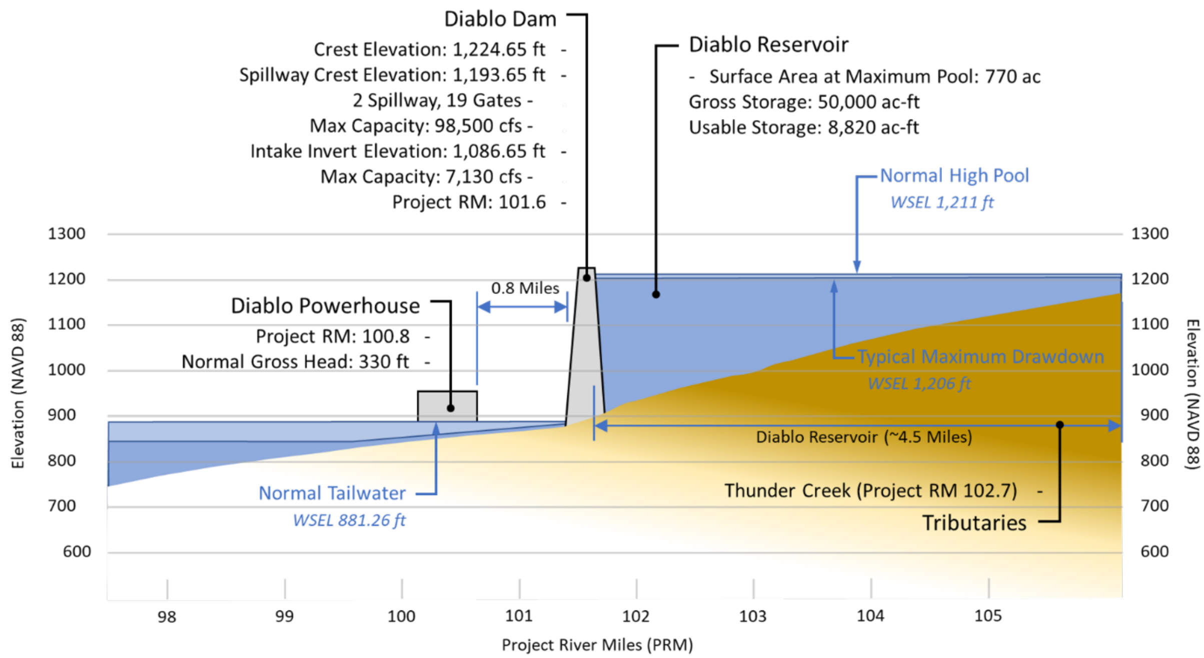


Figure 2.2-12. Diablo Development profile schematic. All elevations reported in NAVD 88.

Diablo Powerhouse is located on the north bank of the Skagit River in the town of Diablo, about 4,000 feet downstream from Diablo Dam (Figure 2.2-13). Water from the reservoir to the powerhouse is conveyed by a single tunnel that leads to three penstocks. There is a surge tank located near the bottom end of the tunnel, uphill from the powerhouse (Figure 2.2-14).

Figure 2.2-13. Diablo Powerhouse.

Figure 2.2-14. Aerial view of Diablo Development and associated facilities (not visible in photo: intake on right bank and valve house on face of the dam).

Diablo Dam, located at PRM 101.6 (USGS RM 101.2), is about 4.5 miles upstream of Gorge Dam and about 4.5 miles downstream of Ross Dam. The concrete arch dam is 389 feet from bedrock to crest and includes decorative arches over the spillways and lighting on the crest of the dam (Figure 2.2-15).

Figure 2.2-15. Diablo Dam.

Diablo Dam has two spillways, one on each side, and a total of 19 spill gates (see Figure 2.2-14 and Figure 2.2-15), 7 on the south spillway and 12 on the north. The three southern-most gates are automated via an electric hoist that can be operated remotely or locally. The remaining 16 gates are controlled locally at the dam using the "mule," an electric motor-driven hydraulic pump that operates two hydraulic cylinders to open or close the associated spill gate. The mule runs on tracks along the road on top of the dam and is positioned over the desired gate. The lifting chains for the gates are accessed below the deck plates on the dam. A valve house on the face of the dam at elevation 1,053.36 feet NAVD 88 (1,047 feet CoSD) has four outlet valves—three butterfly type and one Larner Johnson type—that can evacuate water from the reservoir at levels below the spill gates. The crest of the dam also serves as a road that is open to the public during the day and provides access to City Light facilities, including the ELC, and RLNRA lands on the west side of

Diablo Lake. Engineering plans, profiles, and elevations of Diablo Dam are included as an attachment to this document.[10]

Diablo Lake has a surface area of about 770 acres and gross storage of 50,000 acre-feet at a normal maximum water surface elevation of 1,211.36 feet NAVD 88 (1,205 feet CoSD) (Figure 2.2-12 and Figure 2.2-16). Tributaries to Diablo Lake include Thunder, Colonial, Rhode, Sourdough, and Deer creeks.

Figure 2.2-16. Diablo Lake from overlook east of Colonial Creek Campground.

Figure 2.2-17 depicts potential fish passage facility locations for the Diablo Development. These locations include by Diablo Powerhouse, the upstream and downstream faces of Diablo Dam,

[10] Per guidance from FERC, Attachment A contains CEII and has therefore been omitted from general distribution. This information will be provided to the Fish Passage Study Licensing Participants via SharePoint posting. Procedures for obtaining access to CEII may be found at 18 CFR § 388.113. Requests for access to CEII should be made to the Commission's CEII coordinator. In addition to Fish Passage Licensing Partner submittal, this information will be included in the Final Draft DCD, which will be included as an appendix to the ISR for the Fish Passage Study. It will be filed with FERC with a CEII designation as part of the ISR submittal in March 2022.

Diablo Lake at the confluence of Thunder Creek, and the Hwy 20 crossing at the Thunder Arm of Diablo Lake.

Figure 2.2-17. Aerial of Diablo Dam and associated infrastructure for potential fish passage facilities.

Diablo Dam is accessed by Diablo Dam Road, which connects to SR 20 at MP 127.5. Diablo Powerhouse is in the town of Diablo and is accessed by a spur road off SR 20 at approximately MP 125. Access to Diablo Lake is relatively limited because of the steep, rocky slopes that abut much of the shoreline. All materials, equipment, and staff are transported by boats and barges between the Ross Development and Diablo Dam on Diablo Lake from a boathouse/dock/landing area at the western side of Diablo Lake. As described previously in Section 2.2.1 of this document, refer to Figure 2.2-9 showing the barge landing near the Diablo Lake Boathouse and Figure 2.2-10 showing the dock/landing near Ross Powerhouse.

2.2.3 Gorge Development

The Gorge Development is the farthest downstream of the three Skagit River Project developments. Figure 2.2-18 provides an aerial map of the Gorge Development. Gorge Powerhouse is located at PRM 94.7 (USGS RM 94.2) on the left bank (facing downstream) of the Skagit River just upstream of the town of Newhalem. Gorge Dam is located at PRM 97.2 (USGS

RM 96.6) and the Gorge Bypass Reach spans 2.5 miles between the powerhouse and dam. Gorge Lake (Reservoir) spans approximately 4.5 miles to the base of Diablo dam.

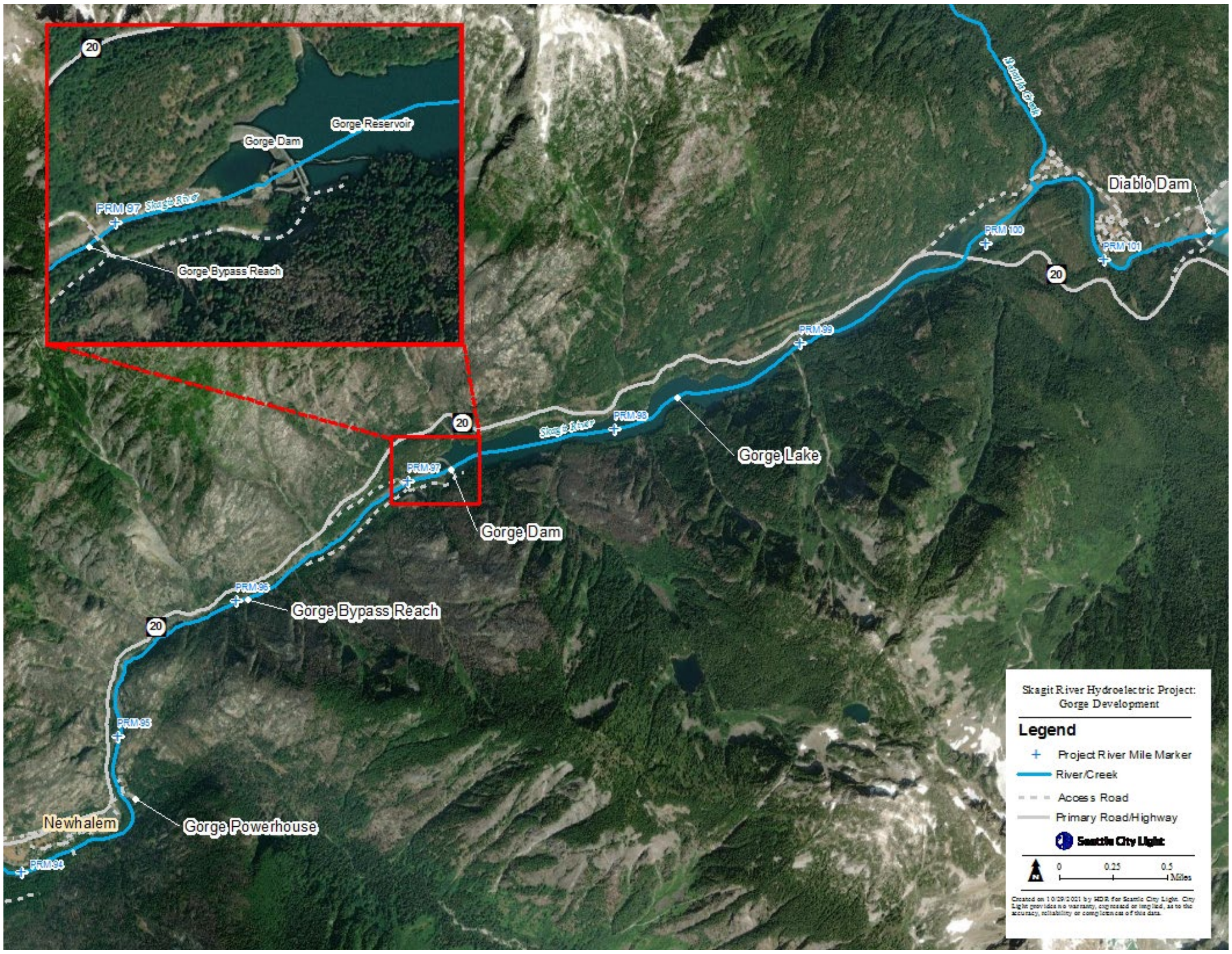


Figure 2.2-18. Gorge Development aerial map.

Figure 2.2-19 provides a schematic profile representation of the Gorge development and reservoir with the normal maximum water surface elevation and typical maximum drawdown. Information from Table 2.2-1 is reproduced in the figure for ease of reference. The typical water surface elevation range for the Gorge reservoir is approximately 3 to 5 feet daily, between about 876 and 880 feet NAVD 88 (between about 869.49 and 873.49 feet CoSD). The anticipated range of stage fluctuation with respect to implementation of fish passage facility technologies and alternatives is discussed in greater detail in Sections 2.3.1.3 and 5.4.3 of this document.

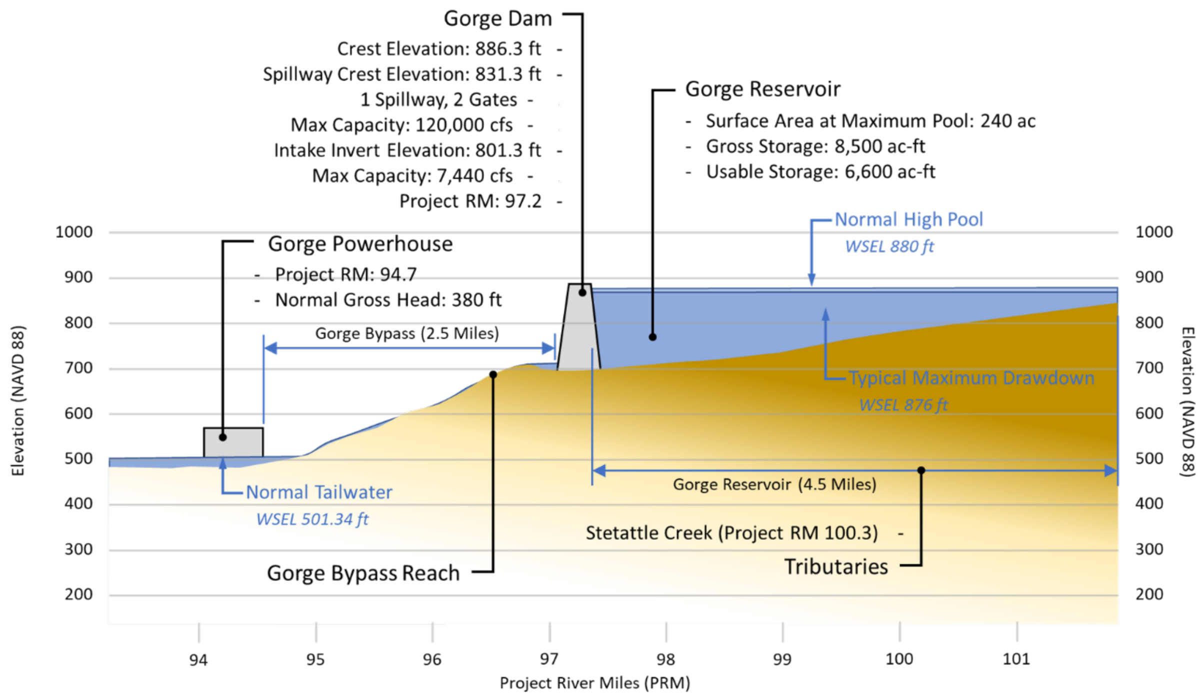


Figure 2.2-19. Gorge Development profile schematic. All elevations reported in NAVD 88.

Gorge Powerhouse is located at PRM 94.7 (USGS RM 94.2) just upstream of the town of Newhalem. In addition to generating power, Gorge Powerhouse is responsible for regulating flows to the river downstream of the Project for fish protection, as stipulated by the current Project license (Figure 2.2-20).

Water from Gorge Lake is conveyed via an intake structure in Gorge Dam into an 11,000-foot-long power tunnel to the powerhouse. The power tunnel passes through the solid rock slope that is adjacent to the Skagit River and then splits into four penstocks. A surge tank and riser with restricted orifice is located at the lower end of the tunnel. A second power tunnel at the Gorge Development was authorized in a license amendment issued by FERC on July 17, 2013. While not yet constructed, if the proposal moves forward, the new tunnel would be 11,000 feet long and 22 feet in diameter and would be below ground and parallel to the existing tunnel. The new tunnel would not change the installed capacity of the Gorge Development; it would, however, increase plant efficiency and would be expected to produce an additional 56,000 MWh annually.

Figure 2.2-20. Gorge Powerhouse.

Gorge Dam, located at PRM 97.2 (USGS RM 96.6), is about 2.5 miles upstream of Gorge Powerhouse and approximately 4.5 miles downstream from Diablo Dam (Figure 2.2-21). The current Gorge Dam, which was completed in 1961, is a combination concrete arch and gravity structure that rises 300 feet from bedrock to crest (Figure 2.2-21). There have been two other Gorge dams—a timber-crib dam, built in 1923-1924, and a masonry dam, finished in 1951. The timber-crib dam was removed after construction of the masonry dam. The pool resulting from construction of the current dam inundated the earlier masonry dam and is still present along the historical channel flow line, which was much lower. Therefore, the masonry dam is still believed to be present within the historical river channel that now resides beneath Gorge Lake.

Figure 2.2-21. Gorge Dam.

The existing dam has a small log chute near its center which allows wood to be passed downstream of the Project. There are two spillways with gates that are operated by an electric hoist on top of the dam (Figure 2.2-22). One gate can be remotely controlled to a limited height; the other must be opened and closed locally at the dam. Training walls on either side of the spillway direct water into the river channel downstream. Two outlet valves on the face of the dam at elevation 770.51 feet NAVD 88 (764 feet CoSD) can be used to evacuate water from Gorge Lake below the spill gate level. Engineering plans, profiles, and elevations of Gorge Dam are included as an attachment to this document.[11]

[11] Per guidance from FERC, Attachment A contains CEII and has therefore been omitted from general distribution. This information will be provided to the Fish Passage Study Licensing Participants via SharePoint posting. Procedures for obtaining access to CEII may be found at 18 CFR § 388.113. Requests for access to CEII should be made to the Commission's CEII coordinator. In addition to Fish Passage Licensing Partner submittal, this information will be included in the Final Draft DCD, which will be included as an appendix to the ISR for the Fish Passage Study. It will be filed with FERC with a CEII designation as part of the ISR submittal in March 2022.

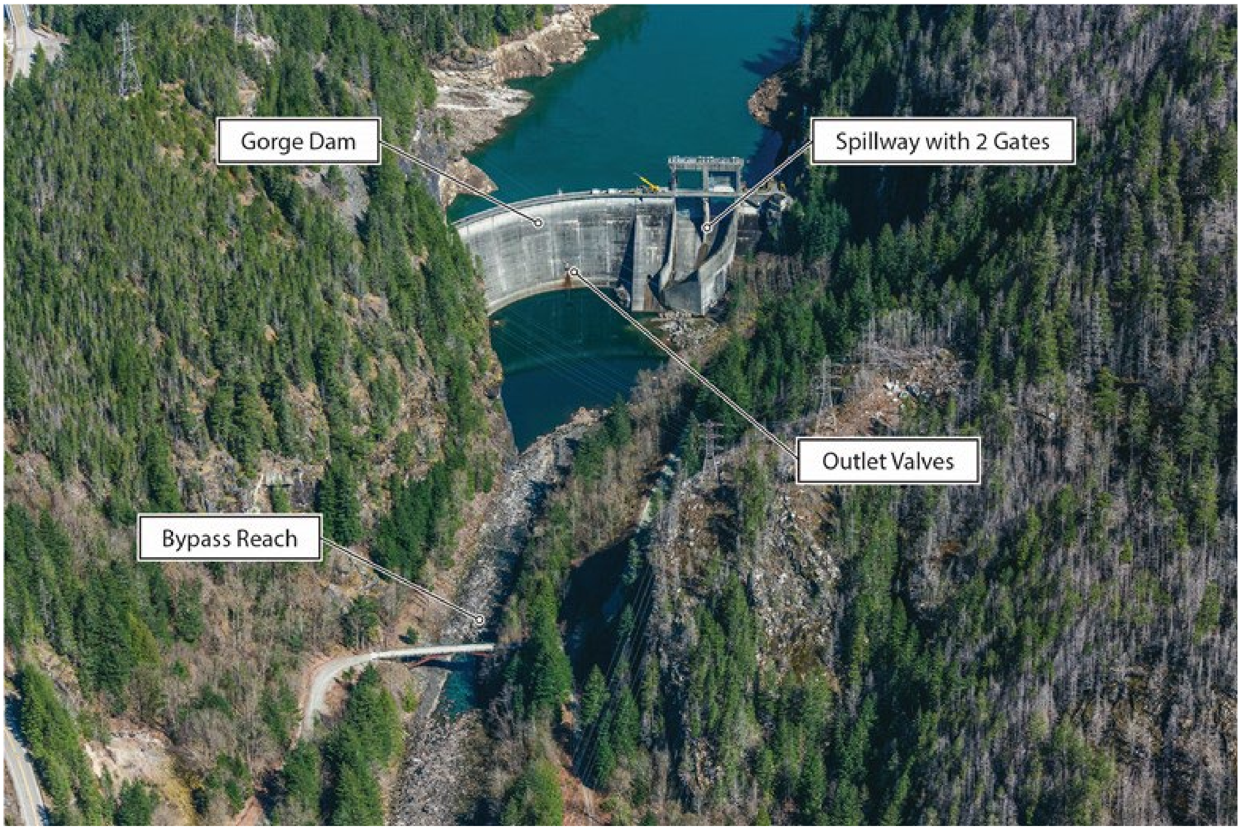


Figure 2.2-22. Aerial view of Gorge Development and associated facilities (not visible on photo: log chute on face of dam, Gorge Powerhouse, and surge tank about 2.5 miles downstream of the dam).

Gorge Lake is 4.5 miles long and extends to the base of Diablo Dam (Figure 2.2-18). At the normal maximum water surface elevation of 881.51 feet NAVD 88 (875 feet CoSD), the lake has a surface area of 240 acres and gross storage of 8,500 acre-feet (Figure 2.2-19). Under normal operations at both the Gorge and Diablo developments, there is a short section of free-flowing river between the Diablo Powerhouse tailrace and the upper end of Gorge Lake. Stetattle Creek, the largest tributary to Gorge Lake, enters the Skagit River in this area.

Figure 2.2-23 depicts potential fish passage facility locations for the Gorge Development. These locations include by Gorge Powerhouse, the upstream and downstream faces of Gorge Dam, and the head of Gorge Reservoir at the confluence of Stetattle Creek.

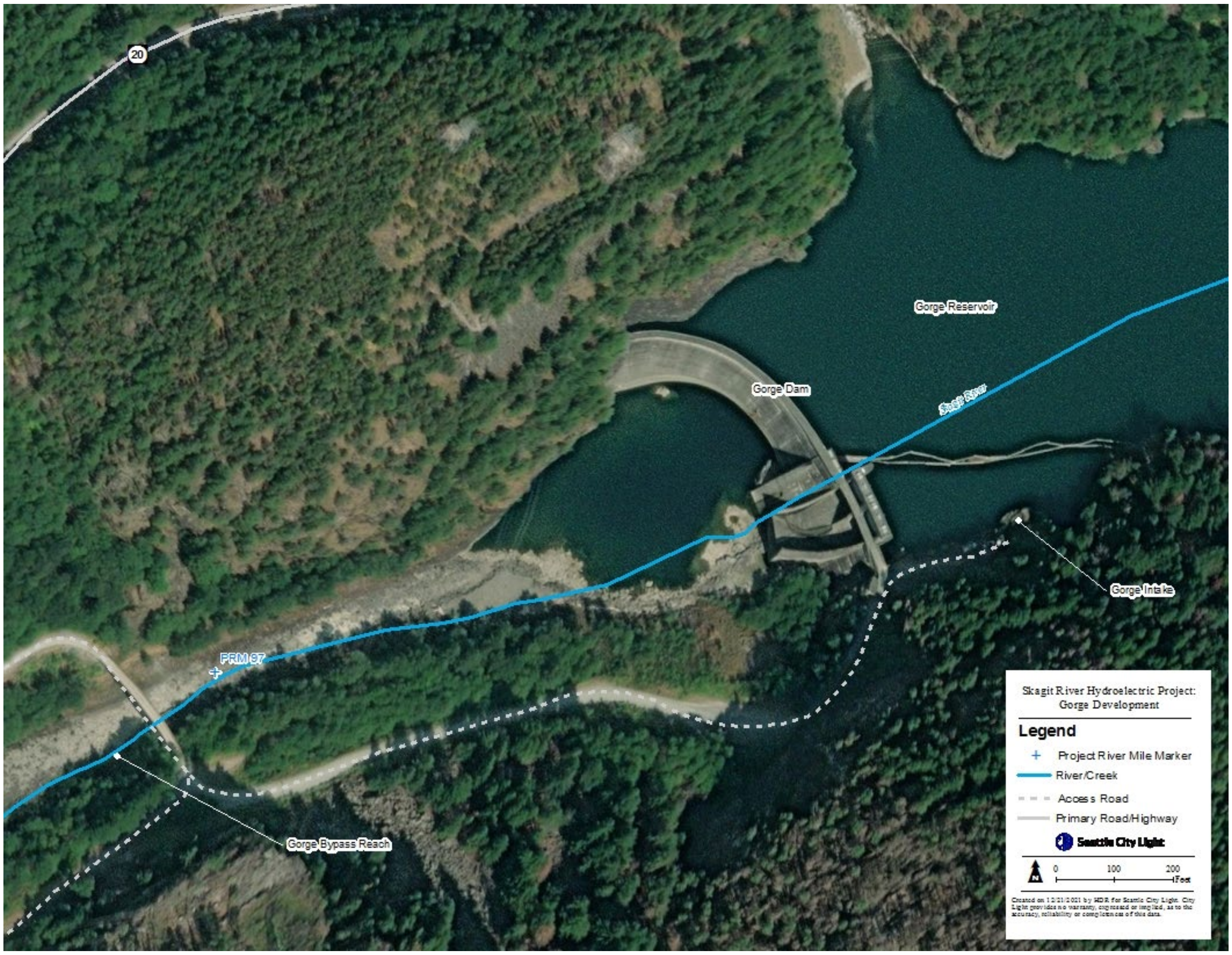


Figure 2.2-23. Aerial of Gorge Dam and associated infrastructure for potential fish passage facilities.

Gorge Powerhouse is reached via a bridge across the river that connects to SR 20 (Figure 2.2-20). Gorge Dam is accessed via a spur road off SR 20, at about MP 122, which is gated at a bridge over the river and not open to the public (Figure 2.2-23). Although visible from SR 20, which runs along the north side, Gorge Lake (Reservoir) is relatively inaccessible by vehicle because of its location in a steep rocky canyon (Figure 2.2-18).

2.2.4 Gorge Bypass Reach

The reach of the Skagit River between Gorge Dam and Powerhouse is referred to as "the bypass reach" and is about 2.5 miles long.[12] Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach. A large portion of the reach is upstream of two existing high-gradient features that exhibit elevated channel complexity. Through initial visual observation, baseflows (i.e., 5 to 10 cfs) up to approximately 800 cfs exhibit limited hydraulic connectivity at these features, and hydraulic drops are observed along several hydraulic pathways. At flows above approximately 800 cfs, hydraulic connectivity improves, and hydraulic drops

12 Previous documents note that the Gorge bypass reach length is 2.7 miles. Current calculations by City Light (2020a) show that it is 2.5 miles.

diminish, as hydraulic velocity and turbulence increase. The most downstream of these existing features (Existing Feature 1) is located 0.5 mile upstream of Gorge Powerhouse at PRM 95.7 (USGS RM 95.2), while the feature farther upstream (Existing Feature 2) is located at PRM 96.2 (USGS RM 95.7). Figure 2.2-24 and Figure 2.2-25 show existing features at baseflow and approximately 1,100 cfs conditions. Figure 2.2-26 shows Existing Feature 2 at flows of approximately 24,000 cfs during recent flood events (November 16, 2021).

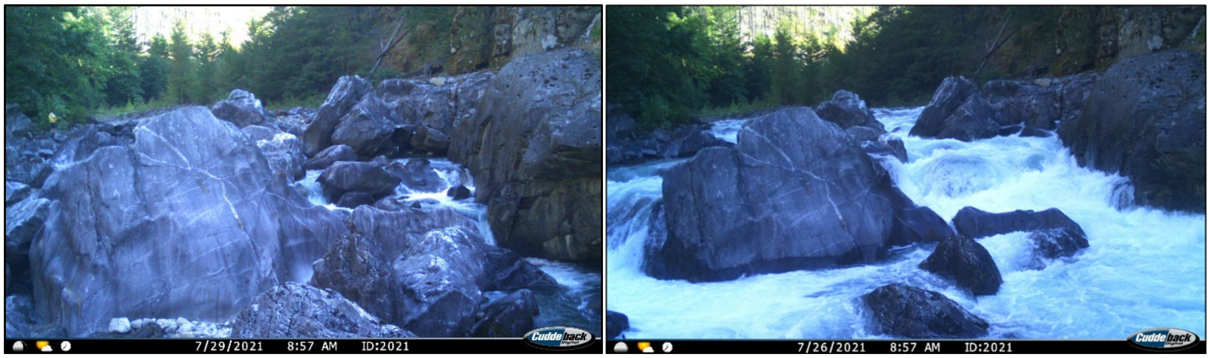


Figure 2.2-24. Gorge Bypass Existing Feature 1 shown at baseflow and 1,100 cfs conditions.

Figure 2.2-25. Gorge Bypass Existing Feature 1 shown at baseflow and 1,100 cfs conditions.

Figure 2.2-26. Existing Feature 2 at flows of approximately 24,000 cfs.

The FA-05 Bypass Reach Instream Flow Model Development Study being conducted concurrently has collected extensive hydraulic data for the Gorge bypass reach and is evaluating in-stream flow conditions. Results of this study will evaluate the results of instream flow conditions prepared in the Bypass Reach Instream Flow Model Development Study. The results of this modeling effort coupled with multi-faceted data collection efforts will be used to support the Fish Passage Study objective to investigate potential flow conditions that may offer fish passage for target fish species of this study. The Bypass Reach Assessment is being conducted in parallel with the Fish Passage Facilities Assessment, and a report on the findings will be developed in 2022.

2.2.5 Transportation Infrastructure

Construction and operation of potential fish passage facilities require adequate transportation infrastructure to each program element. If not adequate, improvements may be required as part of implementation. Current transportation infrastructure at the Project includes roads, marine facilities, and helipads. The marine facilities and helipads are displayed on Figure 2.2-27. The railway that was constructed for the Project was dismantled in 1954. The incline lift that carried rail cars, equipment, and personnel from Diablo up the hillside to Diablo Lake still exists though is no longer functional.

2.2.5.1 Access Roads

Up until the early 1940s, the Project was accessible only by rail. USFS constructed a dirt road to Newhalem that was gradually improved and eventually extended to Diablo. Today, the main Project access is via SR 20, the northern-most cross-state highway, which was completed in 1972. This road, which is maintained by the Washington State Department of Transportation (WSDOT), is closed in the winter (usually from November through April) on both the west and east sides of the Cascades due to heavy snow and avalanches. The typical closure site on the west side is at the trailhead to Ross Lake (MP 134), but there are also gates at the bridge over Thunder Arm and at Newhalem. In most years, avalanches close the section of highway between Newhalem and Diablo at least once or twice.

The only vehicle access to the north end of Ross Lake is via the Silver-Skagit Road, a gravel road which starts in Hope, British Columbia, and extends for approximately 40 miles until it terminates at the U.S.-Canada border. The Silver-Skagit Road provides access to recreational facilities in Skagit Valley Provincial Park and transitions into an unnamed road network at Hozomeen within RLNRA which is used by recreationists, the NPS, and City Light crews. The Silver-Skagit Road is closed from November through April of each year. Most of the roads associated with the generation facilities and townsites were constructed and are maintained by City Light. A preliminary list of roads includes the following:

- All roads within the towns of Newhalem and Diablo (paved);
- The roads to Gorge Powerhouse (paved, gated) and Dam (gravel/dirt surface, gated);
- Diablo Dam Road (paved);
- A short, spur road from Diablo Dam to the top of the Incline Lift (paved);
- The road to Babcock Communications Tower (gravel/dirt surface, gated);
- The road from Ross Powerhouse to Ross Lake (aka the "Ross Haul Road," gravel surface) and associated tunnel;
- Two spur roads off the road to Ross Lake—one to a ferry landing and the other to Ross Dam (gravel surfaces); and
- The road to the storage area at Newhalem Ponds (aka "Agg Ponds") and associated spur roads to ponds and river (gravel/dirt surface, gated).

Additional roads exist and will be evaluated for utility as part of the conceptual design process in stage 2 of the Fish Passage Facilities Alternatives Assessment. Although City Light uses these roads for Project operations, most are shared with other parties, including recreationists and NPS and North Cascades Institute staff. Diablo Dam Road and portions of the Ross Haul Road receive substantial use by the public to access water-based recreation and NPS trailheads. Babcock Creek Road, in addition to providing access to City Light microwave and radio systems, is also used by five other entities with communication equipment on Babcock ridge. City Light also constructed and maintains some roads to access the transmission lines. City Light is in the process of documenting all roads used for transmission line access and will submit this information in the license application.

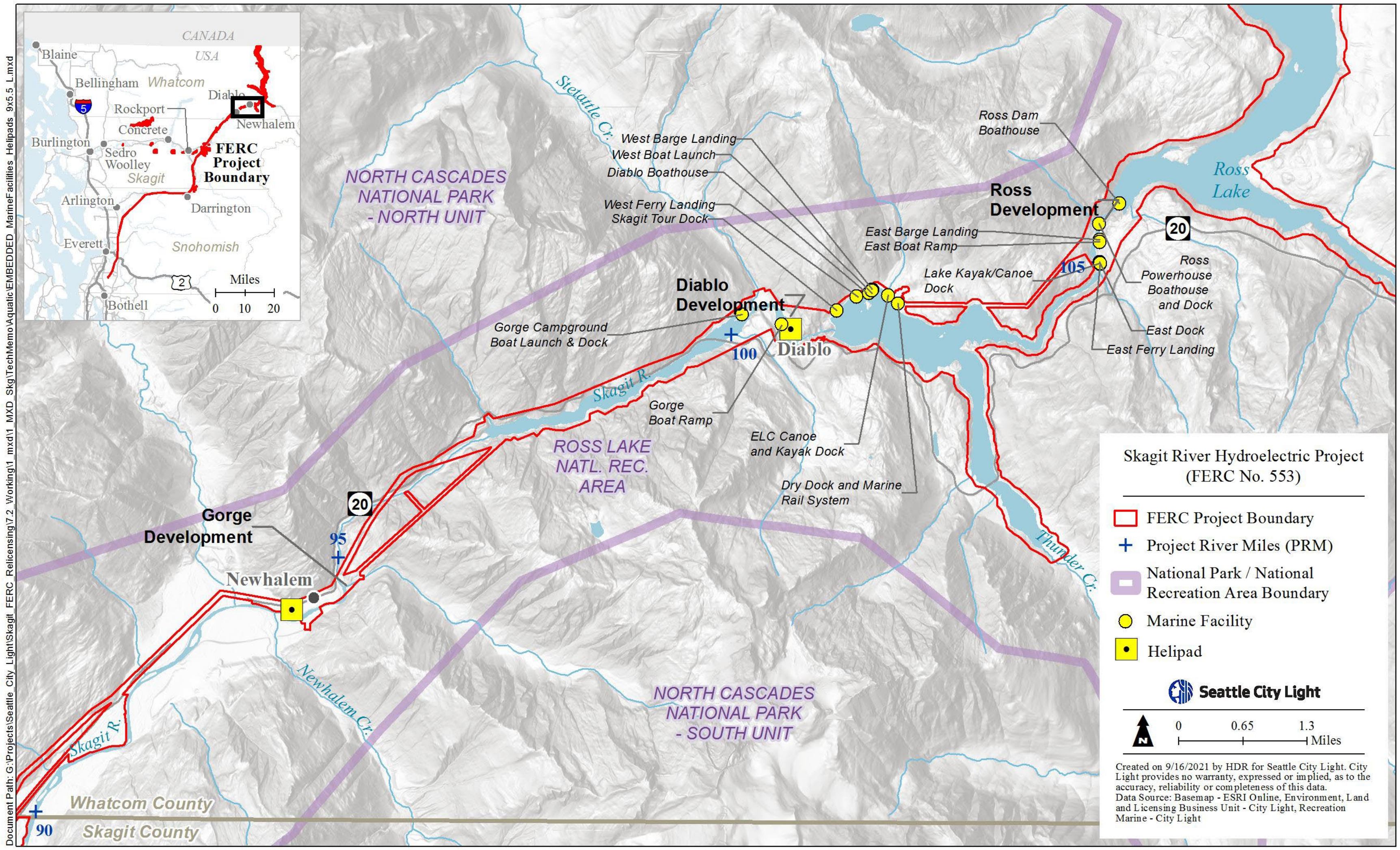


Figure 2.2-27. Helipads and marine facilities for the Skagit River Project.

2.2.5.2 Helipads

There are two helipads at the Project—one in Newhalem and the other on Reflector Bar in Diablo (Figure 2.2-27). The Newhalem helipad is routinely used in the winter by contractors conducting snow surveys. During times when SR 20 is closed at Newhalem, helicopters shuttle staff and supplies to Diablo, where they can then be transported to Ross Lake or other upriver facilities as needed. There is also a designated helicopter landing area in a cleared area near Ross Dam, but this is used only in emergencies.

2.2.5.3 Marine Facilities

Given the relatively limited access to the Project reservoirs, a variety of marine facilities and boats are required to support generation operations. The locations of marine facilities are shown on Figure 2.2-27.

The bulk of City Light marine facilities are located on Diablo Lake because it is the primary means of accessing the Ross Development. All materials, vehicles, and staff needed at Ross Powerhouse or Dam travel by boat. In addition, the current Project license requires that City Light provide a ferry service for public access to Ross Lake. The marine facilities on Diablo Lake are clustered in two locations (Figure 2.2-27):

- North shoreline at the west end of Diablo Lake and accessed by Diablo Dam Road:
  - Skagit Tour Dock – Used to support public boat tours of Diablo Lake offered by City Light during the summer months.
  - West Ferry Landing – Provides public access via a ferry to the east end of Diablo Lake, typically from mid-June through October.
  - Diablo Boathouse – Provides covered slips and dock moorage for City Light's boats on Diablo Lake, which include one to three tugboats, two crew boats, a ferry boat, and a tour boat. This structure also contains the offices for the boat crews and space for maintenance and storage. There is also an adjacent fueling dock.
  - West Barge Landing – Used to load and unload barges of materials going to/from Ross Powerhouse and Dam.
  - West Boat Launch – Used to launch and take out smaller boats.
  - ELC Canoe and Kayak Dock.
  - Dry Dock and Marine Rail System – Used to take boats out of the water for storage and maintenance.
- South shoreline at the east end of the reservoir near Ross Powerhouse:
  - Ross Powerhouse Boathouse and Dock – Provides covered storage and docking space for crew boats and a dock for the tour boat.
  - East Barge Landing – Terminus/return of materials and equipment arriving by barge.
  - East Boat Ramp – Used to get smaller boats on and off Diablo Lake and to/from Ross Lake.

- East Ferry Landing – Loading/unloading dock for visitors travelling to and from Ross Lake. Visitors can walk to/from the reservoir or be transported via a shuttle run by Ross Lake Resort, which is privately owned and operated under a NPS Special Use Permit. The resort provides the only lodging on Ross Lake.
- Lake Kayak/Canoe Dock – Next to the Ferry Dock; used mostly by visitors needing to shuttle non-motorized craft to Ross Lake.
- East Dock – Built by City Light for NPS to temporarily moor small boats used to patrol Diablo Lake.

Other marine facilities on Diablo Lake are operated and maintained by NPS; these include a boat ramp and dock at Colonial Creek Campground and a nearby boathouse.

Access to Ross and Gorge lakes is not routinely needed by City Light staff and is generally limited to crews managing wood on these lakes or engaged in scientific data collection. On Gorge Lake there is a paved boat ramp and dock in Gorge Campground that is primarily used by the public. There is also a primitive boat ramp in the Reflector Bar section of Diablo that is used by City Light to access the portion of Gorge Lake near the tailrace and base of Diablo Dam. On the southern end of Ross Lake, City Light built and maintains a boathouse on the face of the dam that floats up and down with reservoir elevation (Figure 2.2-28). This facility is accessed via a locked gate and stairs from the top of Ross Dam. The boathouse, which is shared with NPS and U.S. Customs and Border Patrol, has two covered docks/slips and an external dock on each side. There is a boat launch and dock on the east side of Ross Lake just upstream of Ross Dam. Use of this boat launch and dock is shared by City Light, NPS, and Ross Lake Resort. The only fueling dock on the reservoir is at Ross Lake Resort. City Light purchases fuel for its boats used on Ross Lake at this facility. NPS has a boat ramp and dock at the northern end of Ross Lake, which is used by City Light when needed.

Figure 2.2-28. Ross Lake boathouse.

2.2.6 Recreation and Visitor Service Facilities

Implementation and operation of potential fish passage facilities and subsequent use of existing or new transportation routes will need to consider impacts to existing recreational uses and facilities. Because of its location in RLNRA, most of the recreation facilities within the Project Boundary are managed by NPS, not City Light. These include multiple campgrounds and trailheads along Diablo and Ross lakes. The current Project license provided capital funding for NPS to construct and upgrade a variety of recreational facilities in RLNRA. Funding was also provided to USFS to develop and improve multiple recreational sites within the Skagit River Wild and Scenic River System and along SR 20. The major capital projects identified in and subsequent to the license have been or will be completed during the current Project license term. City Light continues to provide funds for recreational programs and site maintenance to both agencies as per the terms of the current Project license. City Light Project recreational sites and non-Project recreational sites near the Project generation facilities, some of which are for administrative use only, are displayed in Figure 2.2-29.

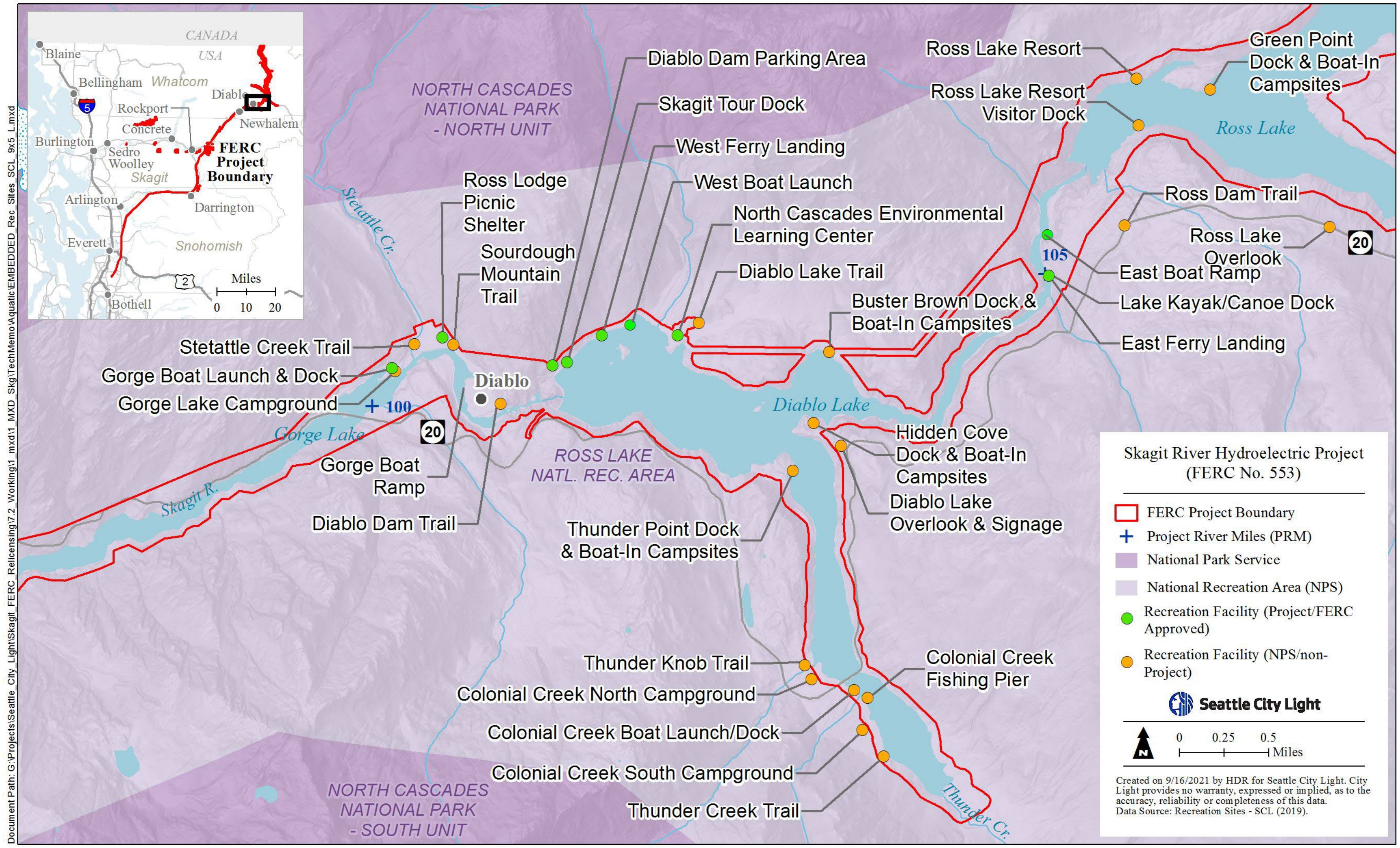


Figure 2.2-29. Project and non-Project recreation facilities near Project generation facilities.[13]

[13] Note that additional recreational use sites are mapped throughout the FA-04 study area. Refer to the concurrent relicensing study RA-01, Recreational Use and Facility Assessment Study, for more information.

2.2.7 Other Facilities

City Light owns and maintains a few other auxiliary facilities throughout the Project Boundary; however, most are not relevant to the Fish Passage Study because they are far removed from generation facilities. However, various fiber optic cables are mounted on transmission line towers and/or distribution poles between Newhalem and Diablo; Diablo and Ross; and Ross and the ELC. These facility locations must be considered when designing any fish passage facilities.

2.2.8 Project Lands

The Skagit River Project Boundary consists of 32,773 acres and encompasses all Project facilities, including the dams, powerhouses, reservoirs, power tunnels, switchyards, transmission lines, and the towns of Newhalem and Diablo, as well as most of the fish and wildlife lands and several recreation sites. It terminates in Washington State, at the U.S.-Canada border. The Project Boundary along Diablo and Gorge lakes extends about 200 feet (horizontal measurement) beyond the normal maximum water surface elevation. For Ross Lake, the Project Boundary was established to accommodate High Ross. As a result, the Project Boundary around Ross Lake reaches significantly up several of the major tributaries, including Big Beaver, Little Beaver, Lightning, and Ruby creeks. The land within the Project Boundary around the generating facilities is entirely in federal and City Light ownership.

Under the current FERC license, the Project Boundary does not include the bypass reach between Gorge Dam and Powerhouse or the Skagit River downstream of Gorge Powerhouse except for areas that overlap the transmission lines and Trail of the Cedars. The width of the Project Boundary along the transmission lines ranges from about 300 to 400 feet when the two lines share the same ROW and from 150 to 200 feet when the lines separate. There are some guy wires and transmission line ROW access trails and roads that may be outside the Project Boundary or only partially included. Lands within the Project Boundary include a mix of federal, state, county, and private lands, with most of the federal lands located north of Marblemount. Land ownership in the vicinity of generating facilities is depicted below (Figure 2.2-30).

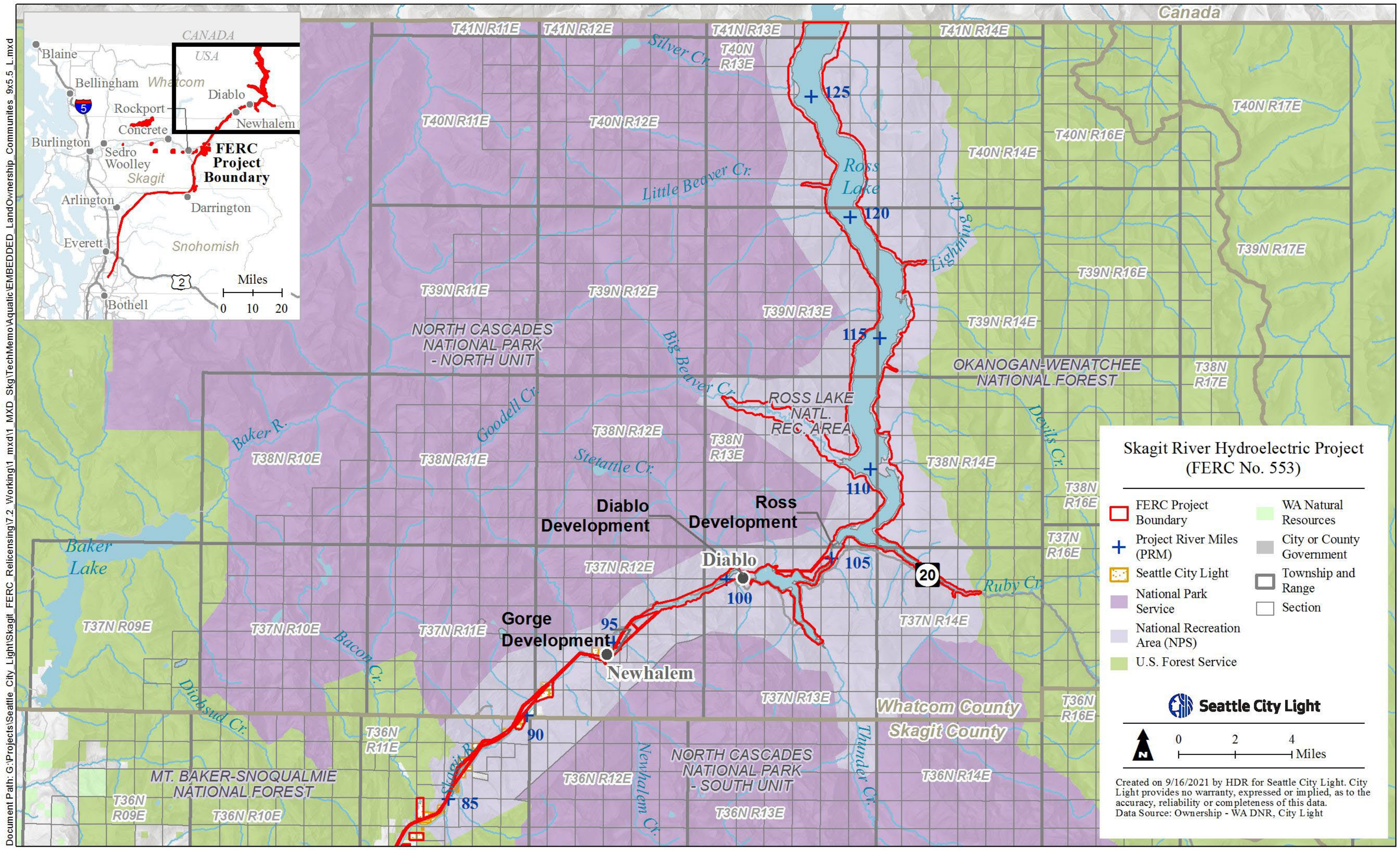


Figure 2.2-30. Skagit River Project vicinity land ownership.

2.3 Existing Operations

The three Skagit River developments are hydraulically coordinated to operate as a single project. As stated in the Skagit Pre-Application Document Executive Summary, the operational priorities for the Project are, in descending order of importance: flood control, downstream fish protection, recreation, and power production. Reservoir operations are a key component in understanding the physical operating environment within which fish passage facilities may operate. Reservoir water quality, storage volume, residence times, and thermal regimes also significantly influence reservoir transit of upstream and downstream migrating juvenile fish. Water quality, including thermal regimes throughout each reservoir and each forebay, are currently the subject of two concurrent relicensing studies (WQ Monitoring Study and WQ Temperature Model Development Study), the results of which will better inform fish passage parameters related to juvenile collection and reservoir transit, pending the future selection of fish passage strategies. Existing operations at each of the Skagit River Project developments are described in the subsections below.

2.3.1 Reservoir Operations

Reservoir operations are conducted to provide water for power generation at each Project development; however, operations must also be regulated to accommodate other purposes. Article 302 of the current Project license requires that City Light comply with requests for operational changes from the U.S. Army Corps of Engineers (USACE) during flood conditions. In addition, operations at each reservoir involve managing woody material that enters the system from the shorelines or tributaries.

2.3.1.1 Ross Development

Ross Lake is the primary upstream storage reservoir for the Project and is drawn down in the winter to capture water from spring runoff and to provide for downstream flood control. City Light typically begins drawing down the reservoir shortly after Labor Day. Storage capacity at a normal maximum water surface elevation of 1,608.76 feet NAVD 88 (1,602.5 feet CoSD) is 1,435,000 acre-feet; usable storage in 1,052,000 acre-feet—which is 68 times the combined usable storage of the other two reservoirs. If needed, the reservoir can be surcharged by 2.5 feet to the top of the spill gates to absorb an additional 95,000 acre-feet.

Annual and monthly minimum, average, and maximum water surface elevations at Ross Lake for the period 1997-2020 are provided on Figure 2.3-1 and Figure 2.3-2, respectively. A stage-duration analysis was performed using the daily end-of-day water surface elevation in Ross Lake for the period 1997-2020. The resulting stage-duration curve shows the percentage of days a given water surface elevation (stage) is exceeded and provides insight into reservoir fluctuation patterns. The resulting stage-duration curve for Ross Lake is provided on Figure 2.3-3.

The influence of water surface fluctuation in Ross Lake on selection and conceptual development of potential fish passage facility alternatives is discussed in more detail in Section 5.5.1 of this document.

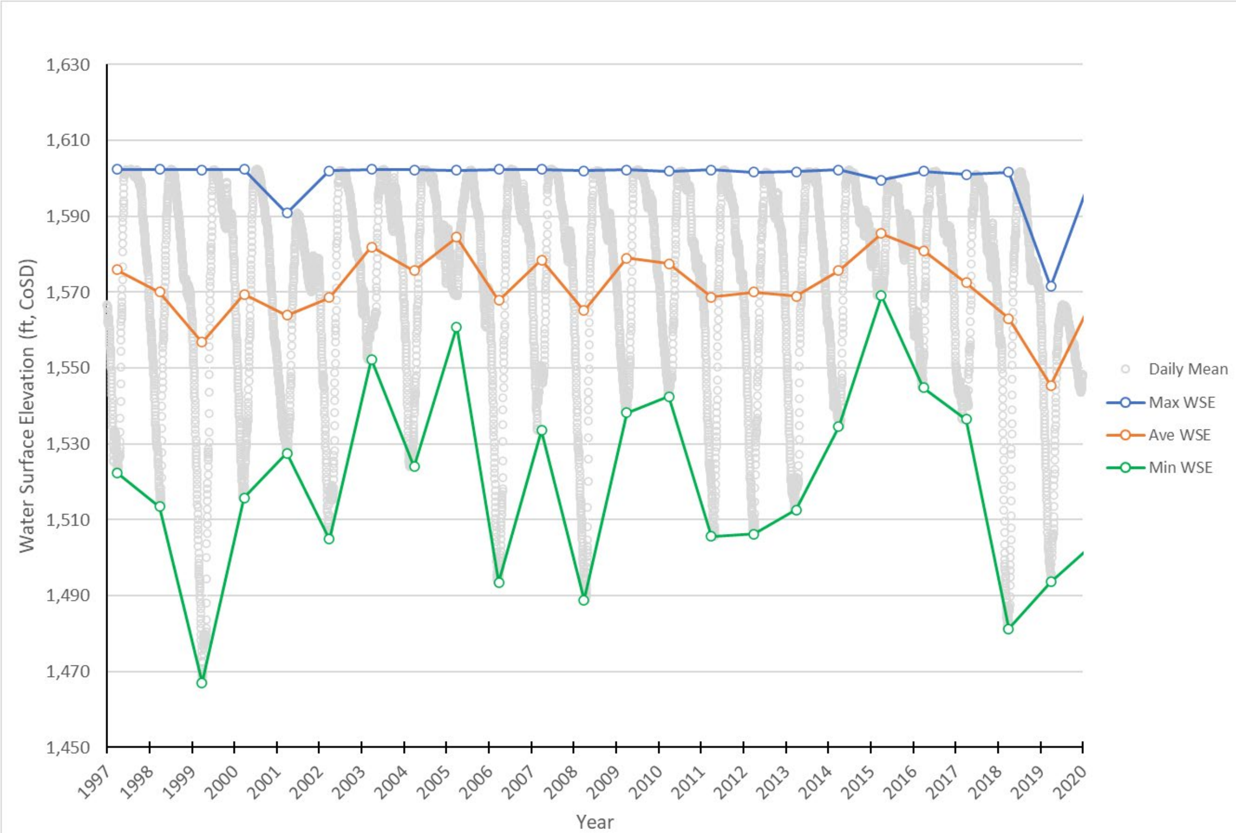


Figure 2.3-1. Annual maximum, average, minimum, and mean daily water surface elevations at Ross Dam (1997-2020).

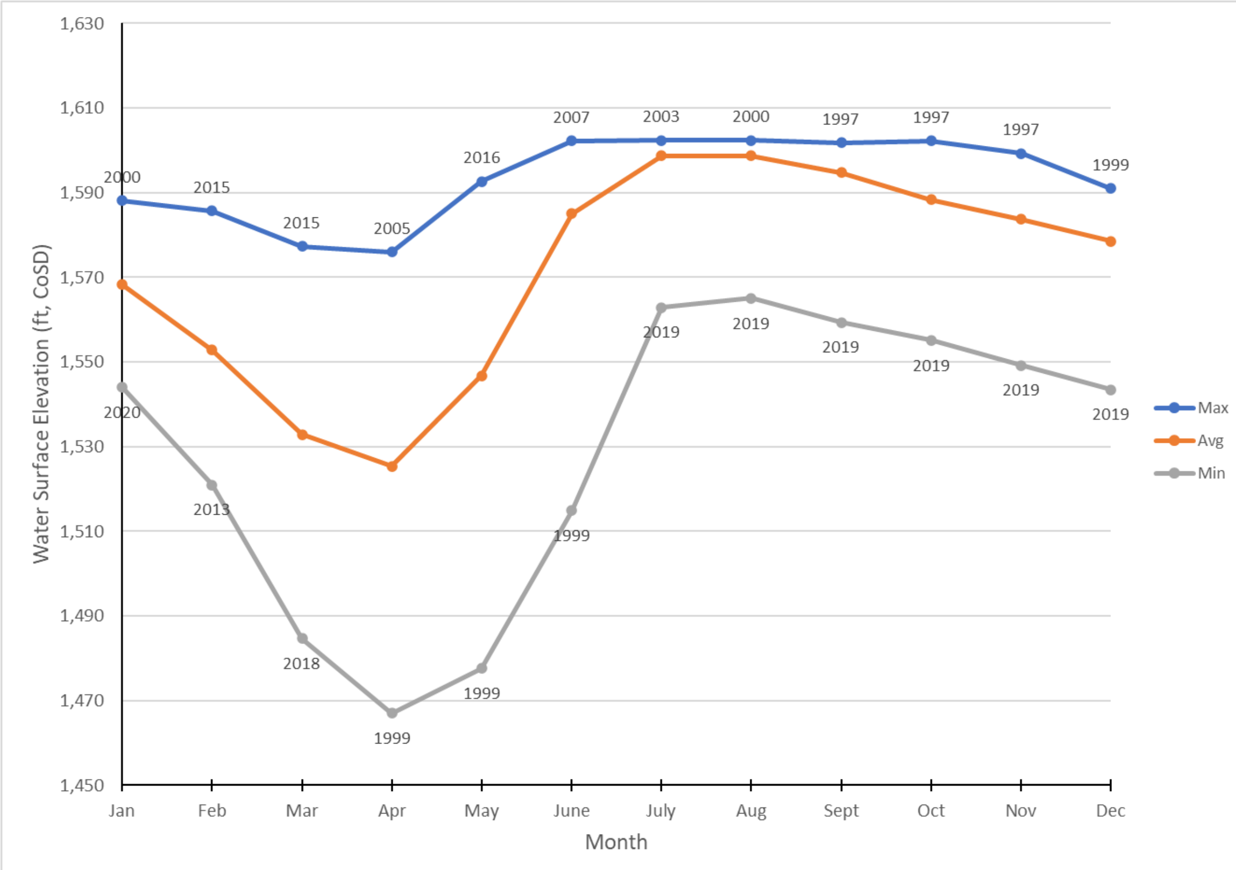


Figure 2.3-2. Monthly maximum, average, and minimum water surface elevations at Ross Dam (1997-2020).

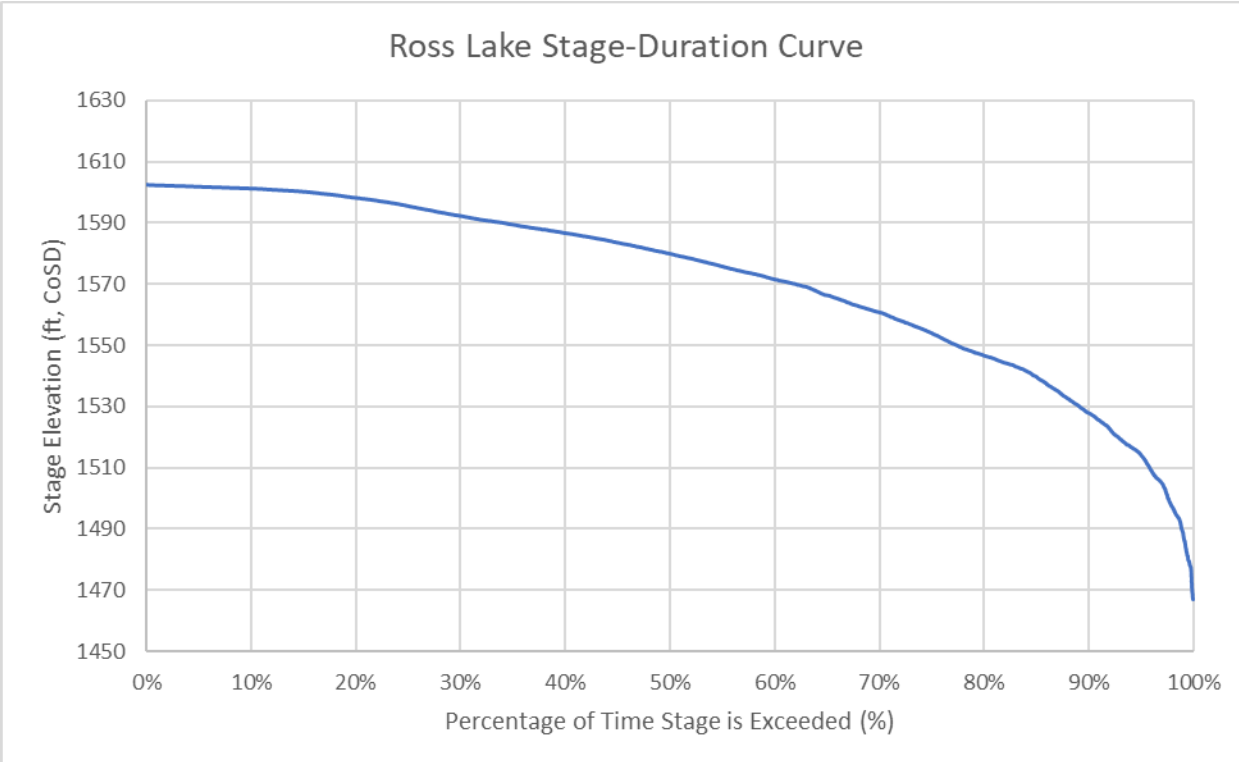


Figure 2.3-3. Daily end-of-day stage-duration curve for Ross Lake water surface elevation (1997-2020).

Winter reservoir levels below elevation 1,598.26 feet NAVD 88 (1,592 feet CoSD) are managed for generation based on forecasted precipitation. In advance of a predicted flood event, generation at Ross is increased to the maximum generation to provide additional usable storage in the reservoir. Ross Lake can fill quickly, up to a foot a day during spring runoff and more during warm rain-on-snow events.

In addition to forecasted precipitation, City Light also uses snowpack data to manage winter drawdown levels in Ross Lake (Figure 2.3-4). Snow surveys are conducted monthly from December 1 through April 1 by an independent contractor using a helicopter to access 16 snow course stations on the ridges of the watershed. The data on snow depth and water content are used to predict the amount of spring runoff, which is then used to determine the lowest drawdown level, which is typically reached in late March or early April.

Figure 2.3-4. Ross Lake under winter drawdown conditions.

Article 301 of the current Project license addresses flood control operations at Ross Lake. Specifically, City Light is required to:

- Provide storage for flood control: 60,000 acre-feet by November 15; 120,000 acre-feet by December 1 (1,598.26 feet NAVD 88 [1,592 feet CoSD]) and through March 15.
- Release only such flows as are necessary for normal generation at all three Project developments but no more than 5,000 cfs (plus or minus 20 percent allowance for operation latitude) whenever the National Weather Service, Northwest River Forecast Center, forecasts that the natural flow at the gaging station near Concrete, WA, will equal or exceed 90,000 cfs in 8 hours on a rising stage of flood.
- Surcharge the reservoir if the water surface elevation reaches 1,608.76 feet NAVD 88 (1,602.5 feet CoSD) before flood recession occurs to provide the greatest reduction of discharge downstream.
- Comply with “Details of Regulation for Use of Storage Allocated for Flood Control in Ross Reservoir, Skagit River, WA” (Corps of Engineers, revised May 1967), which is incorporated into the Project license by reference.

License Article 403 addresses recreational uses at Ross Lake and requires that City Light:

- Fill as soon as possible after April 15.

- Achieve normal maximum water surface elevation by July 31.
- Maintain normal maximum water surface elevation through Labor Day subject to adequate runoff, anadromous fish protection flows downstream of the Project, flood protection, spill minimization, and firm power generation needs.

Spills are infrequent at Ross Dam due to the large reservoir storage capacity. They are typically associated with gate testing, are of short duration, and average only a few cfs (Figure 2.3-5). Since 1997, Ross Dam has spilled between 0 and 30 days annually, with an average hourly flow of 785 cfs per spill day (Figure 2.3-5). Exceptions to this include periods of spill required to reduce downstream flooding, including recent flood events in November and December 2021.

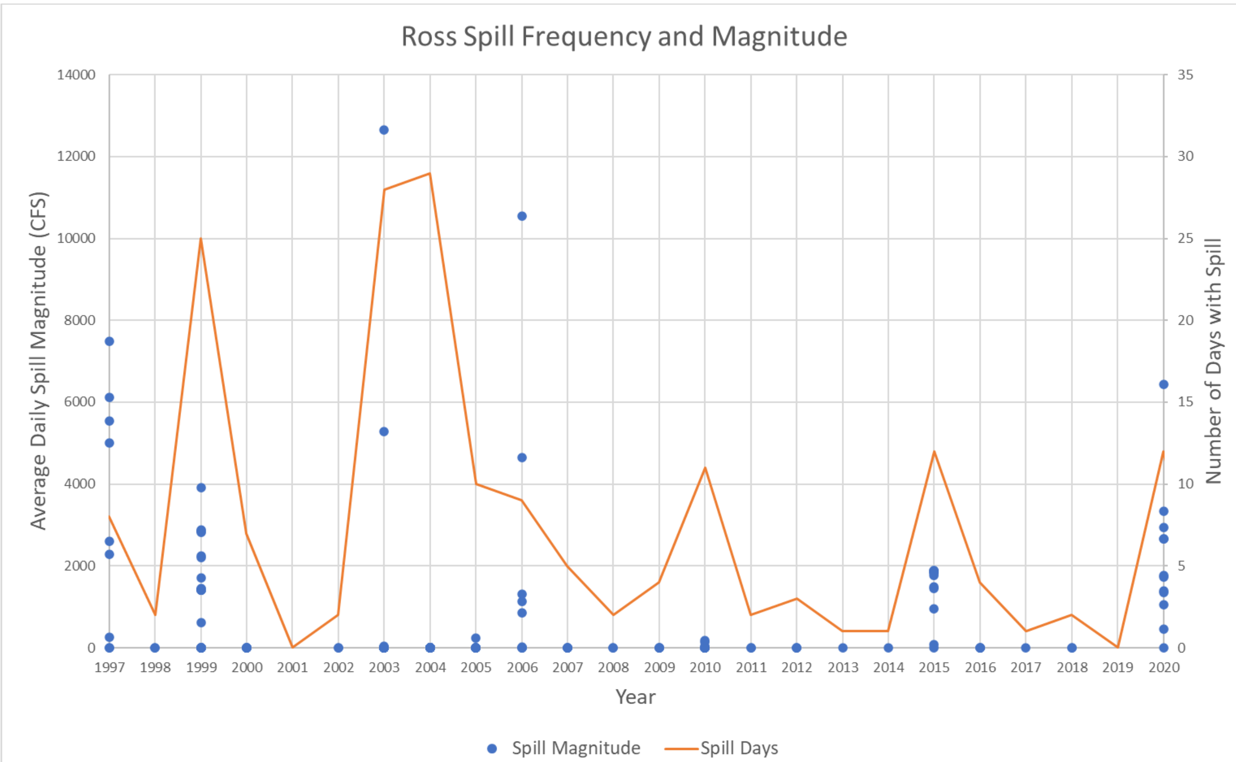


Figure 2.3-5. Spill frequency and magnitude at Ross Dam by year.

2.3.1.2 Diablo Development

The primary function of Diablo Lake is to reregulate flows between the Ross and Gorge developments. The storage capacity of Diablo Lake is 50,000 acre-feet at a normal operating water surface elevation of 1,211.36 feet NAVD 88 (1,205 feet CoSD). The lake typically fluctuates only 4-5 feet daily, although drawdowns of 10-12 feet occur occasionally as needed for construction projects or maintenance. Annual and monthly minimum, average, and maximum water surface elevations at Diablo Lake for the period 1997-2020 are provided on Figure 2.3-6 and Figure 2.3-7, respectively. The lowest water surface elevation recorded in the current Project license period was 1,199.26 feet NAVD 88 (1,193 feet CoSD) in September 2017, but drawdowns to this level are relatively rare because of constraints related to marine facility specifications and recreational uses. Like Gorge, Diablo Lake can be lowered through spill or generation to provide some additional usable storage in advance of a predicted flood. A stage-duration analysis was performed using the daily end-of-day water surface elevation in Diablo Lake for the period 1997-2020. The resulting stage-duration curve shows the percentage of days a given water surface elevation (stage) is exceeded and provides insight into reservoir fluctuation patterns. The resulting stage-duration curve for Diablo Lake is provided on Figure 2.3-8. The influence of water surface fluctuation in Diablo Lake on selection and conceptual development of potential fish passage facility alternatives is discussed in more detail in Section 5.6.2 of this document.

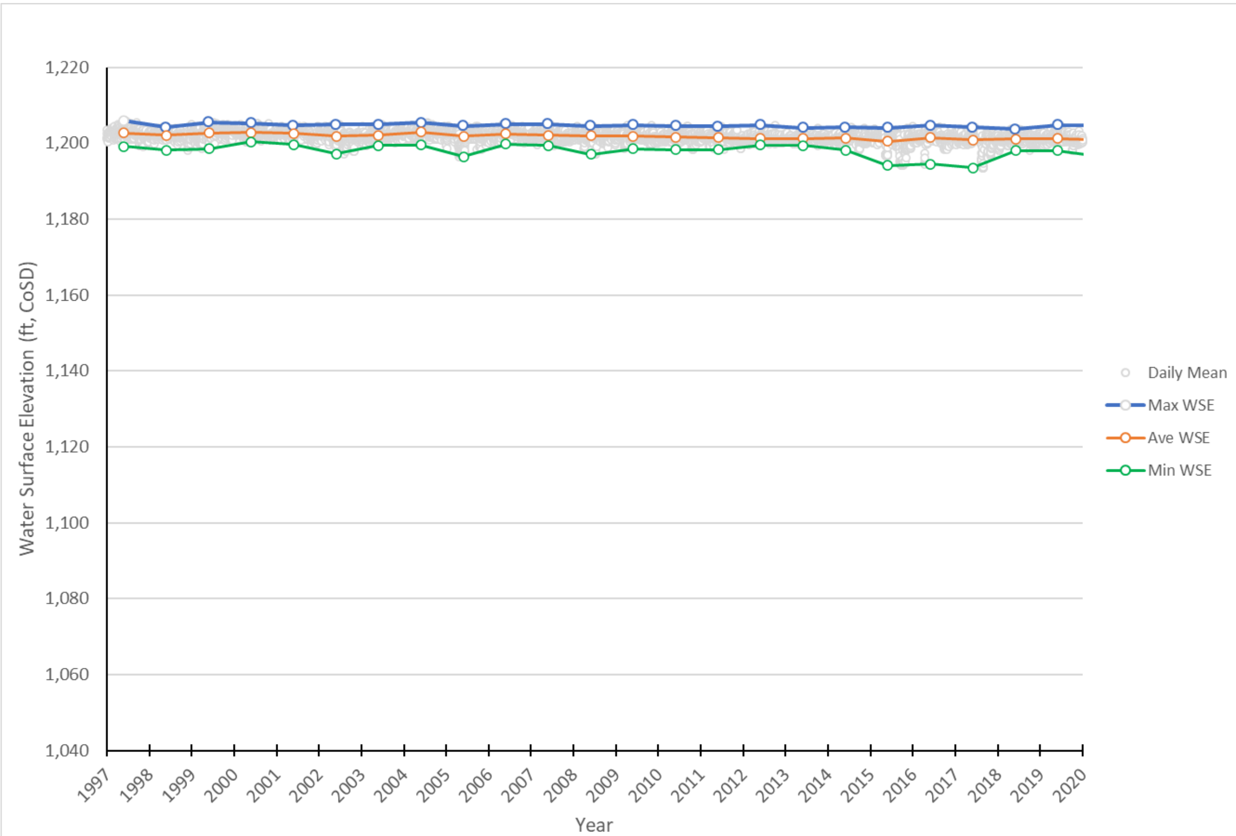


Figure 2.3-6. Annual maximum, average, minimum, and mean daily water surface elevations at Diablo Dam (1997-2020).

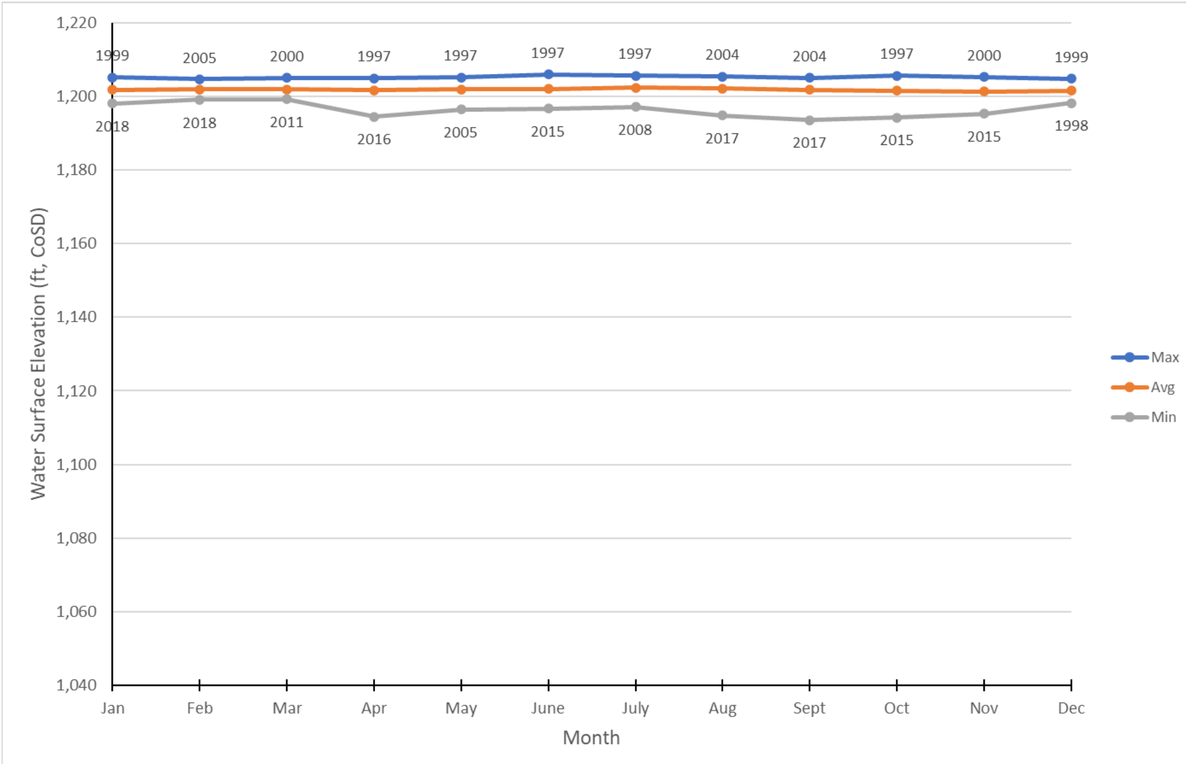


Figure 2.3-7. Monthly maximum, average, and minimum water surface elevations at Diablo Dam (1997-2020).

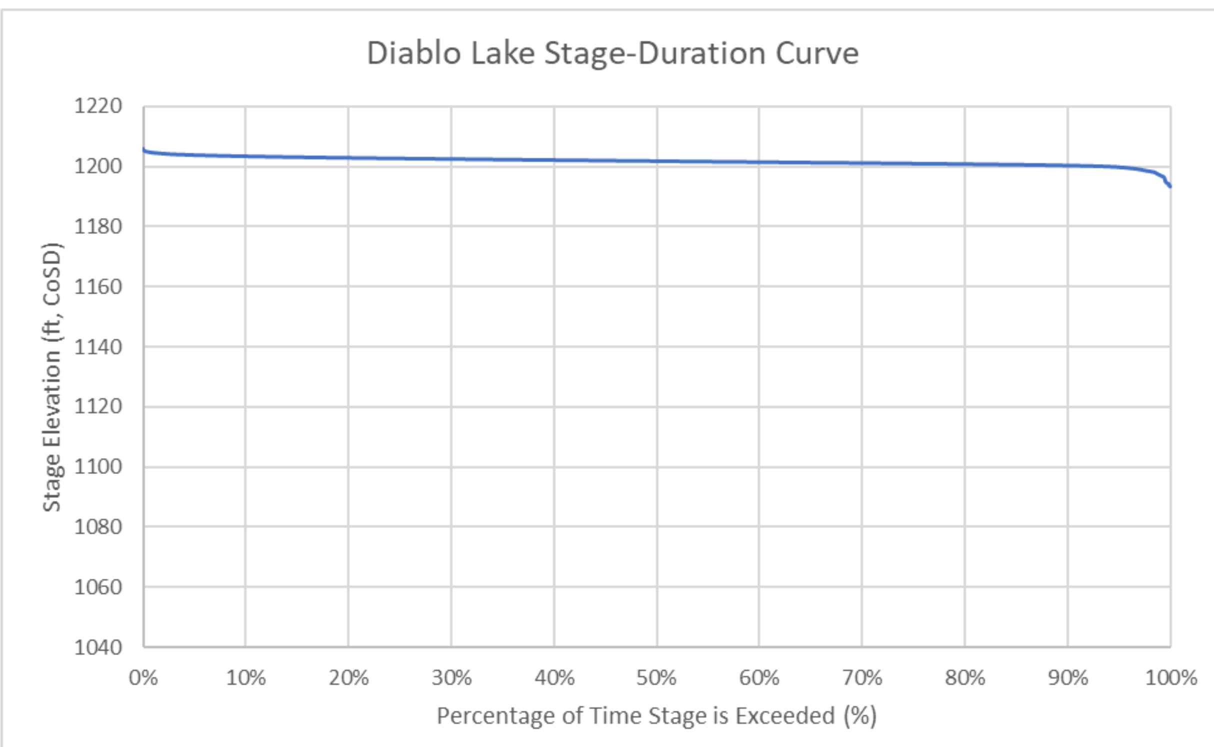


Figure 2.3-8. Daily end-of-day stage-duration curve for Diablo Lake water surface elevation (1997-2020).

Because of its role as a reregulation facility, Diablo Lake spills more frequently than either of the other Project reservoirs (Figure 2.3-9 and Figure 2.3-10). With usable storage limited to 8,820 acre-feet, spill can occur any time inflow to the reservoir exceeds plant capacity, typically during periods of high runoff, particularly during the spring or early summer. Diablo also spills when units are off-line at the powerhouse or when additional water is needed to meet flow requirements downstream of Gorge. Over the past five years, the number of days per year with recorded spill events has varied greatly (Figure 2.3-10). Under typical operations—for example, 2014-2016—Diablo Dam spills an average of 30 days per year. However, in years when significant flooding has occurred (e.g., November 2021) or when unit maintenance occurs at Diablo Powerhouse (e.g., 2017 and 2018), spill events are significantly more frequent and of longer duration. Since 1997, Diablo Dam has spilled between 6 and 274 days annually, with an average hourly flow of 1,517 cfs per spill day (Figure 2.3-10).

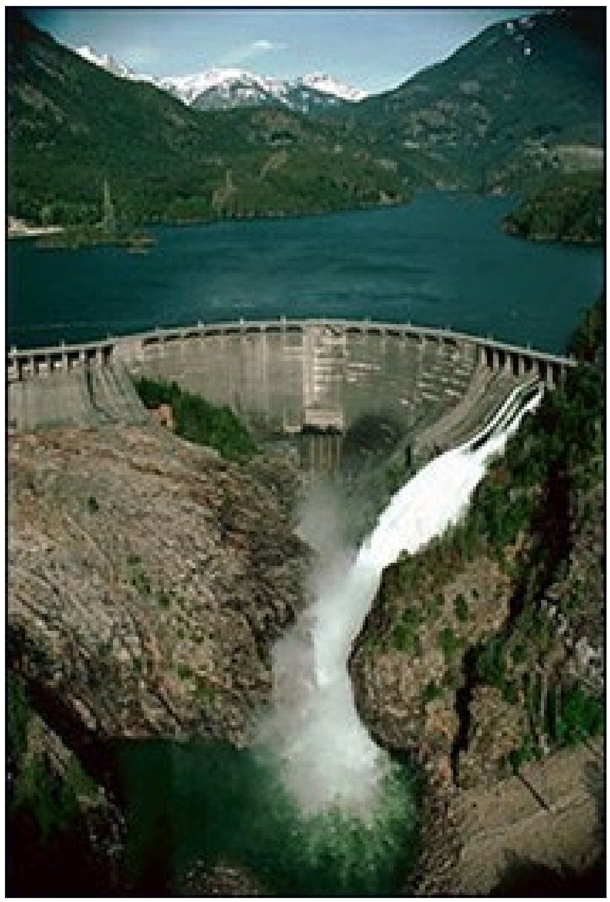


Figure 2.3-9. Spill at Diablo Dam.

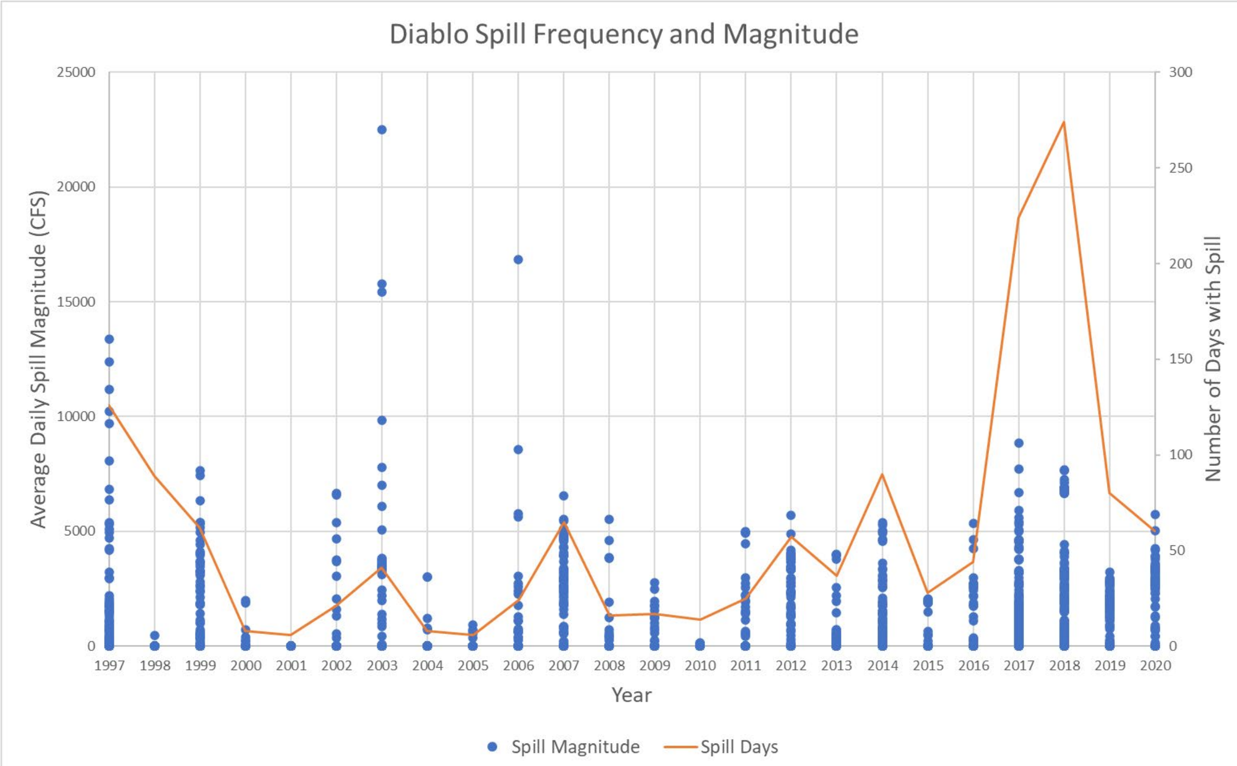


Figure 2.3-10. Spill frequency and magnitude at Diablo Dam by year.

2.3.1.3 Gorge Development

The primary function of Gorge Lake is to regulate downstream flows for fish protection. It has a gross storage capacity of 8,500 acre-feet at normal maximum water surface elevation of 881.51 feet NAVD 88 (875 feet CoSD); usable storage is only 6,600 acre-feet. Like Diablo Dam, unplanned spills at Gorge Dam can occur any time inflow exceeds generation capacity. In addition, because flows from the Gorge Development are critical for fish protection in the Skagit River, water from the reservoir is spilled if the powerhouse is not generating enough to maintain downstream minimum flow requirements. Since 1997, Gorge Dam has spilled between 1 and 79 days annually, with an average hourly flow of 2,298 cfs per spill day (Figure 2.3-11).

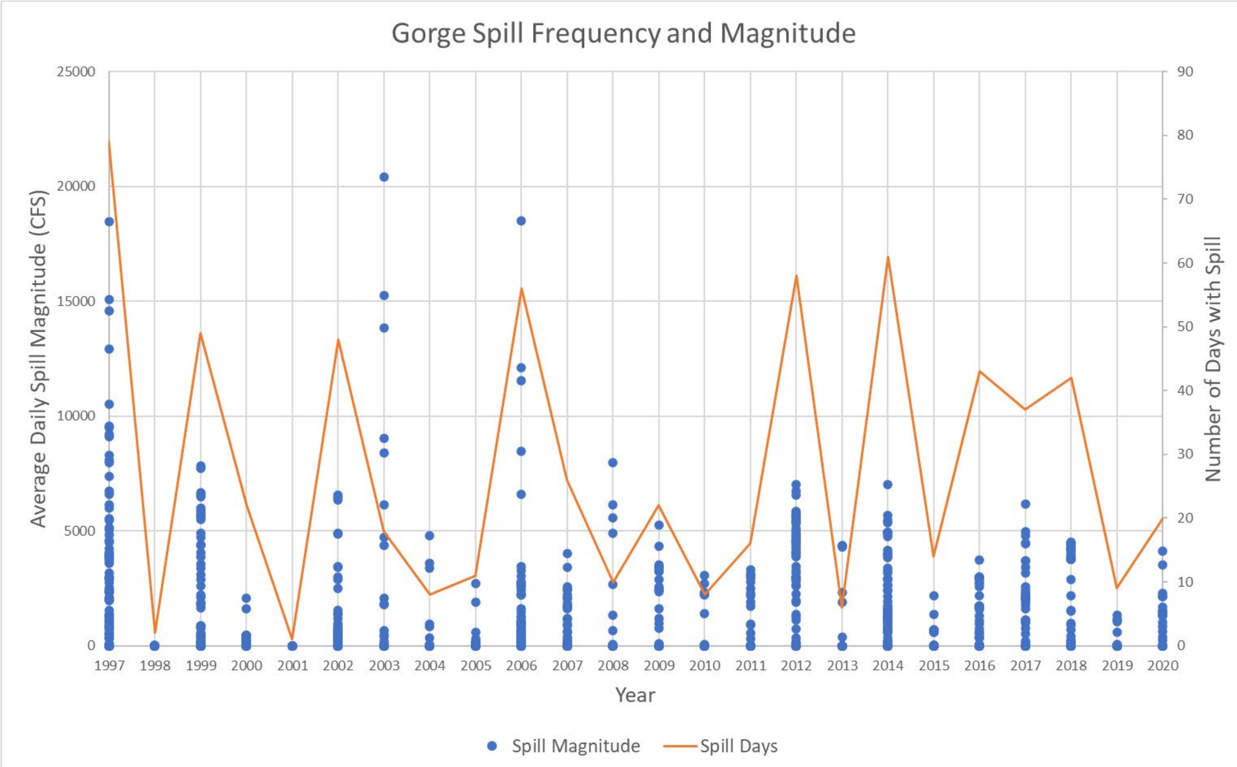


Figure 2.3-11. Spill frequency and magnitude at Gorge Dam by year.

Annual and monthly minimum, average, and maximum water surface elevations at Gorge Lake for the period 1997-2020 are provided in Figure 2.3-12 and Figure 2.3-13, respectively. Gorge Lake typically fluctuates only 3-5 feet, but drawdowns of 50 feet are occasionally needed for spill gate maintenance or inspection. The lowest water surface elevation recorded within the current Project license period was 788.51 feet NAVD 88 (782 feet CoSD) in August 1997. An extended drawdown (823.51–826.51 feet NAVD 88 [817-820 feet CoSD]) for spill gate painting occurred in 2013; another much shorter drawdown for spill gate testing occurred in 2019. In addition, Gorge Lake is drawn down, via spill or generation, to provide some additional usable storage in advance of a predicted flood event. A stage-duration analysis was performed using the daily end-of-day water surface elevation in Gorge Lake for the period 1997-2020. The resulting stage-duration curve shows the percentage of days a given water surface elevation (stage) is exceeded and provides insight into reservoir fluctuation patterns. The resulting stage-duration curve for Gorge Lake is provided in Figure 2.3-14. The influence of water surface fluctuation in Gorge Lake on selection and conceptual development of potential fish passage facility alternatives is discussed in more detail in Section 5.5.3 of this document.

A series of controlled spill events was conducted at Gorge Dam in late October. Hourly flows ranged from 157 to 3,700 cfs from October 25-30, 2021. A series of additional spill events occurred in November and December 2021 for flood control operations. During this period, the peak spill recorded at Gorge Dam was 24,072 cfs on November 16, 2021.

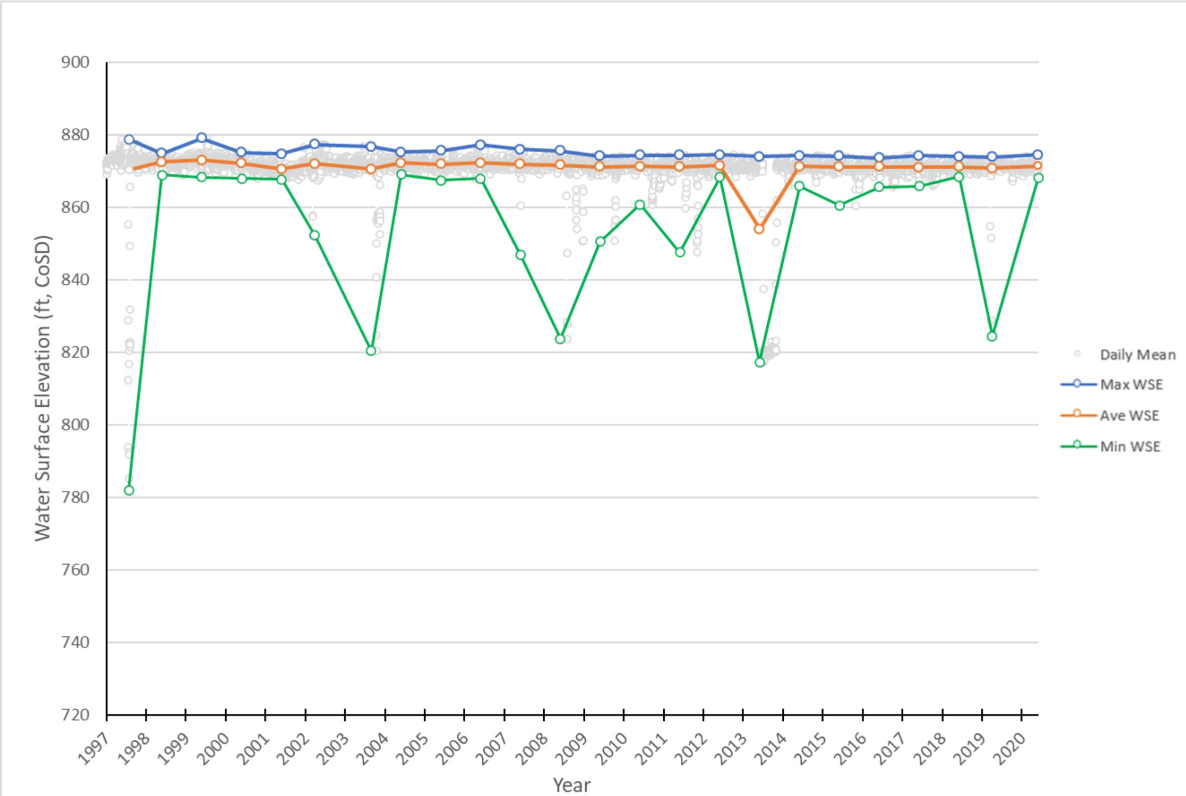


Figure 2.3-12. Annual maximum, average, minimum, and mean daily water surface elevations at Gorge Dam (1997-2020).

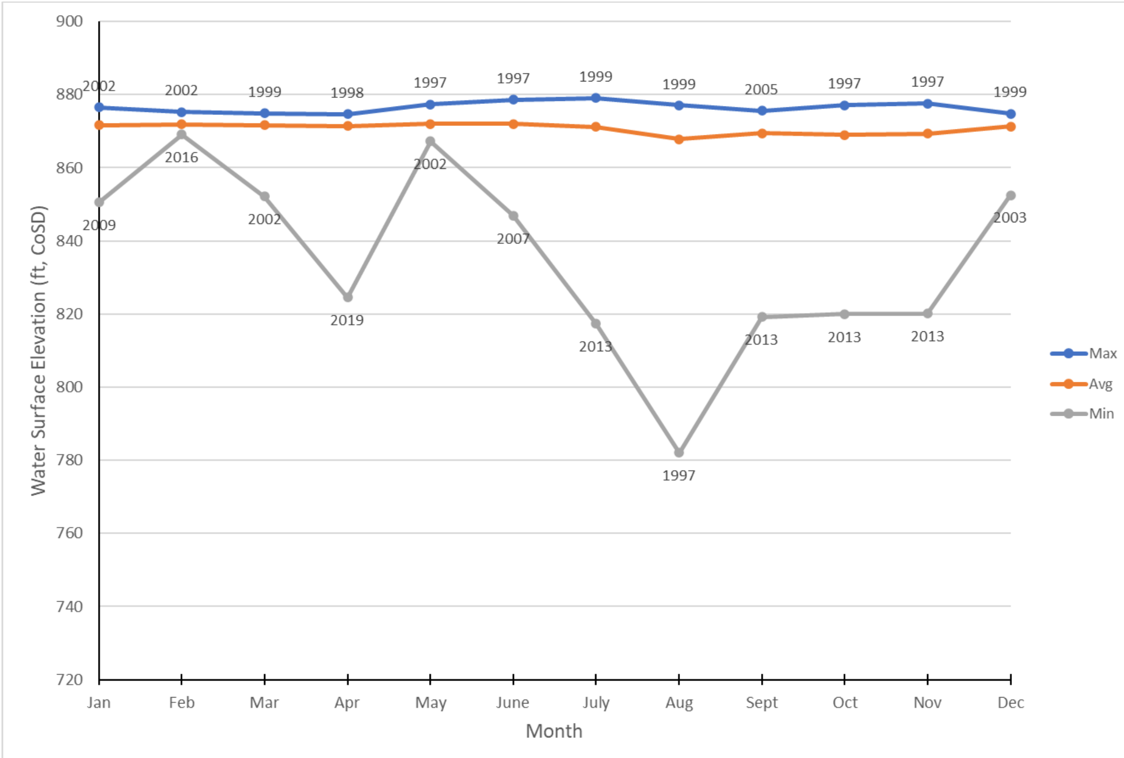


Figure 2.3-13. Monthly maximum, average, and minimum water surface elevations at Gorge Dam (1997-2020).

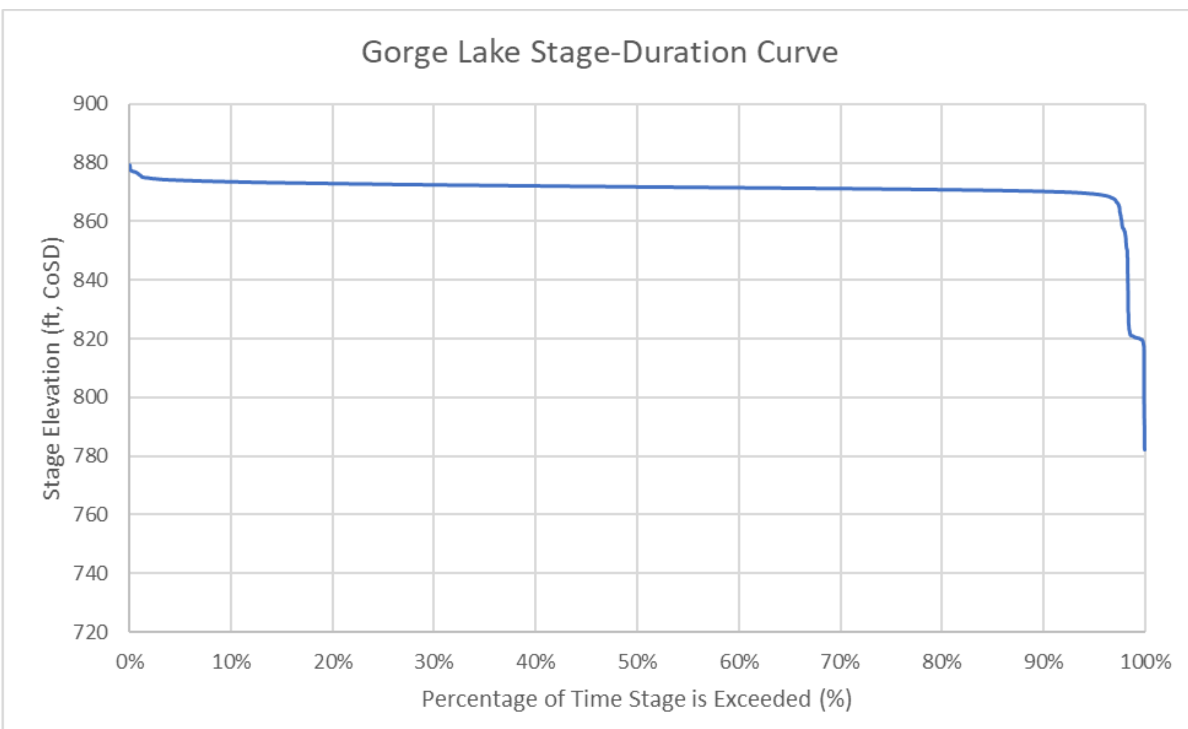


Figure 2.3-14. Daily end-of-day stage-duration curve for Gorge Lake water surface elevation (1997-2020).

2.3.2 Gorge Bypass Reach

The Gorge bypass reach occurs between the Gorge Dam and Powerhouse with a total reach length of approximately 2.5 miles long. Under the current Project license, City Light is not required to release any flow into the Gorge bypass reach, and flow is limited to baseflows from runoff (i.e., 5 to 10 cfs) and operational spills originating from Gorge Dam. Gorge Lake has relatively low storage volume and spills occur when inflow exceeds generation capacity. Flows from the Gorge Development are critical for fish protection in the Skagit River, and water from the reservoir is spilled if the powerhouse is not operating at sufficient capacity to maintain downstream minimum flow requirements. Figure 2.3-11 provides annual Gorge Dam spill frequency and magnitude between 1997 and 2020, showing the number of days that flow within the Gorge bypass has been above baseflow over the past 23-year period of record.

In addition to spill frequency and magnitude per year, flow characteristics in the Gorge bypass reach can be better understood by observing the seasonality of spill events from Gorge Dam and the daily unregulated flow record developed by the Skagit Operations Model (OM-01 Operations Model Study). Figure 2.3-15 illustrates cumulative days for monthly spill events from 1997 to 2020. Under current operations, most spills occur between May and August, likely corresponding to spring snow-melt events. October through December capture another higher frequency period of spill events, as the wet season begins, prior to the onset of freezing temperatures. Relatively infrequent spills occur January through April, likely when most precipitation falls in the form of snow. Figure 2.3-16 illustrates results from a flow-duration analysis of estimated unregulated flows. The resulting flow-duration curve shows the percentage of days a given discharge is exceeded.

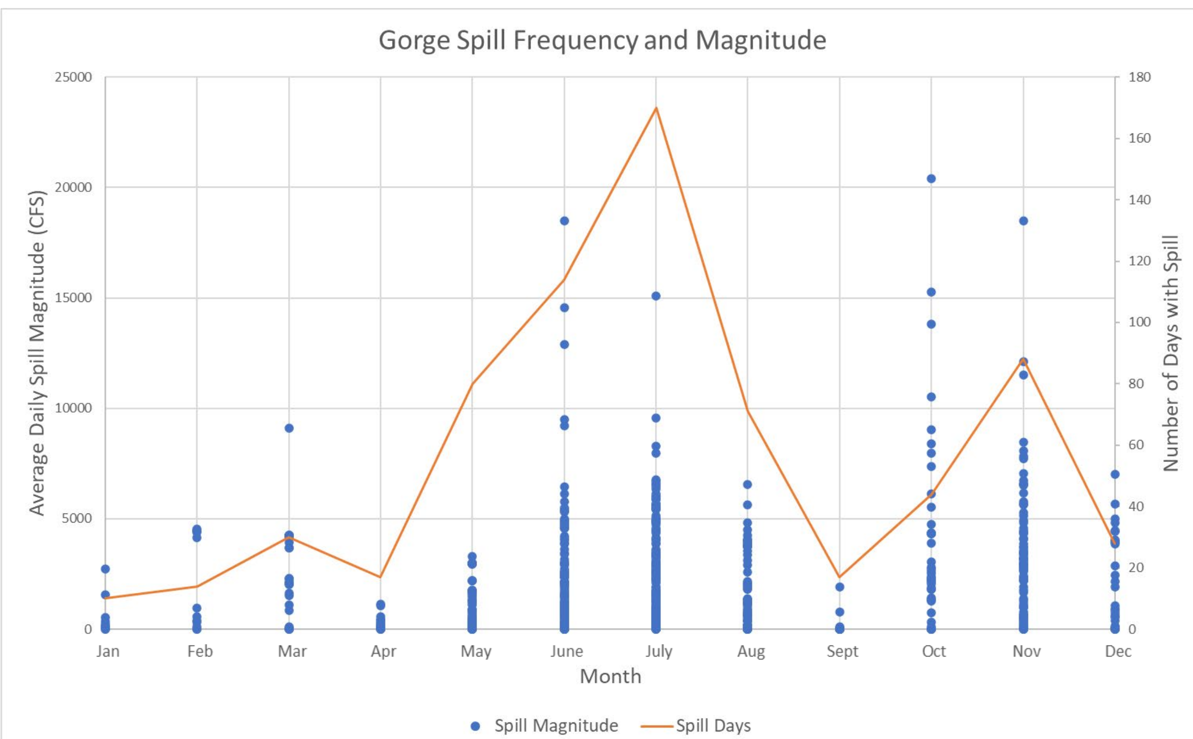


Figure 2.3-15. Spill frequency and magnitude at Gorge Dam by month (1997-2020).

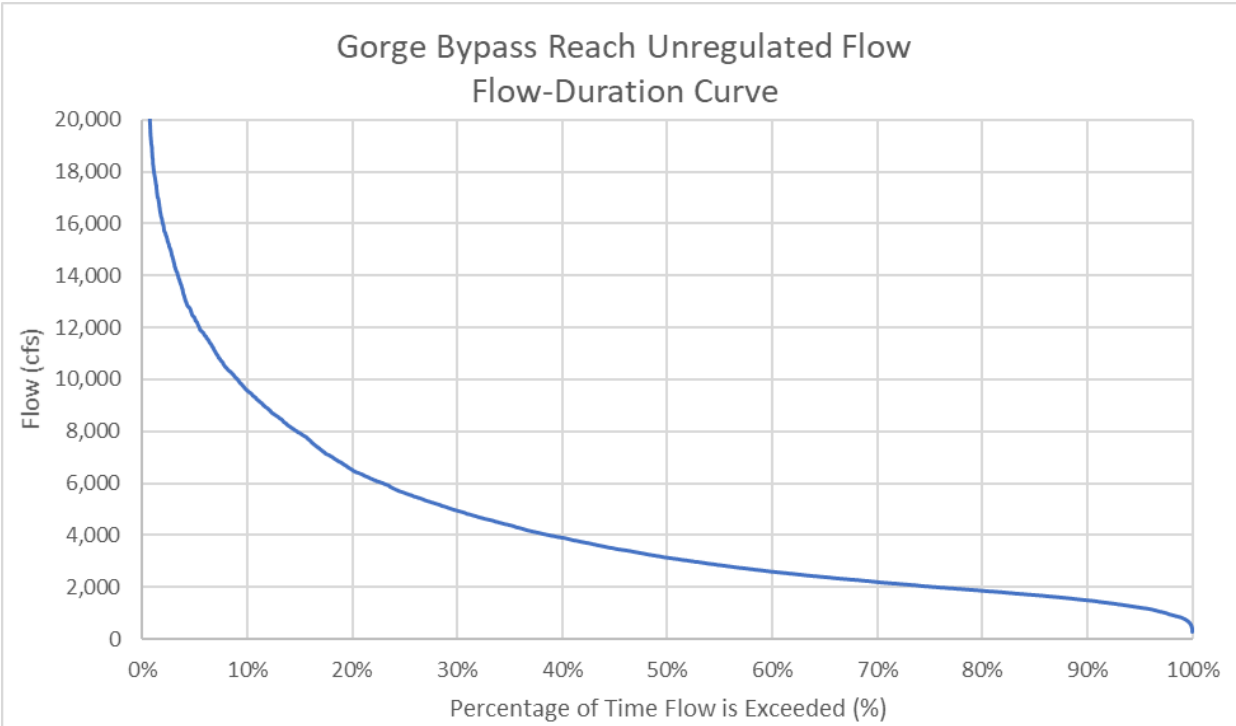


Figure 2.3-16. Flow duration curve of daily unregulated flow record developed by Skagit Operations Model.

2.3.3 River Operations

From 1991 through 2012, flows in the mainstem Skagit River downstream of Gorge Powerhouse were determined by the Project license issued by FERC in 1995 which fully incorporated the measures included in the Flow Plan of the Fisheries Settlement Agreement (FSA) (City Light 1991). The primary purpose of the Flow Plan was to minimize the effects of Project operations on salmon and steelhead. The measures included in the Flow Plan were developed based on extensive research on the effects of Project operations on fish and by hydrological and operational modeling (Pflug and Mobrand 1989). The Flow Plan also established a Flow Plan Coordinating Committee (FCC), which consists of representatives from the Indian Tribes, WDFW, NMFS, USFWS, NPS, and City Light to address and approve any deviations from the planned flow measures needed to respond to changing conditions (i.e., flow insufficiency or flood flows).

The Project license was amended in 2013 to incorporate a Revised FSA Flow Plan (City Light 2011), which included four measures City Light had been implementing voluntarily since 1995 to further reduce Project effects on steelhead and salmon. The specific flow measures and ramping rate restrictions included in the Project license as amended (FERC 2013) and the Revised FSA Flow Plan (City Light 2011) are described below by species and life stage.

2.3.3.1 Salmon Spawning and Redd Protection

The primary means of protecting spawning salmon and redds downstream of the Project are to: (1) limit maximum flow levels during spawning to minimize redd building along the edges of the river in areas exposed by daily load following generation; and (2) maintain minimum flows throughout the incubation period to keep redds covered until the fry emerge.

The Revised FSA Flow Plan identifies anticipated spawning periods for each species which are based on historic habitat use data collected by resource agencies and Indian Tribes. The spawning periods for each species as identified in the Revised FSA Flow Plan are as follows:

- Chinook Salmon – August 20 to October 15 each year.
- Pink Salmon – September 12 and ends on October 31 in odd years.
- Chum Salmon – November 1 and ends on January 6 each year.

During the spawning period of each salmon species, daily flows may not exceed 4,500 cfs for Chinook Salmon, 4,000 cfs for Pink Salmon, and 4,600 cfs for Chum Salmon unless: (1) the flow forecast made by City Light shows a sufficient volume of water will be available to sustain a higher incubation flow, thereby permitting a higher spawning flow; or (2) uncontrollable flow conditions are present. The seasonal spawning flow for each species is defined as the average of the highest ten daily spawning flows at the Newhalem gage during the spawning period of that species.

In addition, the current Project license requires City Light to provide minimum flows, which are dependent on spawning flows, during the salmon incubation period. For purposes of this requirement, incubation is presumed to begin on the first day of the spawning period identified for each species and end on April 30 for Chinook and Pink Salmon, and May 31 for Chum Salmon. As a result, instantaneous minimum flows are provided from August 20 through May 31 each year (see Appendix C of the Revised FSA; City Light 2011).

2.3.3.2 Salmon Fry Protection

The salmon fry protection period specified in the Revised FSA Flow Plan is January 1 through May 31, which is when salmon fry are emerging from redds and may be subject to stranding on gravel bars (Pflug and Mobrand 1989). Stranding refers to entrapment and death of juvenile salmonids on gravel bars that become exposed (dry) when the river drops rapidly in response to operational changes from a hydroelectric project. The vulnerability of salmonid fry to stranding depends on several biological, temporal, and physical factors, in addition to hydroelectric project operational factors. Stream flow properties include the river's height (stage) in relation to a specific habitat and the rate at which the stage changes in response to stream flow changes. Operational factors control changes in stream flow, which reflect electrical power requirements.

To minimize fry stranding, the Project license requires City Light to limit daily down-ramp amplitude; maintain minimum flows throughout the salmon fry protection period that are adequate to cover gravel bar areas commonly inhabited by salmon fry; and limit down-ramping to nighttime hours except in periods of high flow, as follows:

- **Down-ramp Amplitude** – The down-ramp amplitude is limited to no more than 4,000 cfs.
- **Down-ramping Rate** – During periods of daylight, no down-ramping is allowed from the moment when the flow at Marblemount is predicted to be ≤ 4,700 cfs. Down-ramping may proceed at a rate of up to 1,500 cfs per hour as long as the flow at Marblemount is predicted to

be > 4,700 cfs. During periods of darkness, down-ramping is allowed at a rate up to 3,000 cfs per hour.

- **Salmon Fry Protection Release** – To maintain a predicted Marblemount flow of 3,000 cfs during the salmon fry protection period, the Project must release up to 2,600 cfs.

2.3.3.3 Steelhead Spawning and Redd Protection

As is done for salmon, the primary means of protecting spawning steelhead and redds downstream of the Project are to: (1) limit maximum flow levels during spawning to minimize redd building along the edges of the river in areas exposed by daily load following generation; and (2) maintain minimum flows throughout the incubation period to keep redds covered until the fry emerge.

Measures to protect spawning steelhead and redds downstream of the Project include limiting maximum flow levels during spawning; shaping daily flows for uniformity over the extended spawning period; and maintaining minimum flows through the incubation period adequate to keep redds covered until fry emerge from the gravel. To protect eggs and embryos from dewatering, the measures in the Revised FSA Flow Plan (City Light 2011) substantially reduce the difference between spawning and incubation flows, thus decreasing the area of river channel subjected to dewatering.

The steelhead spawning period specified in the Revised FSA Flow Plan (City Light 2011) is from March 15 – June 15 each year. This spawning period is divided into three sub-periods: March 15-31, April 1-30, and May 1 – June 15. Each sub-period is treated separately for the purpose of determining succeeding steelhead spawning and incubation flows. Planned flows may not exceed 5,000 cfs for March steelhead, 5,000 cfs for April steelhead, and 4,000 cfs for May 1 – June 15 steelhead, unless the forecasted inflow and storage is great enough to provide incubation flows that are at least as high as the spawning flows. As stipulated in the Revised FSA Flow Plan, any planned spawning flows greater than these flow ranges are not to be implemented without prior discussion with the FCC. The actual spawning flow for each sub-period is defined as the average of the ten highest daily spawning flows at the Newhalem gage during that sub-period.

The incubation periods for each steelhead spawning group starts on the first day of the spawning sub-periods and ends on June 30 for March steelhead and July 31 for both April steelhead and May – June 15 steelhead. An instantaneous minimum incubation flow for each day of the incubation period is provided as follows:

- Incubation flows during the first 10 days of each spawning sub-period are based on the planned spawning flow.
- Thereafter, daily incubation flows are based on the average of the highest 10 daily spawning flows that have occurred up to that day. Appropriate incubation flows for any given day are determined by the season spawning flows in Appendix G of the Revised FSA (City Light 2011).
- During the month of August, the instantaneous daily minimum flow at Newhalem gage is 2,000 cfs.

2.3.3.4 Steelhead Fry Protection

Newly emerged steelhead fry are protected from potential stranding by limiting daily down-ramp amplitudes and rates and by maintaining minimum flows from June 1 – October 15 adequate to cover gravel bar areas commonly inhabited by steelhead fry. Implementation details include:

- **Down-ramp Amplitude** – The maximum 24-hour, down-ramp amplitude is limited to 3,000 cfs when flows at the Newhalem gage are > 4,000 cfs. When flows at Newhalem gage are ≤ 4,000 cfs, the down-ramp amplitude is limited to 2,000 cfs per day from June 1 – August and to 2,500 in September and October. During the month of August, down-ramp amplitude is further restricted to 500 cfs per day when flow insufficiency provisions are in effect (see Revised FSA Section 6.4; City Light 2011).
- **Down-ramping Rate** – When the Newhalem instantaneous flow is ≤ 4,000 cfs, the allowed down-ramp rate is up to 500 cfs per hour. When the Newhalem instantaneous flow remains > 4,000 cfs, a down-ramp rate of up to 1,000 cfs per hour is allowed.
- **Steelhead Fry Protection Flow** – Minimum flows at the Newhalem gage must be the higher of flows specified in Appendix I of the Revised FSA Flow Plan (City Light 2011; Table 2.3-1) or by required steelhead incubation flows. During the portions of June and October excluded from the steelhead fry protection period, minimum flows are determined by required salmon incubation flows.

Table 2.3-1. Fry protection at Newhalem gage.

Month	Minimum Sufficient Instantaneous Flow (cfs)[1]
January	[2]
February	1,800
March	1,800
April	1,800
May	1,500
June	1,500
July	1,500
August	2,000
September	1,500
October	1,500
November	[2]
December	[2]

1 Minimum flow may be reduced to 1,500 cfs when natural flow on the inflow day is less than 2,300 cfs (Section 6.3.3.2 (3) of the Revised FSA).

2 Minimum flows in these months are determined by incubation flow requirements.

2.3.3.5 Steelhead and Chinook Salmon Yearling Protection

To protect steelhead and Chinook Salmon yearlings from stranding and to minimize local displacement from foraging habitats down-ramp rates are limited to < 3,000 cfs/hr from October 16 to January 31 each year.

2.3.3.6 Other Flow Management Measures

The Revised FSA Flow Plan recognizes that some effect to anadromous fish spawning, incubation, and rearing may occur notwithstanding the protection measures described above, particularly when uncontrollable flow events occur (City Light 2011). In addition to the downstream flow requirements, it was recognized that specific voluntary actions may be needed to better protect salmon and steelhead spawning areas, redds, and fry as a result of new information on the effects of flows on spawning, incubation, and fry survival. These voluntary actions are cooperatively developed through the FCC, which considers Project system flexibility, economic ramifications, and potential effects to all anadromous species and life stages at a given time. Critical data considered include tributary inflows between Newhalem and Marblemount and field monitoring of redd locations. Implementation of voluntary actions typically involves development of a proposed action by City Light during or at the end of the spawning season for each species (or spawning group in the case of steelhead) and whenever uncontrollable flow events occur during the spawning, incubation, and rearing periods. The proposal is then presented to the FCC for review and discussion to reach consensus on a plan of action.

2.3.3.7 Water Supply

City Light is not a water supply utility and the Skagit River Project is not used for this purpose. Domestic water for the townsites and Gorge and Diablo powerhouses is supplied by wells. A tap off the penstock provides domestic water for Ross Powerhouse from the Happy Creek water right.

2.3.3.8 Outflow

Annual flow duration curves for Ross Lake, Diablo Lake and Gorge Lake outflows (1991-2018) are provided in Figure 2.3-17 through Figure 2.3-19. Outflow from the Ross and Diablo developments is calculated from generation and spill data. Outflow from the Gorge Development is measured at the USGS stream gage in Newhalem, just downstream of the powerhouse.

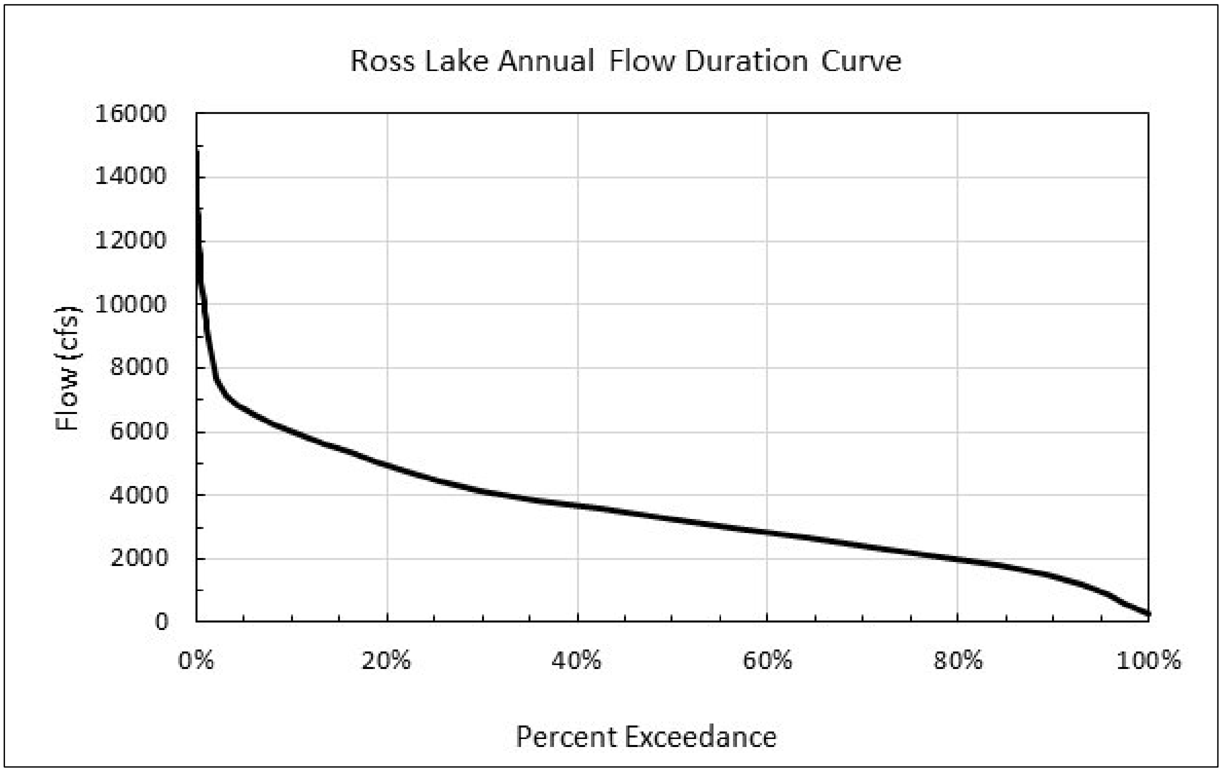


Figure 2.3-17. Annual flow duration curve for Ross Lake outflows (1991-2018).

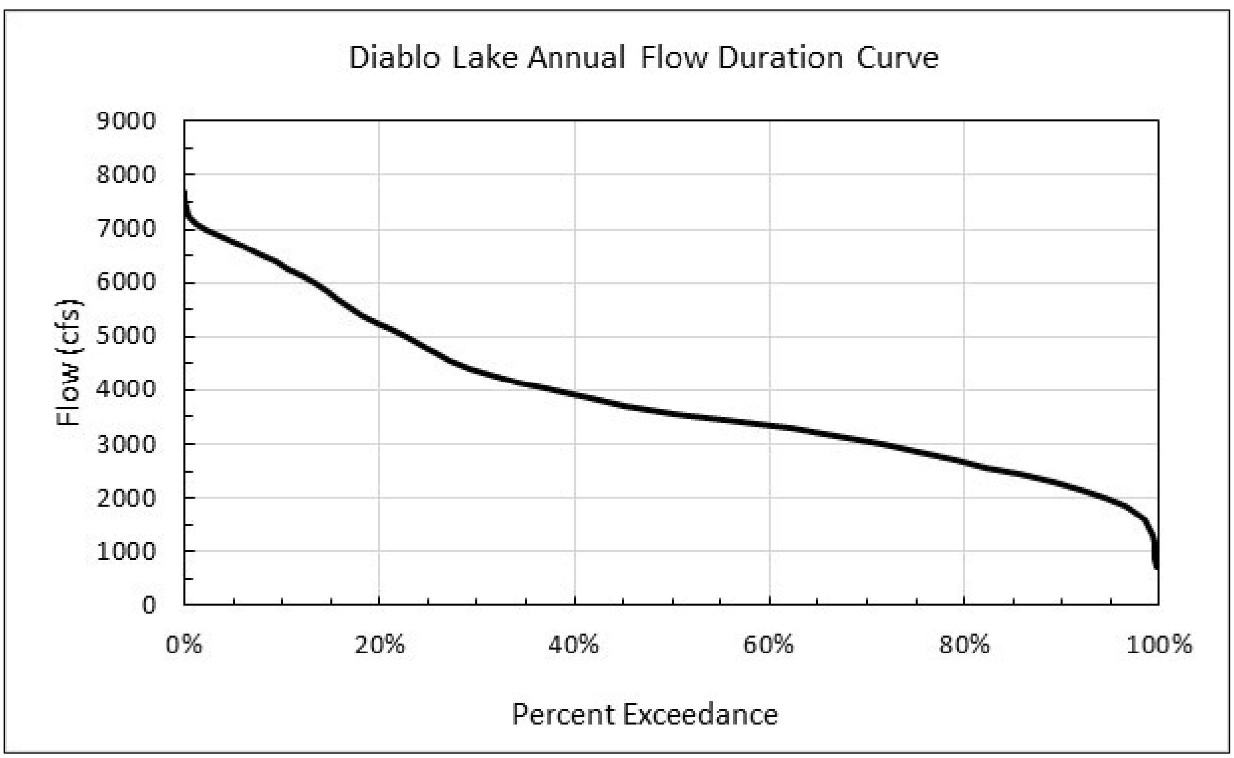


Figure 2.3-18. Annual flow duration curve for Diablo Lake outflows (1991-2018).

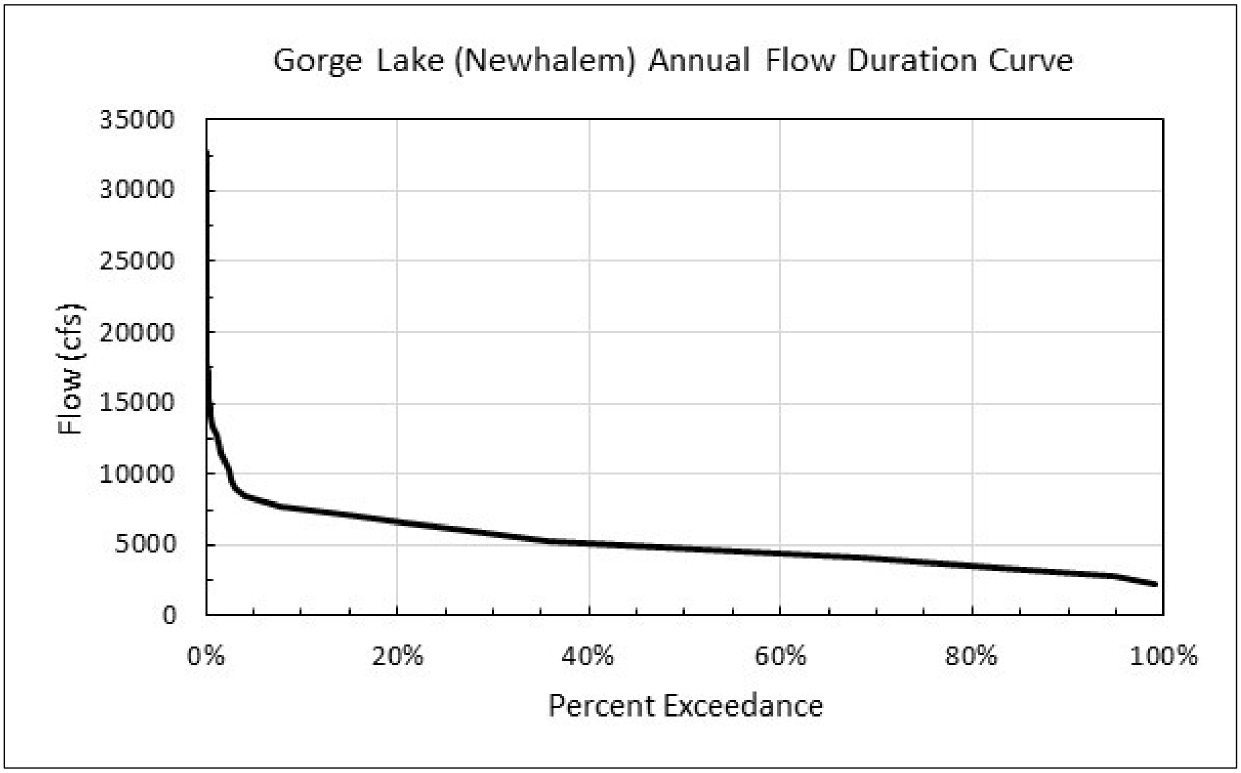


Figure 2.3-19. Annual flow duration curve for Gorge Lake outflows (Newhalem gage) (1991-2018).

2.4 Debris and Sedimentation Management

All fish passage facilities require primary and secondary measures to manage debris and sedimentation. Debris can negative influence facility performance and level of operational effort, and can be a primary source of fish injury or mortality. The following sections discuss the prevalence and management of debris for the Skagit River system upstream of Gorge Dam. The types, sizes, and volumes of known sedimentation and debris conditions at the Project developments will help inform the need for additional infrastructure or equipment requirements as potential fish passage facility concepts are developed.

2.4.1 Sedimentation

Baseline conditions relative to sedimentation in all reservoirs will be informed by other relicensing studies. Relative to the Fish Passage Study, sedimentation will be addressed as part of operations and management for conceptual designs.

2.4.2 Medium and Large Woody Material

City Light manages woody material at various locations in each of the Project reservoirs (Figure 2.4-1 and Figure 2.4-2). Woody material management operations, including the use of temporary and permanent storage areas, and the use of boats and barges for collection and transport should be considered for any fish passage facility design to ensure designs are compatible with ongoing operations.

Woody material management at Ross Lake differs from that at the other two reservoirs, due both to the quantity of accumulating debris in each reservoir, and specific features at the dams. Gorge Dam contains a wood chute that shunts woody material downstream, where it accumulates in a bypass reach until City Light spills water, at which point it reenters the recruitment process. Diablo Lake is accessible by road, which facilitates vehicular removal of woody material that is collected from the lake by boat.

Since 2017, City Light crews report total quantities for specific wood categories collected at each lake during annual wood management efforts. For Ross and Diablo, data is reported on tracking sheets spanning from the summer of one year to the winter of the next. For instance, the 2017-2018 reporting year includes collection data from the summer of 2017, transportation in fall 2017, and placement in the Skagit River in winter 2018. Data collected from the 2017-2021 management seasons is presented in a wood management memo prepared by City Light (2021c), which is available upon request. When reporting data, City Light currently classifies wood into the following categories:[14]

- High-quality large wood:
  - Pieces greater than 20 feet long and greater than 12 inches in diameter; or
  - Pieces less than 20 feet long that contain an intact rootwad.
- Low-quality large wood: Pieces 8-20 feet long and less than 12 inches in diameter
- Medium-sized wood: Pieces 6-8 feet long and 8-12 inches in diameter
- Small wood debris: Pieces 0-10 feet long and less than 8 inches in diameter

2.4.2.1 Ross Lake

An estimated 1,500 to 6,000 cubic yards of wood enter Ross Lake annually from the Skagit River and other tributaries during winter high flow events and from shoreline erosion (Zapel 2019). Approximately 0.5 percent of the wood is large trees and 2.5 percent includes rootwads. The remainder (97 percent) are smaller logs, limbs, and bark. Prevailing winds on the reservoir tend to move the debris to the upstream end of Ross Lake. Until 2010, the wood floating on Ross Lake was collected in the summer and stockpiled in British Columbia and burned in the fall.

Since 2010, wood is collected each summer and moved to storage pens throughout the reservoir. Woody material collected from the north end of the lake is indefinitely[15] stored at Hozomeen and permanently stored at Dry Creek and Roland Bay (Figure 2.4-1 and Figure 2.4-2). An estimated 27 acre-feet, or 443,559 cubic yards, of woody material is currently stored at the head of the lake near Hozomeen and in a few other inlets. At Hozomeen, the stored material covers a surface area of about nine acres. Material that is extracted from the south end of Ross Lake is temporarily stored at Green Point and extracted annually in early November. Material that is extracted from Ross Lake must be cut to 12-foot pieces and is eventually transported to the Skagit River Aggregate

[14] Beginning in summer 2021, City Light has started collecting additional data for wood exceeding 20 feet in length and 12 inches including expanded length and diameter categories and log decay status.

[15] Woody material stored at Hozomeen will eventually be moved or processed on or off-site in a manner to be determined.

Storage Facility (Aggregate Ponds) located downstream and along the right bank of the river about two miles southwest of the town of Newhalem (Figure 2.4-2).

2.4.2.2 Diablo Lake

The amount of wood entering Diablo Lake is very small compared to Ross Lake; the majority originates in Thunder Creek, with minor contributions from the other tributaries and the lake shore. Logs, rootwads, and woody material that enter Diablo Lake are collected throughout the year and temporarily stored in a pen at Buster Brown Cove (Figure 2.4-2), then towed to a collection point near the mouth of Sourdough Creek and extracted using an excavator. The wood is transported via dump truck to the Aggregate Storage Facility south of Newhalem and then placed into the Skagit River from October through April to allow higher flows to transport the wood.

Unlike Ross Lake, woody material can be collected at any time of the year on Diablo Lake. Like wood extracted from Ross Lake, high- or low-quality large wood is cut into 12-foot pieces prior to loading and transported to the Aggregate Ponds for later placement into the river.

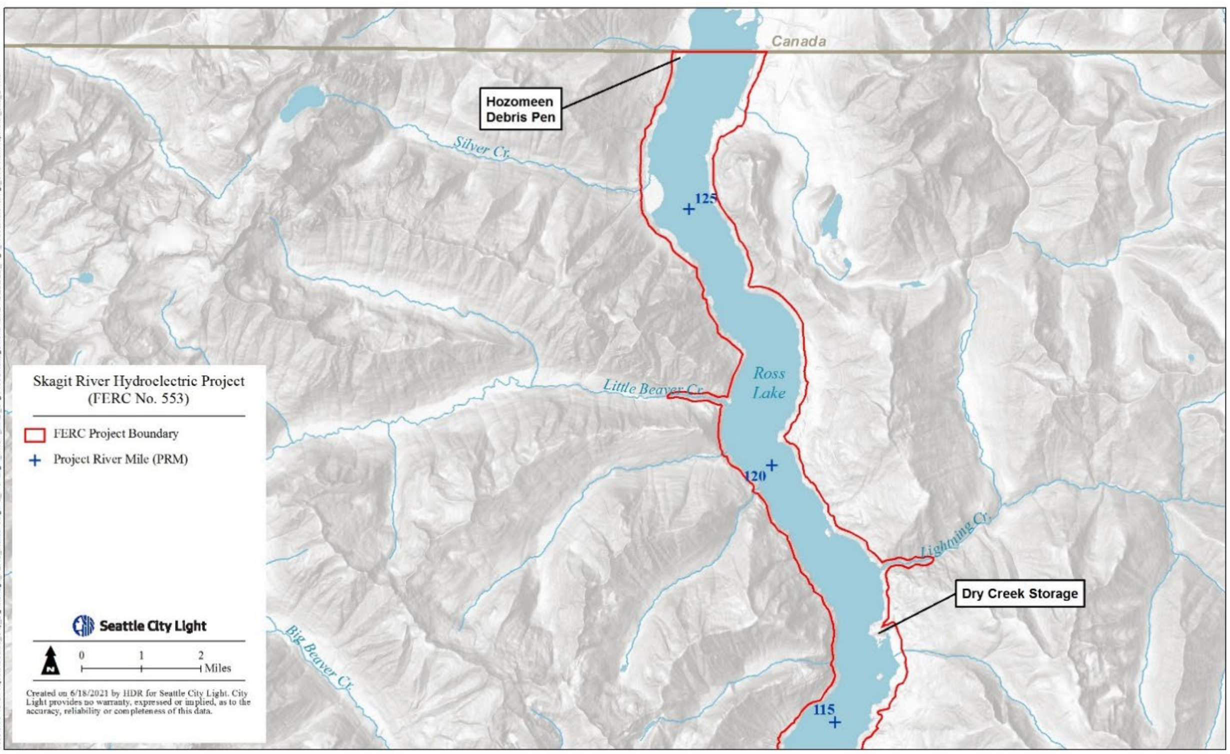


Figure 2.4-1. Skagit River Project woody material management overview map – north (Ross Lake).

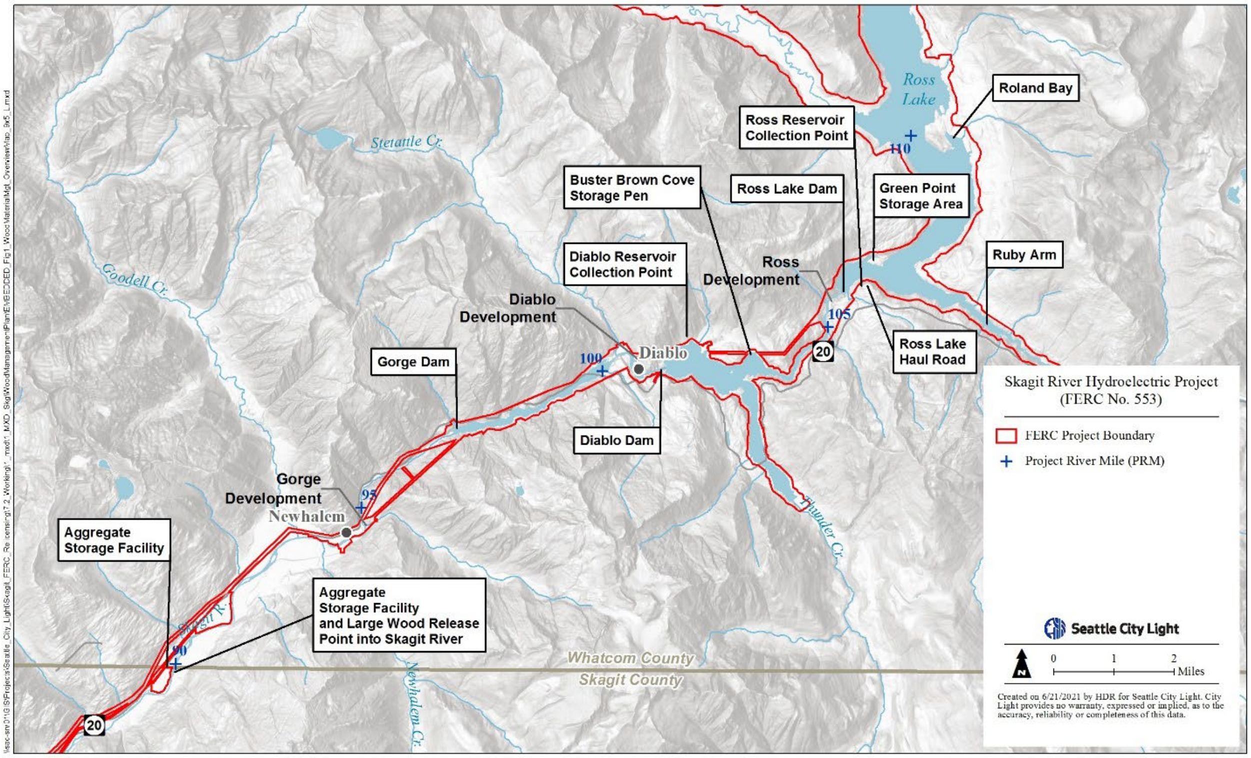


Figure 2.4-2. Skagit River Project woody material management overview map – south.

2.4.2.3 Gorge Lake

Gorge Dam contains a wood chute that shunts small- and medium-sized woody material (about two to three bags per year, or 500 to 750 cubic yards) downstream, where it accumulates in the bypass reach until City Light spills water, at which point it reenters the Skagit River recruitment process. Available data for log chute wood management from 2017-2021 is presented in the Summary of Performance Standards and Evaluation attached to this document. Although not yet included in the data, City Light recently has started to place collected wood from the trash rack into the Skagit River with the rest of the collected wood at the Aggregate Ponds. This quantity averages approximately 20 cubic yards per year. Woody material from the trash rack tends to be fresher, less deteriorated material.

2.5 Water Temperature Conditions[16]

Reservoir thermal regimes influence fish passage in two primary ways: reservoir temperature affects the ability of juvenile and adult fish to transit upstream and downstream in the reservoir, and temperature stratifications influence their vertical position in reservoir at different times of year. For example, during warmer months, thermal stratification may keep fish at lower depths below the entrance to collection facilities. Warming patterns and surface water temperatures vary among the three Project reservoirs. Figure 2.5-1 through Figure 2.5-3 show mean daily water

[16] The Fish Passage Study team acknowledges that concurrent relicensing studies are developing temperature profiles for each of the three forebays and reservoirs, the results of which are anticipated to be included in the Initial Study Report (ISR) to be prepared as part of the Project relicensing process in March 2022. This information will be incorporated into future reporting for the Fish Passage Study, as available.

temperatures measured at various depths at the log booms located in the forebays in each reservoir from fall 2014 through fall 2015/spring 2016. Moving in a downstream direction, surface water temperatures are highest in Ross Lake and successively lower in Diablo Lake and Gorge Lake. In addition, peak temperatures occur later in the season in the two downstream reservoirs. Figure 2.5-1 through Figure 2.5-3 show that Ross Lake is the most stratified of the three reservoirs, and Gorge Lake is the least stratified. Although stratified, Diablo Lake is cooler than Ross Lake in the upper portion of the water column; daily surface temperatures in Diablo Lake very rarely exceeded 16 degrees Celsius (°C) during the measurement period. Gorge Lake is weakly stratified during summer, which is expected given that detention time in this reservoir is 0.8 days. Detention time for Ross Lake and Diablo Lake are 189.4 days and 9.4 days, respectively. Daily surface water temperatures in Gorge Lake rarely exceeded 13°C during the measurement period. Thermal regimes throughout each reservoir and each forebay are currently the subject of two concurrent relicensing studies (FA-01a WQ Monitoring Study and FA-01b WQ Model Development Study). Results of these concurrent studies are anticipated to become available in 2022 and will better inform fish passage parameters related to juvenile collection and reservoir transit, pending the future selection of fish passage strategies.

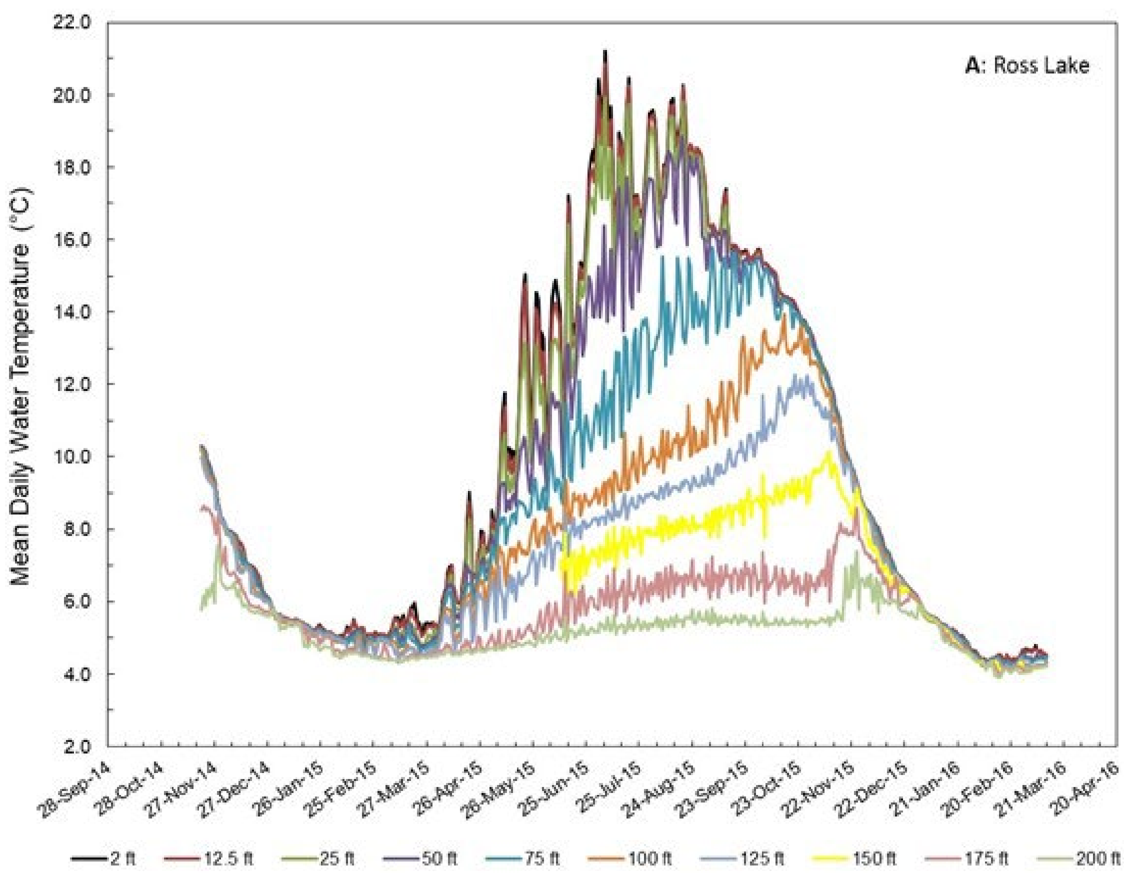


Figure 2.5-1. Mean daily temperature (°C) vertical profile measurements made at the log boom in Ross Lake from fall 2014 through winter 2015/spring 2016.

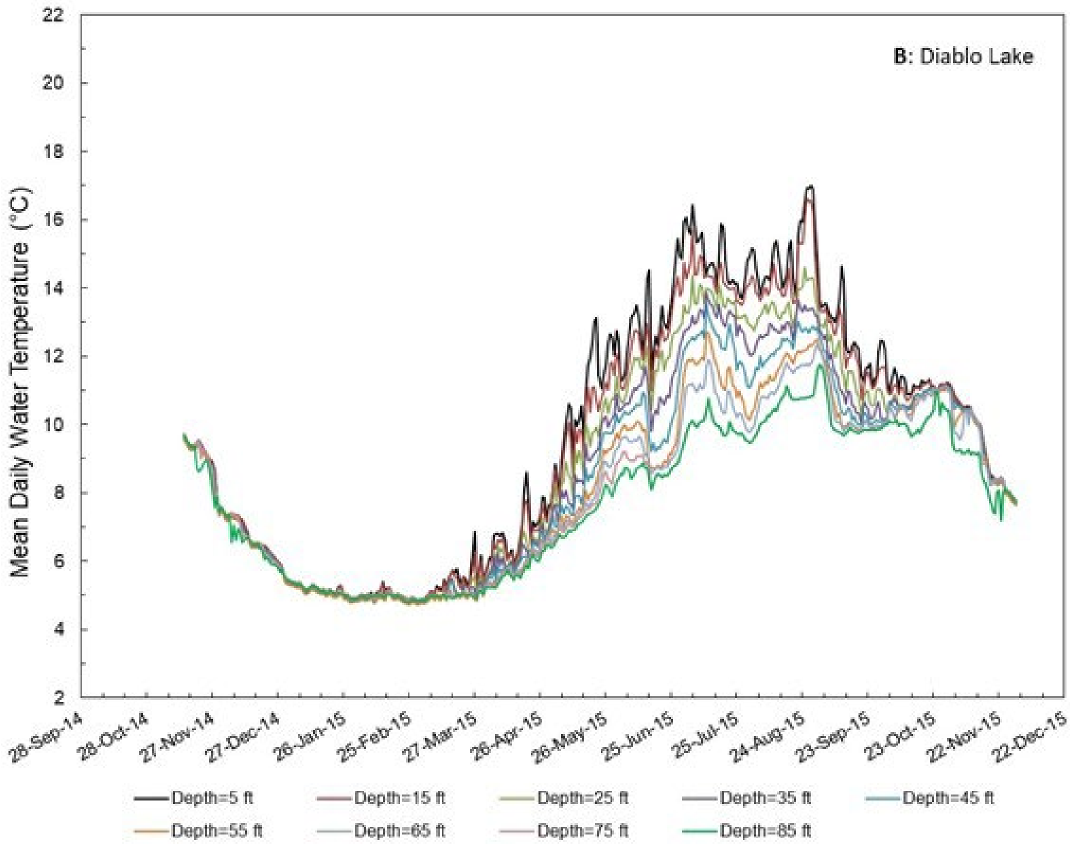


Figure 2.5-2. Mean daily temperature (°C) vertical profile measurements made at the log boom in Diablo Lake from fall 2014 through winter 2015/spring 2016.

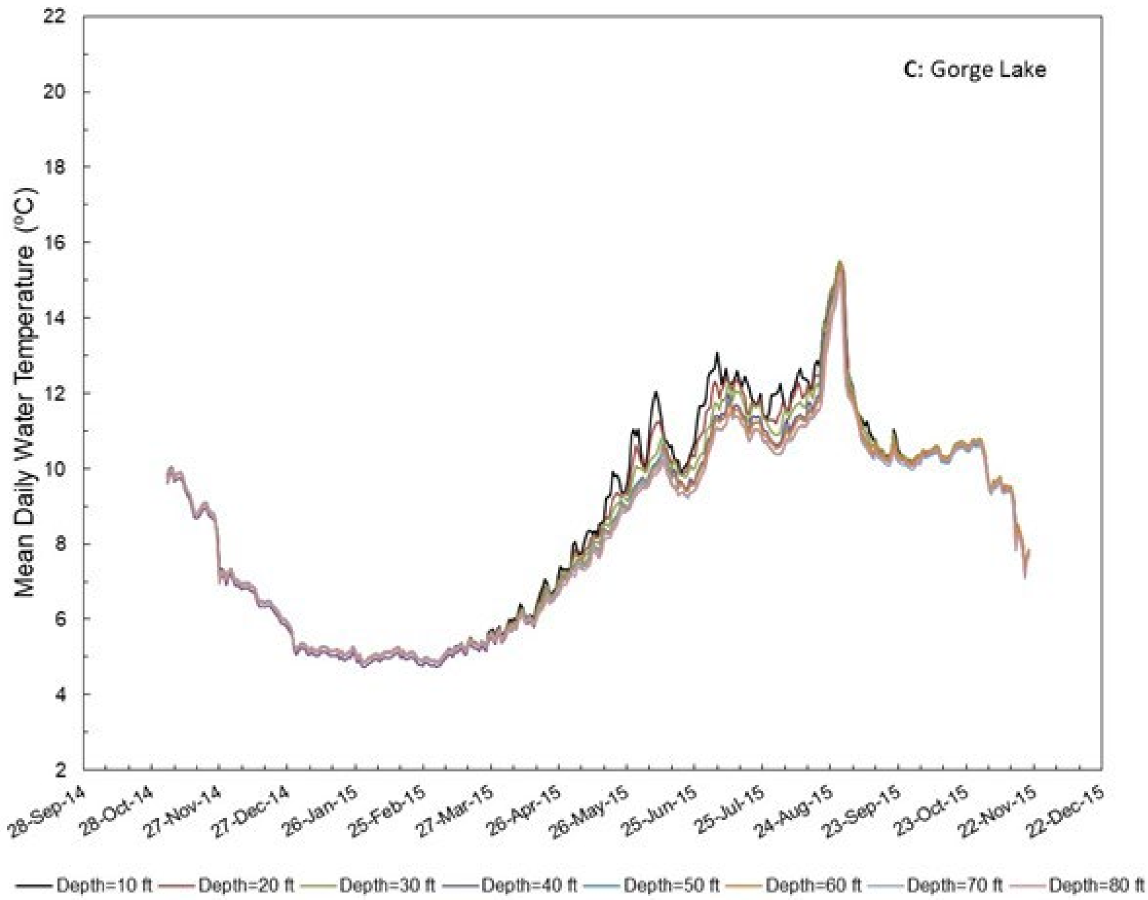


Figure 2.5-3. **Mean daily temperature (°C) vertical profile measurements made at the log boom in Gorge Lake from fall 2014 through winter 2015/spring 2016.**

2.5.1 Ross Lake

Surface water temperatures in Ross Lake increase in summer, at which time a thermocline forms and the reservoir becomes stratified (about 95 percent of the reservoir's volume is below the thermocline). Temperatures measured along a depth profile in Ross Lake during 2017 (also at the log boom site) display patterns similar to those shown in Figure 2.5-1. Mean daily surface temperatures were elevated in summer: the highest mean surface temperature, measured at a depth of 2 feet, was 20.8°C. However, deeper water remained cool during summer: at a depth of 75 feet, mean water temperatures exceeded 16°C on only three days, and between 100 feet and 200 feet mean temperatures never exceeded 13.6°C. As shown in Figure 2.3-3, Ross Lake remains on average above elevation 1,570 feet NAVD 88 during the summer months; therefore, the forebay intake is on average at depth of at least 140 feet, with the minimum depth of 80.8 feet occurring in 1999.

The maximum temperature measured at 2 feet was 21.7°C (on August 3, 2017), and maximum surface water temperatures exceeded 16°C on 85 days. Previously collected data (from 2000-2002) also showed that Ross Lake stratifies during summer. At that time, however, maximum surface water temperature was 19.3°C, and temperatures below the thermocline were 10°C or less (R2 Resource Consultants 2009). Based on these data, temperatures in Ross Lake do not appear to be limiting to fish passage, as existing temperatures do not exceed levels that would impede passage throughout the water column. The relationship of this temperature profile to future juvenile/adult collection designs for downstream passage will be explored during later stages of the Fish Passage Study.

2.5.2 Diablo Lake

The highest mean daily surface (at five feet depth) water temperature measured at the log boom site in Diablo Lake during 2017 was 16.4°C, and mean surface temperatures exceeded 16°C on only 2 days. This is similar to observations in 2014-2015 (Figure 2.5-2). The maximum surface water temperature measured at the log boom site in Diablo Lake during 2017 was 17.6°C, and maximum surface temperatures exceeded 16°C on only 15 days (7-DADMax surface temperatures at times exceeded 16°C). However, at 15 feet, the maximum temperature exceeded 16°C on only 1 day, and maximum temperatures between 25 feet and 85 feet never exceeded 14.8°C. These depths correspond to the upper reservoir profile and are much shallower than the forebay intake (at a depth of 125 feet, from normal maximum water surface elevation, and 118 feet from maximum drawdown elevation). The relationship of this temperature profile to future juvenile/adult collection designs for downstream passage will be explored during later stages of the Fish Passage Study. Based on these data, temperatures in Diablo Lake do not appear to be limiting to fish passage, as existing temperatures do not exceed levels that would impede passage throughout the water column.

Diablo Lake, with a detention time of 9.4 days, is considered a riverine waterbody per Washington State Water Quality Standards (WAC 173-201A-600).

2.5.3 Gorge Lake

During 2017, maximum surface water temperature (at 10 feet depth) measured at the log boom site in Gorge Lake was 14.0°C, and maximum temperatures between 25 feet and 85 feet never exceeded 12.2°C. The intake depth during summer is on average approximately 60 feet deep. The highest daily mean surface (at 10 feet depth) water temperature measured at the log boom site in Gorge Lake during 2017 was 11.8°C; mean temperatures were slightly lower than they were in 2014-2015[17] (Figure 2.5-3); however, profile data collection at the Gorge Lake log boom ceased on August 3, 2017, so data are unavailable for a portion of the time of year when water temperatures would be highest. Based on available data, temperatures in Gorge Lake do not appear to be limiting to fish passage, as existing temperatures do not exceed levels that would impede passage throughout the water column. The relationship of this temperature profile to future juvenile/adult collection designs for downstream passage will be explored during later stages of the Fish Passage Study.

[17] Note that water temperatures in Gorge Lake were higher than usual during the latter half of August 2015 due to uncharacteristic Project operations (Figure 2.5-3). The atypical warming occurred because City Light was required to shut down the Project from August 19-29, 2015, due to the Goodell Fire, which resulted in spills at all three reservoirs during this period; more surface water from Ross Lake was released than would have been under normal operations.

3.0 BIOLOGICAL SETTING

The following sections include relevant existing information that characterizes biological factors for target fish species that influence concept development of potential fish passage facilities. The four primary biological design criteria that have the most influence on facility type, size, and configuration are the following:

- Fish occurrence and distribution: Informs the selection of species and life stages targeted for fish passage design (i.e., target species).
- Fish migration timing: Informs the understanding of seasonality, anticipated hydrologic conditions, and duration of periods when target fish species may be expected to migrate upstream and/or downstream of the dam location.
- Fish abundance: Informs the estimation of the annual number of fish that require fish passage as well as the peak daily rate of migration that influences facility size and operation requirements.
- Fish size: Informs the biomass of fish that is anticipated to occur at the facility and influences the instantaneous holding capacities of facility features such as tanks, hoppers, holding areas, and transport equipment.

Additional specific information on the fish populations such as estimates of anticipated adult population abundance that may be experienced at the Project, fish size, and timing of migration will be incorporated into future deliverables of the Fish Passage Study as the information becomes available and is provided by LPs per information requests. City Light will continue to work with LPs to define these factors.

Considered with the physical environment of each Project development (discussed in Section 2.0 of this document), biological factors relevant to each target species will establish the overall setting that is used to assess the technical feasibility of developing potential upstream and downstream fish passage facility alternatives. Section 5.0 of this document provides development-specific information that will be used to inform more in-depth analyses of feasibility under future stages of the Fish Passage Study.

3.1 Target Fish Species

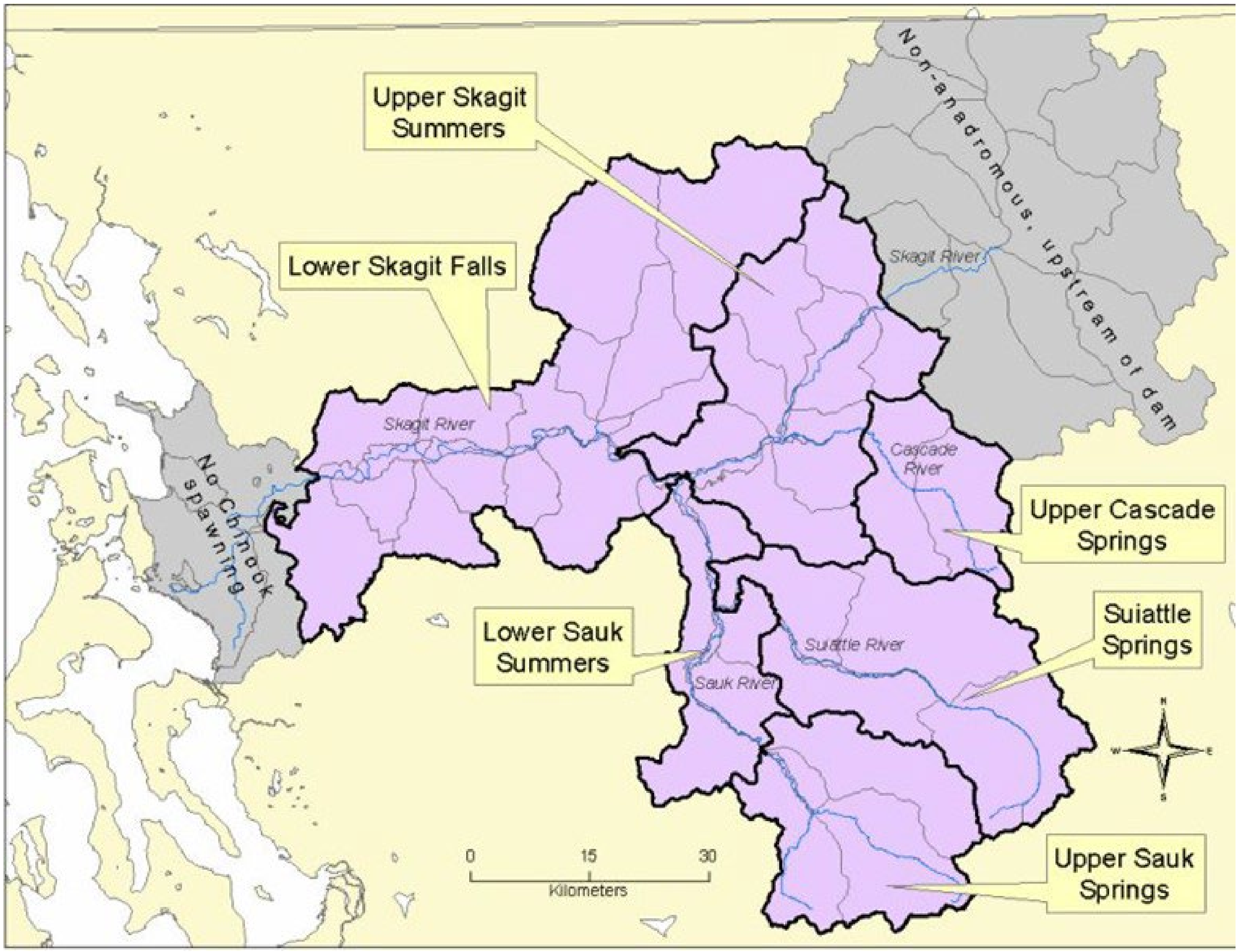
The target species considered for this assessment include the species presented in the Fish Passage Study RSP, and additional species requested by LPs to be considered for the Bypass Reach Instream Flow Model Development Study as documented in the NOA (City Light 2021b). These species include Chinook Salmon (*Oncorhynchus tshawytscha*), Coho Salmon (*O. kisutch*), Sockeye Salmon (*O. nerka*), steelhead (*O. mykiss*), Bull Trout (*Salvelinus confluentus*), Chum Salmon (*O. keta*), Pink Salmon (*O. gorbuscha*), sea-run Cutthroat Trout (*O. clarkii)*, Dolly Varden (*S. malma*), Pacific Lamprey (*Entosphenus tridentatus*), and Salish Sucker (*Catostomus catostomus*).[18] A detailed description of each species, distribution, abundance, and migration

[18] In response to a comment from the NPS, City Light may consider Mountain Whitefish (*Prosopium williamsoni*) and Largescale Sucker (*Catostomus macrocheilus*) as incidental, non-target species for passage. However, facilities will not be designed primarily for passage of these species because they have not been studied, and any designs would be experimental in nature and beyond the scope of this study.

timing in the Skagit River, as well as occurrence in the three Project reservoirs, as applicable, is provided in the following sections. Of the target species, Rainbow Trout, Bull Trout, and Dolly Varden are the only native fishes known to currently occur upstream of the dams (Smith and Anderson 1921).

3.1.1 Chinook Salmon

The Puget Sound Technical Recovery Team identified 22 independent Chinook Salmon populations within five biogeographic regions in the Puget Sound Evolutionarily Significant Unit (ESU) (Ruckelshaus et al. 2006). The Skagit River watershed includes six of these populations: (1) Lower Skagit Fall Chinook Salmon; (2) Upper Skagit Summer Chinook Salmon; (3) Lower Sauk Summer Chinook Salmon; (4) Upper Sauk Spring Chinook Salmon; (5) Suiattle Spring Chinook Salmon; and (6) Upper Cascade Spring Chinook Salmon (Figure 3.1-1). Each are considered “demographically independent populations” (DIP) that were identified using distinct trends in population abundance and variability, genetic separation, differences in life history characteristics and age structure, spatial and/or temporal separation of spawners, unique habitat and hydrological characteristics of a watershed, and catastrophic risk (e.g., drainage located near a volcano) (PSTRT 2005). The Skagit River and its tributaries upstream of the Sauk River support two of these populations, Upper Skagit Summer Chinook Salmon and Upper Cascade Spring Chinook Salmon; however, there is some overlap in the distribution of Upper Skagit Summer Chinook and Lower Skagit Fall Chinook near the confluence with the Sauk River (WDFW 2019). SRSC and WDFW (2005) determined that all populations of Chinook Salmon in the Skagit River produce both ocean- and stream-type juveniles. Chinook Salmon have been reported to migrate to a barrier below the Diablo Dam site, although passage to this location has not been verified (Envirosphere 1989). The adult migration for Chinook Salmon populations in the upper Skagit River occurs from May through mid-September (Figure 3.1-2).



Source: SRSC and WDFW 2005.

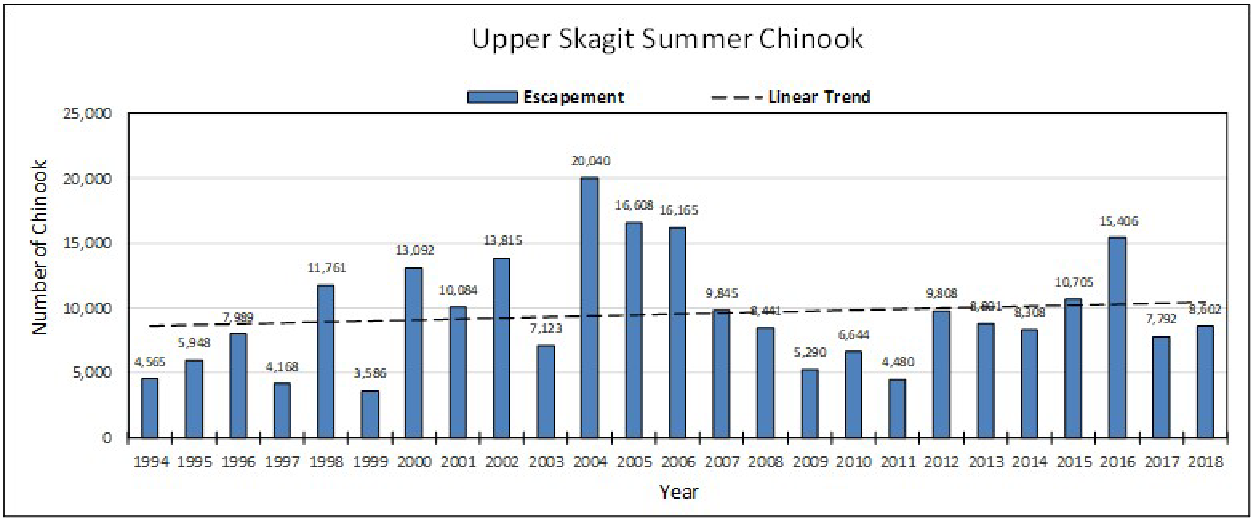
Figure 3.1-1. Skagit River basin Chinook Salmon populations.

Three primary juvenile out-migration life history strategies are expressed in Chinook Salmon from the Skagit River: fry migrants, subyearling parr, and yearling smolts (Hayman et al. 1996; Beamer et al. 2000); each of these are present in all six Skagit River populations (SRSC and WDFW 2005). Fry out-migrants are assumed to undergo little if any rearing in the main-stem Skagit River, and their size range is 40-50 millimeters (mm) (Pflug and Mobrand 1989). Subyearling parr out-migrants rear for several months in the Skagit River before migrating at an average length of 75 mm (Seiler et al. 1998; Kinsel et al. 2008). Yearling smolt out-migrants (>100 mm) rear in the Skagit River overwinter and migrate at sizes greater than 99 mm. Subyearling out-migrants comprise greater than 96 percent of the total Skagit River Chinook Salmon freshwater production (Zimmerman et al. 2015). Outmigrants demonstrate a bimodal distribution that varies annually, with fry migrating early in the migration season and parr migrants later in the season, with an estimated 905,000-6,553,000 fry migrants and 537,000-2,188,00 par migrating annually between 1993 and 2008 (Zimmerman et al. 2015).

Upper Skagit Summer Chinook Salmon spawn in the Skagit River mainstem and its tributaries upstream of the confluence with the Sauk River (WDFW 2002; SRSC and WDFW 2005). Important tributaries include the lower Cascade River and Illabot, Diobsud, Bacon, and Goodell creeks (Figure 3.1-1). Spawning begins in late August, but primarily occurs in September to early

October, which is somewhat earlier than the Lower Skagit Fall Chinook Salmon population (Figure 3.1-1). The upper extent of spawning is near the Gorge Powerhouse.

Data[19] collected since the issuance of the current Project license indicate that the Upper Skagit Summer Chinook Salmon population had a geometric mean escapement of 8,663 fish for return years 1994 to 2018, and 9,651 fish for return years 2013 to 2018 (Figure 3.1-2).



Source: WDFW 2019.

Figure 3.1-2. Upper Skagit Summer Chinook Salmon spawning escapement (1994-2018).

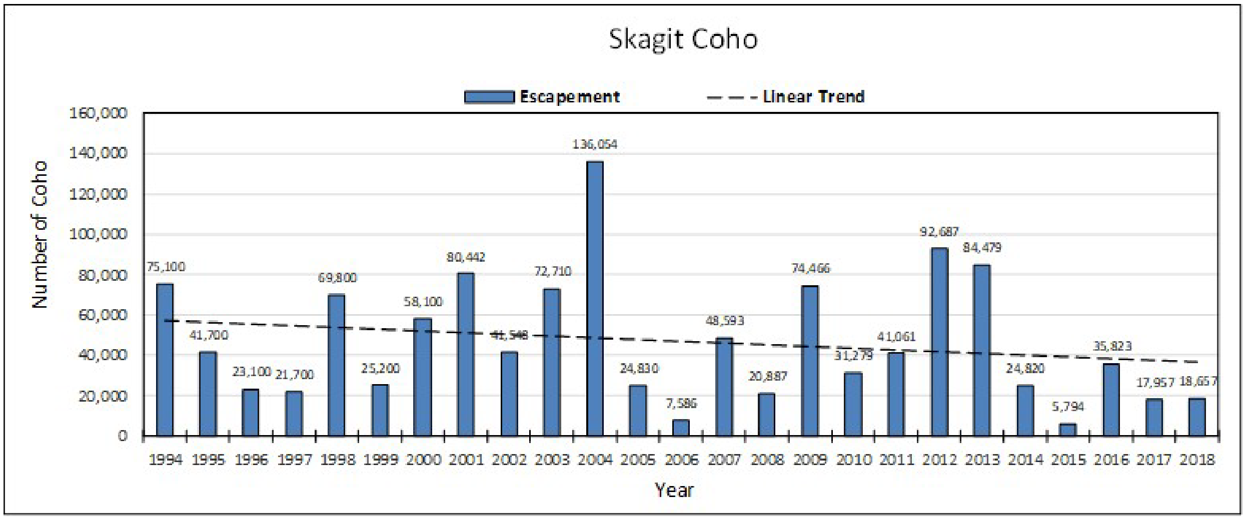
3.1.2 Coho Salmon

Coho Salmon are native to the Skagit River basin and the WDFW has identified two stocks within the Project vicinity: Skagit River Coho and Baker River Coho (WDF, WDFW, and Western Washington Treaty Indian Tribes [WWTIT] 1994). Coho Salmon are distributed throughout the upper Skagit Basin and accessible tributaries (WDFW 2021), and have been observed in the Gorge Bypass Reach (USIT 2020). Adult Skagit River Coho Salmon generally spawn in the tributaries to the Skagit River, although some spawning may occur inside channels and sloughs along the mainstem. Juvenile Coho Salmon are present throughout the year in the mainstem Skagit River, rearing in pools and off-channel habitats. Skagit River adults migrate from August through December and spawn from early October through mid-February.

The average terminal run size of Skagit River Coho Salmon from 1991 to 2017 was 199,761 hatchery- and natural-origin fish. The median over the same time period was 203,629 fish, ranging from a single-year terminal run size low of 64,223 fish in 2015 to a single-year high of 309,701 in 2012 (PFMC 2019). The geometric mean escapement of Skagit River Coho Salmon for return years 1994 to 2018 was 36,703 fish (Figure 3.1-3). The geometric mean escapement for return years 2013 to 2018 was 22,942 fish. At this time, the Baker trap is the best available source of information for adult monitoring of Coho Salmon in the basin (Lowery, pers. comm. 2021).

19 Escapement reflects the number of fish returning to the spawning grounds (i.e., it does not include fish that are harvested in commercial or recreational fisheries).

Adult Coho Salmon migration in the Skagit River from August through December (Figure 3.1-3). In the Baker River, a tributary to the Skagit River, Coho Salmon largely migrate in September and October, with approximately 95 percent migrating in these 2 months (Puget Sound Energy [PSE] 2020).



Source: WDFW 2019.

Figure 3.1-3. Skagit River Coho Salmon spawning escapement (1994-2018).

3.1.3 Sockeye Salmon

In the Skagit River, Sockeye Salmon production is largely from the Baker River population. However, a small number of riverine Sockeye Salmon are found in the mainstem upper Skagit River during monitoring surveys and observed in accessible tributaries including lower Bacon Creek and Newhalem Creek. Sockeye Salmon are also present in the Sauk River basin. The abundance of Sockeye Salmon in the Project vicinity is unknown since there is little to no abundance information for the upper Skagit River.

The adult Sockeye Salmon migration period in the Skagit River occurs from April through November (Figure 3.1-3); spawning generally occurs in late summer and fall (August to November). In the Baker River, a tributary to the Skagit River that supports the largest population in the basin, Sockeye Salmon exhibit a highly peaked migration pattern with fish largely migrating from June through August and approximately 80 percent migrating in July (Puget Sound Energy 2020). The juvenile Sockeye Salmon downstream migration occurs from March through August (Figure 3.1-3), and in the Baker River largely occurs from mid-April through mid-June with approximately 95 percent of juveniles migrating during this period (Puget Sound Energy unpublished data 2021).

3.1.4 Steelhead

Myers et al. (2015) grouped the Puget Sound Steelhead (*O. mykiss*) distinct population segment (DPS) populations into three extant major population groups (MPG) containing a total of 32 DIP based on genetic, environmental, and life history characteristics. Populations can include summer steelhead only, winter steelhead only, or a combination of summer and winter run timing (e.g., winter-run, summer-run or summer/winter-run). The Skagit River contains four steelhead DIPs, as identified in Myers et al. (2015): (1) Skagit River Summer Run and Winter Run; (2) Nookachamps Creek Winter Run; (3) Sauk River Summer Run and Winter Run; and (4) Baker River Summer Run and Winter Run (Myers et al. 2015). Steelhead were historically found in "considerable numbers" in the Skagit River up to the construction camp for the Project near Newhalem (Smith and Anderson 1921), and historical evidence suggests that small runs of steelhead migrated as far as Stetattle Creek (City Light 1988). At that time, Smith and Anderson (1921) identified Goodell Creek as the farthest branch of the Skagit from the mouth that contained anadromous fish (NMFS 2012). Historical evidence suggests the only harvestable fishes reported above the Skagit Gorge at Newhalem prior to dam construction are trout and char (Smith and Anderson 1921).

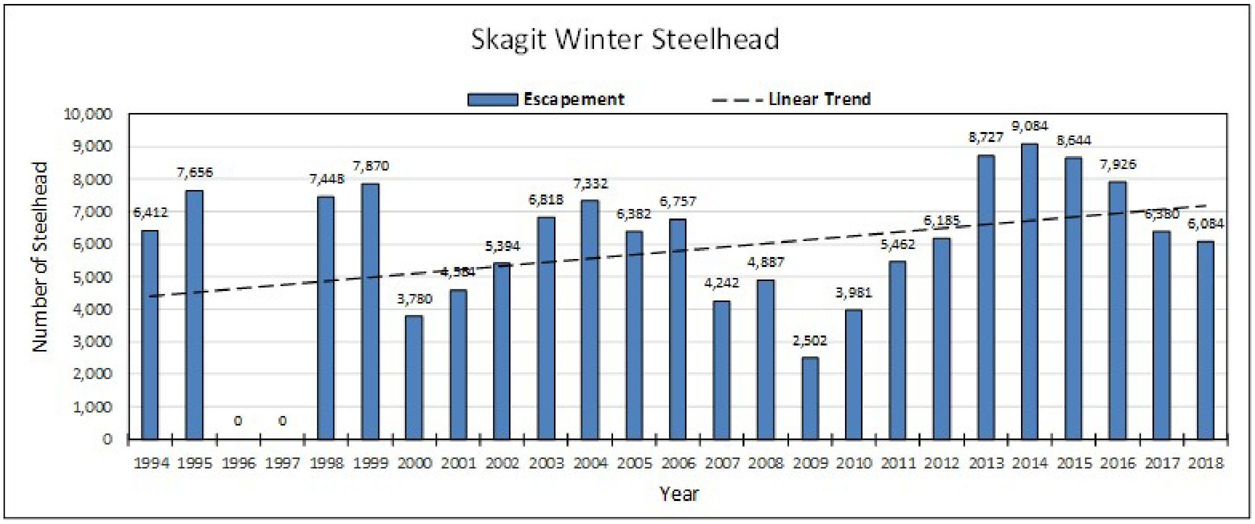
Most of the steelhead in the Skagit River are winter-run, but summer-run steelhead are also present (Busby et al. 1996; NMFS 2012, 2018). Skagit River steelhead typically migrate to marine waters after spending two to three years in fresh water (NMFS 2012). They then generally reside in marine waters for two or three years prior to returning to their natal stream to spawn as four-, five-, or six-year-olds. Steelhead adults typically spawn between December and June (Bell 1990; Busby et al. 1996).

3.1.4.1 Skagit River Winter Steelhead

The Skagit River Winter Steelhead DIP currently spawns in the mainstem Skagit River between PRM 23.3 and 94.6 (USGS RM 22.5 and 94.1) and in Nookachamps, Alder, Diobsud, Mill, Grandy, Pressentin, Finney, Jackman. Rocky, O'Toole, Cumberland, Day, Anderson, Sorenson, Hansen, Illabot, Bacon, Rocky, Newhalem, Goodell, and Jones creeks (WDFW 2002, 2019). WDFW (2019) and WDFW (2002) also reported that winter steelhead spawn in the Sauk River and Cascade River, but these spawning areas are continuous with the mainstem Skagit River. Sauk River spawning occurs from its confluence with the Skagit River to PRM 41.6 (USGS RM 41), portions of the South Fork Sauk River, the Suiattle River, the White Chuck River, and several tributaries such as White Creek, Dan Creek, Murphy Creek, and Falls Creek. The spawning distribution in the Cascade River extends from the Skagit River to near the confluence with the Middle Fork Cascade River (WDFW 2019).

Skagit River Winter Steelhead enter the river beginning in November (Hard et al. 2007). Spawning occurs from March through June, with peak spawning in May. Steelhead kelts outmigrate immediately after spawning (Shapalov and Taft 1954; Boggs et al. 2008). Fry emergence peaks in early August (WDFW 2004). Outmigration occurs primarily from late April through early June (WDFW 2004). Skagit River winter smolt outmigration occurs during the spring with peak densities typically in late April and early May, with outmigration trailing off in early June (Kinsel et al. 2008).

The geometric mean escapement of Skagit River Winter Steelhead for return years 1994 to 2018 was 6,020 fish (Figure 3.1-4). The geometric mean escapement for return years 2013 to 2018 was 7,715 fish.



Source: WDFW 2019.

Figure 3.1-4. Skagit River Winter Steelhead spawning escapement (1994-2018).

3.1.4.2 Skagit River Summer Steelhead

Although there is considerable information indicating that summer-run steelhead existed historically in the Skagit River tributaries, recent surveys suggest that the summer-run component is at a critically low level. Locations where summer-timed fish have been reported include Finney Creek, Day Creek, the Cascade River, the upper Sauk River, and the South Fork Sauk River. However, despite extensive surveys, the only location where summer-timed fish are currently known to spawn is from USGS RMs 8.0 to 11.6 of Finney Creek. Summer steelhead enter Finney Creek in October and November, with spawning occurring primarily from February through March (Sauk-Suiattle Indian Tribe et al. 2018). Fry emergence peaks in early August (WDFW 2004). Outmigration timing may be similar to that of the mainstem Skagit winter population, which occurs primarily from early April through early June (Kinsel et al. 2008).

Because there is no summer steelhead hatchery program and no allowable harvest of wild summer steelhead, harvest management of Skagit River steelhead targets winter-run fish. The viability of the summer steelhead population is unknown.

3.1.5 Bull Trout

In the Puget Sound region, Bull Trout are found in habitats ranging from headwater reaches in the upper portions of watersheds to lower mainstem and marine waters. The USFWS (2015) identified five core areas in the Puget Sound Region within the Bull Trout Coastal Recovery Unit, including the Lower Skagit and Upper Skagit core areas. These core areas support the most stable and abundant Bull Trout populations in the recovery unit.

3.1.5.1 Lower Skagit Core Area Population

Bull Trout populations found in the Skagit River and its tributaries downstream of the Gorge Development exhibit complex gradients within three life history types (resident, fluvial, anadromous)[20] (Lowery and Beauchamp 2015).

Bull Trout spawning occurs in mid-September through mid- to late November as water temperatures decrease to below 9°C (McPhail and Murray 1979; Weaver and White 1985), with peak spawning occurring in October (Reiman and McIntyre 1993; Downen 2006). Bull Trout are only known to spawn in the tributaries to the Skagit River between Gorge Powerhouse and the Sauk River confluence. Spawning has been documented in Illabot, Bacon, and Goodell creeks, and the Cascade River drainage (Lowery and Beauchamp 2015). Using genetic data, Smith (2010) determined that adult and sub-adult Bull Trout collected from the Skagit River immediately downstream of Gorge Powerhouse were primarily comprised of fish from Goodell Creek (38 percent) and Cascade River (35 percent), followed by smaller percentages of Illabot Creek (13 percent), Downey Creek (8 percent), Bacon Creek (4 percent), and Sauk River (2 percent) fish. None of the fish originated from the populations located above Gorge Dam. Analysis also showed that Bull Trout below Gorge Dam are significantly different genetically from Bull Trout in the upstream reservoirs (Smith 2010). The concurrent Reservoir Fish Genetics Study is anticipated to further the understanding of the genetic structure of Bull Trout in the Project area, and results from the study will supplement the existing information. It also is apparent that Bull Trout originating from some of these spawning tributaries exhibit anadromy. Genetic analysis of Bull Trout captured in the Skagit River estuary determined that approximately 12 percent originated from the Cascade River and 8 percent originated from Illabot Creek, with the remainder originating from the Sauk River system (M. Small, WDFW, unpublished data cited in Lowery and Beauchamp 2015).

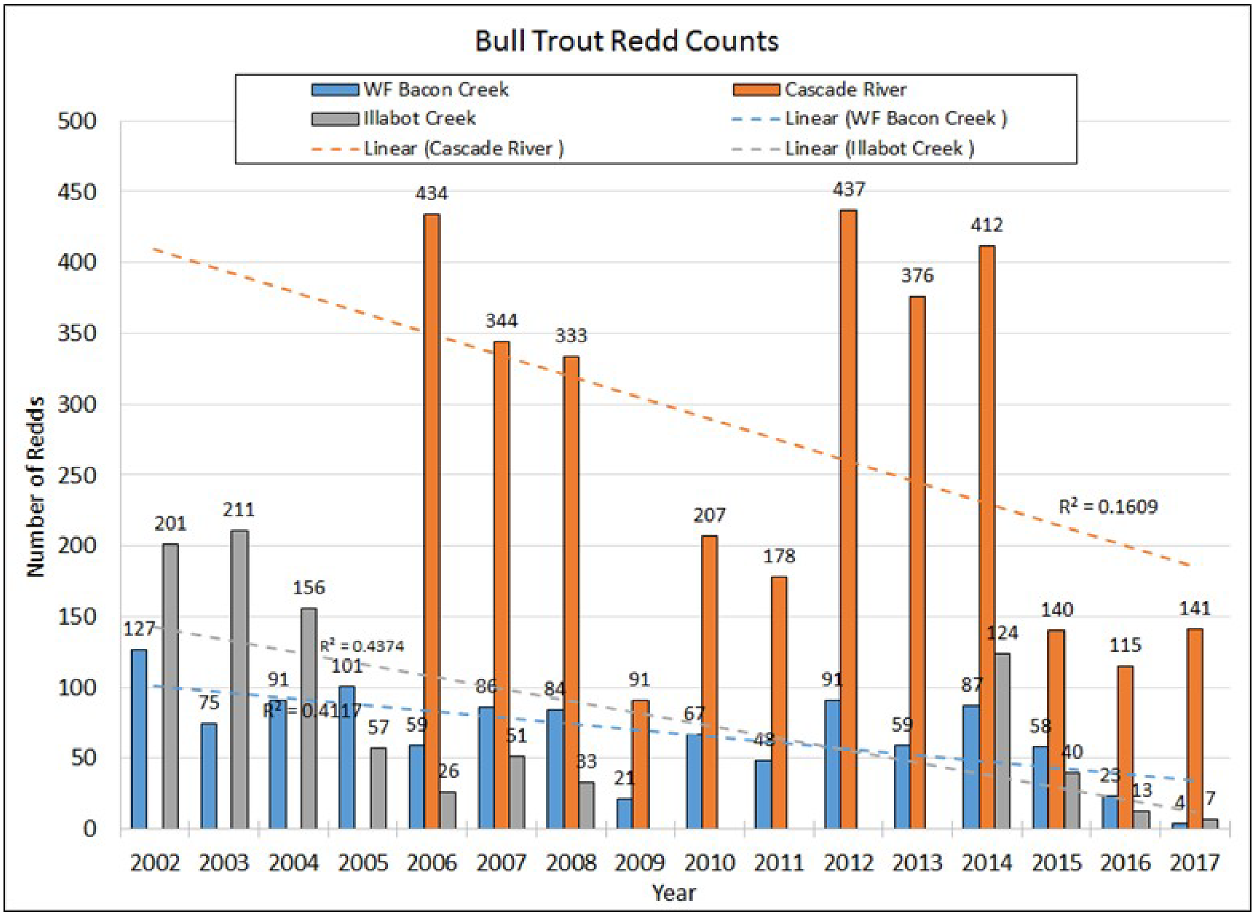
After spawning, Bull Trout disperse downstream to overwintering and foraging areas during October through November (Connor et al. 2009). Overwintering and foraging habitat for fluvial populations includes larger pools and deep runs in the upper reaches of the mainstem Skagit River, but may also include the Sauk River (USFWS 2004) and estuarine/marine habitats. Post-spawning anadromous Bull Trout outmigrate to the estuary during February through April with peak movements in mid-March (Connor et al. 2009).

Lowery (2009) reported that large fluvial Bull Trout adults are abundant in the mainstem Skagit River between Gorge Powerhouse and the Sauk River confluence. Pilot level snorkel surveys conducted in February and March indicated that the reach contained 1,602 Bull Trout longer than 300 mm (95 percent confidence interval = 1,191-2,014; coefficient of variation = 13 percent). Lowery (2009) estimated that the tributary habitats upstream of the Sauk River confluence contained 179,265 Bull Trout between ages 1 and 3.

Resource managers use spawning surveys to enumerate Bull Trout redds in Bacon, Illabot, and Goodell creeks, and within the Cascade River drainage. The redd survey data sets for Bacon, Illabot, and Cascade drainages extend over a fairly long period of time (various monitoring from

[20] Resident Bull Trout spawn, rear, and live as adults generally in one headwater stream. Migratory Bull Trout spawn and rear in headwater streams and then, typically after one to four years, migrate downstream to larger rivers (fluvial) or lakes and reservoirs (adfluvial) where they grow to maturity. Anadromous Bull Trout remain in freshwater for one to three years before migrating to the marine environment.

2002 to 2017). While the linear trends are relatively weak (indicated by low R^2 values), these data suggest that the total number of Bull Trout redds in the index declined over the monitoring time period (Figure 3.1-5[21]). A similar decline in Bull Trout redds was also observed in the South Fork Sauk River spawning survey index over the same time period (Fowler 2018). However, researchers have found that index surveys have generally low power to detect adult Bull Trout spawner abundance trends (Maxell 1999; Dunham et al. 2001; Al-Chokhachy et al. 2005; Jacobs et al. 2009; Howell and Sankovich 2012). There is no current Bull Trout redd count or escapement information in the upper Skagit River, and thus their abundance in the vicinity of the Gorge Powerhouse and Gorge Dam is unknown.



Source: Fowler 2018.

Figure 3.1-5. Total yearly Bull Trout redd counts from index reaches within Skagit River tributaries upstream of the Sauk River confluence.

3.1.5.2 Upper Skagit Core Area Population

Bull Trout are considered native and indigenous upstream of Gorge Dam. Genetic analyses of Bull Trout upstream and downstream of Gorge Dam indicate that Bull Trout populations downstream of Gorge Dam are significantly genetically different from the upstream population (Smith 2010; Small et al. 2016). Hybrid Dolly Varden/Bull Trout, and hybrid Dolly Varden/Brook Trout have

[21] It is important to note that escapement data should not be the only data considered for passage design.

been documented in upper basin reservoirs and their tributaries on both the U.S. and Canadian side of the basin (McPhail and Taylor 1995; Small et al. 2016).

The co-occurrence of Bull Trout and Dolly Varden in the upper Skagit River was first reported in the literature by McPhail and Taylor (1995). Bull Trout and Dolly Varden are present in all three Project reservoirs (Smith 2010; Small et al. 2016; Table 3.1-1).

Table 3.1-1. Annual number and length (TL) range for Bull Trout and Dolly Varden collected with gill net sampling, 2005-2012,[1] at Skagit River Hydroelectric Project.

Species	Ross	Diablo	Gorge
Native Char (Bull Trout and Dolly Varden)	24-92 (109-813 mm)	14-55 (115-730 mm)	22-29 (122-751)

Source: Anthony and Glesne 2014 as presented in City Light 2020a
1 Sample years are: Ross 2006-2008, 2012; Diablo 2005, 2010; Gorge 2006, 2011.

Due to their similar appearance, the majority of the fish population studies conducted in the Skagit River upstream of Gorge Dam do not differentiate these two species. As such, researchers often refer to them as "native char." Researchers have also documented the presence of Dolly Varden/Bull Trout and Dolly Varden/Brook Trout hybrids in the reservoirs through genetic analyses, further complicating assessments of these individual species in the field and laboratory (Smith 2010; Small et al. 2016). The Reservoir Fish Genetics Study is collecting data to determine the genetic population structure within and among target species populations, including Bull Trout and Dolly Varden. Results from the study will be used to determine the number of fish populations within and among Project reservoirs and will supplement previous analyses completed for the study area.

Bull Trout are most prevalent in Ross Lake and least prevalent in Gorge Lake, while Dolly Varden appear to be more prevalent than Bull Trout in Gorge and Diablo lakes (Anthony and Glesne 2014). However, the low sample size based on gill net sampling creates uncertainty when comparing abundance of the two species across Project lakes, particularly due to species identification of individuals smaller than 300 mm, which may be Bull Trout, Dolly Varden, or hybrids (City Light 2012). However, genetic analysis indicates that most native char over 300 mm are likely Bull Trout (Smith 2010; City Light 2011; Small et al. 2016). The annual number of native char collected with gill net sampling ranged from 14 to 92 fish (109-813 mm) depending on the lake sampled (Table 3.1-1). Using 300 mm as a conservative identification threshold, approximately 96 percent of the native char surveyed were adult Bull Trout (City Light 2012). With consideration of the biennial spawning strategy and areal coverage of Ross Lake, the estimated number of adult Bull Trout in Ross Lake was 4,800 fish (City Light 2012). The Ross Lake estimate was scaled down to the areal coverage of Diablo and Gorge lakes to obtain estimates of 370 and 100 Bull trout, respectively.

Native char found upstream of Gorge Dam exhibit resident, adfluvial, and fluvial life history types (McPhail and Taylor 1995; R2 Resource Consultants 2009). Native char begin to migrate towards spawning areas in mid- to late-September (City Light 2011). Pre-spawning adults have been observed to stage at the mouth of spawning tributaries and also move up to and hold in pools while they ripen (City Light 2011). Spawning occurs in late September through late November, peaking in October (City Light 2011). Acoustic-telemetry-tracking of native char in Ross Lake suggests that spawning migrations occur at night (R2 Resource Consultants 2009). This work and earlier radio-tracking studies (Nelson et al. 2004) have demonstrated that the majority of adfluvial native char spawn in the upper Skagit River in Canada, though several reservoir tributary streams (located in the United States) are also used. Ongoing acoustic tracking studies indicate that Bull Trout migrate to foraging areas in Ross Lake, including the mouths of Ruby, Lightning, and Big Beaver creeks where juvenile Rainbow Trout are known to concentrate (R2 Resource Consultants 2009; City Light 2011; Eckmann 2015).

Genetic analysis suggests that the upper Skagit River Bull Trout populations have remained geographically isolated and genetically different from those in the lower Skagit River (Smith 2010; Small et al. 2016). Genetic analysis of native char suggests that Bull Trout, Dolly Varden, and hybrids of these two species are present in all three lakes, with Bull Trout being most prevalent in Ross Lake and least prevalent in Gorge Lake (Anthony and Glesne 2014). Dolly Varden appear to be more prevalent than Bull Trout in Gorge Lake and in Diablo Lake (Smith 2010; Anthony and Glesne 2014; Small et al. 2016). However, low sample size inhibits definitive distribution delineation between these two species. McPhail and Taylor (1995) found a mixture of Dolly Varden, Bull Trout. and hybrids of these two species in the upper Skagit River basin in British Columbia (McPhail and Taylor 1995).

Most of the large migratory native char that inhabit Ross Lake are thought to spawn and rear in at least six streams in the Skagit River drainage north of the U.S.-Canada border, including the mainstem Skagit, upper (East Fork) Skagit, Klesilkwa, Skaist, and Sumallo rivers, and Nepopekum Creek (McPhail and Taylor 1995). Bull Trout may also spawn and rear in McNaught, St. Alice, Maselpanik, and Snass creeks (McPhail and Taylor 1995). Within the U.S., native char have been documented in Ruby (including its tributaries, Canyon and Granite creeks), Panther, Lightning, Big Beaver, Little Beaver, Roland, Silver, Pierce, and Devils creeks (USFS 2002; USFWS 2004; R2 Resource Consultants 2009; Downen 2014). Lightning, Ruby, Big Beaver, and Little Beaver creeks are likely the primary native char spawning tributaries to Ross Lake outside of Canada. Thunder Creek is the only native char spawning tributary to Diablo Lake. Other tributaries to Diablo Lake that may be used by native char include Colonial and Rhode creeks; however, these two creeks have a limited amount of habitat (City Light 2012). Stetattle Creek is the only native char spawning tributary to Gorge Lake (Anthony and Glesne 2014).

The results of NPS's most recent fish surveys (for native char) in the Project reservoirs are summarized in Table 3.1-2 (Anthony and Glesne 2014; NPS 2020a).[22] Individual native char/Brook Trout hybrids have apparently been mistaken for pure native char during many prior field studies in the upper Skagit reservoirs (Anthony and Glesne 2014). Genetic samples taken from some of the "native char" collected during sampling (up to 30 percent) were found to be Dolly Varden/Brook Trout hybrids (Anthony and Glesne 2014). Small et al. (2016) also documented suspected Dolly Varden/Brook Trout hybrids in Diablo and Gorge lakes. Opportunistic genetic sampling has shown no evidence of hybridization between Bull Trout and Brook Trout in the Project reservoirs.

22 Catch per unit effort (CPUE) was reported in Anthony and Rawhouser 2017. However, because sample sites consisted of a single overnight gillnet set with gillnets of various sizes and were not consistent between years/reservoirs, the information is not included.

While some researchers in the upper Skagit River have not distinguished Bull Trout from Dolly Varden in the field, the results of recent genetic testing indicate that any native char over 300 mm found in the upper Skagit River drainage are likely Bull Trout (Smith 2010; Small et al. 2016; McPhail and Taylor 1995; City Light 2011). Any native char smaller than 300 mm may be Bull Trout, Dolly Varden, or hybrids of some combination of Bull Trout, Dolly Varden, and Brook Trout.

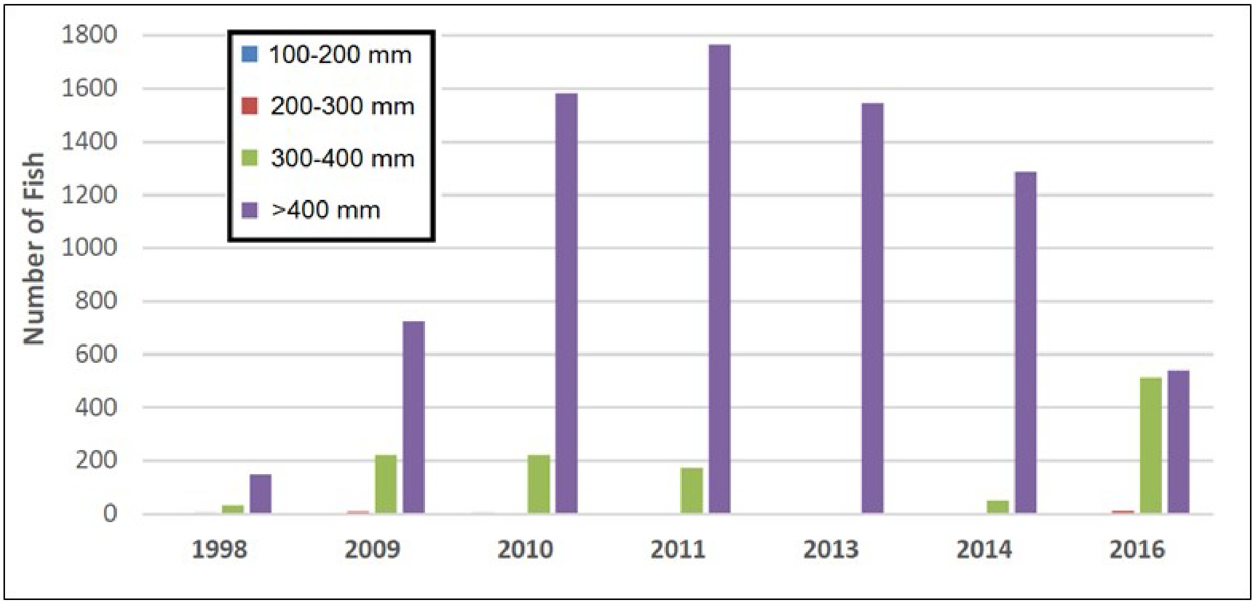
Table 3.1-2. Project reservoir native char gillnet sampling summary.

Reservoir	Year	Native Char Statistics				
		No. Caught	% Total (n)	% Total (weight)	Size Range (TL mm)	No. Sample Sites (% Occupied)
Ross	2006	24	15.2	51	186-760	6 (100%)
Ross	2007	54	12.5	52.4	120-813	Not reported
Ross	2008	92	15.4	38.9	109-720	Not reported
Ross	2012	53	17.4	62.5	196-759	13 (85%)
Diablo	2005	55	17.7	28.5	115-730	12 (67%)
Diablo	2010	14	3.6	14	163-505	12 (25%)
Diablo	2013	38	36.2	64.5	120-609	Not Reported
Diablo	2017	36	20.6	6.3.4	126-756	Not Reported
Diablo	2020	8	7.8	20.2	194-623	11 (45%)
Gorge	2006	22	17.7	59.4	130-751	9 (78%)
Gorge	2011	29	28.4	28.8	122-319	10 (70%)

Source: Anthony and Glesne 2014; NPS 2020a.

Snorkel counts conducted over a 22-mile reach divided into 14 contiguous sections in the upper Skagit River (upstream of Ross Lake) indicate that the number of native char appear to have increased from 1998 to 2011 to several thousand fish (Triton 2020). Large Bull Trout are highly piscivorous and it is thought that the introduction of Redside Shiner into Ross Lake in the early 2000s has been a major factor contributing to the increase in Bull Trout abundance upstream of Ross Dam (Anaka et al. 2012; Downen 2014). After the initial large increase in Bull Trout counts in the upper Skagit River in response to this new prey base, native char (assumed to be Bull Trout) appear to have decreased somewhat from the 2011 peak, but native char counts have remained substantially above what they were prior to Redside Shiner introduction. Nearly 100 percent of the char observed during these counts were over 300 mm (Figure 3.1-6) and are assumed to be Bull Trout. Less than one percent of all native char counted in the index snorkel surveys were less than or equal to 300 mm (Anaka et al. 2012; Triton 2017).

Although the index snorkel survey was conducted over a 22-mile reach and a 1-week period that minimizes double counting of fish, the counts should be viewed as a minimum number of fish in the population and not an estimate of total abundance (Anaka et al. 2012; Triton 2017). While total numbers of Bull Trout and Dolly Varden in Ross Lake and its tributaries are unknown, available data suggest that there are at least several thousand adult individuals of each species (Triton 2017). City Light is currently investigating production potential for Bull Trout in the Project reservoirs under the ongoing Food Web Study being conducted by the USGS. The results from that study may better inform Bull Trout occurrence data and future fisheries management decisions that should be considered by resource agencies and co-managers in concert with feasibility assessments for fish passage at each of the Project developments.



Source: Triton 2017.

Figure 3.1-6. Size class of native char counted in a 22-mile index reach of the upper Skagit River upstream of Ross Lake (1998-2016).

There are no population estimates for native char in the Gorge and Diablo lake drainages, but based on the available data, abundance is lower than in the Ross Lake drainage, primarily due to limited habitat area. Recent native char spawning surveys have reported up to 34 adults in Stetattle Creek, 81 adults in Colonial Creek, and 41 adults in Thunder Creek (NPS 2020b).

City Light conducted a study of habitat use (including depths and temperatures), daily migration patterns, and seasonal migration timing of Bull Trout in Ross Lake using acoustic telemetry from 2009 to 2012 (City Light 2012). Acoustic tags were implanted in 42 Bull Trout ranging from 365 to 600 mm during the fall of 2009. All 42 Bull Trout were detected during fall 2009 through winter 2012 (City Light 2012). An analysis of tag detections over time indicates that Bull Trout were detected on nearly a continuous basis, with the only major gaps in detections observed when some fish likely moved into tributary streams in August and September prior to spawning. These fish were later detected after returning to the reservoir in October and November following spawning.

An analysis of time spent in the vicinity of the forebay indicated relatively low use of the area, as the majority of the fish spent 1 percent or less of the tag battery lifespan in this location. Five fish never migrated into the forebay area; conversely, another five fish frequented the forebay area. Most (50 percent) of the detections in the forebay area occurred during May and October. The least number of detections near the forebay occurred during the winter months of January, March, and the summer months of July and August. Acoustic tagging results for Bull Trout in comparable waterbodies with similar facilities also suggested that that Bull Trout occupied the forebay area at relatively low rates, instead preferring the upstream portions of the reservoirs (Martins et al. 2013; Harrison et al. 2020).

3.1.6 Chum Salmon

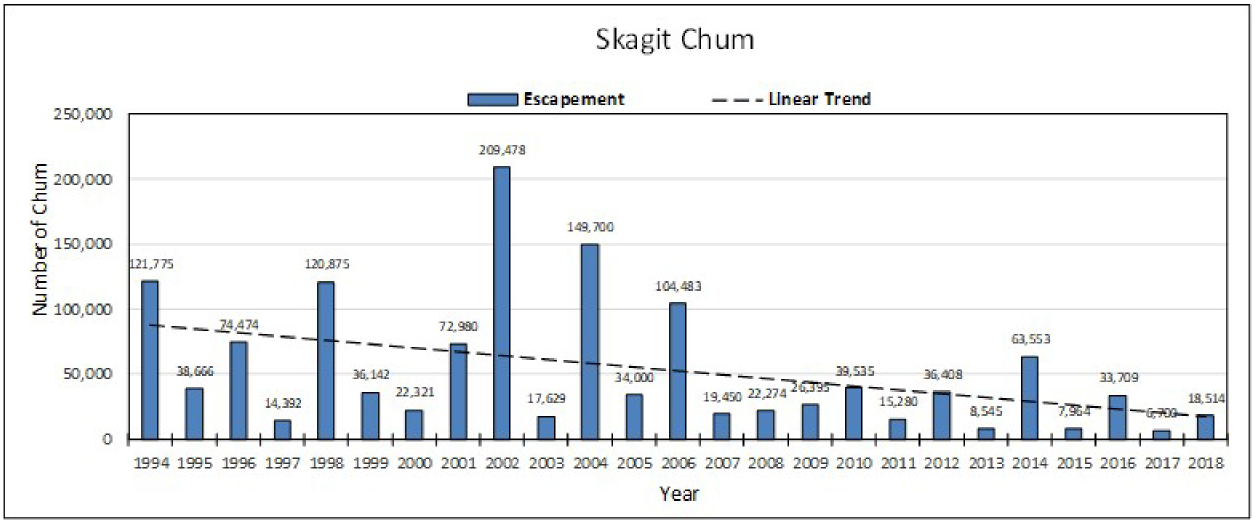
Chum Salmon enter freshwater at an advanced stage of sexual development and spawn in the lower reaches of coastal rivers, with redds usually dug in the mainstem or inside channels from just above tidal influence. Like Pink Salmon, juvenile Chum Salmon emerge from the gravel in the spring and outmigrate to saltwater almost immediately following emergence (Salo 1991). However, in Washington, they may reside in freshwater for as long as a month, migrating from late January through May (Johnson et al. 1997). This ocean-type life history strategy reduces the mortality associated with the variable freshwater environment but makes Chum more dependent on estuarine and marine habitats. When Chum Salmon enter the estuary, some fry remain near the mouth of their natal river, but most disperse within a few hours into tidal creeks and sloughs up to several miles from the mouth of their natal river (Johnson et al. 1997).

Most Chum Salmon mature between three and five years of age and enter natal river systems from June to March, depending on characteristics of the population or geographic location (Salo 1991). In Washington, a variety of seasonal runs are recognized, including summer, fall, and winter populations; fall-run fish predominate.

Chum Salmon spawn from early November to mid-January. Typically, incubating eggs hatch in about 2 to 18 weeks (Johnson et al. 1997; Wydoski and Whitney 2003). Most Chum Salmon fry promptly migrate downstream to estuarine water where they remain until they make the transition to areas of higher salinity (Johnson et al. 1997; Wydoski and Whitney 2003).

WDFW (2002) identified 69 Chum Salmon stocks in the Puget Sound region. Three of these are found in the Skagit River basin: (1) mainstem Skagit Fall Chum; (2) lower Skagit Tributary Fall Chum; and (3) Sauk River Fall Chum. Mainstem Skagit Fall Chum spawn from mid-November through December in the mainstem Skagit River from PRM 34.9 to 93.5 (USGS RM 34 to 93) and in the Cascade River, Nookachamps, Gilligan, Illabot, and Bacon creeks.

All three Skagit Chum populations are of native origin with wild production. The geometric mean of Skagit River Chum Salmon escapement for return years 1994 to 2018 was 34,694 fish (Figure 3.1-7). The geometric mean escapement for return years 2013 to 2018 was 16,201 fish.



Source: WDFW 2019.

Figure 3.1-7. Skagit River Chum Salmon spawning escapement (1994-2018).

3.1.7 Pink Salmon

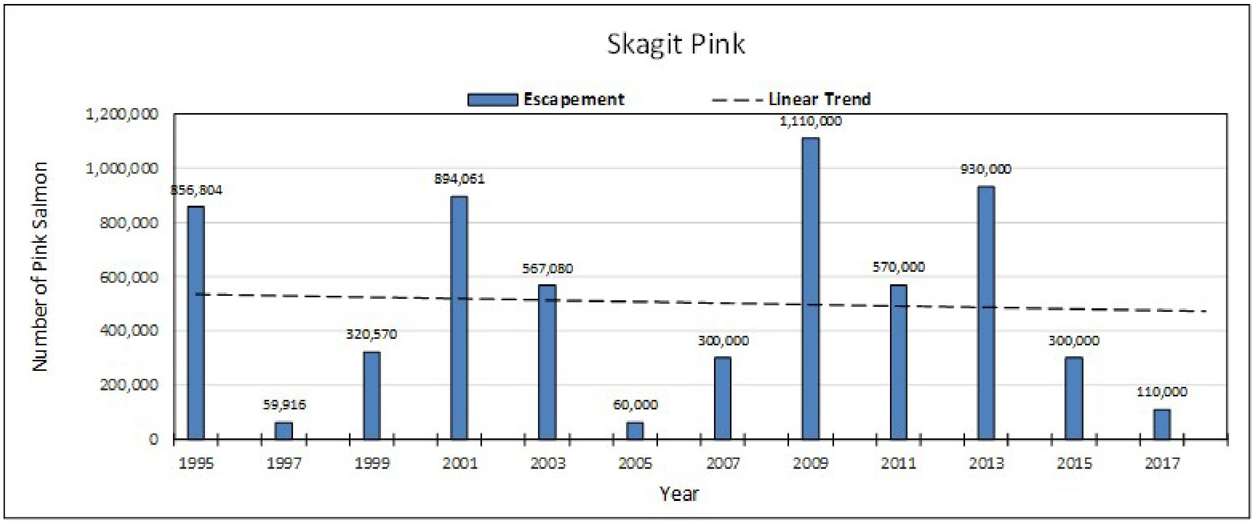
Pink Salmon are distinguished from other Pacific salmon species by their obligate two-year life cycle and relatively small size (weighing an average of four pounds at maturity) (Wydoski and Whitney 2003). Like Chum Salmon (described below), they use freshwater almost exclusively as a spawning and incubation environment, moving downstream to the ocean or estuary almost immediately after emergence. In Washington and southern British Columbia, river entry usually occurs from July to October, and spawning is observed from August to October (Heard 1991).

A native, wild Pink Salmon population spawns in odd years in the mainstem Skagit River and tributaries such as Bacon and Goodell creeks and the Cascade, Sauk, and Suiattle rivers.[23] Spawning generally occurs from September through October from Newhalem (PRM 94.5 [USGS RM 94]) downstream to Sedro-Woolley (PRM 23.9 [USGS RM 23]), with the heaviest spawning concentrated in the mainstem Skagit River from Marblemount (PRM 78.3 [USGS RM 78]) upstream to Newhalem (FERC 2006).

Skagit River Pink Salmon are part of the odd-year Pink Salmon ESU in Washington and southern British Columbia. NMFS reviewed the status of this ESU and ruled on October 4, 1995, that odd-year Pink Salmon were not currently at risk of extinction; therefore, no Endangered Species Act (ESA)-listing of the species was proposed (60 FR 51928). WDFW considers this Pink Salmon stock to be healthy, with overall abundance close to historical levels (WDFW and WWTIT 2003).

The geometric mean escapement for return years 1995 to 2018 was 345,729 fish for the Skagit River Pink Salmon populations (Figure 3.1-8). The geometric mean escapement for return years 2011 to 2017 was 363,679 fish.

[23] The largest population of Pink Salmon in the contiguous United States is produced in the Skagit River (Connor and Pflug 2004).



Source: WDFW 2019.

Figure 3.1-8. Skagit River Pink Salmon spawning escapement (1994-2018).

3.1.8 Sea-run Cutthroat Trout

The life history of Coastal Cutthroat Trout is extremely complex (Trotter 1991; Johnson et al. 1999). Both migratory and non-migratory (anadromous, adfluvial, fluvial, and resident) forms may be present within the same population. Anadromous Coastal Cutthroat Trout, or "sea-run" Cutthroat Trout, rarely over-winter at sea and do not usually make extensive ocean migrations (Johnson et al. 1999).

All Cutthroat Trout, regardless of their life history type, are spring spawners. Actual spawning time depends on latitude, altitude, water temperature, and flow conditions (Trotter 1991). As with all salmonids, substrate composition, cover, water depth, water velocity, and water quality are important habitat elements before and during spawning (Bjornn and Reiser 1991). In general, adult Coastal Cutthroat Trout spawn in low gradient riffles and in shallow pool tail-outs. The preferred spawning substrate is clean pea-sized to walnut-sized gravel (Trotter 1997). The volume of water in spawning streams seldom exceeds 10 cfs during the low flow period, and most average less than 5 cfs (Johnston 1989; Trotter 1991). Coastal Cutthroat Trout have been known to spawn each year for more than six years (Johnson et al. 1999).

Both resident and anadromous coastal Cutthroat Trout are found throughout the Skagit River basin. The anadromous life history form is present in the mainstem Skagit River and tributaries throughout the anadromous reaches of the system. The resident form is found in the Skagit River and its major tributaries; however, the species' distribution and abundance above Gorge Dam is not well documented. Spawning occurs from January through mid-June and can occur throughout the watershed, primarily in small tributary streams. Survival after spawning and the number of times an anadromous Cutthroat Trout spawns during its lifetime are variable across its range. Most juveniles remain in freshwater for two to four years before smolting and migrating to saltwater, though the range extends from one to six years (Trotter 1989; Bjorn and Reiser 1991).

3.1.9 Dolly Varden

Dolly Varden are present in all three Project reservoirs (Smith 2010; Small et al. 2016). The upper Skagit likely supports the only sympatric populations of Bull Trout and Dolly Varden trout in the United States. However, due to their similar appearance, the majority of the fish population studies conducted in the Skagit River upstream of Gorge Dam do not differentiate these two species. Therefore, the life history, abundance, and distribution information for Dolly Varden follows that described for native char in Bull Trout Upper Skagit Core Area Population in Section 3.1.5.2 of this document.

3.1.10 Pacific Lamprey

In Washington, Pacific Lamprey are found in most large coastal river systems including the Skagit River and its major tributaries (Wydoski and Whitney 2003). Pacific Lamprey are anadromous. As juveniles, they are filter feeders, using a hood-like flap to filter microscopic plants and animals from above and within the substrate. As adults, Pacific Lamprey are external parasites, feeding on the body fluids of various species of fish, using their sucker-like mouths to attach to a fish. In the lower Strait of Georgia and in Puget Sound, Pacific Lamprey are a major predator on salmon (Beamish and Neville 1995).

Pacific Lamprey spawn in the headwaters of both large and small streams in low gradient, sandy gravel areas located at the upstream end of riffles. Spawning takes place in spring (from April to July) when water temperatures are between 10 and 16°C.

Based on a review of existing literature, there is limited information describing the distribution and abundance of Pacific Lamprey in the Skagit River basin. However, Goodman et al. (2008) reported capturing Pacific Lamprey ammocoetes in tributaries of the Nooksack, Skagit, and Pilchuck (tributary to the lower Snohomish River) rivers in 2004. Hayes et al. (2013) also reported capturing River Lamprey and Western Brook Lamprey and generic “lamprey” as incidental catch in salmon smolt traps in systems around Puget Sound, including the Skagit River. In addition, Pacific Lamprey environmental DNA (eDNA) has been detected in the lower Skagit River near Mount Vernon at approximately PRM 17 (Ostberg et al. 2018) and in the Sauk River (Young et al. 2021).

3.1.11 Salish Sucker

The Salish Sucker (*Catastomus catostomus*) is distributed to a limited number of tributaries in the Fraser River and northwestern Washington State (McPhail 1987). It is considered to be an evolutionarily significant unit that evolved from a population of the longnose sucker (*C. catostomus*) that became geographically isolated in the Chehalis River valley during the Pleistocene glaciations (McPhail and Taylor 1999). Although reported to occur in the Skagit River basin (Government of Canada 2021), little information is available regarding their abundance or distribution in the basin. Salish Sucker has been documented in the Skagit River basin in Illabot Slough (48°29'39.13" N, 121°29'53.08" W), Harrison Slough (48°28'53.32" N, 121°32'20.66" W), and Eagle Slough (48°29'31.14" N, 121°33'40.95" W) (Rawhouser 2021), more than 20 miles downstream of the Gorge Dam. Salish Sucker have not been documented in the Skagit River above the Gorge Powerhouse.

Salish Suckers are small, short-lived (McPhail 1987), and early maturing relative to most populations of long-nose suckers, spawning at age 2, mostly at less than 155 mm (Pearson and Healy 2003). Salish suckers occupy lakes and pools of headwater streams, spawn in riffles, and prefer long/deep pools with slower water velocities that are adjacent to shallow habitat with abundant vegetation (i.e., in-stream and over-stream cover). Spawning occurs from March to early July. The Salish Sucker spawning movements coincide with the spawning period and have been reported of up to 300 meters (Pearson and Healy 2003), and thus it is anticipated that migration and occurrence of Salish Sucker at the Project would be limited and incidental to fish inhabiting areas in the direct vicinity of the Project.

3.2 Fish Assemblage Above the Project Dams

As reported in the Pre-Application Document (City Light 2020), six species of fish occur in the Skagit River above the Project, including three native species, Bull Trout, Dolly Varden, and Rainbow Trout (*O. mykiss*); and three non-native species, Brook Trout (*Salvelinus fontinalis*), Cutthroat Trout (*O. clarki*), and Redside Shiner (*Richardsonius balteatus*). These species are found within all three Project reservoirs and some of the reservoirs' tributaries, except for Cutthroat Trout, which are not found in Diablo Lake or Gorge Lake, as reported by gill net sampling (Table 3.2-1). As previously discussed, of the target species, only Bull Trout and Dolly Varden are known to occur upstream of the Project. Salish Suckers have not been documented in the Skagit River upstream of the Project, and it is not currently known if they occur.

Table 3.2-1. Annual number and length (TL) range for species collected with gill net sampling, 2005-2021, at Skagit River Hydroelectric Project.

Species	Ross	Diablo	Gorge
Native Char (Bull Trout & Dolly Varden)	24-92 (109-813 mm)	14-55 (115-756 mm)	22-29 (122-751 mm)
Rainbow Trout	73-311 (106-538 mm)	31-170 (90-405 mm)	53-85 (103-322 mm)
Brook Trout	1-40 (120-351 mm)	21-94 (116-326 mm)	17-20 (124-290 mm)
Cutthroat Trout	6	0	0
Redside Shiner	4-224 (90-127 mm)	0-137 (85-123 mm)	0

Source: Anthony and Glesne 2014 as presented in City Light 2020a; NPS 2020a

1 Sample years are: Ross 2006-2008, 2012; Diablo 2005, 2010, 2013, 2017, 2020; Gorge 2006, 2011

Bull Trout are most prevalent in Ross Lake and least prevalent in Gorge Lake, while Dolly Varden appear to be more prevalent than Bull Trout in Gorge and Diablo lakes (Anthony and Glesne 2014). Estimates of Bull Trout adult abundance reported 4,800 adults in Ross Lake, 370 adults in Diablo Lake, and 100 fish in Gorge Lake (City Light 2012). Size ranges of Bull Trout collected during gill net sampling are similar between reservoirs and range from 109 to 813 mm.

Rainbow Trout are more abundant in Ross Lake, followed by Diablo and Gorge lakes (Table 3.2-1). The number collected during gill net sampling ranged from 73-311 in Ross Lake to 53-85 collected in Gorge Lake. The size of fish collected across all lakes ranged from 99 to 538 mm. Brook Trout are more abundant in Diablo Lake and least abundant in Ross Lake. The size range collected across all lakes with gill net sampling ranged from 116 to 351 mm. Spawning survey data indicate that Rainbow Trout spawning in Roland Creek and Dry Creek (tributaries to Ross Lake) occurs from mid-May through mid-August and peaks in late July (NPS 2019). Estimated annual escapement in these two streams in 2002 to 2011 ranged from 41 to 854 fish in Roland Creek and 28 to 330 fish in Dry Creek. Snorkel survey data from 1998 to 2020 report observations of 750 to 2,100 Rainbow Trout in the Canadian portion of the Skagit River, with the highest densities occurring in the lower 2 miles of the river (Triton 2020).

Redside Shiner was initially introduced into Ross Lake around 2000 and has since shown up in Diablo and Gorge lakes. In 2010, Redside Shiners were documented in Diablo Lake, and they were observed in Gorge Lake in 2019, indicating that they are spreading to the downstream reservoirs through spill or entrainment through the turbines. Annual number collected with gill net sampling ranged from 4 to 224 in Ross Lake and 0 to 137 in Diablo Lake (Table 3.3-1). No Redside Shiner were collected with gill net sampling in Gorge Lake during the 2006 and 2011 study period. The size of fish collected ranged from 85 to 127 mm across all Ross and Diablo lakes. The Redside Shiner population in Ross Lake was estimated to exceed 1.2 million fish based on snorkel counts conducted in 2006 (Downen 2014).

Several concurrent relicensing studies, including FA-07 Reservoir Tributary Habitat Assessment Study and the USGS Food Web Study, will further inform the availability and production potential of habitat fish in the reservoirs and/or reservoir tributaries. Data collected and obtained from concurrent studies is anticipated to inform considerations for fish passage at the Project by contributing to the understanding of baseline conditions regarding the fish community, predation, foraging potential, non-native species, and other factors that may affect or be affected by future fish passage strategies.

3.3 Typical Fish Migration Timing (Skagit River Downstream of Projects)

Upstream and downstream migratory periods for Skagit River target species, by life stage, are provided in Table 3.3-1. These migratory periods (both timing and duration) will significantly influence the design and operation of potential fish passage facilities.

The migration timing presented in Table 3.3-1 is based upon data available at the time of this writing (February 2022). Additional research and synthesis of available information will occur as the study progresses. Note that this table does not display spawning, fry emergence, and rearing periods and focuses solely on known migratory periods for target species in the Skagit River basin. The periodicities reported in this table will be updated pending ongoing discussions among the FA-02 Instream Flow Model Development HSC technical team and LPs that will continue to take place through late 2021. If those discussions result in agreed-upon changes to periodicities, the updated information will be presented in the next iteration of this document.

Table 3.3-1. Draft upstream and downstream migratory periods for selected target species based on information for fish in the upper Skagit River.

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Skagit Summer Chinook Salmon	Adult Migration[1]												
	Juv. Outmigration												
Upper Cascade Spring Chinook Salmon	Adult Migration												
	Juv. Outmigration												
Skagit Coho Salmon	Adult Migration[2]												
	Juv. Outmigration												
Skagit River Sockeye	Adult Migration												
	Juv. Outmigration												
Skagit Winter Steelhead	Adult Migration												
	Kelt Migration[3]												
	Juv. Outmigration												
Cascade River Summer Steelhead	Adult Migration												
	Kelt Migration[3]												
	Juv. Outmigration												

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lower Skagit Core Area Bull Trout	Adult Migration (Fluvial & Anadromous)												
	Post-spawning outmigration (Fluvial & Anadromous)												
Dolly Varden	Adult Migration												
Skagit Pink Salmon	Adult Migration												
	Juv. Outmigration												
Mainstem Skagit Fall Chum Salmon	Adult Migration												
	Juv. Outmigration												
Pacific Lamprey	Adult Migration[4]												
	Juv. Outmigration												
Sea-run Cutthroat Trout (Nooksack River, WRIA 1)	Adult Upstream Migration												
	Adult Outmigration												
	Juv. Outmigration												
Salish Sucker	Adult Spawning Movements[5]												

Sources: Weitkamp et al. 1995; Gustafson et al. 1997; Close et al. 2002; Pearson and Healey 2003; Connor and Pflug 2004; City Light 2011; Lowery et al. 2013; Zimmerman et al. 2015; and WDFW 2019.

Note: Table is considered draft and will be updated in other documents, as applicable, to include additional information, as available, including steelhead kelt timing and other refinements being considered as part of ongoing discussions with the HSC technical team.

1 Migration during month of May to be confirmed with Skagit River System Cooperative Data during HSC periodicity meetings.

2 Migratory period for March extends to mid-month (March 15).

3 Kelt migration periods are currently being discussed among the HSC technical team and LPs and will updated as new information becomes available.

4 HSC group may extend adult migration through September based on pending data from the Upper Skagit Indian Tribe.

5 Spawning movements of less than one mile have been documented for the Salish Suckers (Pearson 2004); thus, passage would be incidental to those that occur in the Project vicinity.

3.4 Fish Abundance

Fish abundance and upstream migration rates have a significant influence on the applicability, selection, sizing, and operational characteristics of potential fish passage facility alternatives. In general, abundance can be summarized in terms of peak annual and peak daily rates of migration. These values are used to size many components of upstream fish passage facilities and have a strong influence on layout and operational complexity. Given the correlation to project size and operational effort, differences in abundance significantly influence capital and operation costs. For example, the peak daily number of fish expected to enter a facility will determine such factors as the volume of water for holding fish, specific flow rates required to support life, the number of holding facilities, the size and complexity of temporary holding vessels, and the cycle time of mechanical equipment, as applicable. When considering trap and transport fish passage strategies, these factors can influence the layout of a facility, its complexity of operation, reliability, and cost. In terms of evaluating directive-type facilities (as opposed to non-directive or fully volitional), consideration of these factors influences the size and capacity of transit vehicles (i.e., moving fish with a small cooler-sized vessel in a small vehicle or multiple daily trips in a specially equipped, weight-rated truck).

In cases of population recovery or introduction, biological objectives and population targets for a given basin are typically examined and identified as part of a process that occurs prior to or in conjunction with an engineering feasibility study so that potential fish passage facilities, their features, and estimated costs adequately reflect known or agreed-upon future goals. At this phase of study completion, future goals in consideration of future recovery targets have not yet been established. To address this need, City Light offered to initiate discussions regarding biological goals and objectives of the Fish Passage Study during AWS meeting No. 6, held on October 18, 2021. However, the consensus among AWS participants was that establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of the Fish Passage Study, but rather will be informed by concurrent studies and agency/tribal discussions in the future with consideration of recovery planning targets and current and future harvest objectives. Therefore, the Fish Passage Study will not establish biological goals and objectives for fisheries resource management but will rather consider biological requirements of target species within the anticipated operating environments of the Gorge, Diablo, and Ross developments. These factors will inform a range of upstream and downstream passage facility alternatives that may be evaluated as part of the study.

The following sections summarize the available abundance information for the target species and application of this information to development of conceptual fish passage facilities. Input from LPs is required to finalize the design basis regarding potential future populations and their various characteristics for use in the future phases of the Fish Passage Facilities Alternatives Assessment. However, in the absence of such data, including biological goals and objectives for each target species to be determined by others outside of the scope of this study, City Light must make assumptions to inform elements of facility designs that rely upon estimates of abundance for sizing and space requirements (e.g., holding and sorting facilities).

3.4.1 Upstream Migration

Upstream fish passage technologies considered in high-dam applications frequently consider the use of trap and transport strategies for successful upstream passage, a determination of population abundance is a necessary step in the alternative formulation process. For directive transport programs, the number of anticipated adults is used in concept development for the purposes of estimating the relative size and associated footprint of potential holding and transport equipment, facilities, and vehicles. Peak daily counts can be estimated as 10 percent of the maximum annual run (Bates 1992). The associated number and weight of the adults are needed to determine the volume of holding galleries, hopper volumes, flow rates of life support systems, and ultimately the number of cycles that a transport activity must undertake during the peak periods of outmigration. The number and target age of species may also influence the need for multiple holding galleries, segregated areas during holding periods, and regular monitoring and evaluation of collection and passage performance metrics.

Estimates of adult population sizes occurring at the Project location needed to inform the upstream fish passage facilities concept formulation process are not currently available. Available population information includes adult spawner survey results and escapement records for anadromous salmonids within the greater Skagit River below the Project (Table 3.4-1). Historical sub-basin-level spawning data are available for the Upper Skagit Summer Chinook Salmon and Skagit River basin-scale data for Coho Salmon and steelhead (WDFW 2019d). Abundance information for Skagit River Sockeye Salmon in the upper Skagit River is not available. Bull trout adult abundance information includes redd counts for lower Skagit core area stocks (WDFW 2019) and snorkel survey data for the Skagit River above Ross Lake (Triton 2020). Native char spawning surveys have reported that in 2017 to 2020, annual native char spawners ranged from 5 to 34 fish in Stetattle Creek, 5 to 32 fish in Colonial Creek, 29 to 42 fish in Thunder Creek, 21 fish in Ruby Creek (2020), and 1 fish in Pyramid Creek (2020) (NPS 2020b). Further estimates of the abundance of the populations that may be passed are needed to inform the size of facility components.

Table 3.4-1. Summary of Skagit River adult salmonid species abundance based upon existing data.

Species / Population	Minimum	Maximum	Average
Chinook Salmon / Upper Skagit Summer[1]	3,586	20,040	8,663
Coho Salmon / Skagit River[1]	5,794	136,054	36,703
Steelhead / Skagit River Winter-run[1]	2,502	9,084	6,020
Sockeye Salmon	Unknown	Unknown	Unknown
Bull Trout / Skagit River Mainstem	N/A	N/A	1,602[2]
Chum Salmon / Skagit River[1]	6,700	209,478	34,694
Pink Salmon / Skagit River[1]	59,916	1,110,000	345,729
Lamprey	Unknown	Unknown	Unknown

1 Source: WDFW (2019). Spawning escapement for 1994-2018.
2 Source: Lowery (2009). Estimated abundance based on snorkel surveys. Value is from one year of data.

Historical abundance information is the most relevant source of information available at this time and is a starting point to development of anticipated populations sizes that may require upstream passage at potential concept fish passage facilities. It is intended that this study consider values for abundance and peak rates of migration on an existing and future basis—bracketing a range of possible future outcomes. Values for abundance will be developed in coordination with input received from LPs and addressed in future deliverables prepared for this study.

3.4.2 Downstream Migration

Like upstream fish passage facilities, the number of anticipated outmigrating target fish species and life stages is also used in the development of downstream fish passage facility concepts. The associated number and weight of smolts are needed to determine the volume of holding galleries, hopper volumes, flow rates of life support systems, and ultimately the number of cycles that a transport activity must undertake during the peak periods of outmigration. The number and target age of species may also influence the need for multiple holding galleries, segregated areas to limit predation during holding periods, and for regular monitoring and evaluation of collection and passage performance metrics.

Estimates of juvenile population sizes occurring at the Project location needed to inform the downstream fish passage facilities concept formulation process are not currently available. Juvenile abundance data in the Skagit River below the Project are largely estimates of Skagit River basin-wide juvenile production and sub-basin level production. In the absence of this information, concept level downstream passage facilities will be developed based on existing facilities that are similar in size and complexity to that anticipated to support passage objectives at the Project. The designs may be revised based on additional information, including estimates that result from the FA-07 Reservoir Tributary Habitat Assessment Study, management or recovery goals that are established, or other information or guidance as it becomes available.

3.5 Fish Size

Typical adult fish sizes for target species are summarized in Table 3.5-1. For steelhead and salmon, the sizes presented below are based on regional size information provided Bell (1991). Adult native char sizes apply collectively to Bull Trout and Dolly Varden and are based on information from Ross Lake adults where the species cannot be differentiated in the field (City Light 2018). During review of the Preliminary Draft DCD, NMFS requested that data reflect fish size specific to Skagit River populations. Additional Skagit River specific salmonid size information from tribal net fisheries data from 2012 to 2021 was provided by the Skagit River System Cooperative (SRSC 2021).

Table 3.5-1. Size ranges of target species adults.

Species	Range (lbs)	Typical Average Size (lbs)	Skagit River Average Size (lbs)[1]
Chinook Salmon[2] Spring Chinook Summer/Fall Chinook	10-20	15	--- 13.0 13.3
Coho Salmon[2]	5-20	12	6.2
Sockeye Salmon[2]	3-8	6	4.9
Steelhead[2]	5-28	8	8.6
Upper Skagit Native Char (Bull Trout and Dolly Varden)[3]	2-5	3	Not Reported
Chum Salmon[2]	8-12	10	11.5
Pink Salmon[2]	3-10	4	4.1
Coastal Cutthroat Trout	0.5-4	1	Not Reported
Pacific Lamprey[4]	0.1-1.5	0.5	Not Reported
Salish Sucker[5]	0.1-0.4	0.1	Not Reported

1 Source: Skagit River System Cooperative 2021. Data from tribal net fisheries include hatchery and wild fish and may be biased by mesh sizes used and timing of capture.
2 Source: Bell 1991.
3 Source: City Light 2018.
4 Source: Orlov et al. 2008
5 Source: Pearson and Healy 2003

4.0 TECHNICAL FISH PASSAGE FACILITY DESIGN CRITERIA AND GUIDELINES

There are numerous guidelines and design criteria available which provide the engineering and ecohydraulic design principles for the development of upstream and downstream fish passage facilities. Other literature sources are available which provide design guidance and biological criteria for the collection, handling, and transport of fish. Although not explicitly referenced herein, a broad range of applicable criteria will be used throughout future fish passage facility concept development and the fish passage alternative formulation process. Example references and technical criteria are included in the following subsections.

4.1 General Fish Passage Engineering and Design Guidance Documents

A selection of typical reference documentation used in the design of fish facilities includes but is not limited to:

- Bates. 1992. Fishway Design Guidelines for Pacific Salmon.
- Bell. 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria. Prepared by the U.S. Army Corps of Engineers Fish Passage Development and Evaluation Program. Third edition.
- NMFS. 2011. Anadromous Salmonid Passage Facility Design.
- WDFW 2000. Draft Fish Protection Screen Guidelines for Washington State.
- WDFW 2000. Draft Fishway Guidelines for Washington State.
- Rajaratnam, N., C. Katopodis, and S. Solank. 1992. New Designs for Vertical Slot Fishways. Canadian Journal of Civil Engineering, volume 19, pages 402-414.
- Clay, C.H. 1961. Design of Fishways and other Fish Facilities. Department of Fisheries, Canada. FS 31-1961/1.

While these reference documents provide passage criteria for salmonids and trout species, surrogate passage technologies will be considered, in collaboration with USFWS and WDFW, for other target species (e.g., lamprey). Currently, the City Light consultant team will consider the best available science relating to the lamprey passage at dams and in fishways. This includes information contained in the scientific literature, lessons learned from experimental facilities at U.S. Army Corps of Engineers dams on the Columbia River, and past interviews with researchers on other passage projects who specialize in studying lamprey behavior and navigational capabilities. The following resources will be considered and outline the best practices for passage design for adult lamprey:

- Keefer et al. 2012. Adult Pacific Lamprey Passage: Data Synthesis and Fishway Improvement Prioritization Tools
- Keefer et al. 2014. Adult Pacific Lamprey: Known passage challenges and opportunities for improvement

- U.S. Department of Agriculture Natural Resources Conservation Services (NRCS). 2011. Pacific Lamprey and NRCS: Conservation, Management and Guidelines for Instream and Riparian Activities
- U.S. Fish and Wildlife Service (USFWS). 2010. Best Management Practices to Minimize Adverse Effects to Pacific Lamprey
- USFWS. 2017. Practical guidelines for incorporating adult Pacific lamprey passage at fishways.
- U.S. Department of Agriculture (USDA). 2010. Pacific Lamprey Protection Guidelines for USDA Natural Resources Conservation Service Instream and Riparian Activities
- USFWS. 2011. Lamprey Passage in the Willamette Basin: Considerations, Challenges, and Examples.
- Stevens et al. 2015. Evaluation of Adult Pacific Lamprey Fish Passage at Snake River Dams.

NMFS (2011) and WDFW (2000a) have developed guidelines for the design of passage facilities for adult and juvenile salmonids. Similarly, the USFWS has established passage guidelines for Pacific Lamprey (USFWS 2017). However, although WDFW (2000a) notes that resident species should also be considered for passage, passage guidelines for resident fish species are not currently available. Swim speed and jump height available from the literation can inform future design considerations. A summary of the target species and life stages with documented information on swim speeds and jump heights is provided in Table 4.1-1. Facilities could be designed to accommodate the passage of all target species, to the extent possible. However, the passage of some resident species (e.g., Salish Sucker) will be considered incidental to the passage of targeted anadromous salmonids, Pacific Lamprey, and Bull Trout.

Table 4.1-1. Summary of target fish species and life stages for which information on swim speeds and jump heights is available.

Species	Life Stage	Swim Speed	Jump Height
Spring-run Chinook Salmon	Adult	●	●
Fall-run Chinook Salmon	Adult	●	●
Coho Salmon	Adult	●	●
Sockeye Salmon	Adult	●	●
Winter-run steelhead	Adult	●	●
Summer-run steelhead	Adult	●	●
Spring-run Chinook Salmon	Juvenile	●	●
Fall-run Chinook Salmon	Juvenile	●	●
Coho Salmon	Juvenile	●	●
Sockeye Salmon	Juvenile	●	●
Winter-run steelhead	Juvenile	●	●
Summer-run steelhead	Juvenile	●	●
Coastal Cutthroat Trout	Adult	●	●
Bull Trout	Adult	●	●
Pacific Lamprey	Adult	●	N/A
Catastomus spp.	Adult	●	

Note: ● = Indicates that information is available.

4.2 Fish Screen Criteria

Specific criteria relative to adequate screen area, maintenance features, and facility hydraulics must be met to assure compliance with regulatory requirements. Fish screens are designed using the NMFS Northwest Region's Anadromous Salmonid Passage Facility Design (NMFS 2011). The intent of the fish screening criteria is to provide design guidelines and criteria that protect juvenile fish from entrainment or impingement and to guide juveniles to a collection and/or bypass system.

The following is a summary of the fish screen criteria for the design of a screening system:

- Structure Orientation – In a river, the screen must be oriented parallel to river flow. Upstream and downstream transitions must minimize eddies. In a reservoir, the screening and bypass system must be designed to withdraw water from the appropriate elevation for best fish attraction and providing appropriate water temperature control downstream. The design must accommodate the entire range of forebay fluctuations (NMFS 2011).
- Screen Size – The minimum screen area required is determined by dividing the maximum screened flow by the allowable approach velocity (NMFS 2011).
- Approach Velocity – Uniform approach velocity must be provided across the face of the screen. Approach velocity for the listed target species must be less than 0.4 feet/second (ft/s) for actively cleaned systems and hydraulic evaluations of fish screens must include confirmation of uniform approach velocity over the entire screen face. For passively cleaned screens, approach velocity must not exceed 0.2 ft/s (NMFS 2011).

- Sweeping Velocity – The sweeping velocity should be greater than the approach velocity. Sweeping velocity must be maintained or gradually increase for the entire length of screen. Optimally, sweeping velocity should be at least 0.8 ft/s and less than 3 ft/s (NMFS 2011).
- Travel Time – Fish can only be exposed to a screen face for a maximum of 60 seconds, assuming fish are moving at rate equal to the sweeping velocity (NMFS 2011).
- Multiple Entrances – Multiple bypass entrances should be used if the sweeping velocity may not move fish to the bypass within 60 seconds, assuming fish are transported along the length of the screen face at a rate equaling sweeping velocity.
- Screen Openings – For salmonid fry, screen opening size must not exceed 1.75 mm, with a minimum open area of 27 percent. If the screen is made from wire mesh or perforated plate, the screen opening size must not exceed 3/32 inch on a side, with a minimum open area of 27 percent (NMFS 2011).
- Screen Materials – The screens must be constructed of rigid, corrosion-resistant material with no sharp edges or projections (e.g., stainless steel, plastic) (NMFS 2011).
- Screen Cleaning – Automatically cleaned screens are referred to as active screens. Cleaning systems should provide complete debris removal at least every five minutes and operated as required to prevent debris accumulation. The cleaning system should be automatically triggered if the head differential across the screen exceeds 0.1 foot or as agreed to by NMFS (NMFS 2011).
- Redundancy – Although not required by fisheries regulatory agencies, it is common design practice to oversize screen area for maximum diversion by a factor of 1.2 to 1.3.

4.3 Fish Bypass Criteria

Bypass systems are designed to facilitate both juvenile and adult fish downstream passage back to the river system, typically around a diversion or fish screen system, in a manner that minimizes risk of injury and delay. Fish bypass systems typically contain three major components: the bypass entrance, conduit, and exit.

4.3.1 Bypass Entrance Criteria

- Flow Control – Independent flow control should be provided at each bypass entrance (NMFS 2011).
- Travel Time – Fish are to enter a bypass within 60 seconds of exposure to any length of screen (NMFS 2011).
- Velocity – Bypass entrance velocity must be greater than 110 percent of the maximum screen-sweeping velocity. Velocity should not decrease between the screen terminus and bypass entrance and should accelerate gradually (NMFS 2011).
- Acceleration – The flow should not decelerate and should not exceed an acceleration rate of 0.2 ft/s per foot of travel (NMFS 2011).
- Lighting – Ambient lighting is required at the entrance to the bypass flow control (NMFS 2011).
- Dimensions – Bypass entrance should be a minimum of 18 inches wide, and its height must extend from floor of the screen to water surface (NMFS 2011). For weirs used in bypass

systems that have diversions greater than 25 cfs, a minimum weir depth of 1 foot should be maintained throughout the smolt out-migration period (NMFS 2011).

- Juvenile Capture Velocity – A minimum velocity of eight ft/s is a common design threshold used in situations that require the capture of juvenile salmonids. Experience with current projects will be considered if a bypass system becomes part of the facility design.

4.3.2 Bypass Conduit Criteria

- Materials and fittings – Smooth pipes, joints, and other interior surfaces are required to minimize turbulence and the potential for fish injury. Closure valves should not be used within the bypass pipe (NMFS 2011).
- Flow Transitions – Pumping if fish are within the bypass system is not allowed. If site conditions permit, bypass flows should be open channel (NMFS 2011). Where site conditions do not permit open channel bypass flows, a bypass pipe may be used. NMFS criteria state that pressures within bypass pipes must be equal to or above atmospheric pressure. NMFS criteria also state that transitions from pressurized to non-pressurized (or vice-versa) should be avoided within the pipe. Free-fall of fish within a pipe or enclosed conduit within the bypass system is not allowed (NFMS 2011).
- Bypass Flow – Bypass flow should be approximately 5 percent of the total screened flow (NMFS 2011). Based on professional judgment, this proportion may be considered a minimum. Higher bypass flow proportions will be considered if a bypass is included in the design.
- Velocity – NMFS criteria state the bypass pipe should be designed to have velocities between 6 and 12 ft/s; however, higher velocities can be approved with special attention to pipe and joint smoothness (NMFS 2011).
- Geometry – NMFS requires the open channel or pipe diameter to be sized based on bypass flow and slope in order to meet other bypass conduit criteria.
- Bends – The ratio of bypass centerline to pipe diameter must be five or greater, and larger ratios may be required for super-critical velocities (NMFS 2011).
- Depth – NMFS criteria requires a minimum depth of at least 40 percent of the bypass pipe diameter, unless otherwise approved (NMFS 2011).
- Hydraulic Jump – Hydraulic jumps should not occur within the pipe (NMFS 2011).

4.3.3 Bypass Exit Criteria

- Velocity – The outfall impact velocity, the velocity of the bypass flow entering the river, should not exceed 25 ft/s (NFMS 2011).
- Location – The outfall should be located in an area with strong downstream currents, at least four ft/s, free of eddies, reverse flow, or likely predator habitat. The outfall should also be located in an area with sufficient depth to avoid fish injuries (NMFS 2011).
- Adult Attraction – The bypass outfall must be designed to avoid the attraction of upstream migrants. Upstream migrants might leap at the outfall; therefore, provisions for minimizing risk to injury or stranding on the bank must be included in the outfall design (NMFS 2011). It should be noted that this criterion is applicable only where upstream and downstream passage facilities are separate.

4.3.4 Velocity Barrier Criteria

Velocity barriers create a combination of shallow depth and high velocity conditions that restrict a fish's ability to swim and leap into oncoming flow. Barriers are commonly used to help guide upstream migrating fish to the entrance of a fish passage facility. A velocity barrier typically consists of a full-spanning concrete apron that distributes streamflow evenly across the width of the channel, and a vertical weir that is higher than the leaping ability of the target fish species. Velocity barrier design guidelines for anadromous salmonids have been developed by NMFS (NMFS 2011) and include the following:

- The minimum weir height relative to the maximum apron elevation is 3.5 feet.
- The minimum apron length (extending downstream from base of weir) is 16 feet.
- The minimum apron downstream slope is 16:1 (horizontal:vertical).
- The maximum head over the weir crest is two feet.
- The elevation of the downstream end of the apron shall be greater than the tailrace water surface elevation corresponding to the high design flow.
- Other combinations of weir height and weir crest head may be approved by NMFS staff on a site-specific basis.
- The flow over the weir must be fully and continuously vented along its entire length, to allow a fully aerated nappe to develop between the weir crest and the apron.

4.4 Fishway Criteria

Upstream fish passage designs at dams use widely recognized fishway design guidelines and references and are traditionally designed for the adult fish life stage. There are three major components to a fishway: the fishway entrance, fish ladder, and fishway exit. The fishway entrance's primary objective is to maximize fish attraction. The fish ladder's primary objective is to provide hydraulic conditions that promote fish passage up and around a passage barrier. The fishway exit's primary function is to maintain hydraulic conditions suitable for fish passage for the range of forebay or reservoir water surface elevations. The design criteria specific to each component are presented below.

4.4.1 Fishway Entrance

- Entrance Location – The entrance located should be based on site-specific operations and stream flow characteristics. Entrances must be placed in locations where fish can easily locate the attraction flow. Multiple entrances may be required if the site has multiple locations where fish hold (NMFS 2011).
- Entrance Geometry – The entrance should have a minimum width of four feet and depth of six feet (NMFS 2011).
- Entrance Head Differential – The head differential at the entrance should be maintained between 1.0 and 1.5 feet (NMFS 2011).
- Attraction Flow – Minimum 5 to 10 percent of high fish passage design flow (NMFS 2011). Fishway attraction flow must be adequate to compete with spillway or powerhouse flows for

attraction of fish. Auxiliary water systems may be used to increase the fishway entrance attraction flow.

4.4.2 Fish Ladder Design

- Head Differential – The hydraulic drop between each pool within the fish ladder must be a maximum of one foot (NMFS 2011).
- Minimum Pool Dimensions – Minimum of eight feet long, six feet wide, and five feet deep (NMFS 2011).
- Energy Dissipation Factor (EDF) – Each pool volume should be sized to have a maximum energy dissipation factor of four ft-lb/sec/ft^3. Only the volume of the pool having active flow and contributing to energy dissipation should be included in the energy dissipation calculation (NMFS 2011).
- Minimum Depth Over Weirs – Overflow weirs in fishways should have one foot of flow depth over weirs (NMFS 2011).
- Turning pools – Turning pools are required at each location where the fishway bends more than 90 degrees. Turning pools should be at least double the length of the designed standard pool measured along the centerline (NMFS 2011).
- Orifice Dimensions – NMFS criteria state orifices should be a minimum of 15 inches high and 12 inches wide (NMFS 2011).
- Freeboard – Freeboard must be a minimum of three feet within the fish ladder at the high design flow (NMFS 2011).
- Lighting – The use of ambient lighting throughout the entire fishway is preferred. Abrupt lighting changes within the fishway are not allowed (NMFS 2011).

4.4.3 Fishway Exit

- Head Differential – The fishway exit head differential should range from 0.25 to 1.0 foot (NMFS 2011). In order to accommodate forebay fluctuations this may require the use of adjustable weirs, multiple exits at different elevations, or other engineered solutions that accommodate forebay fluctuations.
- Length – A minimum channel length of two standard ladder pools should be incorporated upstream of the exit control (NMFS 2011).
- Location – The exit should be located along the shoreline at a location with similar depths to those within the fishway and with velocities less than 4.0 ft/s. Exits should be located well upstream of spillways, sluiceways, and powerhouses to minimize the risk of being swept downstream.
- Debris Rack – Coarse trash racks should be installed at the fishway exit and must be oriented at a deflection angle greater than 45 degrees relative to the river flow (NMFS 2011).

4.4.4 Adult Lamprey Fishway Considerations

Lamprey passage technologies are relatively new, and few facilities exist in the western United States that target lamprey for passage or collection and transport above dams. Where applicable, readily available best practices, lessons learned from experimental facilities on the Columbia River, and interviews with researchers who specialize in the understanding of lamprey behavior and navigational capabilities were used to inform lamprey passage facility requirements and anticipated performance. Using information from the lamprey best management resources presented in Section 4.1 of this document, preliminary upstream passage criteria for adult lamprey that may be considered for future discussions with the agencies are summarized below (Table 4.4-1).

Table 4.4-1. Preliminary lamprey passage design criteria for discussion and consideration.

Criteria	Value	Reference
Flow velocity	6 feet per second, maximum	USDA 2010
Ramp width	1.0 foot minimum	Stevens et al. 2015
Distance between resting pools	20 feet maximum	Stevens et al. 2015
Water depth in ramp	3 inches, minimum	Stevens et al. 2015
Wetted surface finish	Smooth	Stevens et al. 2015

Note: Additional design characteristics have shown to be effective as part of retrofitting existing fish ladders on the Columbia River including rounded corners, ramps to elevated orifices, and attachment plating around floor-oriented auxiliary water supplies, among others.

4.5 Debris Rack Criteria

Debris racks are commonly used to exclude large debris from entering fish passage facilities. Debris rack openings should be a minimum of 8 inches clear, or 12 inches clear if adult Chinook are present. NMFS criteria state that approach velocity should be less than 1.5 ft/s. Debris racks should be sloped at 1:5 or flatter to assists with manual cleaning. In systems with coarse floating debris, debris booms or other provisions must be incorporated into the debris rack design (NMFS 2011).

4.6 Fish Trapping and Holding Criteria

If the design requires trapping, holding, and handling of fish, the following criteria apply:

- Holding Pool Volume – Fish-holding pools must be sized to provide a minimum volume of 0.25 cubic feet per pound of fish. For holding durations greater than 72 hours, holding pool volumes should be increased by a factor of three. The maximum daily fish return, or number of fish expected to be trapped before fish are removed, is used to determine the required trap capacity (NMFS 2011).
- Temperature – Water temperatures must be less than 50°F. If temperatures exceed this threshold, the poundage of fish held should be reduced 5 percent for each degree above 50°F (NMFS 2011).
- Dissolved Oxygen – Must be maintained between six and seven parts per million (NMFS 2011).
- Water Supply – A minimum of 0.67 gallon per minute per adult fish must be supplied to the holding pool (NMFS 2011).
- Handling – Fish must be handled with extreme care; use of nets should be minimized or eliminated. Fish should be anesthetized before being handled and be handled only by individuals trained to safely handle fish (NMFS 2011).
- Frequency of Removal – Fish must not remain in traps for more than a day. Traps may have to be cleared more often to prevent crowding or adverse water quality (NMFS 2011).
- Adult Jumping Provisions – Fish may be injured by jumping, and provisions must be included in the holding pool design to minimize adult jumping. Provisions can include the following:

freeboard of five feet or more; covering of the holding pool to create a darkened environment; use of netting over the pool; or sprinklers above the holding pool (NMFS 2011).

- Segregation of Fish – Specific criteria for segregating different species and life stages of fish are established on a site-specific basis. This could include picket panels, screens, and other materials to limit certain sizes of fish holding in pools.

5.0 PROJECT-SPECIFIC FACTORS INFLUENCING FISH PASSAGE FACILITY ALTERNATIVE FORMULATION

5.1 Fish Passage Goals and Objectives

The establishment of biological goals and objectives for fish passage are key to the development of successful fish passage strategies that also consider benefits, risks, and constraints for each strategy. When all of those factors are assembled, feasible fish passage technologies can be refined to support identified goals. As stated previously in this document, City Light offered to initiate discussions regarding biological goals and objectives of the Fish Passage Study during AWS meeting No. 6, held on October 18, 2021. However, the consensus among AWS participants was that establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of the Fish Passage Study, but rather will be informed by concurrent studies and agency/tribal discussions in the future with consideration of recovery planning targets and current and future harvest objectives. Therefore, the Fish Passage Study will not establish biological goals and objectives for fisheries resource management but will rather consider biological requirements of target species within the anticipated operating environments of the Gorge, Diablo, and Ross developments. These factors will inform a range of upstream and downstream passage facility alternatives that may be evaluated as part of the study. The results of several concurrent relicensing studies will inform potential carrying capacity of tributary streams for target species upstream of the Project developments; specifically, the Reservoir Tributary Habitat Assessment. Results of this assessment will facilitate target species abundance estimates and facility sizing requirements for fish passage.

Regardless of future goals and objectives to be established by others independent of the Fish Passage Study, each fish passage technology must consider the biological and physical setting upon which designs can be developed.

5.2 Fish Passage Performance Standards

Should standard upstream and downstream passage technologies be implemented at each or some of the Project developments, future licensing requirements will include performance standards and requirements to monitor compliance with those standards. The typical performance standards for upstream and downstream passage at high dams in the Pacific Northwest are discussed in the subsections below. If fish passage is advanced beyond this study and considered for implementation in the future, similar upstream and downstream performance standards for passage efficiency and survival would be expected to be developed for Project facilities. It should be noted that, if future strategies include pilot studies or experimental passage technologies at the Project, typical performance standards could be adjusted, in coordination with regulatory resource agencies, to address the experimental nature of such facilities.

5.2.1 Regulatory Performance Standards

Fish management agencies involved in the oversight of fish passage programs are responsible for designing solutions that facilitate "safe, timely and effective" fish passage through barriers (NMFS 2011). To evaluate whether a facility is achieving the safe, timely and effective passage of fish, numeric performance standards are developed by fish management agencies and applied to upstream and downstream passage facilities. To determine "usual and customary" performance standards established for similar facilities that could be used to assess technical feasibility, fish passage facility performance information for the upstream and downstream passage components of programs currently in operation were compiled and evaluated.

High dams are often defined as those with hydraulic differentials on the order of 100 feet or greater; however, several dams with hydraulic differentials less than 100 feet utilize fish passage technologies or strategies similar to those exceeding this threshold. Like facilities are those that are employed on multipurpose impoundments rather than run-of-the-river facilities found on the Columbia River. In most cases, both upstream and downstream fish passage technologies applied at high dams are classified as evolving, innovative, and experimental (Northwest Power and Conservation Council 2016). Development of such technologies began over 70 years ago, with the greatest advancements occurring in the past 15 years. Only facilities implemented in the strictest of regulatory environments (such as is the case for licensure with FERC when ESA-related effects exist) carry with them specified performance targets and are required to provide the results of more elaborate annual monitoring efforts. The following sections provide a summary of the types of performance standards that are required by the resource agencies at a selection of the most modern high-dam fish passage facilities currently in operation. These performance standards are representative of the standards that would be mandated for fish passage facilities at the Project.

5.2.1.1 Upstream Passage Performance Requirements

When specific performance criteria exist, full-scale upstream fish passage facilities are expected to provide Adult Passage Efficiencies of 75 (minimum compliance) to 95 (target) percent with survival standards of 95 to 98 percent (PacifiCorp 2016, 2017; Northwest Power and Conservation Council 2016). Adult Passage Efficiency is defined as the number of marked or tagged fish passed or recaptured at a facility divided by the number of initial fish collected, marked or tagged, and released downstream of a passage facility. Minimum compliance targets must be met annually, with the expectation that facility owners continuously invest in physical or operational improvements until the target 95 percent passage efficiency is met.

5.2.1.2 Downstream Passage Facility Performance Requirements

Downstream passage facilities at high-head dams in the Pacific Northwest have been required to provide safe and effective passage of juvenile and adult fish. Passage requirements have been established by the USFWS and NMFS Federal Power Act Section 18 prescriptions, which frequently provide site-specific criteria and performance requirements. At this time, performance standards and evaluation requirements for downstream passage facilities at high-head dams have focused on passage of juvenile anadromous species and are subject to site-specific considerations for calculating performance (see attached Summary of Performance Standards and Evaluation). A summary of downstream passage collection facilities and their required performance standards for juvenile fish is provided in Table 5.2-1. Additional details and references associated with these facilities are provided in the Summary of Performance Standards and Evaluation attached to this document. As demonstrated through review of FERC license documentation for these facilities, the expectation by the resource agencies indicates that reservoir passage efficiencies must fall within a range of 75 to 85 percent, collection efficiencies must be as high as 95 percent, and survival of smolt through the passage facilities must be between 98 and 99.5 percent. The overall downstream fish passage survival for these existing facilities, as mandated by the resource agencies, is expected to range from 75 to 97 percent. Specific performance requirements and evaluation of downstream passage of adult or subadult Bull Trout and steelhead kelts may be established for downstream passage facilities as part of the design process or during agency consultation.

Table 5.2-1. Example downstream fish passage facilities performance standards.[24]

Facility Name and Location	First year of Operation	Reservoir Passage (R)	Collection (C)	Survival (S)	Overall Survival (RxCxS)
Baker River – Baker Lake, WA	2008	80%	95%	98%	75%
Baker River – Lake Shannon, WA	2013	80%	95%	98%	75%
Cushman Project – Lake Cushman, WA	2014	Unspecified	95%	Unspecified	95% target 75% min
Clackamas River Project – North Fork Reservoir, OR	2015	Unspecified	Unspecified	Unspecified	97%
Clackamas River Project (River Mill) – Estacada Lake, OR	2012	Unspecified	Unspecified	Unspecified	97%
Cowlitz Falls Dam – Lake Scanewa, WA	2017	Unspecified	Unspecified	Unspecified	95% target 75% min all species
Pelton Round Butte Project – Lake Billy Chinook, OR	2009	50% temp facility 75% permanent facility	Unspecified	93% temp facility 96% permanent facility	Unspecified
Lewis River Project – Swift Reservoir, WA	2012	Unspecified (Calculated as 85-86%)	95%	95% fry 99.5% smolt	80%

Note: See the Summary of Performance Standards and Evaluation attached to this document for a full list of table citations and references.

5.2.2 Cumulative Fish Passage Performance at Multi-Dam Complexes

An important component of assessing overall passage effectiveness through the Project is the presence of the three dams and reservoirs and the resulting cumulative effects of multiple-dam passage on target populations. Keefer et al. (2021) examined upstream passage through fishways across multiple dams and reservoirs in the Columbia River basin to provide a broader view of fish passage at single dams. When the average adult upstream passage efficiency across all Columbia River dams (0.966) was compounded over four lower Columbia dams or eight dams (lower Columbia plus lower Snake River dams), multi-dam passage efficiencies were reduced to 0.871 and 0.758, respectively. In a species-specific analysis of the same data, they reported that the

24 Reservoir Passage Efficiency (R) is calculated by dividing the number of fish that reach a designed zone of influence in the reservoir by the total number of fish released at a designated point near the head of reservoir. Collection Efficiency (C) is calculated by dividing the number of fish that are collected in a facility by the total number of fish that were released at the zone of influence. Survival (S) represents the number of fish released at a downstream release point divided by the number of fish that were collected.

product of the eight full-dam passage efficiency estimates (mean values) was 0.821 for spring–summer Chinook Salmon and 0.846 for steelhead, suggesting impacts on 15 to 18 percent of each population (e.g., between-dam harvest, fallback risk, or, as a worst-case, population-level losses for the most upstream stocks).

Similar compounding effects could be expected for upstream passage through all three Skagit Project developments, even if observed passage efficiencies for target species complied with established performance standards at each dam independently. Therefore, upstream adult passage efficiency standards for each dam would be 95 percent, while cumulative efficiencies across the full Project could range from 75 to 85 percent. Similar reductions to cumulative juvenile downstream passage efficiencies and survival would be expected and should be considered when establishing overall Project passage performance standards. Although downstream passage mortality through a single dam may be low (i.e., 5-10 percent), system-wide cumulative mortalities across multiple dams may be considerable (Marohn et al. 2014). Further, downstream passage efficiencies and survival would be directly influenced by the type of facility provided for passage at each development (Amaral et al. 2012), as summarized in Section 7.2.3 of this document.

Passage efficiency is closely tied to facility design and performance, and survival is a performance metric of the facility design and reservoir transit efficiency. Therefore, total survival past all three Project dams will be influenced by all of these, and other, factors. It may be critical to establish performance standards that consider the compounding effects of multi-dam passage on passage performance with the understanding that an accumulation of effects is inevitable for the most upriver populations. Keefer et al. (2021) emphasize that the cumulative effects on passage effectiveness for individuals and populations are understudied and should be further researched given the global existence of many multi-dam rivers. Given the above, it is recommended that fish passage performance for the Skagit Project be evaluated independently at each dam as well as cumulatively, given the potential reduced passage efficiency and survival across the full Project, should selected fish passage alternatives incorporate a multi-facility approach, including reservoir transit strategies.

5.3 Species Selected for Fish Passage Program Development

As described in Section 3.1 of this document, a range of target species are considered for this assessment and include the species presented in the Fish Passage Study RSP and those presented in the June 9, 2021 Notice. Of those species considered, all but one will be considered in fish passage facility concept development, Salish Sucker (*Catastomus catostomus*). Salish Sucker passage could be considered but may be incidental to the other target species, given their life history requirements and lack of substantial movement from natal areas.

Abundance, size, migration timing, swimming capability, and swimming behavior for the following species will be considered in this Fish Passage Study.

- Chinook Salmon (Oncorhynchus tshawytscha)
- Coho Salmon (*O. kisutch*)
- Sockeye Salmon (*O. nerka*)
- Steelhead (*O. mykiss*)

- Bull Trout (Salvelinus confluentus)
- Chum Salmon (*O. keta*)
- Pink Salmon (*O. gorbuscha*)
- Sea-run Cutthroat Trout (*O. clarkii*)
- Dolly Varden (Salvelinus malma)
- Pacific Lamprey (Entosphenus tridentatus)

5.4 Abundance and Peak Rates of Migration

Target species abundance and peak rates of migration are critical factors to consider when designing fish passage facilities because these parameters will inform facility sizing and water needs and will determine the condition of baseline factors (e.g., reservoir elevations) that influence both upstream and downstream collection technologies and efficiencies. Although these parameters are critical, and escapement data and migration periods for each target species (Table 3.3-1) shed light on baseline conditions for Skagit River populations below the Gorge development, City Light will continue to collect and synthesize data from concurrent relicensing studies that will inform abundance estimates for target species upstream of the Project developments. Studies including the Reservoir Tributary Habitat Assessment will provide estimates of intrinsic habitat potential and carrying capacity and can be used by the Fish Passage Study team to better define abundance targets, which will then be used to refine fish passage technologies determined to be feasible during later stages of the Fish Passage Study. In addition, populations below Gorge Dam could provide information on the migration timing for existing populations. Further analysis of existing data and additional examination of run timing and Intrinsic Potential studies being conducted under FA-07 may help inform the abundance and timing of fish that may be experienced at the Project. This information may be considered in later phases of passage facility design. Consensus on these factors as related to fish passage may require ongoing coordination with LPs following the completion of this study.

5.5 Reservoir Operations and Stage Fluctuation

To determine operating ranges for potential fish passage facilities, the recorded stage data and corresponding stage-duration frequencies were further examined to identify the typical operating range of water surface elevations that occur coincident with the fish passage migration period. Section 2.3.1 of this document presents reservoir operations information including minimum, average, and maximum reservoir stage; spill magnitude and frequency; and stage-duration analyses for all three developments. Differing rule curves, management goals, and reservoir uses between each development result in unique stage fluctuations and typical operating water surface elevations. These fluctuations influence upstream and downstream passage facility suitability and have the potential to impact passage success, because associated structures must be designed to operate at the range of typical changing water levels (Kock et al. 2019).

Stage data are of particular interest when fish are migrating and therefore when passage facilities are expected to be in operation. The draft life history stage timing for target fish species in the upper Skagit River is presented in Table 3.3-1. This periodicity information was used to refine stage fluctuation data, presented in Section 2.3.1 of this document, resulting in typical stage elevation fluctuation ranges for migration periods. The migratory window of all target fish species in the upper Skagit River spans the full calendar year. However, existing infrastructure as well as any potential fish passage facility will require maintenance, upkeep, and revision throughout its operational life. Therefore, the targeted range of water surface fluctuations requiring fish passage facility operations may be less than the authorized maximum operational range at each development.

Although the maximum stage fluctuation range presented in Section 2.3.1 of this document is useful to observe the total range of water levels each reservoir operates, it does not provide a complete picture of the typical operational ranges when fish passage facilities may be in operation. Targeted conditions where fish passage facilities may be required to be operational should exclude periodic or episodic drawdowns or anomalies that occurred over the historical period of record due to the occurrence of maintenance, repairs, and similar activities where operation of fish passage facilities would not be anticipated. For simplicity, the stage-duration curves prepared for each development in Section 2.3 of this document are brought forward and the stage elevations corresponding with the 95 percent and 5 percent exceedance are identified. This method truncates operating conditions that are least likely to occur based upon information available on current and historical operations. This range is selected for future use in determining suitable fish passage technologies and development of concept fish passage facility alternatives. Sections 7.2.2 and 7.2.3 of this document provide descriptions of the range of potential upstream and downstream fish passage technologies, and Section 7.3 of this document discusses the suitability of each technology at each individual project development.

5.5.1 Ross Lake

The total operational maximum water surface elevation range authorized under the current FERC license for Ross Lake is approximately 128 feet (refer to Section 2.3.1.1 of this document for additional background on reservoir operations and rule curve description). Figure 2.3-3 provides a more complete picture of reservoir stage fluctuation ranges in Section 2.3.1.1 of this document, showing the percentage of days a stage elevation is exceeded. Figure 5.5-1 provides the same stage-duration analysis with the 5 percent and 95 percent exceedance elevations identified. Results of this assessment show that Ross Lake water surface elevations fall within an 87.45-foot range (1,514.23 feet CoSD to 1601.68 feet CoSD) for 90 percent of the daily end-of-day stage elevations recorded throughout the period of record. It is assumed, for the purpose of this study, that water surface elevations outside of this range are anticipated to occur during episodic events such as maintenance or for flood control and do not represent typical operational ranges.

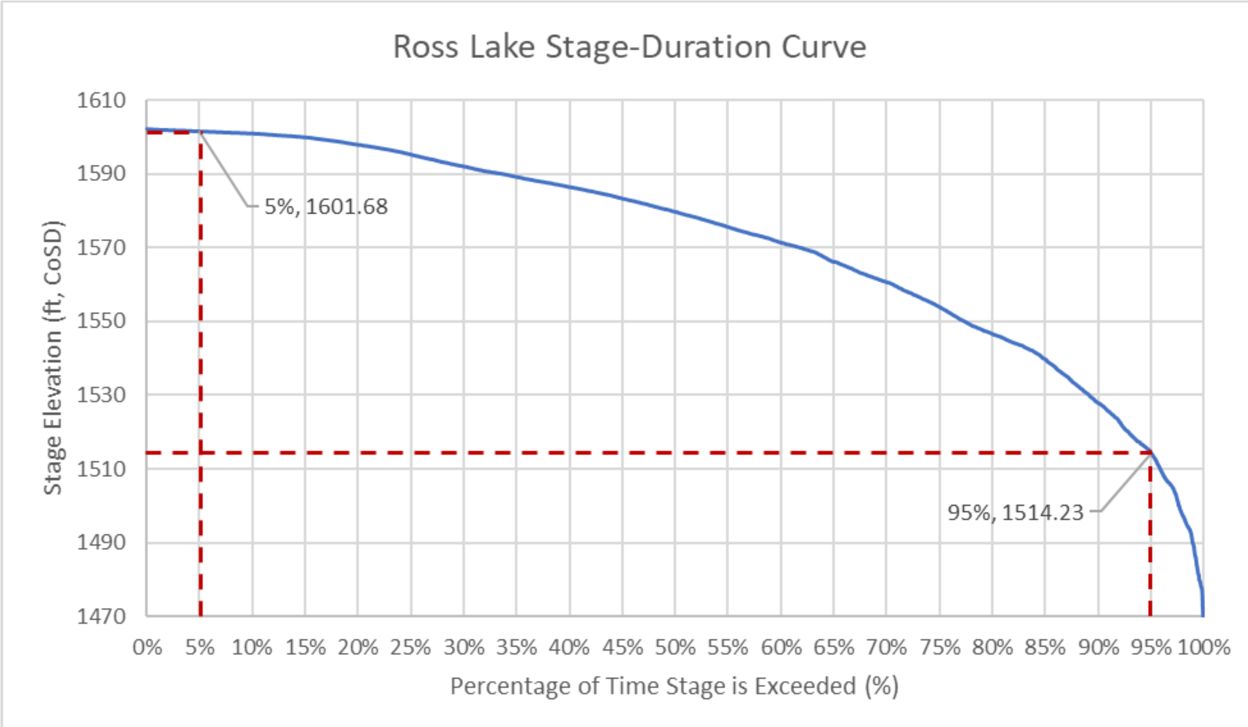


Figure 5.5-1. Daily end-of-day stage-duration curve for Ross Lake water surface elevation.

5.5.2 Diablo Lake

The total operational maximum water surface elevation range for Diablo Lake authorized under the current FERC license is approximately seven feet (refer to Section 2.3.1.2 of this document for additional background on reservoir operations and rule curve description). Figure 2.3-7 provides a more complete picture of reservoir stage fluctuation ranges in Section 2.3.1.2 of this document, showing the percentage of days a stage elevation is exceeded. Below, Figure 5.5-2 provides the same stage-duration analysis with the 5 percent and 95 percent exceedance elevations identified. As shown, Diablo Lake water surface elevations fall within a 3.99-foot range (1199.80 feet CoSD to 1203.79 feet CoSD) for 90 percent of the daily end-of-day stage elevations recorded throughout the period of record. It is assumed, for the purpose of this study, that water surface elevations outside of this range are anticipated to occur during episodic events such as maintenance or flooding and do not represent typical operational ranges.

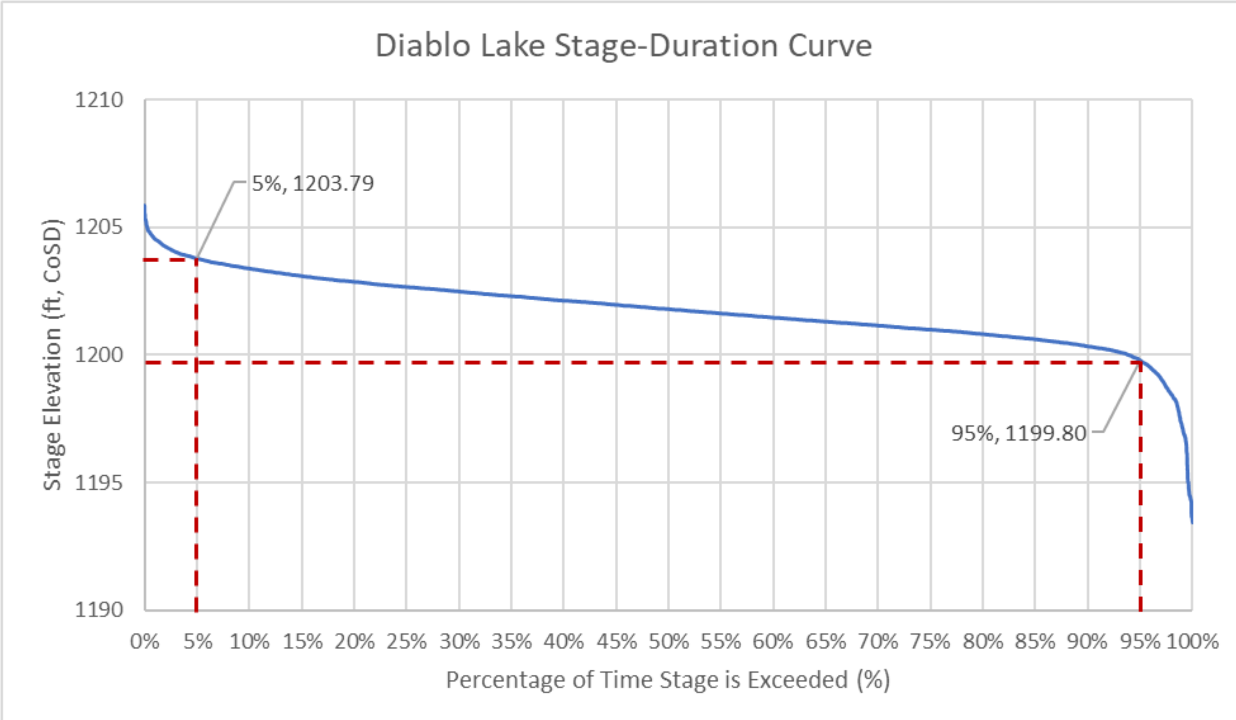


Figure 5.5-2. Daily end-of-day stage-duration curve for Diablo Lake water surface elevation.

5.5.3 Gorge Lake

The total maximum water surface elevation range for Gorge Lake authorized under the current FERC license is approximately 50 feet (refer to Section 2.3.1.3 of this document for additional background on reservoir operations and rule curve description). In Section 2.3.1.3 of this document, Figure 2.3-14 provides a more complete picture of reservoir stage fluctuation ranges, showing the percentage of days a stage elevation is exceeded. Below, Figure 5.5-3 provides the same stage-duration analysis with the 5 percent and 95 percent exceedance elevations identified. As shown, Gorge Lake water surface elevations fall within a 4.66-foot range (869.18 feet CoSD to 873.84 feet CoSD) for 90 percent of the daily end-of-day stage elevations recorded throughout the period of record. It is assumed, for the purpose of this study, that water surface elevations outside of this range are anticipated to occur during episodic events such as maintenance or flooding and do not represent typical operational ranges.

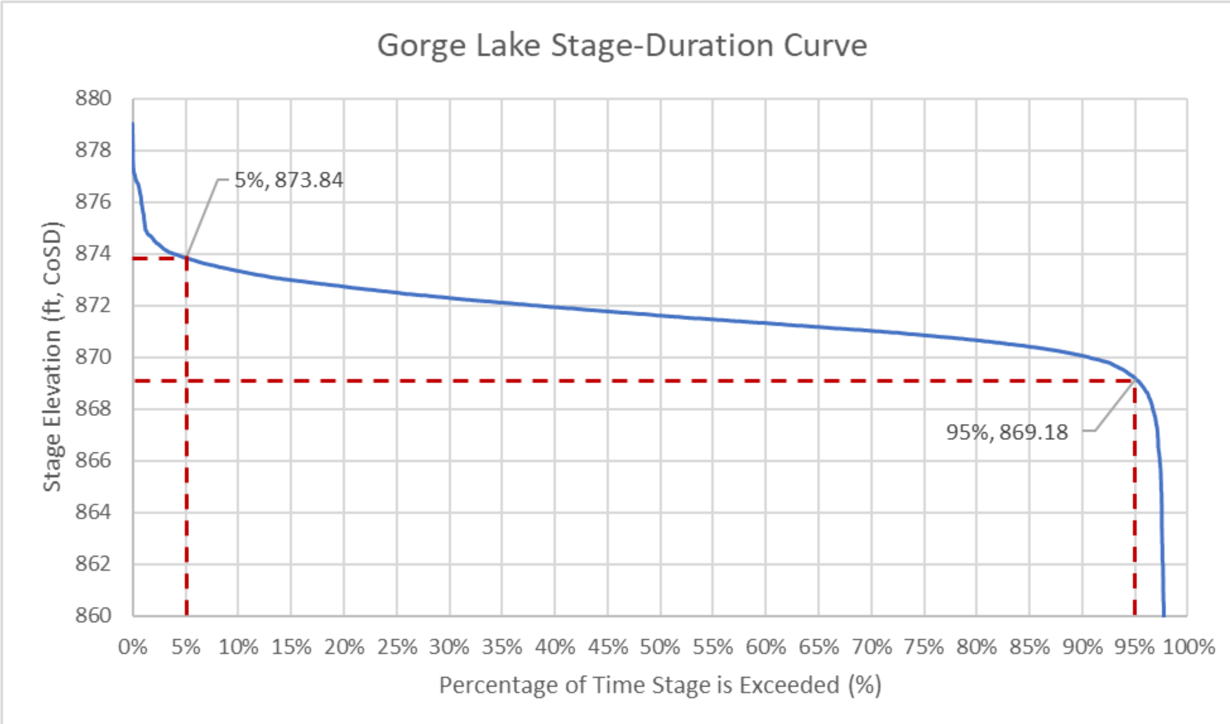


Figure 5.5-3. Daily end-of-day stage-duration curve for Gorge Lake water surface elevation.

5.6 Reservoir Transit

Reservoir transit is an important factor in considering fish passage strategies, species management, and expectations for performance of downstream passage facilities. The physical conditions that exist in a reservoir, such as overall complexity, length, volume, depth, hydrologic and hydraulic conditions, velocities, and temperatures are factors that affect the survival, transit, and potential success of fish passage through the reservoir which significantly influences overall fish passage efficiency and facility success. Numerous studies are available that describe the movement of outmigrating spring-run Chinook and steelhead at reservoirs in the Pacific Northwest. The USGS reports that more than 116 documents have been published to describe fish passage evaluations of anadromous fish at USACE-owned facilities alone since 1960 (Hansen et al. 2017). Results from these studies are useful when evaluating two critical factors associated with downstream passage success: (1) are juvenile fish likely to successfully navigate to a specific location where they can be collected, and (2) are factors known to influence their residence time, location, and potential for loss or mortality in the reservoir prior to collection likely to be significant? Although the general migration behavior tends to be similar, the unique environmental conditions within a reservoir influence juvenile life histories and experience in the reservoir differently.

Downstream migrating juvenile salmonids rely on several environmental factors for behavioral cues that trigger their movements and help direct them down a river channel, eventually to the ocean. The presence of reservoirs provides a potential physical barrier to downstream migration and may confound a fish’s ability to use natural environmental cues to successfully navigate downstream through the impoundment to a dam or reservoir outlet. Reservoir conditions expose downstream migrants to a number of factors that may prolong their residence time in the reservoir. The higher residence time increases the probability of predation, residualization, exposure to false pathways, and greater chance of mortality. Juveniles exposed to these factors are no longer able to continue their migration downstream and complete their natural life cycle, critical to population sustainability for anadromous salmonids. As an example, USGS tracked the survival/loss over time in several Willamette Basin reservoirs and determined that the highest loss rates were observed in reservoirs where migration rates were the slowest (Hansel et al. 2017). The results suggest that there is a steep loss rate of fish in the first 20 days of residence. Only 10 to 20 percent of the juveniles were ever found after experiencing a residence time of 40 to 80 days. Loss (or lack of detection) was attributed to multiple unknowns that could include residualization, predation, bi-directional migration, disease, mortality, or other factors.

Reservoirs created by high-head dams often create challenging passage conditions for migratory fish because water storage is one of the main purposes of these dams and uses such as flood control, recreation, and power generation dictate flow releases. Storage reservoirs are typically large, deep reservoirs, and are drained during dry periods and refilled during wet periods on seasonal or annual cycles. Reservoirs used in power generation applications exhibit more frequent regulated flow conditions and more consistent water surface elevations. Downstream water currents in the large reservoirs are typically low because of the relatively small outflows that occur compared to inflows and storage volumes, resulting poor migration queues for the fish to navigate the reservoirs (Kock et al. 2019). Thus, juvenile salmonid passage through a reservoir can be impaired by these conditions and are susceptible to delayed migration, residualization, predation, disease, and parasitism (Keefer et al. 2012, 2013c; Monzyk et al. 2015; Beeman et al. 2016). Velocity fields within reservoirs generally flow from the head of reservoir toward the reservoir outlet and guide juvenile fish downstream. Larger reservoirs generally have larger cross-sectional areas and lower velocities to guide fish downstream. Similarly, narrower reservoirs with relatively large hydropower generation flows in comparison to reservoir volume typically provide more continuous velocity field through the reservoir for fish to queue on. Facilities with such characteristics tend to result in more favorable conditions for forebay collection systems at the dam as the higher velocities provide sufficient migration cues that outmigrating fish can follow (Kock 2017).

Considering these factors, conditions at the Project reservoirs are examined in the following sections to qualitatively characterize if reservoir conditions would inhibit safe and timely migration through the reservoir. The physical characteristics of the Project reservoirs were compared with other reservoirs where either fish passage performance of an existing passage facility is known or where there are study results available that demonstrate how environmental conditions within the reservoir influence fish behavior. Key factors to consider at several Pacific Northwest reservoirs are presented in Table 5.6-1.

The following sections provide a qualitative characterization of the physical conditions of each reservoir and discuss potential transit conditions for the downstream passage of juvenile salmonids. However, the specific reservoir conditions (e.g., hydrologic, hydraulic, and temperature) during the migration timing of the target species, and their respective biological and behavioral responses are not known at this time, given that many of the target species do not currently occur throughout the Project above Gorge Dam. These site-specific factors, the biological responses, resulting fish behavior, and influence on passage success can be highly variable between species and life history strategies and need to be considered for understanding the likely fish transit conditions if a fish passage program is executed. Information from other reservoirs can be used to inform the process at a qualitative level, but must consider relative reservoir size, length, physical configuration and operational conditions.

Table 5.6-1. Comparison of Pacific Northwest reservoirs (with fish passage studies and/or facilities) to Project reservoirs.

Project	Dam Height (ft)	Surface Area (acres)	Reservoir Length (miles)	Storage Capacity (acre-ft)	Estimated Detention Time[1] (days)	Water Surface Fluctuation (ft)	Facility Type
Upper Baker Dam – Baker Lake, WA	312	4,980	9	285,371	32.7	50	Primarily Hydropower[2]
Lower Baker Dam – Lake Shannon, WA	285	2,190	8	161,470	19.9	68	Primarily Hydropower[3]
Cushman No. 1 – Lake Cushman, WA	235	4,010	8.6	453,349	77.7	20	Hydropower
River Mill Dam – Estacada Lake, OR	85	---	2.5	2,300	0.8	7	Hydropower
North Fork Dam – North Fork Reservoir, OR	207	220	4	19,000	1.6	5	Hydropower
Round Butte Dam – Lake Billy Chinook, OR	440	4,000	Metolius R: 13 Deschutes R: 9 Crooked R: 7	535,000	23.1	2	Hydropower
Swift Dam No. 1 – Swift Reservoir, WA	512	4,620	9	755,600	41.7	122	Multipurpose
Cougar Dam – Cougar Reservoir, OR[4]	519	1,280	5	219,000	100.4	167	Multipurpose
Detroit Dam – Detroit Reservoir, OR[4]	436	3,500	9	455,000	43.3	119	Multipurpose
Cowlitz Falls Dam – Lake Scanewa	140	700	4	11,000	0.6	6	Hydropower
Ross Dam – Ross Lake, WA	540	11,680	24	1,435,000	45.2	128	Multipurpose[5]
Diablo Lake– Diablo Dam, WA	389	770	4.5	50,000	3.5	7	Hydropower

Project	Dam Height (ft)	Surface Area (acres)	Reservoir Length (miles)	Storage Capacity (acre-ft)	Estimated Detention Time[1] (days)	Water Surface Fluctuation (ft)	Facility Type
Gorge Lake – Gorge Dam, WA	300	240	4.5	8,500	0.6	50	Hydropower

1 Detention time is estimated by comparing storage capacity with maximum hydraulic output to provide an order-of-magnitude comparison between projects.
2 Baker Lake is required to provide only 16,000 acre-feet of flood storage between October 15 and March 1 and up to an additional 58,000 acre-feet of flood storage during September 1 to April 15, as directed by the USACE.
3 Lake Shannon is only required to provide up to 29,000 acre-fee of flood storage during October to March 1, if directed by the USACE.
4 Cougar and Detroit Dams and their associated reservoirs have been studied for the purpose of implementing downstream fish passage technologies, however, facility designs are still in progress at the time this document was published.
5 Ross Lake is required to provide 60,000 acre-feet of flood storage by November 15 and 120,000 acre-feet by December 1 and through March 15.

5.6.1 Ross Lake

Ross Lake is located at the upstream end of the Project and serves as the primary storage reservoir. It is substantially larger and longer than reservoirs in the Pacific Northwest that have downstream surface collectors or have been studied for potential passage feasibility (Table 5.6-1). Ross Lake has approximately twice the length and storage volume of the largest reservoir in the Pacific Northwest where a forebay collector has been installed. Correspondingly, Ross Lake also has a long detention time of 189.4 days and exhibits a much broader range of water level fluctuation. The comparison of the relatively large reservoir to other Pacific Northwest reservoirs, in terms of both surface area and length, long detention time, and operational conditions, suggests that reservoir velocities are likely lower and may not support safe and timely migration through the reservoir. The long detention time likely increases the risk of extending the residence time of juvenile fish in the reservoir, increasing the potential for delayed migration, residualization, predation, and mortality in the reservoir. The physical comparison of Ross Lake to reservoirs with existing surface collectors suggests that juvenile fish migration in Ross Lake may be significantly more challenging compared to in reservoirs where downstream passage programs are currently in operation.

5.6.2 Diablo Lake

Diablo Lake is a relatively small and narrow reservoir in comparison to other reservoirs in the Pacific Northwest that have downstream surface collectors or have been studied for potential passage feasibility (Table 5.6-1). The primary function of Diablo Lake is to reregulate flows released from Ross Dam, and thus it operates as a quasi, run-of-river facility. The reservoir has a detention time of 9.4 days. The relatively small reservoir in comparison to other Pacific Northwest reservoirs, short detention time, and operational conditions suggest that reservoir currents likely support safe and timely migration through the reservoir. In addition, compared to high-head dams (which are typically storage dams), conditions at run-of-the-river dams are often more conducive to downstream fish passage because reservoir currents guide fish toward the dam, multiple passage routes can be modified to provide effective alternatives, and stable reservoir elevations provide predictable conditions for planning and implementing passage solutions (Kock et al. 2019).

The information suggests that juvenile fish migration in the Diablo Lake would be similar to migration in reservoirs where downstream passage programs are currently in operation and would be more conducive to providing suitable reservoir transit. Further future analysis of velocity fields and thermal regime in Diablo Lake would better inform the understanding of conditions in the reservoir and verify that conditions would support downstream migration of juvenile fish. Such additional assessments would not be a part of this study, but potentially integral to further alternative development if fish passage is to be implemented at Diablo Lake.

5.6.3 Gorge Lake

Gorge Lake is the smallest of the three reservoirs and is 240 acres in area, is 4.5 miles long, and has a relatively low storage capacity of 8,500 acre-feet. The primary function of Gorge Lake is to regulate downstream flows for fish protection, and thus it operates as a run-of-river facility. The reservoir has a detention time of less than one day at peak gross storage and maximum hydraulic output. The relatively small reservoir in comparison to other Pacific Northwest reservoirs, short detention time, and operational conditions suggest that reservoir currents likely support safe and timely migration through the reservoir. In addition, compared to other high-head dams (which are typically storage dams), conditions at run-of-the-river dams are often more conducive to downstream fish passage because reservoir currents guide fish toward the dam, multiple passage routes can be modified to provide effective alternatives, and stable reservoir elevations provide predictable conditions for planning and implementing passage solutions (Kock et al. 2019)

The information suggests that juvenile fish migration in Gorge Lake would be similar to migration in reservoirs where downstream passage programs are currently in operation and would be more conducive to providing suitable reservoir transit. Further future analysis of velocity fields and thermal regime in Gorge Lake would better inform the understanding of conditions in the reservoir and verify that conditions would support downstream migration of juvenile fish. Such additional assessments would not be a part of this study, but would be potentially integral to further alternative development if fish passage is to be implemented at Gorge Lake.

5.7 Intake, Forebay Configuration, and Potential for Entrainment

The intake, forebay configuration and conditions, and potential for entrainment are all factors that can affect and interact with forebay collection technologies and are important to consider during development of potential fish passage facilities. Kock et al. (2019) assessed the factors influencing performance of forebay fish collectors and reported that the forebay conditions and configuration in relation to a collector heavily influence the effectiveness of a facility. Specifically, the forebay shape, size, and depth are important factors influencing the potential performance of a collector. Forebay collectors, fixed and floating, typically operate as the main passage route for fish at high-head dams. With that in mind, successful fish passage routes are created with forebay collectors by creating conditions that maximize discovery, attraction, entrance, and retention of target fish species, where these are sequential events that must successfully occur in order and cumulatively affect the effectiveness of a collection facility. Furthermore, analysis of these factors indicates that there is significant interaction between collector entrance area and effective forebay area, and this relationship between collector entrance area is more important in large forebays than small forebays. Existing lessons learned also indicate that maximizing inflow to the collector and the collector entrance area while minimizing the area in a forebay that fish can access increases the likelihood of success. Sizes of forebays and designed attraction flow at Pacific Northwest dams where surface-oriented forebay collectors have installed are summarized in Table 5.7-1.

Table 5.7-1. Summary of the forebay area and designed attraction flow at seven Pacific Northwest dams with forebay collectors.

Site	Forebay Area (acres)	Design Attraction Flow (cfs)
Upper Baker Dam	72	1,000 cfs
Lower Baker Dam	121	1,000 cfs
Cushman Dam	200	250 cfs
Swift Dam	368	1,000 cfs
North Fork Dam	42	1,000 cfs
River Mill Dam	17	1,000 cfs
Pelton Round Butte Dam	94	6,000 cfs

Source: Kock et al. 2019

Where the relative hydraulic conditions (e.g., forebay size, collector entrance and inflows, velocities) may affect the ability of fish to locate a collector entrance, thermal conditions can also affect collection effectiveness (Kock et al. 2019). Thermal stratification can be substantial in reservoirs and can affect the performance because fish avoid the warm surface waters and thus may not find a passage facility entrance that is located at the surface. For this reason, reduced performance has been observed in summer months at some collection facilities. Therefore, the species and life history patterns need to be considered when designing juvenile passage systems. Life history strategies such as juvenile steelhead, which out-migrate as smolts during spring months when surface temperatures are cool, have a higher probability of collection than those that migrate in warmer months (Kock et al. 2019). For example, many juvenile Chinook Salmon outmigrate from headwater streams as subyearlings during summer and fall months, when warm surface temperatures occur (Schroeder et al. 2016), which may limit their collection (Kock et al. 2019). An approach for mitigating the warm surface temperature conditions is to increase the collector entrance area and depth to increase attraction of fish that are at depth when surface temperatures rise in the summer months.

The dam intake location, depth, and coincident operations (peaking or run-of-river operations) can influence the hydraulic conditions in the reservoir and the effectiveness of a collector. Examples of effects of these factors include the timing of attraction flows, relative velocities, flow patterns and eddies in the forebay, location of attraction in the forebay, and depth of attraction flows in the forebay. These factors must be considered in the design of a passage facility.

The potential for entrainment is also a factor that must also be considered and may further affect collection efficiencies of a forebay collector (Kock et al. 2019). Not all forebay collectors that have been installed prevent entrainment, either entirely or partially. The number and magnitude of spill events at each development also creates the potential for entrainment. For example, as some collector systems use measures that increase the potential for entrainment by lowering the exclusionary guide nets during spill events to provide a path for flows and debris, thus increasing the potential for entrainment (e.g., Upper Baker and Lower Baker facilities). Barriers, nets, guide nets, and screens can reduce entrainment during the period of migration, and these features would be included as part of design of a forebay collector (fixed or floating) as appropriate to facilitate successful fish passage. In addition, where exclusionary systems are not in place, larger and more frequent spill events increase of volume of flow and increase the entrainment risk where the relative flows of the collector, spillways, and powerhouse flows may reduce the ability of fish to discover the collector and the fish pass via other pathways. Thus, net systems may be used to guide fish to a collector entrance, prevent entrainment, or potential entrainment or preventing fish from accessing undesired areas such as spillways, behind a collector, or recirculating or no flow pattern areas.

In addition, the biological differences between species should be considered; age at migration, migration timing, and species-specific behavioral patterns affect how juvenile fish interact with a forebay collection system, and thus the likelihood of collection differs among species (Kock et al. 2019). These factors are important considerations for potential success of a collection facility. Despite the best efforts to design facilities according to established criteria and understanding of site conditions, it is not uncommon that a facility does not meet passage performance standards due to site specific conditions and sometimes unpredictable site-specific species, life history patterns, behaviors, and interactions with the physical environment. Mitigation for such uncertainties requires a research-based, prototype approach where execution of a phased, facility implementation process can provide adequate opportunities to learn about the interaction of fish and fish behavior within the existing or future physical operating environment prior to build-out of full-scale fish passage facilities.

Results provided herein are compiled from qualitative physical characterization of forebay conditions and are interpreted based upon the documented passage of juvenile salmonids at other like locations. Specific forebay conditions as they relate to juvenile collection are not fully understood, including specific flow patterns, velocities, more detailed temperature profiles, and how these factors will interact with a collection facility. For example, discharge from a collector can modify flow patterns in the forebay, creating circulating and confusing flow paths in the forebay that may affect the success of a collection facility. Also, discharge from a collection facility may cause mixing of the forebay, disrupting temperature conditions and profiles, as well as increase flow in interaction with the lakebed. These factors, the biological responses, and influence on passage success can be highly variable between species and life history strategies, and are site specific, and thus need to be considered for understanding the likely fish movement patterns in each reservoir and forebay. Information from other facilities can be used to inform these parameters but must be considered in light of the forebay's physical configuration and operational conditions. While the forebay size and configuration of each facility can be quantitatively assessed, the verification of the conditions and interaction with factors that affect discovery of a collector entrance are not fully understood at the dams. Further examination of flow patterns, velocity field conditions, temperature conditions, and the patterns and behaviors of specific species and life histories are required throughout any future planning or design related endeavors to better inform the potential success of potential forebay collectors at each of the dams.

5.7.1 Ross Lake

The Ross Dam intake structure is located within a rock embankment on the south side of the reservoir, about 200 feet upstream of Ross Dam. The intake gate is at the bottom of the reservoir at a depth of least 140 feet, with a minimum depth of 80.8 feet. The location of the intake at the southern corner of the forebay would be conducive to creating flow patterns to a single point in the reservoir at this location, and therefore potentially suitable for siting of a collection facility. The intake may create attraction flows at associated depths and thus should be accounted for in design, including the depth of the entrance of the facility and the need for barriers, exclusionary or guide net, and screens to reduce entrainment during the period of migration. In addition, the flow patterns created by powerhouse operations will need to be examined (i.e., computational fluid dynamics model) to confirm that the hydraulic conditions in the forebay are conducive to successful fish discovery of the entrance of a forebay collector.

Ross Dam has 12 spillways, 6 on each side of the dam. The spillways on both sides of Ross Dam were designed to be operated in synchrony; water is always released from at least one spillway, on each side, in matched pairs (the most outside spillway on the right side with the most outside spillway on the left). Fish that are in the forebay may be entrained in spill during flood events. As described in Section 2.3.1.1 of this document, spills events are infrequent at Ross Dam due to the large reservoir storage capacity and typically associated with gate testing, are of short duration, and average only a few cubic feet per second. Since 1997, Ross Dam has spilled between 0 and 30 days annually. While spill is not as common at Ross Dam as it is at other Project dams (Gorge and

Diablo), exclusionary features such as barrier nets or guide nets are features that could be included in the design to prevent or reduce spillway entrainment at Ross Dam.

The Ross Lake effective forebay area is 51.6 acres (Figure 5.7-1) and smaller than many of the effective forebay areas those where successful forebay collectors have been installed (Table 5.7-1) (Kock et al. 2019). The forebay is narrow and maintains a similar width leading out to the main reservoir, and would likely provide a continuous flow path toward the dam and potential area site of a fish collector for fish to discover a collector.

Reservoir temperature and thermal stratification are shown to influence the vertical location of outmigrating smolts in the water column as well as their access to suitable migration pathways. Studies on Willamette Basin reservoirs in Oregon have indicated that in the summer months when surface water temperatures increase, fish occupy deeper, cooler parts of the water column (Monzyk et al. 2012, 2013; Khan et al. 2012). Outmigrating juveniles also move to areas where they cannot be collected or move downstream through available passage pathways when surface temperatures increase in the summer months (Hansen et al. 2017). Reports from 2015 and 2016 monitoring and evaluation activities at six different surface collection systems indicate that outmigrating juveniles move to lower depths in the water column as thermal stratification develops in multi-purpose reservoirs during the months of August, September, and October. During these months, many of the collection systems are shut down for maintenance activities due to lack of downstream movement and reduced number of fish collected (Kock 2017).

PacifiCorp reported that 99 percent of the collected smolts passed before water temperatures reached 16 °C (PacifiCorp 2017). As temperatures began to rise above 16 °C, an increased percentage of the smolts were recorded sounding below the exclusion nets and passing downstream of the collection system to remain in preferred temperatures as they migrated downstream. This response to temperatures above 16 °C follows the Environmental Protection Agency (EPA; 2003) guidelines for Pacific Northwest salmonids: 16 °C for juvenile rearing and 18 °C for juvenile migration. The EPA (2003) also recommends 14 °C as a threshold for protection of waters where steelhead smoltification may occur, and this generally applies in April and May during their peak migration period. As described in Section 2.5.1 of this document, Ross Lake remains below 16 °C through the spring juvenile migration season. However, the reservoir is the warmer of the three reservoirs and thermally stratifies in summer, when temperatures reach 21 °C at the surface, 18 °C at 50 feet of depth, and less than 16 °C at 75 feet of depth (Figure 2.5-1). This temperature profile suggests that juvenile salmonids would likely remain at depths well below the surface in summer months where temperatures in their preferred ranges occur. Therefore, entrance depth of a juvenile fish collection facility would need to accommodate these depths to facilitate collection of juvenile fish migrating in warm summer months.

The available information suggests that the Ross Lake forebay would be conducive to juvenile collection when compared to other forebays where downstream passage programs are currently in operation. However, thermal stratification and warm surface temperatures would likely limit fish collection and passage in the warm summer months.

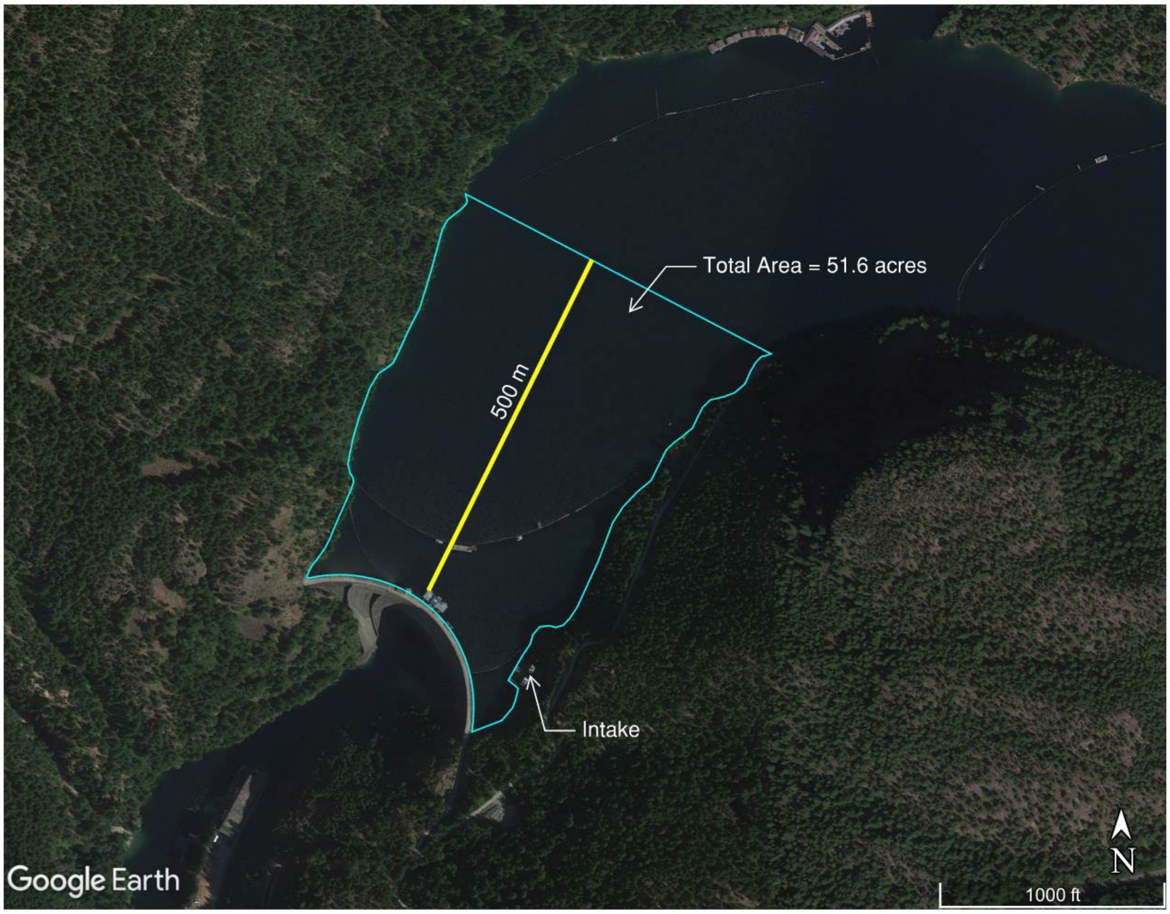


Figure 5.7-1. Ross Development effective forebay size.

5.7.2 Diablo Lake

The Diablo forebay intake is located on the north bank and at a depth of 125 feet from normal maximum water surface elevation and 118 feet from maximum drawdown elevation. The location of the intake at the northern corner of the forebay would be conducive to creating flow patterns to a single point in the reservoir at this location. Potential flow pattens leading to this area of the forebay may be useful for siting of a collection facility. The depth of the intake may create attraction flows and thus should be accounted for in design, including the depth of the entrance of the facility and the need for barriers, exclusionary or guide net, and screens to reduce entrainment during the period of migration. In addition, the flow patterns created by powerhouse operations will need to be examined (i.e., continuous flow dynamics model) to confirm that the hydraulic conditions in the forebay are conducive for successful fish detection of the entrance of a forebay collector.

Diablo Dam has five spillways: three on the south side of the dam and two on the north side of the dam. Diablo Lake spills more frequently than either of the other Project reservoirs typically during periods of high runoff, particularly during spring or early summer. Under typical operations, Diablo Dam spills an average of 30 days per year and since 1997 has spilled between 6 and 274 days annually. Spill events at Diablo Dam need to be factored into the design of a collection facility, including examination of flow patterns and potential interactions with the facility and attraction flows, measures to minimize or prevent spill entrainment (e.g., guide/exclusionary nets), siting to minimize flow conflicts or avoidance of spill flow pathways, and minimization of operational conflicts or restrictions during spill.

The Diablo Lake effective forebay area is 80.8 acres (Figure 5.7-2) and is similar in size to many of the effective forebay areas where successful forebay collectors have been installed (Table 5.7-1) (Kock et al. 2019). The forebay is relatively narrow at the dam (approximately 0.25 mile) and broadens to approximately 0.5 mile in width at the main reservoir, and would likely provide a continuous flow path toward the dam and potential area site of a fish collector for fish to discover a collector. However, the two islands located in the vicinity of the forebay and associated surrounding bathymetry may influence flow patterns or the complexity of net systems if used, but also may be useful for siting of a collection facility.

As described in Section 2.5.2 of this document, Diablo Lake is stratified in the summer, but surface and upper water column temperatures are cooler than in Ross Lake. Daily surface temperatures in Diablo Lake very rarely exceed 16°C, which is within the preferred temperature ranges of juvenile salmonids and below the EPA (2003) temperature thresholds for juvenile salmonid rearing (16 °C) and migration (18 °C) (Figure 2.5-2). This temperature profile suggests that temperature conditions in the forebay are not expected to limit fish distribution in the water column and inhibit discovery of a collector entrance in summer months. Additional examination of temperature profiles at the time of migration and associated fish location patterns would better inform the need for a collector entrance to accommodate depths that fish occur due to temperature conditions.

The information suggests that the Diablo Lake forebay would be conducive to juvenile collection when compared with other forebays where downstream passage programs are currently in operation.

Figure 5.7-2. Diablo Development effective forebay size.

5.7.3 Gorge Lake

The Gorge Dam intake structure is in a rock abutment about 100 feet upstream from the dam on the south bank of the reservoir. The intake gate is at the bottom of the reservoir and is on average approximately 60 feet deep during summer months. The location of the intake at the southern corner of the forebay would be conducive to creating flow patterns to a single point in the reservoir at this location. Similar to both Ross and Diablo, potential flow pattens to this area of the forebay may be useful for siting of a collection facility. The depth of the intake may create attraction flows to these depths and thus should be accounted for in design, including the depth of the entrance of the facility and the need for barriers, exclusionary or guide net, and screens to reduce entrainment during the period of migration. In addition, the flow patterns created by powerhouse operations will need to be examined (i.e., continuous flow dynamics model) to confirm that the hydraulic conditions in the forebay are conducive for successful fish detection of the entrance of a forebay collector.

Gorge Dam has a single spillway with two gates on the south side of the dam. Spill is relatively common at Gorge Dam, where unplanned spills at the dam can occur any time inflow exceeds generation capacity. Under current operations, most spills occur between May and August and between October and December. The relatively frequent spill events at Gorge Dam need to be factored into the design of a collection facility, including examination of flow patterns and potential interactions with the facility and attraction flows, measures to minimize or prevent spill entrainment (e.g., guide/exclusionary nets), siting to minimize flow conflicts or avoidance of spill flow pathways, and minimization of operational conflicts or restrictions during spill.

The Gorge Lake effective forebay area is 25.9 acres (Figure 5.7-3) and is similar in size to many of the effective forebay areas where successful forebay collectors have been installed (Table 5.7-1) (Kock et al. 2019). The forebay is narrow (approximately 0.1 mile) and maintains a similar width through the main reservoir, and thus would likely provide a continuous flow path toward the dam and the potential area site of a fish collector. The narrow forebay will likely minimize the potential for fish milling and may reduce the risk of fish not discovering a collector entrance.

As described in Section 2.5.3 of this document, daily surface water temperatures in Gorge Lake rarely exceeded 13 °C, and the reservoir is weakly stratified during summer. This temperature profile suggests that temperature conditions in the forebay are below the EPA (2003) temperature thresholds for juvenile salmonid rearing (16 °C) and migration (18 °C) and would not limit fish distribution in the water column and inhibit discovery of a collector entrance in summer months. Additional evaluation of temperature profiles at the time of migration would better inform the need to accommodate depths that fish occur due to temperature conditions.

For example, discharge from a collector can modify flow patterns in the forebay, creating eddies and confusing flow paths that may impair the success of a collection facility. Also, discharge from a collection facility may cause mixing of the forebay, disrupting temperature conditions and profiles, as well as increasing flow in interaction with the lakebed.

The information suggests that the Gorge Lake forebay would be conducive to juvenile collection when compared to other forebays where downstream passage programs are currently in operation.

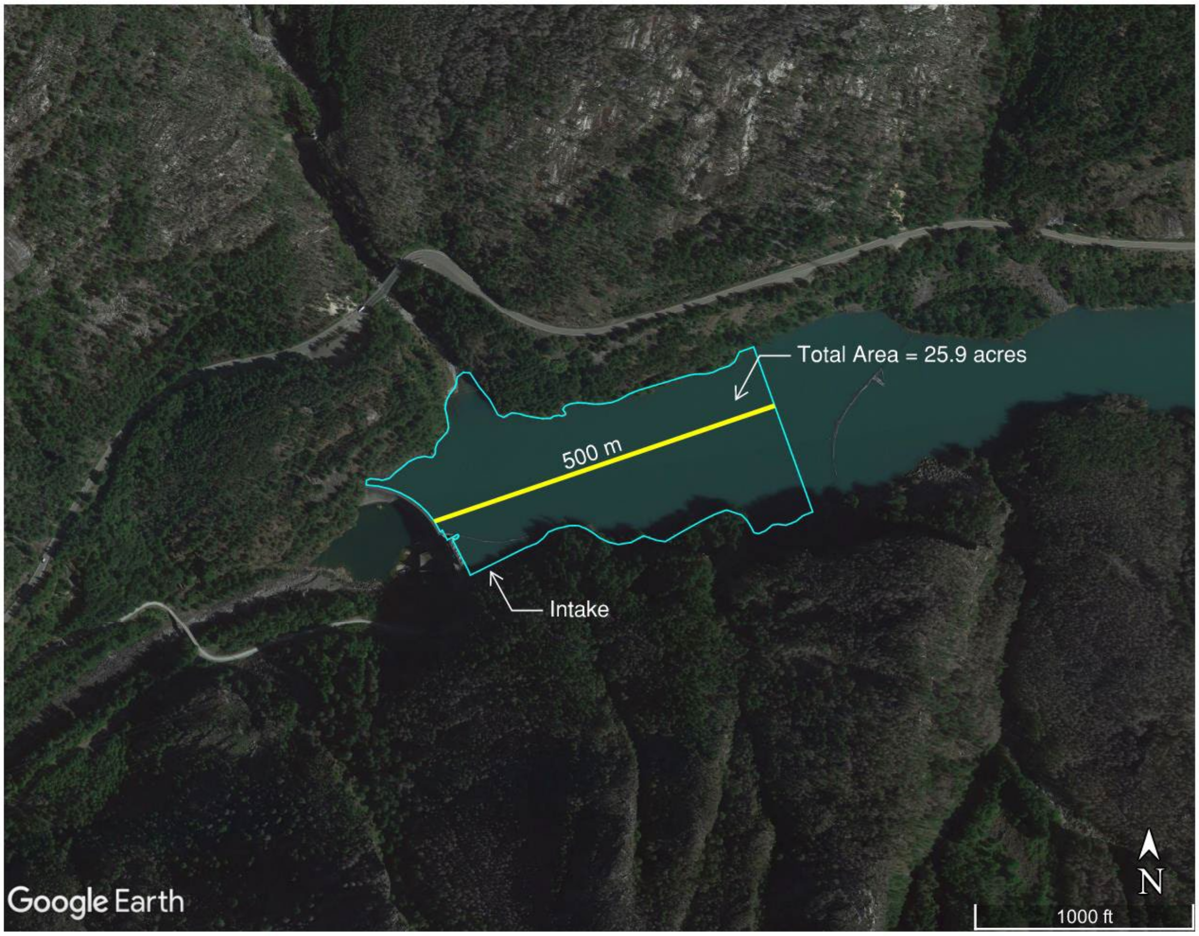


Figure 5.7-3. Gorge Development effective forebay size.

5.8 Factors Influencing Fish Passage Feasibility

A host of factors must be considered when studying the feasibility of fish passage at a project. Engineering projects customarily begin with an understanding of what is intended to be achieved, what constitutes a successful project, and what performance metrics must be met. Feasibility is taken as its common usage: “possible to achieve” (Webster 1992). For a project to be determined to be feasible, it must be able to achieve the objectives established by the project developer(s) and the standards of performance established for projects of a similar nature and purpose.

In the specific case of investigating the likelihood of success of facilitating access of anadromous fish to the reach of the Skagit River upstream of Gorge Dam, consideration must be given to, among other things, the feasibility of building and operating fish passage facilities that will meet the required performance criteria (i.e., “technical feasibility”), biological and ecological factors affecting the establishment and maintenance of viable populations (i.e., “biological feasibility”), and overall life-cycle cost and reasonable cost:benefit tests (socioeconomic effects, including impacts to existing uses). Although biological and socioeconomic feasibility are components in the comprehensive evaluation of establishing fish populations above fish passage barriers, this report evaluates only the question of “technical feasibility.” The information provided by this feasibility study will be considered in future fisheries management decisions for establishing fish populations above passage barriers in combination with many additional evaluation factors, such as those referenced by Anderson et al. (2014) and McClure et al. (2018). In concert with fish passage methods, these factors require an evaluation of complex biological benefits, risks, and constraints for establishing populations (e.g., colonization strategies, source populations) that are beyond the scope of this fish passage technical feasibility study.

For the purposes of determining if a potential alternative is technically feasible, alternative concepts will be developed and examined using the evaluation factors defined below:

- Factor 1 – Ability to Meet Engineering, Constructability, and Operational Constraints: alternatives must be able to be engineered, constructed, and operated in the context of the existing physical makeup of the site geology, existing structures, site hydrology, reservoir operations, site constraints, and a host of operational and safety requirements.
- Factor 2 – Ability to Operate in conjunction with Existing Uses: alternatives must be capable of being implemented while considering their influence on the viability, purpose, or objectives of existing uses. In some cases (e.g., such as flood control facilities), alternatives must not interfere with the life and safety requirements already established. However, some passage strategies can consider operational changes if they do not interfere with ongoing objectives.
- Factor 3 – Ability to Meet Usual and Customary Fish Passage Performance Standards: alternatives must be able to achieve the usual and customary performance standards established for similar facilities, such as collection efficiency, survival through a passage facility, and overall passage efficiency.
- Factor 4 – Adaptability: Alternatives shall accommodate a foreseeable range of future operational conditions, biological objectives, and population management strategies and are capable of adapting as lessons learned are experienced through years of operation.

Feasibility will be explored for a range of selected fish passage facility alternatives included in future deliverables prepared for this Fish Passage Study. Alternatives and their level of feasibility will be documented in Stage 2 of this study, including those alternatives that may be deemed "infeasible" by the Fish Passage Study Team. A determination of technical feasibility requires a finding that there is a high level of confidence the established project performance criteria for each evaluation factor can be achieved. If it is not realistic to expect that these goals or performance criteria can be met, the alternative may be judged "not feasible." The designation of "not feasible," does not mean that there is no possibility of an alternative functioning at some level of performance; it simply means that it is unlikely to achieve the stated performance thresholds or is unproven given the context in which it is being applied. For example, if a technology is to be applied in a way such that performance cannot be reasonably estimated or assured, it is more properly identified as "experimental." Experimental is defined as "an operation carried out to discover a fact," or a "method adopted without knowing just how it would work" (Webster 1992). Fish passage facility alternatives deemed "experimental" may be implemented using a research-based, prototype approach in which program elements are added in phases based upon the monitoring and results of subsequent experiments. These designations are to be used in this report and future study documents to designate whether an alternative is judged to be technically feasible, not feasible, or experimental.

6.0 PERFORMANCE OF PNW FISH PASSAGE FACILITIES AT HIGH HEAD DAMS

The following sections provide a summary of measured performance metrics available for selected existing Pacific Northwest fish passage facilities. The information is useful in understanding regulatory requirements in comparison to actual facility performance. There are many other example facilities present in Canada, along the Pacific Coast, and across the United States, however only a relative few are required to implement complex monitoring and reporting activities resulting in the availability of measurable results of established performance metrics.

The following information is presented to illustrate the overall context and nuance between regulatory requirements versus application of the state of the science. Although performance expectations are set by a numeric standard, actual measured performance varies greatly for certain state of the art facilities after construction, years of operation, and refinement. For perspective, implementation of high-dam fish passage strategies can be viewed as a combined array of proven technologies applied in an experimental operating environment subject to numerous unique biological and physical variables. Although fish passage technologies have advanced quickly in the Pacific Northwest in the past 20 years, it is commonly very difficult to predict how well a selected fish passage technology or program will perform with great certainty. Lessons learned at other facilities prove that careful study, development, long-term planning, and long-term financial commitments are required to successfully implement new fish passage programs. Even in those circumstances, continual monitoring, adaptive management, and revision are required for the life of some facilities to meet the standards and goals set forth by the fish management agencies prior to implementation (Anderson et al. 2014).

6.1 Measured Performance of Existing Upstream Passage Facilities

Although the majority of facilities in operation at high-head dams in the Pacific Northwest use a trap and transport method to move fish upstream, a few technical fish ladders still remain in operation. Measured performance for facilities at high-head dams in the Pacific Northwest are summarized below (see Table 6.1-1 and Table 6.1-2). Data available from many of the facilities include numbers of fish passed on an annual basis, whereas detailed fish passage efficiency data are available only for a select few.

Table 6.1-1. Summary of upstream fish passage facility performance at high-head dams in the Pacific Northwest.

Location	Species Transported/Passed	Number of Adults Transported Annually (Order of Magnitude)
Baker River, Washington	Sockeye Salmon, Coho Salmon	10,000s
Cowlitz River, Washington	Steelhead, Chinook Salmon, Coho Salmon, Cutthroat Trout	10,000s
Deschutes River, Oregon	Sockeye Salmon, Chinook Salmon, Steelhead, Bull Trout	10s
Lewis River, Washington	Steelhead, Chinook Salmon, Coho Salmon, Cutthroat Trout	10,000s
North Fork Skokomish River, Washington	Chinook, Coho, Sockeye, Chum, Cutthroat Trout	100s
Fall Creek, Oregon	Chinook Salmon	100s
McKenzie River, Oregon	Chinook Salmon, Bull Trout, Rainbow Trout, Cutthroat Trout	100s
Middle Fork Willamette River, Oregon	Chinook Salmon	1,000s
North Fork Dam, Clackamas River, Oregon	Steelhead, Chinook Salmon, Cutthroat Trout, Bull Trout	10,000s
North Santiam River, Oregon	Chinook Salmon	1,000s
River Mill Dam, Clackamas River, Oregon	Steelhead, Chinook Salmon, Cutthroat Trout, Bull Trout	10,000s
Snake River, Washington	Sockeye Salmon	100s
South Santiam River, Oregon	Steelhead, Chinook Salmon	1,000s
Toutle River, Washington	Steelhead, Coho Salmon, Cutthroat Trout	1,000s
Wynoochee River, Washington	Steelhead, Coho Salmon, Chinook Salmon	1,000s
White River, Washington	Chinook Salmon, Steelhead, Coho Salmon, Pink Salmon, Bull Trout, Chinook Salmon	100,000s
Yakima River, Washington	Sockeye Salmon	1,000s
Elwha River, Washington	Coho Salmon	100s

Source: Kock et al. 2021.

Table 6.1-2. Summary of upstream trap and haul facility fish passage facility performance at the Merwin Adult Fish Transport Facility.

Facility	Species	Collection Efficiency (Percentage)	Survival Percentage
Merwin Dam[1]	Coho	73	99.7
	Spring Chinook	90	94.5
	Winter Steelhead	86-99	99.8

Source: PacifiCorp and Cowlitz County 2020.

6.2 Measured Performance of Existing Downstream Passage Facilities

High-head dams, such as the dams at the Project, provide unique challenges for providing downstream fish passage, including factors such as flood storage and operational requirements, fluctuating reservoir elevations, large reservoirs with limited water currents for fish to cue on, and dynamic and irregular currents in the forebays. To provide fish passage at these dams, downstream fish passage facilities known as forebay collectors have been installed at some Pacific Northwest hydroelectric projects to address the issues that these dams present and to provide safe and effective downstream passage of juvenile salmonids. However, performance of these facilities has been highly variable, and the collection efficiency varies by location and species. For this reason, owners have needed to make iterative adjustments of the facilities to improve performance in an attempt to meet passage performance goals. A summary of the performance of juvenile forebay fish collectors is provided in Table 6.2-1 and a full summary is provided in the Summary of Performance Standards and Evaluation attached to this document. Kock et al. (2019) evaluated the success of forebay fish collectors and identified the following significant factors that affect performance for forebay collectors and are important considerations for selecting and designing these types of facilities:

- Collector inflow – increased collector inflow is associated with improve collection efficiency.
- Use of lead nets – lead nets reduce fish wandering in the forebay, maximize discovery of the collector entrance, and physically concentrate their movements at the entrance.
- Size of the collector entrance area – improves likelihood of discovery of the collector flow field and entrance.
- Relative size of the dam forebay – fish are more likely to discover a collector entrance in a small forebay than in a large forebay.
- Interaction between collector entrance and the forebay area – collector entrance area is less important in small forebays than in large forebays.

Table 6.2-1. Summary of Pacific Northwest downstream juvenile forebay fish collectors estimated fish collection efficiency.

Site	Species	Reservoir Passage[1]	Fish Collection Efficiency[2, 3]	Overall Survival[4]
Upper Baker Dam	Coho	---	83-99%	---
Upper Baker Dam	Sockeye	---	69-95%	---
Lower Baker Dam	Coho	---	88-96%	---
Lower Baker Dam	Sockeye	---	83-99%	---
Cushman Dam	Coho	20%	33-61%	19-48%
Cushman Dam	Sockeye	43%	39-66%	24-43%
Swift Dam[5]	Coho	62%	39%	20%
Swift Dam	Chinook[6]	58%	44%	17%
Swift Dam	Steelhead	73%	42%	10%
North Fork Dam	Coho	---	94-96%	95%[7]
North Fork Dam	Chinook	---	78-90%	92%
North Fork Dam	Steelhead	---	92-97%	97%
River Mill Dam	Coho	---	99%	---
River Mill Dam	Chinook	---	98%	---
River Mill Dam	Steelhead	---	96%	---
Pelton Round Butte Dam[8]	Chinook	24-31% (Hatchery) 22-29% (Natural)	---	---
Pelton Round Butte Dam	Steelhead	17-21% (Hatchery) 6-20% (Natural)	---	---
Cougar Dam[9,10]	Chinook	94%	96%	<1%
Cowlitz Falls Dam[11]	Coho	---	71%	75%
Cowlitz Falls Dam	Chinook	---	58%	63%
Cowlitz Falls Dam	Steelhead	---	70%	70%

1 Percentage of fish that were collected among those that were either released into the forebay or arrived in the forebay after release near the head of the reservoir.
2 Results provided include the range or most recent study results following facility modifications.
3 Proportion of fish that were collected among those released near the head of the reservoir.
4 Overall Efficiency = reservoir passage x collection efficiency x collection facility survival.
5 Values are from the 2020 study year and indicate performance following facility adjustments.
6 Juvenile Chinook Salmon ocean-type or stream-type life history type not distinguished in this table.
7 Overall efficiency reported proportion of fish collected at North Fork and River Mill Dams and provides a close indication of Project-wide survival.
8 Values are from the 2020 study year.
9 Average for research years 2014 and 2015/2016.
10 The Cougar Dam portable floating fish collector facility is a mobile, prototype facility used for the purposes of mark-recapture research and is not representative of the full facility considered for the fish passage program.
11 Cowlitz Falls Dam values are averages for years 2017-2020.

7.0 OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES AND TECHNOLOGIES TO BE USED IN ALTERNATIVE FORMULATION

For the purposes of this study, formulation of potential fish passage facility alternative concepts is advanced using a stepwise process that spans the three stages of the Fish Passage Facilities Alternatives Assessment defined in the RSP. In general, fish passage facility alternative concepts are formulated by completing the following activities:

- Preparation of example Fish Passage Strategies that may be implemented in the future by fisheries co-managers to accommodate the different biological objectives and fisheries management goals that may be desired in the future as part of program execution
- Development of pertinent fish passage technologies that may be used to accommodate upstream or downstream fish passage at potential Project locations
- Comparison of fish passage technologies to site-specific operating environments and initial assessment of fish passage technology suitability
- Facilitation of brainstorming opportunities where fish passage strategies and fish passage technologies are combined to form a range of fish passage options
- Selection of fish passage options that reflect the range of potential future biological objectives and fisheries management goals desired by LPs that are to be developed into concept-level alternatives

This section documents the results generated during completion of the first three steps of the process outlined above. Summaries of fish passage strategies are provided in Section 7.1 of this document and include a range of fish passage facility assemblies that are arranged to achieve different biological, management, and operational goals for the Project. Section 7.2 of this document provides descriptions of potential upstream and downstream fish passage technologies that may be suited for specific operating environments. Section 7.3 of this document provides an initial qualitative assessment of fish passage technology suitability. A summary of potential fish passage options resulting from several brainstorming sessions is provided in Section 8.0 of this document. A discussion of fish passage options selected for advancement into stage 2 of the Fish Passage Facilities Alternatives Assessment took place during Workshop No. 3, held on December 16, 2021. Subsequent discussion on selected alternatives occurred during AWS meeting No. 11, held on January 10, 2022, during which participating LPs concurred on the list of fish passage options to be advanced to the next stage of the study. Options selected for advancement to concept development are summarized in Section 8.5 of this document.

Although fish passage strategies at dams typically consider the assembly of various facilities to achieve specific biological, management, and operational goals of a potential fish passage program, such goals will not be formulated as part of this study. Rather, biological and fisheries resource management goals will be determined by resource management agencies, including co-managers and tribes, upon completion of this study and other concurrent relicensing studies including those that will inform intrinsic habitat potential for target species upstream of Ross Dam. Therefore, as noted by NMFS representatives during the comment period for the Preliminary Draft DCD, the Fish Passage Study “outcome is not ‘Is passage feasible and how should it be conducted’ but 'Is it feasible and by what methods.'… many interconnected studies are occurring at the same time that may have bearing on preferred fish passage strategies" (NMFS 2021).

Alternative development will occur during a future phase of work (refer to Stage (2) referenced in Section 1.3 of this document and the RSP). The selected combination of strategies and technologies will then be progressed to a concept level stage of development, which represents the second stage of this element of the Fish Passage Study. As noted throughout this document, future fish passage strategies will be informed by several concurrent relicensing studies, the results of which may not be available until mid- to late 2022. Therefore, selection of fish passage strategies and technologies will require ongoing coordination with LPs following the completion of this study.

7.1 Formulation of Fish Passage Strategies

The following subsections provide an example range of fish passage strategies considered during fish passage facility option development. The primary strategies include Reservoir Bypass, Reservoir Tributary, and Reservoir Transit strategies.

7.1.1 Reservoir Bypass Strategy

The Reservoir Bypass Strategy (see Figure 7.1-1) includes a single upstream passage facility at the base of Gorge Dam (or Gorge Powerhouse) and downstream passage facilities at the upstream faces of Ross, Diablo, and Gorge dams.

- Upstream fish passage is accomplished by collecting migrating target species at the base of Gorge Dam, and by transporting them upstream via truck to Diablo and then to Ross via barge. Release of fish would occur at a designated recovery facility at Ross Lake. Migrating fish would continue volitionally upstream by transiting through Ross Lake.
- Downstream fish passage is accomplished through collection of outmigrating juveniles and adults (if present) at the face of each dam to account for fish that pass downstream through surface spill operations after transiting downstream through the reservoir. Upon collection at one of the three downstream collection facilities, fish are transported to a recovery facility located at the selected point of release downstream of Gorge Dam.
- One option may be to locate the upstream fish passage facility at or near the Gorge Powerhouse (see Section 7.1.4 of this document).

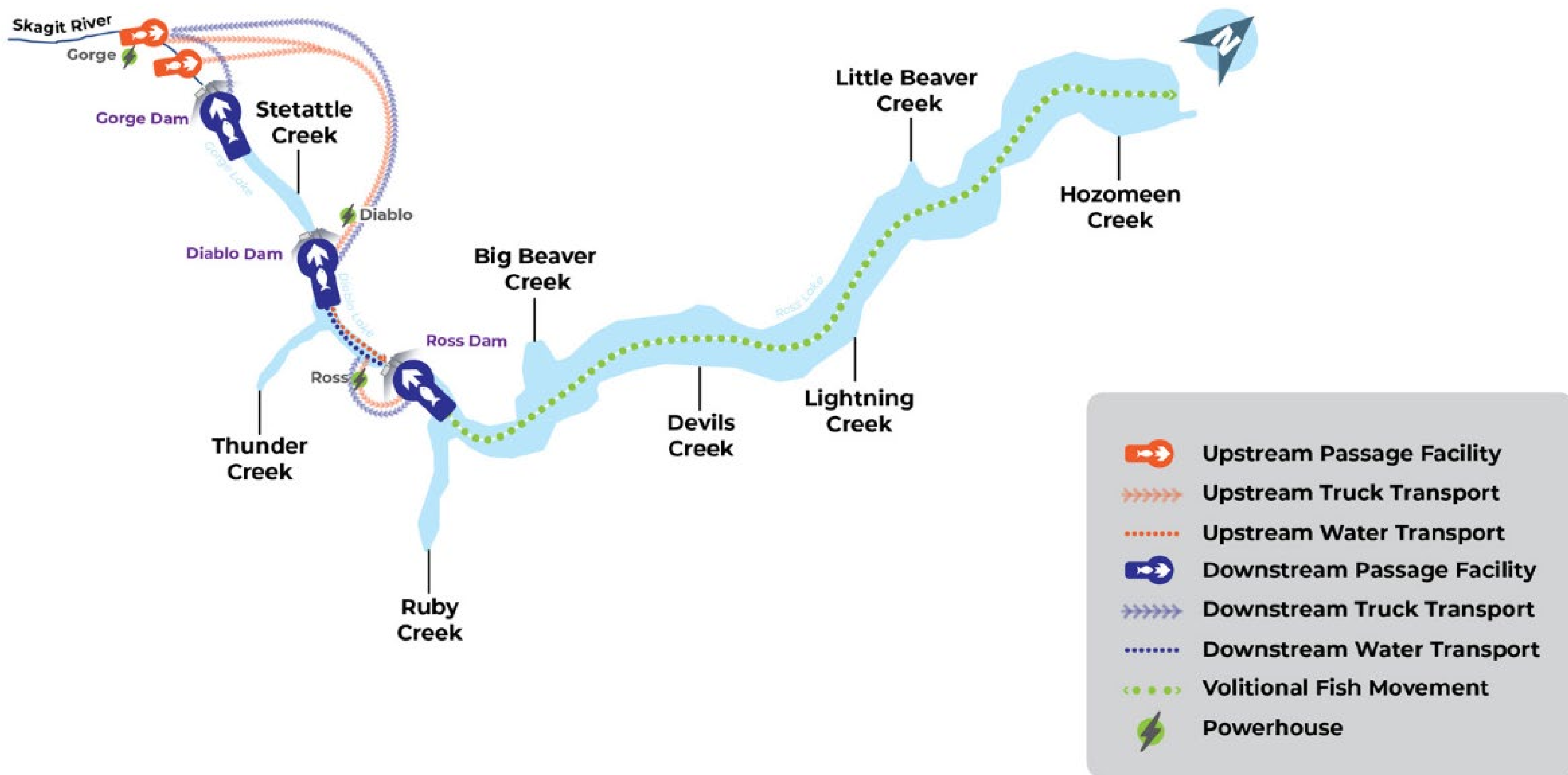


Figure 7.1-1. Illustration summarizing the Reservoir Bypass Strategy.

7.1.2 Reservoir Tributary Strategy

The Reservoir Tributary Strategy (see Figure 7.1-2) includes a single upstream collection facility at the base of Gorge Dam and multiple downstream collection facilities near the confluence of select, high-priority tributaries in Gorge, Diablo, and Ross lakes. These tributaries were selected for intrinsic habitat evaluation under the Reservoir Tributary Habitat Assessment Study because they were identified by NMFS in its Study Request 3 (NMFS 2021) as those that are "…reasonably large enough to support populations of anadromous fishes…"[25] Therefore, the Reservoir Tributary Habitat Assessment Study, a concurrent relicensing study, will provide information on available habitat reservoir tributaries and their potential to support target fish species. City Light expects that the selection of tributaries for this management strategy, if selected, will be determined during future consultations among resource agencies and co-managers. The designs and feasibility of the downstream collection facilities will be based on additional information, including intrinsic habitat potential results from the Reservoir Tributary Habitat Assessment Study, management or recovery goals that may be established, and other physical or biological information or guidance as it becomes available.

- Upstream fish passage is accomplished by collecting migrating adults at the base of Gorge Dam and transporting them upstream to their destined tributary based upon specific population management and production objectives in consideration of the potential production capacity that may be present at specific high-priority tributaries. From Gorge Dam, fish would be transported via truck to Diablo Lake, then to Ross Lake via barge. Release of fish would likely require barge transport to each tributary release facility. Adult fish would continue upstream migration in a designated tributary on a volitional basis after a brief recovery period.
- Downstream fish passage is accomplished through collection of outmigrating juvenile and adult fish (if present) near the mouth of each tributary selected as part of the population management program. After collection, fish are transported, in reverse order, back to a recovery facility located at the selected point of release downstream of Gorge Dam.
- One option may be to locate the upstream fish passage facility at or near the Gorge Powerhouse (see Section 7.1.4 of this document).

[25] Note that additional tributaries have been added to the Reservoir Tributary Habitat Assessment Study since the original study request.

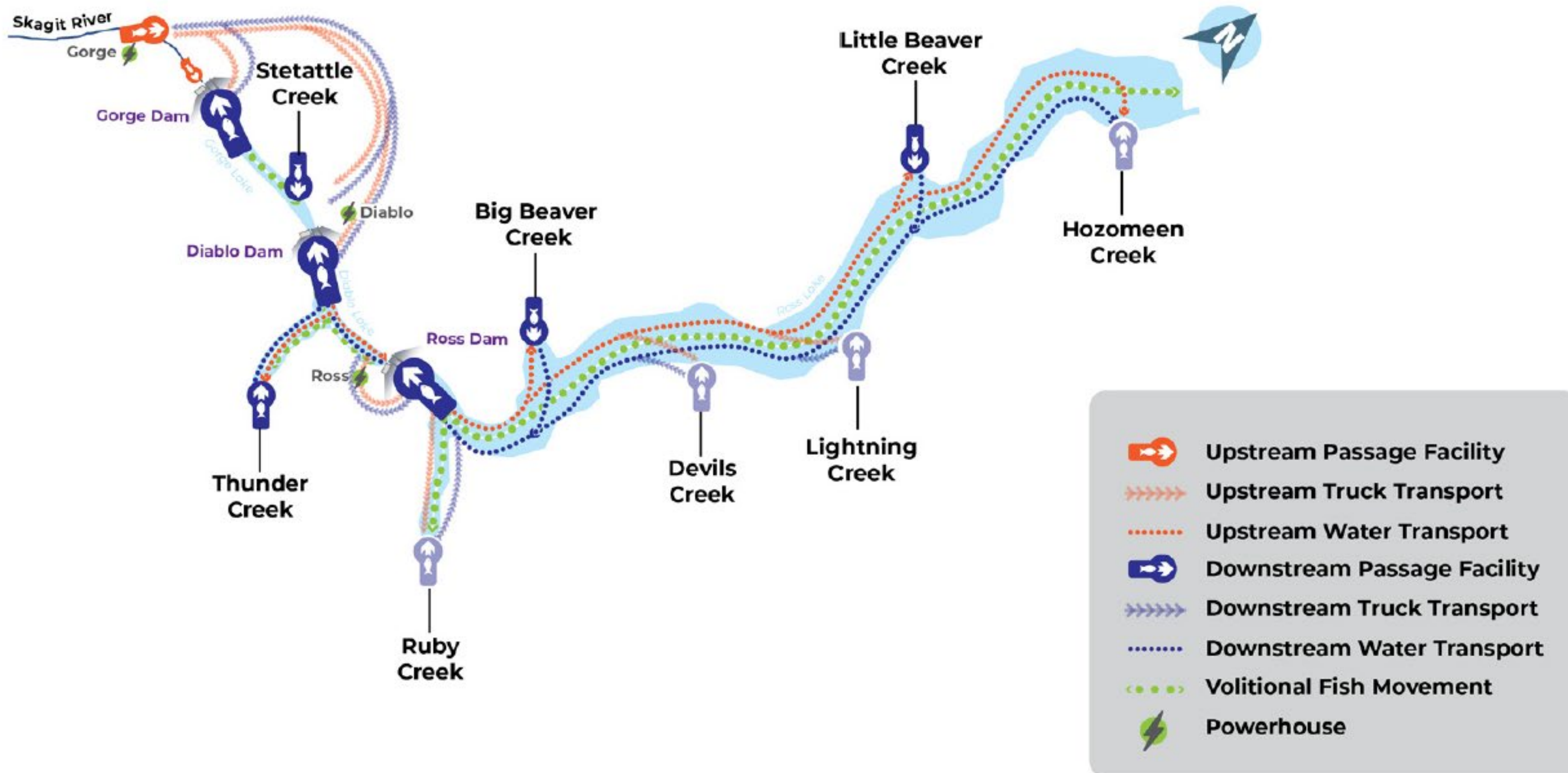


Figure 7.1-2. Illustration summarizing the Reservoir Tributary Strategy.

7.1.3 Reservoir Transit Strategy

The Reservoir Transit Strategy (see Figure 7.1-3) includes an upstream and downstream fish passage facility located at each dam requiring that fish continue upstream or downstream migration by transiting through the existing reservoirs. One of the benefits of the upstream reservoir transit strategy is that it allows fish to sort themselves to find their natal stream. This strategy could be used as one tool to address future genetic objectives that may be established by fisheries co-managers for each of the Project reservoirs. Although this strategy would require more adult handling, the alternative of transporting fish, potentially to the wrong reservoir, could result in a high fallback rate as fish search for olfactory cues in natal tributaries that may be downstream of the transfer location. From an engineering perspective, this strategy could be accomplished by the following means:

- Upstream fish passage is accomplished via an array of upstream fish passage facilities located at the base of Gorge Dam, the Diablo Powerhouse tailrace, and the Ross Powerhouse tailrace. After collection, adult fish would be transported above each of the dams and released into the next adjoining reservoir. Adult fish would continue migration upstream by transiting Gorge, Diablo, and Ross lakes to the next fish passage facility or spawning habitat.
- Downstream fish passage is accomplished via an array of downstream fish passage facilities located near the intake structures for Ross, Diablo, and Gorge dams. After collection, outmigrating juvenile and adult fish (if present) would be transported or conveyed downstream to a designated point near the adjacent "head of reservoir" or powerhouse tailrace. Outmigrating fish would continue downstream by transiting Ross, Diablo, and Gorge lakes and then ultimately be collected at Gorge Dam and transported downstream to a recovery facility located at the selected point of release downstream of Gorge Dam.
- One option may be to locate an upstream fish passage facility at or near the Gorge Powerhouse (see Section 7.1.4 of this document).

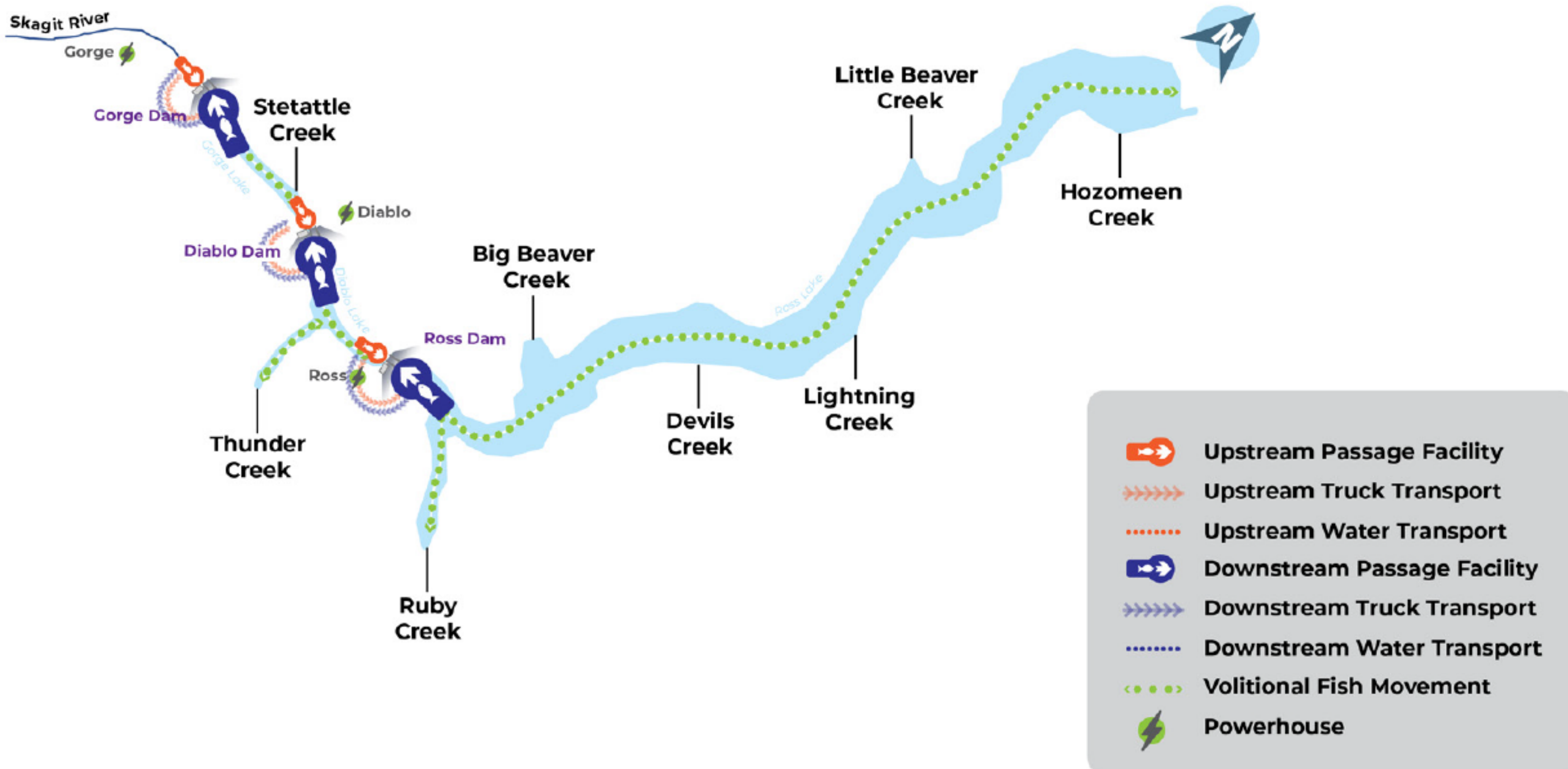


Figure 7.1-3. Illustration summarizing the Reservoir Transit Strategy.

7.1.4 Exclusion of Gorge Bypass Reach

The most downstream point of collection for upstream migrating adults or release of outmigrating juveniles and adults can be accommodated at the Gorge Powerhouse. This strategy would eliminate volitional fish migration through the Gorge Bypass Reach and the uncertainty of passage conditions that exist therein. This option could be integrated with each of the fish passage strategies currently in consideration.

7.1.5 Dam Decommissioning and Removal

The removal of Gorge, Diablo, and/or Ross dams is not considered as part of this study and will not be addressed as part of study conclusions. City Light has committed to performing a decommissioning assessment for Gorge Dam consistent with the FERC 17-factor test for hydroelectric relicensing. The 17-factor test is a tool used to determine whether a more thorough analysis of dam removal is warranted. City Light will seek the input of the license participants during development of this assessment, which will be included in the final license application (April 2023).

7.2 Potential Fish Passage Technologies

Fish passage strategies will require the selection and concept development of multiple fish passage facilities. Each fish passage facility is to be configured using a comprehensive system of technologies that work together to accomplish an anticipated biologically driven objective given a unique physical operating environment. Facilities do not merely “pass fish” but must consider numerous factors in sequence over a range of operating conditions to be effective and to perform as expected. Specifically, facilities may attract, guide, collect, crowd, lift, sort, measure, convey, hold, transfer, transport, and release fish with diligence and adherence to a wide variety of multi-disciplinary engineering principles and criteria. To that end, the following subsections provide an overview of example technologies that may be considered during the fish passage facility concept development.

7.2.1 Potential Fish Guidance and Exclusion Technologies

Fish guidance and exclusion technologies are often employed as part of upstream and downstream fish passage systems. Table 7.2-1 provides examples of technologies used in fish passage facilities that may be considered for fish passage facility development. These systems are typically designed with strict adherence to design guidance and standards specific to the range of species and life stages for which they are designed. Numerous configurations and deployment methods are available to suit the physical environment within which they are to be placed.

Table 7.2-1. Fish guidance technologies examples used in fish passage and collection systems.

Passage Method	Passage Technology	Description
Fish Diversion Systems	Angled screens	Wedge wire or profile bar screen design comprised of narrowly spaced, individual bars used to guide fish to bypass and return channels or pipelines
	Louver screens	Bar rack screen system consisting of an array of evenly spaced, vertical slats aligned across the stream channel at a specified angle to guide fish into a bypass pipe
	Eicher screens	Passive pressure screen designed to be used at hydroelectric facilities with penstocks
	Modular inclined/horizontal screens	Consists of an entrance with trash racks, dewatering stop logs in operating slots, an inclined screen deployed at a shallow angle (between 10 to 20 degrees) to the flow, and a bypass for directing diverted fish into a transport pipe
	Other	Angled rotary drum, inclined plane screens, submerged traveling screens
Physical Barriers	Barrier nets	Nets used to physically block and/or guide fish
	Wedge wire screens	Small screen slot size help prevent entrainment and impingement of juvenile fish
	Submerged traveling screens	Able to act as a fish barrier but also presents a risk for impingement
	Rotary drum screens	Generally used at tributary passage sites and at large irrigation diversions
	Velocity Barrier	A channel-spanning reach of high-velocity flow preventing fish from further migration
	Leap Barrier	A height barrier preventing fish from further migration
	Picket Weir	Similar to a leap barrier, but with slotted weirs allowing for lower upstream water surface elevation while continuing to prevent fish from further migration
Behavioral Guidance Devices	Light	Strobe or flashing lights used to repel/guide fish away from water intakes or toward bypasses
	Sound	Infrasound, impulse bangs, or recorded predator sounds may be used as a means for eliciting avoidance behavior
	Electric fields	Primarily used to stop/slow the spread of non-native, invasive fish into areas of native fish abundance
	Air bubble curtains	Generally ineffective in blocking or diverting fish

7.2.2 Potential Upstream Fish Passage Technologies

Potential upstream fish passage alternatives categories were formulated for inclusion in this report and segregated into three general categories: Trap and Transport, Fish Ladders/Fishways, and Fish Passes. A total of six general passage technologies fit within the four categories and are presented in Table 7.2-2. Descriptions of the nine potential upstream fish passage technologies are provided later in this section. Preferred alternatives may be comprised of multiple technologies based upon their ability to meet the objectives of this study with respect to providing long-term upstream fish passage and the unique operating environment within which they are to be placed.

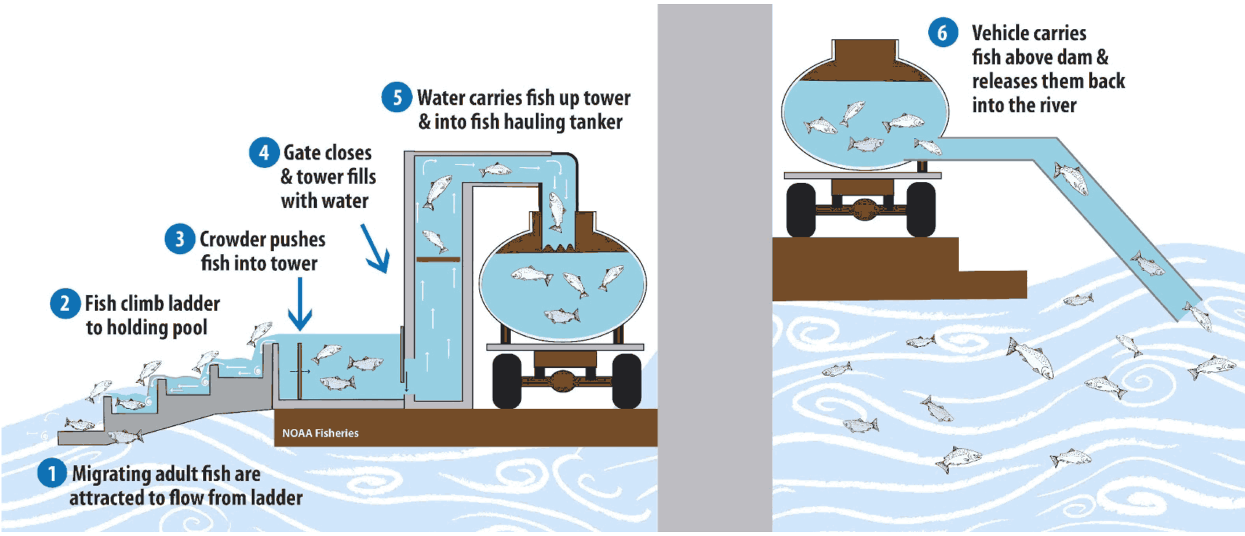
Strategies for upstream fish passage vary by the level of handling or human intervention. The alternatives listed in Table 7.2-2 are also identified as either directive or non-directive strategies. A highly managed fish passage strategy is considered directive and may consist of manual handling of fish and/or transporting fish long distances non-volitionally. A low-managed fish passage strategy is considered non-directive and may consist of mostly volitional passage without significant human intervention.

Table 7.2-2. Example upstream (adult) fish passage technologies at high-head dams.

Passage Method	Directive/ Non-Directive	Passage Technology	Description
Trap and Transport	Directive	Multiple technologies incorporated	Fish are collected near or at a blockage; the adults are then transported by vehicle or vessel above the blockage to one or more pre-determined locations upstream where they will continue their journey to their natal stream to spawn or to a hatchery as broodstock if applicable.
Fish Ladders/Fishways	Non-Directive	Technical Fish Ladders	Consists of a series of pools set in steps that lead from the river below an obstruction to above the obstruction with water flowing downstream from pool to pool. Pools are separated by baffles which control the flow and change in elevation of water in the fish ladder. Different baffling strategies are used for different ranges of fish species and operating environments.
		Nature-like fishways	Bypass channel designed and built to act more like a natural side channel with substrate, flow, channel morphology, and gradient suitable for most aquatic species.
Fish Passes	Directive	Fish elevators, lifts, and locks	Fish elevators utilize water filled hoppers to transport fish from downstream to upstream; Fish locks have lower and upper chambers connected by a sloping or vertical chamber.
		Pneumatic Fish Transport Tube System	Fish are moved through water lubricated tubes via negative pressure (vacuum).

7.2.2.1 Trap and Transport

Trap and transport technologies (Figure 7.2-1) are generally composed of five main components which include a barrier or guidance structure (Figure 7.2-2); a fish entrance (sometimes consisting of a short fish ladder); a collection, sorting, and holding facility (Figure 7.2-3); a vehicle with a transport vessel (tank of water; Figure 7.2-4); and a designated release location or locations. For example, a short ladder with attraction flow from an auxiliary water system would be used to attract fish and collect them from the river. Migrating fish would ascend the ladder and then stage within the existing holding gallery. Next, fish would be transferred to a vehicle fitted with a transport tank with life support systems. The transport tank would be transported to a pre-determined release point or points. At the pre-determined release point, fish would be transferred back to a reservoir or the selected tributaries where they would be able to continue their migration upstream.



Source: NMFS

Figure 7.2-1. Trap and transport facility example.

Figure 7.2-2. Lower Baker River adult trap and transport facility: barrier dam and collection/crowding gallery.

Figure 7.2-3. Overview of adult collection and sorting facility at North Fork Dam.

Figure 7.2-4. Trap and transport facility: truck with fish transport vessel.

7.2.2.2 Technical Fish Ladders

A technical fish ladder consists of a concrete fish ladder traversing one or both sides of a dam, likely adjacent to the spillway. Ladders can be cut into hard rock or potentially attached to the face of structures. Given the elevation difference between the reservoirs and tailraces, a fish ladder would likely run parallel to the Skagit River and may require several directional changes over long distances to traverse the potential elevation rise.

The design target hydraulic differential between baffles in the ladder would follow standard agency design guidelines for the upstream passage of adult salmonids. The pool geometry would be established using NMFS guidelines but would also consider the specific baffle type selected for the ladder. The fish ladder would be composed of typical pools, resting pools, turning pools, and potentially multiple exit pools to account for reservoir stage fluctuations. This technology requires consideration of guidance, attraction, and collection strategies for the fish ladder entrance as well as debris, temperature, and flow control provisions at the entrance. Figure 7.2-5 through Figure 7.2-7 shows example photos of fish ladder alternatives more common at higher-head fish passage facilities.

Figure 7.2-5. The 2.1-mile-long half, Ice-Harbor baffle (pool, weir, and orifice) fish ladder at the Faraday Diversion Dam and North Fork Dam.

Figure 7.2-6. Half Ice-Harbor baffle (pool, weir, and orifice) fish ladder at River Mill Dam.

Figure 7.2-7. Crooked River central vertical slot fishway near Prineville, Oregon. Source: ODFW 2021.

7.2.2.3 Nature-like Fishway

Nature-like fishways are composed of constructed concrete or earthen channels configured at lower gradients that provide quasi-natural hydraulic conditions and typically mimic low-gradient cascades and runs. In most cases, nature-like fishways use an array of rocks or other objects to add roughness, hydraulic depth, and cross-sectional diversity to create multiple hydraulic navigational pathways for fish to ascend.

In barrier dam applications, similar requirements for technical fishway entrances may apply where separate barriers may need to be implemented improve guidance and attraction into the entrance. With typical gradients ranging from 3 to 4 percent, nature-like fishways at any of the three dams would be very long and would likely require large amounts of cut and fill to maintain the targeted slope requirements.

Since nature-like fishways have shallow, fixed cross-sections, additional structural and hydraulic control provisions would be needed at the fishway exits to accommodate reservoir fluctuations greater than two feet. Therefore, a nature-like fishway would require transition back to a technical fish ladder or constructed exit before connecting back to the reservoir. Without such a feature, the nature-like fishway on its own would be unable to maintain hydraulic connectivity with a fluctuating reservoir or control flow into the fishway at high reservoir elevations. Therefore, similar to other fishway technologies, complex hydraulic controls and multiple exit ports would be required to maintain hydraulic connectivity and volitional passage during the anticipated period of steelhead migration. An example of a nature-like fishway is provided in Figure 7.2-8.

Figure 7.2-8. Heuvelton nature-like fishway on the Oswegatchie River in New York.

7.2.2.4 Fish Elevator

Another means of transporting fish to a point above each dam is to carry them over the dam in a transportation vessel either suspended from cables or pulled along rail tracks similar to a trolley system. A fish elevator system would include design and construction of hoists, concrete foundations, rails, structural members, ramps, pumps, and piping along the face of (or adjacent to) the crest of the dam. The elevator, or tram, would require a life support system and means to offload fish in case of mechanical failure while in route. An example of a fish elevator is provided in Figure 7.2-9.

One route option would be to bypass some or the entirety of the reservoirs and release fish near the head of major tributaries within each the reservoir. For this option, there would be significant geotechnical issues and expense associated with upgrading an access road and transport path to the head of the reservoir. Travel time to the major tributaries would be long, and potential for mechanical issues would be greater. Alternatively, fish could be transported and released just over the dam crest. This may reduce travel time and the potential for mechanical issues and associated fish stress or mortality.

Prior to transport, fish would be collected in a similar manner as other trap and transport type alternatives and therefore similar guidance, attraction, water control, fish ladder, and holding gallery components would be required.

Figure 7.2-9. Skokomish Dam No. 2 Adult Collection Facility fish lift.

7.2.2.5 Hydraulic Fish Lock or Lift

Another type of fish passage technology that uses a mechanical means to lift fish up and over a high dam is called a fish lock. This alternative would move fish through a continuous water column beginning at the dam tailrace and ending in the reservoir just beyond the dam crest. The water column could be created using sections of vertical medium-diameter tanks (i.e., 6 to 10 feet in diameter) or a continuous large-diameter pipeline laid on the same gradient as each dam face. Fish enter the bottom of the lock, water is fed into the lock from the bottom, and fish are crowded upwards with a braille system as the lock slowly fills. The lock (or locks) continue to fill until the water level is near the reservoir surface and the fish have moved to the top of the water column. Near the top, a gate is opened and the fish are allowed to swim out of the lock and into the reservoir. The water used to fill the lock system could be provided via gravity to reduce power requirements. In this case, water released from the lock after each cycle would be allowed to flow downstream. Water exiting the lock could be pumped back into the reservoir in order to reduce overall water consumption or loss down the Skagit River, if needed.

Prior to entering the lock, fish would be collected in a similar manner as other trap and transport type alternatives and therefore similar guidance, attraction, water control, fish ladder, and holding gallery components would be required. An example of a fish lock is provided in Figure 7.2-10.

Figure 7.2-10. Fish lock at the trap and transport facility on Baker River operated by Puget Sound Energy.

7.2.2.6 Pneumatic Fish Transport Tube System

The pneumatic fish transport tube system (also known as “Whooshh”) is an experimental technology from the agricultural and fish processing industry that has been adapted over the past decade to provide transport of live fish over distances of 1,700 feet at heights of over 250 feet. The technology is undergoing extensive pilot testing throughout the Pacific Northwest and Northeast on fish species ranging from salmon and steelhead to shad and sturgeon. Overall, the technology is gaining popularity with some resource agencies as a viable and potentially permittable option for safe and timely passage of fish over high- and low-head barriers. The technology is already being used successfully at hatcheries and aquaculture facilities around the world. An example of a pneumatic fish transport tube system can be seen in Figure 7.2-11.

The pneumatic fish transport tube system consists of a flexible plastic tube that is connected to an air pump. A pressure differential of about one to two psi is induced in the tube between the front and the back of the fish, thus pulling and pushing the fish through the tube. Once in the tube, fish travel at a speed of approximately 15 to 30 ft/s and exit the tube directly into the reservoir. Misters are located within the tube and keep the inside surface of the tube wet and relatively frictionless.

More conventional techniques similar to a transport facility are used to provide volitional entry into the pneumatic fish transport tube system. Fish would be attracted to a fish ladder entrance; they would enter a short section of fish ladder that leads to a small transition pool, and a false weir at the end of the transition pool would lead fish to a transport flume that conveys fish into the entrance of the pneumatic fish transport tube system. Different tube diameters are required to transport different-sized fish. Therefore, it is expected that a system accommodating several species of upstream migrating fish would require a multiple tube system. The outlet would likely consist of a small floating platform that would accommodate the full range of reservoir fluctuation and reduce the maximum drop height from the pneumatic fish transport tube system to the reservoir.

Figure 7.2-11. Six-lane pneumatic fish transport tube system (also known as “Whooshh”) at the Big Bar emergency fish transport site, Frasier River, British Columbia.

7.2.2.7 Lamprey Passage

Several fish passage technologies have been used or are being developed to provide adult Pacific Lamprey passage at dams with varying levels of success. Examples of adult lamprey passage technologies and reported success are presented in the following subsections.

Technical Fish Ladders

Technical fish ladders, such as pool-and-weir fishways typical of Columbia Basin dams, are designed for salmonids and often are not generally conducive for passage of Pacific Lamprey. Pacific Lamprey passage efficiencies through the fishways typically range from 40 percent to 80 percent (Moser et al. 2002b; Keefer et al. 2009, 2013a). Thus, physical modifications have been made to these fishways, including changes to entrances such as slotted entrances, bollard additions, rounding of entrance weir (Clabough et al. 2015; Le et al. 2018) and modifications to picketed leads and elevated orifices, rounding of sharp corners, and narrowing of diffuser gratings (USACE 2014).

The River Mill Dam fishway is an example of a technical fish ladder designed to successfully pass salmonids and Pacific Lamprey (Kock et al. 2019). The fishway was commissioned in 2007 and included implementation of lessons learned in the late 1990s and early 2000s at Columbia River and Snake River dams, and incorporated many of the concepts included in modifications at those fishways. The fishway is a half Ice Harbor-style fishway with 88 pools and operated with a flow of 19 cfs. At normal forebay and tailrace levels the elevation gain of the fishway is 83 feet, and the length of the fishway is 1,345 feet, and a mean slope of 6.2 percent. The design incorporated several features intended to facilitate the upstream passage of Pacific Lampreys, focusing on the swimming behavior of lampreys and particularly in high velocity areas. Lamprey-specific design elements included continuous, smooth-wall orifices, wing walls, and weir walls, which were also chamfered so that the maximum angle that a Pacific Lamprey encounters in high-velocity areas is 45-degree smooth edges. The fishway also featured lower entrance velocities and a continuous concrete pathway to provide smooth attachment past the floor diffuser. As a result, the fishway successfully passes Pacific Lamprey with passage efficiency estimates ranging from 84 percent to 98 percent. The median passage time through the fishway was 0.87 days in 2013 and 0.71 days in 2015.

The fishways at mid-Columbia River hydroelectric projects were also modified to improve Pacific Lamprey passage, based on information and testing at facilities on the lower Columbia River. Modifications have been completed at the Rocky Reach Dam, Priest Rapids Dam, and Wanapum Dam to improve passage conditions and the reliability of fish counts (USFWS 2017; Le et al. 2019; Clement 2022; Towey 2022). These improvements were made at all three of the facilities because of the similarities of the fishways and included the following:

- Rounded and smoothed edges on fishway entrance structures
- Installed flat aluminum ramps and plates to aid passage over gratings and through orifices
- Installed ramps where there were perched orifices
- Installed plating along fishway walls and over the diffusion grating in the bifurcation pool and left powerhouse fishway entrance to reduce fallback and increase overall passage
- Installed plating at all weir orifices in the lower fishway
- Made orifices flush with the floor (no steps) and/or flush to the outside fishway wall.
- Installed “slotted” (hour-glass style) fishway entrances that provide differential velocity elevations with a range of high- and low-velocity corridors to suit different species.

- Made counting station improvements, including conversion from count board stations (visual) to dual orifice video stations, a solid ramp leading to the window entrance, and plating (0.25-inch thickness) at the floor-to-crowder transition to improve guidance.

Lamprey Passage Structures

Lamprey passage structures were developed at existing passage facilities at Bonneville Dam on the Columbia River in response to observations of adult lamprey having difficulty entering the fishway, and of those that successfully entered often not successfully ascending the fishways. Lamprey have the greatest difficulty negotiating fishway entrances, collection channels, transition areas, and areas at the top of fishways, and particularly fail to pass the “serpentine” weir sections (Moser et al. 2002; Johnson et al. 2010; Keefer et al. 2013b). As a result, lamprey commonly aggregate in auxiliary water supply channels, located adjacent to the tops of these fishways (Moser et al. 2005). In response to these observations, lamprey passage structure systems were developed improving the guidance of Pacific Lampreys out of fishways. The first lamprey passage structure was installed in 2004 at the auxiliary water supply channel near the top of the Bradford Island fishway and others have since been installed at other Columbia River dams (Moser et al. 2011).

Lamprey passage structures are comprised of a series of wetted aluminum ramps and resting boxes (Moser et al. 2011). Lamprey access the passage structures via the auxiliary water supply channels through connecting trash racks or via picketed leads downstream from fish count stations where there is no readily passable outlet from auxiliary water supply channels to the dam forebay. Lamprey enter the passage structure via one of two collector ramps and then ascend through a series of wetted aluminum ramps, rest boxes, and horizontal flumes that lead to an exit slide as shown on Figure 7.2-12. For example, at the Bonneville Dam Washington-shore lamprey passage structure has an overall length of 62 feet and 30 feet of elevation gain and consists of two entrance ramps, several aluminum 45-degree ramps in a switchback design, rest boxes, and a polyvinyl chloride exit slide that leads to a volitional exit into the forebay at Powerhouse 2. The lamprey passage structures have proven to be an effective technology, with passage efficiencies ranging from 70 to 100 percent and passage times less than an hour (Moser et al. 2012). The success of these facilities is attributed to site selection and attention to lamprey-specific design consideration.

Lamprey passage structures have also been installed inside the Bonneville Dam Washington-shore fish ladder (Clabaugh et al. 2020). These were designed to provide separate lamprey passage routes out of the fishway to avoid the in the serpentine weirs. The structure was built with two ramps extending into the Washington-shore fishway downstream from the adult count station and upstream from the upstream migrant tunnel junction with the main Washington-shore fishway. The structure connects to the existing lamprey passage structure in the adjacent auxiliary water supply channel. The combined system allows adult lampreys to bypass the adult count station and the serpentine weir section of the fishway after ascending ramps in the main fishway channel.

Study results indicate that the majority (42 to 48 percent) of the lamprey that were recorded near the Washington shore entrance and successfully passed the dam passed upstream via the serpentine ladder (Clabaugh et al. 2020). The lamprey passage structures provided an alternative means for passage with 11 to 26 percent passing via the auxiliary water supply fish passage structure and 4 to 8 percent using the in-fishway passage structure. An estimated 24 to 28 percent of the lamprey did not successfully pass via the Washington-shore fishway.

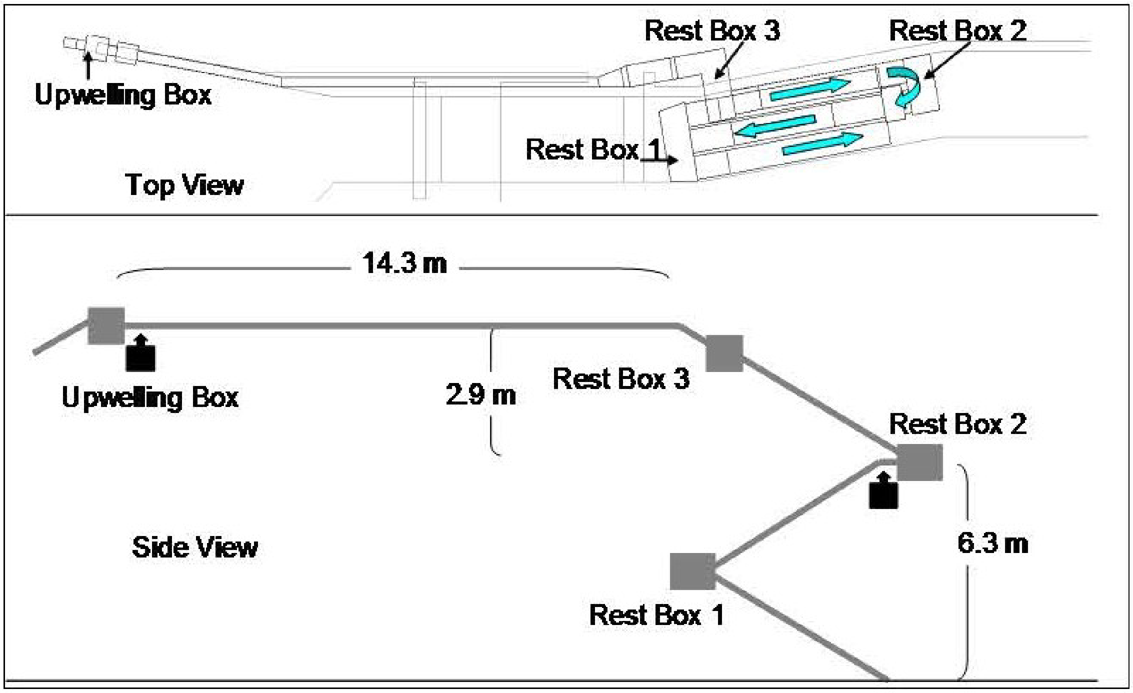


Figure 7.2-12. Schematic of the Bonneville Dam Washington Shore auxiliary water supply lamprey passage structure. Shaded arrows indicate the direction of water flow on the switchback ramps. Lower panel shows side view of the same structure. Source: Corbett et al. 2015.

Wetted Wall Passage Structure

Wetted wall passage structures have been developed as a passage technology to supplement lamprey passage at existing structures for which lamprey passage was not originally considered (e.g., fish ladders designed to pass salmonids). The wetted walls are comprised of a vertical aluminum panel that is wetted with a continuous sheet of water (Figure 7.2-13). Wetted wall passage structures were experimentally developed to take advantage of Pacific Lamprey vertical climbing ability and have been reported to successfully pass Pacific Lamprey. Frick et al. (2017) evaluated an experimental structure, where in lab tests 94 percent of Pacific Lamprey that interacted with the structure successfully ascended the wall. In advancement of the implementation of this technology, Frick et al. (2019) evaluated a prototype wetted wall passage structure installed in the serpentine weir section of the Bradford Island fishway at Bonneville Dam. The wetted wall structure successfully passed 343 lamprey from the fishway during the 3-week review period and it was estimated that passage via the wetted wall accounted for 15 percent of the total lamprey run for the time of operation. Fallbacks did occur on the features, with 91 fallbacks representing 21 percent of attachment events on the vertical wall above the water line (of which 31 percent occurred on a single night, seemingly by the same large fish). Pacific Lamprey used the wetted wall structure almost exclusively at night. When lamprey found and attached to the wetted wall structure, they generally climbed it successfully, indicating that the technology can be a useful component of existing passage systems, aid passage at future facilities, direct them into alternative routes, or provide passage over small barriers.

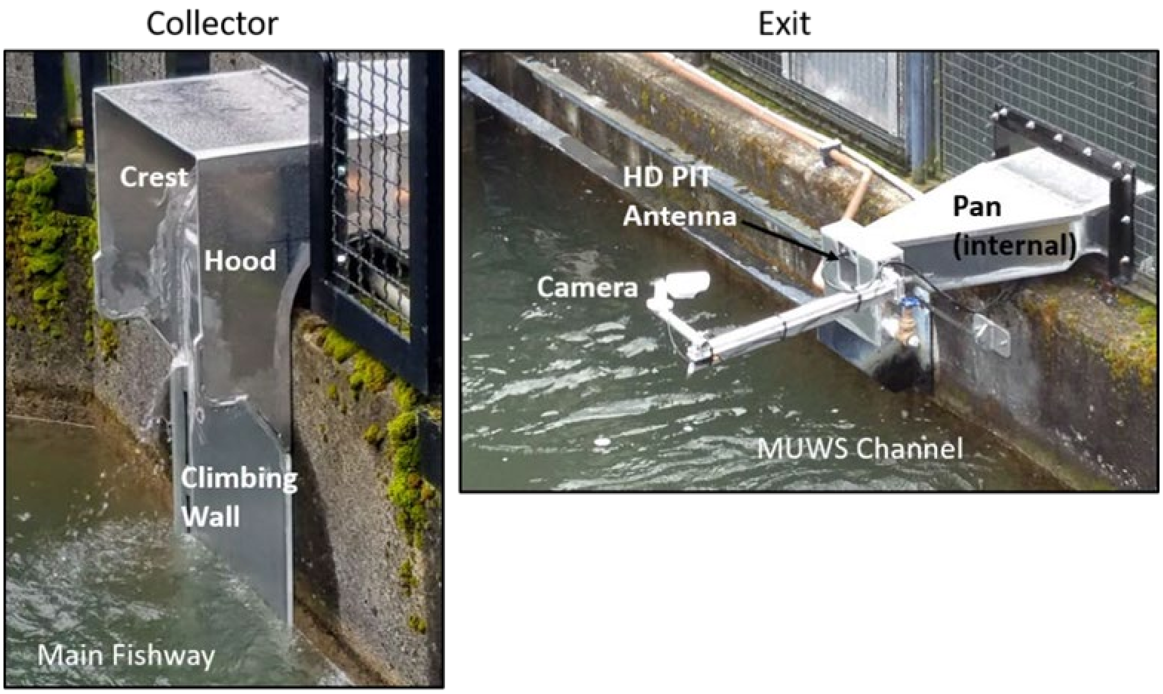


Figure 7.2-13. Images of wetted wall structure showing the collector (left) and exit (right) sections. The prototype wetted wall was installed in the serpentine weir section of the Bradford Island fishway at Bonneville Dam. Source: Frick et al. 2019.

Velocity-Reducing Bollards

Velocity-reducing bollards have been developed to reduce velocities, provide velocity refuges, and provide attachment points for lamprey in passage facilities. The design concept has been used to provide artificial rock structures (bollards) that are installed on the fishway floor to guide lamprey to the passage structures, such as a lamprey passage structure collection ramp (Figure 7.2-14). The bollards are added to the floor just inside the entrance to simulate a rock floor that reduces velocities for lamprey to move through an area. Study results indicated that lamprey actively use the bollard fields to navigate the entrance area and that they can free-swim in the water column in the relatively low-velocity areas of the transition pool section upstream of the entrance (Johnson et al. 2013).

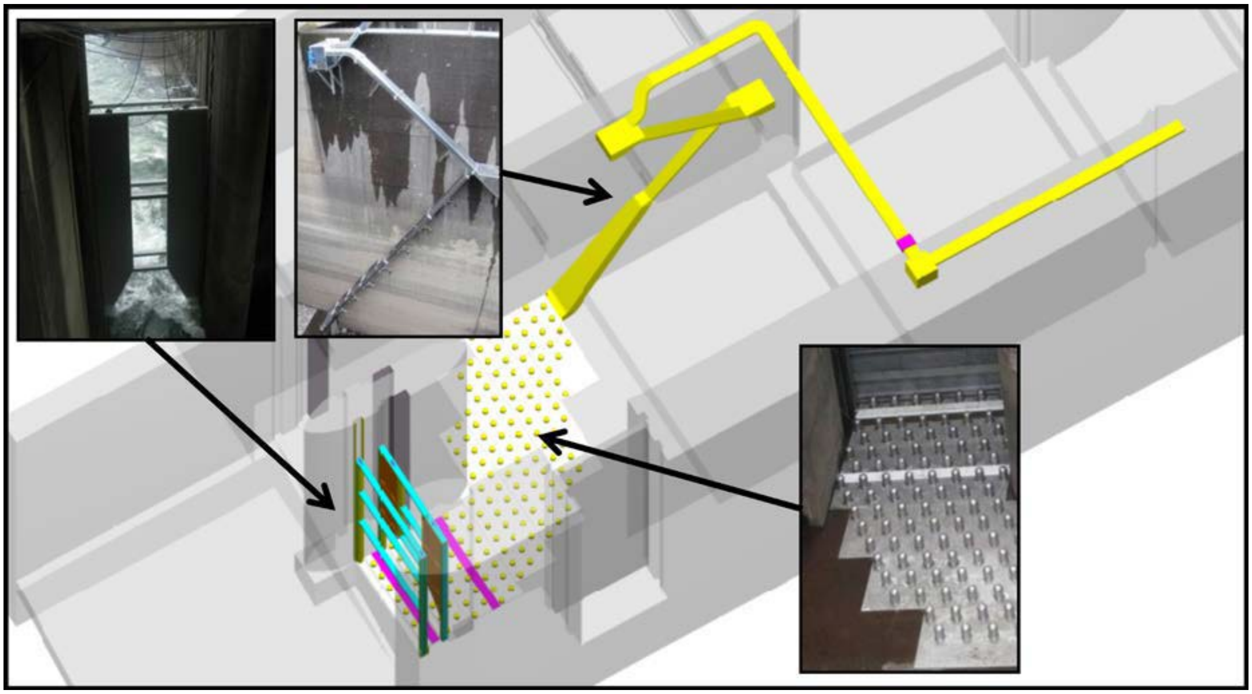


Figure 7.2-14. Bonneville Dam Cascades Island fish ladder included a fixed (variable width) entrance weir with rounded edges, velocity reducing structures (bollards) along the fishway floor, and a lamprey passage structure that leads to the forebay of the dam. Source: USACE 2014.

Adult Fish Facility Lamprey Trap

Adult lamprey traps have been developed at existing facilities for the collection, holding, and transport of lamprey for a number of purposes. An example of an adult lamprey trap is the Bonneville Dam Washington-shore Adult Fish Facility trap, installed in 2018 (Clabaugh et al. 2020). The trap consists of a climbing ramp leading to terminal trap box on the upper fishway deck (Figure 7.2-15). The ramp gains approximately 20 feet in total elevation from the fishway floor and is approximately 19 feet long, with a slope of approximately 55 degrees. The trap has been successful at collecting adult Pacific Lamprey, which have been collected and used for passage evaluation purposes (Clabaugh et al. 2020) and adult translocations and re-establishment efforts (USFWS 2020).

Figure 7.2-15. Bonneville Dam adult fish facility lamprey trap dewatered (left) and in operation (right). Source: Clabaugh et al. 2020.

Adult Lamprey Trap and Transport Operations

Trap and transport of adult Pacific Lamprey has been conducted in the Columbia Basin as part of translocation programs with the goal of reintroduction and augmentation of lamprey in tributaries above Bonneville Dam where populations have been extirpated or are at extremely low levels (Ward et al. 2012). Adult lamprey are collected from lower Columbia River dams (e.g., Bonneville Dam, The Dalles Dam, and John Day Dam) and transported to various river basins including the Umatilla River, Clearwater River, Snake River, Asotin River Yakima River, Wenatchee River, and Methow River basins and released at various locations to expand their spawning range increase ammocoete production as well as assess passage success over dams in the systems (Ward et al. 2012; Lampman 2019; USFWS 2020). Methods for transport of adults include the use of transport totes that are loaded with up to 150 adults per tote. Protocols have been developed for lengthy transport travel times (e.g., two hours) that provide loading density practices and guidance for maintaining suitable water temperature and dissolved oxygen conditions (Yakama Tribe 2021). These programs have been successful at translocating lamprey throughout the Columbia Basin and provide guidance for transport and reintroduction efforts.

7.2.3 Potential Downstream Fish Passage Technologies

The following subsections describe the range of potential downstream fish passage technologies considered for this study. Potential downstream fish passage technologies are differentiated into 7 general categories and a total of 11 technologies. A summary of each technology considered is presented in Table 7.2-3.

Like upstream fish passage technologies, downstream fish passage varies by the level of handling or human intervention. The alternatives listed in Table 7.2-3 are also identified as either directive or non-directive strategies. A highly managed fish passage strategy is considered directive and may consist of manual handling of fish and/or transporting fish long distances non-volitionally. A low-managed fish passage strategy is considered non-directive and may consist of mostly volitional passage without significant human intervention.

Table 7.2-3. Downstream (juvenile) fish passage technologies at high-head dams.

Passage Method	Directive/Non-Directive	Passage Technology/ Strategy	Description
Forebay Collectors	Directive	Fixed Inlet Collectors	Pumped or gravity flow collection facility designed to accommodate a fixed range of reservoir stage elevations generally in the range of 1 to 10 vertical feet of fluctuation. Multiple inlets can be arranged to accommodate a broader range of conditions. Typically composed of numerous technologies to guide, collect, hold, and transport fish to a downstream location. Flow ranges vary: those required for effective attraction and collection can typically range from 500 to 1,000 cfs; other examples exist up to 3,000 cfs.
		Floating Surface Collectors	Pumped flow collection facility on a floating platfom designed to accommodate the full range of anticipated reservoir stage elevations in the range of 1 to 100+ vertical feet of fluctuation. Typically composed of numerous technologies to guide, collect, hold, and transport fish to a downstream location. Flows are generally limited to those required for effective attraction and collection (typically 500 to 1,000 cfs).
		Floating Screen Structures	Gravity flow collection facility on a floating platform designed to accommodate the full range of anticipated reservoir stage elevations in the range of 1 to 100+ vertical feet of fluctuation. Typically composed of numerous technologies to guide, collect, hold, and transport fish to a downstream location. Flows include the full range of flows required for power generation (known to be up to 6,500 cfs).
Head of Reservoir Collection	Directive	Floating Surface Collectors	Floating surface collector that is located at or near the upstream end of the reservoir to minimize fish transit, residualization, predation, and mortality in reservoir. May require modular or self-contained anchoring systems to accommodate a range of reservoir conditions.

Passage Method	Directive/Non-Directive	Passage Technology/ Strategy	Description
		Passive Collectors	Passive, non-pumped, floating trap system at the head of reservoir like those considered at Shasta Lake in Northern California. Consists of guide nets, floating collection platform, and modular anchoring systems.
		In-River or Tributary Collectors	Fixed collection facility located in the river or tributary upstream of the reservoir. Typically composed of numerous technologies to guide, collect, hold, and transport fish to a downstream location.
Turbine Passage	Non-Directive	-	Modify turbines to include more modern fish-friendly turbine technologies which exhibit fewer blades, no gaps, and rotates more slowly than previous conventional turbine technologies. Generally, more acceptable as a supplemental technology at run-of-river facilities.
Surface Spill	Non-Directive	Surface Outlet Modification	Includes the integration of surface-oriented weirs and gates that conveys water and fish to bypass systems or direct release to downstream water body (tailrace or river channel) via flume or bypass system. This approach fish to pass downstream of the dam near the water surface and under lower velocities and lower pressures, providing a more efficient and less stressful dam passage route. Typically, applicable with low reservoir fluctuations and requires additional technologies to effectively attract, guide, and improve collection at the entrance.
Bypass Systems	Non-Directive	-	Fish may be directed to conduits or channels and conveyed downstream over long distances, eliminating transport by truck in some instances.
Project Operational Changes		Reservoir drawdown	Drawing down reservoirs improves fish passage by reducing transit time and additional factors that reduce reservoir transit efficiency and survival.

7.2.3.1 Forebay Collectors

Fish forebay collection systems are comprised of volitional and non-volitional components. Fish are guided into a collection facility, loaded into tanks, and then transported and released downstream. Potential guidance technologies are listed in Table 7.2-3. Three technologies are considered forebay collectors and are listed below. These forebay fish collection technologies vary by methodology and collection location, which includes upstream of the dam within the reservoir forebay (floating) and attached to the dam intake(fixed). These two location collection types are described in the following section.

- Floating Surface Collectors
- Floating Screen Structures
- Fixed Inlet Collectors

Floating Surface Collectors

Floating Surface Collectors (FSCs) include pumped attraction flow, a screened collection inlet, and the ability to collect out migrating smolt throughout a wide range of reservoir water surface elevations (Figure 7.2-16 and Figure 7.2-17). The FSC would float in the main body of the reservoir just upstream of the spillway forebay to take advantage of better orientation and depth in the reservoir (Figure 7.2-18). Full-depth guide nets would narrow the effective collection area in front of the FSC and guide fish to the collection inlet (Figure 7.2-19).

The floating barge of the FSC would fluctuate vertically with changes in reservoir stage. High-capacity, low-head pumps would provide attraction flow by drawing water from the reservoir into the FSC entrance. Water entering the FSC entrance would then be gradually screened through vertical flat plate screens in a vee configuration. A minor flow would remain in the collection channel and would convey fish to on-board holding galleries. From here trap and transport operations would be performed where fish would be crowded into transport hoppers, transported barged to the dam crest, and then released at a location downstream through a water-to-water transfer. Feedback from NMFS on the Preliminary Draft of this document indicated that most FSC with flow less than 1,000 cfs have limited collection efficiencies. Furthermore, if an FSC is feasible, each reservoir would require specific design requirements consistent with each reservoir's rule curves (NMFS 2021).

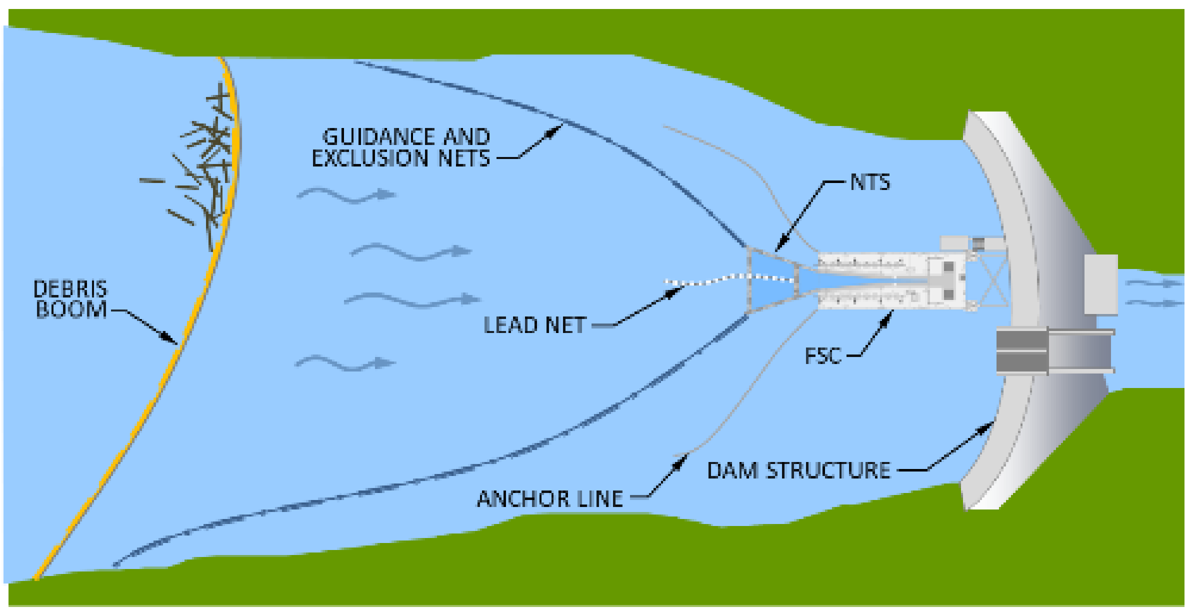


Figure 7.2-16. FSC facility example schematic plan-view.

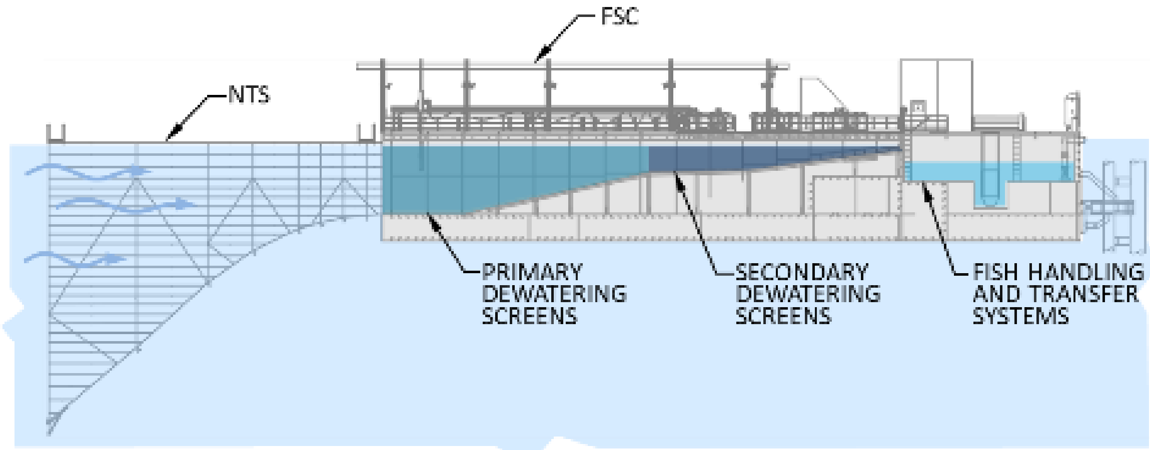


Figure 7.2-17. FSC facility example schematic plan-view.

Figure 7.2-18. FSC on Lake Shannon upstream of Lower Baker Dam operated by PSE.

Figure 7.2-19. Net transition structure for Upper Baker FSC on Baker Lake upstream of Upper Baker Dam operated by PSE.

Floating Screen Structures

Floating Screen Structures (FSSs), like FSCs, would float in the main body of the reservoir; however, FSSs are connected to a structural element such as an intake tower, a dam structure, or a stand-alone structural foundation. They are typically hydraulically connected to the intake and convey the majority of the intake flow, taking advantage of the associated attraction flow (Figure 7.2-20). Exclusion and/or guidance nets could be used on an FSS if data supports their effectiveness.

Water entering the FSS entrance is gradually screened through vertical flat plate screens in a vee configuration. A minor flow would remain in the collection channel and would convey fish to on-board holding galleries (Figure 7.2-21). From here trap and transport operations would be performed where fish would be crowded into transport hoppers, transported barged to a collection location, and then released at a location downstream through a water-to-water transfer.

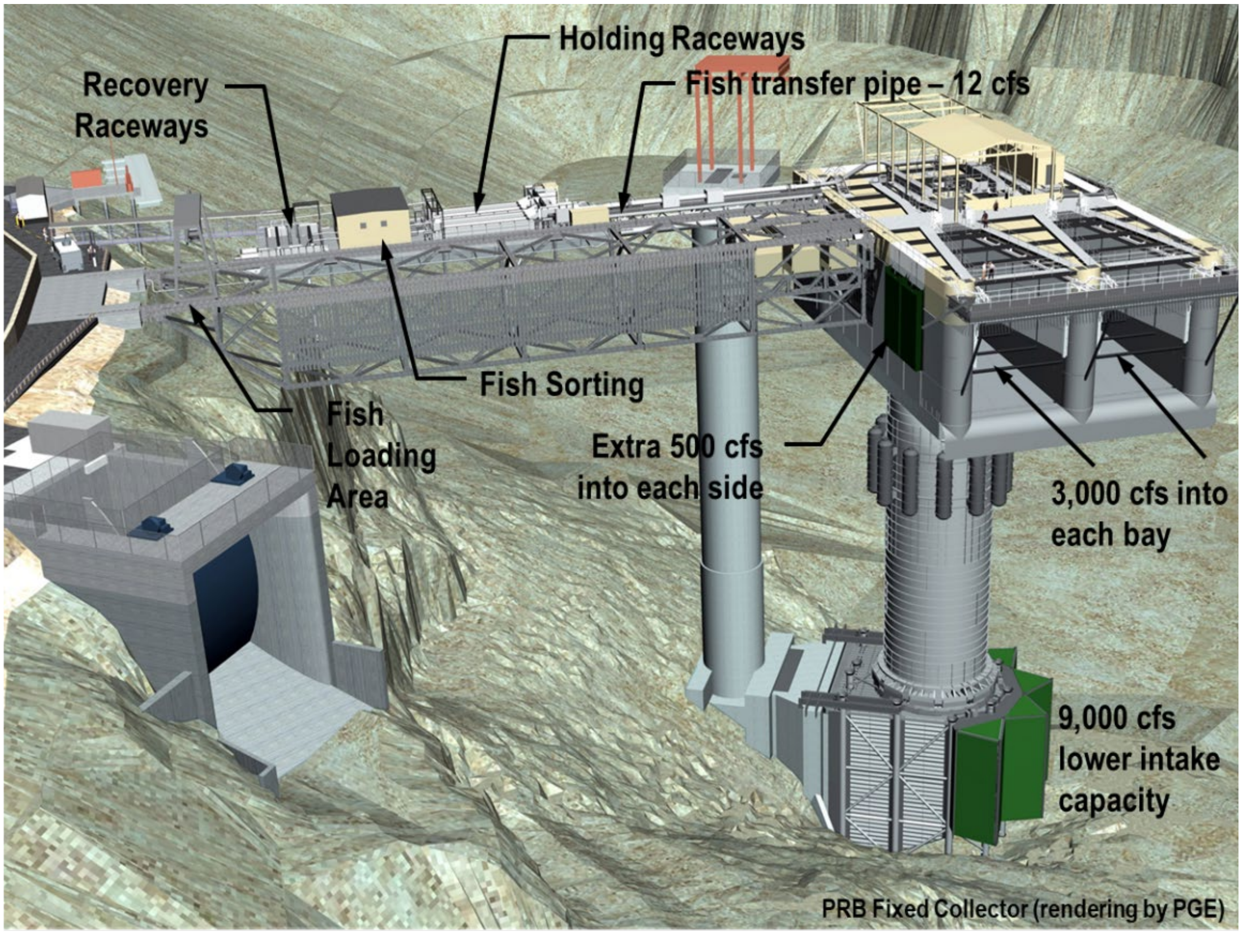


Figure 7.2-20. Rendering of FSS on Deschutes River in Oregon, upstream of Pelton Round Butte Dam operated by PGE.

Figure 7.2-21. Photo of FSS on Deschutes River in Oregon, upstream of Pelton Round Butte Dam operated by PGE.

Fixed Inlet Collectors

Fixed Inlet Collectors (FIC) are typically attached to the dam structure (Figure 7.2-22) and are hydraulically connected to the intake. They convey a portion of the intake flow, also taking advantage of the associated attraction flow (Figure 7.2-23). Exclusion and/or guidance nets could be used on an FIC if data supports their effectiveness.

Similar to FSCs and FSSs, water entering the FIC is gradually screened through vertical flat plate screens in a vee configuration. A minor flow would remain in the collection channel and would convey fish to holding galleries (Figure 7.2-23). From here, trap and transport operations would be performed in which fish would be crowded into transport hoppers, barged to a collection location, and then released at a location downstream through a water-to-water transfer. Figure 7.2-24 shows a FIC entrance adjacent to the intake on River Mill Dam operated by PGE.

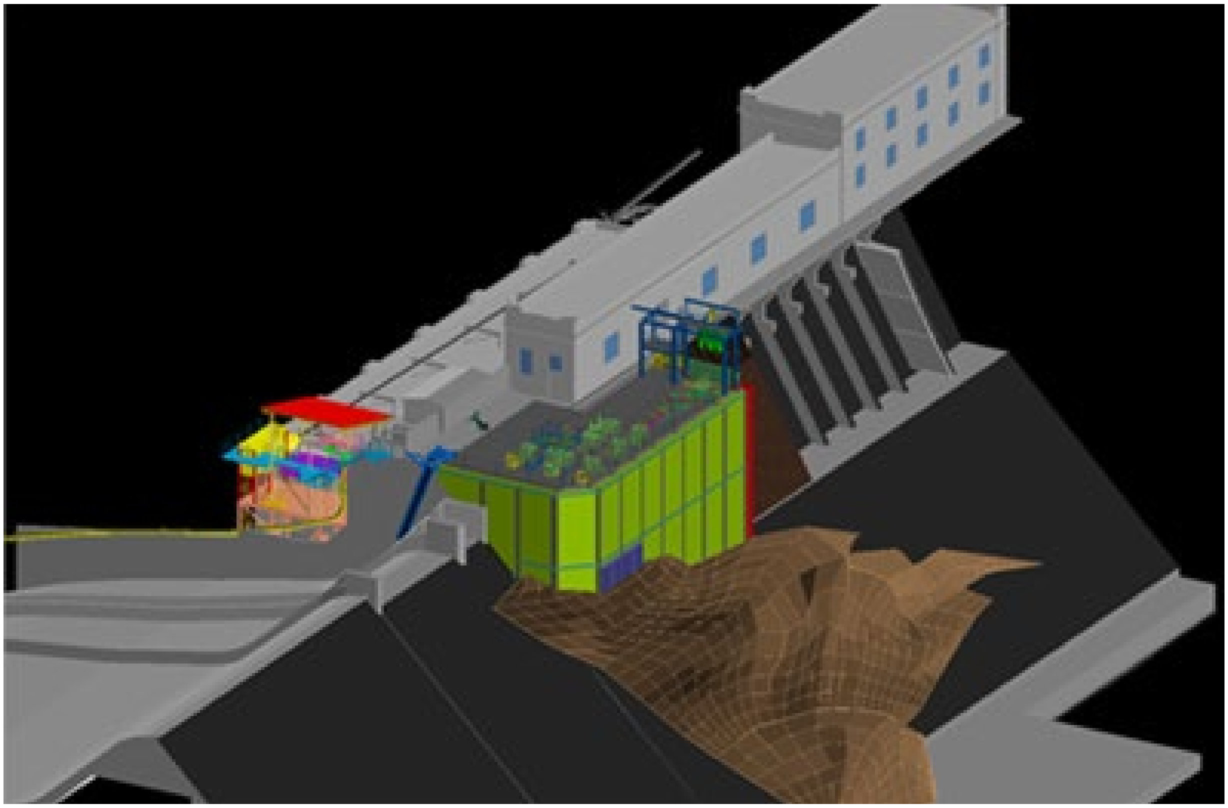


Figure 7.2-22. Rendering of FIC on Clackamas River in Oregon, on River Mill Dam operated by PGE.

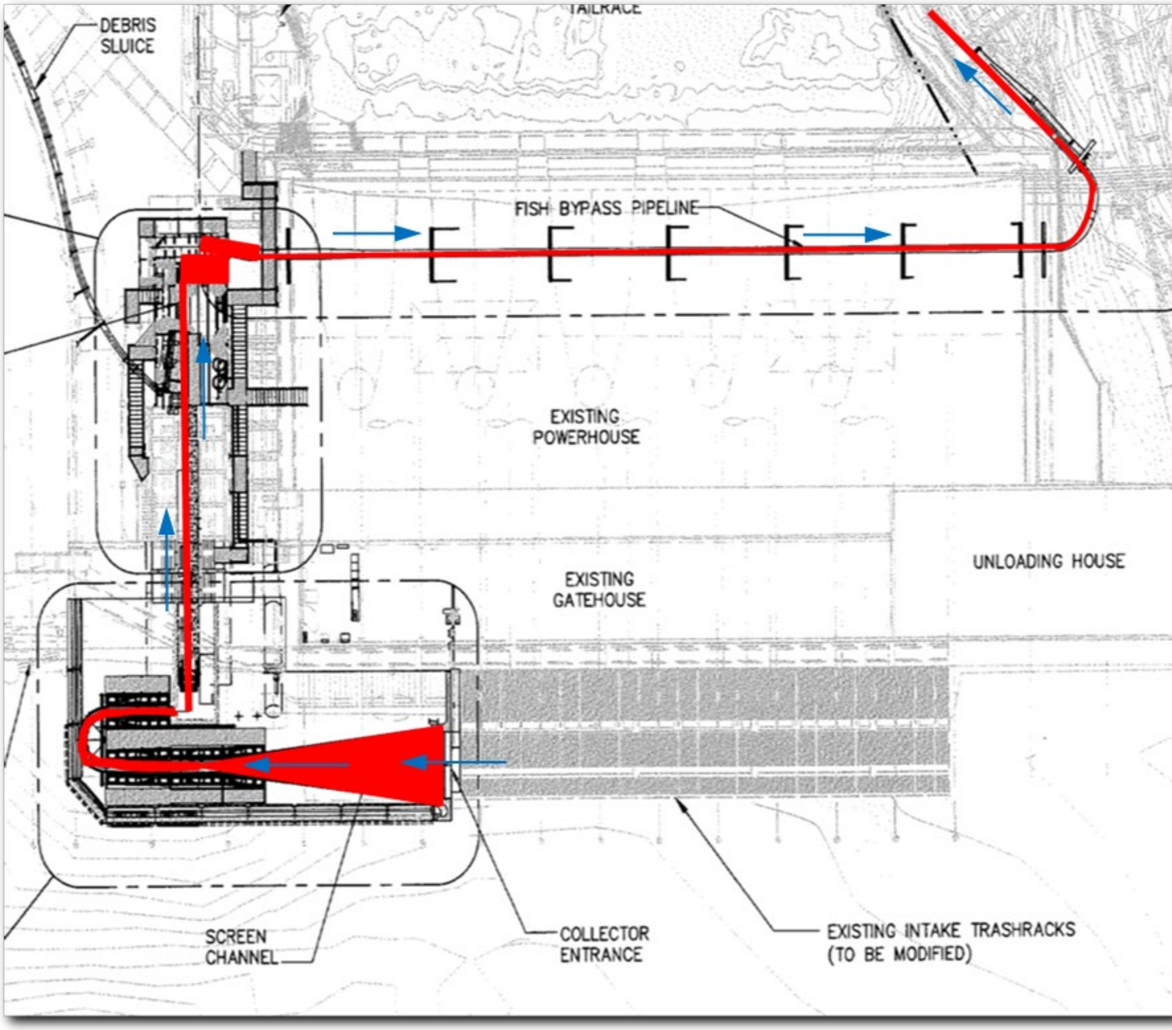


Figure 7.2-23. Diagram of FIC on Clackamas River in Oregon, on River Mill Dam operated by PGE.

Figure 7.2-24. Photo of FIC on Clackamas River in Oregon, on River Mill Dam operated by PGE.

7.2.3.2 Tributary Collectors

An in-channel type collector is a fixed, screened-type in-stream collection structure that, in this case, would be located at each of the major productive tributaries in the upper Skagit River drainage. All the flow passing down the tributaries would enter small impoundments created by adjustable bladder dams. The adjustable dam would direct a portion of the flow through a screened juvenile collection facility. Once inside the collection facility, water would be screened off through an angled vertical flat-plate screen while fish would continue downstream in the collection channel. At the end of the channel, fish would be mechanically size-sorted through floor screens and routed into holding tanks. From the holding tanks, the fish could be crowded into transport tanks and barged to a location where trucks could drive them farther downstream of the dam(s) for release.

The collectors would be effective only within the design capacity of the facilities. When flows exceed the design capacity, the remainder of the water would flow into the reservoir(s) without any fish collection, reducing collection efficiency at times when juvenile migration is occurring. In other words, fish passing downstream during flow events that exceed the design capacity of the facility would pass downstream into the reservoir. Development of this alternative would need to consider the timing, frequency, and magnitude of high flow events and the relationship between the rate of fish migration and flow.

7.2.3.3 Surface Spill

Surface spill technologies incorporate a wide range of facility types and include the integration of specific water control equipment such as weirs and gates that may allow for water and surface-oriented outmigrating fish to spill over and down an opening in a dam. In many instances, they lead to a bypass flume or chute used to safely transition water and fish back to a tailwater pool or tailrace of a powerhouse (see Figure 7.2-25). In many cases, however, surface flow technologies are only pragmatic in conditions where surface water elevations fluctuate up to 10 to 20 feet; otherwise, water control equipment becomes increasingly complex and expensive to operate. The Lower Baker Dam on Baker River, Washington, incorporated a surface-oriented overflow weir as part of their approach to providing downstream fish passage. Given the low attraction flow, loss of water, and limited compatibility with reservoir levels, the technology was completely replaced with a floating surface collector and is no longer used. Surface spill facilities are more prominently used on the run-of-river dams along the Columbia River.

Figure 7.2-25. Example spillway weir and fish bypass flume at Wanapum Dam, Columbia River, Washington.

7.2.3.4 Bypasses

Bypasses may be composed of water conveyance structures such as pipes, channels, or flumes that convey water and fish downstream, eliminating the need for transport via fish pass or truck. In many cases, bypasses are used to convey outmigrating fish short distances from one facility element to the next or from a recovery pool to a release point along the water's edge. In some cases, bypass facilities can convey water and fish for distances of thousands of feet or even miles downstream. Bypasses require the use of water (i.e., sometimes in ranges of five to hundreds of cfs) to convey fish and are designed to specific flow velocities to both exceed the swimming capability of the fish being conveyed, but at the same time create conditions that are safe and limit injury. For example, the North Fork Dam downstream fish passage facilities on the Clackamas River, Oregon, include a gravity-flow bypass pipe routing adult and juvenile outmigrating fish for 7.2 miles. Another example located at the Los Padres Dam Floating Weir Collector on the Carmel River, California, routes adult and juvenile outmigrating fish 1,100 feet downstream to the tailwater pool below the dam (refer to Figure 7.2-26).

Figure 7.2-26. Example of 1,100-foot-long juvenile fish bypass and outfall at Los Padres Dam, Carmel River, California.

7.2.3.5 Turbine Passage

Surface-oriented fish are targeted with fish collection systems (Section 7.2.2.1 of this document); however, with fish that are more inclined to transit in the lower portion of the reservoir, and that are not guided by nets to surface collection facilities (Table 7.2-1), turbine passage can be a viable option. There are risks of injury and mortality to fish that encounter conventional turbines. The primary unjust mechanisms are high shear forces, high pressure, blade strikes. The injury mechanism with the greatest potential for damaging fish will likely be blade strike (Electric Power Research Institute 2011). Fish-friendly turbines have been developed to reduce the risk of injury and mortality. An example of a fish-friendly turbine, developed by Voith Hydro, Inc., is shown on Figure 7.2-27. The fish-friendly turbine design replaced the existing conventional turbines in the Ice Harbor Dam on the Snake River east of Pasco, Washington. This passage route can be provided in conjunction with other downstream fish passage alternatives, as opposed to being a primary passage route.

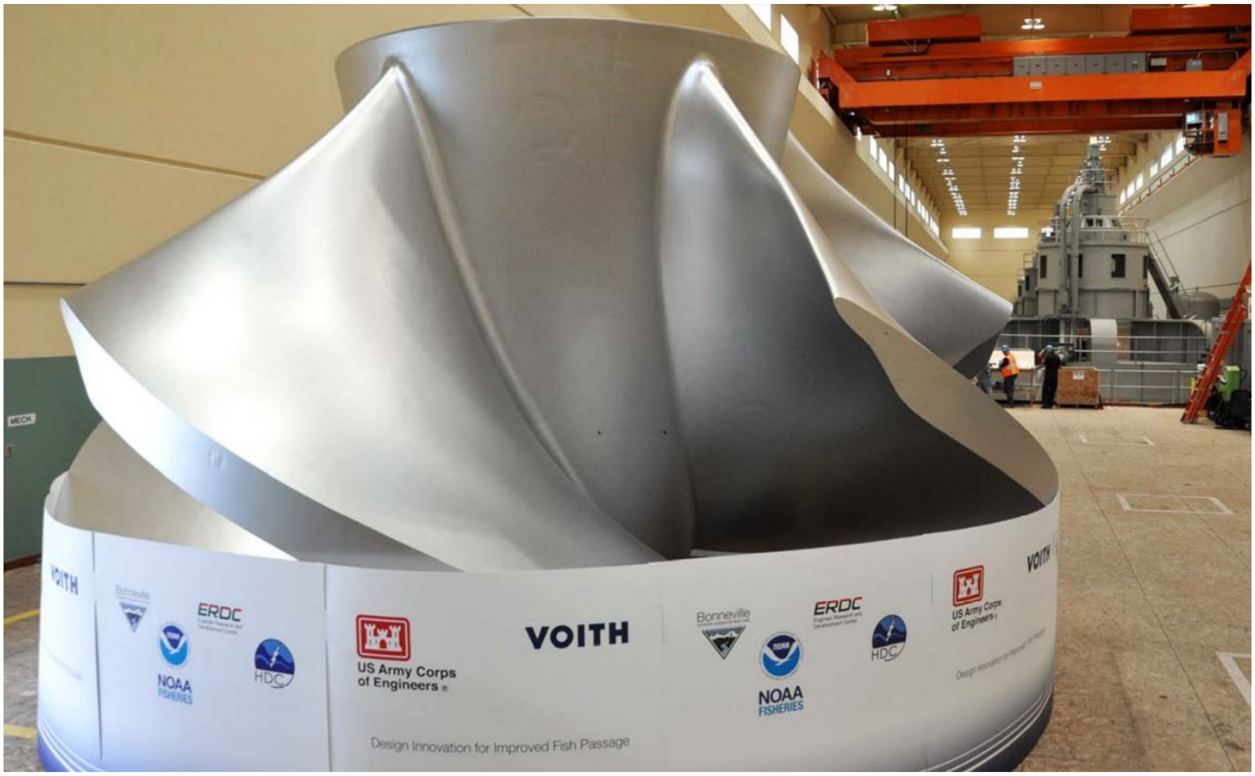


Figure 7.2-27. Example of a fish-friendly turbine used on the Ice Harbor Dam in Eastern Washington.

7.2.3.6 Project Operational Changes

Reservoir Drawdown

Reservoir drawdown during migration periods may decrease transit time for outmigrating fish. This operational change can be provided in conjunction with other downstream fish passage alternatives, as opposed to being a primary passage option. The reservoir drawdown fish passage method will need to consider factors in addition to the effectiveness of improving fish passage, including operational feasibility (e.g., instream flow, power generation, flood management, and reservoir recreational level requirements) as well as effects on the reservoir fish population community, water quality, thermal regime, velocities, and other factors. At this time, Project reservoirs are operated within assigned limits associated with their specific purposes and functions as dictated by FERC and other regulatory entities (e.g., USACE). Significant drawdown, below specified minimum pool elevations, may be inconsistent with current multi-purpose priorities such as flood control, water supply, recreation, and/or power generation operational requirements. Drawdown below these assigned levels is not considered a viable option at this time. The FA-01a Water Quality Monitoring Study, FA-03 Reservoir Fish Stranding and Trapping Risk Assessment, and OM-01 Operations Model Study may provide additional information that informs the viability of this method as a component of a fish passage strategy. If information provided by these concurrent studies indicates potential viability of this alternative, it may be reevaluated in future stages of fish passage program implementation, should that occur after this study has been completed.

7.3 Suitability of Fish Passage Technologies

The following section summarizes general suitability for applying potential fish passage technologies to the unique operating environments exhibited at several potential Project locations. Suitability presented herein is expressed by comparing a range of desired capabilities and operating characteristics with the range of fish passage technologies described in previous sections of this document.

Suitability was determined qualitatively based on the known state of the science and application of the technology within the unique, site-specific operating environments anticipated throughout each of the Project developments. For this initial qualitative assessment, the term suitability is defined according to the following key considerations:

- Are there like fish passage facility examples designed, installed, and operated under a given condition or for the intended purpose?
- Is there a long-term history of operation and record of performance in like circumstances? Does the historical record suggest that customary and expected fish passage performance metrics could be met? Is the technology deemed experimental with little record of performance?
- Are there significant physical, biological, or operational constraints that preclude use of a specific technology in the unique, site-specific circumstances exhibited within the three Project developments? Are there site-specific factors that inhibit application of a specific technology?
- Given the above state of the science and associated available information, is the technology likely to be assessed with a high or moderate level of technical feasibility or is there a higher likelihood that the technology would have a low level of technical feasibility (refer to the factors influencing technical feasibility discussed in Section 5.8 of this document)?

Table 7.3-1 and Table 7.3-2 provide a suitability rating of low (open fish), moderate (half-filled fish), or high (filled fish) for each characteristic as compared to the upstream and downstream fish passage technologies evaluated. A low rating indicates a lower level of confidence that the above considerations would be met, while a higher rating indicates a higher level of confidence when cross-comparing a given technology with a specific capability or application. Given this relative rating scheme, suitability ratings were provided as follows:

- High (filled fish): There are like fish passage facilities/technologies applied in similar operational environments with a longer record of operation that are documented to successfully provide safe and effective passage, resulting in a high level of confidence that customary fish passage performance standards could potentially be met.
- Moderate (half fish): There are fewer fish passage facilities/technologies applied in similar operational environments and/or the technology exhibits a shorter record of operation with mixed success, implying that there is some level of uncertainty that customary fish passage performance standards could potentially be met.
- Low (open fish): There are no known fish passage facilities/technologies applied in a similar operational environment with a successful record of long-term performance and/or the record of operation implies a low level of confidence that customary fish passage performance standards could be accomplished.

Information presented in Table 7.3-1 focuses on the comparison of each potential upstream technology with a range of potential capabilities and operating characteristics. The bottom five rows provide a qualitative summary of how well each technology compares to the unique operating conditions exhibited at five Project locations. Given the information presented, the following general conclusions are made:

- **Upstream Trap and Transport** – There are numerous examples of trap and transport facilities with long histories of success operating in a wide variety of operating environments including high dams with structure heights greater than 100 feet. Trap and transport facilities can include a broad range of technologies suited to a wide variety of operating environments and fish species. Advantages of trap and transport facilities include the capability of incorporating a wide variety of fisheries management goals, monitoring, selective passage (including removal of invasive species), and lower initial capital costs. Negative tradeoffs associated with trap and transport facilities have been known to include fish stress induced from handling and transport as well as high (long-term) operations and maintenance costs. Many of the negative tradeoffs associated with fish stress can generally be mitigated through the selection of collection technologies that limit physical handling and dewatering of fish, water conditioning within the transport vessel, and the incorporation of recovery facilities at the point of release.
- **Fish Ladders and Fishways** – Fish ladders and fishways (inclusive of both nature-like fishways and technical fish ladders) have been implemented world-wide to accommodate fish passage for the broadest range of fish species and life stages. In general, there are thousands of examples and lessons learned from facilities that have been designed for, constructed, and operated at impediments (including dams) with hydraulic head differentials less than 100 vertical feet. However, the presence of successful technical fish ladders at dams with hydraulic head differentials greater than 100 or even 200 vertical feet is significantly less frequent, and those that exist present a very nuanced record of success. There are very few fish ladders in existence that provide fish passage for a broad range of species successfully for head differentials greater than 300 feet (like Gorge, Diablo, and Ross dams). Attraction at fish ladder entrances, consistent water quality throughout very long ladders, baffle configuration, flow magnitude, slope, and variability of headwater and tailwater conditions all play a key role in fish ladder success. For this reason, there is a higher likelihood of success at Gorge and Diablo dams where the hydraulic head is lower and reservoir fluctuations remain lower than 20 feet so that a consistent hydraulic connection with the reservoir can be maintained without extraordinary, very complex fish ladder exit technologies (as compared to Ross Dam with higher head and much larger water surface fluctuations). Even though Gorge and Diablo dams exhibit a more suitable range of water level fluctuations, several significant biological uncertainties, engineering challenges, operational conditions, and high capital costs will need to be considered during future advancement of fish ladder concepts.
- **Pneumatic Fish Transport Tube** – In many ways, the innovative Whooshh fish transport system advances the application of trap and transport capabilities in numerous potential operational environments. Over recent years, numerous short-term, temporary installations and studies have taken place to inform reliability and performance of this technology. Advantages include the automation of fish monitoring and sorting, decrease in fish passage delay, accommodation of variable headwater and tailwater conditions, and elimination of truck transport over relatively short distances (approximately 1,000 to 1,500 feet). This technology does not, however, currently have a historic record of long-term operation and success in like

environments, and it is uncertain as to how it could accommodate the wide range of target species and life stages considered for this study. Further, this technology requires infrastructure (e.g., barrier or guidance structures, ladders, holding galleries, and holding/collection facilities) like those required for more traditional technologies and is not believed to provide substantial benefit over other proven technologies (e.g., trap and transport), especially if transport over long distances is required. At this time, this technology may be more suited to short-term pilot studies or as a component of future trap and transport facilities as more long-term operational experience is obtained.

- **Fish Passes including Fish Lifts, Fish Elevators, and Hydraulic Locks** - This range of technologies is frequently applied, to some degree, as a component of numerous trap and transport facilities around the world. In most cases, they are used to accommodate the movement of fish on the order of 10 to 50 vertical feet from the point of collection to sorting stations, holding pools, or release pools. Very few examples exist at dams with hydraulic heads over 100 feet, and although theoretically capable in many operational environments, there are limited information and long-term operational records available to support a high level of confidence that such technologies would meet customary fish passage performance standards expected for a facility at Gorge, Diablo, or Ross dam. One risk that is considered at high dam facilities is the overall mechanical complexity of such facilities and the inherent long cycle times when transport vessels are moving fish with limited emergency access or rescue opportunity, should a mechanical failure occur. Such scenarios may be mitigated through local manual operation (rather than autonomous or automated systems), on-board water conditioning equipment, and redundant lift systems should a manual rescue be required.

Table 7.3-1. Summary of upstream fish passage facility suitability factors.

	Potential Upstream Fish Passage Technology			
	Trap and Transport	Fish Ladders and Fishways	Pneumatic Fish Transport Tube	Fish Passes
Capability and Characteristic of Operating Environment				
Monitoring capability	High	Moderate	High	Moderate
Selective passage (potential for removal of invasive species)	High	Low	Moderate	Low
Holding, sorting, sampling, biometrics, tagging, etc.	High	Low	High	Moderate
Multiple points of release	High	Low	Low	Low
Volitional passage	Low	High	Moderate	Moderate
Tailwater fluctuation (0 to 10 ft)	High	High	High	High
Tailwater fluctuation (10 to 20 ft)	Moderate	Moderate	Moderate	Moderate
Tailwater fluctuation (>20 ft)	Moderate	Low	Moderate	Moderate
Forebay fluctuation (0 to 10 ft)	High	High	High	High
Forebay fluctuation (10 to 20 ft)	High	Moderate	Moderate	High
Forebay fluctuation (>20 ft)	High	Low	Moderate	Moderate
Total hydraulic head (0 to 50 ft)	High	High	High	High
Total hydraulic head (50 to 100 ft)	High	Moderate	High	Moderate
Total hydraulic head (>100 ft)	High	Low	Moderate	Low
Long history of performance	High	High	Low	High
Experimental technology	No	No	Yes	No
Operational Suitability at Project Locations				
Gorge Powerhouse	High	Low	Low	Low
Gorge Dam	High	Moderate	Moderate	Moderate
Diablo Powerhouse	High	Moderate	Low	Low
Diablo Dam	High	Moderate	Moderate	Moderate
Ross Dam	High	Low	Moderate	Low

Note: = Low Suitability; = Moderate Suitability; = High Suitability

Information presented in Table 7.3-2 focuses on the comparison of each potential downstream technology with a range of potential capabilities and operating characteristics. The bottom five rows provide a qualitative summary of how well each technology compares to the unique operating conditions exhibited at five Project locations. Given the information presented, the following general conclusions are made:

- **Forebay Collectors** – Forebay Collectors have been designed, implemented, monitored, refined, and improved for decades. Fixed Collector installations are common among the run-of-river dams of the Columbia River system and other high-dam locations where reservoir fluctuations are operated within a narrow range of approximately 10 feet. Since 2008, full-scale implementation of Floating Surface Collectors and Floating Screen Structures operated in highly fluctuating reservoirs have generated numerous lessons learned regarding uncertainty in the biological and physical operating environment in addition to considerations that must be incorporated into planning and design of such installations. When appropriately studied, sited, configured, and operated at hydropower facility intakes, Forebay Collectors are known to achieve moderate to high levels of performance for outmigrating adult and life stages of pacific salmonids and bull trout. Forebay Collectors can also be implemented with both trap and transport and, when the reservoir and physical site characteristics are compatible, bypass conveyance strategies. Overall, Fixed Collectors may be suitable for consideration at Gorge and Diablo Dams while a floating collector (FSC or FSS) may be suitable for consideration at Ross Dam.

- **Head of Reservoir Collectors –** Head of Reservoir Collectors include an experimental genre of floating, passive collection weir systems that have been considered largely throughout the west but have not yet been implemented on a full-scale basis. Although floating collection systems like 'screw traps' and 'fish wheels' have been used for sampling purposes for decades, floating systems configured near the head of lakes or reservoirs for the purpose of high efficiency collection of all downstream migrating fish have not been developed beyond the prototype level. Head of Reservoir Collectors rely on an arrangement of guidance nets, a floating barge, and an anchoring array that would be required to remain in place when fish collection is desired. The arrangement would require adjustments in reservoirs that exhibit a high range of water surface fluctuation. The arrangement would require less effort and adjustment in reservoirs that exhibit a narrower range of water surface elevations. In concept, they could be applied in remote, hard-to-reach areas of the reservoir where constructed In-River Tributary Collectors may be too impactful to construct. Head or Reservoir Collectors may be more suitable for use in Gorge and Diablo Lakes, but could be used on a prototype basis in Ross Lake as part of tributary prioritization and fish passage program implementation.
- **In-River Tributary Collectors –** In-River Tributary Collectors consist of a fixed or seasonal system of elements that are common to channel-spanning fish collection facilities. In general, fixed elements such as channel-spanning barrier weirs (typically designed with picket panels and bar racks), collection boxes, hydraulic control features, foundations, and access improvements are designed to accommodate the size of the water body, the types of debris and flow that they will experience, and the number, species, and life stages of fish they are anticipated to collect. These facilities must be visited daily to collect fish, remove any debris that has accumulated from the day before, and make operational adjustments. During periods of high flow, the barrier weirs are laid down on the channel bottom or removed so that they aren't damaged. Appropriate designs can be implemented to accommodate both juvenile and adult outmigrating fish but can typically only operate over a very specific range of flows which may or may not meet the fish management goals of a future fish passage program. It is also recognized that many of the tributaries present along the Gorge, Diablo, and Ross Lakes exist within designated wilderness and culturally sensitive areas. During the concept development process, LPs expressed concern with the potential long- and short-term impacts and frequent disturbance that In-River Tributary Collectors could cause at numerous tributaries. Given these concerns over the potential for impacts to existing resources, this type of technology may be less suitable for widespread implementation throughout the Gorge, Diablo, and Ross developments.

- **Turbine Passage** – Fish friendly turbines have made significant advances over the past several decades and turbine retrofit projects at several run-of-river Columbia River Dams have resulted in the successful passage of juvenile salmonids downstream with less injury and mortality than with earlier turbine technologies. Although, Turbine Passage technologies have been successful at these lower head projects, the Skagit Project dams and power generation infrastructure exhibit hydraulic head pressures of more than 300 feet. Such hydraulic head pressures preclude the safe and effective passage of downstream migrants through the penstocks and powerhouses. Such differentials have the high likelihood of inducing pressure-related barotrauma injuries or mortality, and thus are not expected to meet the performance criteria anticipated for downstream passage survival at Gorge, Diablo, or Ross developments.

Table 7.3-2. Summary of downstream fish passage facility suitability factors.

	Potential Downstream Fish Passage Technology							
	Fixed Inlet Collectors	Floating Surface Collectors	Floating Screen Structures	Head of Reservoir Collection	In-River or Tributary Collectors	Turbine Passage	Surface Spill	Bypass Systems
Capability and Characteristic of Operating Environment								
Monitoring capability	●	●	●	●	●	○	○	◐
Selective passage (potential for removal of invasive species)	●	●	●	●	●	○	○	◐
Holding, sorting, sampling, biometrics, tagging, etc.	●	●	●	●	●	○	○	◐
Multiple points of release	●	●	●	●	●	○	○	○
Volitional downstream passage	◐	○	○	○	○	●	●	●
Reservoir stage fluctuation (0 to 10 ft)	●	●	●	●	N/A	●	●	●
Reservoir stage fluctuation (10 to 20 ft)	◐	●	●	◐	N/A	◐	◐	◐
Reservoir stage fluctuation (>20 ft)	○	●	●	○	N/A	○	○	○
Total hydraulic height (0 to 50 ft)	●	◐	◐	●	N/A	◐	●	●
Total hydraulic height (50 to 100 ft)	●	●	●	●	N/A	●	◐	●
Total hydraulic height (>100 ft)	●	●	●	●	N/A	○	○	●
Effective forebay Size (<100 ac)	●	●	●	N/A	N/A	●	●	●
Effective forebay Size (100-200 ac)	◐	◐	◐	N/A	N/A	◐	◐	◐
Effective forebay Size (>200 ac)	○	○	○	N/A	N/A	○	○	○
Reservoir thermal stratification (strong)	○	○	○	●	●	○	○	○
Multiple target species	◐	◐	◐	●	●	◐	○	◐
Peak rates of migration (high i.e., >20,000)	●	●	●	○	○	●	●	●
Peak rates of migration (low i.e., <20,000)	●	●	●	●	●	●	●	●
Long history of high performance	●	◐	◐	○	◐	◐	●	●
Experimental technology	No	No	No	Yes	Yes	No	No	No
Capable of providing high attraction flow	◐	◐	●	○	○	●	◐	◐
Ability to manage high debris loads	○	○	○	○	○	◐	◐	◐
Operational Suitability								

	Potential Downstream Fish Passage Technology							
	Fixed Inlet Collectors	Floating Surface Collectors	Floating Screen Structures	Head of Reservoir Collection	In-River or Tributary Collectors	Turbine Passage	Surface Spill	Bypass Systems
Capability and Characteristic of Operating Environment								
Gorge Dam	High	Moderate	Moderate	High	Moderate	Low	Low	Moderate
Diablo Dam	High	Moderate	Moderate	High	High	Low	Low	Moderate
Ross Dam	Low	High	High	Low	Moderate	Low	Low	Moderate

Note: = Low Suitability; = Moderate Suitability; = High Suitability

The general suitability of each technology for each of the target species is provided in Tables 7.3-3 and 7.3-4. The suitability of passage was determined based on known state of the science for the technology and for the species and migratory life stage. The information available for passage at a high-head dam varies for each target species, the technology, and the direction of passage (i.e., upstream or downstream). For example, extensive study and monitoring information is available for Pacific Salmon and steelhead because these species have been the focus of fish passage in the Northwest. However, upstream passage information is largely for adults and juvenile upstream passage is sparse, and vice versa for downstream passage (adult passage is largely incidental). Some information is available for passage of resident salmonid species such as Bull Trout, Cutthroat Trout, and Rainbow Trout because passage of these species is commonly a secondary priority and documentation, reporting, and further study are not as common. Little information is available on passage of non-salmonid species at high-head dams.

Table 7.3-3. Summary of upstream fish passage facility suitability for target species and life stages.

Target Species	Potential Upstream Fish Passage Technology			
	Trap and Transport	Fish Ladders and Fishways	Pneumatic Fish Transport Tube	Fish Passes
Chinook Salmon – adults	High	High	High	High
Chinook Salmon – juveniles	Low	Moderate	Low	Low
Coho Salmon – adults	High	High	High	High
Coho Salmon – juveniles	Low	Moderate	Low	Low
Sockeye Salmon – adults	High	High	High	High
Sockeye Salmon - juveniles	Low	Moderate	Low	Low
Steelhead – adults	High	High	High	High
Steelhead – juveniles	Low	Moderate	Low	Low
Chum Salmon – adults	High	High	High	High
Chum Salmon – juveniles	Low	Moderate	Low	Low
Pink Salmon – adults	High	High	Moderate	High
Pink Salmon – juveniles	Low	Moderate	Low	Low
Bull Trout – adults	Moderate	Moderate	Moderate	Moderate
Bull Trout – subadults	Low	Moderate	Low	Low
Bull Trout – juveniles	Low	Moderate	Low	Low
Sea-run Cutthroat Trout – adults	Moderate	Moderate	Moderate	Moderate
Sea-run Cutthroat Trout – juveniles	Low	Moderate	Low	Low
Dolly Varden – adults	Moderate	Moderate	Moderate	Moderate
Dolly Varden – subadults	Low	Moderate	Low	Low
Dolly Varden – juveniles	Low	Moderate	Low	Low
Pacific Lamprey – adults	Moderate	Moderate	Low	Low
Salish Sucker – adults	Low	Moderate	Low	Low
Salish Sucker - juveniles	Low	Low	Low	Low

Note: (open fish symbol) = Low Suitability; (half-filled fish symbol) = Moderate Suitability; (filled fish symbol) = High Suitability.

Table 7.3-4. Summary of downstream fish passage facility suitability for the target species.

Target Species	Potential Downstream Fish Passage Technology							
	Fixed Inlet Collectors	Floating Surface Collectors	Floating Screen Structures	Head of Reservoir Collection	In-River or Tributary Collectors	Turbine Passage	Surface Spill	Bypass Systems
Chinook Salmon – adults	High	High	High	Moderate	High	Low	High	High
Chinook Salmon – juveniles	High	High	High	High	High	High	High	High
Coho Salmon – adults	High	High	High	Moderate	High	Low	High	High
Coho Salmon - juveniles	High	High	High	High	High	High	High	High
Sockeye Salmon – adults	High	High	High	Moderate	High	Low	High	High
Sockeye Salmon – juveniles	High	High	High	High	High	High	High	High
Steelhead – adults (pre-spawn)	High	High	High	Moderate	High	Low	High	High
Steelhead – kelts (post-spawn)	High	High	High	Moderate	High	Low	High	High
Steelhead – juveniles	High	High	High	High	High	High	High	High
Chum Salmon – adults	High	High	High	Moderate	High	Low	High	High
Chum Salmon – juveniles	High	High	High	High	High	High	High	High
Pink Salmon – adults	High	High	High	Moderate	High	Low	High	High
Pink Salmon – juveniles	High	High	High	High	High	High	High	High
Bull Trout – adults	High	High	High	Moderate	High	Low	High	High
Bull Trout – subadults	High	High	High	Moderate	High	Low	High	High
Bull Trout – juveniles	High	High	High	Moderate	High	High	High	High
Sea-run Cutthroat Trout - adults	High	High	High	Moderate	High	Low	High	High
Sea-run Cutthroat Trout – juveniles	Moderate	Moderate	Moderate	Moderate	High	High	High	High
Dolly Varden – adults	Moderate	Moderate	Moderate	Moderate	High	Low	High	High
Dolly Varden – subadults	Moderate	Moderate	Moderate	Moderate	High	High	High	High
Pacific Lamprey – adults	Low	Low	Low	Low	Moderate	Low	Low	High
Pacific Lamprey – juveniles	Low	Low	Low	Low	Moderate	Low	Low	High
Salish Sucker – adults	Low	Low	Low	Low	Moderate	Low	Low	High
Salish Sucker – juveniles	Low	Low	Low	Low	Moderate	Low	Low	High

Note: (open fish) = Low Suitability; (half-filled fish) = Moderate Suitability; (solid fish) = High Suitability.

8.0 POTENTIAL FISH PASSAGE FACILITY OPTIONS

Potential fish passage facility options were formulated by combining the range of potential fish passage strategies (summarized in Section 7.1 of this document) with fish passage technology types (summarized in Section 7.2 of this document) considering numerous physical locations within each development. Potential options considered for the Ross, Diablo, and Gorge developments were formulated with LP input as part of three AWS meetings that occurred on November 1, 2021; November 15, 2021; and November 29, 2021; with each session dedicated to a single development. These discussions focused on the range of technical options, criteria, and design considerations that influence fish passage option formulation and provided an open forum for brainstorming, discussion, and feedback with AWS participants. Each of the three brainstorming engagements were comprised of the following format for each Project development:

- Review of existing conditions and site-specific factors that influence the type, size, complexity, and location of potential fish passage facilities at each Project development.
- Summary of example strategies and technologies that could be considered as potential fish passage options
- Facilitation of a brainstorming session and discussion of potential fish passage options using the interactive Mural platform. Brainstorming topics included:
  - Fish Collection/Entrance Locations (upstream/downstream)
  - Fish Release/Exit Locations (upstream/downstream)
  - Key Considerations (upstream/downstream)
  - Risks or Concerns (upstream/downstream)
  - Potential Technologies (upstream/downstream)
  - Data Gaps
  - Other

The resulting AWS agenda, summary notes, and presentation slides resulting from the brainstorming process are provided in the Fish Passage Study Agency Work Session Discussion Summaries attached to this document. An overview of the range of potential fish passage options formulated during the brainstorming process for each development are discussed in the following subsections (Sections 8.1 through 8.3) of this document. The potential fish passage options included in this document represent an initial list of ideas generated with the purpose of bracketing a wide range of possible outcomes. Each subsection includes a narrative summary and illustration of the options generated during the brainstorming sessions as well as key considerations that influence option development and advancement, should they move forward to Stage 2 of the Fish Passage Facilities Alternatives Assessment. Additional considerations applicable to all developments are provided in Section 8.4.

The initial list of options and the technical description of each option were reviewed by LPs as part of DCD development during additional AWS meetings and FA-04 Workshop 3 conducted in December 2021 and January 2022. Subsequent feedback obtained during the review process has been incorporated into this Final DCD. Based upon the results of these discussions and the feedback obtained by LPs, a selected subset of potential fish passage facility options and technologies was selected to advance to the next stage of the overall Fish Passage Study in 2022 (see Section 8.6 of this document). The list of options selected for advancement to the next stage of the Fish Passage Study received concurrence from LPs during AWS meeting No. 11, held on January 10, 2022. As part of the concurrence on the list of options selected to carry forward in this study, LPs requested narratives providing rationale for the exclusion of some technologies discussed in Section 7.2 of this document. Such rationale associated with removal from further consideration is presented in Section 8.5 for each development.

8.1 Ross Development

A potential range of fish passage options formulated for the Ross Development are summarized in Table 8.1-1. Summary descriptions of each option are provided in Table 8.1-2. Example Figures 8.1-1 through 8.1-3 illustrating concept facility locations and fish movement pathways are provided for a select number of options. Details for options advancing to the next stage of development will be expanded in subsequent iterations of the study documentation.

Table 8.1-1. Summary of potential fish passage options considered for the Ross Development.

Option Characteristic	Option						
	Option R1	Option R2	Option R3	Option R4	Option R5	Option R6	Option R7
Facility Locations							
Ross Powerhouse	✓	✓	✓	✓	✓	✓	✓
Forebay at Ross Intake	✓	✓			✓	✓	✓
Ross Lake at Tributary			✓				
Tributary(s) to Ross Lake				✓			
Gorge Powerhouse							
Fish Passage Strategy							
Reservoir Bypass							
Tributary Management			✓	✓	✓	✓	
Reservoir Transit	✓	✓			✓	✓	✓
Technologies for Upstream Passage							
Fish Ladder (volitional)		✓					
Trap and Transport (non-volitional)	✓		✓	✓	✓	✓	
Pneumatic Fish Transport Tube							✓
Fish Pass							
Technologies for Downstream Passage							
Forebay Collector	✓	✓			✓	✓	✓
In Tributary Collector				✓			
Head of Reservoir Collector			✓		✓	✓	
Downstream Trap and Haul	✓	✓		✓	✓		✓
Bypass Pipe/Channel						✓	✓

Table 8.1-2. Summary descriptions of potential fish passage options considered for the Ross Development.

Option Characteristic	Option Summary
Option R1	▪ Upstream passage: Trap and transport facility at Ross Powerhouse near the base of Ross Dam. Upstream truck transport is accomplished along the Ross Dam haul road. ▪ Downstream passage: Forebay collector located near the Ross Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a FSS or FSC is likely due to the high range of water surface fluctuation present at Ross Lake. Downstream truck transport is required down the Ross Dam haul road. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods emphasizing volitional fish movement through Diablo and Ross Lake, self-selection to existing tributaries, and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.1-1).
Option R2	▪ Upstream passage: Volitional fish ladder from Ross Powerhouse to Ross Lake. Requires a significantly complex, experimental ladder exit system due to the presence of high headwater fluctuation occurring during the upstream migration period. ▪ Downstream passage: Forebay collector located in the forebay of Ross Reservoir near the intake structure and downstream trap and haul. Use of a FSS or FSC is likely due to the high-water surface fluctuation of Ross Reservoir ▪ This fish passage strategy accommodates volitional upstream migration and downstream trap and transport methods and emphasizes volitional fish movement through Diablo and Ross Lakes as well as selected downstream fish transport to alternative release sites as desired through the future development of specific fish management goals.
Option R3	▪ Upstream passage: Trap and transport facility at Ross Powerhouse near the base of Ross Dam. Upstream truck transport is accomplished along the Ross Dam haul road. Water transport via boat or barge system is required to select tributary release locations. ▪ Downstream passage: Multiple head-of-reservoir floating collection barges deployed and operated near the confluence of select tributaries to Ross Lake. Downstream fish transport is accomplished via boat or barge system to Ross Dam. Downstream truck transport is required down the Ross Dam haul road. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level. The number and priority of tributaries can be informed a later date as additional information becomes available from the FA-07 Reservoir Tributary Habitat Assessment (refer to Figure 8.1-2).
Option R4	▪ Upstream passage: Trap and transport facility at Ross Powerhouse near the base of Ross Dam. Upstream truck transport is accomplished along the Ross Dam haul road. Water transport via boat or barge system is required to select tributary release locations.

Option Characteristic	Option Summary
	▪ Downstream passage: Multiple fixed or seasonal in-tributary fish collection facilities near the confluence of select tributaries to Ross Lake. Downstream fish transport is accomplished via boat or barge system to Ross Dam. Downstream truck transport is required down the Ross Dam haul road. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level. The number and priority of tributaries can be informed a later date as additional information becomes available from the FA-07 Reservoir Tributary Habitat Assessment (refer to Figure 8.1-2).
Option R5	▪ Upstream passage: Trap and transport facility at Ross Powerhouse near the base of Ross Dam. Upstream truck transport is accomplished along the Ross Dam haul road. Water transport via boat or barge system is required to select tributary release locations. ▪ Downstream passage: Forebay collector located in the forebay of Ross Lake near the intake structure in addition to multiple head-of-reservoir floating collection barges deployed and operated near the confluence of select tributaries to Ross Lake. Downstream fish transport is accomplished via boat or barge system to Ross Dam. Downstream truck transport from Ross Dam to selected release location(s) are required down the Ross Dam haul road. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level when desired as well as volitional transit through Ross Lake and self-selection to natal tributaries. The number and priority of tributaries can be informed a later date as additional information becomes available from the FA-07 Reservoir Tributary Habitat Assessment.
Option R6	▪ This option is like Option R5 and incorporates an additional bypass pipe that provides downstream transport from the Ross Lake forebay collector to the head of Diablo Lake near the Ross Lake Powerhouse and reduces the dependency of truck transport down the Ross Dam haul road.
Option R7	▪ This option is like Option R1 and incorporates a pneumatic fish transport tube technology to transport fish from a Ross Powerhouse fish collection facility upstream to Ross Lake. This option reduces the dependency of upstream truck transport up the Ross Dam haul road. ▪ This option incorporates an additional bypass pipe that provides the option of downstream bypass transport and/or selective downstream transport. Use of the bypass transport system reduces the dependency of downstream truck transport down the Ross Dam haul road.

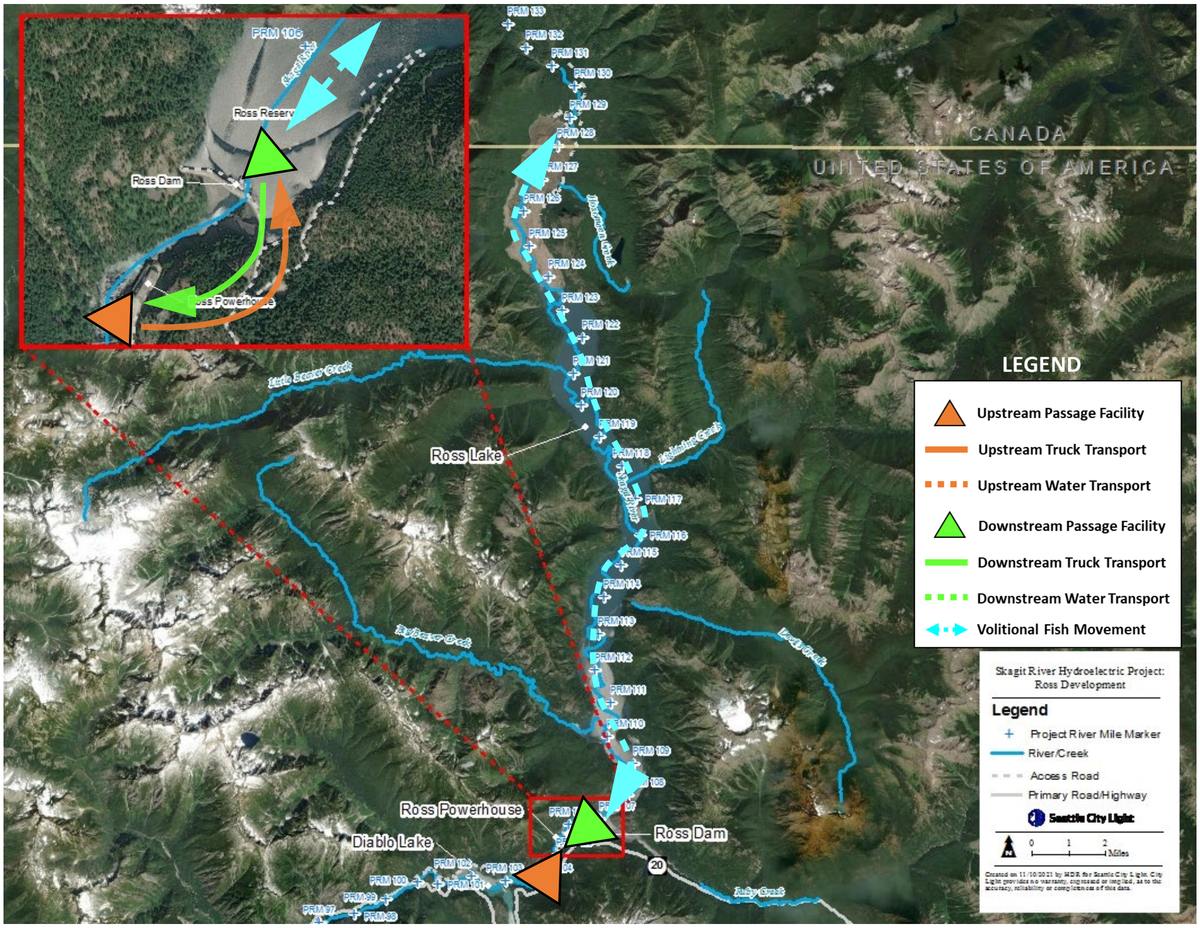


Figure 8.1-1. Option R1 – Ross Development.

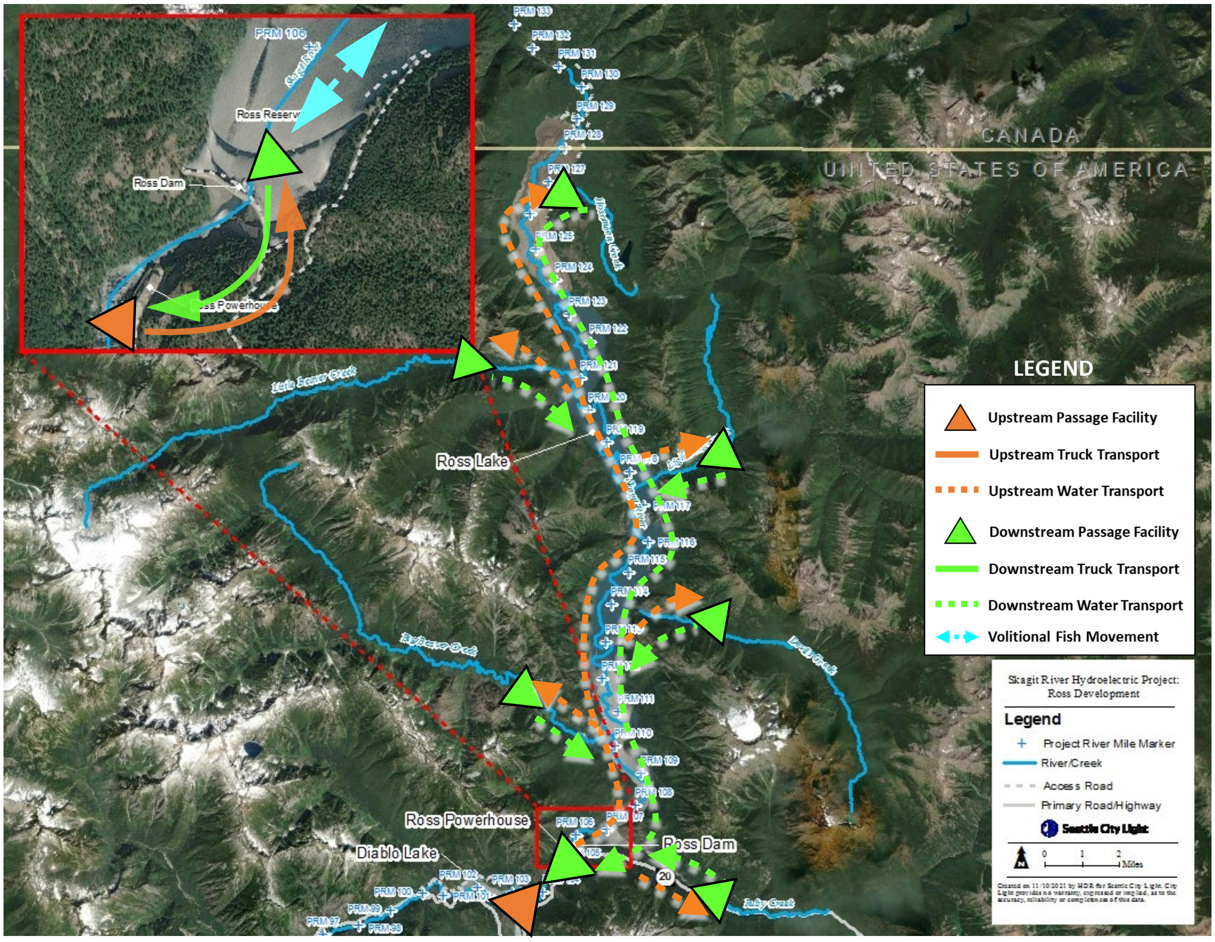


Figure 8.1-2. Option R3 and R4 – Ross Development.

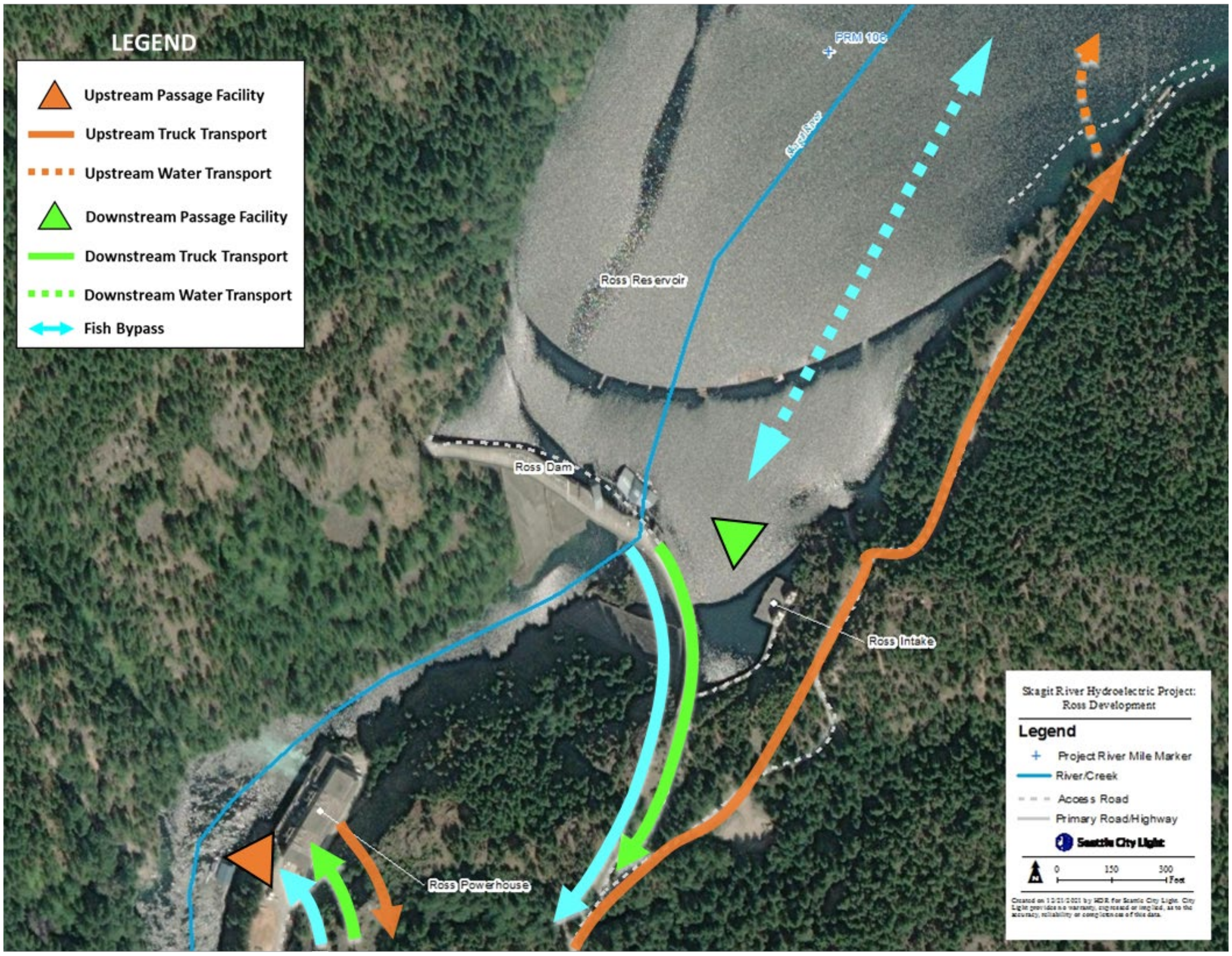


Figure 8.1-3. Option R7 and R8 – Ross Development.

8.1.1 Additional Key Considerations for Facility Implementation at the Ross Development

Additional considerations identified during the initial brainstorming sessions for development of fish passage options at the Ross Development are summarized in the list below. Considerations applicable to all three Project developments are summarized in Section 8.4 of this document.

- The drawdown and stranding of fish at the tributaries should be scrutinized as part of consideration of In-Tributary or Head of Reservoir Collection technologies. Rapid and/or extensive reservoir fluctuations will impede the reliability and performance of Head-of-Reservoir Collection Systems while significantly increasing operation and maintenance level of effort.
- The existing haul road would need to be improved to modern safety, engineering, and design standards to accommodate the upstream or downstream transport of fish.
- Fish transport along the Ross Dam Haul Road will increase the level of traffic throughout that area in perpetuity and may impact the safety of public recreationists that have access to that area. Public safety measures shall be considered as part of Haul Road improvements.

- Integration of new transportation infrastructure from Highway 20 to Ross Dam should be explored as part of fish passage facility alternative development.

8.2 Diablo Development

A potential range of fish passage options formulated for the Diablo Development are summarized in Table 8.2-1. Summary descriptions for each option are provided in Table 8.2-2. Example Figures 8.2-1 through 8.2-3 illustrating concept facility locations and fish movement pathways are provided for a select number of options. Details for options advancing to the next stage of development will be expanded in subsequent iterations of the study documentation.

Table 8.2-1. Summary of potential fish passage options considered for the Diablo Development.

Option Characteristic	Option								
	Option D1	Option D2	Option D3	Option D4	Option D5	Option D6	Option D7	Option D8	Option D9
Facility Locations									
Diablo Powerhouse	🐟		🐟		🐟		🐟		🐟
Diablo Dam		🐟		🐟		🐟		🐟	
Forebay at Dam Intake	🐟	🐟	🐟	🐟			🐟	🐟	🐟
Hwy 20 at Thunder Creek					🐟	🐟	🐟	🐟	
Gorge Powerhouse									
Fish Passage Strategy									
Reservoir Bypass									
Tributary Management					🐟	🐟	🐟	🐟	
Reservoir Transit	🐟	🐟	🐟	🐟			🐟	🐟	🐟
Technologies for Upstream Passage									
Fish Ladder (volitional)			🐟	🐟					
Trap and Transport (non-volitional)	🐟	🐟			🐟	🐟	🐟	🐟	
Pneumatic Fish Transport Tube									🐟
Fish Pass									
Technologies for Downstream Passage									
Forebay Collector	🐟	🐟	🐟	🐟			🐟	🐟	🐟
In Tributary Collector									
Head of Reservoir Collector					🐟	🐟	🐟	🐟	
Downstream Trap and Haul	🐟	🐟	🐟	🐟	🐟	🐟	🐟	🐟	🐟
Bypass Pipe/Channel							🐟	🐟	

Table 8.2-2. Summary descriptions of potential fish passage options considered for the Diablo Development.

Option Characteristic	Option Summary
Option D1	▪ Upstream passage: Trap and transport facility at Diablo Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Diablo, along Highway 20, and to the Diablo Dam boathouse. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Diablo Lake. Downstream truck transport is required from the Diablo Dam boathouse, down Highway 20, and to selected release points such as the Diablo Dam Powerhouse. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods emphasizing volitional fish movement through Diablo Lake, self-selection to existing tributaries (Thunder Creek), and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.2-1).
Option D2	▪ Upstream passage: Trap and transport facility near the base of Diablo Dam. Upstream truck transport is accomplished along new access infrastructure from the collection facility to existing road infrastructure at Diablo. From Diablo, truck transport continues along Highway 20 and to the Diablo Dam boathouse. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Diablo Lake. Downstream truck transport is required from the Diablo Dam boathouse, down Highway 20, and to selected release points such as the Diablo Dam Powerhouse or new Diablo Dam collection facility location. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods emphasizing volitional fish movement through Diablo Lake, self-selection to existing tributaries (Thunder Creek), and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.2-1).
Option D3	▪ Upstream passage: Volitional fish ladder from Diablo Powerhouse to Diablo Lake. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Diablo Lake. Downstream truck transport is required from the Diablo Dam boathouse, down Highway 20, and to selected release points such as the Diablo Dam Powerhouse. ▪ This fish passage strategy accommodates volitional upstream migration and downstream trap and transport methods and emphasizes volitional fish movement through Diablo Lake as well as selected downstream fish transport to alternative release sites as desired through the future development of specific fish management goals.

Option Characteristic	Option Summary
Option D4	▪ Upstream passage: Volitional fish ladder from a point near the base of Diablo Dam to Diablo Lake. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Diablo Lake. Downstream truck transport is required from the Diablo Dam boathouse, down Highway 20, and to selected release points such as the Diablo Dam Powerhouse or a point near the base of Diablo Dam. ▪ This fish passage strategy accommodates volitional upstream migration and downstream trap and transport methods and emphasizes volitional fish movement through Diablo Lake as well as selected downstream fish transport to alternative release sites as desired through the future development of specific fish management goals.
Option D5	▪ Upstream passage: Trap and transport facility at Diablo Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Diablo, along Highway 20, and to the Highway 20 crossing of Thunder Creek. ▪ Downstream passage: Head-of-reservoir floating collection system deployed and operated at the Highway 20 crossing of the Thunder Creek tributary. Downstream fish transport is accomplished via truck transport along Highway 20 to selected release points. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level (refer to Figure 8.2-2).
Option D6	▪ Upstream passage: Trap and transport facility near the base of Diablo Dam. Upstream truck transport is accomplished along new access infrastructure from the collection facility to existing road infrastructure at Diablo. From Diablo, truck transport continues along Highway 20 and to the Highway 20 Crossing of Thunder Creek. ▪ Downstream passage: Head-of-reservoir floating collection system deployed and operated at the Highway 20 crossing of the Thunder Creek tributary. Downstream fish transport is accomplished via truck transport along Highway 20 to selected release points. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level (refer to Figure 8.2-2).

Option Characteristic	Option Summary
Option D7	▪ Upstream passage: Trap and transport facility at Diablo Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Diablo, along Highway 20, and to the Diablo Dam boathouse or to the Highway 20 crossing of Thunder Creek. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure and head-of-reservoir floating collection system deployed and operated at the Highway 20 crossing of the Thunder Creek tributary, both using downstream fish truck transport along existing infrastructure to select release points such as the Diablo Dam Powerhouse. ▪ This option incorporates an additional bypass pipe that provides the option of downstream bypass transport and/or selective downstream transport. Use of the bypass transport system reduces the dependency of downstream truck transport. ▪ This fish passage strategy accommodates a broader range of upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level when desired as well as volitional transit through Ross Lake and self-selection to natal tributaries (refer to Figure 8.2-3).
Option D8	▪ Upstream passage: Trap and transport facility near the base of Diablo Dam. Upstream truck transport is accomplished along new access infrastructure from the collection facility to existing road infrastructure at Diablo. From Diablo, truck transport continues along Highway 20 and to the Diablo Dam boathouse or to the Highway 20 Crossing of Thunder Creek. ▪ Downstream passage: Head-of-reservoir floating collection system deployed and operated at the Highway 20 crossing of the Thunder Creek tributary. Downstream fish transport is accomplished via truck transport along Highway 20 to selected release points. ▪ This option incorporates an additional bypass pipe that provides the option of downstream bypass transport and/or selective downstream transport. Use of the bypass transport system reduces the dependency of downstream truck transport. ▪ This fish passage strategy accommodates a broader range of upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level when desired as well as volitional transit through Ross Lake and self-selection to natal tributaries (refer to Figure 8.2-3).
Option D8	▪ This option is like Option D2 and incorporates a pneumatic fish transport tube technology to transport fish from a collection facility near the base of Diablo Dam to Diablo Lake. This option reduces the dependency of upstream truck transport along existing infrastructure.

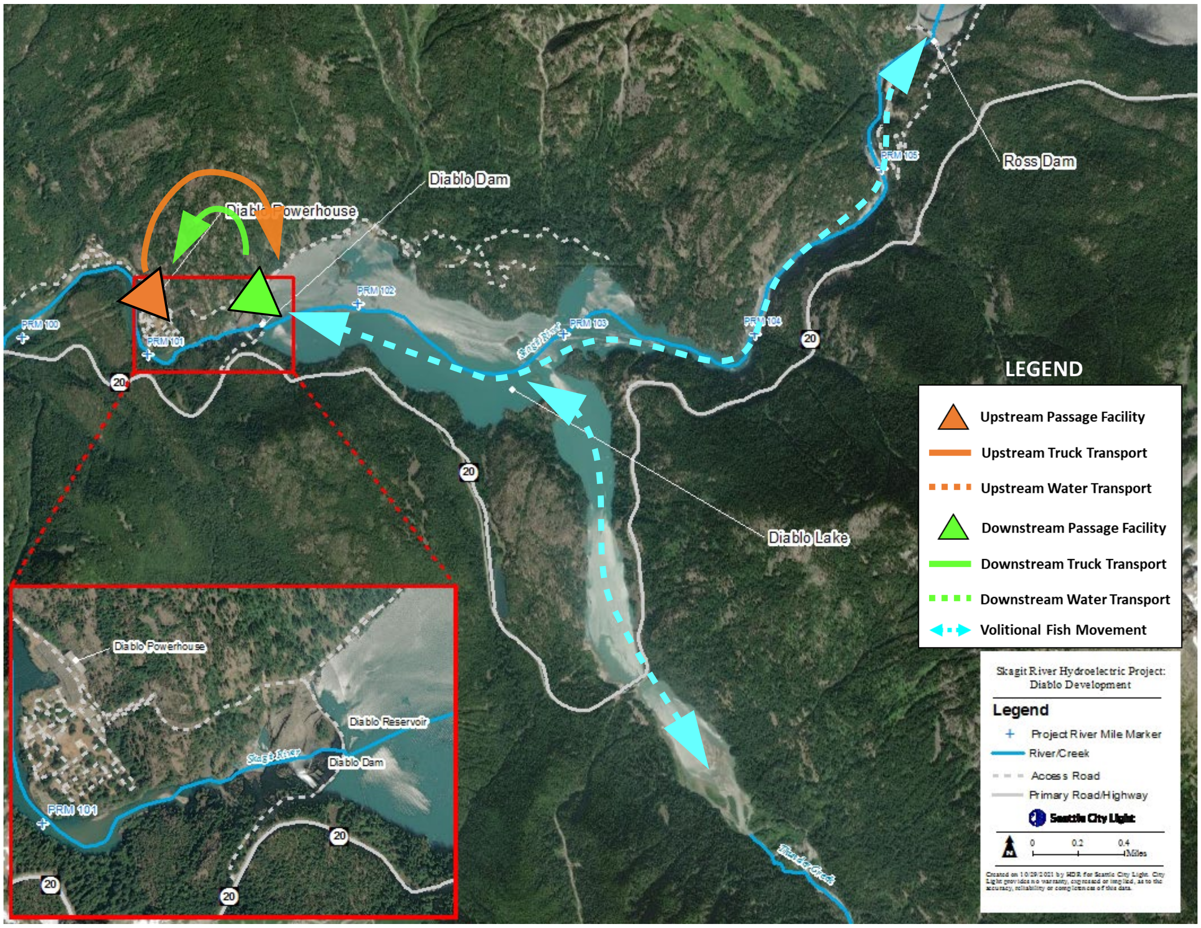


Figure 8.2-1. **Option D1 and D2 – Diablo Development.**

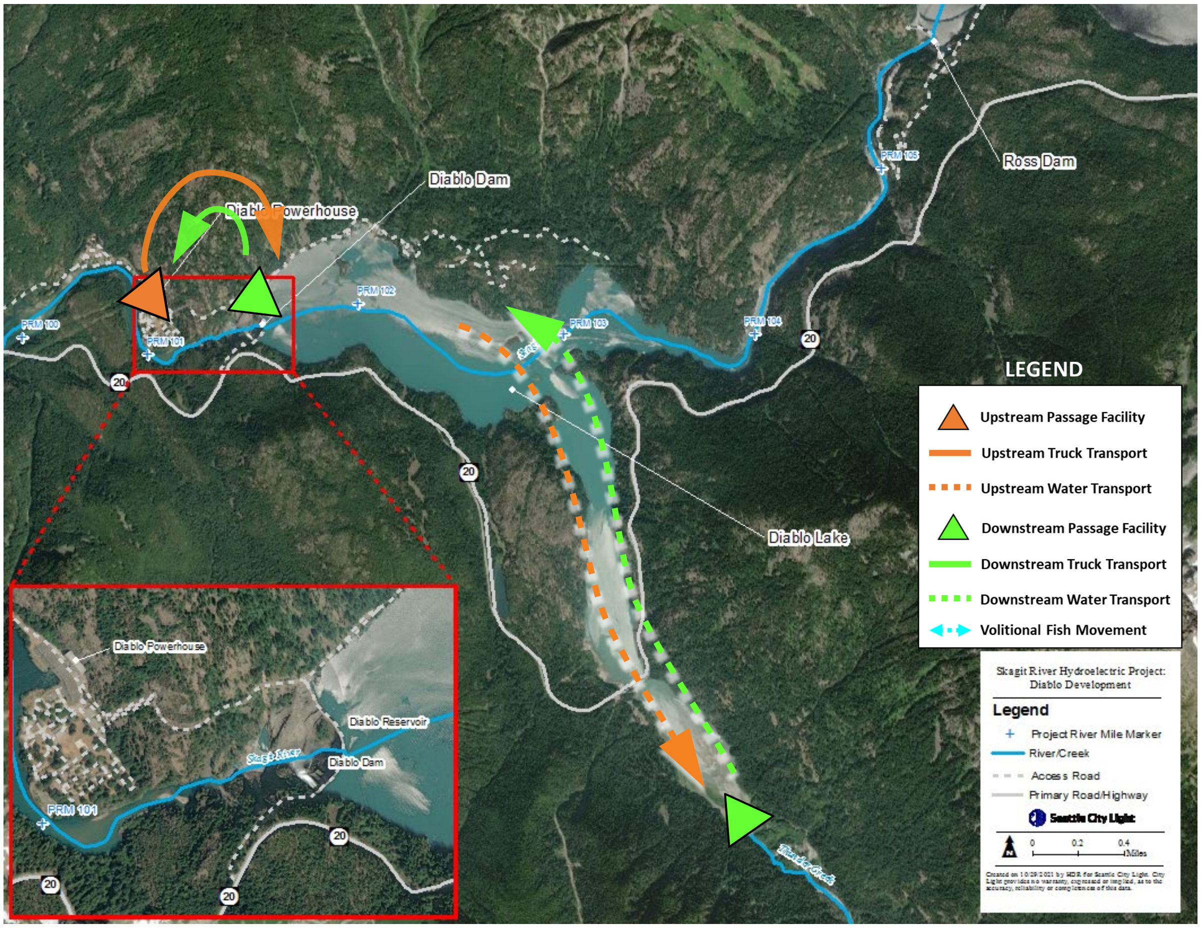


Figure 8.2-2. Option D5 and D6 – Diablo Development.

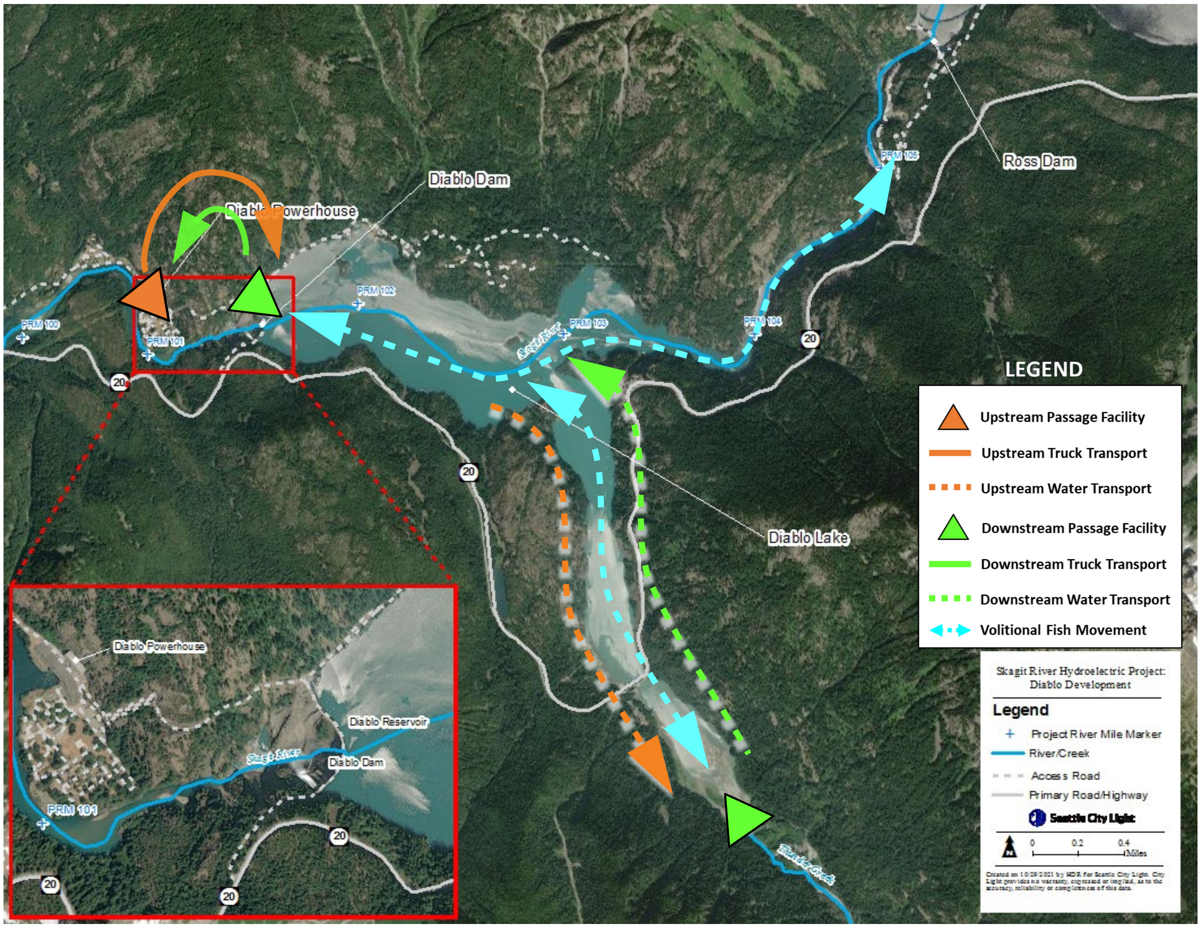


Figure 8.2-3. Option D7 and D8 – Diablo Development.

8.2.1 Additional Key Considerations for Facility Implementation at Diablo Development

Additional considerations identified during the initial brainstorming sessions for development of fish passage options at the Diablo Development are summarized in the list below. Considerations applicable to all three Project developments are summarized in Section 8.4 of this document.

- Any potential tributary or reservoir collection system at Thunder Creek will require careful consideration of debris management. There are potentially high magnitude, frequency, and duration of debris events that may negatively influence fish passage facility operation at the tributary level.
- Potential tributary or reservoir collection facilities at Thunder Creek must also consider safety and impacts to recreation (e.g., boat launch and campgrounds located in the Thunder Arm vicinity).
- Existing road infrastructure that can accommodate truck transport to Ross Dam does not exist. The anticipated transit time for barge transport through Diablo Reservoir will require consideration during fish passage facility development.
- Integration of new transportation infrastructure from Highway 20 to Ross Dam should be explored as part of fish passage facility alternative development.

8.3 Gorge Development

A potential range of fish passage options formulated for the Gorge Development are summarized in Table 8.3-1. Summary descriptions for each option are provided in Table 8.3-2. Example Figures 8.3-1 and 8.3-2 illustrating concept facility locations and fish movement pathways are provided for a select number of options. Details for options advancing to the next stage of development will be expanded in subsequent iterations of the study documentation.

Table 8.3-1. Summary of potential fish passage options considered for the Gorge Development.

Option Characteristic	Option							
	Option G1	Option G2	Option G3	Option G4	Option G5	Option G6	Option G7	Option G8
Facility Locations								
Gorge Powerhouse	🐟	🐟			🐟		🐟	
Gorge Dam			🐟	🐟		🐟		🐟
Forebay at Dam Intake	🐟	🐟	🐟				🐟	🐟
Hwy 20 at Stetattle Creek					🐟	🐟	🐟	🐟
Fish Passage Strategy								
Reservoir Bypass	🐟		.					
Tributary Management					🐟	🐟	🐟	🐟
Reservoir Transit	🐟	🐟	🐟	🐟			🐟	🐟
Gorge Bypass Reach			🐟	🐟		🐟		🐟
Technologies for Upstream Passage								
Fish Ladder (volitional)				🐟				
Trap and Transport (non-volitional)	🐟	🐟	🐟		🐟	🐟	🐟	🐟
Fish Pass								
Technologies for Downstream Passage								
Forebay Collector	🐟	🐟	🐟	🐟			🐟	🐟
In Tributary Collector								
Head of Reservoir Collector					🐟	🐟	🐟	🐟
Downstream Trap and Haul	🐟	🐟	🐟	🐟	🐟	🐟	🐟	🐟
Bypass Pipe/Channel							🐟	🐟

Table 8.3-2. Summary descriptions of potential fish passage options considered for the Gorge Development.

Option Characteristic	Option Summary
Option G1	▪ Upstream passage: Trap and transport facility at Gorge Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Gorge Powerhouse, along Highway 20, to the Diablo boathouse, by water transport to the base of Ross Dam, and up the improved Ross Dam haul road to the upstream face of Gorge Dam. ▪ Downstream passage: Forebay collector located near the Ross Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a FSS or FSC is likely due to the high range of water surface fluctuation present at Ross Lake. Downstream truck transport is required down the improved, Ross Dam haul road, via water transport to the Diablo boathouse, down Highway 20 to selected release points such as the Gorge Powerhouse or other areas to be determined in future phases of program implementation. ▪ This fish passage strategy bypasses both Gorge and Diablo Lakes for upstream and downstream migrants and emphasizes volitional fish movement through Ross Lake, self-selection to existing Ross Lake tributaries, and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.3-1). Collection will occur downstream of the Gorge Bypass Reach thereby reducing uncertainty regarding upstream fish passage to the base of Gorge Dam. Existing fish assemblages and populations within Gorge and Diablo Lakes will not be modified through fish passage efforts and inter-reservoir transport will not be provided.
Option G2	▪ Upstream passage: Trap and transport facility at Gorge Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Gorge Powerhouse, along Highway 20, and up an improved access road to the upstream face of Gorge Dam. ▪ Downstream passage: Forebay collector located near the Gorge Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Gorge Lake. Downstream truck transport is accomplished down an improved access road, down Highway 20, and to selected release points such as the Gorge Powerhouse or other areas to be determined in future phases of program implementation. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods emphasizing volitional fish movement through Gorge Lake, self-selection to existing tributaries (Stetattle Creek), and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.3-1). Collection of upstream migrating fish will occur downstream of the Gorge Bypass Reach thereby reducing uncertainty regarding upstream fish passage to the base of Gorge Dam.

Option Characteristic	Option Summary
Option G3	▪ Upstream passage: Trap and transport facility near the base of Gorge Dam. Upstream truck transport is accomplished along an improved access road from a location near the base of Gorge Dam to the upstream face of Gorge Dam. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Gorge Lake. Downstream truck transport will be accommodated down an improved access road to selected release points such as the stilling pool to Gorge Dam, the Gorge Powerhouse, or other areas to be determined in future phases of program implementation. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods emphasizing volitional fish movement through Gorge Lake, self-selection to existing tributaries (Stetattle Creek), and selective fish transport to alternative release sites as desired through the future development of specific fish management goals (refer to Figure 8.3-2). Collection of upstream migrating fish will occur at or near the upstream end of the Gorge Bypass Reach and may be limited by fish passage conditions through two existing features.
Option G4	▪ Upstream passage: Volitional fish ladder from a point near the base of Gorge Dam to Gorge Lake. ▪ Downstream passage: Forebay collector located near the Diablo Lake intake structure accommodating a downstream trap and haul fish transport strategy. Use of a Fixed Collector is likely due to the low range of water surface fluctuation present at Gorge Lake. Downstream truck transport will be accommodated down an improved access road to selected release points such as the stilling pool to Gorge Dam, the Gorge Powerhouse, or other areas to be determined in future phases of program implementation ▪ This fish passage strategy accommodates volitional upstream migration and downstream trap and transport methods emphasizing volitional fish movement through Gorge Lake, self-selection to existing tributaries (Stetattle Creek), and selective fish transport to alternative release sites as desired through the future development of specific fish management goals.
Option G5	▪ Upstream passage: Trap and transport facility at Gorge Powerhouse. Upstream truck transport is accomplished along existing road infrastructure from Gorge Powerhouse, along Highway 20, and up an improved access road to the upstream face of Gorge Dam. ▪ Downstream passage: Head-of-reservoir floating collection system deployed and operated in Gorge Lake near Stetattle Creek. Downstream fish transport is accomplished via truck transport along Highway 20 to selected release points. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level. Collection of upstream migrating fish will occur downstream of the Gorge Bypass Reach thereby reducing uncertainty regarding upstream fish passage to the base of Gorge Dam.
Option G6	▪ Upstream passage: Trap and transport facility near the base of Gorge Dam. Upstream truck transport is accomplished along an improved access road from a location near the base of Gorge Dam to the upstream face of Gorge Dam. ▪ Downstream passage: Head-of-reservoir floating collection system deployed and operated at the Highway 20 crossing of the Thunder Creek tributary. Downstream fish transport is accomplished via truck transport along Highway 20 to selected release points. ▪ This fish passage strategy accommodates upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level. Collection of upstream migrating fish will occur at or near the upstream end of the Gorge Bypass Reach and may be limited by fish passage conditions through two existing features.

Option Characteristic	Option Summary
Option G7	▪ Upstream passage: Trap and transport facility at Gorge Powerhouse. Upstream truck transport is accomplished along existing road infrastructure along Highway 20 to Gorge Dam or to the Highway 20 crossing of Stetattle Creek. ▪ Downstream passage: Forebay collector located near the Gorge Lake intake structure and head-of-reservoir floating collection system deployed and operated at the mouth of the Stetattle Creek tributary, both using downstream selective fish transport to alternative release sites as desired through the future development of specific fish management goals. ▪ Collection of upstream migrating fish will occur downstream of the Gorge Bypass Reach thereby reducing uncertainty regarding upstream fish passage to the base of Gorge Dam. ▪ This option incorporates an additional bypass pipe that provides the option of downstream bypass transport and/or selective downstream transport. Use of the bypass transport system reduces the dependency of downstream truck transport. ▪ This fish passage strategy accommodates a broader range of upstream and downstream trap and transport methods that emphasizes selective fish transport and management at the tributary level when desired as well as volitional transit through Ross Lake and self-selection to natal tributaries.
Option G8	▪ This option is like Option G3 and incorporates a pneumatic fish transport tube technology to provide upstream transport of fish from a collection facility near the base of Gorge Dam to Gorge Lake. This option reduces the dependency of upstream truck transport along existing infrastructure. ▪ This option incorporates an additional bypass pipe that provides the option of downstream bypass transport and/or selective downstream transport. Use of the bypass transport system reduces the dependency of downstream truck transport. ▪ Collection of upstream migrating fish will occur at or near the upstream end of the Gorge Bypass Reach and may be limited by fish passage conditions through two existing features.

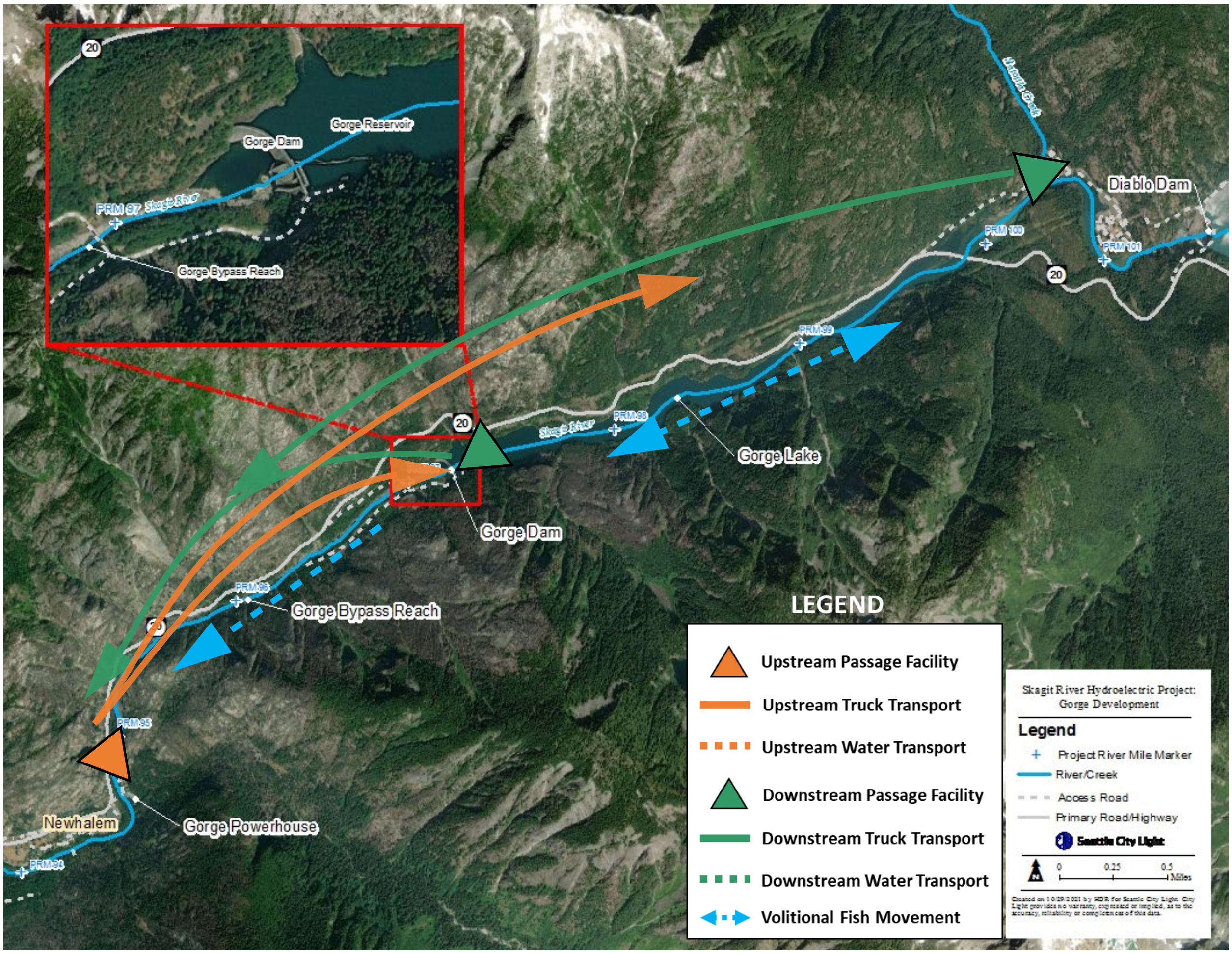


Figure 8.3-1. Options G1 and G2 – Gorge Development.

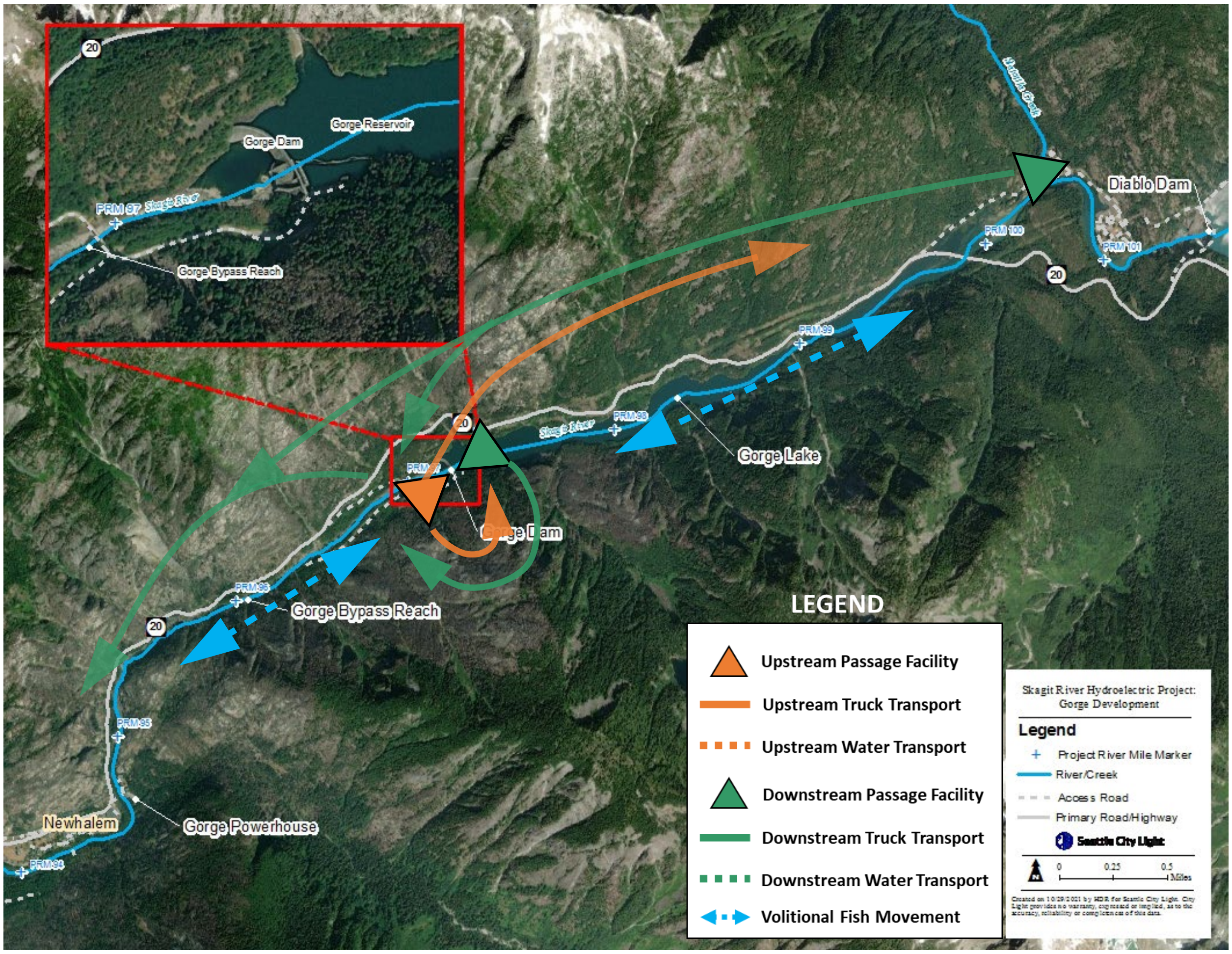


Figure 8.3-2. Option G3 – Gorge Development.

8.3.1 Additional Considerations for Facility Implementation at the Gorge Development.

Additional considerations identified during the initial brainstorming sessions for development of fish passage options at the Diablo Development are summarized in the list below. Considerations applicable to all three Project developments are summarized in Section 8.4 of this document.

- Detailed arrival and abundance information at the Gorge Powerhouse does not currently exist.
- Detailed characterization of fish use, occurrence, and distribution of fish throughout the Gorge Bypass Reach does not currently exist.
- The range of flows where target fish species can ascend the Gorge Bypass Reach is not currently known.

8.4 Additional Key Design Considerations for Facility Implementation at All Project Developments

Additional considerations identified during the initial brainstorming sessions for development of fish passage options at all three Project developments are summarized in the list below. These considerations will continue to help guide option formulation and alternative development in subsequent stages of the Fish Passage Study process.

- Potential fish passage facilities sited in designated wilderness areas will be subject to additional levels of approval and permitting efforts. This will likely influence the allowable location, type, and seasonality of a proposed facility.
- All fish passage facilities and infrastructure shall limit disturbance to cultural resources (e.g., aesthetics, auditory).
- Any potential tributary or reservoir collection system will require careful consideration of debris management. There are potentially high magnitude, frequency, and duration of debris events that may negatively influence fish passage facility operation at the tributary level.
- The results and conclusions from concurrent study FA-07 Reservoir Tributary Habitat Assessment will inform the priority or suitability of implementation of fish passage and management at the tributary level. The availability and quality of habitat available in key tributaries may influence the need and desire to use a reservoir transit strategy and/or emphasize methods to promote access to and production in specific tributaries.
- Any potential fish passage facility implemented at the tributary level will need to accommodate the full life-history of Bull Trout.
- Any forebay collection system will require careful consideration of safety protocol and limits associated with existing flood control outlet location and operation.
- Any forebay collection system will require careful consideration of exclusion, guidance, and barrier systems to limit the potential for fish entrainment into the intake and through spillway gates.
- Spill configuration between the spill gates, spill frequency and duration, and how attraction would be influenced by these operational patterns will require consideration during fish passage facility.
- Release and recovery facilities should be included in all downstream fish passage options. The facilities and associated operations at the Baker Adult Fish Passage Facility are good analogues that could inform concept design.
- Volitional Bull Trout passage should be accommodated through each of the reservoir systems to promote foraging and natural migration into available tributary habitat.
- Reservoir transit should consider water temperature, residence time/velocity, water surface fluctuations, predation, and stranding potential. Reservoir transit should be evaluated to the extent possible as part of the fish passage feasibility assessment process.
- Upstream and downstream trap and haul facilities shall include accommodations for sorting, holding, and transporting fish to desired locations within Diablo Lake or elsewhere in the Project as required based upon future management goals not yet determined. Selective fish passage elements shall include the removal of non-native fish species.
- Consider potential operational changes that may influence reservoir conditions (e.g., effects of flow releases on reservoir residence time and fish movement or temperature conditioning for Diablo and Gorge lakes) and include results from flows studies FA-01 and OM-01.

- The results and conclusions of other studies, such as those identified in Section 1.4 of this document, may inform conceptual designs, passage criteria, facility sizing and location, and biological and physical constraints.

8.5 Fish Passage Technologies and Options Not Selected for Further Consideration

Section 7.2 of this document presents a wide range of fish passage technologies that have been implemented at multi-purpose, high-head dams, primarily throughout the Pacific Northwest. Some of these technologies have been implemented at high dams in the Northeastern United States, Canada, Australia, and Asia. These existing facilities have provided lessons learned and keen insight into successes and failures of full-scale fish passage program implementation from the perspectives of both engineering feasibility and operational success when evaluating performance criteria and the ability of each facility to meet feasibility factors. Based on these lessons learned, the historical record of performance and applicability of the technology (considering existing topographic conditions, hydraulic profiles, access challenges and constraints, and regulatory requirements for each development), the upstream and downstream fish passage options described in the sections below are likely to exhibit a low level of feasibility based on the four feasibility factors to be evaluated under future stages of this study (see Section 5.8 of this document). Therefore, after initial consideration, these passage options were not selected for further consideration and will not be advanced to the next concept design development stage of the fish passage feasibility assessment.

Removal of these options from further consideration was discussed during the November 29, 2022, AWS meeting; the December 16, 2021, Workshop No. 3; and the January 10, 2022, AWS meeting, and no objections were made. Further, no additional proposals to consider these technologies as part of additional options were requested. However, it was requested by several LPs that the rationale supporting removal of each technology or option be documented herein. The rationales relative to the removal from consideration at each of the Project developments are provided in the following sections.

8.5.1 Upstream Technical Fish Ladder at Ross Dam

Fish ladders require a continuous hydraulic connection to the waterbodies from which fish will migrate and into which they will eventually ascend and pass. The presence of water surface fluctuations greater than 20 feet at the fish ladder exit structure make exit of migrating fish from the ladder highly challenging from an engineering and operational perspective. As defined in Section 5.5.1 of this document, water surface elevations at Ross Lake can be anticipated to fluctuate more than 87 feet 10 percent of the time based upon the historical record, and licensed operational range allows for fluctuations up to 128 feet. This range is well outside the range of headwater conditions that can be accommodated in more traditional fish ladder exit methods. Water level fluctuations of such magnitude require the engineering and operation of a more experimental exit structure such as a helical or linear multi-ported exit with automated gate systems or a pumped fish return flume. There are no known exit structures with this level of complexity implemented at this scale at other fish ladders, and such a structure would be considered experimental until a historical record of successful performance can be established.

In addition to the substantial engineering challenges, the mechanical systems, automation, and potential water pumping systems would require a much greater level of operational and maintenance effort than that of technical fish ladders applied in a more suitable operating environment. Given the very low potential for success and high level of complexity required at this location, a technical fish ladder was not selected for further consideration at Ross Dam.

8.5.2 Upstream Pneumatic Fish Transport System (Whooshh) at Ross, Diablo, and Gorge Dams

As discussed in Section 7.2.2.6 of this document, the Whooshh system is an innovative, yet experimental technology that lacks examples of similar long-term installations or historical records of successful performance at high-head dams. The technology requires infrastructure (e.g., barrier or guidance structures, ladders, holding galleries, and holding/collection facilities) like those required for more traditional technologies and is not believed to provide substantial benefit over other proven technologies (e.g., trap and transport). Although this system has been used successfully at hatcheries and as temporary passage facilities for the purposes of research, development, or emergency passage, obtaining permits and approval of such a facility from fish management agencies such as NMFS would be challenging. Approval of such a facility for permanent passage at any of the three Skagit developments for long-term operations without additional prototype development, testing, and establishment of successful operation for the target species and life histories required is not likely at this time.

For these reasons, this technology is not considered for further development in later stages of the Fish Passage Facilities Alternatives Assessment. This notwithstanding, any phased approach to fish passage program implementation may still consider the Whooshh technology in short-term prototype trap and haul operations, and permanent trap and haul facilities should be forward-compatible with Whooshh equipment, should the technology make advances in permanent, long-term installation over time.

8.5.3 Upstream Fish Passes (Elevators, Lifts, and Locks) at Ross, Diablo, and Gorge Dams

Fish passage facilities such as elevators, lifts, and locks would require mechanically and structurally complex infrastructure implemented at, adjacent to, and upon the face of Ross, Diablo, and Gorge dams. This type of infrastructure presents significant engineering, operational, and dam safety challenges in addition to permitting concerns related to disturbance of existing historical resources present at each development. Such facilities would also require construction of improved access and egress infrastructure at the base and crest of each dam for the purposes of construction and continued operation. Such endeavors can be accomplished but only at substantial cost, effort, and impact over that of other potential technologies with better long-term historical records of successful performance. Some of the more prominent challenges include the following:

- Cycle times of fish transport vessels (e.g., elevators or lifts) or pumping sequences (locks) require a substantial amount of time to ascend the required height of each dam, putting fish at risk, and at a relative inaccessible state, for longer periods than other technologies.
- The potential for mechanical failure and delayed response time by maintenance crews would require incorporation of on-board life support systems such as oxygen supply systems on proposed transport vessels.

- Should a failure occur mid-cycle, access is inherently very difficult, so additional infrastructure such as gantry or davit cranes would need to be on standby during cycle operation.
- Access to the Diablo and Ross dams is exceptionally difficult given the lack of existing road infrastructure to either location, in addition to the presence of vertical bedrock terrain within which construction would need to take place.
- There are no known hydraulic lock systems of this scale implemented at other multipurpose high dams, and the mechanical pumping requirements of such an option would make operation substantially challenging, complex, and costly.

Considering the complexities associated with regulatory authorizations from both FERC dam safety and agencies responsible for the preservation of the nation's historic resources, the lack of obvious benefits from these technologies from a performance perspective, and the challenges from a construction and operational standpoint, these options were not selected to advance to later stages of the Fish Passage Facilities Alternatives Assessment.

8.5.4 Downstream Passage Fixed Collector at Ross Dam

As presented in Section 7.2.3.1 of this document, Fixed Collectors are typically attached to the existing dam and intake infrastructure at a fixed elevation. Both flow and exclusion/guidance nets are used to attract and guide fish into the collection system, which maintains a hydraulic connection to the forebay for a narrow range of water surface elevations (e.g., 10 feet). Although these types of facilities have a history of successful performance for downstream migrants, including both salmonid smolts and adults (e.g., steelhead kelts and Bull Trout), these systems are not appropriate for reservoirs that experience a high degree of water surface elevation differential over the annual operational period. Although smolt outmigration timing is largely known for most salmonid target species, steelhead kelts and adfluvial Bull Trout could migrate downstream at any time of the year. Thus, considering reservoir fluctuations, a fixed collection system could meet the demands for year-round passage only if it contained multiple intake portals like the facility that is currently under construction at the Cle Elum Reservoir in Washington.

Considering the experimental nature and elevated capital cost of such a facility, the required excavation limits, and the limited space present at Ross Dam, the study team did not advance a multi-ported option to the next stage of the Fish Passage Facilities Alternatives Assessment at Ross Dam. Thus, fixed collector systems of either type (singe or multi-portal) were not selected for further consideration at Ross Dam primarily due to the presence of reservoir fluctuations that are too large to successfully implement this technology for downstream passage.

8.5.5 Downstream Floating Forebay Collectors at Diablo and Gorge Dams

Converse to the typical operating environment applicable to fixed forebay collectors, where seasonal water level fluctuations are on the order of 0 to 20 feet, floating forebay collectors are generally deployed in environments where water level fluctuations are anticipated to vary greatly over the course of the outmigration season. Upon review of the mean daily water surface elevations of Diablo Dam (period of record from 1997 to 2021, n=8,766 days), the recorded maximum water surface range is 12.4 feet. As summarized in Section 5.5.2 of this document, the daily water surface elevation is anticipated to remain within a 4.0-foot range 90 percent of the time in Diablo Lake. This consistent, low-magnitude range of water surface fluctuation exhibits a more suitable environment for a fixed forebay collector rather than the more complex floating forebay collector system.

Upon review of the mean daily water surface elevations of Gorge Dam (period of record from 1997 to 2021, n=8,766 days), the recorded maximum water surface range is 97.03 feet. As summarized in Section 5.5.3 of this document, the daily water surface elevation is anticipated to remain within a 5.0-foot range 90 percent of the time in Gorge Lake even though the historical range is much greater than in Diablo Lake. Further inspection of Figure 2.3-12 reveals that the mean daily elevations in Gorge Lake are drawn down by as much as 60 feet once in every 5 years on average from 2000 to 2020. In those cases, mean daily values were drawn down for short periods of 3 to 10 days at a time, except for the 2013 operational year when water surfaces remained near elevation 820 feet for multiple weeks (approximately 50 feet lower than the typical average of 871.4 feet).

Given the above, the anticipated range of water surface elevations for both Diablo Lake and Gorge Lakes remains within a typical narrow range of 4 to 5 feet for 90 percent of the mean daily record. Although there may be times when a fixed collector may not maintain hydraulic connection for short periods of time (approximately 10 days every 5 years) at Gorge Lake, further consideration of FSSs and FSCs for downstream passage at Diablo and Gorge dams were eliminated. Because the water surface elevation change for typical operations is relatively small, the use of fixed collectors is more appropriate at this location. As stated in Workshop 3, when conditions are favorable to support fixed collectors, they are preferred over floating collectors (Negherbon, 2021). By their nature, floating collectors have more technical components, more working pieces, and more opportunity to fail when compared to fixed structures, which would be preferred over floating collectors at these locations.

8.5.6 Downstream Passage In-Tributary Collection Facilities at Ross, Diablo, and Gorge Developments

In-tributary collection systems would require access, mobilization, construction, and operation of facilities on land managed by NPS, much of which is already classified as designated wilderness. During the option formulation process for this study, concern was expressed by numerous LPs regarding the potential impacts to cultural, aesthetic, and ecologic resources already present in areas where tributaries intercept the shorelines of Ross, Diablo, and Gorge lakes. Those concerns, coupled with an uncertain and lengthy permitting process associated with federal lands and designated wilderness areas, makes the potential success of installing and operating permanent or seasonal in-tributary collectors lower than that of other potential alternatives. Given this level of uncertainty, the potential for impacts to existing resources, and the presence of other more pragmatic alternatives, this technology was not selected for further advancement to Stage 2 of the Fish Passage Facilities Alternatives Assessment.

8.5.7 Downstream Passage Turbine Retrofits at Ross, Diablo, and Gorge Developments

Turbine retrofits were eliminated from further consideration for downstream passage for several reasons. Although such retrofits have been implemented at several Columbia River dams, the Skagit Project dams and power generation infrastructure exhibit hydraulic head pressures of more than 300 feet that would preclude the safe and effective passage of downstream migrants. Such differentials have the high likelihood of inducing pressure-related barotrauma injuries or death, and thus do not meet performance criteria for downstream passage survival.

8.5.8 Downstream Surface Spill Passage at Ross, Diablo, and Gorge Dams

Surface spill systems rely on continuous flow over spillway weirs near the surface of the water column and have been successful at improving safe downstream migration of juvenile salmonids throughout the Columbia River and Snake River run-of-river dams. The factors influencing applicability of surface spill systems to specific operating environments are summarized in Section 7.2.3.3 of this document. Application of surface spill methods at Ross, Diablo, and Gorge dams is less feasible because of the following factors:

- All three dams have multi-purpose functionality with structure heights of 300 feet, 389 feet, and 540 feet, respectively, which is much greater than other like facilities with a historical record of successful performance. Such surface spill methods have been abandoned at facilities such as Lower Baker Dam due to operational incompatibility with reservoir fluctuations, ineffective attraction, and injury/mortality concerns associated with the freefall condition over great heights to the tailwater pool.
- Surface spill methods require continuous spill that bypasses the power generation infrastructure. The rate and volume of continuous spill required for fish attraction must be economically feasible from an operational standpoint.
- Given the overall hydraulic height of each dam, spill must be routed to a bypass pipe or flume to safely return downstream migrating fish to appropriate tailwater locations. Spill cannot simply freefall down the face of the dam or be passed down the existing spillways without significant potential for injury or mortality to downstream migrating fish.
- Surface spill is pragmatic only in conditions where surface water elevations fluctuate less than 10 to 20 feet so that a hydraulic connection can be maintained throughout the migration periods of various target species. Ross Lake exhibits much greater levels of water surface fluctuation. Although the spillway weirs can be adjustable, structural modification to the existing dams and operation of water control equipment becomes increasingly complex and expensive.

Given the above concerns and the availability of other more effective technologies at each of the developments, surface spill methods are not selected for further consideration and advancement into Stage 2 of the Fish Passage Facilities Alternatives Assessment.

8.5.9 Operational Changes to Provide Downstream Passage at Ross, Diablo, and Gorge Dams

All technologies selected for further evaluation in Stage 2 of the Fish Passage Facilities Alternatives Assessment will use the conditions and operating environments associated with existing Project operations for concept development. For example, reservoir drawdown will not be evaluated below the current FERC licensed operating conditions required to maintain each reservoir's water supply, recreation, flood control, and power generation purpose and functionality. As part of Stage 3 of the Fish Passage Facilities Alternatives Assessment, feasibility assessments will include a factor to account for adaptability and the potential of selected facility alternatives to function as intended under different foreseeable operational or environment circumstances, should they occur in the future. Further, if such operational changes are identified or proposed as part of other studies being conducted concurrently with the Fish Passage Study, City Light and LPs can determine how to incorporate those potential modifications into this study as it is being completed later in 2022.

8.6 Options Selected for Further Consideration and Concept Design Development

City Light, the Fish Passage Study team, and LPs continued the process of option refinement and selection as part of Workshop No. 3 conducted in December 2021. The range of options selected for further advancement to Stage 2 of the Fish Passage Facilities Alternatives Assessment was revised based upon early feedback from LPs between Workshop No. 3 and AWS meetings conducted in January of 2022. During AWS meetings held on January 10 and 24 2022, consensus among the AWS participants was gained to advance a "multi-objective" fish passage alternative, along with two options, ,to the conceptual design phase (Stage 2) of the Fish Passage Facilities Alternatives Assessment. The potential locations, technologies, and applicable fish passage strategies selected for advancement are described in this section.

Using a "mix-and-match" menu of applicable technologies for each development, the selected alternative options include a range of applicable technologies implemented throughout the three Project developments and support a broad range of potential biological goals and fisheries management strategies[26]. Table 8.6-1 provides a summary of all fish passage strategies, technologies, and facility locations selected for further advancement and progression to Stage 2 of the Fish Passage Facilities Alternatives Assessment. As presented in the table, upstream fish passage technologies will focus on trap and haul facilities or fish ladders at Gorge and Diablo developments, with solely trap and haul selected at Ross Dam. Downstream fish passage technologies will focus on fixed forebay collectors with the possibility of a bypass system for downstream migrating fish at Gorge and Diablo developments with a floating forebay collector and possibly bypass system being considered at Ross Dam. Passive, head-of-reservoir collection systems will be considered for select tributaries where productivity, genetic management, or special status investigations may be desired, as determined by resource agencies and responsible co-managers.

Alternative 1 and the three sub-options emphasize three optional fish passage strategies as follows:

- Alternative 1 - Option A (1A) uses trap and haul technologies for upstream passage emphasizing the capability to select, sort, monitor, and redistribute fish to specific locations based upon a future fisheries management strategy inclusive of reservoir transit, intra-project reservoir transit, reservoir bypass, and/or self-selection to existing tributaries.
- Alternative 1 - Option B (1B) is similar to 1A, but includes a trap and transport facility at Gorge Dam requiring that all upstream migrating fish ascend the 2.5 mile Skagit Project Bypass Reach prior to upstream passage into Gorge, Diablo, or Ross Lakes.
- Alternative 1 - Option C (1C) is like 1A but includes consideration of more volitional fish passage technologies such as fish ladders at Gorge and Diablo Dams in addition to bypass

[26] As determined in early stages of this study, the desired biological goals, fish management strategies, and subsequent elements of a fish passage program, required to achieve those goals, are to be determined outside of the scope of this study at a future date by resource agencies and fisheries co-managers in the Skagit River basin.

pipes or channels to convey outmigrating fish downstream rather than relying on truck transport. Although volitional and non-directive strategies are emphasized, there is less opportunity for selective passage strategies as included in 1A.

Table 8.6-1. Summary of all technologies applied at Ross, Diablo, and Gorge Developments as part of Alternative 1 - Options 1A, 1B, and 1C.

Option Characteristic	Project Location										
	George Powerhouse	Gorge Dam	Forebay at Gorge Intake	Stetattle Creek	Diablo Powerhouse	Diablo Dam	Forebay at Diablo	Thunder Creek	Ross Dam	Forebay at Ross Intake	Ross Lake Tributaries
Fish Passage Strategy											
Reservoir Bypass				🐟				🐟			🐟
Selective Passage/Transport				🐟				🐟			🐟
Tributary Management				🐟				🐟			🐟
Reservoir Transit				🐟				🐟			🐟
Volitional Self-Selection				🐟				🐟			🐟
Inter-project Reservoir Transit				🐟				🐟			🐟
Technologies for Upstream Passage											
Fish Ladder (volitional)		🐟				🐟					
Trap and Transport (non-volitional)	🐟	🐟			🐟				🐟		
Technologies for Downstream Passage											
Forebay Collector			🐟				🐟			🐟	
Head of Reservoir Collector				🐟				🐟			🐟
Downstream Trap and Haul			🐟	🐟			🐟	🐟		🐟	🐟
Bypass Pipe/Channel		🐟				🐟			🐟		

8.6.1 Alternative 1, Option 1A – Multi-Objective Fish Passage Strategy

Alternative 1, Option 1A was initially presented to LPs during Workshop 3 on December 16, 2021. This option combines the original options R5, D7, and G7, as presented in Sections 8.1 through 8.3 of this documents (see Table 8.6-2 and Figure 8.6-1). Under this option, upstream passage would be provided by trap and transport facilities at Gorge Powerhouse, Diablo Dam, and Ross Dam. From these locations, collected fish can be redistributed upstream as desired to fulfill specific fisheries management goals relative to species, life history, population dynamics, genetics, impacts to resident populations, etc.

Downstream passage would be provided using forebay collectors at each development, with trap and transport fish transit to downstream reservoirs or the mainstem Skagit River below Gorge Powerhouse (as determined under future fish management strategies). Fixed forebay collectors would be constructed at the power generation intakes for Gorge and Diablo. Considering the high level of reservoir water surface fluctuation over the anticipated period of potential outmigration, a floating forebay collector (e.g., a FSC or FSS) would be constructed at the Ross Dam intake (see discussion in Sections 8.5.4 and 8.5.5 of this document). Passive, head of reservoir tributary collectors could also be incorporated into this option, and typical designs for such facilities could be tailored to site-specific conditions at higher priority tributaries as determined by resource agencies and co-managers. Potential head-of-reservoir collector locations are to be modified or supplemented as determined necessary under future agency/tribal fisheries management strategies.

Table 8.6-2. Alternative 1, Option 1A – Summary of Multi-Objective Fish Passage Strategy Technologies at Ross, Diablo, and Gorge Developments.

Option Characteristic	Project Location										
	George Powerhouse	Gorge Dam	Forebay at Gorge Intake	Stetattle Creek	Diablo Powerhouse	Diablo Dam	Forebay at Diablo Intake	Thunder Creek	Ross Dam	Forebay at Ross Intake	Ross Lake Tributaries
Fish Passage Strategy											
Reservoir Bypass				🐟				🐟			🐟
Selective Passage/Transport				🐟				🐟			🐟
Tributary Management				🐟				🐟			🐟
Reservoir Transit				🐟				🐟			🐟
Volitional Self-Selection				🐟				🐟			🐟
Inter-project Reservoir Transit				🐟				🐟			🐟
Technologies for Upstream Passage											
Fish Ladder (volitional)											
Trap and Transport (non-volitional)	🐟				🐟				🐟		
Technologies for Downstream Passage											
Forebay Collector			🐟				🐟			🐟	
In Tributary Collector											
Head of Reservoir Collector				🐟				🐟			🐟
Downstream Trap and Haul			🐟	🐟			🐟	🐟		🐟	🐟
Bypass Pipe/Channel											

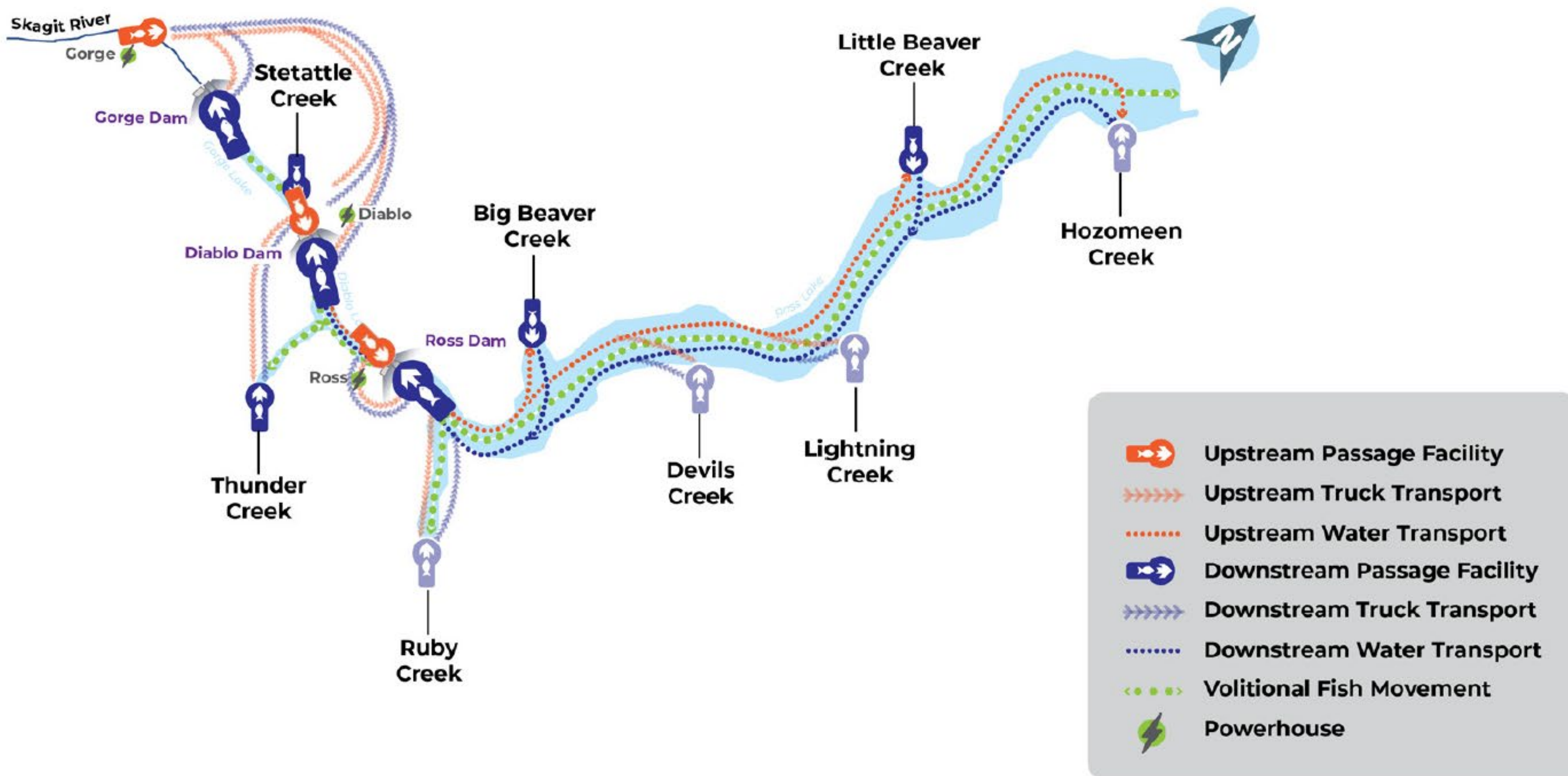


Figure 8.6-1. Alternative 1, Option 1A – Multi-Objective Fish Passage Option with Upstream Collection at Gorge Powerhouse.

8.6.2 Alternative 1, Option 1B – Multi-Objective with Additional Upstream Collection Option at Gorge Dam

Upstream and downstream passage technologies for Option 1B are identical to those of Option 1A with the exception that the most downstream collection facility would be moved upstream to Gorge Dam instead of the Gorge Powerhouse (see Table 8.6-3 and Figure 8.6-2). In this scenario, all upstream migrating fish would need to volitionally ascend the 2.5-mile Gorge Bypass Reach prior to being collected and transported upstream. The potential conditions and ranges of flows that may provide fish passage through the Gorge Bypass Reach for different fish species is being studied concurrently as part of the FA-04 Fish Passage Study. Conclusions associated with this assessment and their influence on fish passage program performance will be addressed as part of the Draft and Final Fish Passage Assessment documentation scheduled for completion in the latter half of 2022.

Table 8.6-3. Alternative 1, Option 1B – Summary of Multi-Objective Fish Passage Strategy Technologies at Ross, Diablo, and Gorge Developments.

Option Characteristic	Project Location										
	George Powerhouse	Gorge Dam	Forebay at Gorge Intake	Stetattle Creek	Diablo Powerhouse	Diablo Dam	Forebay at Diablo Intake	Thunder Creek	Ross Dam	Forebay at Ross Intake	Ross Lake Tributaries
Fish Passage Strategy											
Reservoir Bypass				🐟				🐟			🐟
Selective Passage/Transport				🐟				🐟			🐟
Tributary Management				🐟				🐟			🐟
Reservoir Transit				🐟				🐟			🐟
Volitional Self-Selection				🐟				🐟			🐟
Inter-project Reservoir Transit				🐟				🐟			🐟
Technologies for Upstream Passage											
Fish Ladder (volitional)											
Trap and Transport (non-volitional)		🐟			🐟				🐟		
Technologies for Downstream Passage											
Forebay Collector			🐟				🐟			🐟	
Head of Reservoir Collector				🐟				🐟			🐟
Downstream Trap and Haul			🐟	🐟			🐟	🐟		🐟	🐟
Bypass Pipe/Channel											

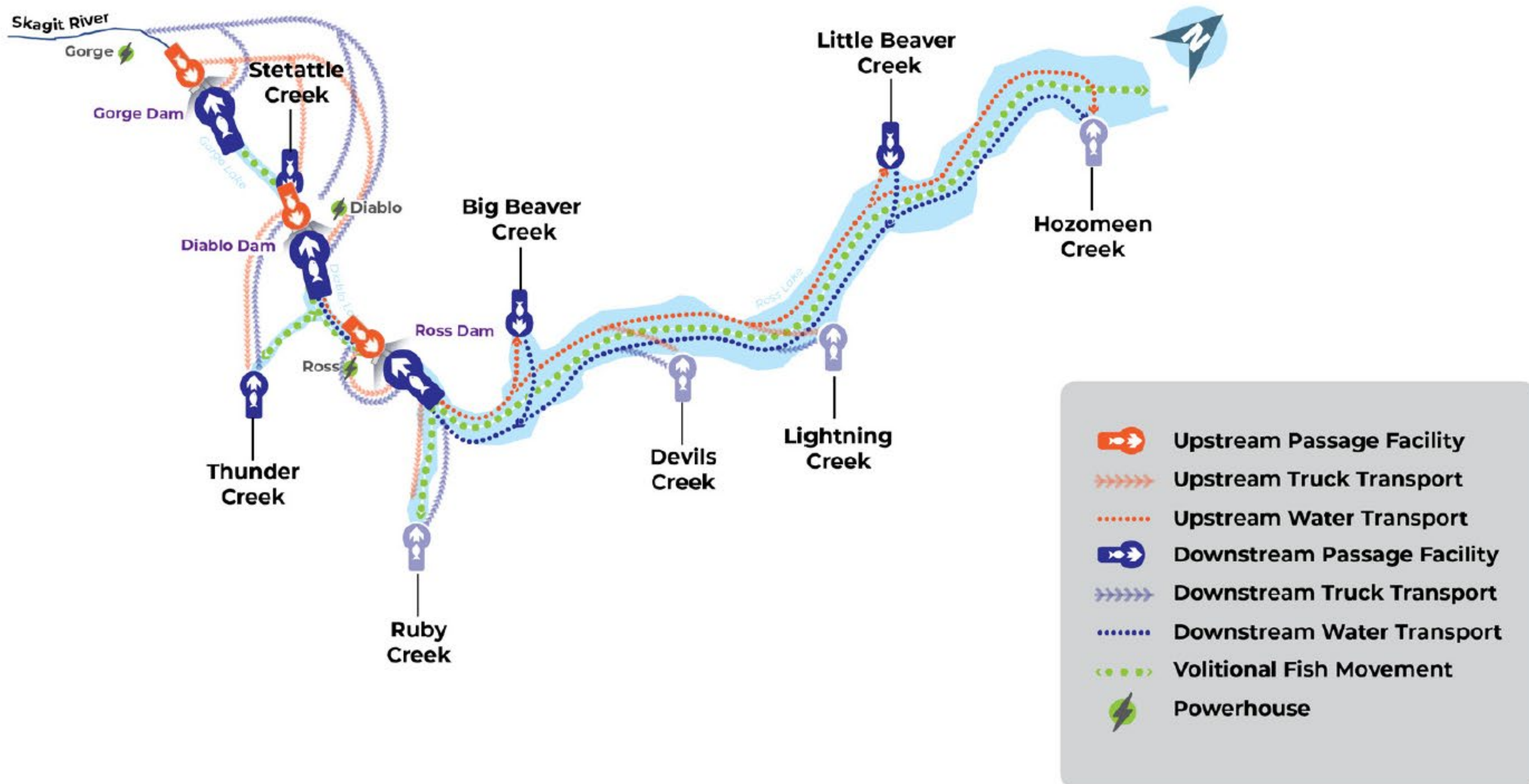


Figure 8.6-2. Alternative 1, Option 1B – Multi-Objective Fish Passage Option with Upstream Collection at Gorge Dam.

8.6.3 Option 1C – Multi-Objective with Fish Ladders at Gorge and Diablo and Downstream Bypass at All Dams

Alternative 1, Option 1C emphasis the use of volitional fish passage facilities at locations that may be more suitable for technologies such as technical fish ladders. For this option, fish ladders would be installed to provide upstream passage at Gorge and Diablo dams. For reasons discussed in Section 8.5.1 of this document, a ladder is not currently considered for Ross Dam. Under this option, downstream non-directive passage would be provided via bypass channels or pipes at all dams; however, forebay collectors would still be required to direct downstream migrating fish into each bypass. Head-of-reservoir collectors could be incorporated into this option, similar to Options 1A and 1B (see Table 8.6-4 and Figure 8.6-3).

Table 8.6-4. Alternative 1, Option 1C – Summary of Multi-Objective Fish Passage Strategy Technologies at Ross, Diablo, and Gorge Developments.

Option Characteristic	Project Location										
	George Powerhouse	Gorge Dam	Forebay at Gorge Intake	Stetattle Creek	Diablo Powerhouse	Diablo Dam	Forebay at Diablo Intake	Thunder Creek	Ross Dam	Forebay at Ross Intake	Ross Lake Tributaries
Fish Passage Strategy											
Reservoir Bypass				🐟				🐟			🐟
Selective Passage/Transport				🐟				🐟			🐟
Tributary Management				🐟				🐟			🐟
Reservoir Transit				🐟				🐟			🐟
Volitional Self-Selection				🐟				🐟			🐟
Inter-project Reservoir Transit				🐟				🐟			🐟
Technologies for Upstream Passage											
Fish Ladder (volitional)		🐟				🐟					
Trap and Transport (non-volitional)									🐟		
Pneumatic Fish Transport Tube											
Fish Pass											
Technologies for Downstream Passage											
Forebay Collector			🐟				🐟			🐟	
In Tributary Collector											
Head of Reservoir Collector				🐟				🐟			🐟
Downstream Trap and Haul			🐟	🐟			🐟	🐟		🐟	🐟
Bypass Pipe/Channel		🐟				🐟			🐟		

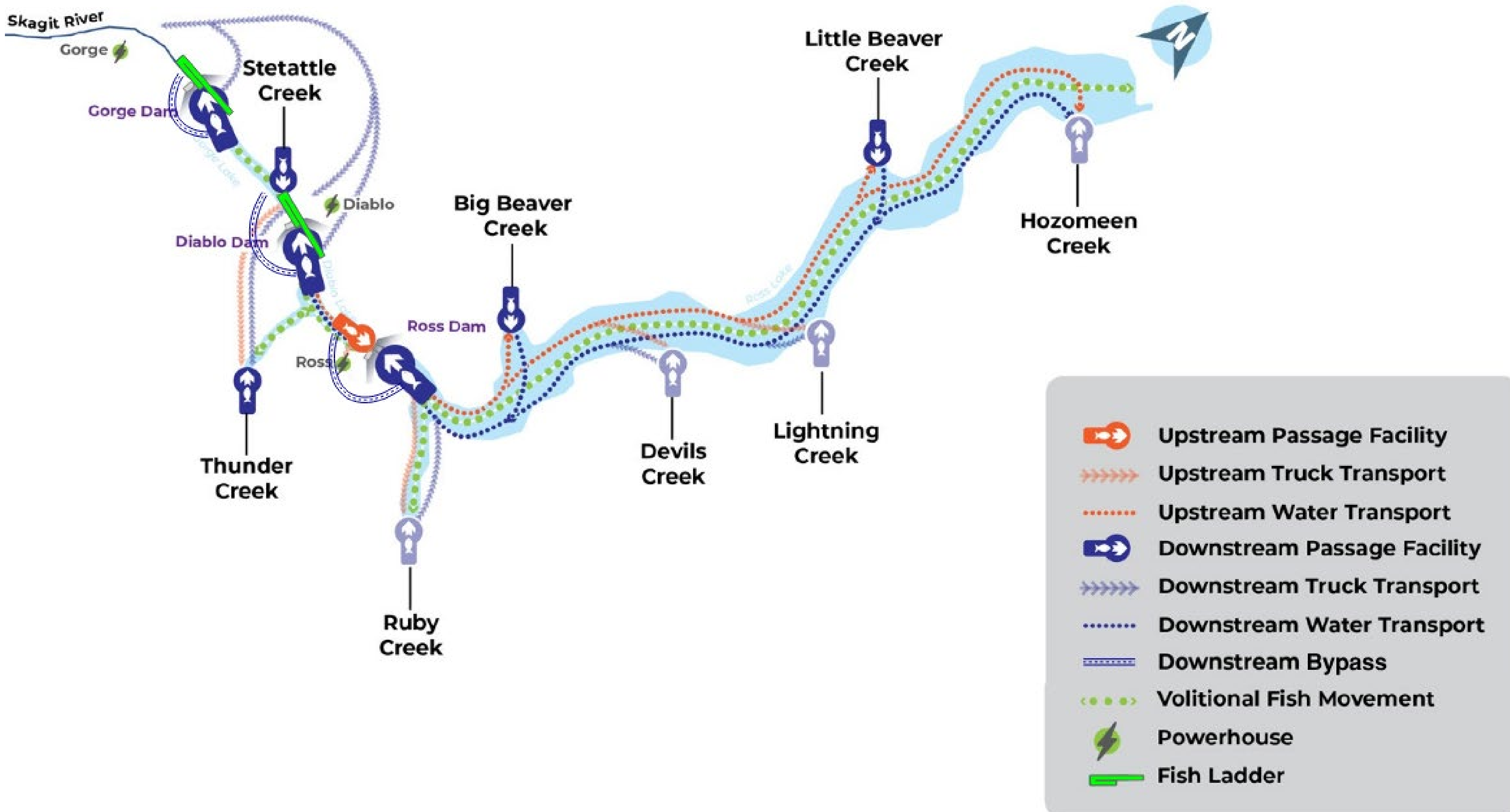


Figure 8.6-3. Alternative 1, Option 1C – Multi-Objective Fish Passage Option with Ladders and Bypasses at Gorge Dam and Diablo Dam.

9.0 CONCLUSIONS AND NEXT STEPS

This Final Draft DCD was developed based on data available at the time of development and feedback received on previous iterations of this document, the Preliminary and Revised Draft DCDs, which were shared with LPs in September 2021 and December 2021, respectively. In addition to LP input and comment on previous drafts, this Final Draft considers information from relevant and concurrent relicensing studies, additional data on existing conditions, and—considering the refined synthesis of existing data for existing upstream and downstream passage facilities—the suitability of passage technologies at each development. This document summarizes existing conditions related to biological, physical, and operational factors at each of the three Project developments and recommends a list of fish passage options to be advanced to the next stage (Stage 2) of the Fish Passage Facilities Alternatives Assessment. Stage 2 will present concept-level designs and costs associated with the selected passage options presented in Section 8.5 of this document.

City Light will continue to track concurrent relicensing studies discussed in Section 1.4 of this document to ensure that the most current data is synthesized into the next stages of the Fish Passage Study. Per the RSP, next stages include the development of fish passage concept-level designs, and development of a fish passage feasibility assessment. For the concept-level design stage, City Light will develop conceptual upstream and downstream fish passage alternatives and their estimated costs. City Light will develop functional site layouts, process descriptions and diagrams, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable costs for select fish passage alternatives. Generally, the work undertaken to develop the Fish Passage Concept Development Report will include the following:

- Complete concept-level facility layouts and configurations of fish passage and auxiliary structures for each alternative in accordance with the requirements contained in the Fish Passage Conceptual Design Criteria Document, including necessary construction requirements (e.g., cofferdams), modifications to existing Project structures, and features needed for fish passage operations and maintenance purposes (e.g., permanent access facilities).
- Prepare a list of potential facility operational changes that may be associated with construction or operations of the fish passage facilities.
- Develop an estimate of reasonably expected performance of the facilities consistent with site characteristics identified in the Fish Passage Conceptual Design Criteria Document and/or prepare a list of additional information needed to provide such estimates.
- Develop site layouts and constructability to the level consistent with generally accepted engineering practice for planning/reconnaissance level studies (e.g., USACE 1999, 2000; AACE 2003; U.S. Bureau of Reclamation 2012).
- Prepare an estimate for the annual operations and maintenance costs associated with each fish passage concept.
- Hold Workshops 4 and 5 to review progress during the concept development work.
- Prepare draft and final Fish Passage Concept Development reports.

This status of this information will be summarized in the next deliverable defined in the RSP, the draft Fish Passage Concept Development Report, which will be submitted to LPs for review in April 2022. At that time, a list of potential fish passage options for all three developments, by fish passage strategy, will be available for review. The Fish Passage Concept Development Report will be finalized in July 2022.

Following completion of the Fish Passage Concept Development Report, City Light will identify fish passage concepts that appear viable and that are consistent with the requirements of the DCD. Each technical option for facilitating fish passage above Gorge Dam will be evaluated in four ways (i.e., feasibility factors): (1) its ability to be engineered, constructed, and operated in the context of site geology, existing Project and non-Project structures, site hydrology, reservoir and riverine operations, and safety requirements (i.e., technical feasibility); (2) its ability to operate without significantly interfering with existing Project and non-Project uses; (3) the facility's ability to meet customary performance standards established for similar facilities, such as facility collection efficiency, survival through the passage facility, and overall Project-wide passage effectiveness; and (4) its ability to accommodate a foreseeable range of future operational conditions, biological objectives, and population management strategies, and its capability of adapting as lessons learned are experienced through years of operation. Habitat availability and quality upstream of the Project dams, based on the results of the Reservoir Tributary Habitat Assessment, when available, will also influence evaluations of benefits to anadromous fish populations. Note that feasibility factors will be refined during future AWS meetings prior to the initiation of Stage 3 of this Fish Passage Facilities Alternatives Assessment. The consultant team will solicit feedback on these factors from LPs to better define each of the factors and provide site-specific context for Project and non-Project uses.

As a final step to this study and based on the outcome of the technical engineering assessment described above, City Light, in consultation with LPs, will identify any next steps or additional studies that may be needed in accordance with planning recommendations put forward in Anderson et al. (2014) and McClure et al. (2018), and the results of concurrent relicensing studies that may influence passage designs and strategies.

10.0 REFERENCES

Al-Chokhachy, R., P. Budy, and H. Schaller. 2005. Understanding the significance of redd counts: a comparison between two methods for estimating the abundance of and monitoring bull trout populations. North American Journal of Fisheries Management 25:1505-1512.

Amaral, S., C. Fay, and G. Hecker. 2012. Estimating Total Passage Survival for Fish Migrating Downstream At Hydropower Projects. Presentation at National Conference on Engineering and Ecohydrology for Fish Passage. June 5-7, 2012.

Anaka, R.J., K.J. Scott, and R.A. Masson. 2012. Snorkel survey of trout and char in the Canadian Skagit River, 2011, dated May 2012. Prepared for Skagit Environmental Endowment Commission, Ministry of Environment, North Vancouver, British Columbia, CA, prepared by Scott Resource Services Inc. Mission, British Columbia, CA. B.C., Project No. 540.04.

Anderson, J.A., G.R. Pess, R. W. Carmichael, M. J. Ford, T. D. Cooney, C. M. Baldwin, and M. M. McClure. 2014. Planning Pacific Salmon and Steelhead Reintroductions Aimed at Long-Term Viability and Recovery.

Anthony, H.D., and R.S. Glesne. 2014. Upper Skagit River Reservoir Fish Population Monitoring, 2010 - 2012. Natural Resource Technical Report NPS/XXXX/NRTR—20XX/XXX. National Park Service, Fort Collins, Colorado.

Beamer, E. M., J. C. Sartori, and K. A. Larsen. 2000. Skagit Chinook life history study: progress report number 3. Federal Energy Regulatory Commission, Project 553, Washington, DC. [Online] URL: www.skagitcoop.org/index.

Beeman, J.W., S.D. Evans, P.V. Haner, H.C. Hansel, A.C. Hansen, G.S. Hansen, T.W. Hatten, J.M. Sprando, C.D. Smith, and N.S. Adams. 2016a. Evaluation of the biological and hydraulic performance of the portable floating fish collector at Cougar Reservoir and Dam, Oregon, 2014. U.S. Geological Survey Open-File Report 2016-1003.

Bell, M. 1991. Fisheries Handbook of Engineering Requirements and Biological Criteria. U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of Salmonids in streams. American Fisheries Society, Special Publication 19:83-138.

Boggs, C.T., M.L. Keefer, C.A. Peery, J.T. Dalen, P.L. Madson, R.H. Wertheimer, K. Collis, and A.F. Evans. 2008. A multi-year summary of steelhead kelt studies in the Columbia and Snake Rivers. Department of Fish and Wildlife Sciences, University of Idaho, Moscow, Report for U.S. Army Corps of Engineers, Portland District, Portland, OR. Technical Report 2008-13.

Busby, P.J., T.C. Wainwright, G.J. Bryant, L.J. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California. U.S. Dept. Commerce, NOAA Technical Memorandum NMFS-NWFSC-27.

Clabough, T.S., E.L. Johnson, M.L. Keefer, C.C. Caudill, C.J. Noyes, J. Garnett, L. Layng, T. Dick, M.S. Jepson, K.E. Frick, S.C. Corbett, and B.J. Burke. 2015. Evaluation of adult Pacific Lamprey passage at lower Columbia River dam and behavior in relation to fishway modifications at Bonneville and John Day dams – 2014. Report by the University of Idaho and National Marine Fisheries Service for the U.S. Army Corps of Engineers, Portland District, Draft Technical Report 2015-10, Portland, Oregon.

Clement, M. 2022. Email summarizing passage improvements at Priest Rapids Dam and Wanapum Dam from Mike Clement, Grant County PUD, to Jacob Venard, HDR Senior Project Manager. January 13, 2021.

Close, D., M. Fitzpatrick, and H. Li. 2002. The Ecological and Cultural Importance of a Species at Risk of Extinction, Pacific Lamprey. Fisheries 27:19-25.

Connor, E., and D. Pflug. 2004. Changes in the Distribution and Density of Pink, Chum, and Chinook Salmon Spawning in the Upper Skagit River in Response to Flow Management Measures. North American Journal of Fisheries Management 24:835-852.

Connor, E., F. Goetz, D. Pflug, and E. Jeanes. 2009. Migration Studies of Bull Trout and Steelhead in the Skagit River, Washington. Presentation to the Pacific Ocean Shelf Tracking (POST) Project Science Forum. June 18, 2009.

Corbett, S. C., M. L. Moser, K. E. Frick, B. Wassard, M. L. Keefer, and C. C. Caudill. 2015. Adult Pacific lamprey passage structures: Use and development at Bonneville Dam and John Day Dam south fishway, 2014. Portland, OR: Portland District, U.S. Army Corps of Engineers.

Downen, M. 2006. Skagit Bull Trout Monitoring Program: 2002-2005 report. Report prepared for Seattle City Light. WDFW, La Conner, Washington.

______. 2014. Final report: Ross Lake rainbow broodstock program, upper Skagit reservoir fish community surveys and management plan, dated September, 2014. Washington Department of Fish and Wildlife, Shelton, Washington.

Dunham, J., B. Reiman, and K. Davis. 2001. Sources and magnitude of sampling error in redd counts for bull trout. North American Journal of Fisheries Management 21:343–352.

Eckmann, M. 2015. Bioenergetic Evaluation of Diel Vertical Migration by Bull Trout. Master's Thesis, Oregon State University.

Electric Power Research Institute. 2011. Fish Passage Through Turbines: Application of Conventional Hydropower Data to Hydrokinetic Technologies.

Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. Region 10 Office of Water, Seattle, WA

Envirosphere. 1988. Study of Skagit Dams Original Impacts on Wildlife and Fish Habitats and Populations. Final report prepared for Seattle City Light by Envirosphere Company, Bellevue, Washington.

______. 1989. Gorge Bypass Reach Fisheries Report. Prepared for Seattle City Light by Envirosphere Company.

Federal Energy Regulatory Commission (FERC). 1997. Order Approving Revised Exhibit M and Revising Annual Charges. 80 FERC ¶ 62,056. July 23, 1997.

______. 2006. Final Environmental Impact Statement for the Baker River Hydroelectric Project No. 2150-033. September 8, 2006.

Fowler, A. 2018. Bull trout population monitoring field study in the Skagit River Basin in 2017. Prepared by Washington Department of Fish and Wildlife, Fish Program, Region 4, prepared for Seattle City Light through Memorandum of Understanding WDFW#16-07206-Amendment One, dated March 30, 2018.

Frick, K., S.C. Corbett, and M.L. Moser. 2017. Climbing success of adult Pacific lamprey on a vertical wetted wall. Fisheries Management and Ecology 24.

Government of Canada. 2021. Species at Risk Public Database. [Online] URL: https://www.sararegistry.gc.ca/default.asp?lang=En&n=DA152E67-1&offset=2&toc=show. Accessed September 16, 2021.

Gustafson, R.G., T.C. Wainwright, G.A. Winans, F.W. Waknitz, L.T. Parker, and R.S. Waples. 1997. Status review of sockeye salmon from Washington and Oregon. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-33, 282 p.

Hansen, A.C., T.J. Kock, and G.S. Hansen. 2017. Synthesis of downstream fish passage information at projects owned by the U.S. Army Corps of Engineers in the Willamette River Basin, Oregon: U.S. Geological Survey Open File Report 2017-1101, 118 p. [Online] URL: https://doi.org/10.3133/ofr20171101.

Hard, J.J., J.M. Myers, M.J. Ford, R.G. Cope, G.R. Pess, R.S. Waples, G.A. Winans, B.A. Berejikian, F.W. Waknitz, P.B. Adams, P.A. Bisson, D.E. Campton, and R.R. Reisenbichler. 2007. Status review of Puget Sound Steelhead (*Oncorhynchus mykiss*). U.S. Department of Commerce NOAA Technical Memorandum NMFS-NWFSC-81.

Hayman, R.A., E.M. Beamer, and R.E. McClure. 1996. Fiscal year 1995 Skagit River Chinook restoration research. Skagit River Systems Cooperative, Final Project Performance Report for Northwest Indian Fisheries Commission Contract 3311, La Conner, Washington.

Heard, W.R. 1991. Life history of pink salmon. In Pacific salmon life histories. Edited by C. Groot and L. Margolis. University of British Columbia Press, Vancouver, B.C.

Howell, P.J., and P.M. Sankovich. 2012. An evaluation of redd counts as a measure of bull trout population size and trend. North American Journal of Fisheries Management, 32:1, 1-13.

Jacobs, S.E., W. Gaeuman, M.A. Weeber, S.L. Gunckel, and S.J. Starcevich. 2009. Utility of a probabilistic sampling design to determine bull trout population status using redd counts in basins of the Columbia River plateau. North American Journal of Fisheries Management 29:1590-1604.

Johnson, E.L., T.S. Clabough, M.L. Keefer, M.A. Jepson, C.C. Caudill, and M.L. Moser. 2010. Effects of lowered fishway water velocity on fishway entrance success by adult Pacific lamprey at Bonneville Dam, 2007-2009. Technical Report 2010-4 of Idaho Cooperative Fish and Wildlife Research Unit to U.S. Army Corps of Engineers, Portland District.

Johnson, E.L., T.S. Clabough, M.L. Keefer, C.C. Caudill, P.N. Johnson, M.A. Kirk, and M.A. Jepson. 2013. Evaluation of Dual Frequency Identification Sonar (DIDSON) for monitoring Pacific Lamprey passage behavior at fishways of Bonneville and John Day dams, 2012. Department of Fish and Wildlife Sciences, University of Idaho, Moscow, Report for U.S. Army Corps of Engineers, Portland District, Portland, OR. Technical Report 2013-5.

Johnson, O.W., W.S. Grant, R.G. Kope, K. Neely, F.W. Waknitz, and R.S. Waples. 1997. Status review of chum salmon from Washington, Oregon, and California. U.S. Department Of Commerce, NOAA Technical Memorandum NMFS-NWFSC-32, 280 p.

Johnson, O.W., M.H. Ruckelshaus, W.S. Grant, F.W. Waknitz, A.M. Garrett, G.J. Bryant, K. Neely and J.J. Hard. 1999. Status review of coastal cutthroat trout from Washington, Oregon and California. NOAA Technical Memorandum NMFS-NWFSC-37.

Keefer, M.L., C.T. Boggs, C.A. Peery, and C.C. Caudill. 2013a. Factors affecting dam passage and upstream distribution of adult Pacific Lamprey in the interior Columbia River basin. Ecology of Freshwater Fish 22:1–10.

Keefer, M.L., C.C. Caudill, T.S. Clabough, M.A. Jepson, E.L. Johnson, C.A. Peery, M.D. Higgs, and M.L. Moser. 2013b. Fishway passage bottleneck identification and prioritization: a case study of Pacific lamprey at Bonneville Dam. Canadian Journal of Fisheries and Aquatic Science, 70:1551-1565.

Keefer, M.L., G.A. Taylor, D.F. Garletts, C.K. Helms, G.A. Gauthier, T.M. Pierce, and C.C. Caudill. 2013. High-head dams affect downstream survival in the Middle Fork Willamette River. River Research and Applications 29:483–492.

Keefer, M.L., M.L. Moser, C.T. Boggs, W.R. Daigle, and C.A. Peery. 2009. Effects of body size and river environment on the upstream migration of adult Pacific Lampreys. North American Journal of Fisheries Management 29:1214–1224.

Keefer, M.L., G.A. Taylor, D.F. Garletts, C.K. Helms, G.A. Gauthier, T.M. Pierce, and C.C. Caudill. 2012. Reservoir entrapment and dam passage mortality of juvenile Chinook Salmon in the Middle Fork Willamette River. Ecology of Freshwater Fish 21:222–234.

Keefer, M.L., M.A. Jepson, T.S. Clabough, and C.C. Caudill. 2021. Technical fishway passage structures provide high passage efficiency and effective passage for adult Pacific salmonids at eight large dams. PLoS ONE 16(9): e0256805. [Online] URL: https://doi.org/10.1371/journal.pone.0256805.

Kendall, N.W., J.R. McMillan, M.R. Sloat, T.W. Buehrens, T.P. Quinn, G.R. Pess, K.V. Kuzishchin, M.M. McClure, R.W. Zabela. 2015. Anadromy and residency in steelhead and rainbow trout (*Oncorhynchus mykiss*): a review of the processes and patterns. Canadian Journal of Fisheries and Aquatic Sciences, 2015, 72(3):319-342.

Khan F., G.E. Johnson, I.M. Royer, N.R. Phillips, J.S. Hughes, E.S. Fischer, K.D. Ham, and G.R. Ploskey. 2012. Acoustic Imaging Evaluation of Juvenile Salmonid Behavior in the Immediate Forebay of the Water Temperature Control Tower at Cougar Dam, 2010. PNNL-20625, final report submitted to the U.S. Army Corps of Engineers, Portland District, Portland, Oregon, by Pacific Northwest National Laboratory, Richland, Washington.

Kinsel, K., M. Zimmerman, L. Kishimoto, and P. Topping. 2008. 2007 Skagit River Wild 0+ Chinook Production Evaluation. Annual Report to Salmon Recovery Funding Board. WDFW, Olympia, Washington. 62 pp.

Kock, T.J. 2017. Surface Collectors in the Pacific Northwest: Operating Characteristics and Collection Success. Short Course – Downstream Passage of Fish at High Head Dams.

Presentation at the International Conference on Engineering and Ecohydrology for Fish Passage. Oregon State University, June 19-21, 2017.

Kock, T., J. Ferguson, M. Keefer, and C. Schreck. 2021. Review of trap-and-haul for managing Pacific salmonids (*Oncorhynchus* spp.) in impounded river systems. Reviews in Fish Biology and Fisheries 31:1-42.

Kock, T., N. Verretto, N. Ackerman, R. Perry, J. Beeman, M. Garello, and S. Fielding. 2019. Assessment of Operational and Structural Factors Influencing Performance of Fish Collectors in Forebays of High-Head Dams. Transactions of the American Fisheries Society 148:464-479.

Lampman, R., T. Beals, D. Lumley, S. Goudy, and R. Rose. 2019. Yakama Nation Pacific Lamprey Project 2018 Annual Progress Report. Prepared for the U.S. Department of Energy, Bonneville Power Administration (Project No. 2008-470-00), Portland, Oregon. 85 pp.

Lane, R.N. and B. Lane. 1977. Indians and Indian Fisheries of the Skagit River System. La Conner, WA: Skagit System Cooperative.

Le, B., E. Anderson, J. Maenhout, and M. Clement. 2018. 2017 Pacific Lamprey management plan comprehensive annual and 10-year biological objectives status report. Prepared for Public Utility District 2 of Grant County, Priest Rapids Hydroelectric Project, Federal Energy Regulatory Commission 2114, Ephrata, Washington.

Lowery, E. 2021. Personal communication between Erin Lowery, Seattle City Light Fish Biologist, and Jacob Venard, HDR Senior Project Manager. September 15, 2021.

Lowery, E.D. 2009. Trophic relations and seasonal effects of predation on Pacific salmon by fluvial bull trout in a riverine food web. Master of Science, University of Washington.

Lowery, E.D., J.N. Thompson, J.P. Shannahan, E. Connor, D. Pflug, B. Donahue, C. Torgersen, and D.A. Beauchamp. 2013. Seasonal Distribution and Habitat Associations of Salmonids with Extended Juvenile Freshwater Rearing in Different Precipitation Zones of the Skagit River, WA. [Online] URL: http://blogs.nwifc.org/psp/2013/10/final-progress-report-deliverables-5/.

Lowery, E.D., and D.A. Beauchamp. 2015. Trophic Ontogeny of Fluvial Bull Trout and Seasonal Predation on Pacific Salmon in a Riverine Food Web. Transactions of the American Fisheries Society, 144:4, 724-741.

Malick, M.J., and S.P. Cox. 2016. Regional-scale declines in productivity of Pink and Chum Salmon stocks in western North America. PLoS ONE 11(1):e0146009.

Marohn, L., E. Prigge, and H. Reinhold. 2014. Escapement success of silver eels from a German river system is low compared to management-based estimates. Freshwater Biology 2014;59:64–72.

Maxell, B.A. 1999. A prospective power analysis on the monitoring of bull trout stocks using redd counts. North American Journal of Fisheries Management 19:860-866.

McClure, M., J. Anderson, G. Pess, T. Cooney, R. Carmichael, C. Baldwin, J. Hesse, L. Weitkamp, D. Holzer, M. Sheer, and S. Lindley. 2018. Anadromous Salmonid Reintroductions: General Planning Principles for Long-Term Viability and Recovery. U.S. Department of

Commerce, NOAA Technical Memorandum NMFS-NWFSC-141. [Online] URL: https://doi.org/10.7289/V5/TM-NWFSC-141.

McPhail, J.D. 1987. Status of the Salish sucker, *Catostomus* sp, kin Canada. Canadian Field Naturalist 101:231-236.

McPhail, J.D., and E.B. Taylor. 1995. Final Report to Skagit Environmental Endowment Commission. Skagit Char Project (94-1). Dept. of Zoology, University of British Columbia, Vancouver, Canada.

______. 1999. Morphological and genetic variation in northwestern longnose suckers, Catastomus Catostomus: the Salish sucker problem. Copeia 1999:884-893.

Monzyk, F.R., J.D. Romer, R. Emig, and T.A. Friesen. 2012. Life-history characteristics of juvenile spring Chinook salmon rearing in Willamette Valley reservoirs: Report of Oregon Department of Fish and Wildlife, Corvallis, prepared for U.S. Army Corps of Engineers, Portland, Oregon,contract W9127N-10-2-0008-0007.

Monzyk, F.R., R. Emig, J.D. Romer, and T.A. Friesen. 2013. Life-history characteristics of juvenile spring Chinook salmon rearing in Willamette Valley reservoirs: Report of Oregon Department of Fish and Wildlife, Corvallis, prepared for U.S. Army Corps of Engineers, Portland, Oregon, contract W9127N-10-2-0008-0007.

Monzyk, F.R., T.A. Friesen, and J.D. Romer. 2015. Infection of juvenile salmonids by Salmincola californiensis (Copepoda: Lernaeopodidae) in reservoirs and streams of the Willamette River basin, Oregon. Transactions of the American Fisheries Society 144:891–902.

Moore, J.W., J.D. Yeakel, D. Peard, J. Lough, and M. Beere. 2014. Life-history diversity and its importance to population stability and persistence of a migratory fish: steelhead in two large North American watersheds. Journal of Animal Ecology 83(5):1035-1046.

Moser, M.L., P.A. Ocker, L.C. Stuehrenberg, and T.C. Bjornn. 2002. Passage efficiency of adult Pacific lamprey at hydropower dams on the lower Columbia River, USA. Transactions of the American Fisheries Society 131:956-965.

Moser, M.L., D.A. Ogden, H.T. Pennington, M.L. Keefer, and C.C. Caudill. 2012. Development of passage structures for adult Pacific lamprey at Bonneville Dam, 2009-2010. Report to U.S. Army Corps of Engineers, Portland District, Portland, Oregon.

Myers, J.M., J.J. Hard, E.J. Connor, R.A. Hayman, R.G. Kope, G. Lucchetti, A.R. Marshall, G.R. Pess, and B.E. Thompson. 2015. Identifying historical populations of Steelhead within the Puget Sound distinct population segment. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-128.

National Marine Fisheries Service (NMFS). 2011. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

______. 2012. Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat (EFH) Consultation, License Amendment of Seattle City Light's Skagit River Hydroelectric Project, FERC No. P-533. NMFS Consultation Number 2011/06440.

______. 2018. Proposed Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (*Oncorhynchus mykiss*). National Marine Fisheries Service, Seattle, Washington.

______. 2021. Comments on Preliminary Draft DCD. Uploaded to Triangle Associates' Project SharePoint site, October 14, 2021.

National Park Service (NPS). 2012. Ross Lake National Recreation Area. General Management Plan. National Park Service, U.S. Department of the Interior. July 2012.

______. 2020a. Diablo Lake Reservoir Fish Assessment, 2020, Annual Report. National Park Service, U.S. Department of the Interior.

______. 2020b. Native char spawning survey data summaries in upper Skagit tributaries , 2017 – 2021. National Park Service, U.S. Department of the Interior.

Negherbon, L. 2021. Personal communication from L. Negherbon (NMFS) during Seattle Relicensing Project, Fish Passage Study (FA-04) Workshop No. 3. December 16, 2021.

Nelson, T.C., C. Mussell, and J. Rissling. 2004. Upper Skagit Watershed Native Char Project. Progress Report 2003 prepared for Ministry of Water, Land and Air Protection, Surrey, BC and BC Parks, North Vancouver, BC.

Northwest Power and Conservation Council. 2016. Staff Paper: Review of Fish Passage Technologies at High-Head Dams. Document Number 2016-14. December 2016.

Orlov, A., V. Savinyh, and D. Pelenev. 2008. Features of the spatial distribution and size structure of the Pacific Lamprey *Lampetra tridentata* in the North Pacific. Russian Journal of Marine Biology 34:276-287.

Ostberg, C.O., D.M. Chase, M.C. Hayes, J.J. Duda. 2018. Distribution and seasonal differences in Pacific Lamprey and *Lampetra spp* eDNA across 18 Puget Sound watersheds. PeerJ 6:e4496 https://doi.org/10.7717/peerj.4496

Pacific Fishery Management Council (PFMC). 2019. Review of 2018 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. (Document prepared for the Council and its advisory entities.) Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.

PacifiCorp. 2016. Lewis River Fish Passage Program 2015 Annual Report. Prepared for PaciCorp and Public District No. 1 of Cowlitz County. April 15, 2016.

______. 2017. Lewis River Fish Passage Program 2016 Annual Report. Prepared for PaciCorp and Public District No. 1 of Cowlitz County. April 4, 2017.

PacifiCorp and Cowlitz PUD. 2020. Lewis River Fish Passage Program 2019 Annual Report (Final), Monitoring and Evaluation (M&E) Plan Metrics. FERC Project Nos. 935, 2071, and 2213, dated April 9, 2020. Prepared by PacifiCorp and Public Utility District No. 1 of Cowlitz County.

Puget Sound Energy. 2020. Settlement Agreement Article 103 Upstream Fish Passage 2019 Annual Report. October 2020.

Pearson, M., M. Healey, and D. Buth. 2003. Life-History Characteristics of the Endangered Salish Sucker (*Catostomus* sp.) and Their Implications for Management. Copeia 2003:759-768.

Pflug, D., and L. Mobrand. 1989. Skagit River salmon and steelhead fry stranding studies. Prepared by R. W. Beck Associates for Seattle City Light, Environmental Affairs Division, Seattle, Washington.

Puget Sound Energy. 2020. Settlement Agreement Article 103 Upstream Fish Passage 2019 Annual Report. October 2020.

Puget Sound Technical Recovery Team (PSTRT). 2005. Supplement to the Draft Puget Sound Salmon Recovery Plan. National Marine Fisheries Service. Northwest Region.

Rawhouser, A. 2021. Email documenting Salish Sucker occurrence from Ashley Rawhouser, National Park Service Aquatic Ecologist to Becky Holloway, HDR Senior Environmental Biologist. December 13, 2021.

Reiman, B., and J. McIntyre. 1993. Demographic and habitat requirements for the conservation of bull trout. USFS General Technical Report INT 302.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent Populations of Chinook Salmon in Puget Sound. U.S. Dept. Commer. NOAA Technical Memorandum NMFS-NWFSC-78. 125 p.

R2 Resource Consultants. 2009. Fish Migration in Studies in Ross Lake. Draft data report prepared for Seattle City Light. R2 Resource Consultants, Redmond, Washington.

Salo, E.O. 1991. Life History of Chum Salmon (*Oncorhynchus keta*). In Groot, C., and L. Margolis (eds.), Pacific salmon life histories, p. 231-309. University of British Columbia Press, Vancouver, B.C., Canada.

Seattle City Light (City Light). 1988. Study of Skagit dams: original impacts on wildlife and fish habitat populations, final report. May 1988.

______. 2011. Biological Evaluation Skagit River Hydroelectric Project License (FERC No. 553) Amendment: Addition of a Second Power Tunnel at the Gorge Development. June 2011.

______. 1991. Offer of Settlement, Skagit River Hydroelectric Project, FERC No. 553. Seattle, WA. April 1991.

______. 2012. Biological evaluation – supplement: impacts of entrainment on bull trout - Skagit River hydroelectric project license (FERC no. 553) amendment: addition of a second power tunnel at the gorge development – final. July 2012.

______. 2018. Annual Incidental Taker Report for 2017 – Bull Trout; Skagit River Hydroelectric Project (FERC 553). April 30, 2018.

______. 2019. Power System Engineering Information

______. 2020a. Pre-Application Document (PAD) for the Skagit River Hydroelectric Project, FERC Project No. 553. April 2020.

______. 2020b. Proposed Study Plan (PSP) for the Skagit River Hydroelectric Project, FERC Project No. 553. December 2020.

______. 2021a. Revised Study Plan (RSP) for the Skagit River Hydroelectric Project, FERC Project No. 553. April 2021.

______. 2021b. Notice of Certain Agreements on Study Plans for Skagit Relicensing. June 2021.

_____. 2021c. City Light. 2021. Skagit River Hydroelectric Project - Overview of Current Woody Material Management Processes and Data Collection.

Seiler, D.E., L. Kishimoto, and S. Neuhauser. 1998. 1997 Skagit River wild 0C Chinook production evaluation. Washington Department of Fish and Wildlife, Olympia.

Shapovalov, L., and A.C. Taft. 1954. The life histories of the rainbow trout (*Salmo gairdneri gairdneri*) and silver salmon (*Oncorhynchus kisutch*), with special reference to Waddell Creek, California, and recommendations regarding their management. U.S. Fish and Wildlife Service Fishery Bulletin 98:1-373.

Skagit River System Cooperative (SRSC). 2021. Skagit River salmonid size information for 2012-2021. Information provided from the Tribal Online Accounting System, http://nwifc.org/services/webapps/

Skagit River System Cooperative (SRSC) and Washington Department of Fish and Wildlife (WDFW). 2005. Skagit Chinook Recovery Plan. Skagit River System Cooperative, LaConner, Washington, and Washington Department of Fish and Wildlife, Olympia.

Small, M.P., S. Bell, and C. Bowman. 2016. Genetic analysis of native char collected in Diablo Lake, Gorge Reservoir, and Ross Lake in the Skagit River basin. Washington Department of Fish and Wildlife Molecular Genetics Lab, Olympia, Washington.

Smith, E.V., and M.G. Anderson. 1921. A Preliminary Biological Survey of the Skagit and Stillaguamish Rivers. University of Washington.

Smith, M. 2010. Final report, population structure and genetic assignment of bull trout (*Salvelinus confluentus*) in the Skagit River Basin, dated December 2010. School of Aquatic and Fishery Sciences, University of Washington, Seattle, Washington.

Smith, M.J., and K. Naish. 2010. Population Structure and Genetic Assignment of Bull Trout (*Salvelinus confluentus*) in the Skagit River Basin. Draft Report to Seattle City Light, Seattle, Washington.

Stevens, Peter, Ian Courter, Christopher C. Caudill, and Chris Peery. 2015. Evaluation of Adult Pacific Lamprey Passage at Lower Snake River Dams. Prepared under contract W912EF-14-P-5061 for the U.S. Army Corps of Engineers.

Towey, W. 2022. Email summarizing passage improvements at Rocky Reach Dam from William Towey, Chelan County PUD, to Jacob Venard, HDR Senior Project Manager. January 17, 2021.

Triton. 2020. 2020 Skagit River Snorkel Survey Report, Skagit Environmental Endowment Commission. Prepared by Triton Environmental Consulting Ltd., Vancouver, British Columba, Canada.

Trotter, P. 1991. Cutthroat trout. In J. Stolz and J. Schnell (eds.), Trout. The Wildlife Series, p. 236-265. Stackpole Books, Harrisburg, Pennsylvania.

Upper Skagit Indian Tribe (USIT). 2020. Natural Resources Department Memorandum titled “Bypass Survey Compilation.” Sedro-Woolley, Washington.

U.S. Army Corps of Engineers (USACE). 2014. Pacific Lamprey Passage Improvements Implementation Plan: 2008-2018. 2014 Revision.

U.S. Fish and Wildlife Service (USFWS). 2004. Draft Recovery Plan for the Coastal-Puget Sound Distinct Population Segment of Bull Trout (*Salvelinus confluentus*). Puget Sound Management Unit. Portland, Oregon. 410 pp.

______. 2010. Best Management Practices to Minimize Adverse Effects to Pacific Lamprey.

______. 2015. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

______. 2017. Practical guidelines for incorporating adult Pacific lamprey passage at fishways. June 2017. White Paper. 47 pp + Appendix. Available online: https://www.fws.gov/pacificlamprey/mainpage.cfm.

______. 2020. Pacific Lamprey 2020 Regional Implementation Plan for the Snake River Region: Lower Snake, Clearwater and Salmon Regional Management Units. [Online] URL: https://www.fws.gov/pacificlamprey/Documents/RIPs/2020/2020%20Snake%20RIP.pdf. Accessed November 11, 2021.

U.S. Forest Service (USFS). 2002. Upper Skagit River watershed native char project, upper Canyon Creek habitat surveys, upper Canyon Creek snorkel surveys, Canyon and Ruby Creek bull trout spawning surveys – 2001. Okanogan-Wenatchee National Forest, Methow Valley Ranger District. Report prepared April 2002.

United States Geological Survey (USGS). 2019. Stream Stats. [Online] URL: https://streamstats.usgs.gov/ss/. Accessed November 2019.

Ward, D., B. Clemens, D. Clugston, A. Jackson, M. Moser, C. Peery, and D. Statler. 2012. Translocating Adult Pacific Lamprey within the Columbia River Basin: State of the Science. Fisheries 37:351-361.

Washington Department of Fish and Wildlife (WDFW). 2000a. Draft Fishway Guidelines for Washington State.

______. 2000b. Draft Fish Protection Screen Guidelines for Washington State.

______. 2002. Salmonid Stock Inventory. Washington Department of Fish and Wildlife. [Online] URL: http://wdfw.wa.gov/fish/sasi/index.htm. Accessed June 17, 2019.

______. 2004. Draft Environmental Impact Statement for the Lower Skagit River Steelhead Acclimation and Rearing Facility. Washington Department of Fish and Wildlife, Olympia, Washington.

______. 2019. SCoRE (Salmon Conservation and Reporting Engine). [Online] URL: https://fortress.wa.gov/dfw/score/score/. Accessed June 8, 2019.

______. 2021. Salmonscape data for Coho Salmon. [Online] URL: https://apps.wdfw.wa.gov/salmonscape/. Accessed November 4, 2021.

Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and the Western Washington Treaty Indian Tribes (WWTIT). 1994 Washington State Salmon and Steelhead Stock Inventory (SASSI). Washington Department of Fish and Wildlife. 212 pages + three appendices.

Washington Department of Fish and Wildlife (WDFW) and the Western Washington Treaty Indian Tribes (WWTIT). 2003. 2002 Washington State Salmon and Steelhead Stock Inventory, Olympia, Washington.

Weaver, T.M., and R.G. White. 1985. Coal Creek fisheries monitoring study number III. Quarterly progress report to United States Department of Agriculture, Forest Service, Montana State Cooperative Fisheries Research Unit, Bozeman, Montana. 94 p.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-24. Seattle, Washington.

Wydoski, R.S., and R.R. Whitney. 2003. Inland fishes of Washington. University of Washington Press, Seattle, Washington. Second Edition.

Yakama Tribe. 2021. Adult Pacific Lamprey translocation protocols.

Young, M.K., D.J. Isaak, M.K. Schwartz, K.S. McKelvey, D.E. Nagel, T.W. Franklin, S.E. Greaves, J.C. Dysthe, K.L. Pilgrim, G.L. Chandler, S.P. Wollrab, K.J. Carim, T.M. Wilcox, S.L. Parkes-Payne, and D.L. Horan,. 2018. Species occurrence data from the aquatic eDNAtlas database. Fort Collins, CO: Forest Service Research Data Archive. Updated 30 June 2021. https://doi.org/10.2737/RDS-2018-0010. Accessed January 18, 2022.

Zapel, E. 2019. Ross Lake Debris Disposal Study – Final Report. Prepared for City Light.

Zimmerman, M.S., C. Kinsel, E. Beamer, E.J. Connor, and D.E. Pflug. 2015. Abundance, Survival, and Life History Strategies of Juvenile Chinook Salmon in the Skagit River, Washington. Transactions of the American Fisheries Society, 144:3, 627-641.

This page intentionally left blank.

FP-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

ATTACHMENT A

SELECTED ENGINEERING PLAN SHEETS AND SECTIONS FOR SKAGIT GENERATION FACILITIES

Per guidance from the Federal Energy Regulatory Commission (FERC), Engineering Plan Sheets and Sections for Skagit Generation Facilities contain Critical Energy/Electric Infrastructure Information (CEII) and have therefore been omitted from general distribution in Attachment A of the Conceptual Design Criteria Document. This information will be filed with FERC with a CEII designation as part of the Initial Study Report submittal in March 2022. Procedures for obtaining access to CEII may be found at 18 CFR § 388.113. Requests for access to CEII should be made to the Commission's CEII coordinator. CEII is also available upon request to Danielle Hanson at danielle.hanson@hdrinc.com.

FP-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

ATTACHMENT B

SUMMARY OF PACIFIC NORTHWEST HYDROPOWER PROJECTS DOWNSTREAM FISH PASSAGE FACILITIES PERFORMANCE STANDARDS AND EVALUATION

PACIFIC NORTHWEST HYDROPOWER PROJECTS
DOWNSTREAM FISH PASSAGE FACILITIES PERFORMANCE STANDARDS AND EVALUATION

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Baker Lake Project (P-2150), Washington, Puget Sound Energy (PSE) - *Upper*										
Floating Surface Collector with guide nets from surface to bottom	Baker Lake Long (8.5 miles), narrow (max depth of 300 ft)	727.77 max 685 min	80%[1]	95%	98%	75%	Not evaluated	Coho: 83.3-99.0%[2] Sockeye: 69.4-94.5%	Species combined: Exceeds 98%[3]	Not evaluated

Notes

Operational in 2008; 5 years of performance evaluation (2008-2012); 7 years into long-term monitoring (2013-2019); 2 phases, first 500 cfs attraction flow, and second 1,000 cfs attraction flow

If collection efficiency less than the target, PSE, NMFS, and other collaborators will assess the deficiency and recommend modifications to PSE.

Sources

- Settlement Agreement, 11/30/04
- NMFS BO and related Errata, 7/2/08 and 10/20/08, respectively
- License Order, 10/17/08
- Biological Evaluation, Upper Baker Downstream Fish Passage FSC, 2009 Study Report (January 2010)
- Post-Construction Evaluation Plan (Lower Baker), 10/12/12
- SA Article 105, Downstream Fish Passage 2019 Annual Report, (October 2020) (most recent report)

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Baker Lake Project (P-2150), Washington, PSE – *Lower*										
Floating Surface Collector with guide nets from surface to bottom	Lake Shannon Long (7.5 miles), narrow (max depth of 280 ft)	442.35 max 389 min	80%[4]	95%	98%	75%	Not evaluated	Coho: 87.5-96.1%[5] Sockeye: 82.7-99.3%	Species combined: 99.2%[6]	Not evaluated

Notes

Operational in 2013; 3 years of performance evaluation (2013-2015); 1 year into long-term monitoring (2016); 2 phases, first 500 cfs attraction flow, and second 1,000 cfs attraction flow

If collection efficiency less than the target, PSE, NMFS, and other collaborators will assess the deficiency and recommend modifications to PSE.

Sources

- *See Upper Baker.*
- 2013 Biological Evaluation Study Report, Lower Baker Downstream Fish Passage FSC (December 2013)
- SA Article 105, Downstream Fish Passage 2019 Annual Report, (October 2020) (most recent report)

[1] Performance standards per NMFS BO and subsequent errata.
[2] Values for upper Baker are mean performance recapture rate (including non-migrants and predation) for study years 2008-2015 for Coho Salmon and years 2008-2019 for Sockeye Salmon. Evaluation of re-capture of PIT-tagged, released fish; no mention of survival or reservoir passage evaluations in the annual report. Source: Downstream Fish Passage 2019 Annual Report (Table 4).
[3] Based on one year of study, for the initial year of operation. Source: 2009 Upper Baker Downstream Fish Passage FSC Biological Evaluation Report.
[4] Performance standards per NMFS BO and subsequent errata.
[5] Values for lower Baker are mean performance recapture rate (including non-migrants and predation) for study years 2013-2015 for Coho Salmon; 2014-2019 for Sockeye Salmon. Evaluation of re-capture of PIT-tagged, released fish; no mention of survival or reservoir passage evaluations in the annual report. Source: Downstream Fish Passage 2019 Annual Report (Table 5).
[6] Based on one year of study, for the initial year of operation. Source: 2013 Lower Baker Downstream Fish Passage FSC Biological Evaluation Report.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Cushman Project (P-460), Washington, Tacoma Public Utilities – *Cushman No. 1*										
Floating, Surface Collector with barrier nets	Lake Cushman Long (8.5 miles), narrow	738 ft max 735-738 ft (Tacoma Datum) min Memorial Day to Labor Day 690 ft min Nov 1-March 31	Unspecified	FCE:[7] 95%	Unspecified	SS:[8] 95% target 75% minimum	Coho: 20%[9] Sockeye: 43.2[10]	FCE: Coho 32.9-61.4%[11] Sockeye: 39.4% - 65.7%	Coho: 89%[12] Sockeye: 99.7	SS: Coho: 418.6-48.4%[13] Sockeye: 24.0-42.6%[14]

Notes

Operational in 2014; 2 (of 9) demonstration years; 2 phases, first 250 cfs attraction flow, and second 500 cfs attraction flow

Phase One: The Licensee may operate the Phase One FSC for up to nine demonstration years to satisfy Performance Standards. If, in any of these nine (9) years, the FSC satisfies either of the Performance Standards, the Licensee will enter a two-year verification period to verify that the Performance Standard is sustained as described in the paragraph below. If performance is not achieved during a demonstration year or not sustained during a verification period, then the Licensee shall make non-attraction-flow improvements in consultation with the Fisheries and Habitat Committee. Phase One includes up to, but no more than, two verification periods. The Licensee has a minimum of nine years to operate the FSC at 250 cfs, and a maximum of thirteen (13) years if the verification periods are triggered. The Licensee may opt to move to Phase Two at any time prior to expiration of the time limit for operation within Phase One.

Verification shall be measured at a 90% confidence level with a standard error of the estimate that shall be not more than plus or minus 5% (i.e., 10% error), unless otherwise agreed to by the Fisheries and Habitat Committee.

If neither of the Performance Standards are demonstrated and verified within the timeframes provided for the Phase One Demonstration and Verification Periods, Phase One will end. If Phase One ends, the Phase Two FSC will be installed and operational prior to the start of the second fish passage season after Phase One ends. If, however, NMFS, USFWS and BIA believe that one or more of the extenuating factors listed below is likely the cause of the FSC not meeting the performance standards, then NMFS, USFWS, and BIA may approve continued operation of the collector at 250 cfs until such factors are addressed. Extenuating factors may include: (1) environmental conditions (such as predation or disease mortality) that prevent the collector from attaining System Survival (SS) or Fish Collection Efficiency (FCE); (2) technical issues related to measurement of SS or FCE; or (3) other similar surface collection systems not meeting performance criteria.

If FCE is demonstrated and verified but SS is not demonstrated and verified, the Licensee shall continue to operate the Phase One FSC and not develop Phase Two so long as FCE is maintained (see Performance Standard Monitoring, section 7). As long as FCE is maintained, increases in FSC discharge will not be required. However, within twelve (12) months of verifying FCE, the Licensee shall develop a plan for determining factors which may be limiting its ability to demonstrate and verify SS, in consultation

with the Fisheries and Habitat Committee, and shall implement appropriate measures for improving SS as soon thereafter as possible.

If SS is demonstrated, verified, and maintained but FCE is not, the Licensee shall make non-attraction flow modifications to the FSC as determined necessary by the Fisheries and Habitat Committee.

Phase Two: The FSC shall be redesigned to produce a 500 cfs attraction flow, unless otherwise agreed to by NMFS, USFWS, and BIA, provided the total attraction flow shall not exceed 500 cfs. If the Phase Two FSC does not satisfy Performance Standards, the Licensee shall implement appropriate non-attraction flow measures for improving SS and FCE in consultation with the Fisheries and Habitat Committee and based upon the performance monitoring conducted pursuant to Article 416.

Sources

- Settlement Agreement, 01/12/09
- Order on Remand and on Offer of Settlement, Amending License, Authorizing New Powerhouse, and Lifting Stay, 7/15/10
- Downstream Fish Passage Plan, 1/7/11
- Approval of Downstream Fish Passage Plan, 8/16/11
- Approval of Downstream Fish Passage Final Designs, 6/6/12
- Downstream Fish Passage Monitoring 2016 Annual Report, 6/2/17
- Lake Cushman Downstream Migrant Evaluation 2020 Annual Report, February 2021
- FSC as a mechanism for fish collection in trap and haul fish passage operations in the Pacific Northwest, 5/17/17 Presentation, Blue Leaf

[7] Per Cushman Settlement Agreement, proposed Article 414 Downstream Fish Passage, Section 6.2. Fish collection efficiency (FCE) is percentage of tagged group of smolts detected at the log boom (360 ft upstream of dam) and are successfully collected in the floating surface collector (FSC) and safely passed downstream of the Cushman Project.

[8] Per Cushman Settlement Agreement, proposed Article 414 Downstream Fish Passage, Section 6.1. System survival (SS) is percentage of marked group of smolts released near the upstream end of Lake Cushman that is successfully collected by the FSC and safely passed downstream of the Cushman Project.

[9] Average of study years 2015-2016; release TOR to FSC. Source: Blue Leaf PowerPoint presentation, slide 21 (derived from 2015 and 2016 annual reports).

[10] Study year 2020. Most recent study year. Source: Lake Cushman Downstream Migrant Evaluation 2020 Annual Report, Table 13.

[11] Study year 2018; release zone of influence (ZOI) to FSC and FSC to sorting facility (SF). Most recent study year following net guidance structure addition. Source: Lake Cushman Downstream Migrant Evaluation 2020 Annual Report, Table 27.

[12] Average of study years 2015-2016; FSC to sorting facility (combined PIT and Acoustic/PIT tag results). Source: Blue Leaf PowerPoint presentation, slide 21 (derived from 2015 and 2016 annual reports).

[13] . Study year 2018; Most recent study year following net guidance structure addition. Source: Lake Cushman Downstream Migrant Evaluation 2020 Annual Report, Table 27.

[14] Study years 2018-2020. Source: Lake Cushman Downstream Migrant Evaluation 2020 Annual Report, Table 27.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Clackamas River Project (P-2195), Oregon, Portland General Electric (PGE) – *North Fork*										
Floating, Surface Collector with barrier net	North Fork Reservoir Long (4.6 miles), narrow (max depth of 180 ft)	389 max 386 min 382.5 extreme min	Unspecified	Unspecified	Unspecified	97%[15] Injury rate: [16] ≤2% (smolts) ≤4% (fry)	Coho: 98.1%[17] Chinook: 96% Steelhead: 797.2%	FGE: [18] Coho: 94.1-96.1% Chinook: 78-90.3% Steelhead: 92.3-96.7%	Coho: 100%[19] Chinook: 100% Steelhead: 99.6%	PCE[20] Coho: 95.1% Chinook: 91.7% Steelhead: 97.4%

Notes

Operational in late 2015; 1 year of data collected (2016); first, per "A/B Measures", 1,000 cfs attraction flow, second, per "D Measure", 3,000 cfs attraction flow

Tier 1 of initial (A and B measures) and additional (C and D measures), no additional measures if survival standard met. Related to A and B measure implementation, Tier 2 is if survival is 88-<97%, C Round 1 measures to be implemented. Tier 3 is if survival is <88%, D measures to be implemented. Related to C Round 1 measures, Tier 4 is if survival is 91-<97%, C Round 2 measures to be implemented. Tier 5 is if survival is <91%, D measures to be implemented. Related to C Round 2 measures, Tier 6 is if survival is 95-<97%, population level look at all salmonid runs to determine if going to D measures is warranted; if not, Licensee consults w/ Fish Committee regarding other feasible passage measures or a mitigation requirement. Tier 7 is if survival is <95%, implement D measures. Related to D measures, Tier 8 is if survival is <97% Licensee to consult w/ Fish Committee regarding additional passage measures or mitigation measures beyond D measures; if agreement is not reached, any party may request FERC to require additional passage or mitigation measures.

Sources

- Settlement Agreement, 3/30/06
- Order Issuing New License, 12/21/10
- Downstream Fish Passage Studies Schedule, 7/28/11
- 2016 Annual Report: Implementation of the Clackamas Project Fish Passage and Protection Plan, 4/21/17
- Evaluation of Juvenile Salmonid Passage through North Fork, 2016 Progress Report, February 2017
- Evaluation of Juvenile Salmonid Passage through North Fork, 2017 Progress Report, March 2018
- Evaluation of Juvenile Salmonid Passage through North Fork, 2019 Progress Report, February 2020
- Evaluation of Juvenile Salmonid Passage through North Fork, 2020 Progress Report, April 2021

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Clackamas River Project (P-2195), Oregon, PGE – *River Mill*										
Fixed, Surface Collector with exclusion nets	Estacada Lake Long (2.8 miles), narrow (max depth of 80 ft)	665 max 660 normal min 640 extreme min	Unspecified	Unspecified	Unspecified	97%[21] Injury rate: [22] <2% (smolts) <4% (fry)	Chinook: 98.0%[23] Coho:98.9% Steelhead:96.4%	FGE:[24] Chinook: 97.6% Coho: 98.9% Steelhead: 97.5%	Chinook: 9.9%[25] Coho: 99.8% Steelhead: 100%	

Notes

Operational in late 2012; 6 years of data collected (2013-2018); 500 cfs attraction flow

Sources

- *See North Fork*
- Evaluation of Juvenile Salmonid Passage through River Mill Hydroelectric Development, 2018 Progress Report, May 2019

[15] Project-wide smolt passage survival standard of 97%. Per Settlement Agreement, Article 23 Downstream Fish Passage Standards, Table 1.
[16] Per Settlement Agreement, Article 24 Juvenile Salmonid Injury Standards, subpart (a).
[17] Average of study years 2016-2019. Source: Evaluation of Juvenile Salmonid Passage Through the North Fork Hydroelectric Development,2019 Progress Report, Table 20.
[18] FGE is Fish Guidance Efficiency; average of study years 2016-2019. Source: Evaluation of Juvenile Salmonid Passage Through the North Fork Hydroelectric Development, 2019 Progress Report, Table 18.
[19] 2016 and 2017only. Source: Evaluation of Juvenile Salmonid Passage Through the North Fork Hydroelectric Development,2017 Progress Report, Table 32.
[20] PCE is the proportion of fish collected at North Fork and River Mill Dams and provides a close indication of Project-wide survival. Pooled result for years 2016-2019. Source Evaluation of Juvenile Salmonid Passage Through the North Fork Hydroelectric Development, 2019 Progress Report, Executive Summary.
[21] Survival Standard. Per Settlement Agreement, Article 23 Downstream Fish Passage Standards, Table 1.
[22] Per Settlement Agreement, Article 24 Juvenile Salmonid Injury Standards, subpart (a).
[23] Source: Evaluation of Juvenile Salmonid Passage Through the River Mill Hydroelectric Development, 2018 Annual Report, Table 13.
[24] FGE is Fish Guidance Efficiency. Evaluation of Juvenile Salmonid Passage Through the River Mill Hydroelectric Development, 2018 Annual Report, Table 11.
[25] Source: Evaluation of Juvenile Salmonid Passage Through the River Mill Hydroelectric Development, 2018 Annual Report, Table 19.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard: Reservoir Passage (R)	Compliance Standard: Collection (C)	Compliance Standard: Survival (S)	Compliance Standard: Efficiency (overall survival; RxCxS)	Measured Performance: Reservoir Passage (R)	Measured Performance: Collection (C)	Measured Performance: Survival (S)	Measured Performance: Efficiency (overall survival; RxCxS)
Pelton Round Butte Project (P-2030), Oregon, PGE – *Round Butte*										
Selective Water Withdrawal Fish Capture Facility	Lake Billy Chinook Long, complex (3 fingers)	1,945 max 1,944 min summer 1,925 min winter	Capture:[26] >50% (temporary facility averaged over 4 years of study) >75% (permanent facility rolling 4-yr average during the first 12 years)	Unspecified	Downstream Passage Facility Survival:[27] 93% (temporary facility during first 5 years of operation)[28] 96% (permanent facility)[29]	Unspecified	2015 Chinook: 23.8%[30] Steelhead: 26.8% 2020[31] Chinook: 24-31% (Hatchery) 22-29% (Natural) Steelhead: 17-21% (Hatchery); 6-20% (Natural)	--	Chinook: 67%[32] Sockeye: 51% Steelhead: 55% Chinook: 98.8%[33] Steelhead: 99.5% Sockeye: 98.5%	--

Notes/Sources Documents

Operational in 2009; 7 years of data collected (2010-2016); construction of temporary and permanent downstream passage facilities is part of Phase III out of IV related to fish passage, known as the Interim Passage Phase.

Downstream Passage Survival: The Licensee will take any feasible measures or implement modifications within their control that are necessary to meet the 93 percent survival standard for the temporary facility, and 96 percent survival standard for the permanent facility. After correcting facilities, the Licensee will re-test the facilities to ensure compliance. Additional re-testing will only be required if deficiencies are observed.

Reservoir Downstream Passage Survival: Actions will be taken, as appropriate, based on the results of the Testing and Verification studies evaluated according to the measures of success (i.e., performance standards) as follows: If >50 percent standard is achieved at the temporary downstream collection facility, then the Licensee will construct the permanent downstream migrant collection facility in accordance with the schedule set forth in Fish Passage Plan, Appendix VI (Settlement Agreement, Exhibit D). If >50 percent standard is not achieved, then the Licensee will further investigate the cause, and, in consultation with Fish Committee, the Licensee will take any feasible measures or implement modifications within their control that are necessary to meet or exceed the >50 percent objective. Seven years after construction of the temporary downstream migrant collection facility, if the >50 percent standard is not achieved, the Licensee shall provide a comprehensive report, for review, and approval by the Fish Committee, discussing the results of studies to date, the modifications that have been made as a result of those study results and recommendations, if any, for additional modifications. If after the completion of at least four years of study, the >50 percent standard has not been achieved and all steps to improve collection efficacy and reservoir passage or survival have been taken, the Licensee will initiate the appropriate consultation actions.

If >75 percent standard is achieved, then the Licensees' Testing and Verification studies involving tributary trapping will end for that tributary. After the >75 percent standard has been met, the Licensee will continue to monitor smolt emigration numbers at the permanent facility through the remainder of the license period. If the numbers of smolts captured at Round Butte Dam trend down, the Licensee in consultation with Fish Committee, will investigate the causes, including reevaluation of reservoir passage survival and take any feasible measures or implement modifications within the Licensees' control to increase smolt production. If >75 percent standard is not achieved, the Licensee will consult the Fish Committee regarding possible adjustments in study efforts to investigate the cause(s), including the identification of mortality factor(s), and regarding the implementation of any feasible measures or modifications within the Licensees' control necessary to meet or exceed the >75 percent standard.

Sources:
- Settlement Agreement, 8/4/04 (Fish Passage Plan in Exhibit D)
- License Order, 6/21/05
- 2015 Juvenile Migration Test and Verification Study, Annual Report, 6/17/16; 2016 Fish Passage Annual Report 5/22/17; 2020 Juvenile Migration Test and Verification Study, Annual Report May 2021 (most recent report)

[26] Per Settlement Agreement, Proposed License Article 18 Fish Passage Criteria and Goals, subpart (b). Capture in the Round Butte forebay of marked smolts (released at the heads of each of the tributary arms of Lake Billy Chinook) from any of the three tributaries.
[27] Per Settlement Agreement, Proposed License Article 18 Fish Passage Criteria and Goals, subpart (b). From Round Butte collection to lower Deschutes River release point (~100 miles downstream of dam).
[28] Statistically significant sample of tagged outmigrants.
[29] Pit-tagged smolts.
[30] Values are from the 2015 study year. Source: 2015 Juvenile Migration Test and Verification Study, Annual Report, Executive Summary.
[31] Values are from the 2020 study year. Source: 2020 Juvenile Migration Test and Verification Study, Annual Report, Executive Summary.
[32] Values are from the 2015 study year. Source: 2015 Juvenile Migration Test and Verification Study, Annual Report, Executive Summary.
[33] Values are from the 2016 study year. Source: 2016 fish passage annual report.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard: Reservoir Passage (R)	Compliance Standard: Collection (C)	Compliance Standard: Survival (S)	Compliance Standard: Efficiency (overall survival; RxCxS)	Measured Performance: Reservoir Passage (R)	Measured Performance: Collection (C)	Measured Performance: Survival (S)	Measured Performance: Efficiency (overall survival; RxCxS)
Lewis River Project (P-2111), Oregon, PacifiCorp – *Swift No. 1*										
Floating Surface Collector with guide nets from surface to bottom	Swift Reservoir Long (11.5 miles), narrow	1,000 max 878 min	Unspecified (calculated as 85-86%)	CE: [34] 95%	CS:[35] 98% (fry) 99.5% (smolt) Injury rate of 2%	ODS:[36] 80%[37]	2016 Coho: 89.7%[38] Chinook: 33.3%; Steelhead: 70%; 2020 Coho: 62% Chinook: 58% Steelhead: 73%	2016 Coho: 30.6% Chinook: <1% Steelhead 23.5% 2020 Coho: 39% Chinook: 44% Steelhead: 42%	2016 100% (fry) 97.6% (smolt) 2020 100% (fry) 93.3% (smolt) Injury: 2016 0.0% (fry) 0.7% (smolt) 2020 0.0% (fry) 2.51% (combined parr & smolt)	2016 Coho: 33% Chinook: <1% Steelhead: 15% 2020 Coho: 19.6% Chinook: 16.6% Steelhead: 10.3%

Notes/Sources Documents

Operational in 2012; 4 years of evaluation; 600 cfs collector flows

Downstream fish passage at Swift No. 1 part of Phase 1 of reintroduction program; decisions on downstream fish passage facilities at Yale and Merwin TBD in subsequent phases (to be built by 13th (2021) and 17th (2025) years of license, respectively); prior to later of 27th year of new license (2035) or 12th year after reintroduction of anadromous fish above Swift No. 1 Dam, the Services to determine metrics for determining success of reintroduction outcome goals.

Facility adjustments/modifications are to made to achieve the relevant performance standards as soon as practicable as follows: If ODS is not being met, (1) If the CE is less than 95% and greater than or equal to 75% or the CS for smolts is less than 99.5% and greater than or equal to 98%, or the CS for fry is less than 98% and greater than or equal to 96%, or Injuries to juvenile Transported Anadromous Species caused by downstream collection and transport are greater than 2% but less than 4%, PacifiCorp shall make Facility Adjustments directed by the Services to achieve the performance standard or standards that are not being met, but shall not be required to make Facility Modifications; or (2) If the CE is less than 75%, or the CS for smolts is less than 98%, or the CS for fry is less than 96%, or Injuries to juvenile Transported Anadromous Species caused by downstream collection and transport are greater than or equal to 4%, PacifiCorp shall make the Facility Modifications directed by the Services to achieve the performance standard or standards that are not being met; provided that if the Services believe a Facility Adjustment will likely achieve the performance standard or standards that are not being met, then PacifiCorp shall first make Facility Adjustments as directed by the Services. If the ODS is being met but the CE is less than 95%, the CS for smolts is less than 99.5%, the CS for fry is less than 98%, or Injury to juvenile Transported Anadromous Species caused by downstream collection and transport is greater than 2%, PacifiCorp shall make Facility Adjustments directed by the Services to downstream facilities but shall not be required to make Facility Modifications to achieve the performance standard or standards that are not being met.

Sources:

- Settlement Agreement, 11/30/04
- Order on Offer of Settlement and Issuing New License, 6/26/08
- Request for Extension of Time (6 months) regarding fish passage decision, 1/30/17 (includes several evaluations to support the decision)
- Monitoring and Evaluation Plan, First Revision, 2/28/17
- Lewis River Fish Passage Program 2016 Annual Report, 4/4/17; Lewis River Fish Passage Program 2020 Annual Report 4/14/2021 (most recent report)

[34] Per Settlement Agreement, Section 4.1.4, subpart (b). Performance Standards, part Collection efficiency (CE) is the percentage of juvenile salmonids emigrating from Swift Reservoir that is available for collection (i.e., detected within the zone of influence [ZOI], which is area 150 ft diameter by 20 feet deep in front of the exclusion net) and that is actually collected.
[35] Per Settlement Agreement, Section 4.1.4, subpart (b). Collection survival (CS) is the percentage of juvenile anadromous fish of each species collected that leave Release Ponds alive.
[36] Overall downstream survival is percentage of juvenile anadromous fish of each species that enters the reservoir from natal streams and that survive to enter the Lewis River below Merwin Dam by collection, transport, and release vis the juvenile fish passage system, passage via turbines, or some combination thereof.
[37] Per Settlement Agreement, Section 4.1.4, subpart (a). ODS reduced to 75% at such time as the Yale Downstream Facility is built or the In Lieu Fund in lieu of the Yale Downstream Family becomes available.
[38] Values are from 2016 study year. Source: Lewis River Fish Passage Program, 2016 Annual Report, Executive Summary table.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)	Reservoir Passage (R)	Collection (C)	Survival (S)	Efficiency (overall survival; RxCxS)
Cougar Dam, Oregon, U.S. Corps of Engineers (USACE)										
Floating Surface Collector	Cougar Reservoir Long (5 miles), narrow	1,690 max 1,532 min	Unspecified	Unspecified	Unspecified	Unspecified	Chinook RPE: 94%[39]	Chinook FBE: 96%[40]	Chinook DE: 48%[41] EE: 1.3%[42]	Chinook <1%[43]

Notes/Sources Documents

Operational in 2014; completed 2-year research project, then Portable Floating Fish Collector (PFFC) to be moved to Detroit or Lookout Point reservoirs.

Sources:

- Evaluation of the Biological and Hydraulic Performance of the Portland Floating Fish Collector at Cougar Reservoir and Dam, Oregon 2014
- Evaluation of the Biological and Hydraulic Performance of the Portland Floating Fish Collector at Cougar Reservoir and Dam, Oregon, September 2015-January 2016

[39] Average for research years 2014 and 2015/2016. Reservoir passage efficiency (RPE) is number detected at log boom / number released. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.

[40] Average for research years 2014 and 2015/2016. Forebay passage efficiency (FBE) is number detected in cul-de-sac / number detected at log boom. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.

[41] Average for research years 2014 and 2015/2016; average the values for low and high "treatments" (i.e., inflows into the PFCC) within a given study year. Discovery efficiency (DE) is number positioned within 10m from PFCC at 0-6 deep / number positioned in cul-de-sac. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.

[42] Average for research years 2014 and 2015/2016; average the values for low and high "treatments" (i.e., inflows into the PFCC) within a given study year. Entrance efficiency (EE) is number collected at PFCC / number positioned within 10m from route at 0-6 m deep.

[43] Average for research years 2014 and 2015/2016. FCE = RPE x FBE x DE x EE. Source: Biological and Hydraulic Performance Evaluations for 2014 and 2015/16, Tables 9-10 and 8-9, respectively.

Facility Type (floating, fixed, etc.)	Reservoir Geometry	Allowable Operating Range (ft)	Compliance Standard				Measured Performance			
			Reservoir Passage (R)	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**	**Reservoir Passage (R)**	**Collection (C)**	**Survival (S)**	**Efficiency (overall survival; RxCxS)**
Cowlitz Falls Project (P-2833), Washington, Lewis County PUD										
Fixed Collector	Lake Scanewa Long (10.5 miles), narrow	862.0 max 860.0 min	Unspecified	Unspecified	Unspecified	95% 75% for all three species Per settlement agreement Article 1	--	2017 Coho: 50.0% Chinook: 46.2% Steelhead: 55.9% 2018 Coho: 72.3% Chinook: 64.3% Steelhead: 80.5% 2019 Coho: 90.4% Chinook: 70.7% Steelhead: 81.0% 2020 Coho: 69.2% Chinook: 49.4% Steelhead 63.0% Mean Coho: 70.5% Chinook: 57.7% Steelhead: 70.1%	2019 Coho: 100% Chinook: 100% Steelhead: 99.5% 2020 Coho: 100% Chinook: 99.5% Steelhead: 100%	2017 Coho: 51.7% Chinook: 50.7% Steelhead: 57.4% 2018 Coho: 83.1% Chinook: 69.5% Steelhead 74.8% 2019 Coho: 93.4% Chinook: 77.8% Steelhead: 83.0% 2020 Coho: 71.6% Chinook: 54.0% Steelhead: 70.0% Mean Coho: 74.9% Chinook: 63.0% Steelhead: 70.0%

Sources:
- Cowlitz Falls North Shore Collector Downstream Fish Evaluation 2020 Annual Report, Washington

FP-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

ATTACHMENT C

FISH PASSAGE STUDY TECHNICAL WORKSHOP MEETING SUMMARIES

Seattle City Light

MEETING AGENDA

Skagit Hydroelectric Project Relicensing Meeting

FA-04 Fish Passage Workshop No. 1

July 15, 2021, 1:00pm – 4:30pm

WebEx Meeting: [LINK]

Conference Call: +1-510-338-9438 USA

Access code: 1824858219

(Meeting ID: 1824 85 8219)

MEETING PURPOSE

The intent of this workshop is to present an overview of key study milestones, discuss opportunities for feedback and collaboration with the LPs, contrast the different data needs and methods for two interrelated fish passage assessments, and to begin discussing preliminary criteria and considerations. Specific objectives include:

- **Study Plan Milestones -** Review key study plan components and milestones, determine details for the study plan schedule in relation to ILP milestones.
- **Fish Passage Facilities Assessment** – Discuss general approach assessment methodology, data requirements, and concept development activities.
- **Fish Passage Assessment of Existing Features in the Bypass Reach** – Summarize approach, key criteria influencing the assessment of fish passage in the bypass reach, data needs/acquisition.

AGENDA

1:00 – 1:10 pm (15 min)	**Introductions** – *Facilitator* • Roll Call and Introductions
1:10 – 1:20 pm (10 min)	**Meeting Objectives and Agenda Overview** – *Mike Garello (HDR)* • Review Meeting Objectives and Agenda Topics
1:20 – 2:25 pm (65 min)	**Study Plan Overview, Schedule, and Milestones -** *Mike Garello (HDR)* **1. Study Schedule Overview and Discussion** Presentation of process diagram showing two separate assessments on similar timelines. Show interrelation between FA-04 and other concurrent studies via. Gantt Chart. i. **Fish Passage Facilities Assessment** - Provide summary of key deliverables, content, and anticipated release dates. ii. **Fish Passage Assessment of Existing Features in the Bypass Reach -** Provide summary of key deliverables, content, and anticipated release dates. Review relationship to concurrent studies.

	2. Dialogue and engagement within the study schedule: i. **On-going Communication**- Expectations and protocols for LPs and Study Team throughout FA-04 implementation. Review distribution lists, format for questions and feedback, etc. ii. **Interim work products** - Distribution and review of interim reports and work products and how feedback will be used, use of SharePoint site. iii. **Workshops** - Determine quantity, coordination, and content of potential workshop (including invitation list, time prior to workshops, agenda development, notes, and action items, etc.) iv. **Participation of NMFS, USFWS, and WDFW in study implementation -** determine individuals (such as Logan Negherbon, NMFS, Jared McKee, USFWS, Duncan Pfeifer, WDFW, Kevin Lautz, WDFW) that may participate and the frequency of engagement (such as workshop agenda formulation – to be facilitated by Triangle, bi-weekly progress meetings) **v. Timing of formation and involvement of Expert Panel**
2:25 – 2:35pm (10 min)	***Break***
2:35 – 3:00 pm (25 min)	**Focal Species for Fish Passage Assessments** – *Mike Garello (HDR)* Summary of key species used for assessment and concept development. • Table for species considered for Fish Passage Facilities Assessment • Table for species considered for Fish Passage Assessment of Existing Features in the Bypass Reach
2:55 – 3:40pm (45 min)	**Fish Passage Facilities Assessment** – *Mike Garello (HDR)* Overview of this study plan that has two distinct assessments. Summary of key differences between the two different assessment types and how data requirements, data gaps, and key considerations/assumptions can influence study conclusions. **1. Objectives and outcomes** **2. Data requirements** **3. Assessment methodology**
3:40 – 4:20pm (40 min)	**Fish Passage Assessment of Existing Features in the Bypass Reach** - *Mike Garello (HDR)* Objective: Initial performance thresholds for biometric comparison. **i. Assessment methodology** • Objectives and outcomes

	• Data requirements • Assessment methodology **ii. Data Collection** • Strategies for site inspection and visual observation • Collection of flow magnitude, depth, elevation, and velocity data **iii. Range of Observable Discharges**
4:20 – 4:30pm [Last 10 minutes]	**Schedule, Action Items, Next Steps** – *Facilitator and meeting participants* • Review action items • Next steps (discuss if a site visit is warranted?)
[End time]	**Meeting Adjourned**

FA-04 FISH PASSAGE TECHNICAL STUDIES

Workshop 1

7/15/2021

INTRODUCTIONS

- Roll Call
- Introductions

Seattle City Light

WORKSHOP OVERVIEW AND OBJECTIVES

MEETING OBJECTIVES

- Objectives
  - Study Plan Milestones – Review key study plan elements, schedules, and milestone dates
  - Communication and Feedback – Discuss opportunities for LP engagement and input
  - Fish Passage Assessments – Discuss approach, methods, and initial data requirements influencing the initial efforts required for two different Fish Passage Study elements.

MEETING AGENDA

Schedule	Topic
1:00 to 1:10	Introductions
1:10 to 1:20	Meeting Objectives and Agenda Overview
1:20 to 2:25	Study Plan Overview, Schedule, and Milestones
2:25 – 2:35	Break
2:35 – 3:00	Focal Species for Fish Passage Assessments
3:00 – 3:40	Fish Passage Facilities Assessment
3:40 to 4:20	Fish Passage Assessment of Existing Features in the Bypass Reach
4:20 to 4:30	Schedule, Action Items, Next Steps
4:30	Meeting Adjourned

Seattle City Light

STUDY PLAN OVERVIEW AND MILESTONES

STUDY PLAN OVERVIEW, SCHEDULE, AND MILESTONES

- Schedule and Process Overview
- Key Milestones
- Key Content of Reports
- Opportunities for Engagement and Communication

FA-04 FISH PASSAGE STUDY OVERVIEW

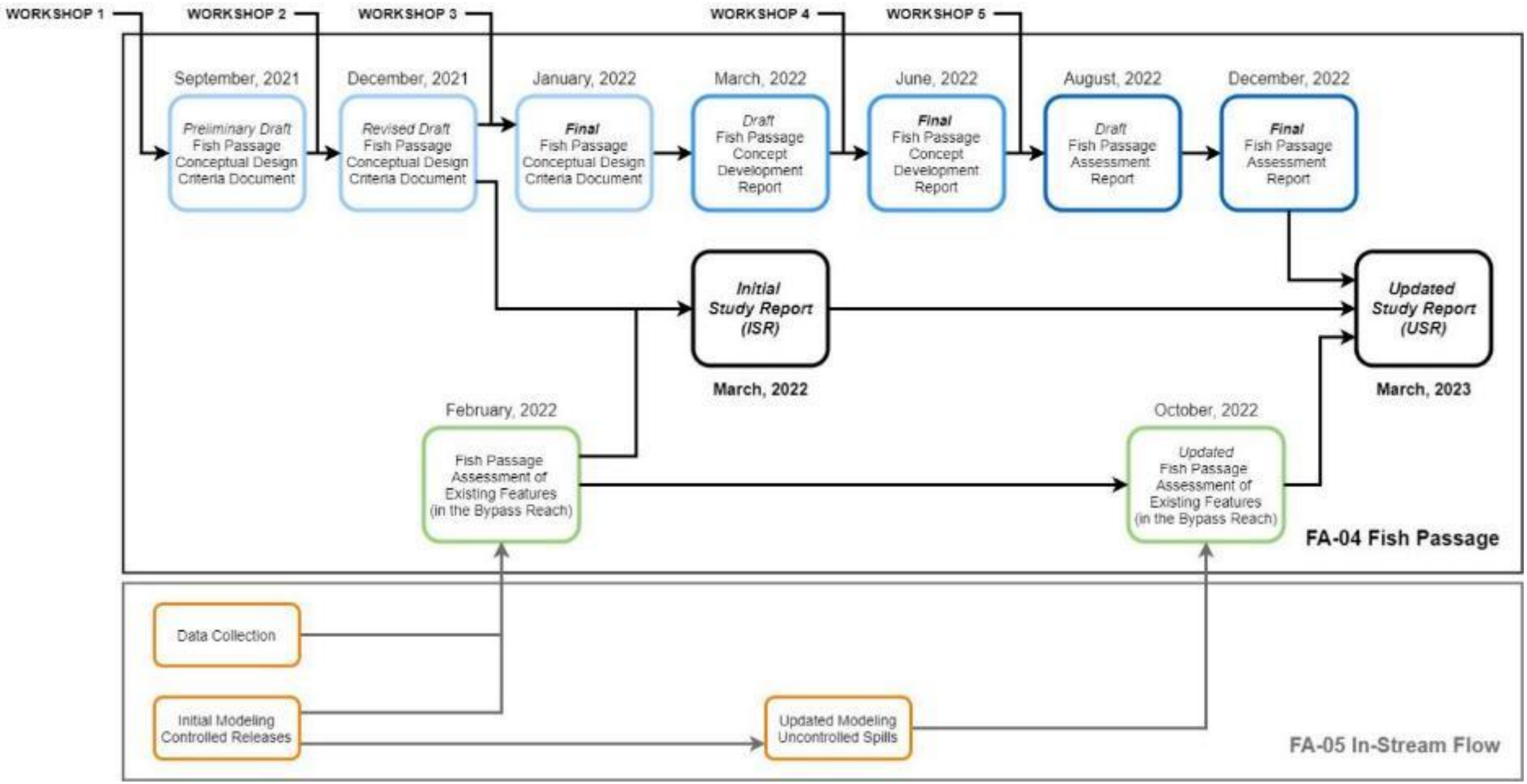
Fish Passage Facilities Assessment

- Establish Fish Passage Goals, Objectives, and Performance Expectations
- Formulation of Potential Fish Passage Strategies and Facilities
- Assessment of Technical Feasibility
- Capital and Lifecycle Costs

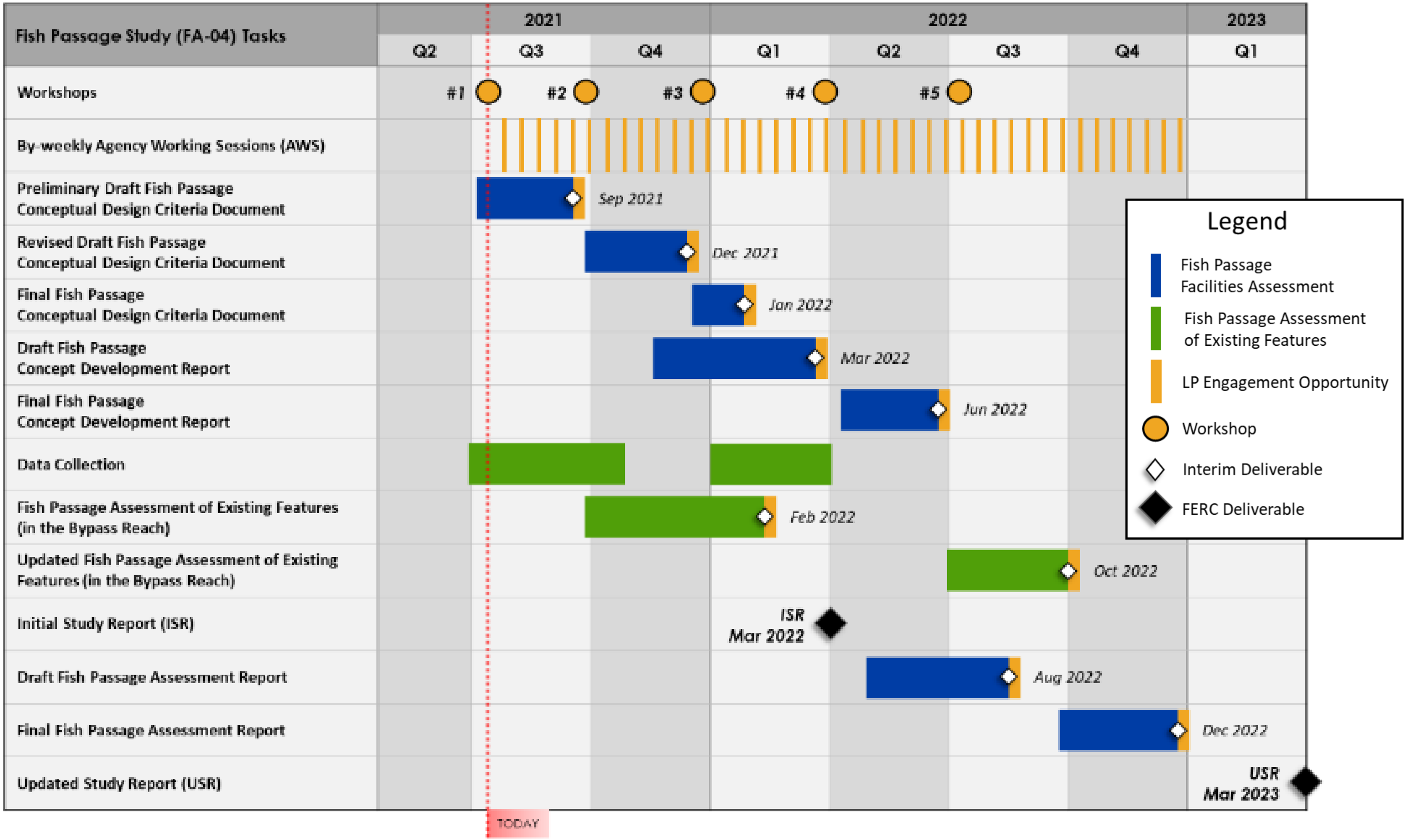
Fish Passage Assessment of Existing Features in the Bypass Reach

- Site Inspection and Survey
- Data Collection
- Hydrodynamic Modeling of Existing Features
- Biometric Comparison of Ecohydraulic Factors Influencing Fish Passage
- Identification of Flow Ranges that may Limit or Promote Fish Passage

PROCESS OVERVIEW



SCHEDULE OVERVIEW



WORKSHOPS

- Purpose – full and active involvement of Licensing Participants

1) Review study plan, people, and processes
2) Review and establish preliminary design criteria and information needs
3) Finalization of design criteria and approval of concept alternatives
4) Draft fish passage concepts
5) Final fish passage concepts

BI-WEEKLY AGENCY WORKING SESSION

- Purpose – Subject matter experts from resource agencies provide more frequent feedback on interim study progress, methods, and outcomes

1) Participation of NMFS, USFWS, and WDFW in study implementation
    1) Logan Negherbon, NMFS
    2) Jared McKee, USFWS
    3) Duncan Pfeifer, WDFW
    4) Kevin Lautz, WDFW
2) Participate in bi-weekly working sessions with consulting team

INTERIM DELIVERABLES AND REPORTS

- Purpose – Provide LPs with an opportunity to exchange information and obtain feedback at interim milestones during study implementation.

1) Provide progress level documentation of study work products at key decision points

2) Obtain more frequent feedback from Licensing Participants

FISH PASSAGE FACILITIES ASSESSMENT – KEY MILESTONES

Milestone	Anticipated Schedule
Fish Passage Facilities Assessment	
Fish Passage Conceptual Design Criteria Report	
Preliminary Draft Report	September 2021
Revised Draft Report	December 2021
Final Report	January 2022
Initial Study Report	March 2022
Fish Passage Concept Development Report	
Draft Report	March 2022
Final Report	June 2022
Fish Passage Assessment Report	
Draft Report	August 2022
Final Report	December 2022
Updated Study Report (USF, Fish Passage Study Sections)	March 2023

FISH PASSAGE FACILITIES ASSESSMENT – WORKSHOP 1 – JULY 15, 2021

- Review study plan objectives, schedule, and major milestones
- Discuss key focal species for two different fish passage assessments
- Discuss the approach to completing the Fish Passage Facilities Assessment
- Discuss the approach to completing the Fish Passage Assessment of Existing Features in the Bypass Reach

FISH PASSAGE FACILITIES ASSESSMENT – KEY DELIVERABLES

Fish Passage Facilities Design Criteria Report
Preliminary Draft (9/17/2021), **Revised Draft** (12/1/2021), **Final** (1/21/2022)

- Maps and Drawings of Existing Facilities
- Reservoir rule curves and operating limits, historical operations data, debris accumulation information, and data on thermal regimes of the reservoirs
- List of conceptual alternatives to be evaluated
- Performance of PNW passage facilities at high-head dams
- Biological and Technical Performance Goals
- Technical Design Criteria

FISH PASSAGE FACILITIES ASSESSMENT – WORKSHOP 2 – (SEPT 2021)

- Review Comments on Preliminary draft Fish Passage Conceptual Design Criteria Document (this is distributed in advance)
- Discuss the design basis and criteria needed to develop upstream and downstream passage alternatives to the concept level
- Identify information needed to proceed to the next phase of study
- Update progress made gathering biological performance information on Pacific Northwest fish passage facilities
- Discuss factors:
  - Estimated adult and juvenile run sizes;
  - Adult and juvenile run timing;
  - Upstream and downstream passage efficiency requirements; and
  - Other design criteria necessary to assist with the layout and configuration of concept-level alternatives

FISH PASSAGE FACILITIES ASSESSMENT – KEY DELIVERABLES

Fish Passage Facilities Concept Development Report
Draft (3/18/2022), **Final** (6/17/2022)

- Concept-level facility layouts and configurations of fish passage and auxiliary structures for each alternative
- List of potential facility operational changes that may be associated with each alternative
- Estimate of reasonably expected performance of the facilities
- Site layouts and constructability
- Estimated annual O&M costs fore each alternative
- Order of magnitude Opinions of Probable Construction Costs for each alternative

FISH PASSAGE FACILITIES ASSESSMENT – WORKSHOP 3 – (DEC 2021)

- Review comments on Draft Fish Passage Conceptual Design Criteria Document
- Review revised list of potential fish passage concept alternatives

FISH PASSAGE FACILITIES ASSESSMENT – WORKSHOP 4 – (MARCH 2022) AND 5 (TBD)

- Review progress during the concept development work
- Present Draft and Final Fish Passage Concepts
  - Concept-level facility layouts and configurations
  - List of potential facility operational changes
  - Estimates of reasonably expected performance of the facilities
  - Estimated O&M Costs
  - Order of magnitude Opinions of Probable Construction Costs for alternatives

FISH PASSAGE FACILITIES ASSESSMENT – KEY DELIVERABLES

Fish Passage Assessment Report
Draft (8/19/2022), **Final** (12/16/2022)

- Identify fish passage concepts that appear viable and consistent with design criteria
- Evaluate each technical option for facilitating fish passage:
- (1) its ability to be engineered, constructed, and operated (i.e., technical feasibility);
- (2) its ability to operate without significantly interfering with existing Project and non-Project uses;
- (3) the facility's ability to meet customary performance standards established for similar facilities.
- Identify any next steps or additional studies that may be needed

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – KEY MILESTONES

Milestone	Schedule
Fish Passage Assessment of Existing Features in the Bypass Reach	
Field Investigation of Existing Features	June 2021 – December 2021
Fish Passage Assessment of Existing Features	February 2022
Initial Study Report	March 2022
Potential Observation of Uncontrolled Spill Events	October 2021 – December 2021
Additional Modeling	January 2022 – March 2022
Updated Fish Passage Assessment of Existing Features	October 2022
Updated Study Report (USF, Fish Passage Study Sections)	March 2023

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – KEY DELIVERABLES

Fish Passage Assessment of Existing Features in the Bypass Reach
Initial Report (February 2022), **Updated Report** (March 2023)

- Site Inspection and Survey
- Data Collection
- Hydrodynamic Modeling of Existing Features
- Biometric Comparison of Ecohydraulic Factors Influencing Fish Passage
- Identification of Flow Ranges that may Limit or Promote Fish Passage

Seattle City Light

BREAK

10 minutes

Seattle City Light

FOCAL SPECIES FOR FISH PASSAGE ASSESSMENTS

FOCAL SPECIES FOR FA-04 FISH PASSAGE STUDY

- Fish Passage Facilities Assessment
  - Requires information on all anadromous and resident populations
  - Informs the type, size, and complexity of potential fish passage strategies and facilities
- Fish Passage Assessment of Existing Features in the Bypass Reach
  - Can be categorized into representative groups with like swimming and leaping abilities
  - Limited/no information available for some species

FOCAL SPECIES
FISH PASSAGE FACILITIES ASSESSMENT

FA-04 Study Plan Species	NOA Species for Consideration
Chinook Salmon	Chum Salmon
Coho Salmon	Pink Salmon
Sockeye Salmon	Sea-run Cutthroat Trout
Steelhead	Dolly Varden
Bull Trout	Pacific Lamprey
	Salish Sucker

- Do all species require passage?
- What reservoir to reservoir passage is required for adfluvial populations?

FISH PASSAGE FACILITIES – BIOLOGICAL DATA REQUIREMENTS

Data Requirement	What We Have	Information Needs
Target species and life stages	Study Plan and extended list from June 2021 NOA species	
Migration timing and periodicity – adult and juvenile	HSC periodicity Reservoir populations	
Abundance – total and peak	Existing for reservoir spp. Annual totals for anadromous spp.	Target total and peak for life stages requiring passage at each dam
Fish length, size, and age information	Reservoir populations	Anadromous populations
Connectivity between reservoirs	Bull Trout telemetry studies	Species and life stages requiring passage at each dam
Fish movement and timing in each reservoir	Bull Trout reservoir studies	Other spp. information
Expectations for performance for species and life stages	Examples from existing facilities	Expectations for Skagit Project
Biosecurity (disease)	Information from other facilities	Agency concerns for Skagit River mainstem and Project reservoirs
Genetic considerations	NMFS PAD comments and proposed FA-06 study plan	Results from FA-06 (Reservoir Native Baseline Genetics)

FOCAL SPECIES
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES

Study Plan Target Species	Other Species for Consideration
Chinook Salmon	Chum Salmon
Coho Salmon	Pink Salmon
Sockeye Salmon	Sea-run Cutthroat Trout
Steelhead	Dolly Varden
Bull Trout	Pacific Lamprey
	Salish Sucker

- Consolidated groups based on swimming/leaping ability characteristics
- Identification of analogue species when no data is available

FISH PASSAGE AT EXISTING BARRIERS – BIOLOGICAL DATA REQUIREMENTS

Data Requirement	What We Have	Information Needs
Target species and life stages	Study Plan species	
Migration timing and periodicity – adult and juvenile	HSC periodicity Reservoir populations	
Fish length, size, and age information	Reservoir populations	Anadromous populations
Swimming Capability	Derived from the literature	
Leaping Capability	Derived from the literature	

Seattle City Light

OVERVIEW – FISH PASSAGE FACILITIES ASSESSMENT

FISH PASSAGE FACILITIES ASSESSMENT

- Objective: assess the potential feasibility of upstream and downstream passage at the three Project developments.
- Outcomes
  - Concept-level upstream and downstream passage strategies and alternatives
  - Technical viability, Project modifications, potential performance, and opportunities/limitations
  - Planning level Opinion of Probable Construction Costs and Lifecycle Cost

FISH PASSAGE FACILITIES ASSESSMENT

Fish Passage Facilities Assessment

- Establish Fish Passage Goals, Objectives, and Performance Expectations
- Formulate Potential Fish Passage Strategies
- Develop Fish Passage Facility Concepts
- Assess Technical Feasibility
- Evaluate Uncertainties vs. Implementation Strategy
- Develop Capital and Lifecycle Costs
- Identify Requirements for Further Development

POTENTIAL LINKAGES TO OTHER STUDIES

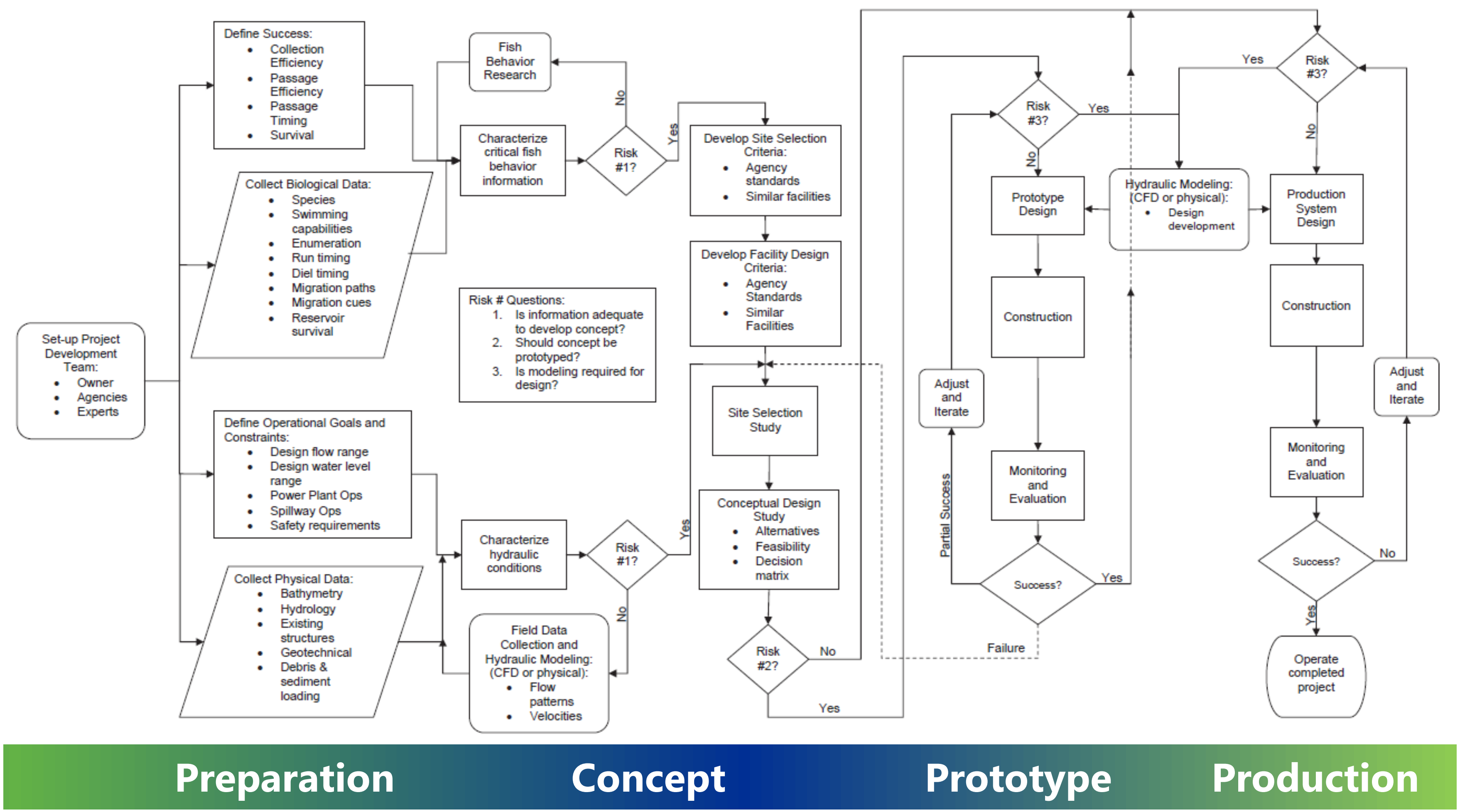
The facilities assessment considers existing physical data and Project operations to define design constraints and assess construction and operational feasibility. On-going studies that may inform this assessment include:

Study	Linkage to FA-04
OM-01: Operational Model	May identify future hydrologic operational scenarios that would impact passage facility efficiency and operation.
RA-01: Recreation Use and Facility Assessment	May identify land use conflicts.
FA-08: Fish Entrainment	May provide additional insight on fish protection, exclusion, collection, and bypass requirements for fish passage facilities.

POTENTIAL LINKAGES TO OTHER STUDIES

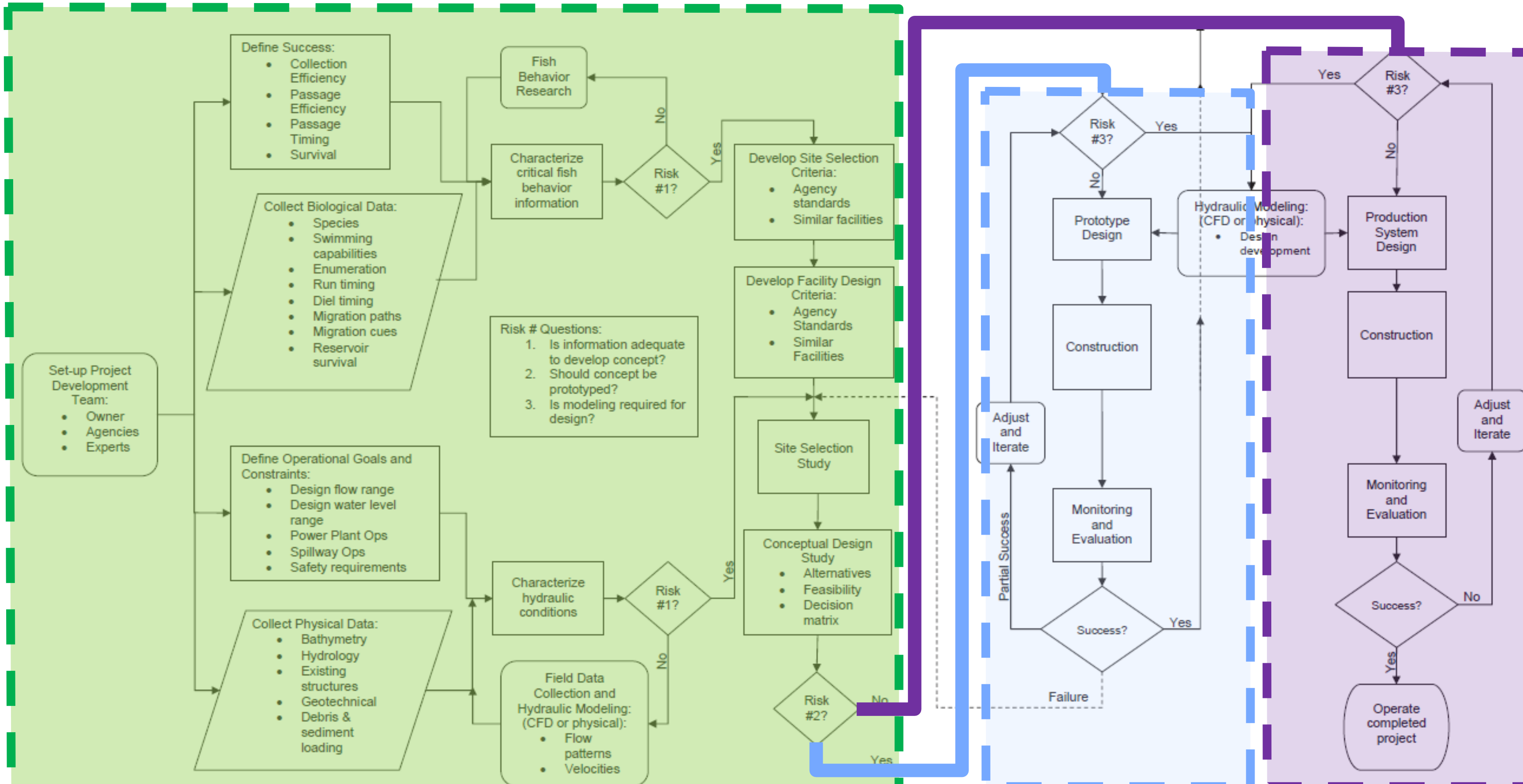
- In addition to FA-04, data from the following studies may inform future goals and objectives for fisheries management upstream of Project dams, including ESA resources:
  - OM-1: Operational Model
  - FA-01: Water Quality Monitoring
  - FA-03: Reservoir Stranding and Trapping Risk Assessment
  - FA-06: Reservoir Native Baseline Genetics
  - FA-07: Reservoir Tributary Habitat Assessment
- City Light has agreed to meet with Licensing Participants to identify relicensing study linkages for the entire Project.

ASSESSMENT METHODOLOGY – FEASIBILITY AND DESIGN PROCESS



Adapted from Willamette Basin Project - USACE, Portland District

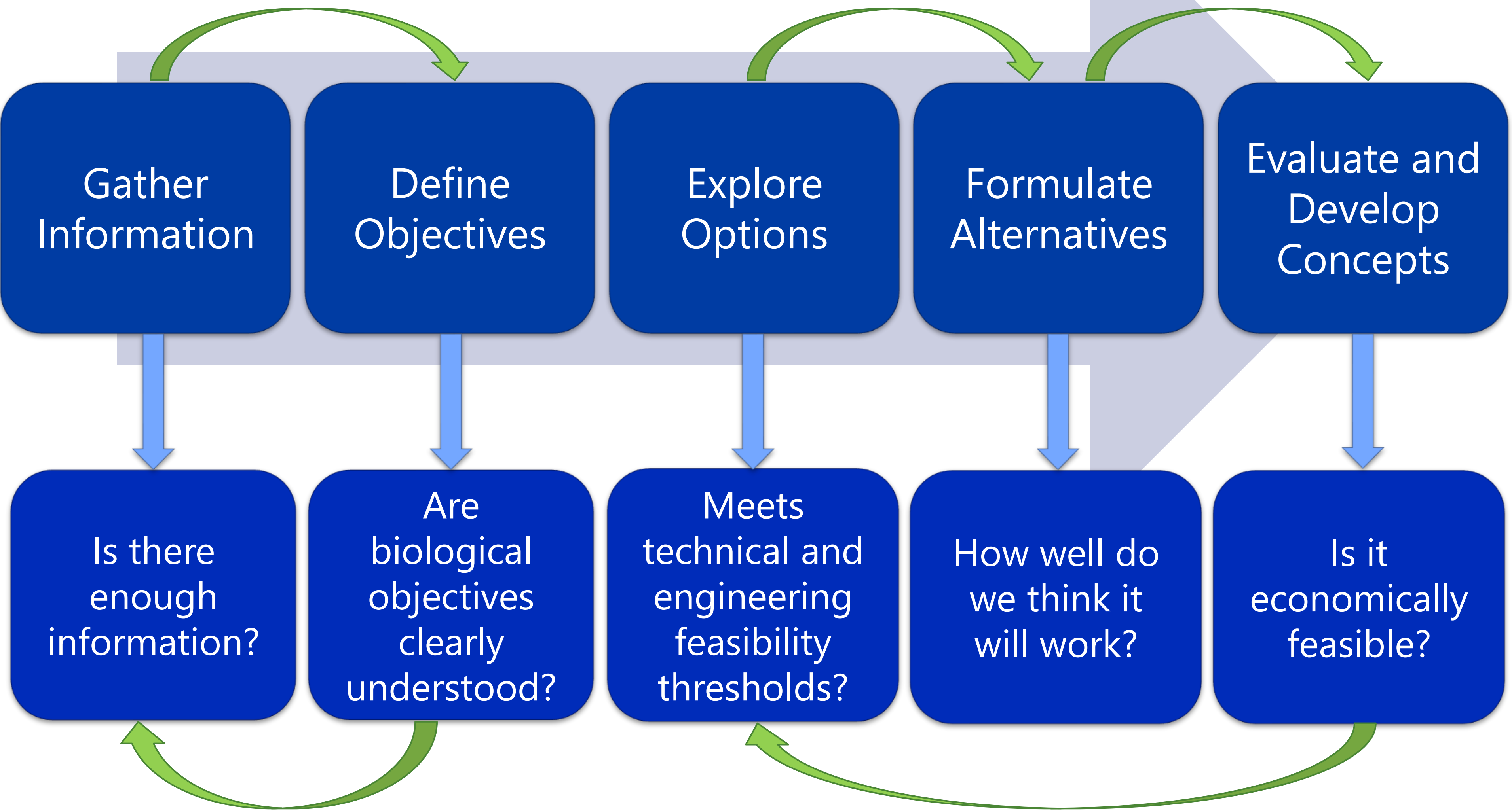
ASSESSMENT METHODOLOGY – FEASIBILITY AND DESIGN PROCESS



Preparation	Concept	Prototype	Production
Feasibility and Pre-Design		Design and Implementation	

Adapted from Willamette Basin Project - USACE, Portland District

ASSESSMENT METHODOLOGY – ASSESSMENT OF TECHNICAL FEASIBILITY



FISH PASSAGE FACILITIES ASSESSMENT

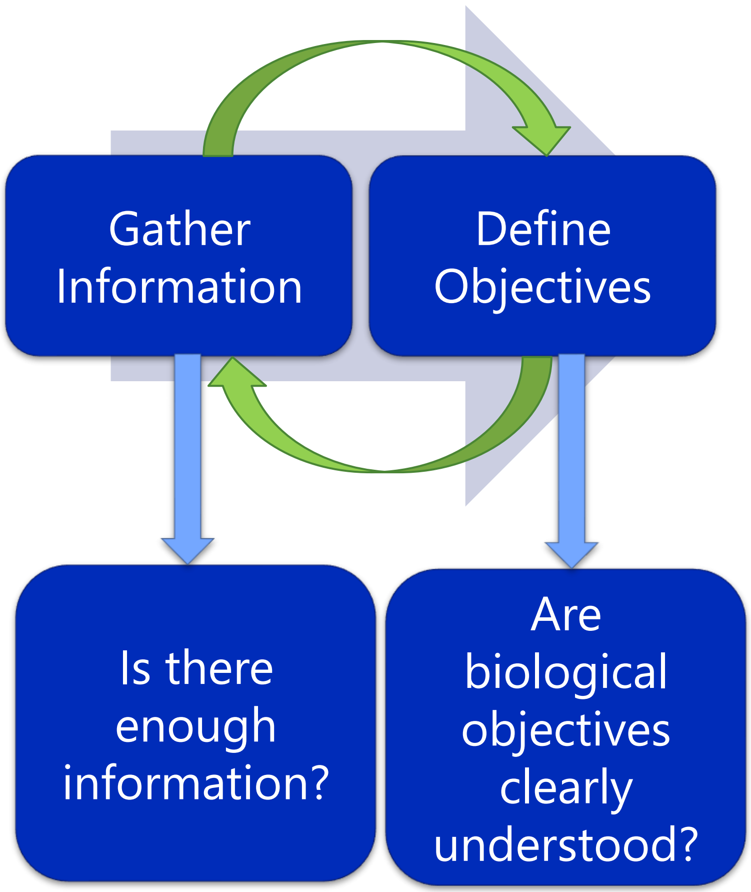
- Fish passage feasibility can be evaluated in the following terms:
  - Technical feasibility
  - Biological/Ecological feasibility
  - Economic feasibility
- Definition is subjective and commonly defined in the early stages of each study, by study participants

FISH PASSAGE FACILITIES ASSESSMENT

- Technical feasibility - Does it satisfy operational and engineering related objectives of the project?
  - Compliance with technical design guidelines, operational criteria/constraints, and performance standards agreed to for the project.
  - Compliance with life and safety requirements
  - Consistent with the intent of the existing operational requirements (i.e. water supply, flood control, hydropower, and/or recreation)
  - Can it be built and operated as intended following applicable engineering design standards?

ASSESSMENT METHODOLOGY – FEASIBILITY AND DESIGN PROCESS

- Create collaborative relationships
- Define the feasibility process and rules (decision tree)
- Establish common goals, objectives, criteria, and expectations
- Gather site specific biological and environmental data



ASSESSMENT METHODOLOGY – OBJECTIVES, OUTCOMES, AND DATA REQUIREMENTS

Project Objectives
- Improve passage
- Introduction/reintroduction

Definition of Success
- Monitoring and evaluation
- Collection and passage efficiency
- Passage timing
- Survival

Operational Objectives
- Design flow range
- Design water level range
- Power plant operations
- Spillway operations
- Safety requirements

Biological Data
- Target species and life stages requiring passage
- Migration timing
- Population abundance and peak rate of migration
- Migration cues
- Reservoir transit and survival
- Colonization method (for introduction/reintroduction projects)

Physical Data
- Existing infrastructure
- Access / Ownership
- Geotechnical
- Debris loading conditions
- Bathymetry
- Hydrology

BIOLOGICAL FACTORS INFLUENCING DESIGN AND ALTERNATIVES DEVELOPMENT

Why are biological linkages important to the technical and economic feasibility?

Significant influence on the facility type, size, location, configuration, and operational requirements

Biological Basis of Design

- Ecological objectives
- Target species and life stages requiring passage
- Migration timing and cues
- Population abundance and peak rate of migration
- Site biomechanics
- Habitat suitability/availability
- Colonization method (for introduction/reintroduction projects)

Operational Requirements

- Performance objectives
- Monitoring and evaluation
- Project operational constraints

PHYSICAL FACTORS INFLUENCING DESIGN AND ALTERNATIVES DEVELOPMENT

Stream/Reservoir Conditions

- Hydrologic conditions: spill, peak timing, duration, magnitude
- Site hydraulic conditions
- Reservoir rule curves and operating limits
- Reservoir temperature conditions

Physical Site Conditions

- Facilities features – dams, spillways, intakes.
- Topography and bathymetry
- Existing facilities and operational requirements/objectives
- River/stream mechanics and natural processes - sediment and debris
- Existing facilities and operational requirements/objectives

FISH PASSAGE FACILITIES ASSESSMENT – NEXT STEPS

- Continue gathering and synthesizing data to address remaining data gaps
- Begin engagement with AWS
- Establish preliminary technical, operational, and biological goals, criteria, and constraints.
- Prepare Fish Passage Facilities Design Criteria Report

FISH PASSAGE FACILITIES ASSESSMENT – NEXT STEPS

Fish Passage Facilities Design Criteria Report
Preliminary Draft (9/17/2021)

- Maps and Drawings of Existing Facilities
- Reservoir rule curves and operating limits, historical operations data, debris accumulation information, and data on thermal regimes of the reservoirs
- List of conceptual alternatives to be evaluated
- Performance of PNW passage facilities at high-head dams
- Biological and Technical Performance Goals
- Technical Design Criteria

Seattle City Light

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – OBJECTIVES AND OUTCOMES

- Objectives and Outcomes
  - Establish swimming and leaping capabilities of fish that may migrate through the Bypass Reach.
  - Characterize and document the physical structure and hydraulic conditions of the Existing features throughout the range of observed and/or modeled flows.
  - Identify ranges of hydraulic conditions where fish may be able to ascend the Bypass Reach
  - Identify conditions that are anticipated to impede passage

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES

Fish Passage Assessment of Existing Features in the Bypass Reach

- Site Inspection and Survey
- Data Collection
- Hydrodynamic Modeling of Existing Features
- Biometric Comparison of Ecohydraulic Factors Influencing Fish Passage
- Identification of Flow Ranges that may Limit or Promote Fish Passage

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES - LINKAGES TO OTHER STUDIES

This assessment considers physical data obtained from other studies to assess fish passage potential in the Gorge bypass reach. On-going studies that may inform this assessment include:

Study	Linkage to FA-04
FA-02: Instream Flow Model Development	Using hydraulic model outputs from FA-05, this study will also assess physical criteria (depth and velocity) that may inform passage conditions in the bypass reach.
FA-05: Skagit River Gorge Bypass Reach Hydraulic and Instream Flow Model Development	The model developed under FA-05 will inform physical conditions related to hydraulics and flow, which will provide information to aid in the assessment of fish passage potential in the bypass reach under a range of flow conditions.

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – FISH PASSAGE METHODS AND TOOLS

- Numerous examples of fish passage evaluation methods and complexities exist
- Guidelines provide insight consistent with their purpose and within a range of applicable conditions
- Custom methods suit more unique site-specific conditions
- Conclusions require a multi-faceted approach and professional judgement
- Not intended to replace or replicate direct observations and conclusions from long-term monitoring programs

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – FISH PASSAGE METHODS AND TOOLS

- WDFW 2019 provides guidance on assessing natural barriers for fish passage
- Suggests that gradient barriers are greater than 20% for over 160 meters
- Recognizes variability in species diversity, swimming speed, and feature complexity – cascades and waterfall features
- Existing features in the Bypass Reach are complex and require a site-specific detailed evaluation

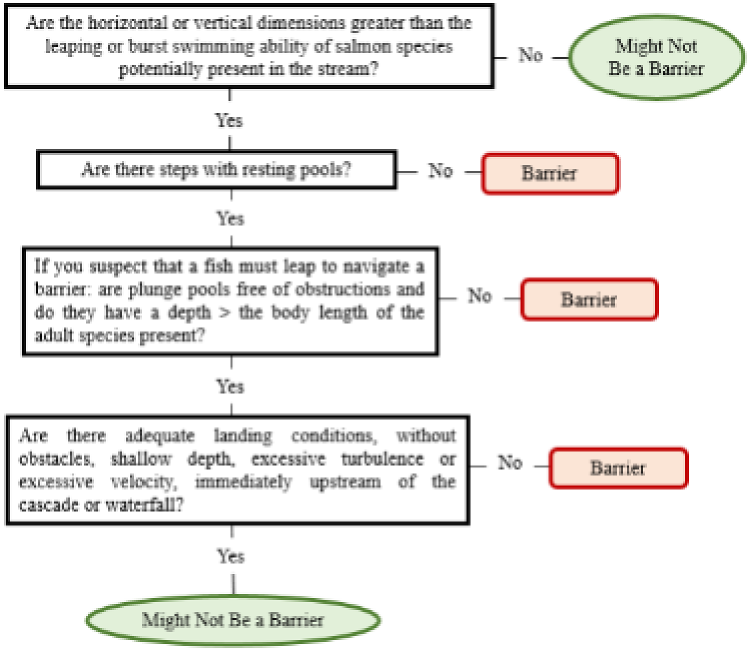
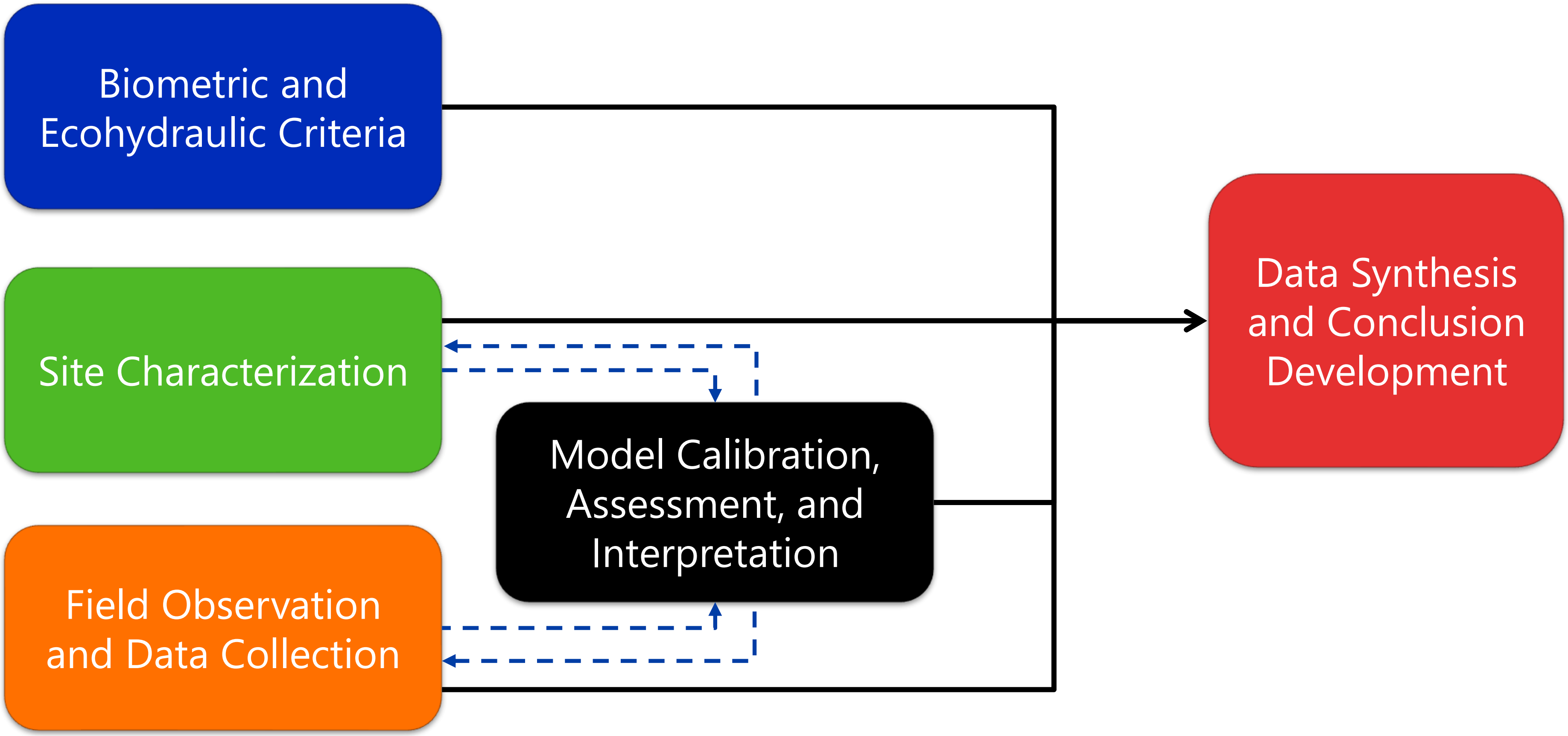


Figure 7.7. Cascade barrier determination. This flowchart provides guidance for determining whether a cascade is a barrier. Remember to consider the range of flows that occur at the site when evaluating the barrier status of a cascade.

Source: WDFW (2019)

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – PROCESS OVERVIEW



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – PROCESS OVERVIEW

Biometric and Ecohydraulic Criteria

- Fish species and characteristics
- Swimming capability
- Leaping capability

Field Observation and Data Collection

- Video Documentation
- Photo Documentation
- Flow Measurement
- Water depth and elevation data
- Velocity

Data Synthesis and Conclusion Development

Site Characterization

- Topography
  Aerial photography
- Site Inspection
- Site Characterization

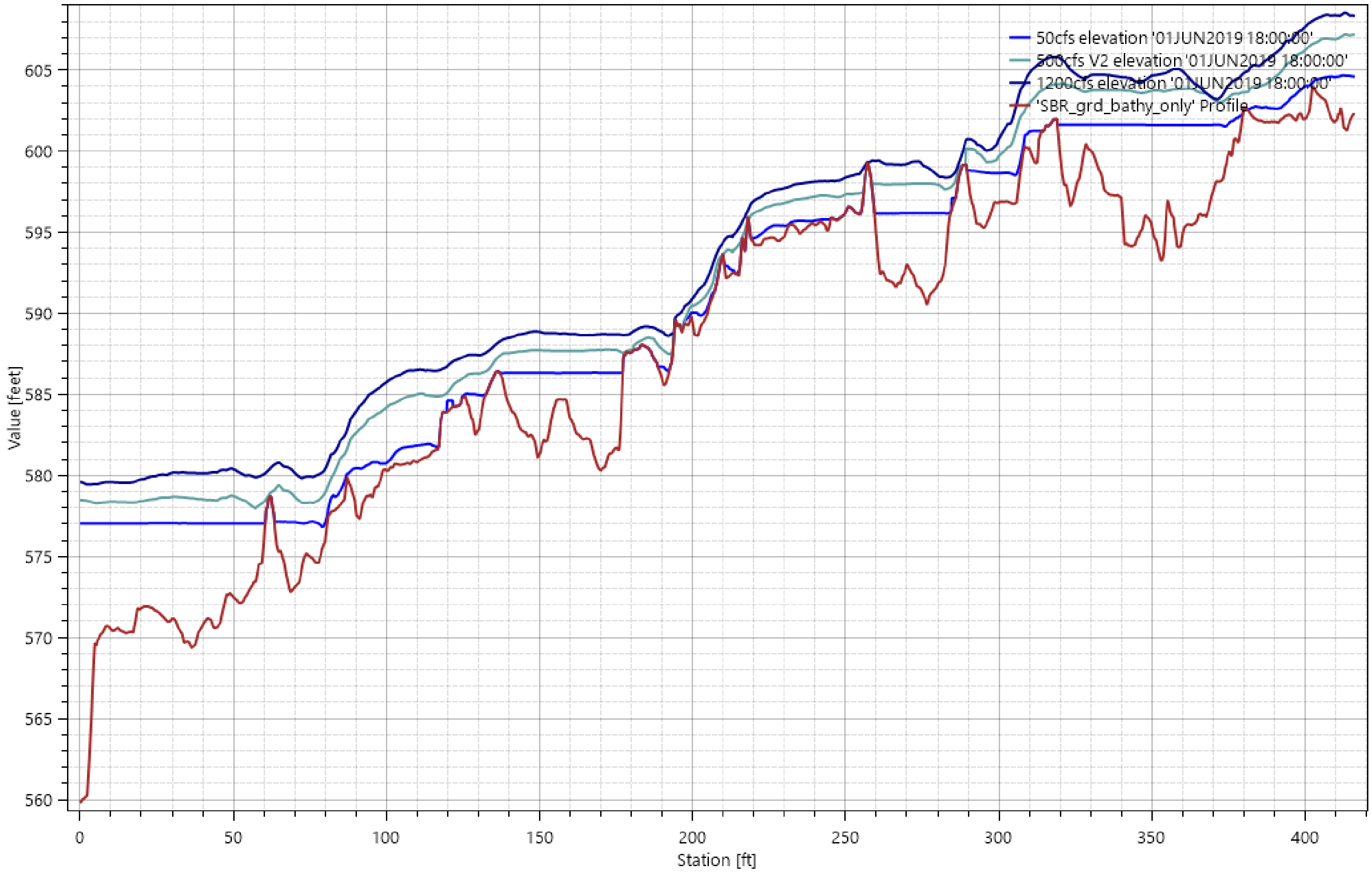
Model Calibration and Assessment

- Hydraulic pathways
- Hydraulic trends and variability assessment
- Water surface profile assessment
- Water velocity assessment

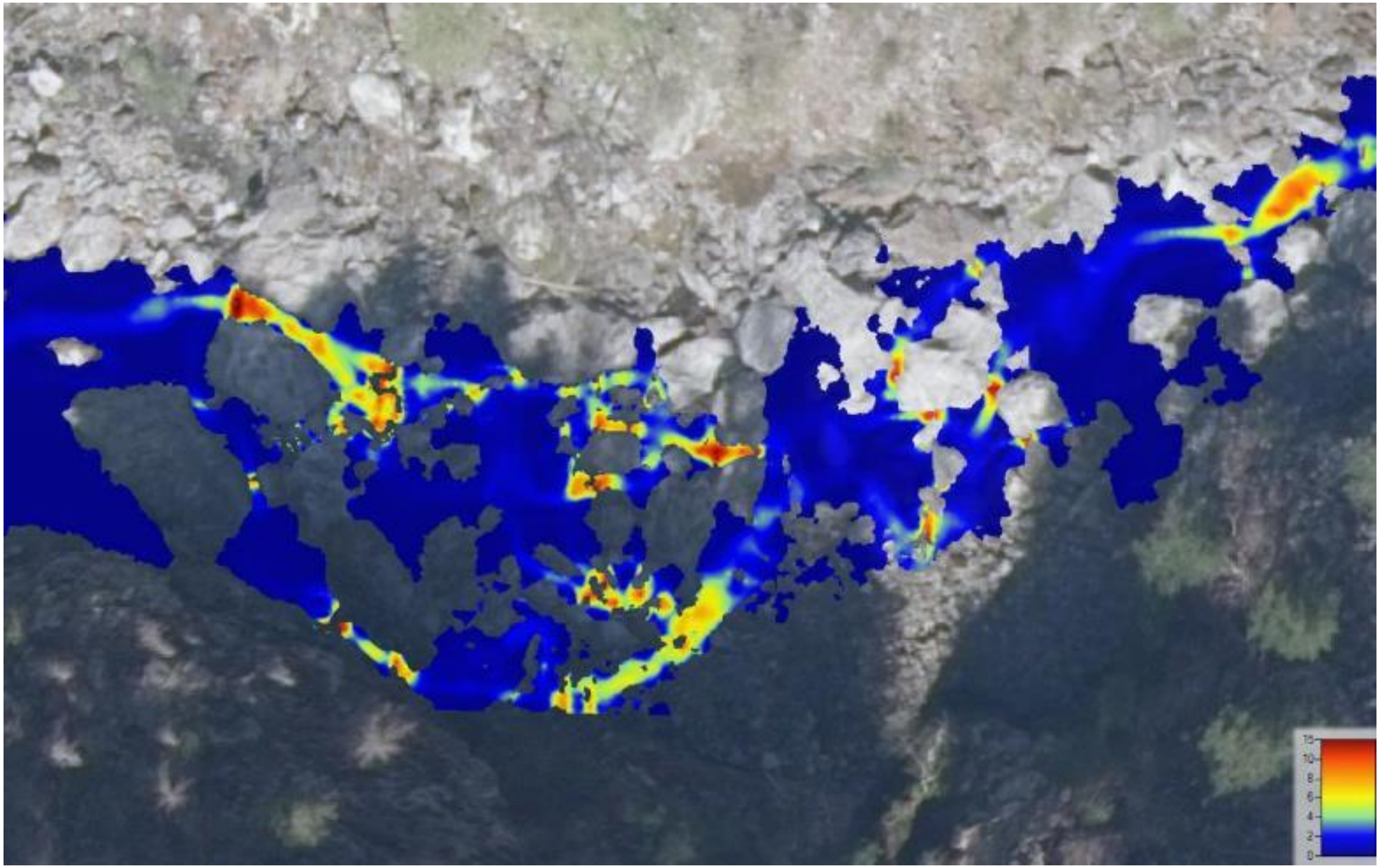
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES –ROLE OF HYDRAULIC MODELING

- Informs data collection methods
- Informs development of hydraulic pathways that may provide passage
- Informs transition between plunging and streaming flow regimes – leaping vs swimming conditions
- Provides a tool to study trends across the range of flows experienced at the site
- Not intended to be a quantitative tool to dictate pass or fail

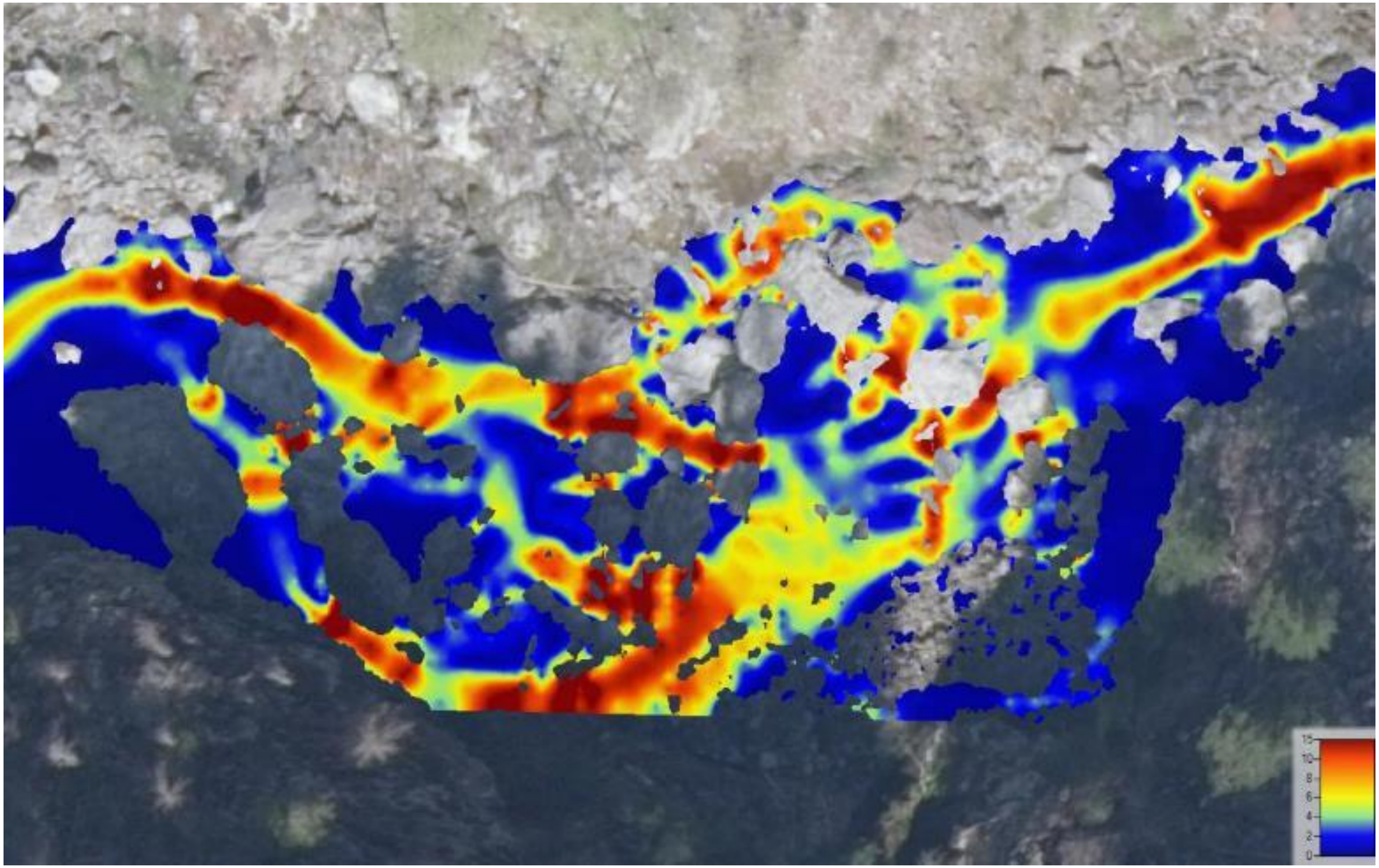
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES –UNCALIBRATED WSEL PROFILE



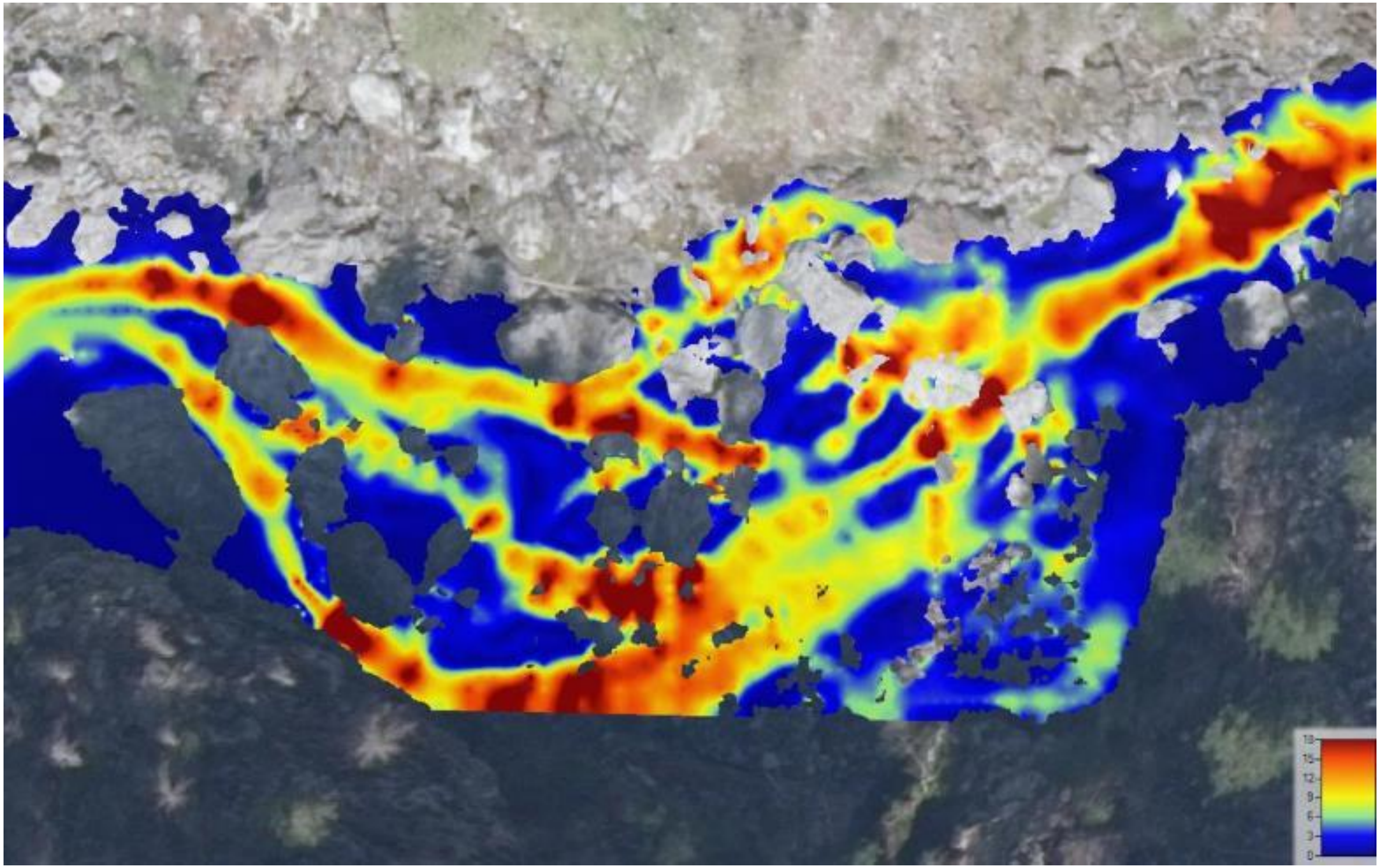
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES –UNCALIBRATED VELOCITY 50 CFS



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES –UNCALIBRATED VELOCITY 500 CFS



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – UNCALIBRATED VELOCITY 1200 CFS



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – EXAMPLE FISH PASSAGE ASSESSMENTS

- Numerous site-specific assessment examples exist with varying level of detail, complexity, and rigor.
- Example fish passage evaluations
  - Clearwater River
  - Mission Creek
  - Nelson Dam Removal
  - Example fish passage simulation technique

SF CLEARWATER RIVER

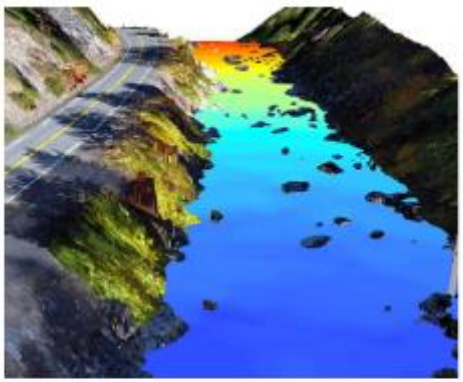
CRAMER FISH SCIENCES

nhc northwest hydraulic consultants

SOUTH FORK CLEARWATER RIVER

MP 28 Hypothesized Velocity Barrier

Final Report



Prepared for:

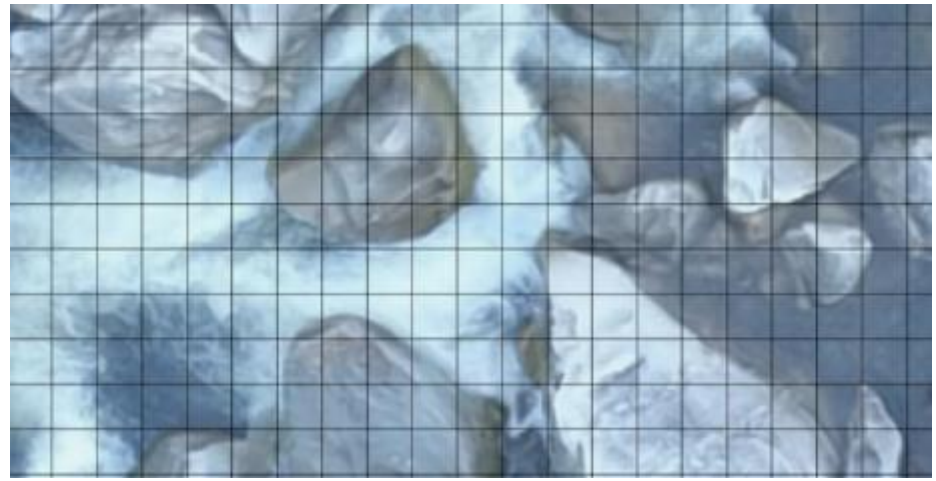
Mark Johnson, Nez Perce Tribe

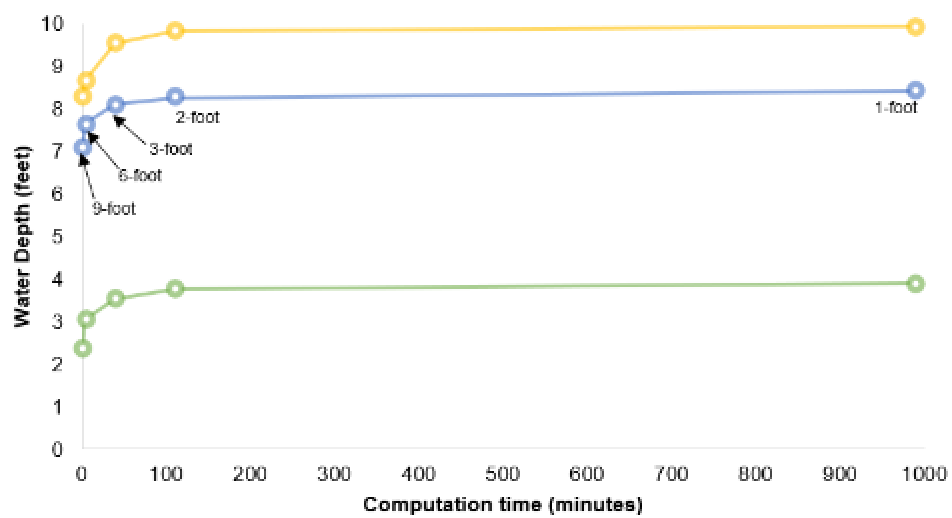
Prepared by:

Ray Timm, Lucius Caldwell, Dana Stroud, and Phil Roni – Cramer Fish Sciences

Andrew Nelson, Chris Long – Northwest Hydraulic Consultants

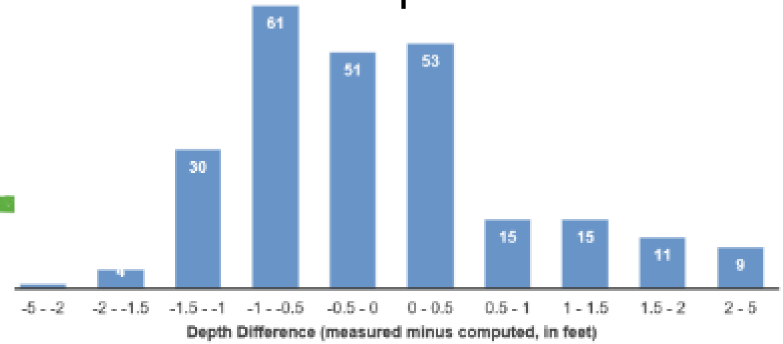
January 18, 2017





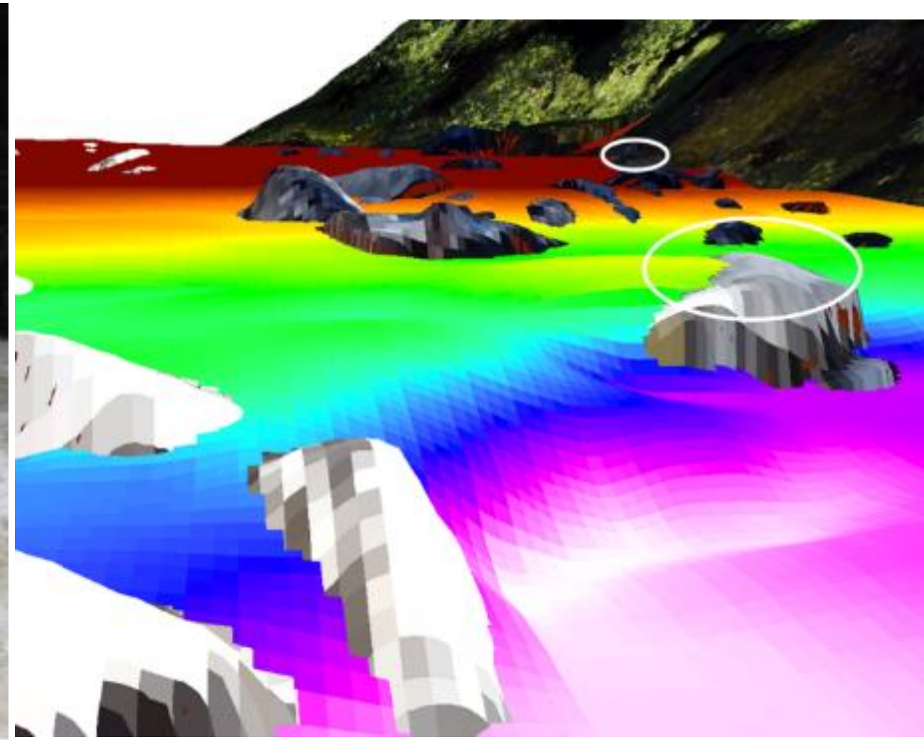
SF CLEARWATER RIVER

- 74% of 182 depths within ± 1′



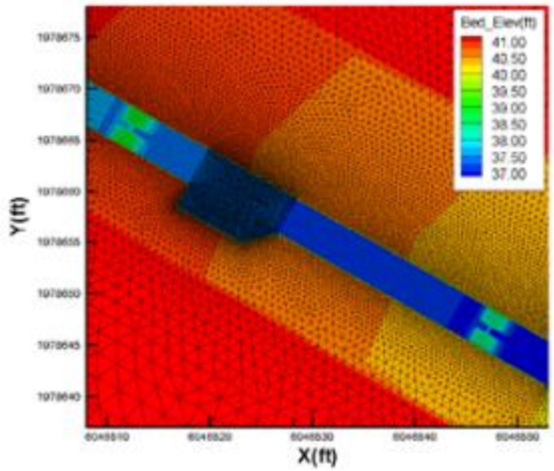
- May 5, 2016 (~1074 cfs)

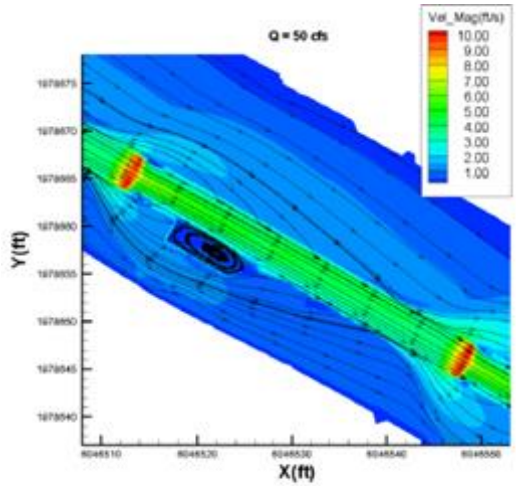
- Calibrated RAS model (1100 cfs)

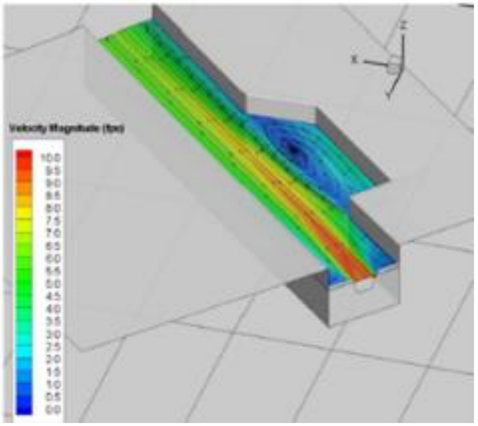


MISSION CREEK

- 1D, 2D, 3D, and physical model development
- 2D model calibrated from physical model results
- 2D model results used to perform energy expenditure simulation informing steelhead passage







TRABUCO CREEK PHYSICAL MODEL STUDIES

- Metrolink Rail Crossing
  - 1:6 Fishway Model
  - 1:20 Comprehensive Model
  - Fish Passage around 30-ft Barrier
  - Objective: Fish Passage
  - Target: California Steelhead


Metrolink Existing Barrier


1:20 Comprehensive


1:6 Fishway


I-5 Comprehensive

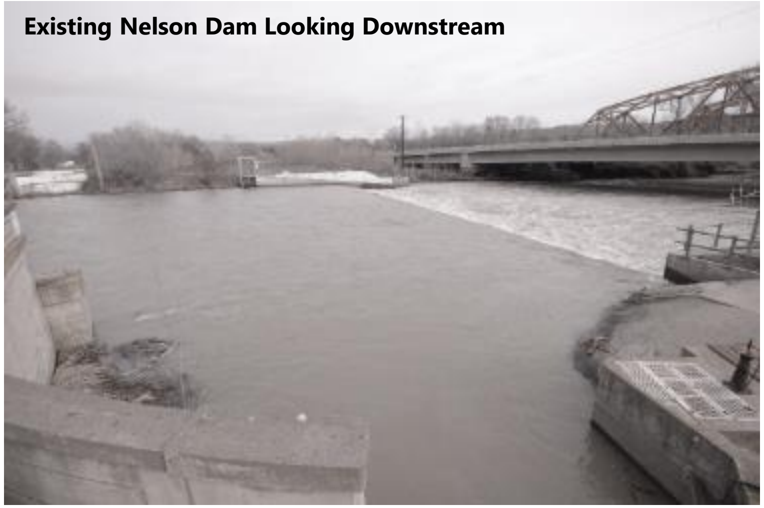

I-5 Fishway Entrance


I-5 Fishway

- I-5 Crossing
  - 1:8 Fishway Model
  - 1:25 Comprehensive Model
  - Fish Passage through Existing Concrete Culverts and Stilling Basin
  - Objective: Fish Passage
  - Target: California Steelhead

NELSON DAM REMOVAL PHYSICAL MODEL STUDIES

- 1:24 Scale Model
- Objective: Dam Removal & Fish Passage
- Fish Channel and Sluiceway



NELSON DAM REMOVAL FISH PASSAGE EVALUATION

Figure 2-3. Swim Distance vs. Flow Velocity for 250 mm and 1,000 mm Salmonids

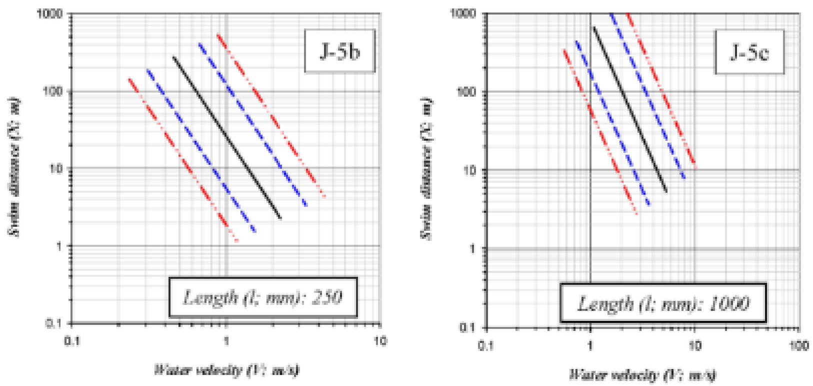
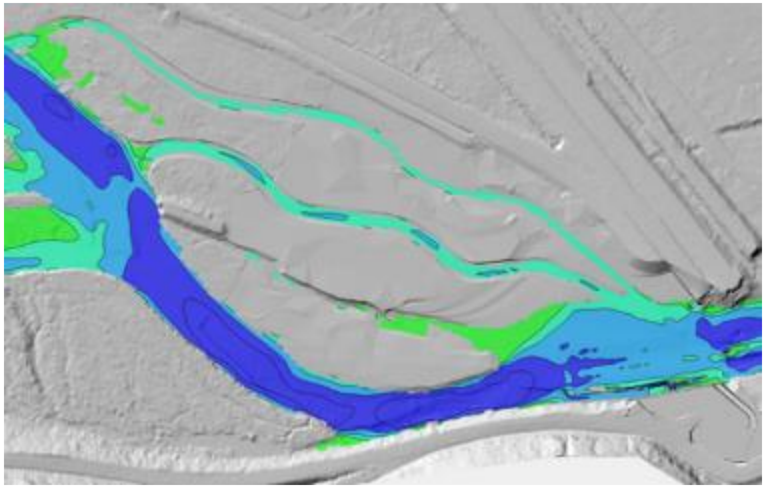
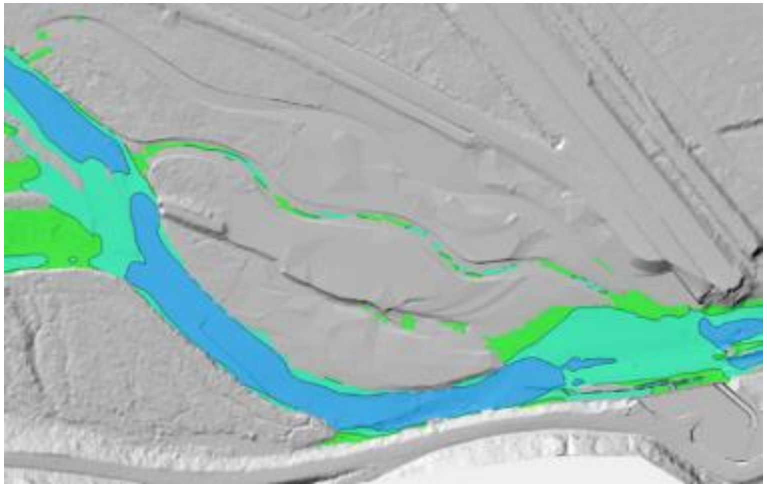


Table 4-8. Swimming Speeds For 250-mm, 1,000-mm, And 710-mm Salmonids for 75th Percentile

Fish Length	Time	Water Velocity (fps)	Swim Distance (ft)	Correlated Swim Speed (fps)
250mm[a] (10 inches)	5 seconds	9.5	16.4	12.8
	20 seconds	6.9	45.9	9.2
	3 minutes	4.3	229.6	5.5
	30 minutes	2.1	1,312.0	2.9
710mm[b] (28 inches)	5 seconds	18.0	30.5	24.1
	20 seconds	12.7	86.2	17.0
	3 minutes	7.3	450.9	9.8
	30 minutes	4.0	2,418.5	5.4

[a] Obtained from Kalopodis and Gervais (2016), Appendix E, Charts J-5b and J-5c.
[b] Interpolated from Kalopodis and Gervais (2016) data using dimensionless length ratio.





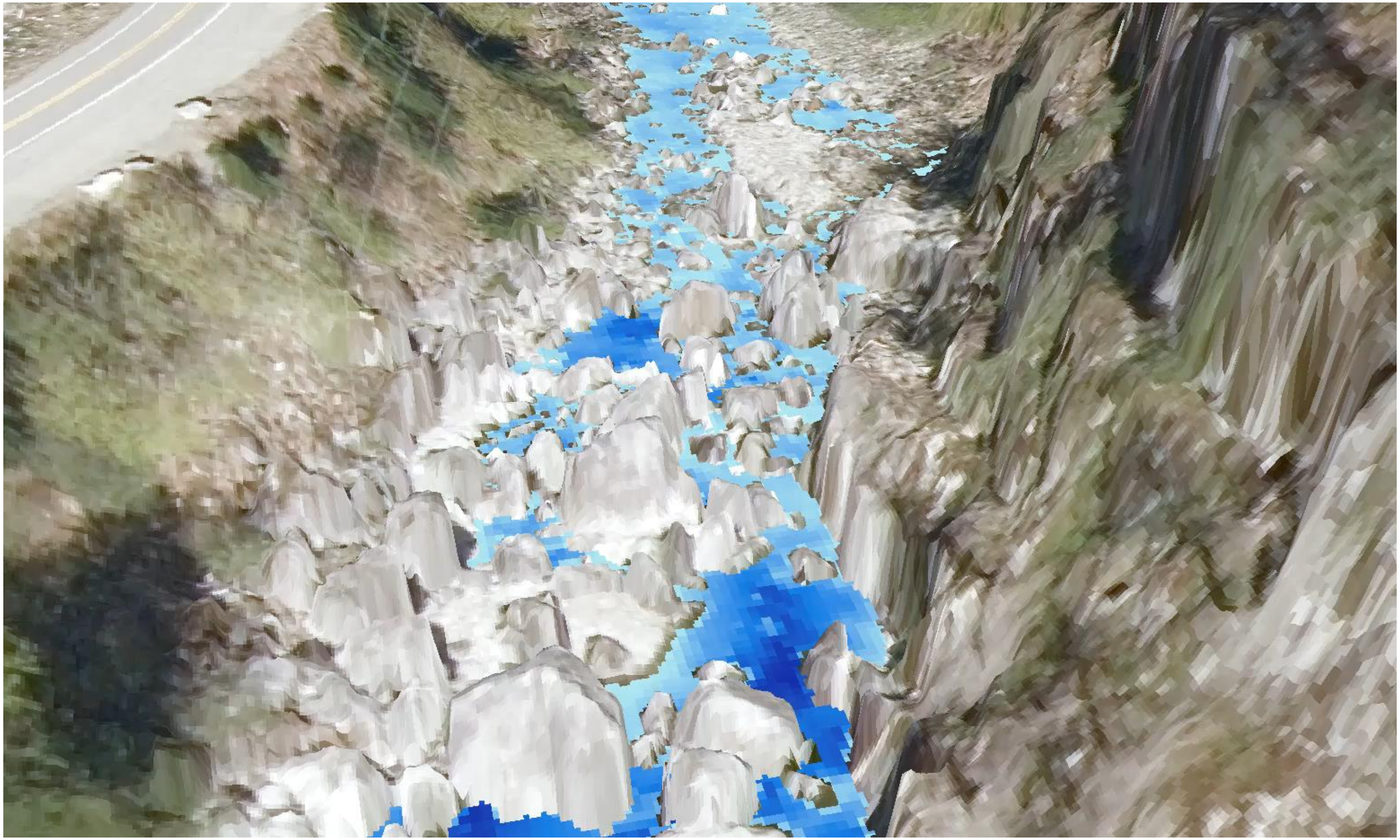
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – DATA REQUIREMENTS

- Physical Data
  - Topography / Bathymetry
  - Flow magnitude
  - Flow depth and water surface profiles
  - Flow velocity
  - Hydraulic pathways and connectivity
  - Turbulence, air entrainment (hydraulic chaos)
  - Range of observable discharges

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – DATA COLLECTION

- Strategies for site inspection and visual observation
  - 2 time-lapse cameras capturing imagery throughout range of flow conditions
  - UAV video with particle tracking imagery for controlled releases
- Collection of flow magnitude, depth, elevation, and velocity data
  - Water surface elevation profiles for baseflow (no release from Gorge Dam) and controlled releases of 50 cfs, ~300 cfs, 500 cfs and 1,200 cfs.
  - Detailed monitoring (depth, velocity, discharge) at 5 transects under baseflow and controlled releases.
  - 12 continuous water level recorders provide data to refine model in passage sections and support fish passage evaluation – for both controlled releases and unscheduled spill in monitoring period.

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – FEATURE TOPOGRAPHY



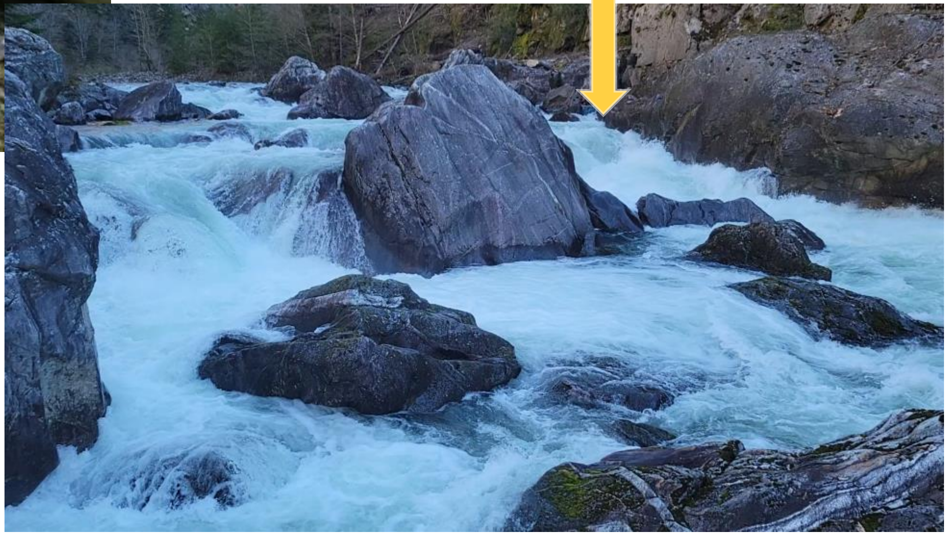
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – SITE INSPECTION AND VISUAL OBSERVATION

Feature complexity

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – SITE INSPECTION AND VISUAL OBSERVATION

Feature 1

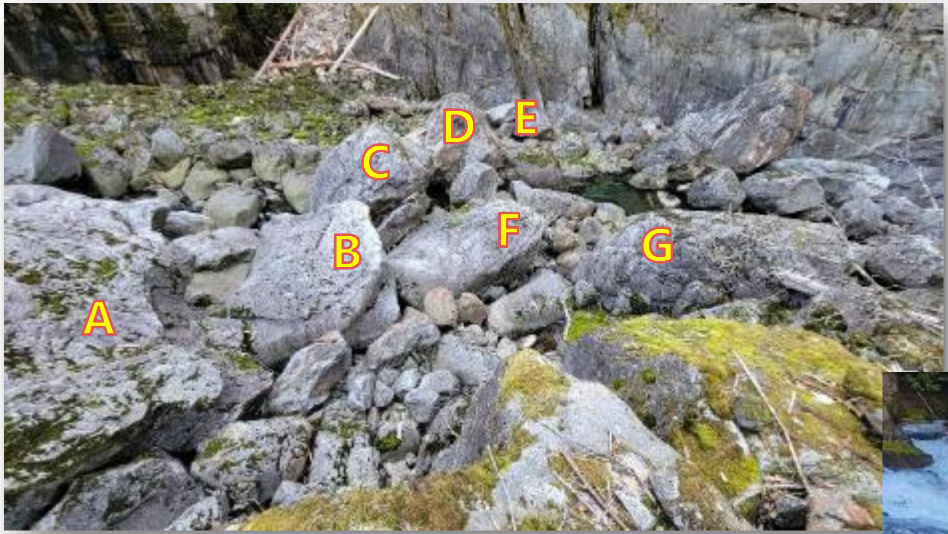
Base flow ~5 to 10 cfs



~1,200 cfs

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – SITE INSPECTION AND VISUAL OBSERVATION

Feature 2

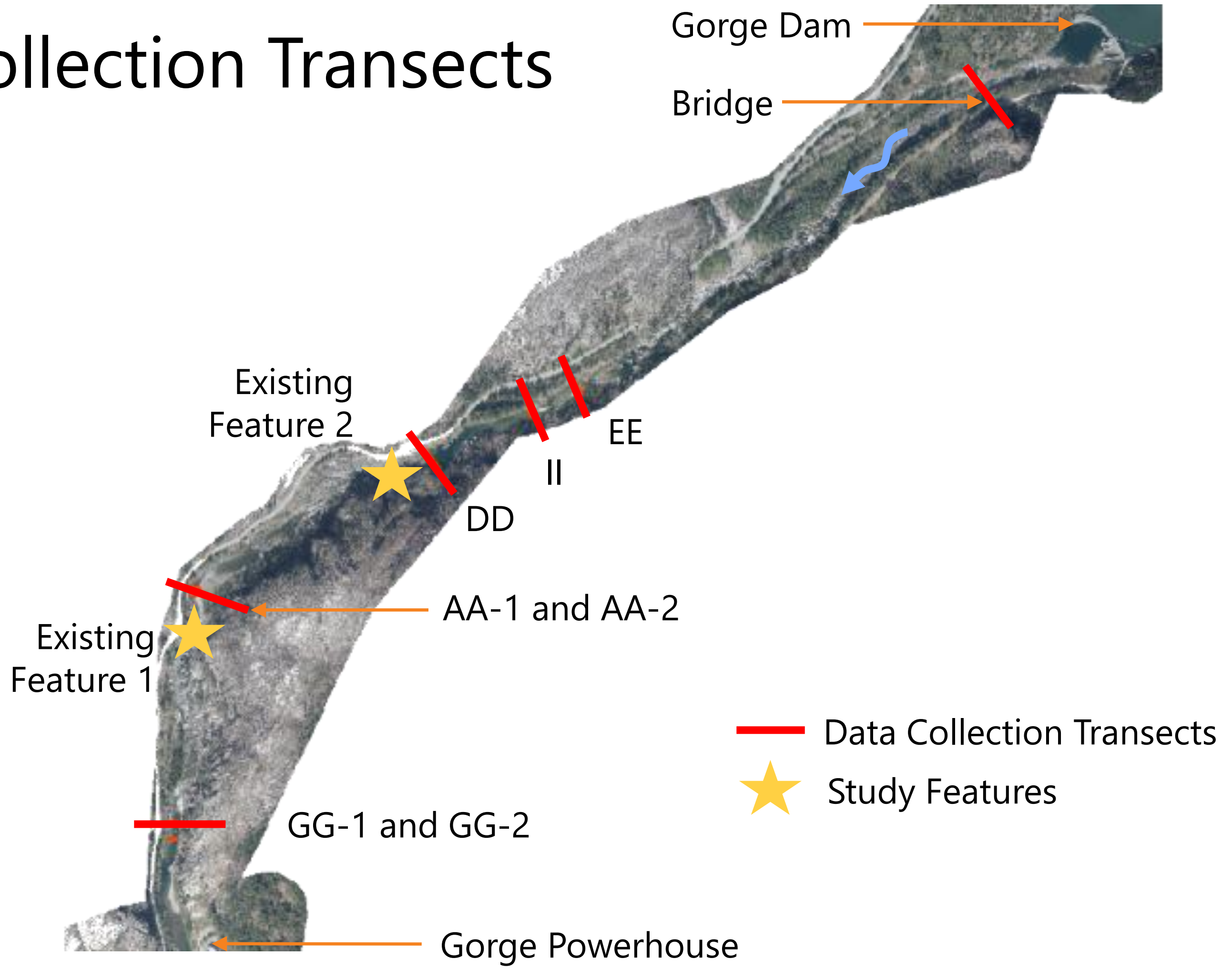


Base flow ~5 to 10 cfs

~1,200 cfs

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – FLOW MAGNITUDE

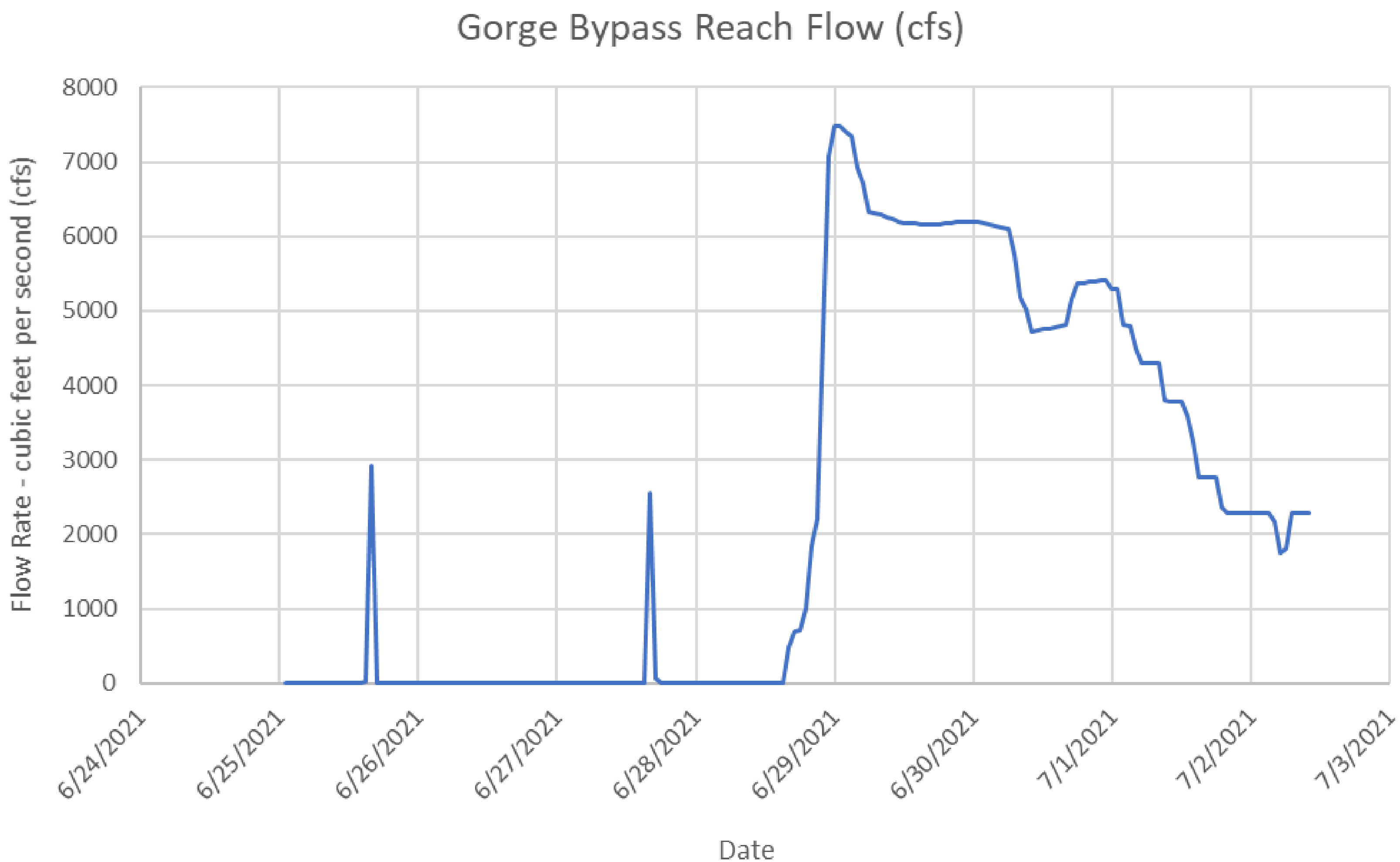
- Flow Data Collection Transects
  - GG-1
  - GG-2
  - AA-1
  - AA-2
  - DD
  - II
  - EE
  - BRIDGE



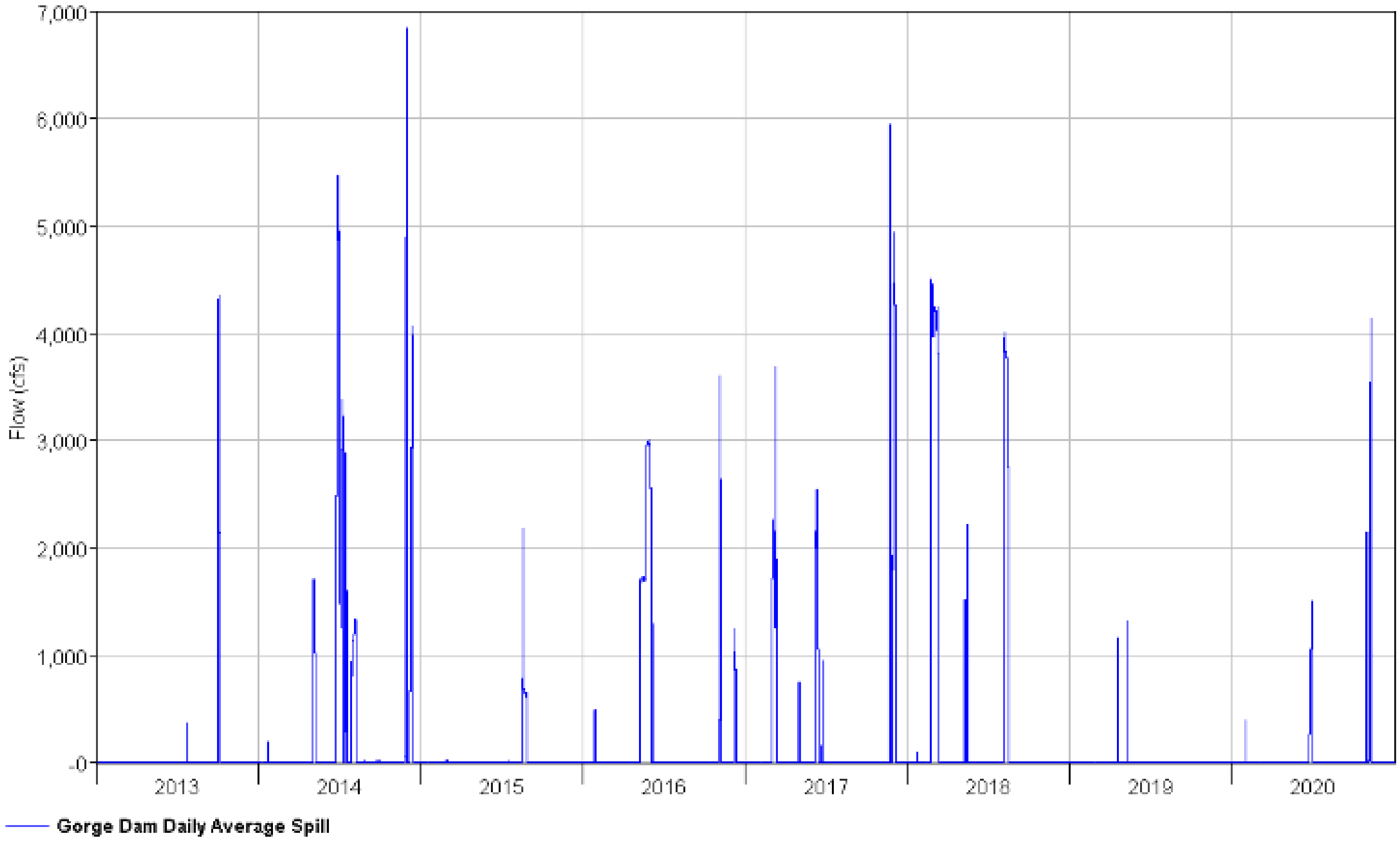
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – FLOW MAGNITUDE

- Opportunistic Spill – opportunity for data collection at higher flows
  - Flows up to 5,000+ cfs observed in records for spring/early summer freshet; 10,000+ cfs in fall/early winter storms.
  - Level loggers and time lapse cameras will be collecting data throughout this period
  - Duration variable dependent upon spill occurrence

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – JUNE/JULY 2021 HYDROGRAPH



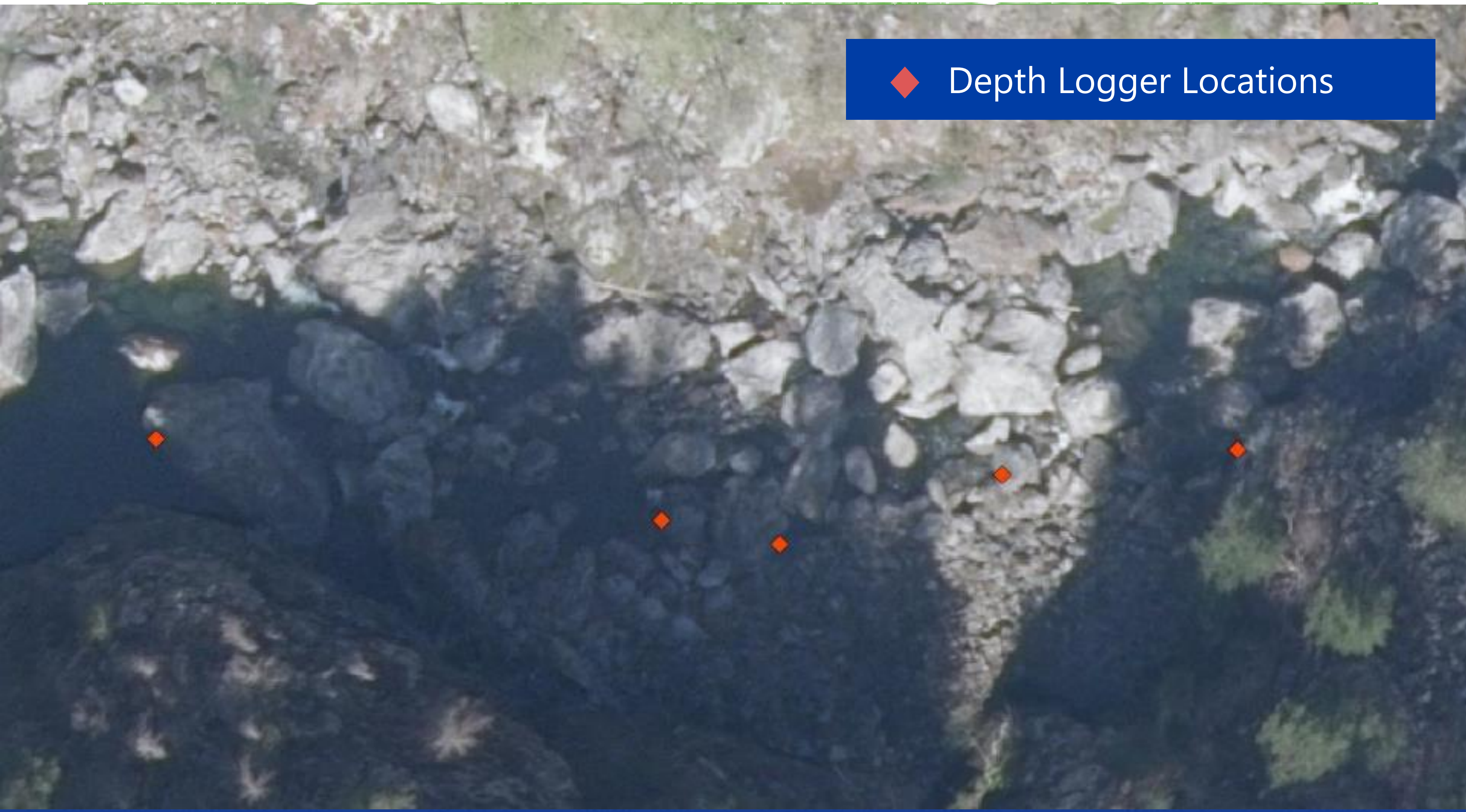
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – RANGE OF OBSERVABLE DISCHARGES



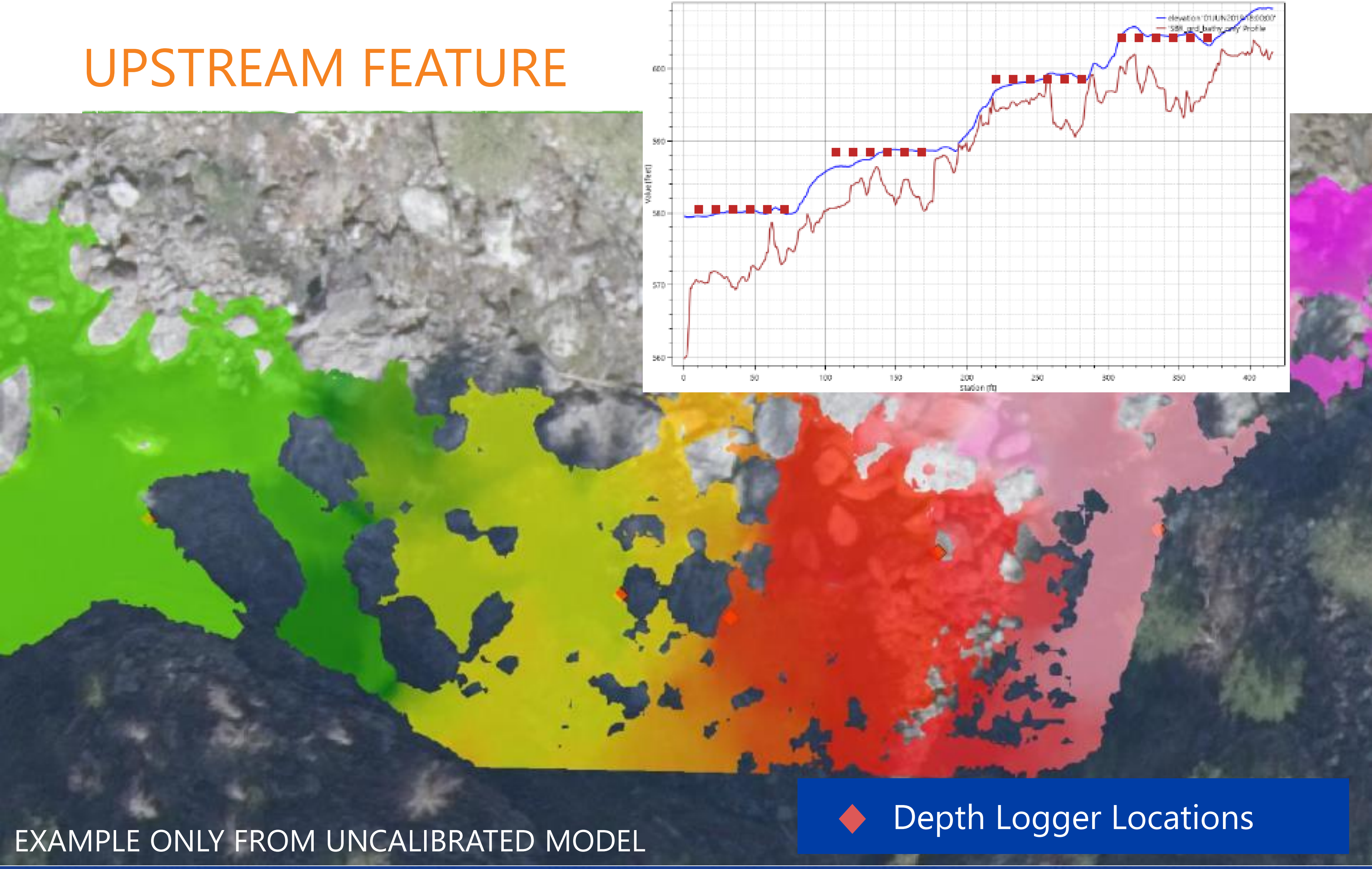
FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – DEPTH MEASUREMENT

- Depth monitoring locations identified using site investigation and initial/uncalibrated 2D model
- Deployment of level probes at 12 select locations
  - 5 at each feature (total of 10)
  - 2 at selected flow measurement transects
- Locations refined further after observations of features at ~1,200 cfs

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – UPSTREAM FEATURE

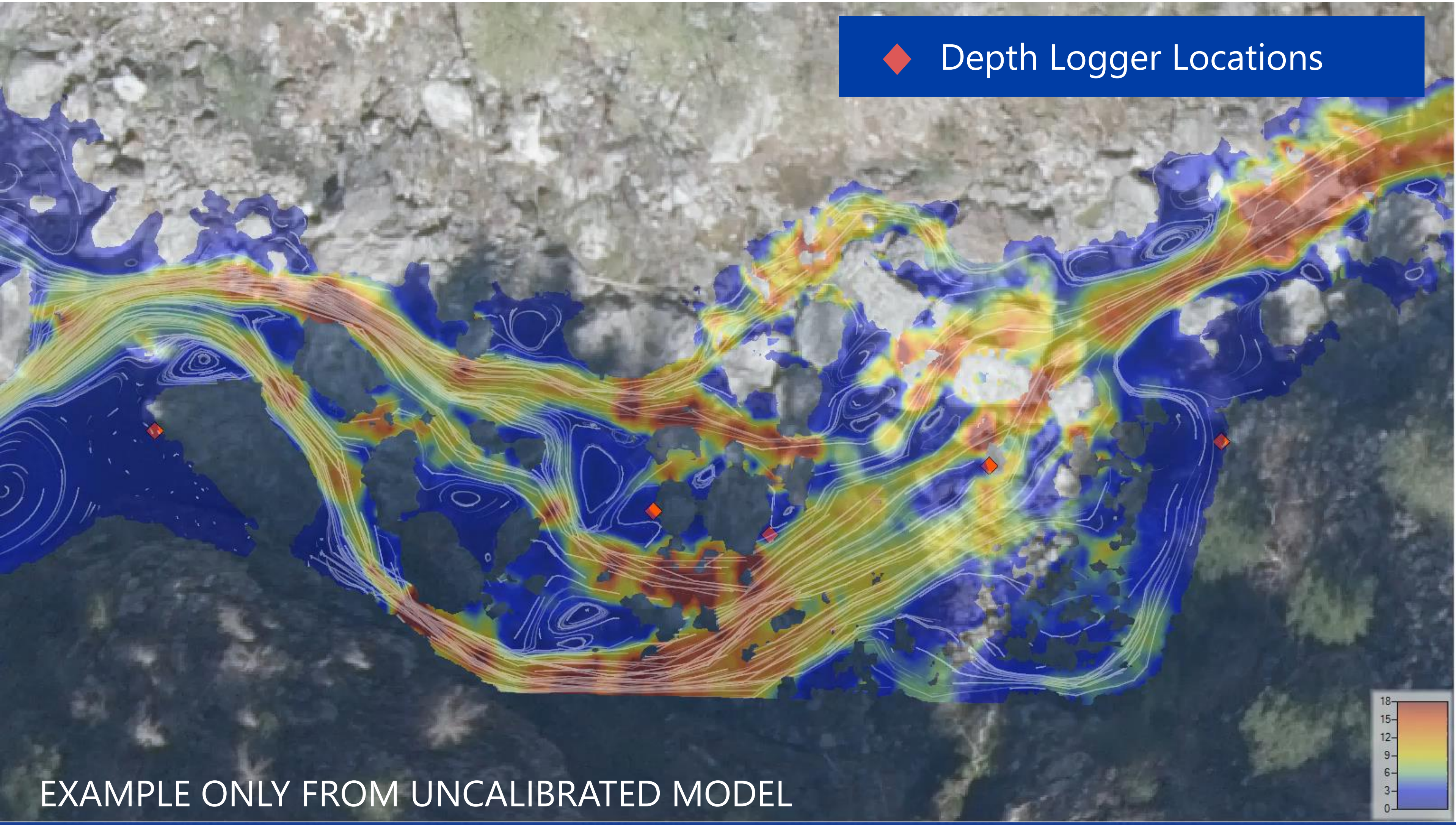


UPSTREAM FEATURE

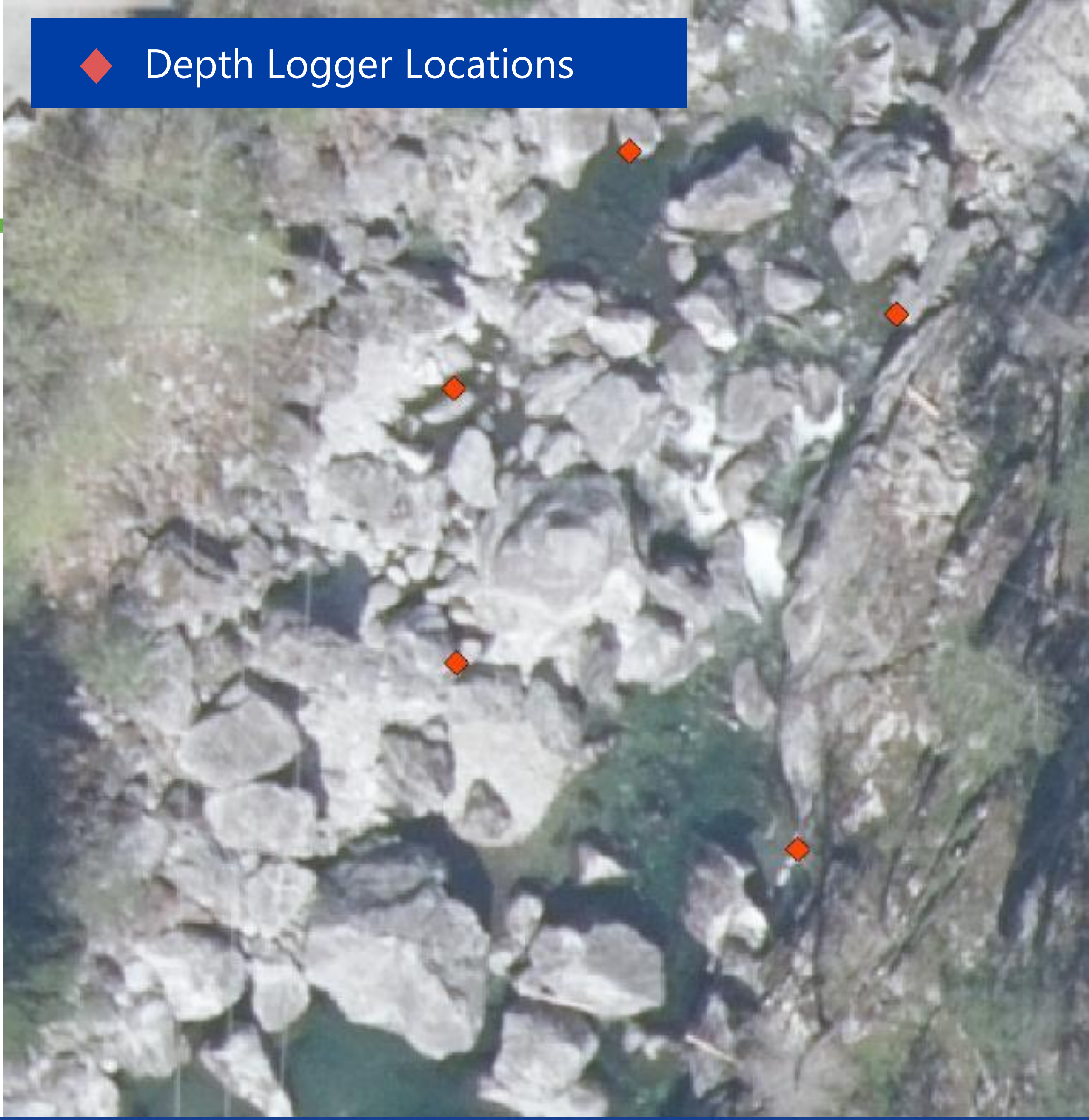


EXAMPLE ONLY FROM UNCALIBRATED MODEL

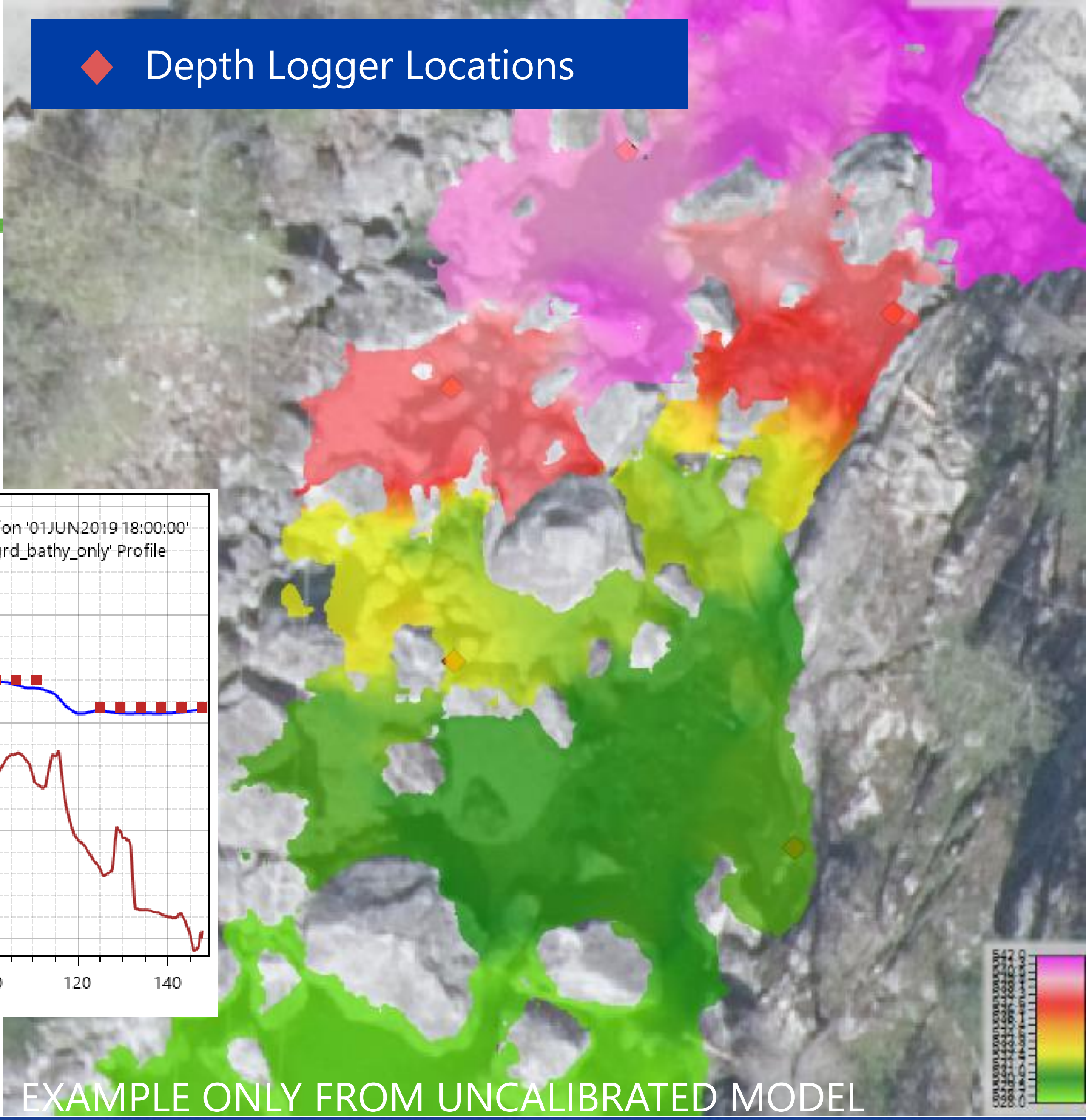
UPSTREAM FEATURE

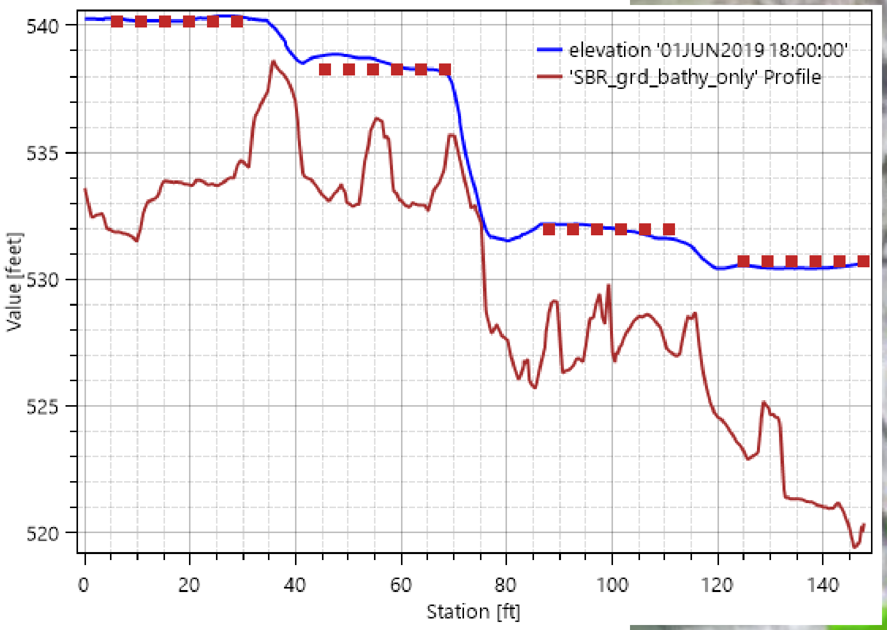


DOWNSTREAM FEATURE

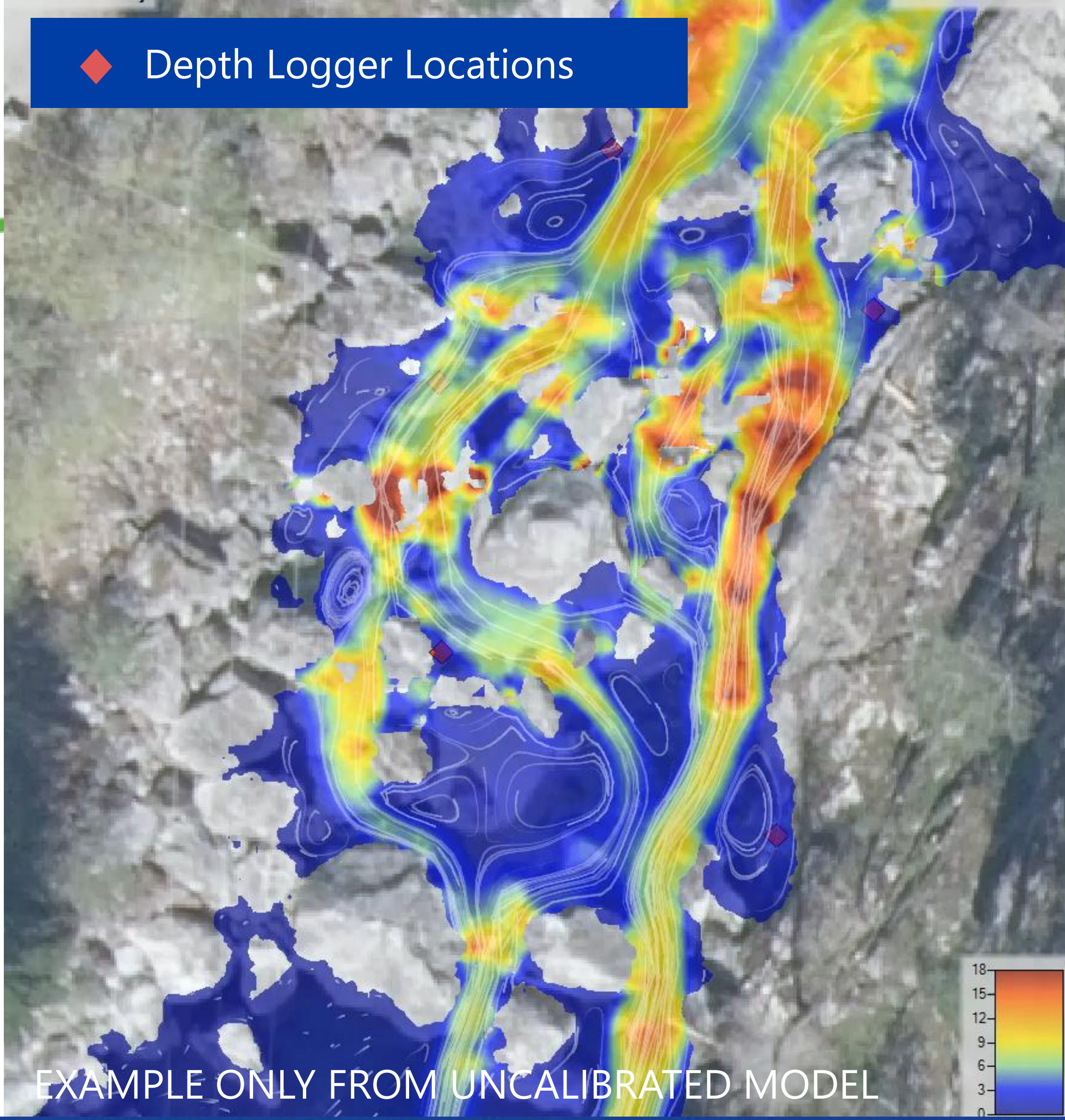


DOWNSTREAM FEATURE





DOWNSTREAM FEATURE



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES - VELOCITY MEASUREMENT

- Difficult and unsafe access at flows above 50 cfs
- High levels of turbulence and multi-directional flow
- Conventional methods likely inadequate
- Strategy for estimating velocities include:
  - UAV aerial and stationary video using particle tracking methodology
  - HEC-RAS 2D hydraulic model using coincident data collected for calibration

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – DATA REQUIREMENTS

- Biological characteristics of species considered
  - Range of size by species
  - Condition upon arrival
  - Swimming capability
  - Leaping capability
- Availability and variance in information available influences basis of biometric or ecohydraulic comparisons

FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – DATA REQUIREMENTS

- Criteria development:
  - Fish Swimming Capability
    - Factors that influence swimming capability
    - Key data available from the literature
    - Swimming capability approach
  - Fish Leaping Capability
    - Key factors that influence leaping capability
    - Methods from the literature
    - Leaping capability approach

FISH SWIMMING CAPABILITY – POTENTIAL FACTORS INFLUENCING SWIMMING CAPABILITY

Topic	References
Length	Topic reviewed in Beamish 1978.
Time to exhaustion	Topic reviewed in Beamish 1978.
Weight	Beamish 1978; Fry and Cox 1978.
Condition Factor	Beamish 1978; Vincent 1960; Green 1964.
Stage of Maturity	Williams and Brett 1987. Collins et al. 1962
Sex	Brett 1965; Williams and Brett 1987.
Disease	Swanson et.al. 1998. Parasitic infections reviewed in Beamish 1978.
River time	Paulik and DeLacy 1957. Sakowicz and Zarnecki (1962)
Strains	Thomas and Donahoo 1977
Stock	Taylor and McPhail 1985; Peake et al. 1997; Gauley and Thompson 1962.
Hatchery vs Wild	McDonald et al. 1998a.

FISH SWIMMING CAPABILITY – POTENTIAL FACTORS INFLUENCING SWIMMING CAPABILITY

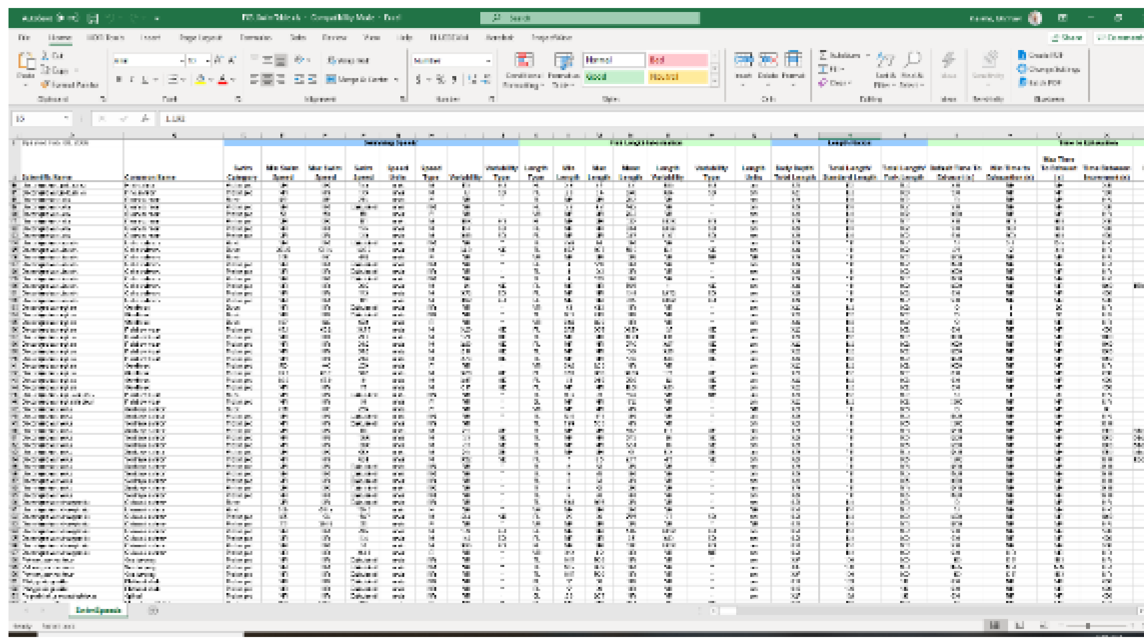
Topic	References
Feeding	Furrell et al. 2001.
Nutrition	Beamish et al. 1989.
Light	Blahm 1963; Pavlou et al. 1972 in Hammer 1995.
Stress	Strange and Cesh 1992.
Oxygen	Topic reviewed in Beamish 1978.
Carbon Dioxide	Dahlberg et al. 1968.
Salinity	Topic reviewed in Beamish 1978.
Toxins	Topic reviewed in Beamish 1978 and in Hammer 1995; Peterson 1974.
Temperature: Sustained and Prolonged Speed	Topic reviewed in Beamish 1978 and in Hammer 1995.
Temperature: Burst Speed	Beamish 1978; Booth et al. 1997.
Previous Training	Topic reviewed in Hammer 1995; Ward and Hilwig 2004.

FISH SWIMMING CAPABILITY – KEY FACTORS INFLUENCING SWIMMING CAPABILITY

- Species
- Fish condition (fatigue/energy stores)
- Fish length
- Water turbulence and air entrainment

FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Numerous sources of swim and endurance data available for focal species
- Not all species have reliable information – variability exists
- Example: FishXing 3 Swim Table
- 230 records
- Over 25 species

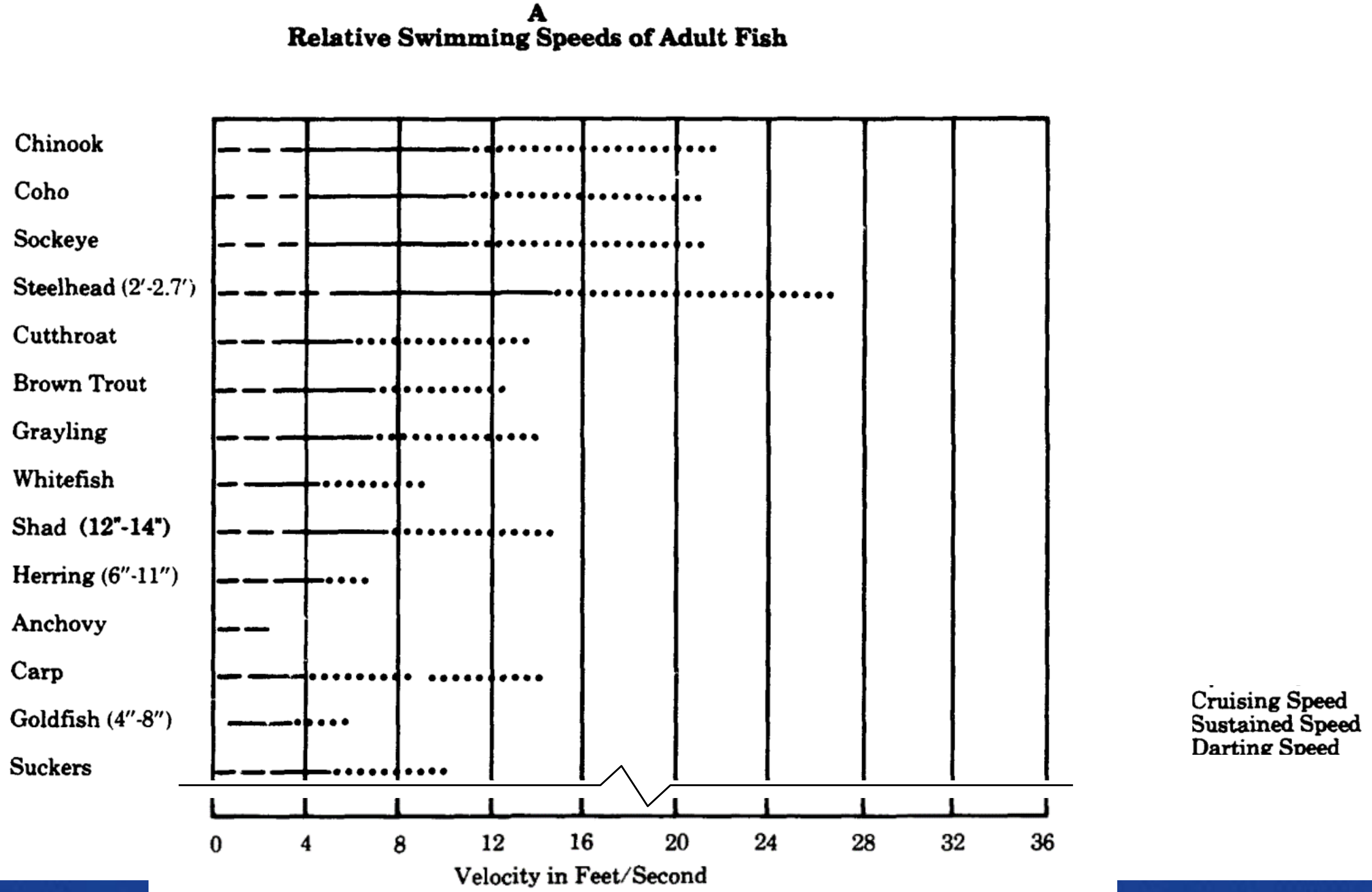


FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Hunter and Mayor (1986) – Swimming ability and time to exhaustion calculated based upon regression curves using historical flume data
  - Calculated "sustained," "prolonged," and "burst" swim speeds and durations were used to assess those situations where steep gradients create high velocity, turbulent conditions through chutes or cascades.
  - The combination of calculated swimming and leaping capabilities was used to identify whether or not a hydraulic feature (high velocity or leap condition) is passable.

FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Bell (1986) – Swimming Speeds of Adult and Juvenile Fish

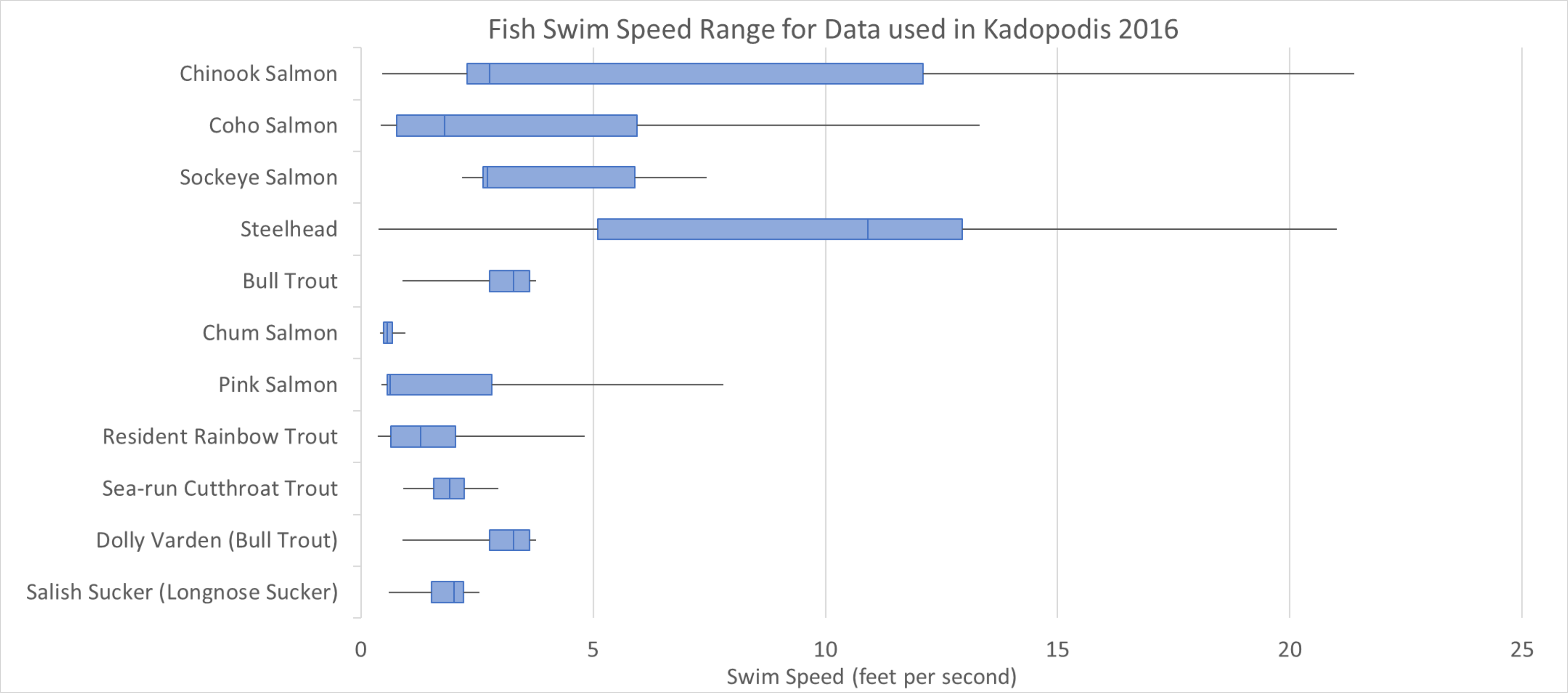


FISH SWIMMING CAPABILITY – ANTICIPATED SWIMMING CAPABILITY BY SPECIES OR ANALOGUE

Species	Adult Burst Swimming Speed (feet per second) *Bell, 1991*
Chinook Salmon	21.7
Coho Salmon	21
Sockeye Salmon	21.2
Steelhead	26.7
Bull Trout	-
Chum Salmon	-
Pink Salmon	-
Resident Rainbow Trout	-
Sea-run Cutthroat Trout	13.5
Dolly Varden	-
Pacific Lamprey	6.7
Salish Sucker	-

FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Katopodis and Gervais (2016) – swimming speed data
  - Emphasizes data available from 1990 forward



FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Katopodis and Gervais (2016) – swimming time vs swimming speed regression

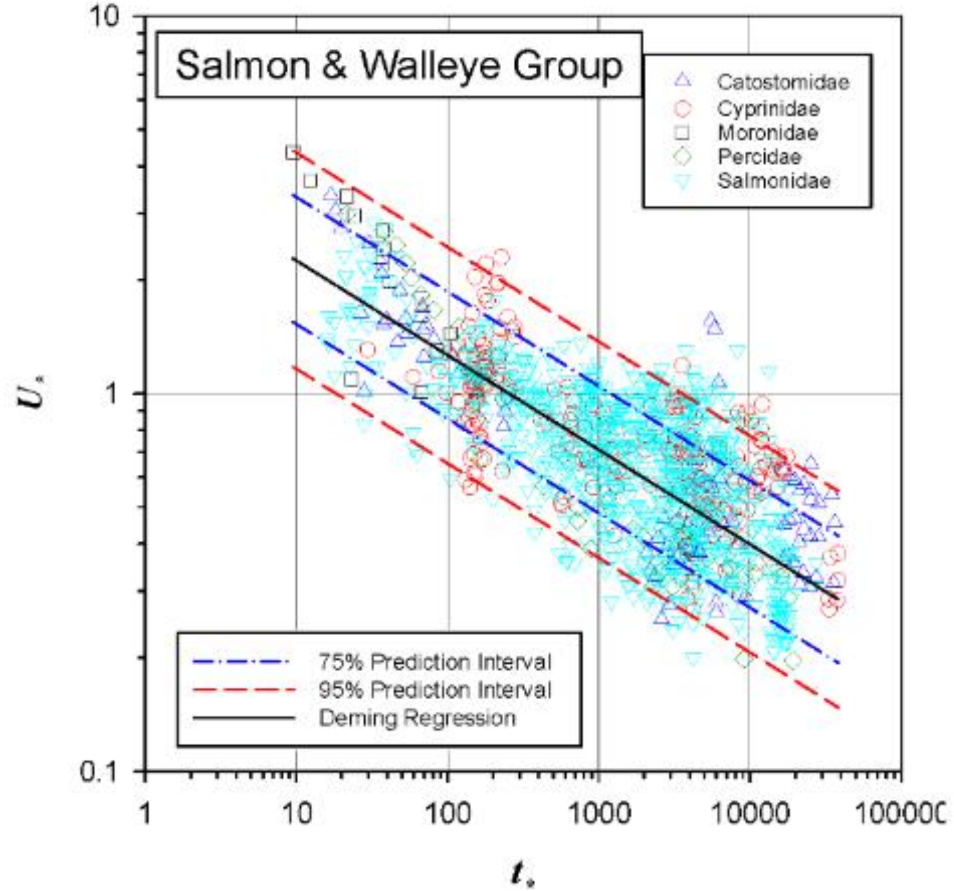
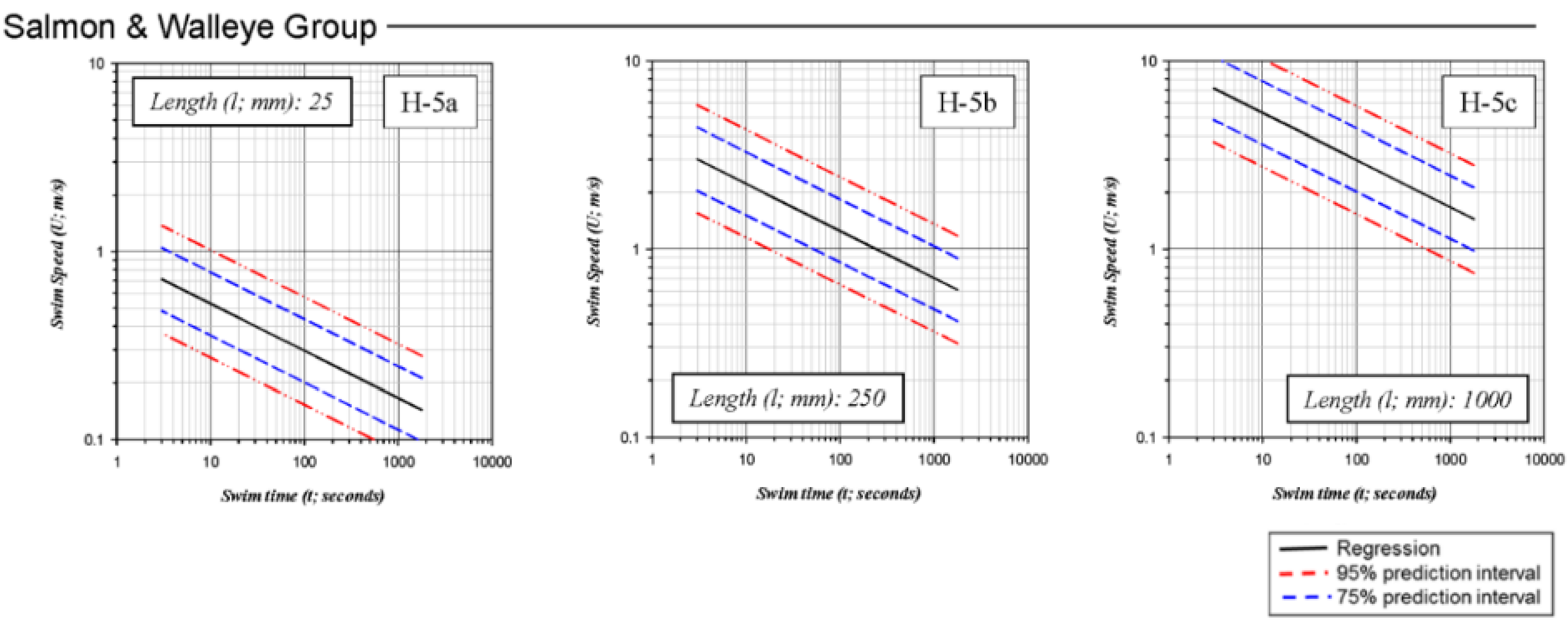


Figure G-5. Salmon and Walleye Group using dimensionless variables with Deming Regression line and the 75% and 95% prediction intervals. Dimensionless Swim Speed (U) versus Swim Time (t*).*

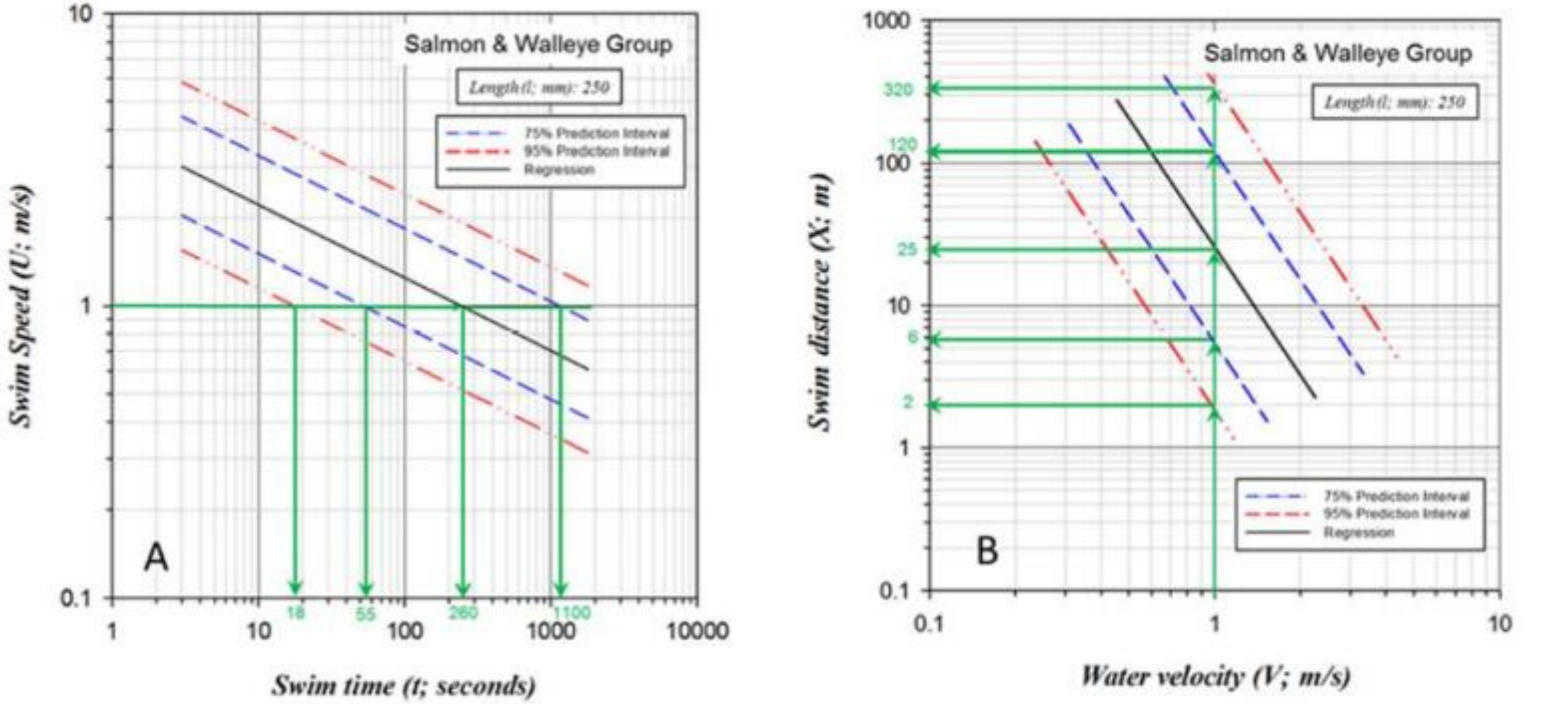
FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

- Katopodis and Gervais (2016) – swimming time vs swimming speed regression by fish length



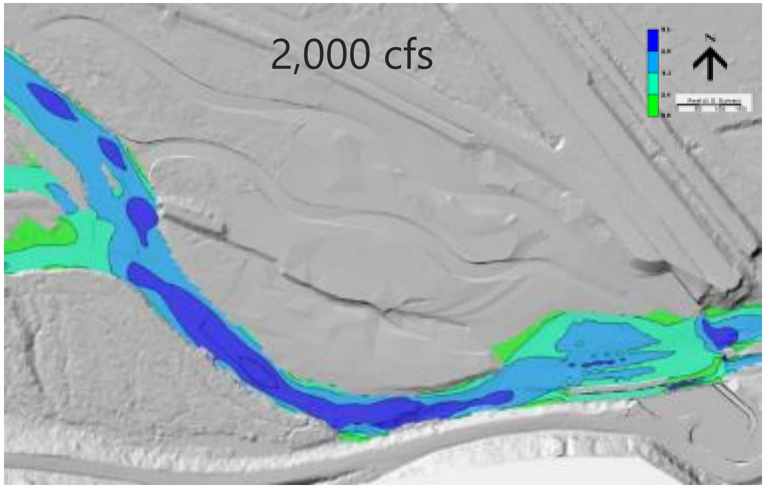
FISH SWIMMING CAPABILITY – KEY DATA AVAILABLE FROM THE LITERATURE

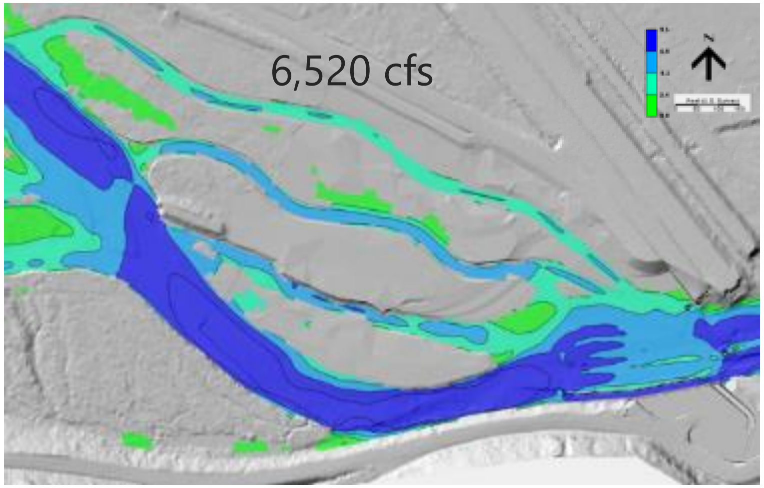
- Katopodis and Gervais (2016) – swimming fatigue nomographs



Example of swim endurance and distance estimates for Salmon and Walleye groups for fish length of 250 mm, in Figure A endurance times corresponding to a swimming speed of 1 m/s are shown and in Figure B swim distances corresponding a water velocity of 1 m/s are shown.

FISH SWIMMING CAPABILITY – PROPOSED APPROACH (EXAMPLE: NACHES RIVER)





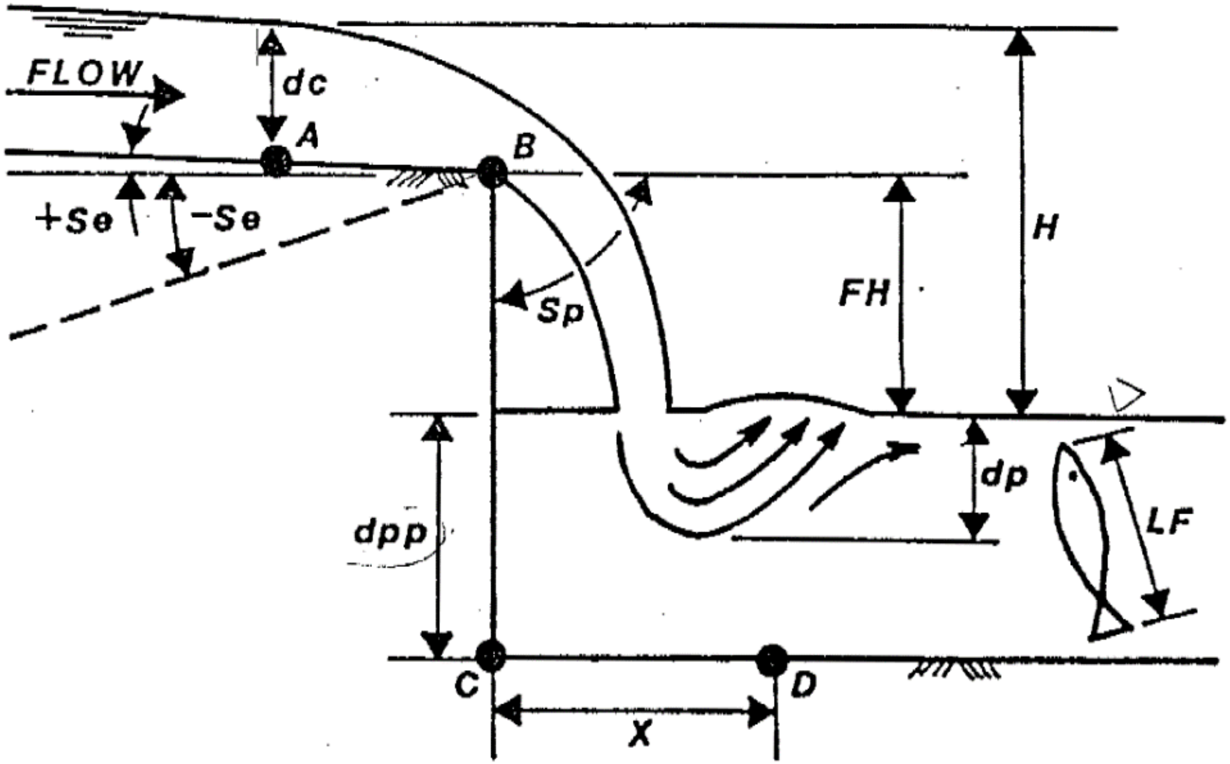
- *Adult Passage Zone 1* (Green; 0 – 4.0 fps): Zone 1 includes corridors in which fish can travel unimpeded. Adult passage through these zones could last for up to 30 minutes up to approximately 2,400 feet.
- *Adult Passage Zone 2* (Light green; 4.0 – 7.3 fps): Zone 2 is characterized by corridors in which fish can travel approximately 3 minutes or 450 feet before requiring a low velocity area (created by channel shape, structures, boulders, etc.)
- *Adult Passage Zone 3* (Light blue; 7.3 – 12.7 fps): Zone 3 is characterized by velocity corridors where adult salmonids could swim for approximately 20 seconds and 85 feet before requiring a low velocity area to rest.
- *Adult Passage Zone 4* (Dark blue; 12.7 – 18.0 fps): Zone 4 is made up of areas with higher velocities, where more velocity refugia are required for larger distances within this zone. Adult salmonids are only expected to be able to traverse approximately 30 feet or 5 seconds.

FISH LEAPING CAPABILITY – KEY FACTORS THAT INFLUENCE LEAPING CAPABILITY

- All factors that influence swimming capability and burst speed
- Feature geometry
  - Depth of leap pool
  - Condition of leap area
  - Condition of landing area
  - Angle

FISH LEAPING CAPABILITY – METHODS FROM THE LITERATURE

- Powers and Orsborn (1985)



Conceptual model of a fall with variables representing physical conditions

FISH LEAPING CAPABILITY – METHODS FROM THE LITERATURE

- WDFW (2019) – Application

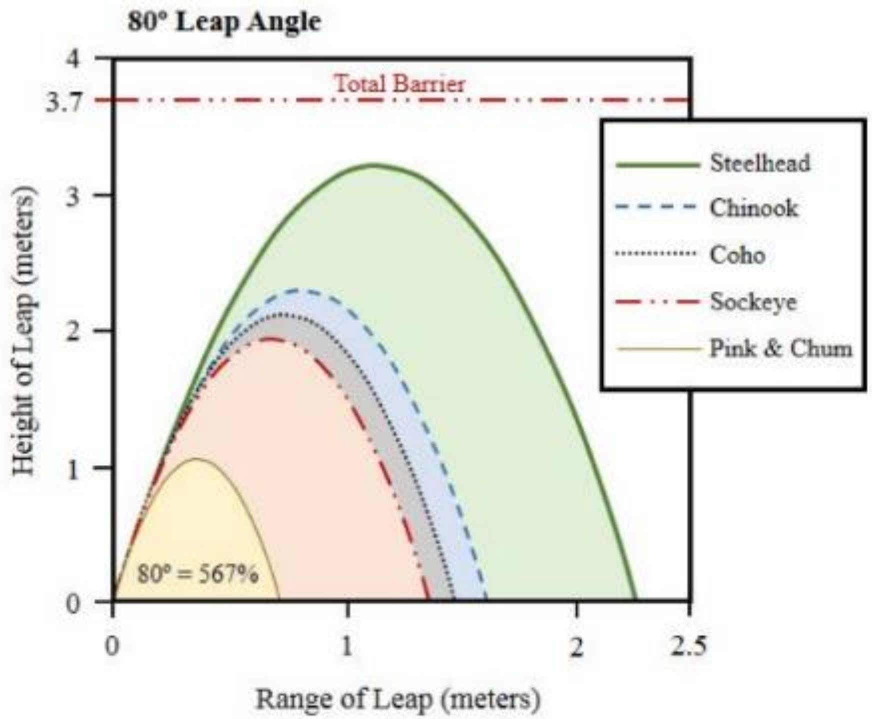


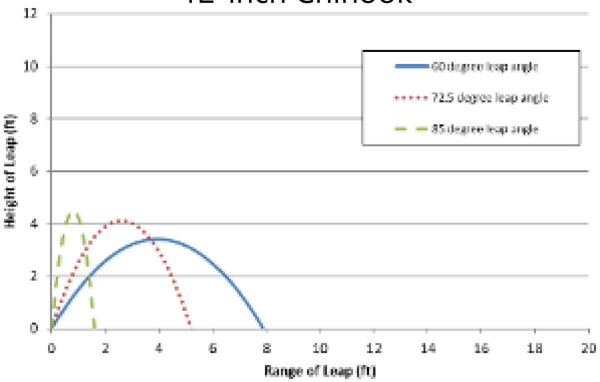
Figure 7.5. Washington State salmon leaping abilities. Illustrates the leap height and range of healthy fish leaving the water at an 80° leap angle (or 567% slope). Figure adapted from Ruggerone (2006) and Powers and Orsborn (1985).

Source: WDFW (2019)

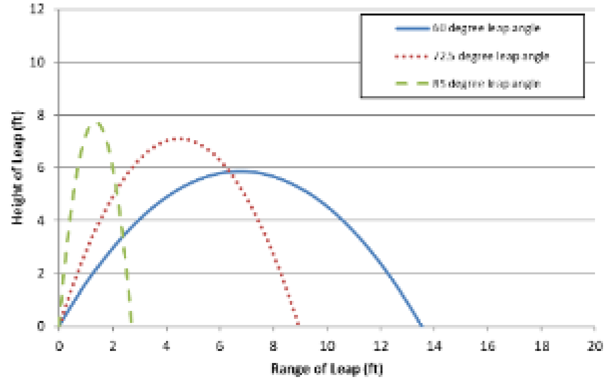
FISH LEAPING CAPABILITY – SUMMARY OF POTENTIAL LEAPING ABILITY

- Powers and Orsborn (1985) - Example: Maximum leaping capability calculated for Chinook and Steelhead in good condition, Cfc=1

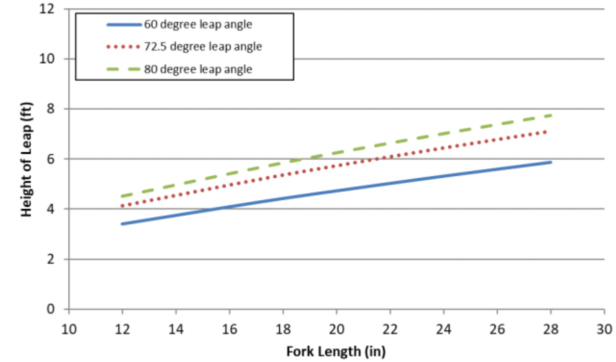
12-inch Chinook



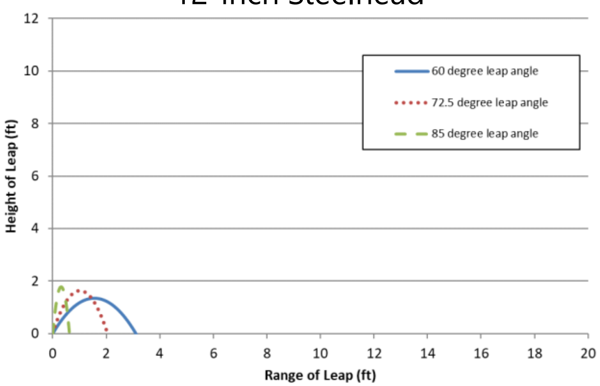
28-inch Chinook



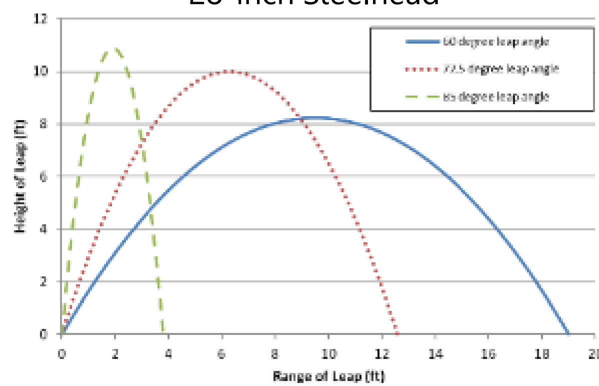
Chinook
Jump Height vs Fork Length



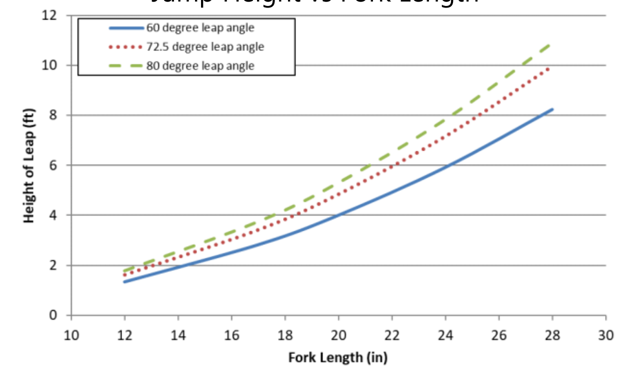
12-inch Steelhead



28-inch Steelhead



Steelhead
Jump Height vs Fork Length



FISH PASSAGE ASSESSMENT OF EXISTING FEATURES – NEXT STEPS

- Complete field data collection program
  - Controlled spills 7/26-7/29
- Begin engagement with AWS
- Establish potential leaping and swimming capabilities for focal fish species or groups

Seattle City Light

NEXT STEPS

FUTURE DISCUSSIONS

- Schedule site visit to existing facilities
- Discuss composition and role of Expert Panel
- Schedule Bi-Weekly Meetings

SCHEDULE, ACTION ITEMS, NEXT STEPS

- Action Items
- Next Steps

OUR MISSION

Seattle City Light is dedicated to delivering customers affordable, reliable and environmentally responsible electricity services.

OUR VISION

We resolve to provide a positive, fulfilling and engaging experience for our employees. We will expect and reinforce leadership behaviors that contribute to that culture. Our workforce is the foundation upon which we achieve our public service goals and will reflect the diversity of the community we serve.

We strive to improve quality of life by understanding and answering the needs of our customers. We aim to provide more opportunities to those with fewer resources and will protect the well-being and safety of the public.

We aspire to be the nation's greenest utility by fulfilling our mission in an environmentally and socially responsible manner.

OUR VALUES

Safety, Environmental Stewardship, Innovation, Excellence, Customer Care

THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

Seattle City Light

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Workshop No. 1
July 15, 2021, 1:00pm – 4:30pm

Meeting Summary

Disclaimer: These notes serve as a high-level summary of the meeting and as a communication tool for the benefit of committee continuity. They are not intended as a formal record of the meeting.

Attendance

Licensing Participants (LPs):
Alphabetical by last name

Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Curtis Clements, Upper Skagit Indian Tribe
Steve Copps, National Marine Fisheries Service (NMFS)
Jeff Garnett, United States Fish and Wildlife Services (USFWS)
Rick Hartson, USIT
Noah Jenkins (NMFS)
Donnie Jones (NEC)
Grant Kirby, Sauk-Suiattle Indian Tribe
Jonathan Kohr, WDFW
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Kevin Lautz, (WDFW)
Jim Meyers, (NMFS)
Logan Negherbon (NMFS)
Duncan Pfeifer (WDFW)
Ashley Rawhouser, National Park Service (NPS)
Dudley Reiser, Swinomish*
JonPaul Shanahan, USIT
Kara Symonds, Skagit County
Erik Young, Skagit Fisheries Enhancement Group (SFEG)

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowrey, City Light
Chris Townsend, City Light
Matt Love, Cascadia Law Group (Legal Counsel)
Andrea Weiser, City Light

Consultant Team:
Mike Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Theo Malone, Consultant Team
Jacob Vernard, Consultant Team
Matt Wiggs, Consultant Team

Facilitation Team:
Betsy Daniels, Facilitation Team
Olivia Smith, Facilitation Team
Anna Shepherd, Facilitation Team

Meeting Materials[1]

Materials were sent in advance (available upon request):

- FA-04 Fish passage meeting agenda
- FA-04 Fish Passage presentation

Action Items

Action	Responsibility	Deadline
City Light Action Items		

[1] (Add link and footnote as appropriate) Meeting materials are available on the Project SharePoint Site here: Terrestrial Resources and Reservoir Erosion RWG > Meeting Materials > 20200623_RWG_Meeting

Add information and metadata to Project SharePoint as it becomes available with notices to meeting participants.	City Light/HDR	Ongoing
Facilitation Team Action Items		
Discuss future meeting topics listed below with City Light and HDR to get necessary workshops/meetings on the calendar.	Triangle	Week of July 19
Schedule September Fish Passage meeting.	Triangle	Week of July 26
Prepare draft meeting summary and send to participating LPs, City Light, and other attendees for review.	Triangle	Week of August 8
Topics for Future Meetings or Workshops		
Consider linkages between Fish Passage and Operational Scenarios, CE-QUAL, FA-01, etc.		
Review Coho observations found on page 35 of USIT's RSP comments filed May 6, 2021.		
Modeling of channel-bottom velocities.		

Summary of Issues Discussed, Action Items, and Decisions

Welcome, Introductions, Agenda Overview

Mike Garello, Consultant Team, introduced the City Light and Consultant Team and gave an overview of the agenda. Mike explained that the purpose of this meeting was to provide an overview of the from the Revised Study Plan (RSP) that includes the Fish Passage Facilities Assessment and Fish Passage Assessment of Existing Features in the Bypass Reach.

Mike shared the meeting objectives discussed by the agenda setting small group are to:

- Provide an overview of the study schedule, including opportunities for License Participant (LP or Participant) engagement and interim work products.
- Provide an overview of the specifics of the study plan for the two separate fish passage assessments, including a summary of focal species.
- Determine the quantity, coordination, and content of a potential workshops (including invitation list, time materials are provided prior to workshops, agenda development, notes, action items, etc.).
- Identify the next steps moving forward with the study and LP engagement in the process.

Study Plan Overview, Schedule, and Milestones

Mike gave an overview of key milestones, key content of reports, and opportunities for engagement and communication. Mike walked through the project Gantt Chart to explain the timeline with key deliverables, content, and anticipated release dates for the two assessments, along with the overall timeline for FERC mandated delivery (See slides 7-23). Essential discussion items included:

- FA-05 and FA-04 will be implemented in the field at the same time and overlap in modeling efforts.

There will be an opportunity through FA-04 to perform high-level monitoring on unconditional and unplanned spills.

- Four workshops are currently planned for FA-05 with an optional 5th.
    - The second workshop in September will give the LPs an opportunity to review comments on the preliminary draft, discuss design criteria, identify information needs to proceed to the next phase, and share an update on biological performance information gathered on fish passage facilities in the Pacific Northwest.

- A sub-committee of the agency engineers participating in this group will be meeting bi-weekly to stay in touch about the specifics of the studies.

- In response to a question about the linkage of these studies to the Initial Study Report (ISR), Mike responded the ISR will be a status report with some level of assessment about work completed to date and this will provide an opportunity for LPs to comment and City Light to consider updates to the study design.

Mike presented a chart outlining the series of milestones and associated deliverables for the two assessments:

<u>Fish Passage Facilities Assessment</u>

Key deliverables include:

- A draft assessment report due on August 19, 2022, and a final report on December 16, 2022.
- Drafts will be available for comment and feedback before the report is finalized.
- The interim deliverable will be a draft concept development report.
- Workshop 4 will be in March 2022 and Workshop 5, if opted, will be held later that year.

<u>Fish Passage Facilities Assessment of Existing Features in the Bypass Reach</u>

Key components of the assessment will include:

- A site inspection and survey,
- hydrodynamic modeling of existing features,
- biometric comparison of Eco hydraulic factors influencing fish passage, and
- identification of flow ranges that may limit or promote fish passage for each focal species specified in or agreed to through the Revised Study Plan and June 9th Notice of Agreement.

The first iteration will be available in May 2022; the second component with additional data will be provided in October 2022.

Mike gave an overview of dialogue and engagement opportunities within the study schedule:

- *Workshops*: The workshops provide opportunities for LPs to review the study plan process and establish preliminary design criteria.
- *Bi-weekly Agency Working Sessions:* The working sessions are an opportunity for subject matter experts to provide more frequent feedback on interim study progress, methods, and outcomes.
- *Interim deliverables and reports:* These products provide LPs with an opportunity to exchange information and receive feedback at interim milestones during study implementation and identify any data needs or additional data that needs to be incorporated.

LPs and Mike discussed the possibility of adjusting reservoir rule curves that are helping to develop criteria for the study plan. Mike explained that another study is looking at project operations to help give direction on this in the future; however, the fish passage assessment will evaluate existing rule curves. Future rule curves could be incorporated into the assessment as next steps following the initial assessment.

The group discussion the potential for an onsite facilitated meeting. LPs indicated that would be helpful for those not familiar with the site to see the project landscape and features in person. This question will be answered closer to the next Workshop in September.

Focal Species for Fish Passage Assessments
Mike presented a summary of key fish species and explained how the two assessments will begin with the same list of species, but how the species integrate into the two assessments may differ.

- Fish Passage Facilities Assessment. The range of species, difference in body size, and different swimming behavior will help inform the type and complexity of potential strategies and facilities. Certain biological considerations will not be addressed in detail in the study, but will be considered in the strategy, an example being the threshold for how big these facilities will be, given abundance based on input from the LPs.

- Fish Passage Facilities Assessment of Existing Features in the Bypass Reach. The same list of species will be analyzed to identify what species we have data for with swimming/leaping capability. Certain species may have more information than others, but there is an existing analog of species with similar swimming patterns. This similarity may allow the assessment to move forward with certain species grouped by size, types of locomotion, swimming/leaping capability, and whether they attach to rock vs. not (ex. Lamprey).

Commented [GU1]: WDFW: Thank you, the notetaker captured this point very well.

The LPs requested metadata so they can properly prepare for these workshops in advance. Mike offered that the consultant team will deliver a preliminary draft report outlining information obtained to date ahead of the next workshop.

***Action Item*:** City Light will add information and metadata to Project SharePoint as it becomes available with notices to meeting participants.

Fish Passage Facilities Assessment
Mike provided an overview of the status and next steps for the study plan and shared objectives and outcomes, data requirements, and assessment methodology. The objective of the assessment is to assess the potential feasibility of upstream and downstream passage at each of the three project developments. Outcomes will include analysis of potential performance and state of science, and the capital costs associated with fish passage improvements looking at level upstream and downstream passages.

- An LP requested clarification on whether the outcomes outlined in the presentation were the same as those in the RSP. Mike and others clarified that they are the same, but that the RSP was more of a high-level overview. The presentation went into more detail.

Upper Skagit Indian Tribe (USIT) asked about dam removal as a possible project modification to consider in the study and that dam removal and fish passage are synonymous from their point of view. City Light noted that while conversations will continue in the future to better understand LP interests, City Light is not considering dam removal at this time.

Commented [GU2]: SCL has since changed their minds. SCL will make an assessment of their dams on whether they should remove the dams.

Commented [A(3R2]: WDFW Comment

Mike explained that this assessment will take an adaptable approach and focus primarily on technical feasibility. The details of the assessment are subject to discussion and are commonly defined by participation within the workgroups. The study will look closely at compliance with technical design guidelines. Efforts are currently focused on gathering data, defining objectives, and considering requirements to implement. To determine technical feasibility, the assessment will need to determine whether the facility satisfies the operational and engineering-related objectives of the project. This will be site-specific and unique to the specific environments and species.

- A Participant asked whether the study would evaluate biological feasibility and cultural and economic feasibility. Mike acknowledged the interlinkages between the elements but said this study plan will focus on technical feasibility. Participants noted how important it is to accurately describe the cultural significance of fish passage in the study. In response to another question about whether the biological/economic/cultural feasibility elements would happen as part of a broader, more complex evaluation or separately, Mike explained that these elements would not be part of this study plan but could be part of a more comprehensive future evaluation.

- An LP asked whether the study team will consider linkages to other studies. Mike responded that this would be the case. Information generated from the operation model would help inform fish passage facility configurations (i.e., facility type, size, location, configuration, and operational requirements).
- An LP asked whether City Light has a dollar amount in mind to measure economic feasibility. City Light explained that they do not have a dollar amount and that commitments for this study are made based on ecosystem needs rather than costs.

Topic for Future Meeting or Workshops: Consider linkages between Fish Passage and Operational Scenarios, CE-QUAL, FA-01, etc.

Fish Passage Assessment of Existing Features in the Bypass Reach

Mike gave an overview of the objectives and outcomes, went over assessment methodology and data collection, and discussed the range of observable discharge. The discussion covered evaluation methods and tools, emphasizing species diversity, swimming speed, and feature complexity that would require site-specific evaluation. The role of hydraulic modeling was also discussed. Mike walked through a process diagram showing biometric and Eco hydraulic factors and how they inform model calibration. He noted that the hydraulic model will be used as a tool, not a pass/fail approach, and will inform where devices are placed, the windows of passage flows for each species, and how velocities are interpreted in some cases.

- USIT noted that the recent documentation of Coho salmon above cascade gardens reaffirms the importance of direct observation as a data collection method. Mike agreed that direct observation should be incorporated into the assessment. (For some reason, the comment section quit working): WDFW's 2019 guidelines for fish passage assessment emphasizes a direct observation as the best method/proof of upstream fish passage.

Topic for Future Meeting or Workshops: Review Coho observations found on page 35 of USIT's RSP comments filed May 6, 2021.

- An LP asked how the assessment will average to find true bottom considering the complexity of the features in the bypass. Mike acknowledged that this is a very complex reach and that the model has limitations. They will need to consider several factors when determining how useful the model is.
- An LP asked whether pass-flow windows will be wide enough to capture flow variability in the river system. Mike said there are two potential flow ranges the team will be looking at: 1) where the model can be calibrated and 2) where the team can use it. They will use a range of scheduled releases to calibrate the model and consider any unplanned releases that could occur later in the season. He noted that data use will depend on the data-collection equipment at that time, and the ability to detect the range of flows. Mike noted that the presentation would cover the range of flows in more detail later in the meeting.
- An LP asked whether City Light was still planning additional flow releases into the bypass reach between 50 and 500 CFS, and whether the model would show values for depth as well as velocity. Mike noted that the model can show velocities that exist when depth exceeds a certain threshold, and that the presentation would go into more detail on planned flow releases shortly. Dudley Reiser clarified that the three flows shown depict uncalibrated model estimates and not the actual flow releases that will occur.

Mike gave an overview of where the loggers were installed upstream and downstream to gather velocity and depth measurements. He noted the data collected would help identify pathways that fish might use to ascend the feature. Mike explained the strategies for visual observation and site inspection and covered some details on the plan for collecting flow magnitude, depth, elevation, and velocity data.

- An LP questioned whether this study would represent velocities along the channel bottom and whether unplanned release events would provide sufficient data. Mike responded that the team is unable to measure that velocity except during the lowest flows but can approximate based on the average.
- LPs asked for clarification on whether the model would be based on a real data point for calibration based on 1,200 CFS. HDR staff explained that they are looking at whether they collected the larger calibration data in the 4,000 to 6,000 CFS range during a recent spill, and that they would try again in the fall or conduct another controlled spill to get the proper calibration point.

Mike summarized criteria and key factors influencing fish swimming and leaping capability, and shared key takeaways from the literature and examples on fish swimming and leaping capability.

- An LP asked whether any literature mentioned included the influence of epigenetics on physical performance. Mike responded that this kind of information can be considered another variable and used if available. Still, the greater question is how it should be used to modify the understanding of swimming capability. Another Participant added it would be helpful if the model also looked at critical rifle passage – or how long fish have to swim over a shallow area. LPs indicated interest in a future meeting on modeling channel bottom velocities.

Topic for Future Meeting or Workshops: Modeling of channel bottom velocities.

Mike noted that the next steps are to 1) complete the field data collection program, with controlled spills planned for 7/26 and 7/29, 2) begin engagement with AWS, and 3) establish potential leaping and swimming capabilities for focal fish species.

Schedule, Action Items, Next Steps

The facilitator noted that the next FA-04 meeting in September will focus on the conceptual design criteria and the fish passage engineers will be meeting biweekly. LPs commented it would be helpful to have another meeting to review the design criteria before meeting in September. The facilitator mentioned the possibility of meeting in person for September, recognizing federal regulations may impact whether this can happen.

***Action Item*:** Triangle to identify the best date for next fish passage meeting.
***Action Item*:** Discuss future meeting topics listed below with City Light and HDR to get necessary workshops/meetings on the calendar.
***Action Item*:** Prepare draft meeting summary and send to participating LPs, City Light, and other attendees for review.

Skagit Hydroelectric Project Relicensing Meeting

FA-04 Fish Passage Workshop No. 2

September 23, 2021: 12:00pm – 4:00pm

WebEx Meeting: [LINK]

Conference Call: +1-510-338-9438 USA Toll

Access code: 1827024467

(Meeting ID: 1827 02 4467)

MEETING PURPOSE

- The intent of this workshop is to discuss the design basis and criteria needed to begin development of upstream and downstream passage facility alternatives to the concept level and to begin discussing any initial feedback on the first FA-04 Study deliverable: *Preliminary Draft Fish Passage Conceptual Design Criteria Document (DCD)*. Specific objectives include:

- **Provide General Overview of Preliminary DCD and Review LP Comments (Advise and Inform)**
- **Identify Data Gaps and Information Needed to Inform Next Phase of Study (Advise)**
- **Review and Assemble Potential Range of Fish Passage Strategies and Technologies that May be Considered for Evaluation (Advise)**
- **Discuss Performance Information for Existing High Dam Passage Facilities (Advise)**
- **Discuss process to establish preliminary technical, operational, and biological goals, criteria, and constraints (Advise)**

AGENDA

12:00 – 12:10 pm (10 min)	**Introductions** – *Facilitator*
12:10 – 12:20 pm (10 min)	**Meeting Objectives and Agenda Overview** – *Mike Garello (HDR)* Review meeting agenda and discussion topics. Request inclusion of additional agenda topics.
12:20 – 1:20 pm (60 min)	**Overview of Preliminary DCD –** *Mike Garello (HDR)* Provide overview of Preliminary Draft Design Criteria Document contents and discuss current data sources and resulting considerations that may be used to formulate fish passage strategies and facility alternatives. 1. Overview of DCD Milestones and Review Cycles • Preliminary DCD comments appreciated by 10/7 2. Outline Review

	3. Discuss Data Obtained to Date and Included in the DCD for: 4. Present preliminary considerations and criteria with respect to their influence on fish passage strategy and facility development. **Discuss Initial LP comments on DCD –** ***All participants***
1:20 – 2:05 pm (45 min)	**Discuss Data Gaps and Identify Data Sources and Timeline to Receive –** *Jacob Venard (HDR) and LPs* Discuss current available sources of data and data gaps identified during report development. 1. Discuss biological RFI and data received to date. Additional data need/refinements include: 2. Upstream and downstream passage efficiency requirements 3. Other design criteria necessary to assist with the layout and configuration of concept-level alternatives
2:05 – 2:20pm (15 minutes)	***Break***
2:20 – 3:00pm (40 minutes)	**Review and Assemble Potential Range of Fish Passage Strategies and Technologies that May be Considered for Evaluation** – *Mike Garello (HDR)* Discuss the overall approach of formulating the range of fish passage strategies and fish passage facility concepts.
3:00 – 3:30pm (30 min)	**Existing Biological Performance Information at PNW Fish Passage Facilities and Discussion on the Development of Performance Criteria for Project –** *Mike Garello (HDR) and licensing participants*
3:30 – 4:00pm (30 min)	**Action Items, Next Steps** – *Facilitator and meeting participants* • Additional discussion time • Review action items
4:00pm [End time]	**Meeting Adjourned**

FA-04 FISH PASSAGE TECHNICAL STUDIES

Workshop 2

September 23, 2021

INTRODUCTIONS

- Roll Call
- Introductions

Seattle City Light

WORKSHOP OBJECTIVES AND OVERVIEW

MEETING OBJECTIVES

- Provide general overview and discuss Preliminary Draft Fish Passage Conceptual Design Criteria Document (DCD)
- Discuss the design basis and criteria needed to develop upstream and downstream passage facility concepts
- Identify data gaps and information needed to inform next phase of study
- Review and assemble potential range of fish passage strategies and technologies that may be considered for evaluation
- Discuss performance for existing high dam passage facilities
- Discuss process to establish preliminary technical, operational, and biological goals, criteria, and constraints

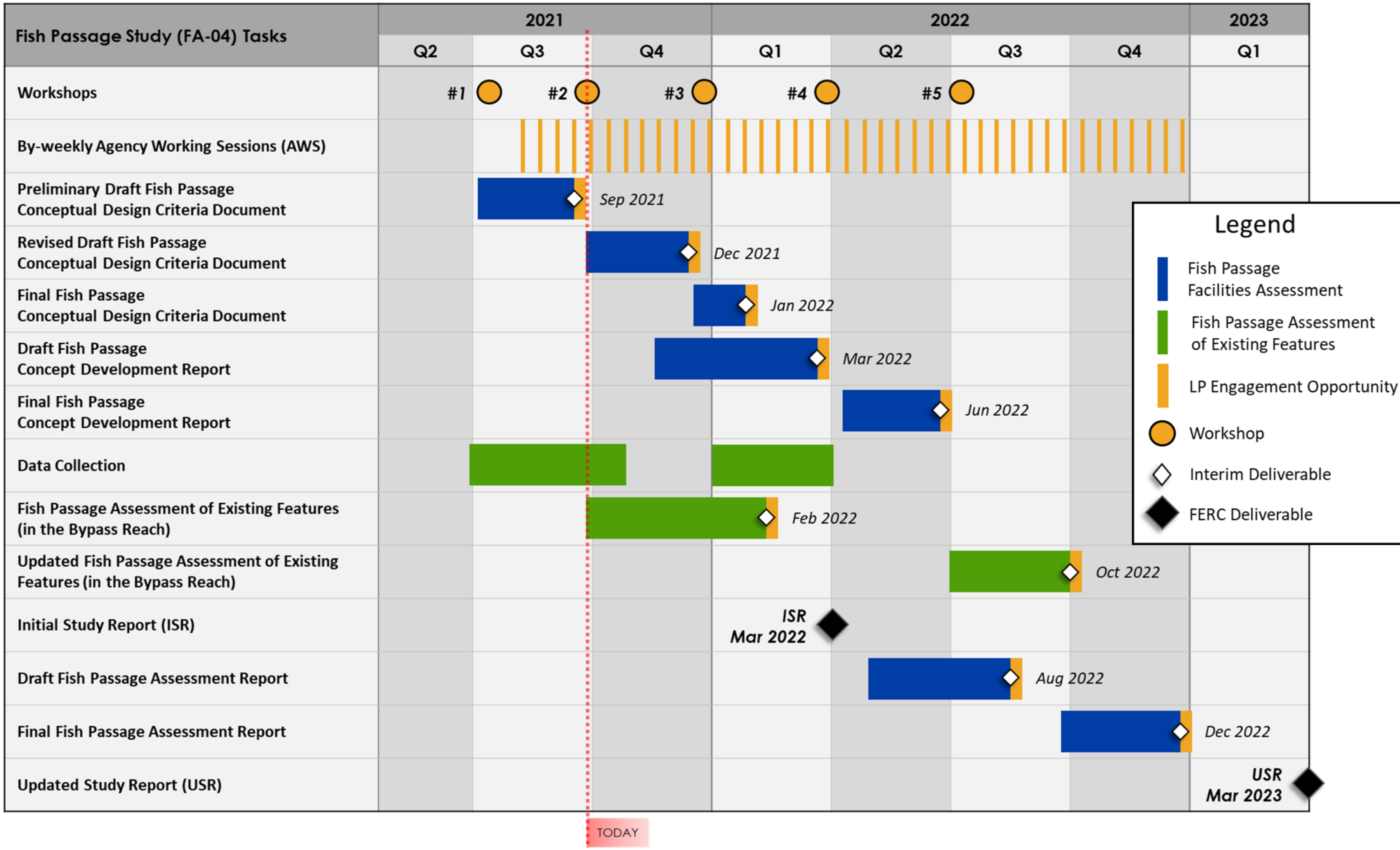
MEETING AGENDA

Schedule	Topic
12:00 to 12:10	Introductions
12:10 to 12:20	Meeting Objectives and Agenda Overview
12:20 to 1:20	Overview of Preliminary Draft Design Criteria Document (DCD)
1:20 – 2:05	Discuss Data Gaps and Identify Data Sources and Timeline to Receive
2:05 – 2:20	Break
2:20 – 3:00	Fish Passage Strategies and Technologies for Evaluation
3:00 to 3:30	Existing Biological Performance and Development of Performance Criteria
3:30 to 4:00	Action Items and Next Steps
4:00	Meeting Adjourned

Seattle City Light

PRELIMINARY DRAFT DESIGN CRITERIA DOCUMENT (DCD) OVERVIEW

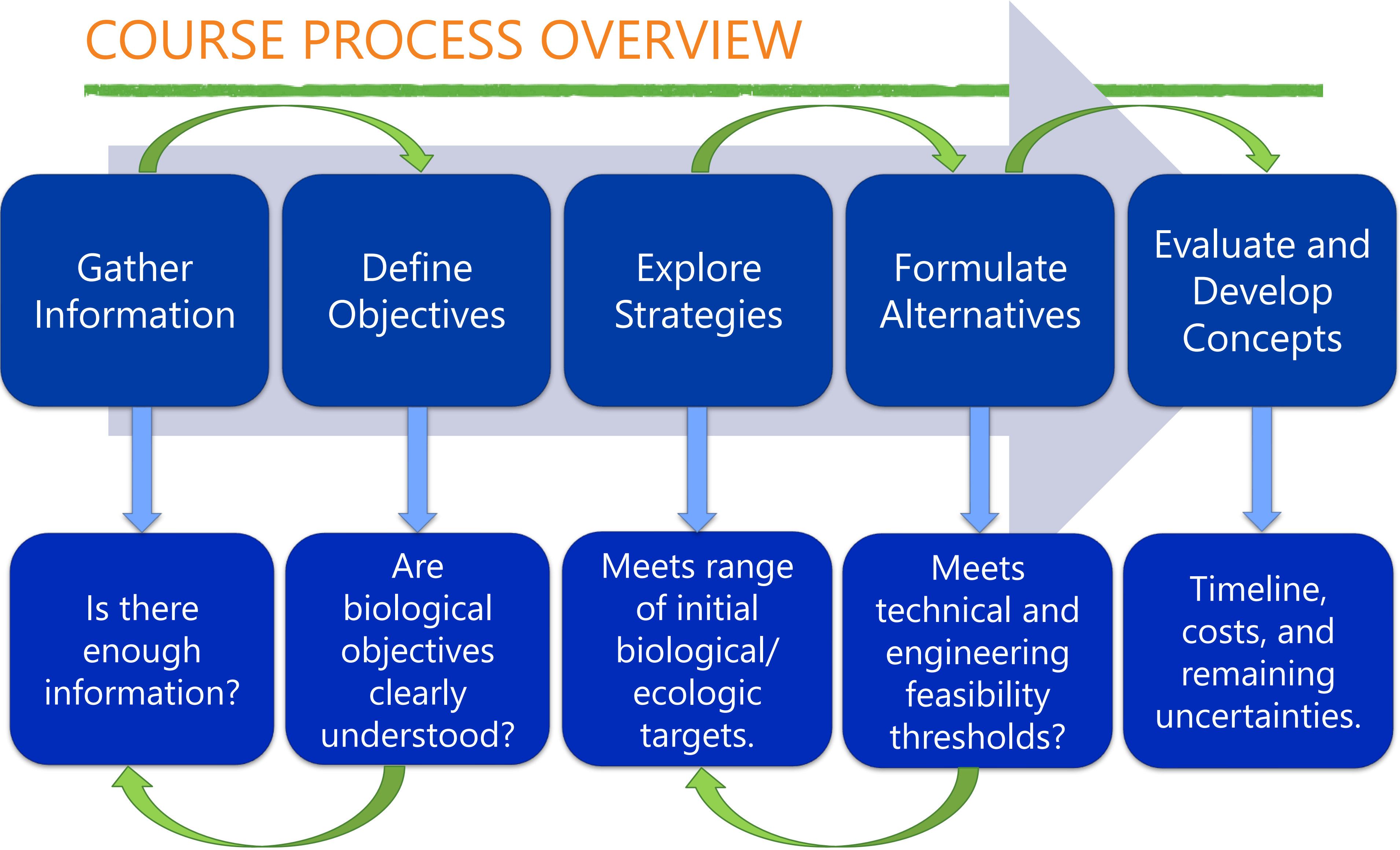
SCHEDULE OVERVIEW



FISH PASSAGE FACILITIES ASSESSMENT – KEY MILESTONES

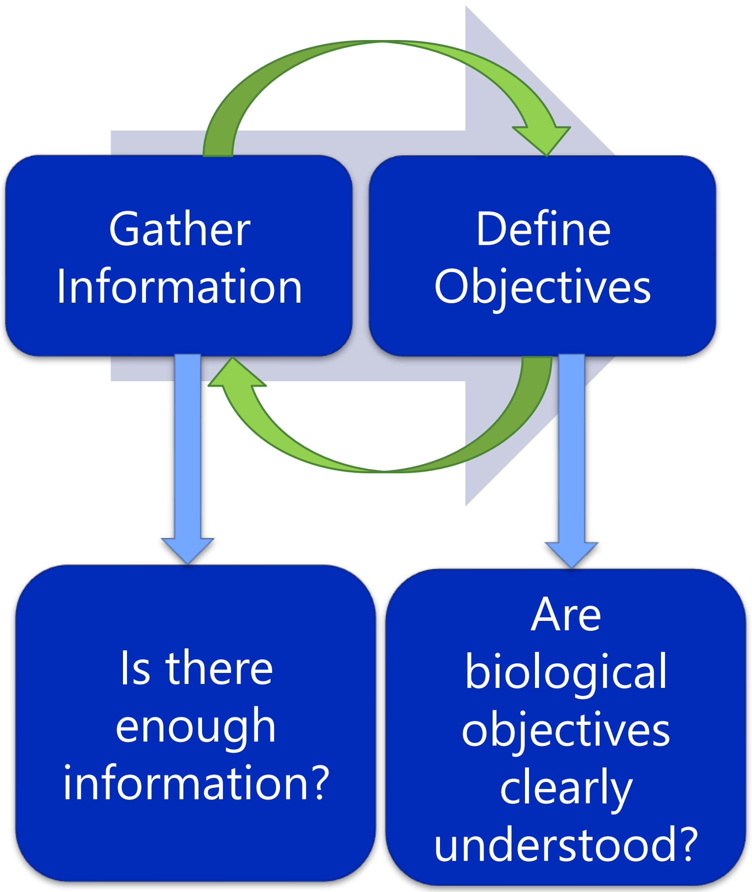
Milestone	Anticipated Schedule
Fish Passage Conceptual Design Criteria Report	
Preliminary Draft DCD and Workshop No. 2	**September 2021**
Revised Draft DCD	December 2021
Final DCD	January 2022
Initial Study Report	March 2022
Fish Passage Concept Development Report	
Draft Report	March 2022
Final Report	June 2022
Fish Passage Assessment Report	
Draft Report	August 2022
Final Report	December 2022
Updated Study Report (USF, Fish Passage Study Sections)	March 2023

FISH PASSAGE FACILITIES ASSESSMENT – COURSE PROCESS OVERVIEW



ASSESSMENT METHODOLOGY – FEASIBILITY AND DESIGN PROCESS

- Initiate AWS and Workshops
- Gather/synthesize specific biological, operational, and physical data
- Establish goals, objectives, criteria, and expectations



FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT

Conceptual Design Criteria Document
Preliminary Draft (9/17/2021), **Revised Draft** (12/1/2021), **Final** (1/21/2022**)**

- Photos, Maps, and Drawings of Existing Facilities
- Physical, Biological, and Operational data and information that inform the development of fish passage alternative concepts
- Conceptual Design Criteria
- Biological and Technical Performance Goals and Objectives
- Performance of PNW passage facilities at high-head dams
- List of conceptual alternatives to be evaluated

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT

- DCD Goals:
  - Document the existing Project operating environment
  - Formulate range of potential fish passage goals, objectives, and alternatives
  - Share information with the LPs and obtain feedback throughout completion of this study (FA-04)

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT

- DCD Objectives:
  - Compile existing information and describe the current potential operating environment for conceptual fish passage alternatives and facilities
  - Document range of fish passage goals and objectives
  - Document conceptual level criteria that are used to formulate alternatives
  - Summarize performance standards and observed performance at other facilities
  - Summarize list of potential fish passage alternatives, strategies, and technologies

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT

- This Preliminary Draft DCD
  - Summarizes Biological, Physical, and Operational data collected to date
  - Summarizes known guidelines, documents, and technical criteria used in fish passage facility design
  - Begins discussion of performance standards and performance of known fish passage facilities at high dams
  - Begins summary of fish passage strategies and technologies

FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT – CONCEPTUAL DESIGN CRITERIA DOCUMENT

- The next Revised Draft DCD
  - Will begin formulation of fish passage goals and objectives
  - Will better define biological setting
  - Will better define facility operational environments at specific Project locations
  - Will begin discussion of fish passage implementation and program execution
  - Will refine strategies, technologies, and will list initial fish passage alternatives

DCD TABLE OF CONTENTS (TOC) OVERVIEW

DCD TOC – PHYSICAL SETTING

- Section 2.0: Physical Setting
  - Project Location
  - Existing Facilities
  - Existing Operations
  - Debris and Sedimentation Management
  - Water Temperature Conditions

DCD TOC – BIOLOGICAL SETTING

- Section 3.0: Biological Setting
  - Focal Fish Species
  - Fish Migration Timing
  - Fish Abundance
  - Fish Size

DCD TOC – TECHNICAL CRITERIA AND GUIDELINES

- Section 4.0: Technical Fish Passage Facility Design Criteria and Guidelines
  - General Fish Passage Engineering and Design Guidance Documents
  - Fish Screen Criteria
  - Fish Bypass Criteria
  - Fishway Criteria
  - Debris Rack Criteria
  - Fish Trapping and Holding Criteria

DCD TOC – CRITERIA FOR CONCEPT DEVELOPMENT

- Section 5.0: Selection of Specific Fish Passage Design Criteria Governing Alternative Formulation
  - Focal Species selected for fish passage
  - Working Definition of Technical Feasibility
  - To be included…
    - Goals and Objectives
    - Risks, Benefits, and Constraints
    - Facility Performance Standards and Expectations
    - Execution/Implementation
    - Abundance and Peak Rates of Migration
    - Reservoir Operations and Stage Fluctuation

DCD TOC – PERFORMANCE OF PNW FISH PASSAGE FACILITIES

- Section 6.0: Performance of PNW Fish Passage Facilities at High Head Dams
  - Regulatory Performance Standards
  - Measured Performance of Existing Upstream Passage Facilities
  - Measured Performance of Existing Downstream Passage Facilities

DCD TOC – OVERVIEW OF STRATEGIES AND TECHNOLOGIES

- Section 7.0: Overview of Potential Fish Passage Strategies and Technologies to be Used in Alternative Formulation
  - Formulation of Fish Passage Strategies
  - Potential Fish Passage Technologies

Seattle City Light

DATA COLLECTION AND INFORMATION NEEDS

DATA COLLECTION AND INFORMATION NEEDS

- Request for Information (RFI) Tracking Table
  - Biological Factors
  - Operational Requirements
  - Physical Characteristics

DATA COLLECTION AND INFORMATION NEEDS

- Summary of data collected
  - Biological Factors
    - Focal Species
    - General life history periodicity and migration timing
    - General annual fish abundance
  - Operational Requirements
    - Reservoir purpose and management goals
    - Facility operation and maintenance programs
    - Reservoir historic operating levels and rule curves
    - General operational constraints

DATA COLLECTION AND INFORMATION NEEDS

- Summary of data collected
  - Physical Characteristics (examples)
    - Maps, charts, Project configuration drawings
    - Property ownership
    - Access routes and transportation infrastructure
    - Engineering drawings of primary structures and facilities
    - Geology and seismicity
    - Mean daily reservoir elevations
    - General reservoir temperature characterization
    - Preliminary basin hydrology

NEXT STEPS – REVISED DCD DEVELOPMENT

- Comments on Preliminary Draft DCD are requested by October 7th
- Study team will continue to move forward with next deliverable – Revised Draft DCD
- Respond to and incorporate feedback from LPs
- Transition from primarily data collection to goal setting

NEXT STEPS – REVISED DCD DEVELOPMENT

- Next discussion topics over the next three months:
  - Goals and Objectives
  - Risks, Benefits, and Constraints
  - Facility Performance Standards and Expectations
  - Execution/Implementation
  - Abundance and Peak Rates of Migration
  - Reservoir Operations and Stage Fluctuation
  - Working Definition of Technical Feasibility

Seattle City Light

DATA GAPS AND DATA SOURCES

IMPORTANCE OF BIOLOGICAL RFI DATA

- Biological Feasibility – typically requires that data gaps and unknowns have been resolved to reasonable certainty
- An understanding of existing information and data gaps will help guide future conversations defining goals and objectives
- Establishing biological goals and objectives of a fish passage program help define:
  - Benefits
  - Risks
  - Constraints
  - Recolonization strategy
  - Methods for passage

IMPORTANCE OF BIOLOGICAL RFI DATA

- Example fish passage program goals may include but are not limited to:
  - Contribute to recovery of target species in the Upper Skagit River
  - Expand existing populations above Gorge Powerhouse and/or Dam
  - Establish new viable and sustainable populations above Gorge Powerhouse and/or Dam
  - Provide social and cultural benefit upstream of Gorge Powerhouse and/or Dam
- Study efforts have been largely information gathering to date
- Baseline biological data is still needed to define the existing biological setting and resolve data gaps if possible
- Future conversations will focus on developing the potential range of goals and objectives with the LPs

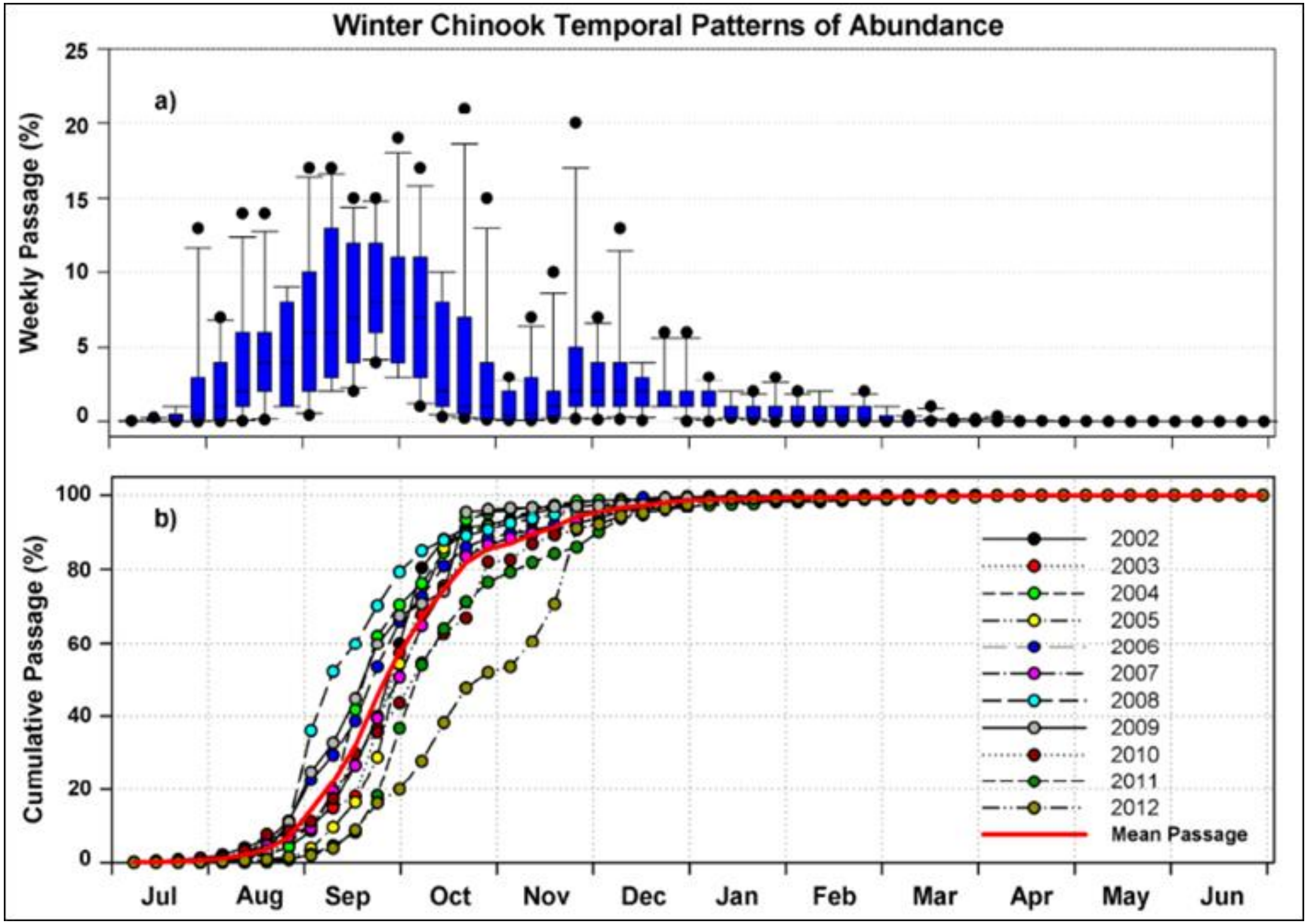
CURRENT SOURCES OF BIOLOGICAL DATA

- Example – Fish abundance and life stage periodicity
- Includes general fish abundance in Skagit basin
  - WDFW escapement data
    - Chinook – Upper Skagit Stock
    - Coho – Skagit Basin
    - Steelhead –Skagit winter-run
  - Bull Trout – WDFW redd counts; mainstem upper Skagit abundance estimate (Lowery 2009)
  - Sockeye – Baker River; no abundance data for upper Skagit

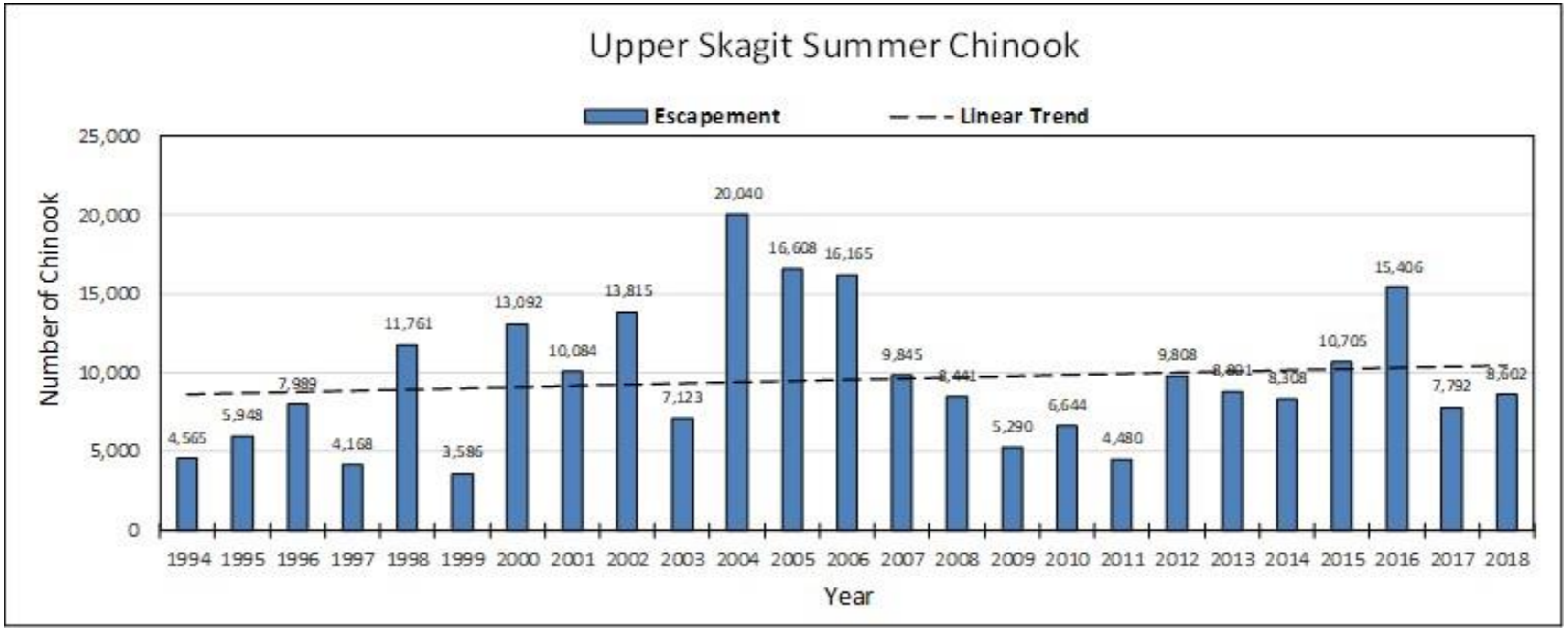
TYPICAL BIOLOGICAL DATA NEEDS

- Data needs include…
  - Abundance and distribution of Salish Sucker
  - Abundance and distribution of Lamprey
  - Additional daily or weekly abundance of fish species if available
  - Others…
- Next steps will require…
  - Establish migration distribution and abundance at point of passage
  - Confirmation of peak run timing
  - Develop target abundances (or range) and peak rates of migration for each species

BIOLOGICAL RFI DATA – TYPICAL INFORMATION USED FOR FISH PASSAGE DESIGN



BIOLOGICAL RFI DATA – AVAILABLE INFORMATION



BIOLOGICAL RFI DATA – AVAILABLE INFORMATION

Species	Minimum	Maximum	Average
Chinook Salmon Upper Skagit summer-run	3,586	20,040	8,663
Coho Salmon Skagit River	5,794	136,054	36,703
Sockeye Salmon Baker River	99	52,773	20,618
Steelhead Skagit River winter-run	2,502	9,084	6,020
Bull Trout Skagit River mainstem	Unknown	Unknown	1,602
Chum Salmon Skagit River	6,700	209,478	34,694
Pink Salmon Skagit River	59,916	1,110,000	345,729
Lamprey	Unknown	Unknown	Unknown

BIOLOGICAL RFI DATA – NEXT STEPS

- Initiate conversations with LPs focusing on the potential range of fish passage goals and objectives
- Establish potential range of methods and timeframes for program execution (implementation)
- Evaluate and establish feasibility framework using existing information
- Begin development of appropriately scaled fish passage concept alternatives
- Revisit information made available from concurrent studies (e.g., FA-06 and FA-07) in Q4 2022

BIOLOGICAL RFI DATA - DISCUSSION

- LP Comments and Discussion
  - What other data is available
  - High priority items to include in next iteration of the document

Seattle City Light

USE OF DATA TO INFORM CONCEPT DEVELOPMENT

KEY FACTORS THAT INFLUENCE THE TYPE, SIZE, AND COMPLEXITY OF FISH PASSAGE FACILITIES

- Biological goals and objectives
- Historical record of performance
- Operating environment

KEY FACTORS THAT INFLUENCE THE TYPE, SIZE, AND COMPLEXITY OF FISH PASSAGE FACILITIES

- Historical record of performance (case studies)
- Examples of select benefits resulting from years in service:
  - Operational data
  - Flexibility and reliability
  - Trials and errors made by others
  - Lessons learned from similar installations
  - Cost of construction and operation
  - Influence on fish and fish populations
  - Performance

KEY FACTORS THAT INFLUENCE THE TYPE, SIZE, AND COMPLEXITY OF FISH PASSAGE FACILITIES

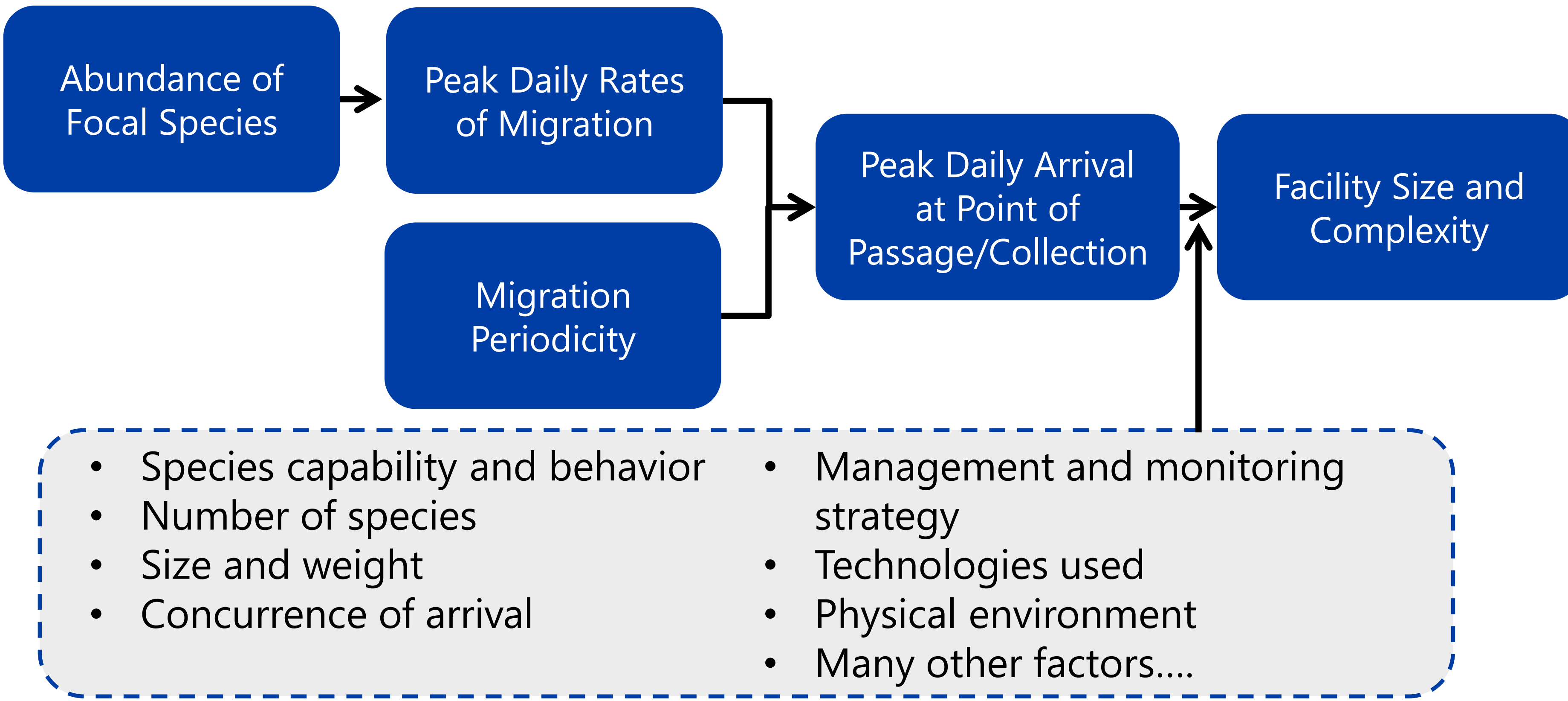
- Operating environment (Examples only)
  - Physical infrastructure
  - Reservoir fluctuation
  - Characteristics influencing reservoir transit (predation, complexity, temperature, migration patterns, etc.)
  - Known fish location and behavior
  - Migration ques
  - Debris characterization
  - Many other important factors…

KEY FACTORS THAT INFLUENCE THE TYPE, SIZE, AND COMPLEXITY OF FISH PASSAGE FACILITIES

- How many fish are going to be there?
- Where are the fish going to be?
  - Depth and orientation to existing infrastructure
  - Migration patterns leading them to the point of collection
  - Contribution of multiple tributaries
- When are fish going to be there?
  - General variation in species life history
  - Migration cues in upper watershed
  - Reservoir conditions

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.1 - Abundance



EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.1 - Abundance

Initial List of Species for Fish Passage Program Development	
• Chinook Salmon • Coho Salmon • Sockeye Salmon • Steelhead • Bull Trout	• Chum Salmon • Pink Salmon • Sea-run Cutthroat Trout • Dolly Varden • Pacific Lamprey • Salish Sucker*

* Design criteria is currently limited. Passage may be incidental to facility design for other fish species. Further discussion required.

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

Skagit River Habitat Modeling
Preliminary Periodicity (9/20/2021)

Species	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Skagit Summer Chinook Salmon	Adult Migration												
	Juv. Outmigration												
Upper Cascade Spring Chinook Salmon	Adult Migration												
	Juv. Outmigration												
Skagit Coho Salmon	Adult Migration												
	Juv. Outmigration												
Skagit River Sockeye	Adult Migration												
	Juv. Outmigration												
Skagit Winter Steelhead	Adult Migration												
	Juv. Outmigration												
Cascade River Summer Steelhead	Adult Migration												
	Juv. Outmigration												
Lower Skagit Core Area Bull Trout	Adult Migration (Fluvial)												
	Adult Migration (Anadromous)												
	Post-spawning outmigration (Fluvial)												
	Post-spawning outmigration (Anadromous)												
Dolly Varden	Adult Migration												
Skagit Pink Salmon	Adult Migration												
	Juv. Outmigration												
Mainstem Skagit Fall Chum Salmon	Adult Migration												
	Juv. Outmigration												
Pacific Lamprey	Adult Migration												
	Juv. Outmigration												
Sea-run Cutthroat Trout (Nooksack River, WRIA 1)	Adult Upstream Migration												
	Adult Outmigration												
	Juvenile Outmigration												
Salish Sucker	Adult Upstream Migration												

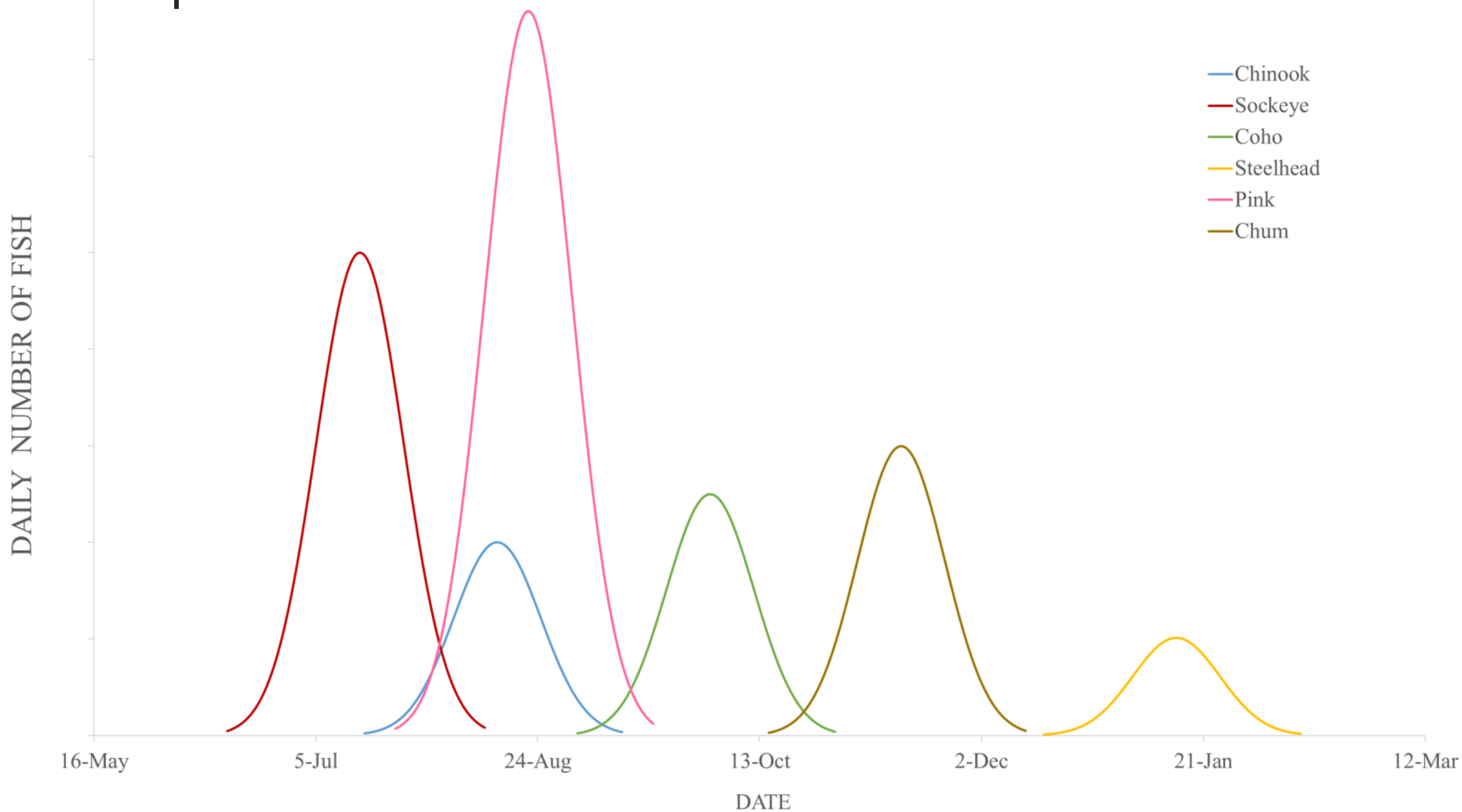
EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Potential fish passage facility operation
  - Upstream migration: January through December
  - Downstream migration: January through August
- Distribution and peak months yet to be identified

All Spp.	Life Stage	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	Adult Upstream Migration												
	Juv. Downstream Outmigration												

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Example Adult Salmonid Peak Run Distribution Curves



EXAMPLE ADULT FISH PEAK RUN DISTRIBUTION CURVES

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.1 – Abundance
  - Example trap and transport facility for 1,000s of fish per day

Baker Adult Collection Facility

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.1 – Abundance
  - Example trap and transport facility for 1,000s of fish per day

Clackamas Adult Collection Facility at North Fork Dam

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.1 – Abundance
  - Example photos for 100s to 1,000 fish per year

Lostine Adult Broodstock Collection Facility

EXAMPLE APPLICATION OF FISH ABUNDANCE ON FACILITY TYPE, SIZE, AND COMPLEXITY

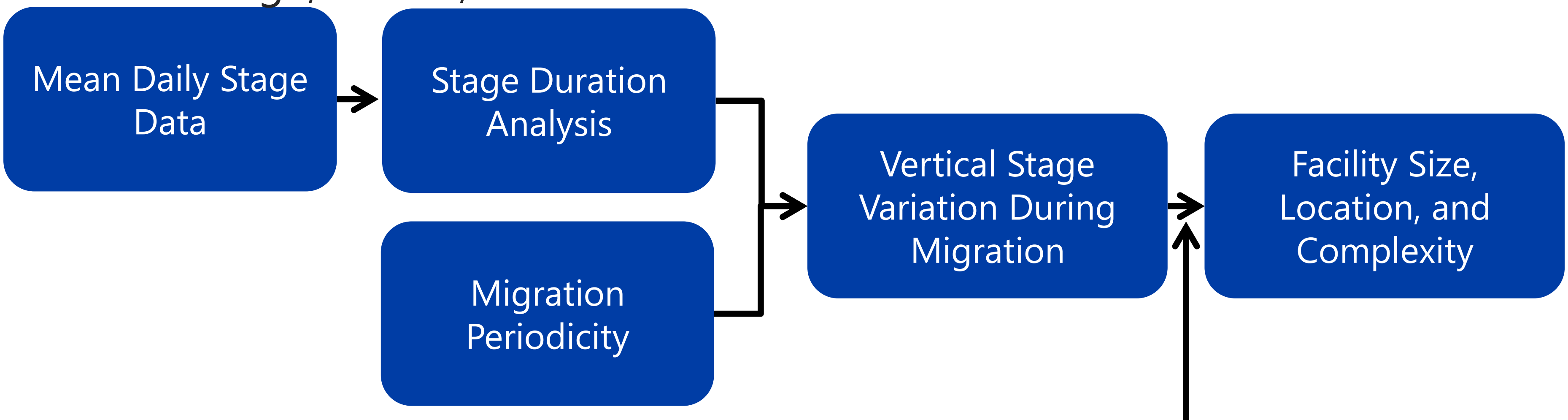
- Simplified Example No.1 – Abundance
  - Example trap and transport facility for 100 fish per year

Los Padres Dam

EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Simplified Example No.2 – Reservoir Fluctuation

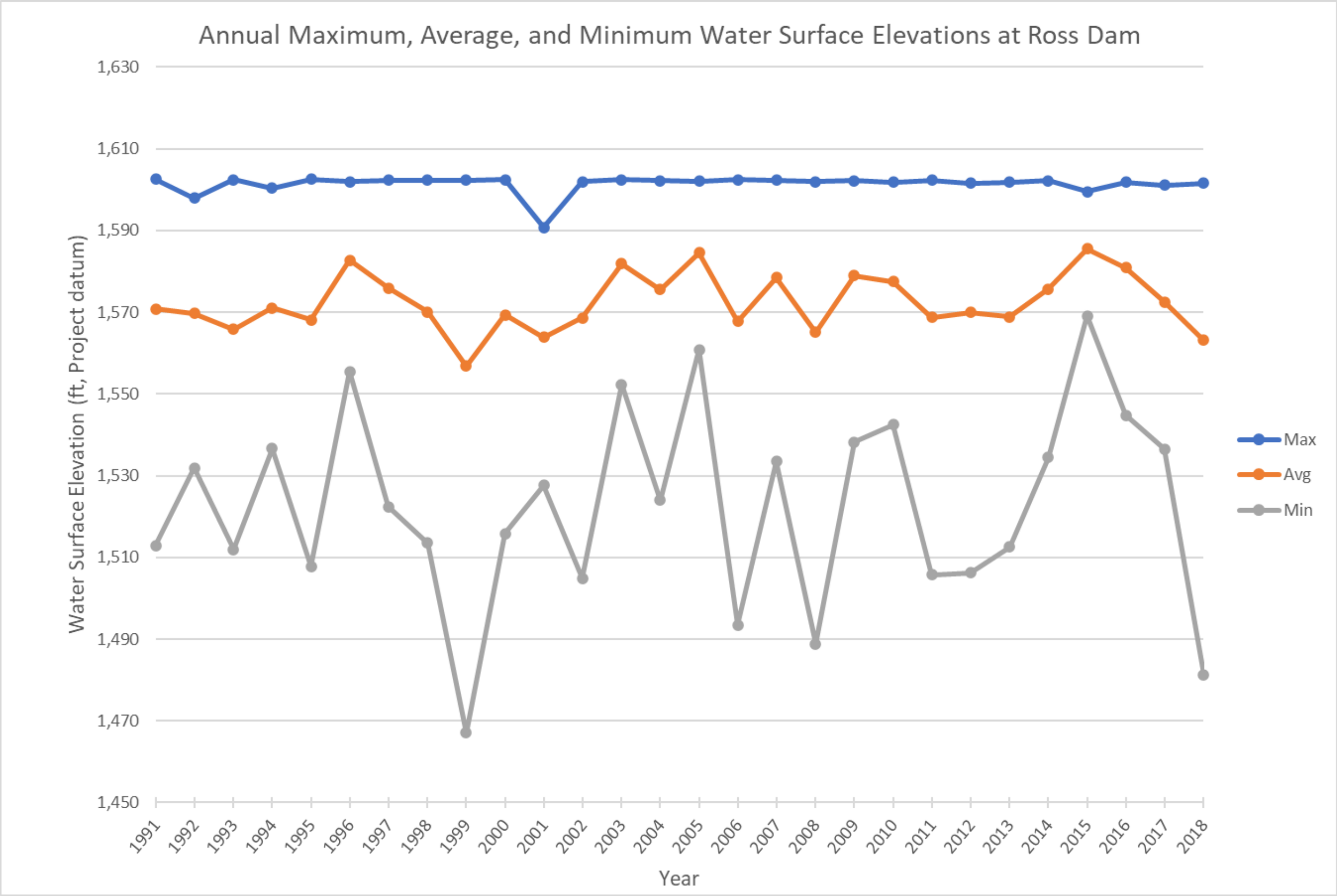
Each for Gorge, Diablo, and Ross



- Species capability and behavior
- Number of species
- Size and weight
- Concurrence of arrival
- Management and monitoring strategy
- Technologies used
- Physical environment
- Many other factors….

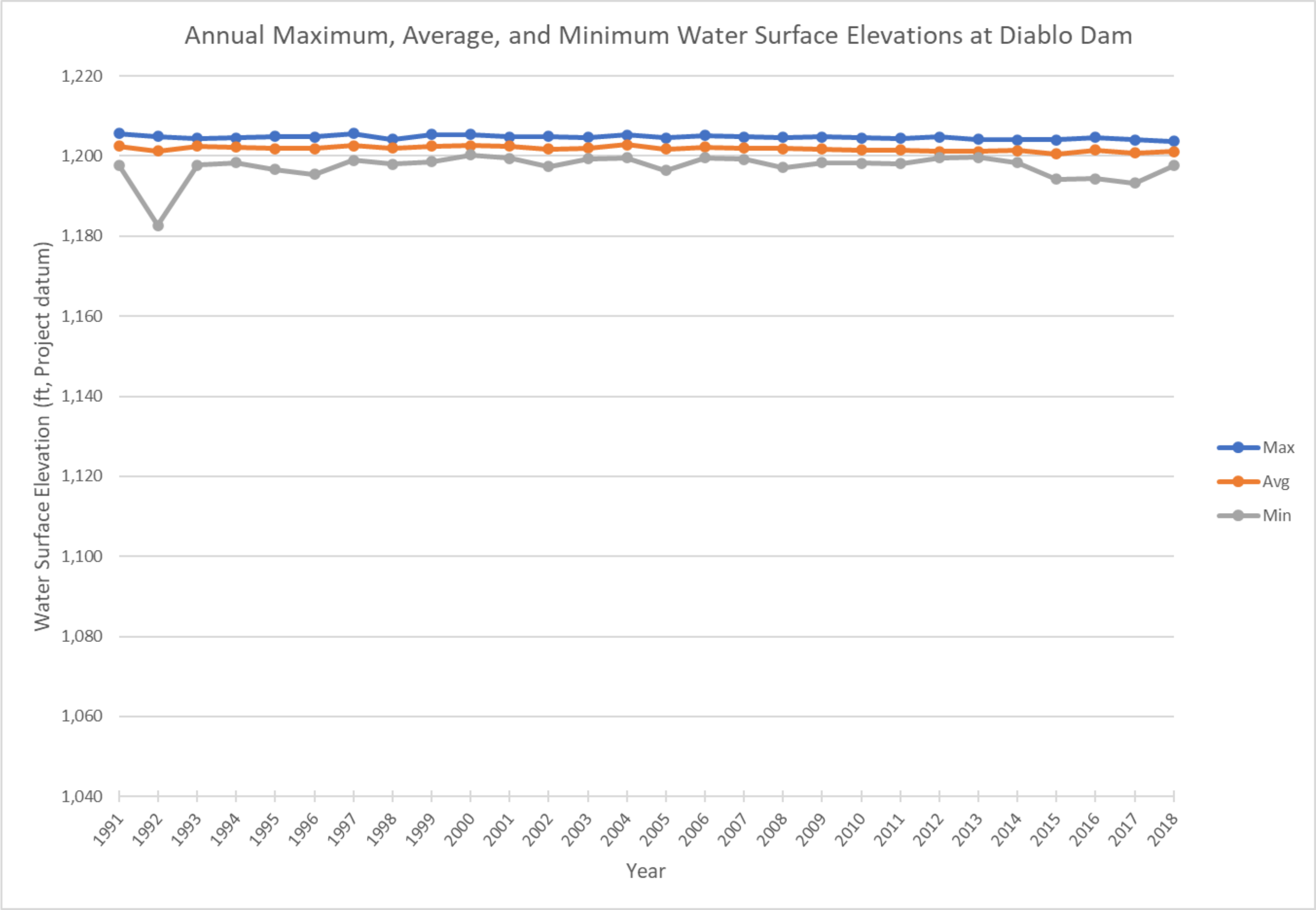
EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Ross Reservoir - Annual Max, Min, and Average Stage (ft)



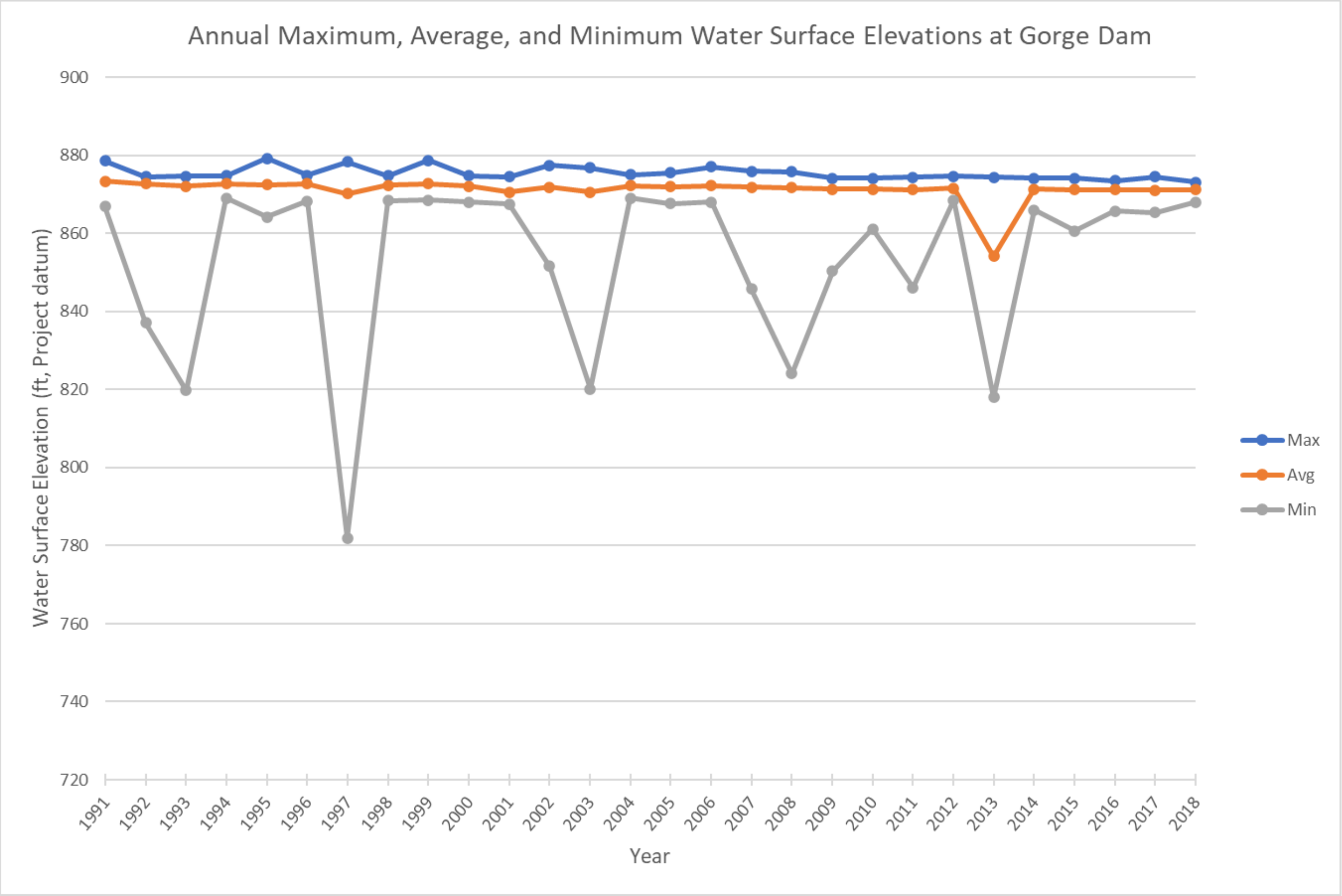
EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Diablo Reservoir - Annual Max, Min, and Average Stage (ft)



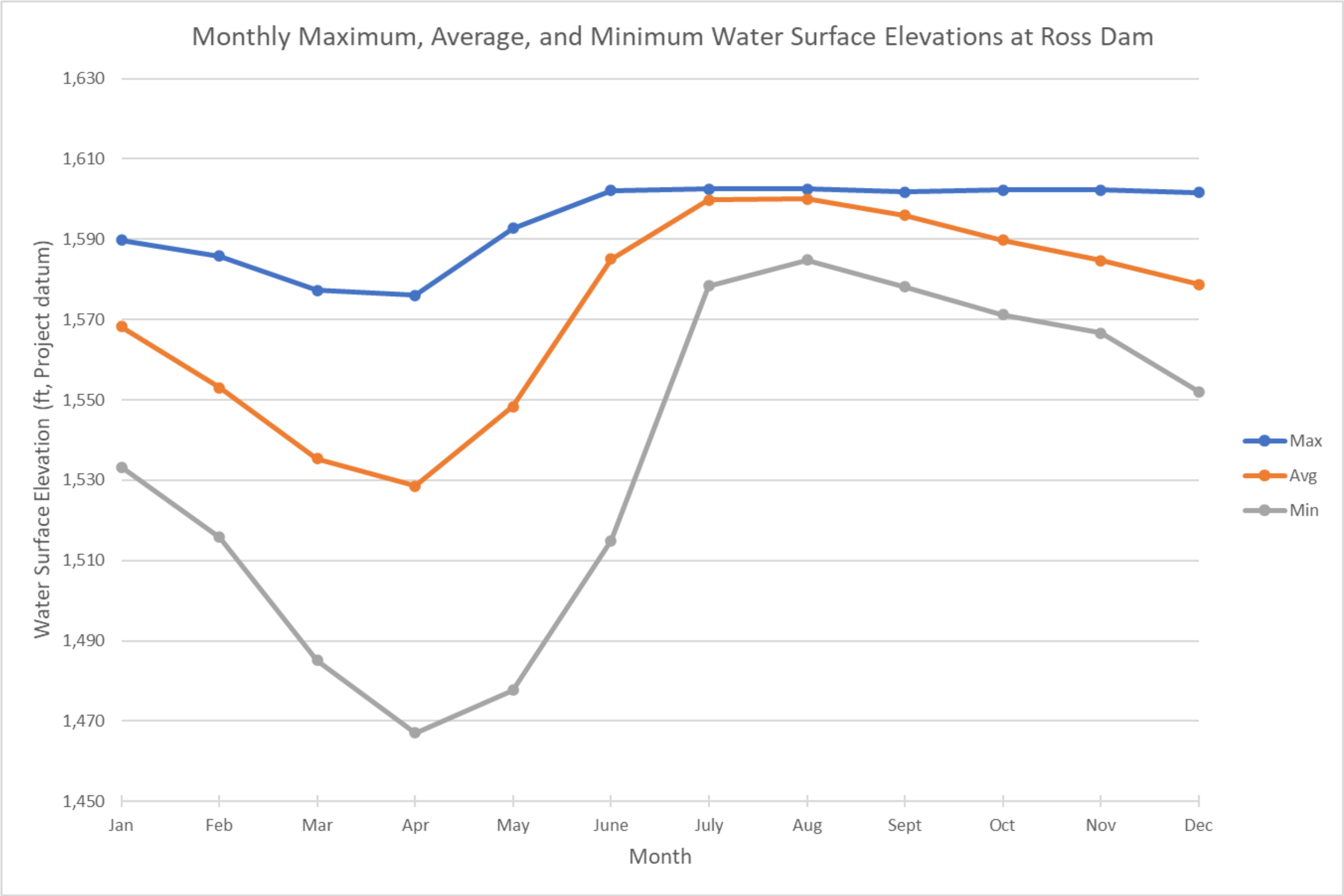
EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Gorge Reservoir - Annual Max, Min, and Average Stage (ft)



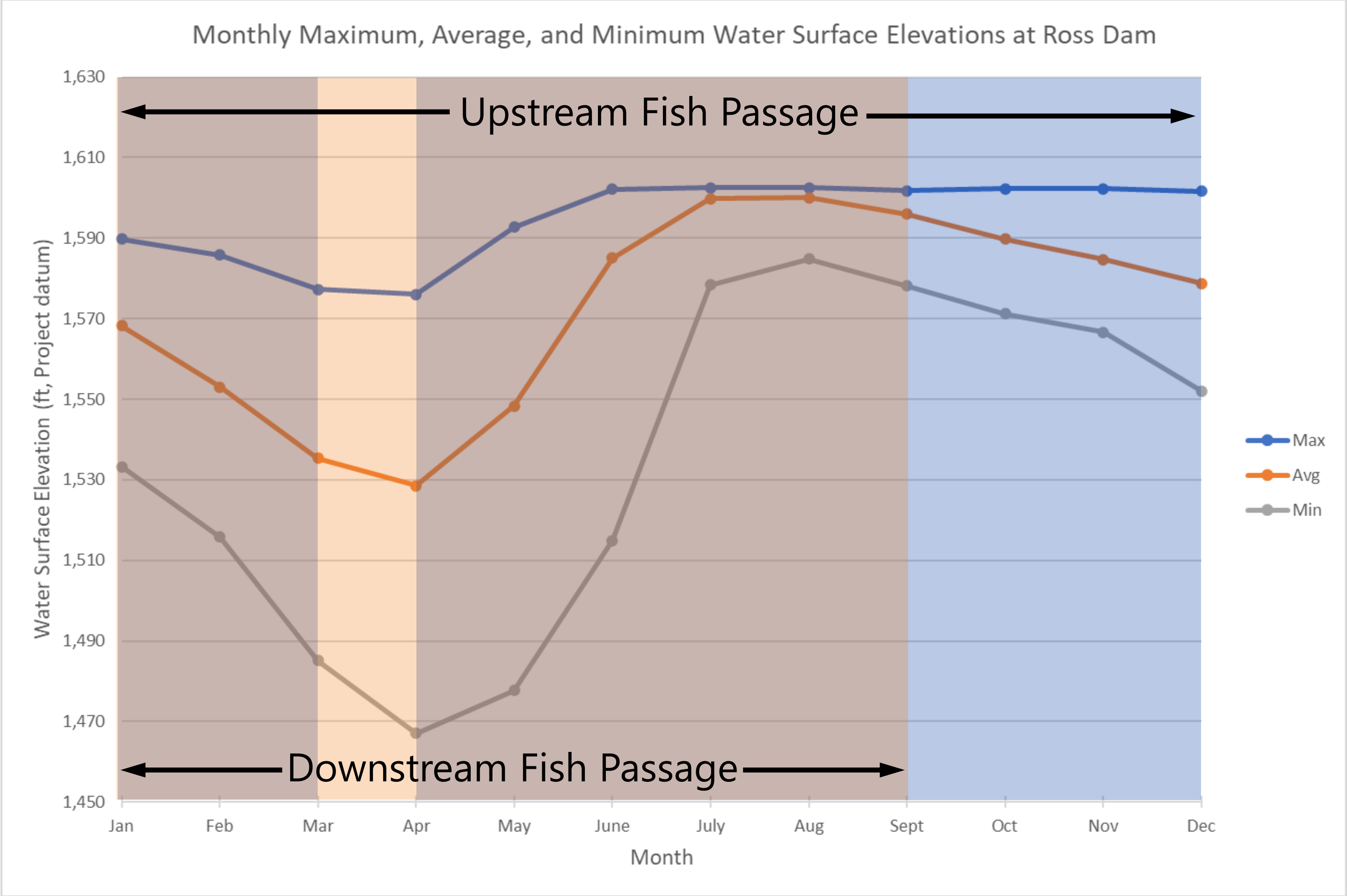
EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Ross Reservoir - Monthly Max, Min, and Average Stage (ft)



EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Ross Reservoir - Monthly Max, Min, and Average Stage (ft)

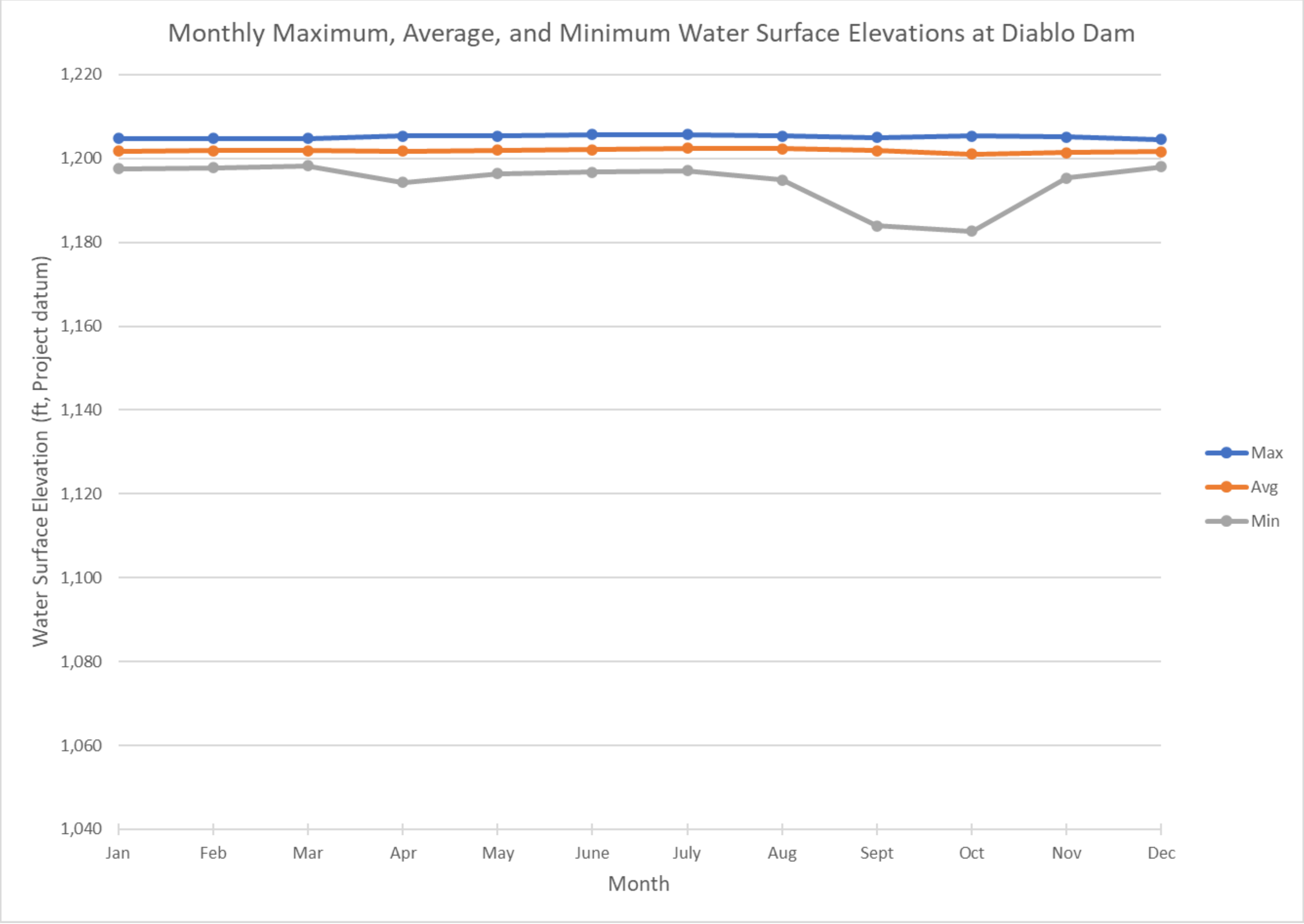


EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Ross Reservoir stage fluctuation during anticipated migration periods
- Upstream (Jan – Dec)
  - Min WSELEV – 1,467.1 feet (Project Datum)
  - Max WSELEV – 1,602.5 feet (Project Datum)
  - Total WSELEV Fluctuation – 135.4 feet
- Downstream (Jan – Sept)
  - Min WSELEV – 1,467.1 feet (Project Datum)
  - Max WSELEV – 1,602.5 feet (Project Datum)
  - Total WSELEV Fluctuation – 135.4 feet

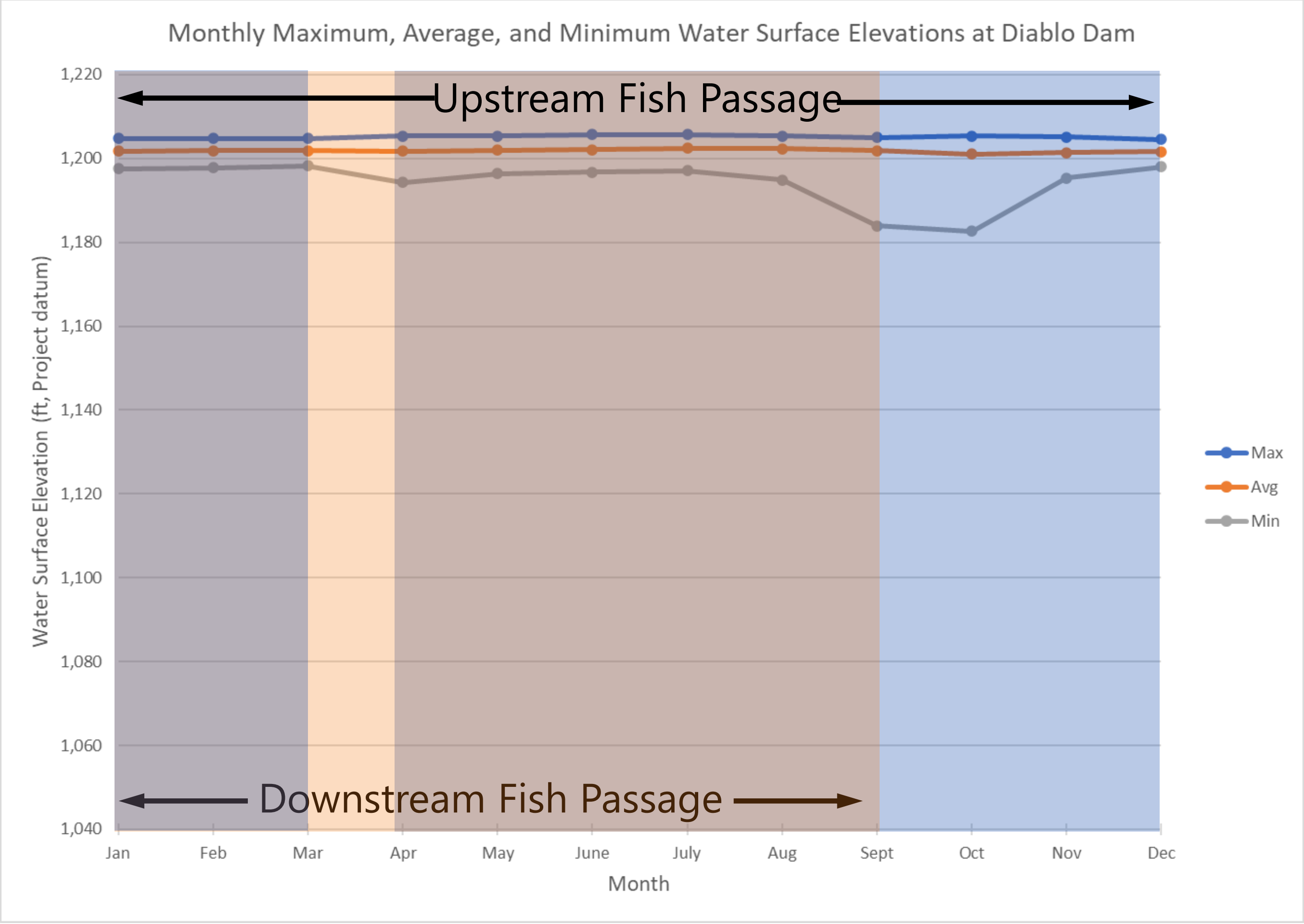
EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Diablo Reservoir - Monthly Max, Min, and Average Stage (ft)



EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Diablo Reservoir - Monthly Max, Min, and Average Stage (ft)

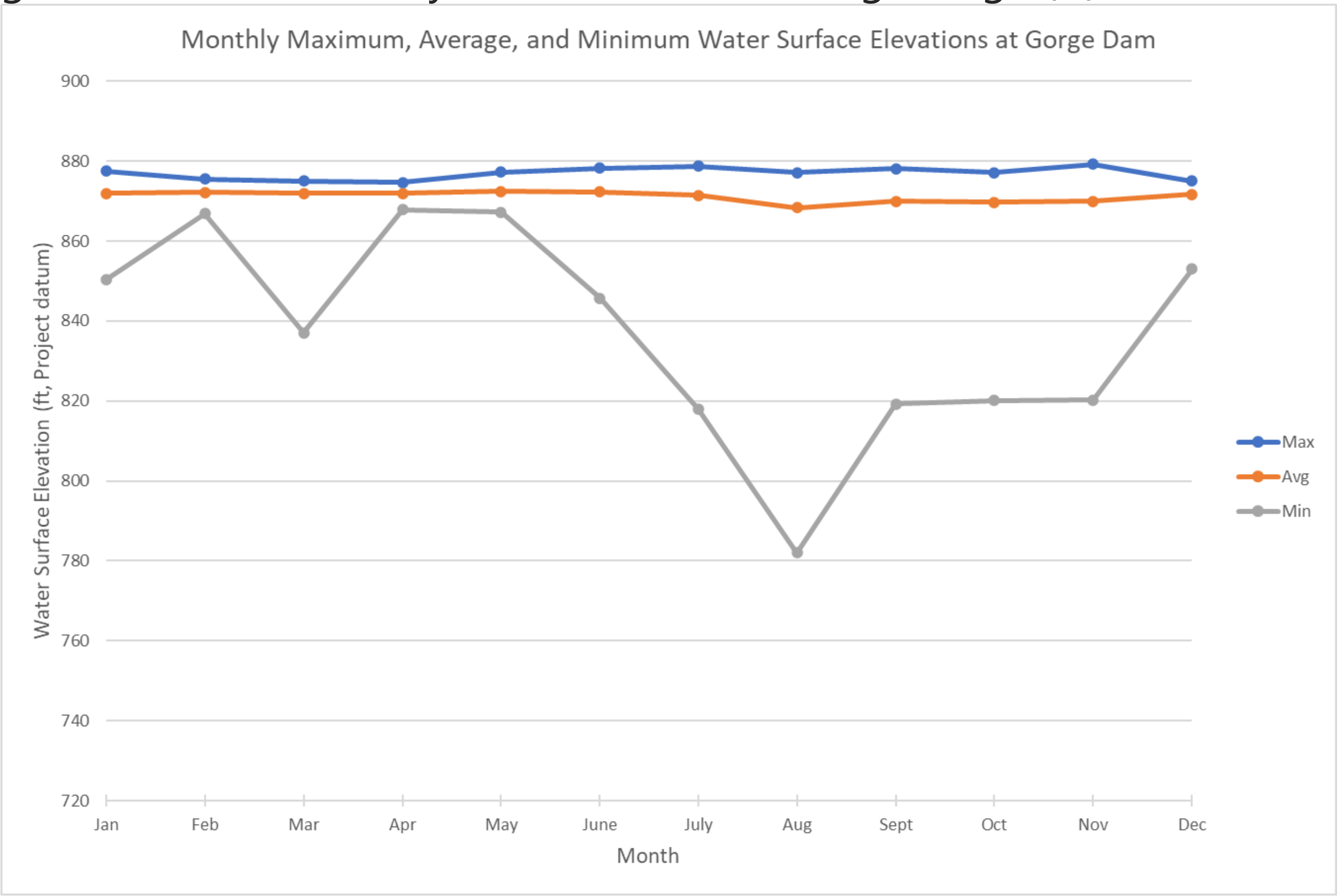


PRELIMINARY CONSIDERATIONS AND CRITERIA – RESERVOIR OPERATIONS & STAGE FLUCTUATION

- Diablo Reservoir stage fluctuation during anticipated migration periods
- Upstream (Jan – Dec)
  - Min WSELEV – 1,182.7 feet (Project Datum)
  - Max WSELEV – 1,205.7 feet (Project Datum)
  - Total WSELEV Fluctuation – 23 feet
- Downstream (Jan – Sept)
  - Min WSELEV – 1,183.9 feet (Project Datum)
  - Max WSELEV – 1,205.7 feet (Project Datum)
  - Total WSELEV Fluctuation – 21.8 feet

EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

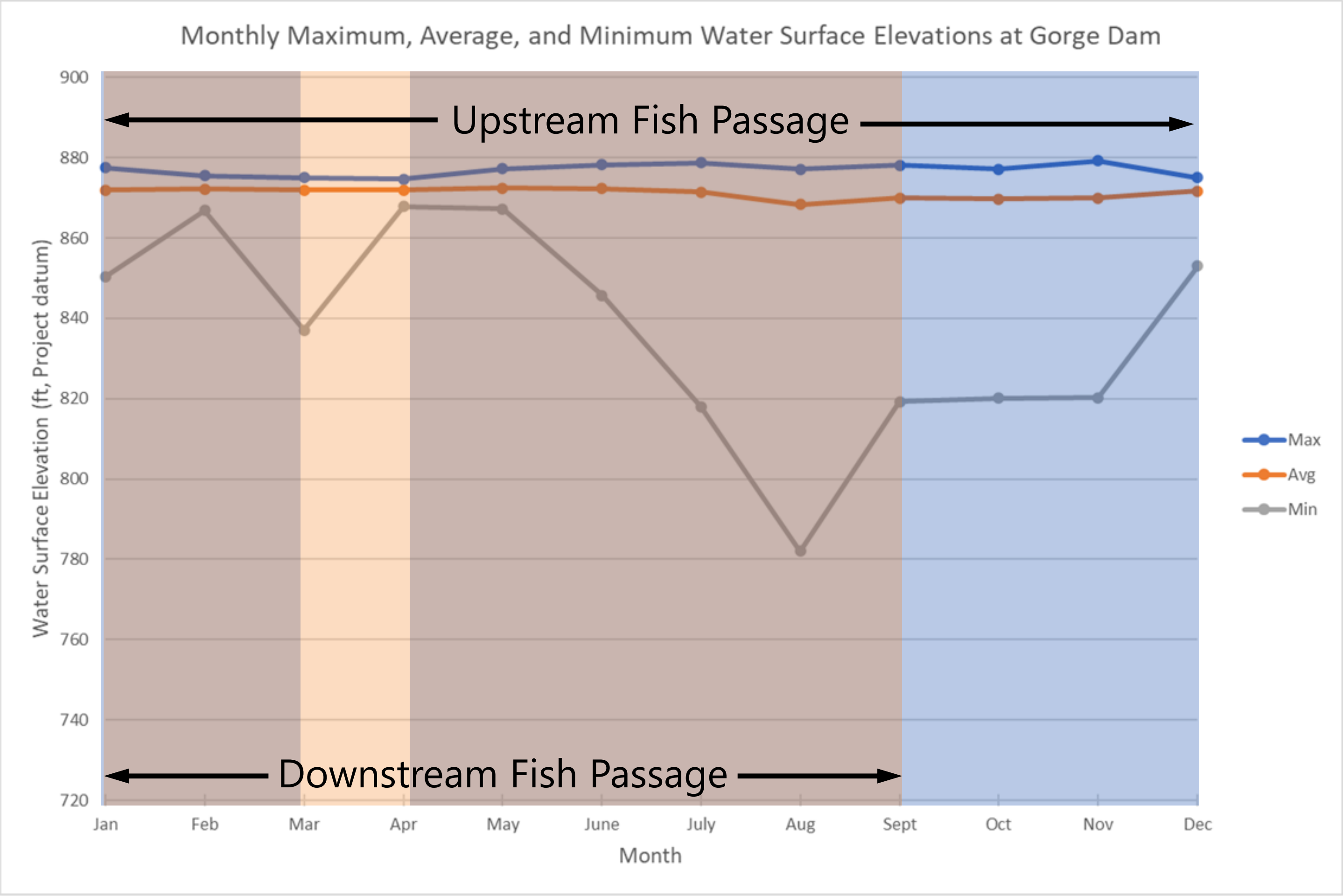
- Gorge Reservoir - Monthly Max, Min, and Average Stage (ft)



Seattle City Light

EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Gorge Reservoir - Monthly Max, Min, and Average Stage (ft)

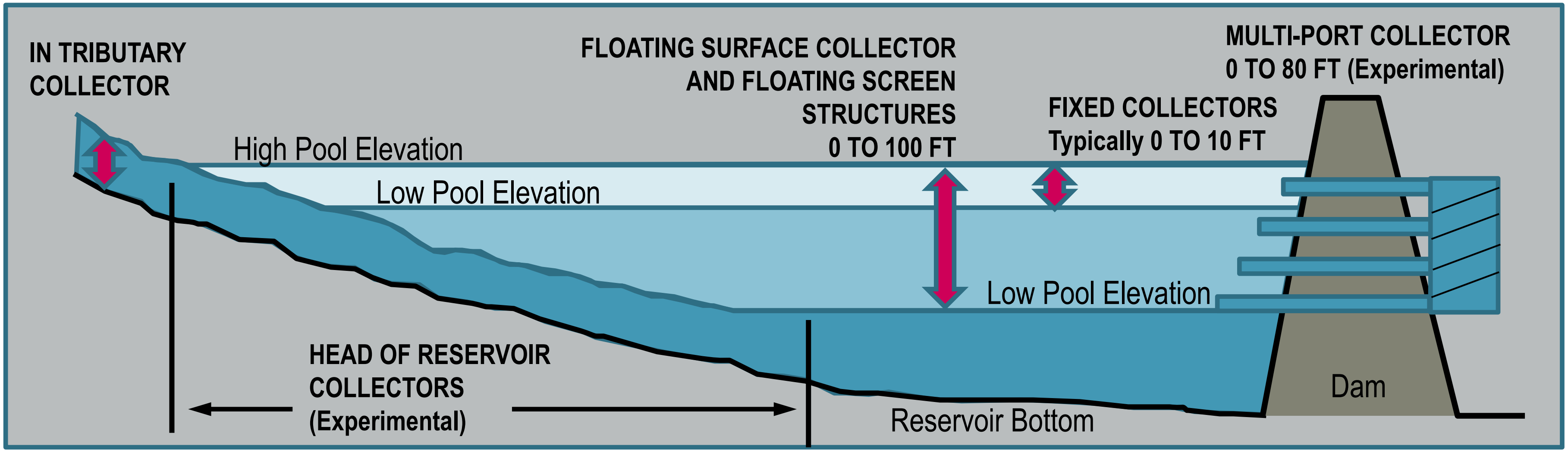


EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Gorge Reservoir stage fluctuation during anticipated migration periods
- Upstream (Jan – Dec)
  - Min WSELEV – 782 feet (Project Datum)
  - Max WSELEV – 879.3 feet (Project Datum)
  - Total WSELEV Fluctuation – 97.3 feet
- Downstream (Jan – Sept)
  - Min WSELEV – 782 feet (Project Datum)
  - Max WSELEV – 878.8 feet (Project Datum)
  - Total WSELEV Fluctuation – 96.8 feet

EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Seasonal changes in pool elevation influence downstream technology selection
  - Baker FSC – 60 ft of seasonal water level change
  - Swift FSC - 100 ft of seasonal water level change
  - Cougar FSS (concept) – 160 ft of elevation change (up to +57 ft or -22 ft per day during flood control operations)
  - River Mill Fixed Collector – Normally regulated with 2 ft of variation, can be up to 6 ft
  - Pelton Round Butte – Normally regulated with 1 ft of variation



EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Applicable Example Technology - Floating Surface Collectors
  - Large collection barge floating on the reservoir surface (60 to 70 feet wide x 120 to 170 ft long)
  - Reservoir fluctuation range of 2 to 100 vertical feet (North Fork vs. Swift)
  - Typical attraction flow capacity 250 to 1,000 cfs
  - Net Transition Structure (NTS) gradually transitions from net barrier/guidance to dewatering screens
  - Capture strategy – FSC and NTS
  - Fish transfer via trap and transport or passive bypass conduit (less common)
  - Five full scale examples currently in operation – numerous in the conceptual stage of development


Swift FSC (photo by PacifiCorps)

Swift FSC (photo by PacifiCorps)

PRELIMINARY CONSIDERATIONS AND CRITERIA – EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- Applicable Example Technology - Floating Surface Collectors
- Collection inlet and dewatering screens fixed in vertical and horizontal position
- Reservoir fluctuation range:
  - Single inlet – 10 feet
  - Multi-Port Inlet – 80 feet
- Capture strategy like FSCs - Similar in configuration to run-of-river bypass facilities on Columbia River
- Examples
  - River Mill
  - Pelton-Round Butte
  - Cle Elum (experimental)

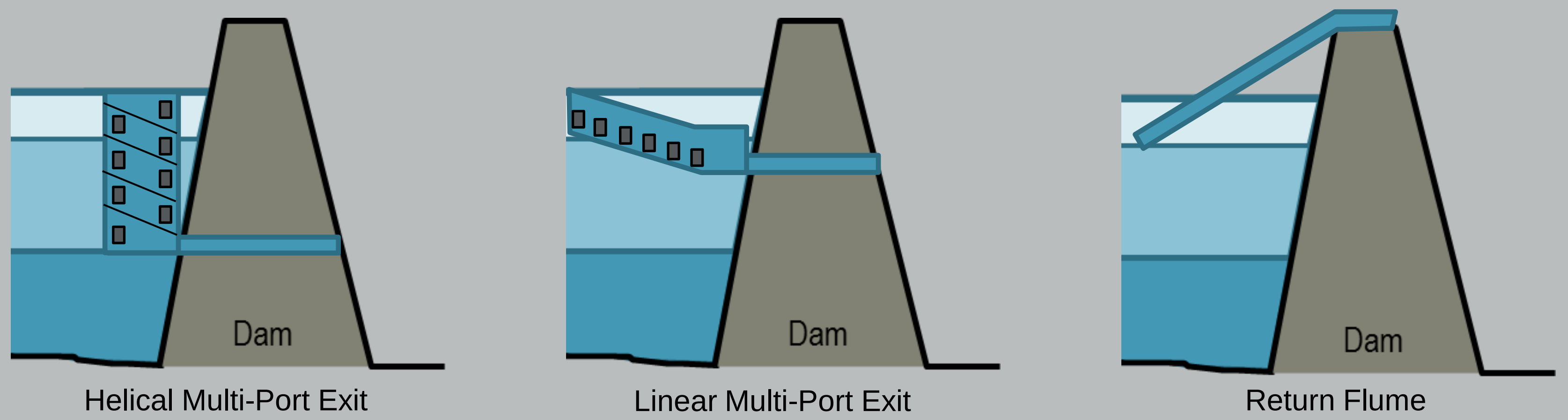

River Mill Fixed Inlet (photo by HDR)


River Mill bypass outfall (photo by HDR)

EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

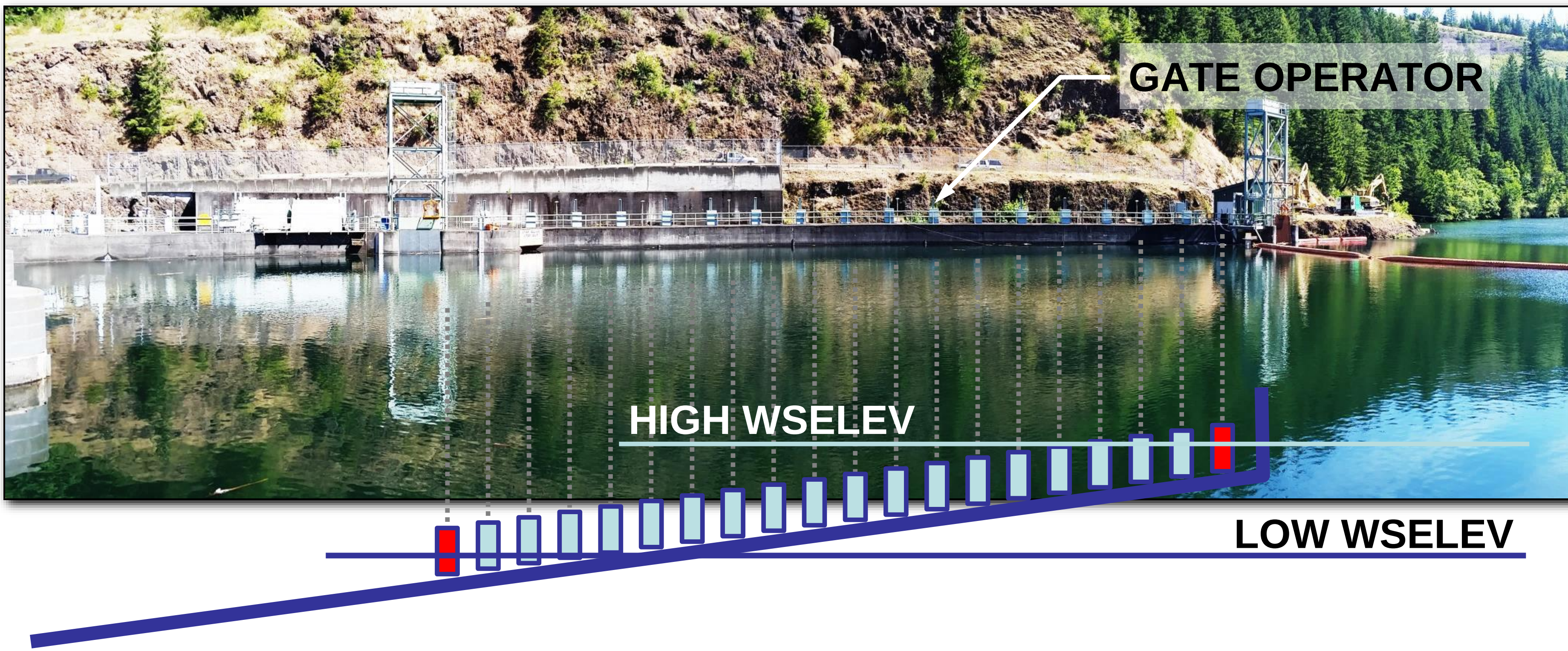
- Seasonal changes in pool elevations influence fish ladder feasibility
  - Soda Springs accommodates roughly 16 feet of fluctuation
  - North Fork was able to accommodate up to 20 feet of fluctuation prior to reservoir operational changes
  - All fish ladder exit concepts at high dams are relatively experimental with little to no record of performance

Fish Ladder Exit Concepts to Accommodate Large Reservoir Fluctuation



EXAMPLE APPLICATION OF RESERVOIR FLUCTUATION ON FACILITY TYPE, SIZE, AND COMPLEXITY

- North Fork Fish Ladder can accommodate hydraulic connection throughout 20 feet of reservoir fluctuation using a linear multi-port gated exit.



Seattle City Light

BREAK

15 minutes

Seattle City Light

EXAMPLES OF POTENTIAL FISH PASSAGE STRATEGIES

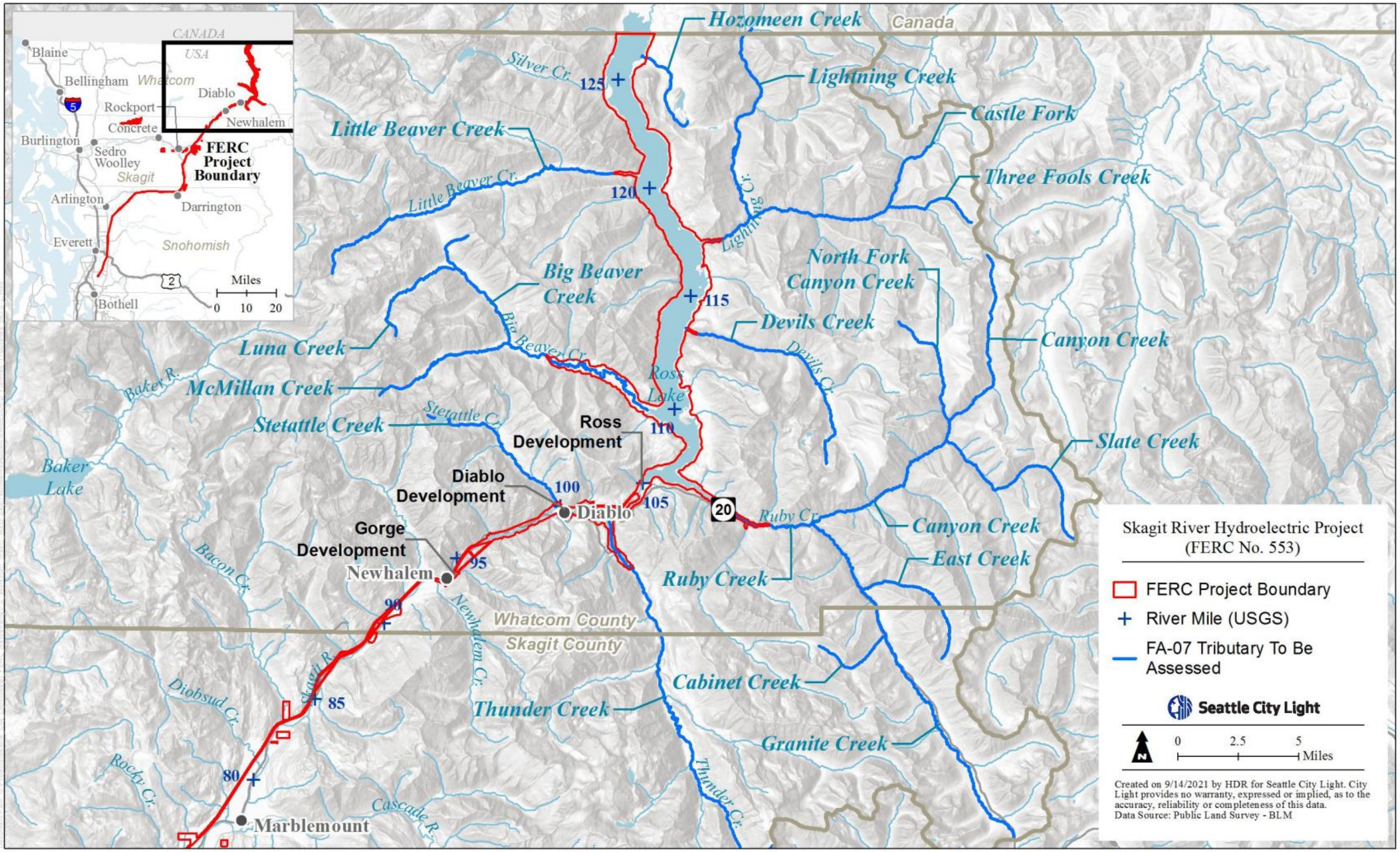
DEFINITION OF FISH PASSAGE STRATEGY AND TECHNOLOGY

- Fish Passage Strategies
  - Assembly of facilities to achieve a specific biological, management, and operation goal
- Fish Passage Technologies
  - Individual facility and associated elements required to operate at a specific location
  - Unique to a specific operating environment
- To be combined at a later stage of study to formulate concept alternatives based upon biological goals and objectives

OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Initial example strategies
- To be developed further in subsequent drafts of the DCD and after additional discussion with LPs
- Upstream/Downstream Fish Passage Strategies
  - Reservoir Bypass Strategy
  - Reservoir Tributary Strategy
  - Reservoir Transit Strategy
  - Option: Circumvent Gorge Bypass Reach

OVERVIEW OF UPPER SKAGIT SYSTEM

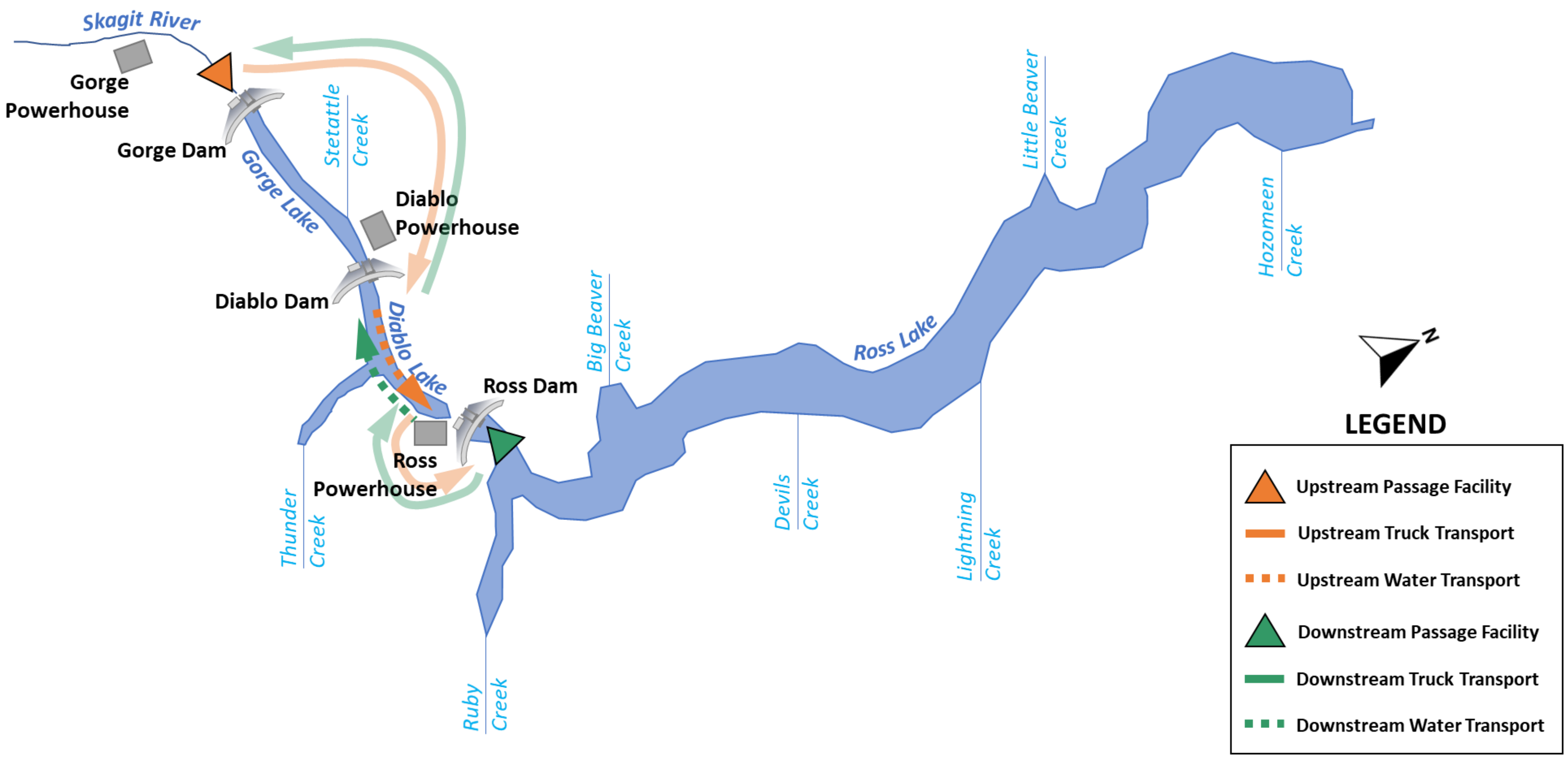


OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Bypass Strategy
  - Upstream
    - Fish passage collection at the base of Gorge Dam
    - Transport fish upstream via truck to Diablo, then to Ross via barge
    - Release of fish at a designated recovery facility at Ross Lake
  - Downstream
    - Fish passage collection at the face of Ross Dam
    - Transport fish, in reverse order, to a recovery/release facility downstream of Gorge Dam

OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Bypass Strategy

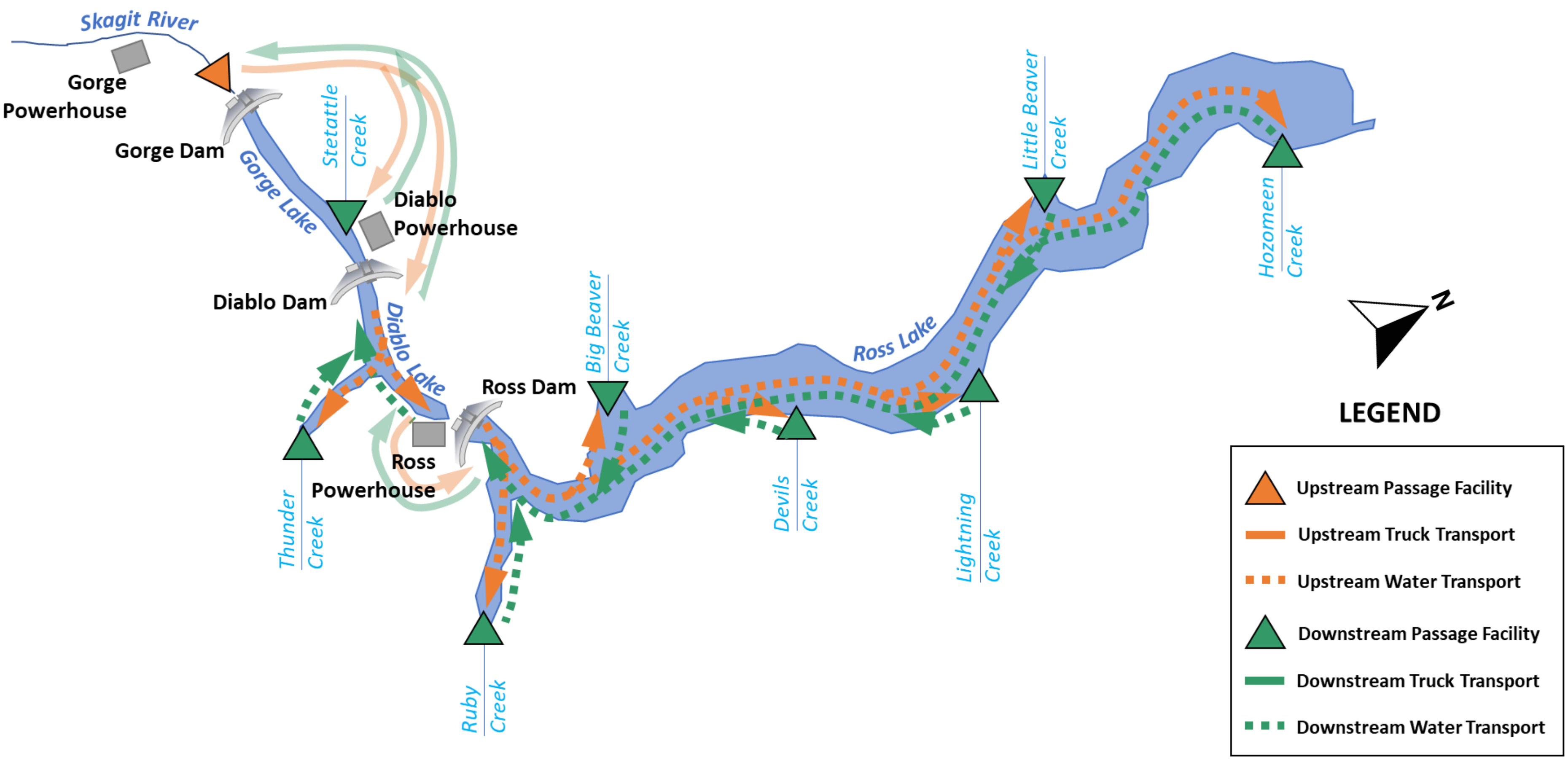


OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Tributary Strategy
  - Upstream
    - Fish passage collection at the base of Gorge Dam
    - Transport fish upstream via truck to Diablo, then to Ross via barge
    - Barge transport to each selected tributary fish-release facility
  - Downstream
    - Fish passage collection near the mouth of each tributary selected
    - Transport fish, in reverse order, to a recovery/release facility downstream of Gorge Dam

OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Tributary Strategy

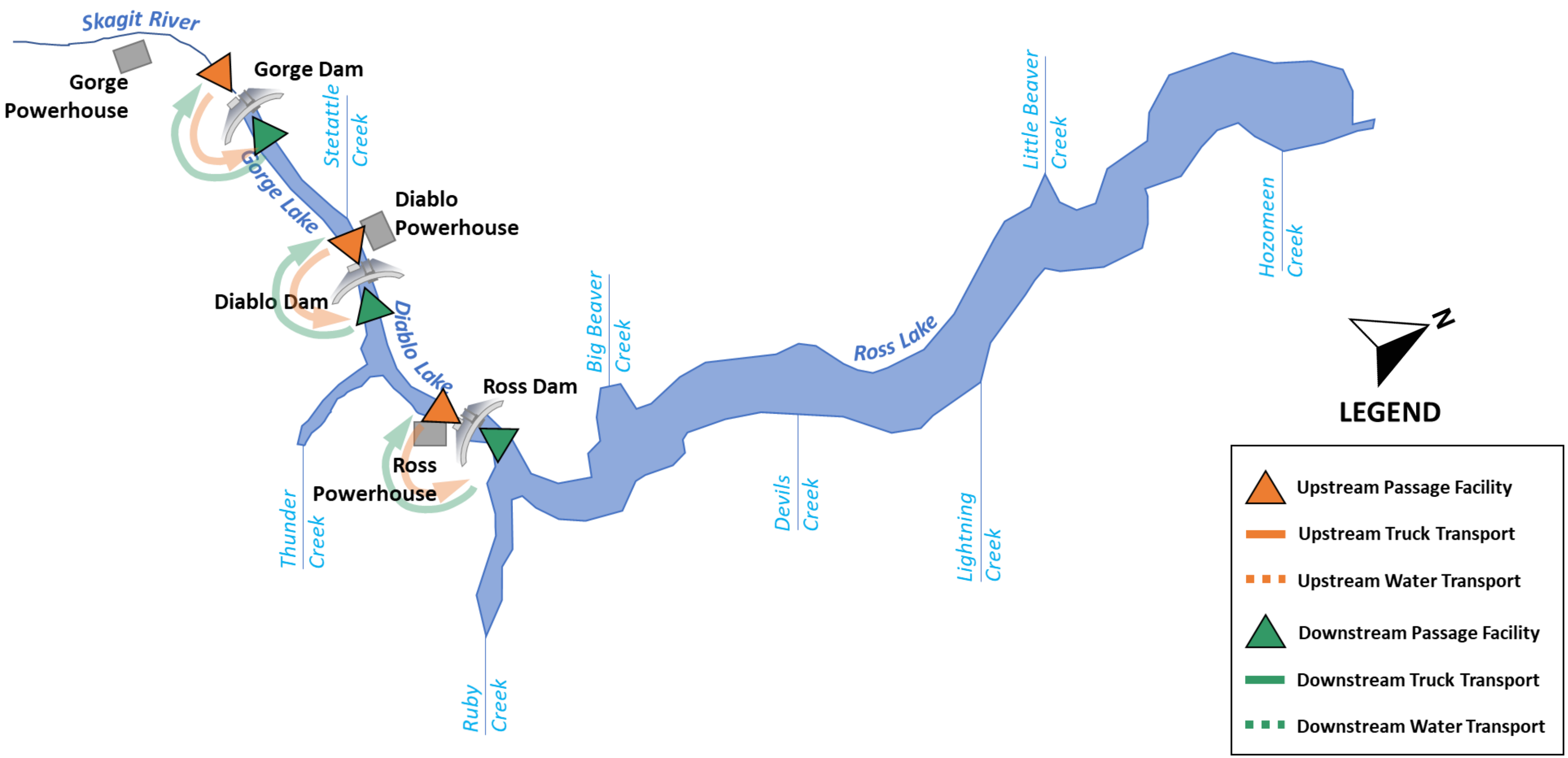


OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Transit Strategy
  - Upstream
    - Fish passage collection at the base of Gorge Dam, the Diablo Powerhouse tailrace, and the Ross Powerhouse tailrace
    - Adult fish transported above each dam and released into the next adjoining reservoir
    - Adult fish transit Gorge, Diablo, and Ross Lakes to the next fish passage facility or spawning habitat
  - Downstream
    - Fish passage facilities located near the intake structures for Ross, Diablo, and Gorge Power Developments
    - After collection, fish would be transported downstream to adjacent "head of reservoir" or powerhouse tailrace
    - Fish transit Ross, Diablo, and Gorge Lakes and are ultimately collected at Gorge Dam and transported downstream to a recovery/release facility

OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Reservoir Transit Strategy

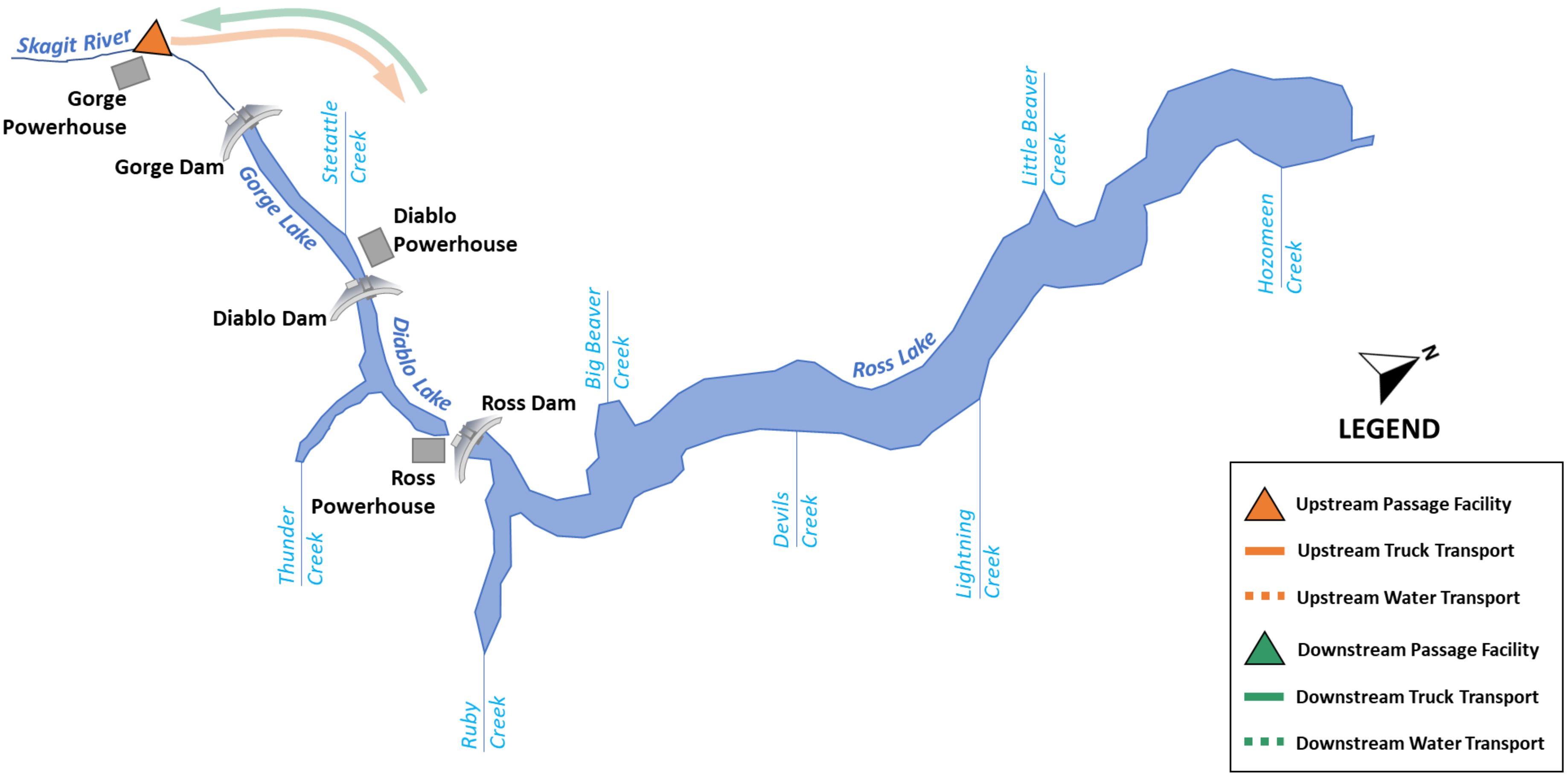


OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Optional Exclusion of Gorge Bypass Reach
  - Add point of collection for upstream fish passage at Gorge Powerhouse
  - Eliminates navigation of bypass reach to accomplish upstream fish passage.

OVERVIEW OF POTENTIAL FISH PASSAGE STRATEGIES

- Optional Exclusion of Gorge Bypass Reach



Seattle City Light

EXAMPLES OF POTENTIAL FISH PASSAGE STRATEGIES

FISH PASSAGE FACILITY DESIGN

- What technologies and components do fish passage facilities need to consider?

FISH PASSAGE FACILITY DESIGN

- Block fish
- Guide fish
- Attract fish
- Collect fish
- Crowd fish
- Sort fish
- Lift fish
- Convey fish
- Measure fish
- Tag fish
- Transport fish
- Release fish

A complete system of design elements that work together to accomplish a biological/ecological driven objective given unique operational environment…

DIRECTIVE VS NON-DIRECTIVE FISH PASSAGE

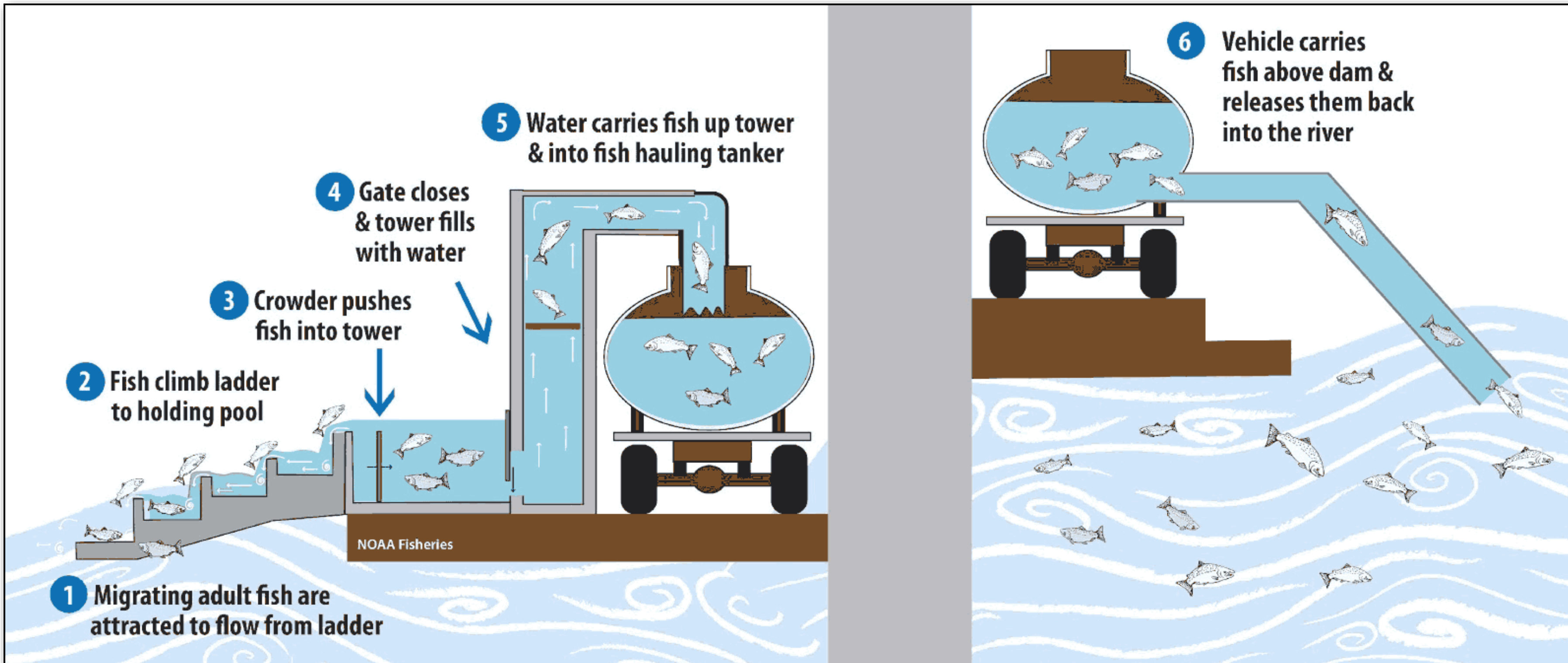
- Directive Fish Passage Technologies
  - Requires a high level of human intervention (e.g., trap and transport)
- Non-Directive Fish Passage Technologies
  - Fish may volitionally pass without human intervention (e.g., technical fish ladder or nature-like fishway)

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES

- Potential Upstream Technologies
  - Trap and Transport
  - Fish Ladders/Fishways
    - Technical Fish Ladders
    - Nature-like fishways
  - Fish Passes
    - Fish elevators, lifts, and locks
    - Pneumatic Fish Transport Tube System ("Whooshh")

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

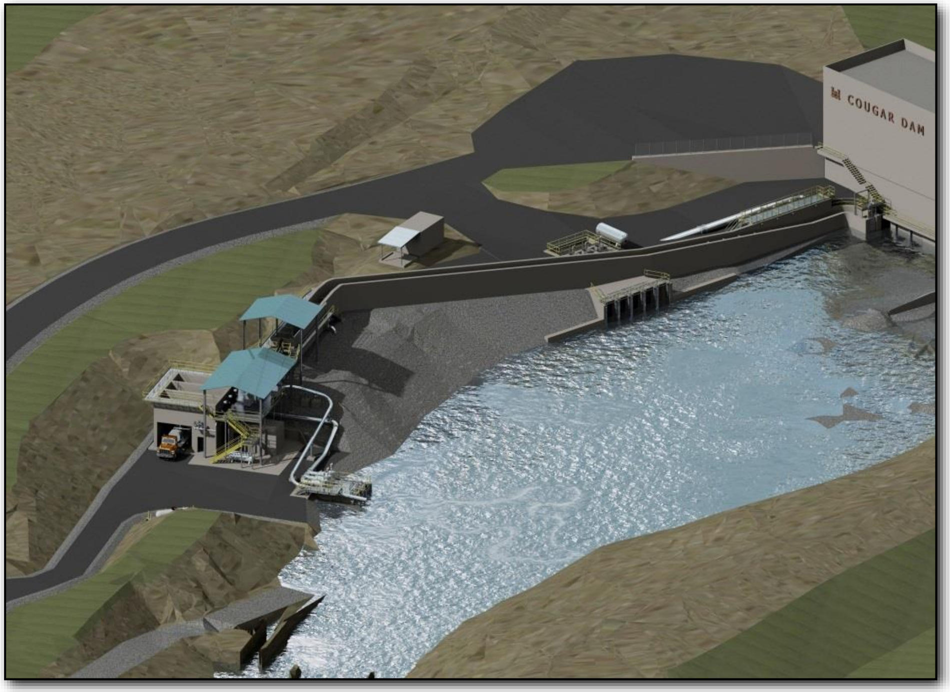
- Trap and Transport



Source: NMFS

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

- Trap and Transport



Cougar Dam Adult Fish Collection Facility
S. Fork McKenzie River, OR
(rendering by USACE)

Lower Granite Dam Adult Collection Facility
Snake River, WA

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

- Fish Ladders/Fishways – Technical Fish Ladders

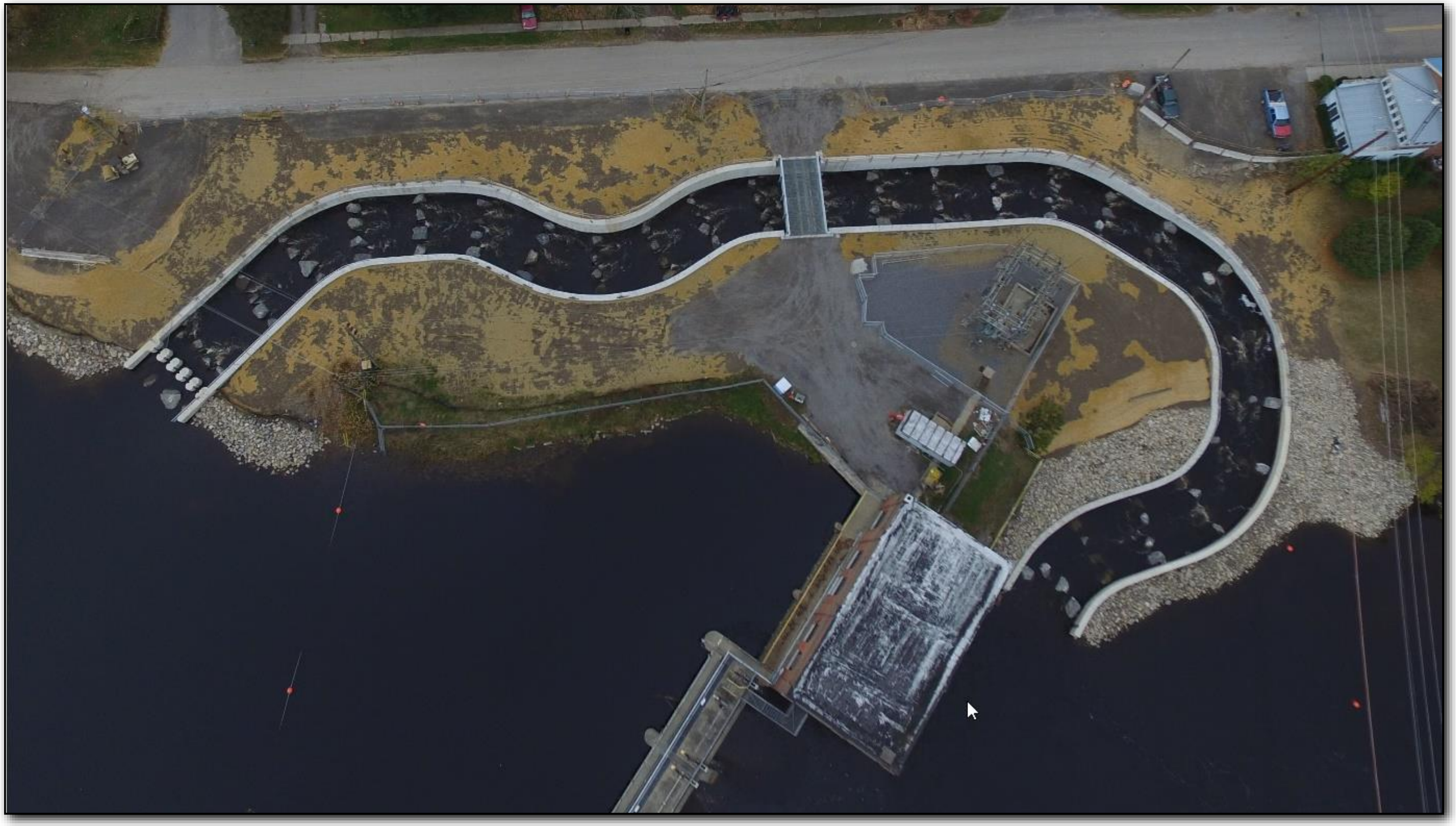
Crooked River central vertical slot fishway near Prineville, Oregon (Source: ODFW)

Half Ice-Harbor baffle (pool, weir, and orifice) fish ladder at River Mill Dam.

2.1 mile long half, Ice-Harbor baffle (pool, weir, and orifice) fish ladder at the Faraday Diversion Dam and North Fork Dam.

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

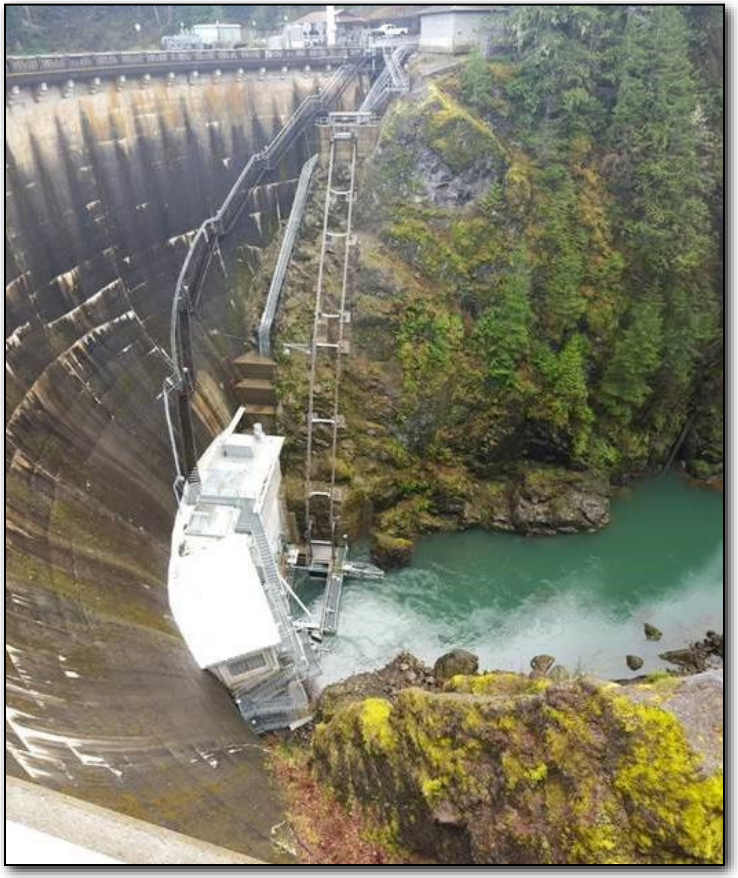
- Fish Ladders/Fishways – Nature-like fishways



Heuvelton nature-like fishway on the Oswegatchie River in New York.

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

- Fish Passes – Fish elevators, lifts, and locks



Skokomish Dam No. 2 Adult Collection Facility fish lift

Fish lock at the trap and transport facility on Lower Baker River

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – UPSTREAM

- Fish Passes – Pneumatic Fish Transport Tube System ("Whooshh")

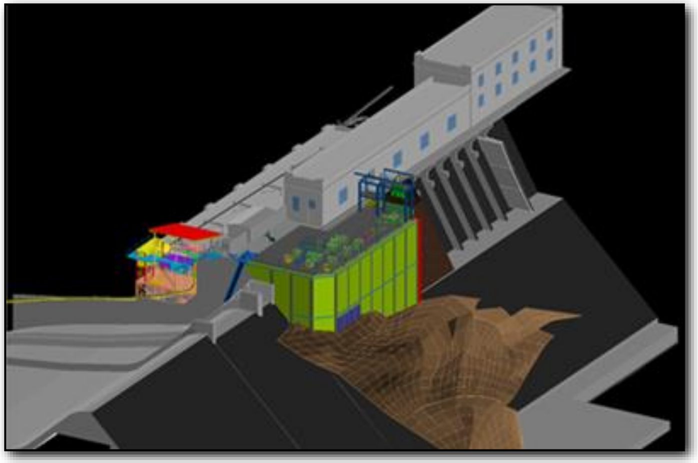
Six-lane pneumatic fish transport tube system (also known as "Whooshh") at the Big Bar emergency fish transport site, Frasier River, British Columbia.

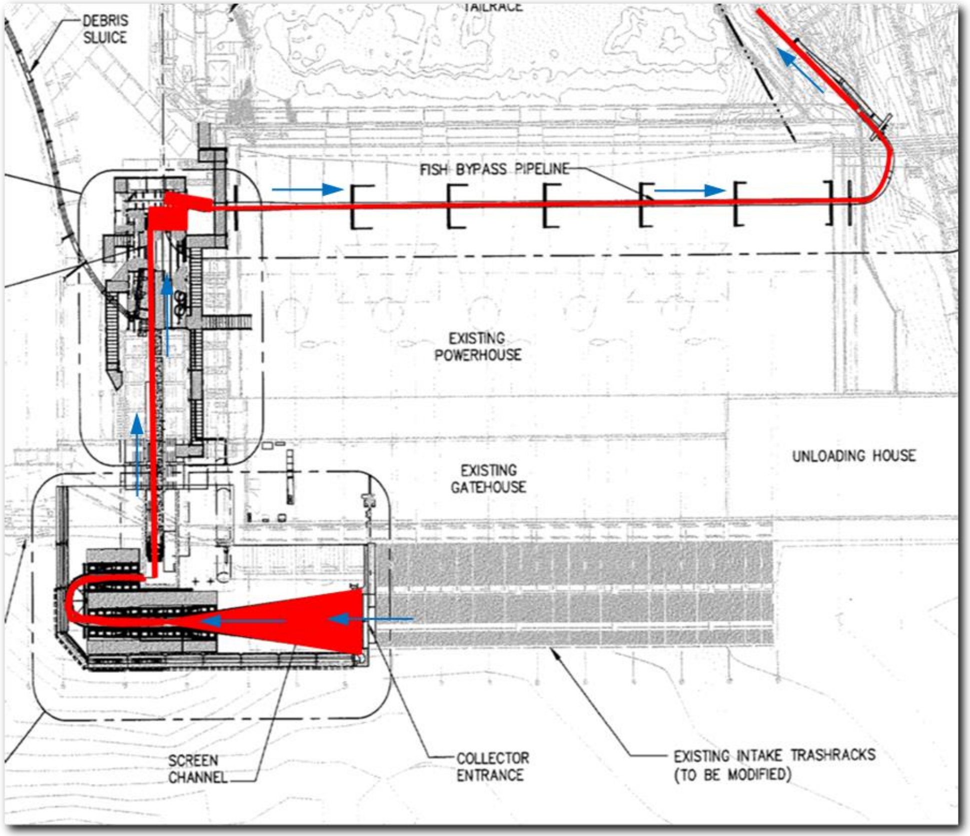
OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES

- Potential Downstream Technologies
  - Forebay Collectors
    - Fixed Inlet Collectors
    - Floating Surface Collectors
    - Floating Screen Structures
  - Head of Reservoir Collection
    - Floating Surface Collectors
    - Passive Collectors
    - In-River or Tributary Collectors
  - Turbine Passage
  - Surface Spill
  - Bypass Systems
  - Reservoir drawdown

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Forebay Collectors – Fixed Inlet Collectors

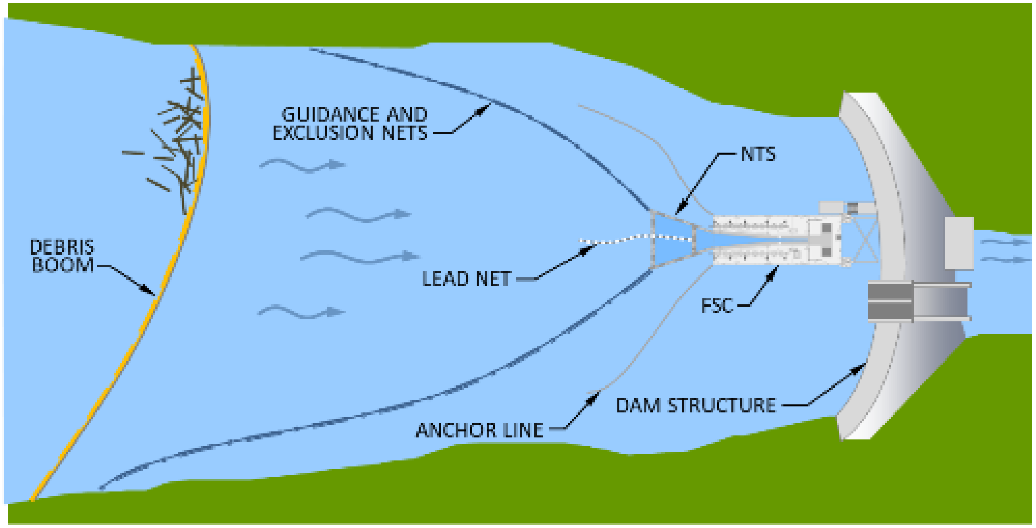


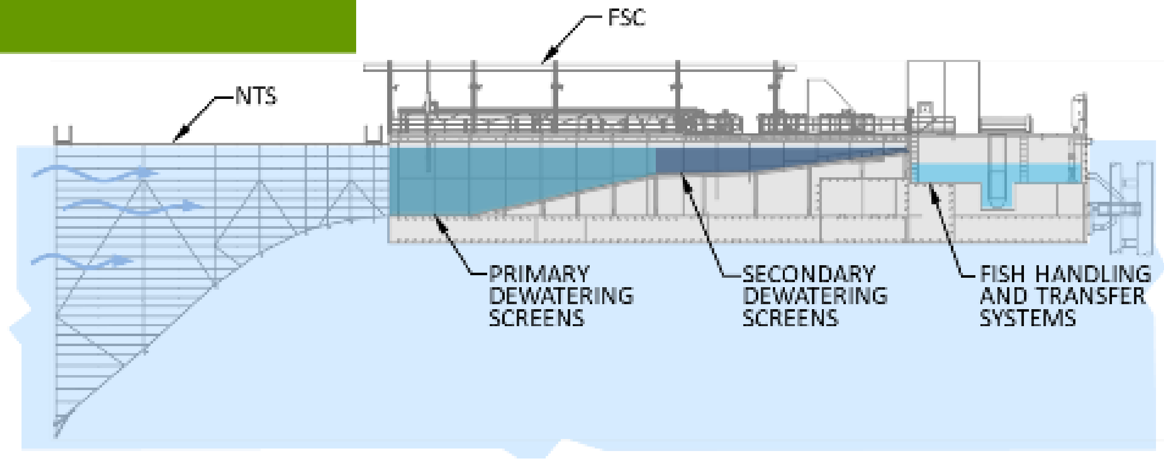


River Mill Hydroelectric Project

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Forebay Collectors – Floating Surface Collectors





OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

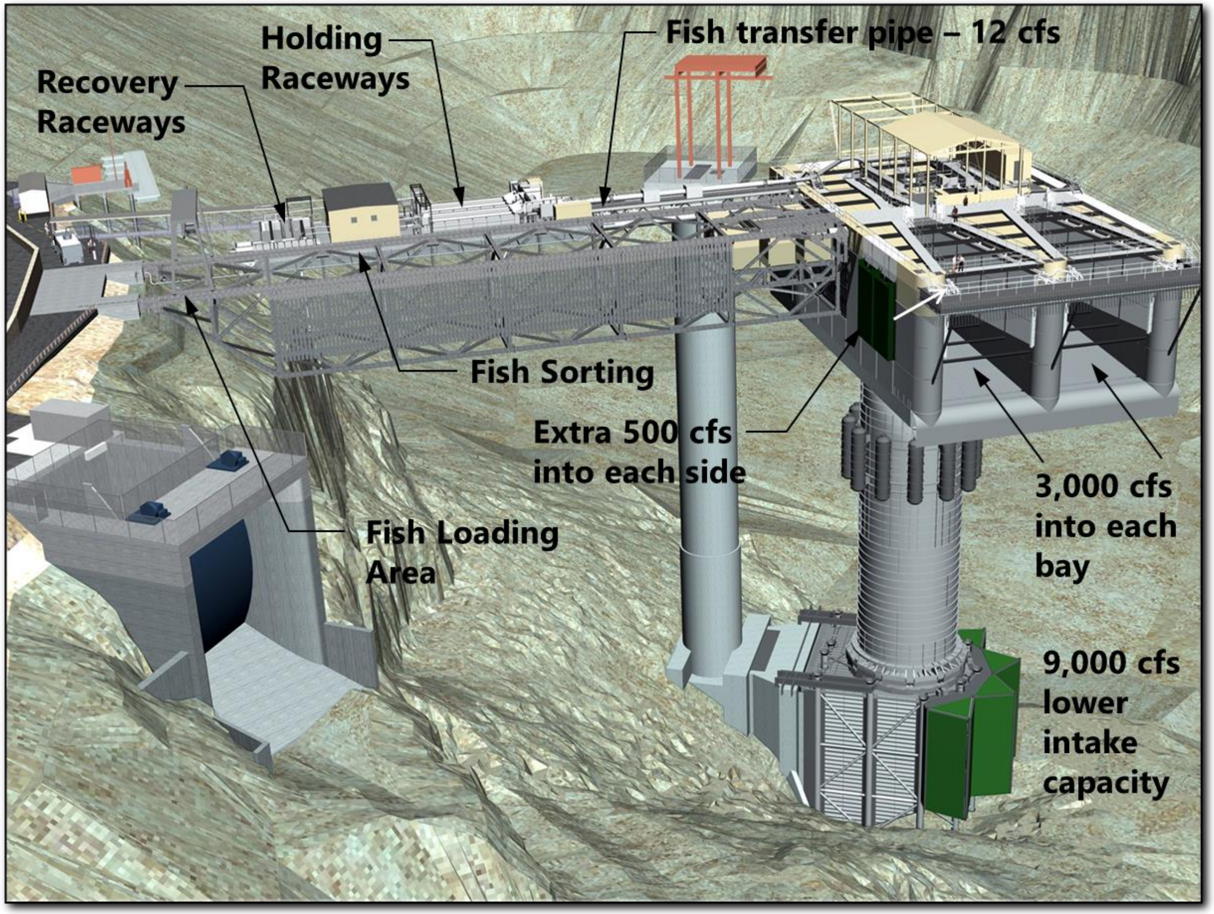
- Forebay Collectors – Floating Surface Collectors

Floating Surface Collector (FSC)
Upper Baker Dam, WA
(photo by PSE)

Upper Baker FSC
Net Transition Structure (NTS)
(photo by PSE)

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

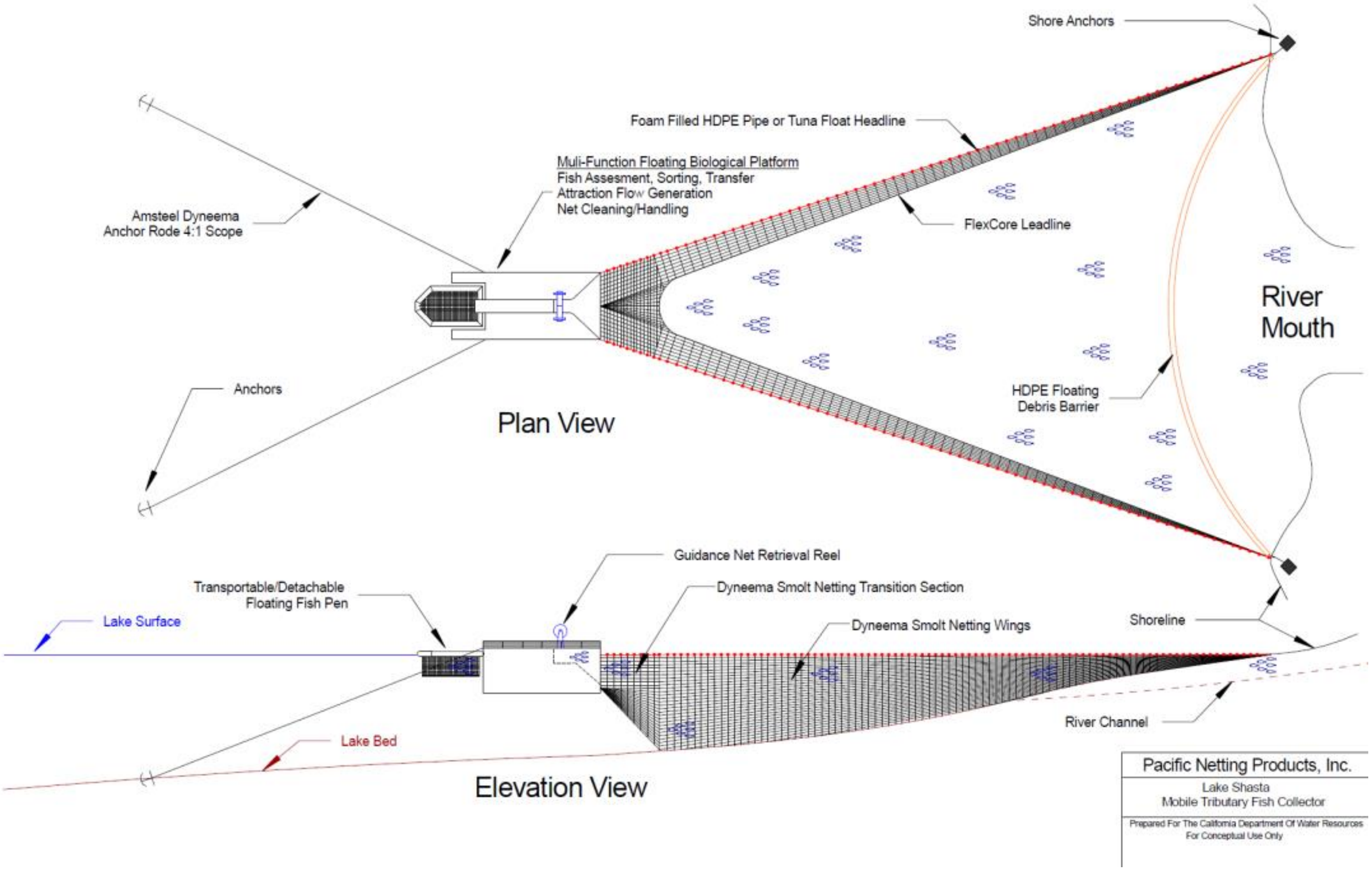
- Forebay Collectors – Floating Screen Structures



Pelton Round-Butte Fixed Collector (rendering by PGE)

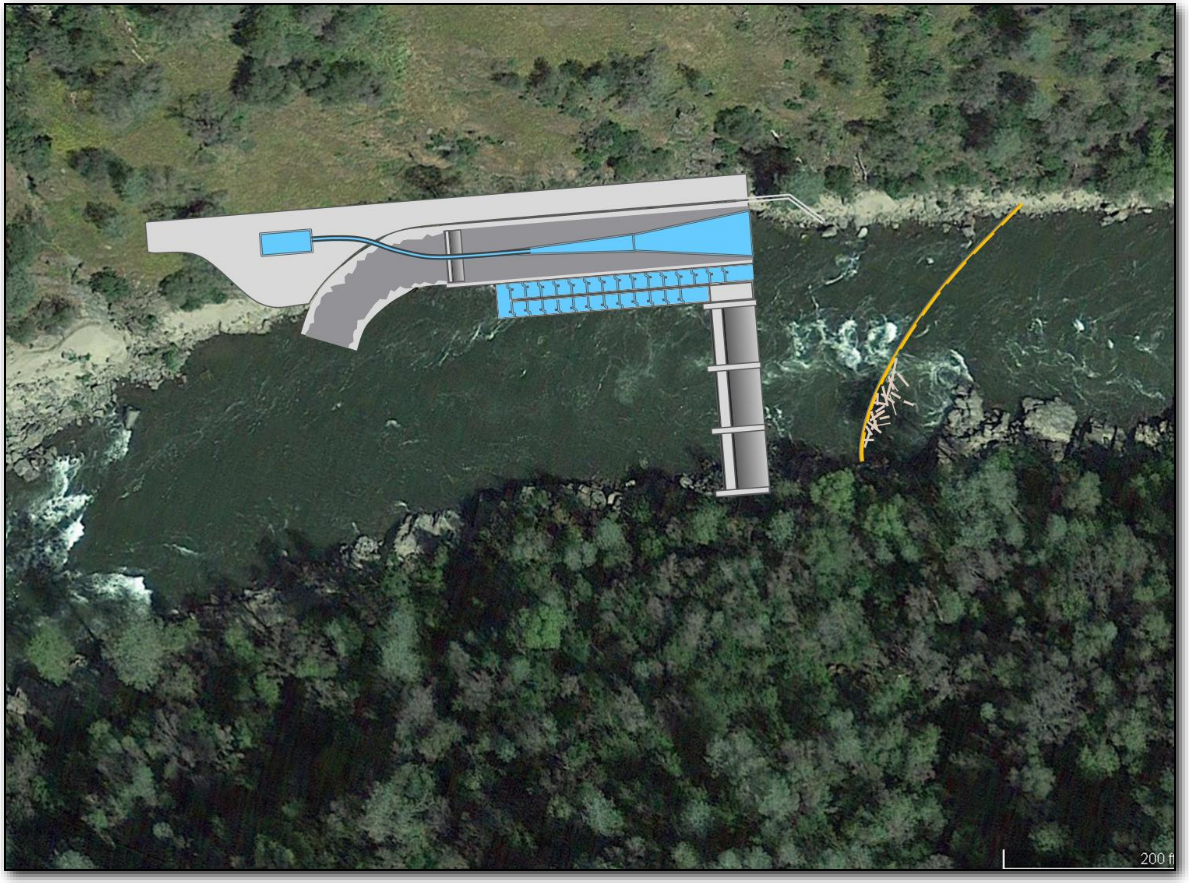
OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Head of Reservoir Collection



OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- In-River Tributary Collectors



- Components
  - Holding Gallery and Transport Hopper
  - River Return Screens
  - Debris Boom
  - Abutment
  - Obermeyer Weir
  - Fish Screens
  - Fish ladder
  - Fish bypass pipe

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Turbine Passage

Fish-friendly turbine used on the Ice Harbor Dam in Eastern Washington.

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Surface Spill Facilities

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Bypass Systems

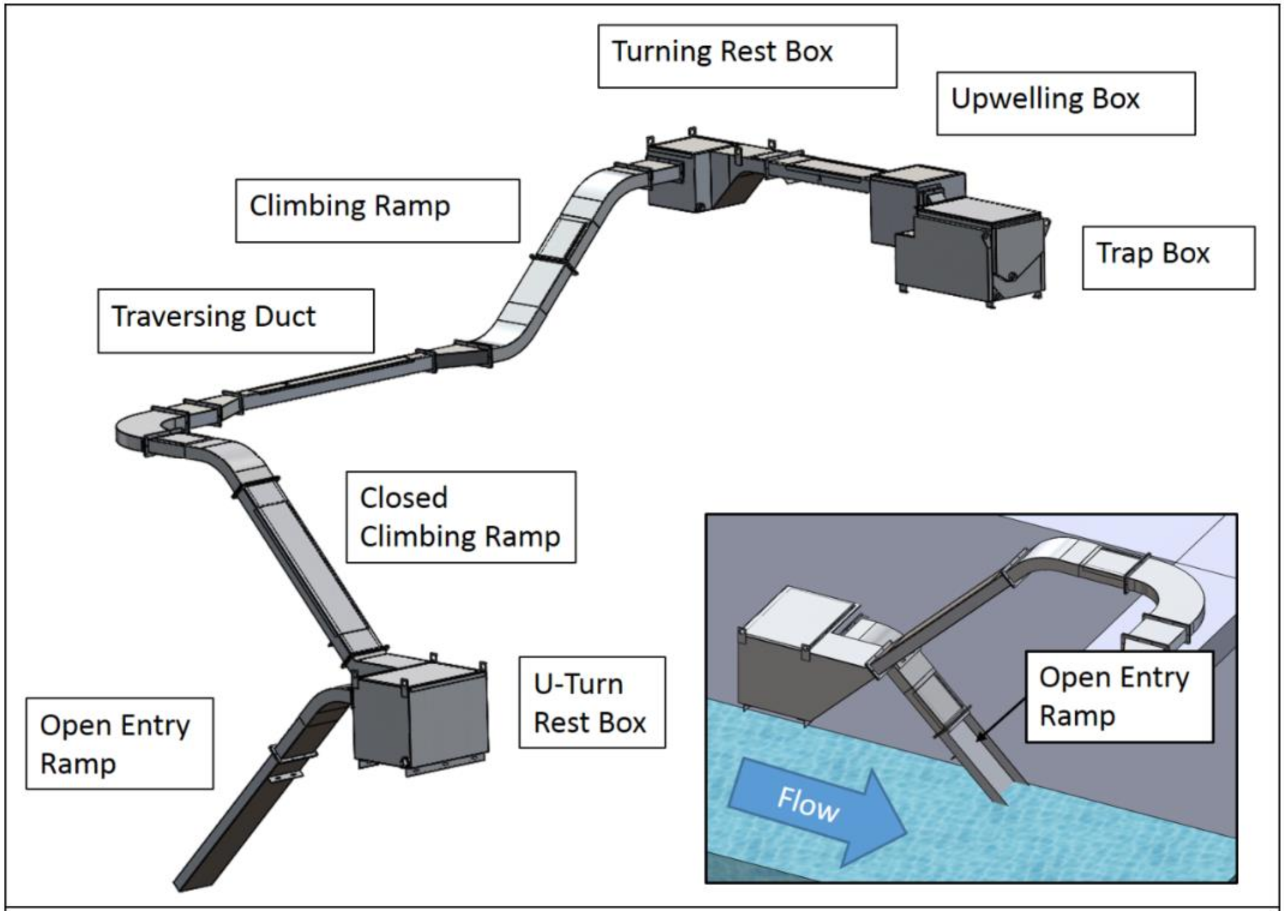
OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES – DOWNSTREAM

- Project Operational Changes – Reservoir drawdown


Ross Lake under winter drawdown conditions

OVERVIEW OF POTENTIAL FISH PASSAGE TECHNOLOGIES

- Lamprey Passage



Zabott et al. 2015. Design Guidelines for Pacific Lamprey Passage Structures.

Seattle City Light

BIOLOGICAL PERFORMANCE OF EXISTING FACILITIES AND DEVELOPMENT OF PERFORMANCE CRITERIA

DEVELOPMENT OF PERFORMANCE CRITERIA FOR PROJECT

- Measurable Fish Passage Program Objectives
  - Number transported upstream & downstream at points of collection
- Fish Program Performance Standards – Definition of Success
  - Upstream: Passage efficiency: 75-95%; Survival: 95-98%
  - Downstream: Overall Efficiency = R x C x S
    - Reservoir passage: 75-85%
    - Collection efficiency: 95%
    - Survival: 98-99%
- Standards for experimental populations

BIOLOGICAL PERFORMANCE OF EXISTING PNW FISH PASSAGE FACILITIES

- Upstream Fish Passage Performance

Facility	Species	Collection Efficiency (Percentage)	Survival Percentage
Merwin Dam	Coho	73	99.7
	Spring Chinook	90	94.5
	Winter Steelhead	86-99	99.8

BIOLOGICAL PERFORMANCE OF EXISTING PNW FISH PASSAGE FACILITIES

- Adults Transported Annually

Location	Species Transported	Adults Transported Annually
Baker River (WA)	Sock, Coho	10,000s
Cowlitz River	Sthd, Chin, Coho, Cutthroat	10,000s
Lewis River	Sthd, Chin, Coho, Cutt	10,000s
McKenzie River	Chin, BT, RBT, Cutt	100s
M.F. Willamette River	Chin	1,000s
North Santiam River	Chin	1,000s
S.F. Skykomish River	Sthd, Coho, Sock, Chin, Cutt, Pink, BT	10,000s
Wynoochee River	Sthd, Coho, Chin	1,000s
White River	Chin, Sthd, Coho, Pink BT	100,000s

BIOLOGICAL PERFORMANCE OF EXISTING PNW FISH PASSAGE FACILITIES

Site	Species	Reservoir Passage[1]	Fish Collection Efficiency[2, 3]	Overall Efficiency[4]
Upper Baker Dam	Coho	---	83-99%	---
Upper Baker Dam	Sockeye	---	69-95%	---
Lower Baker Dam	Coho	---	88-96%	---
Lower Baker Dam	Sockeye	---	83-99%	---
Cushman Dam	Coho	20%	33-61%	19-48%
Cushman Dam	Sockeye	43%	39-66%	24-43%
Swift Dam	Coho	62%	39%	20%
Swift Dam	Chinook	58%	44%	17%
Swift Dam	Steelhead	73%	42%	10%
North Fork Dam	Coho	---	94-96%	95%[6]
North Fork Dam	Chinook	---	78-90%	92%
North Fork Dam	Steelhead	---	92-97%	97%
River Mill Dam	Coho	---	99%	---
River Mill Dam	Chinook	---	98%	---
River Mill Dam	Steelhead	---	96%	---
Pelton Round Butte Dam	Chinook	22-29% (Natural)	---	---
Pelton Round Butte Dam	Steelhead	6-20% (Natural)	---	---
Cougar Dam	Chinook	94%	96%	<1%

Seattle City Light

ACTION ITEMS AND NEXT STEPS

ACTION ITEMS AND NEXT STEPS

- Review action items
- Next steps
  - Continue gathering and synthesizing data to address remaining data gaps
  - Establish preliminary technical, operational, and biological goals, criteria, and constraints
  - Continue developing Draft Fish Passage Facilities Design Criteria Document

OUR MISSION

Seattle City Light is dedicated to delivering customers affordable, reliable and environmentally responsible electricity services.

OUR VISION

We resolve to provide a positive, fulfilling and engaging experience for our employees. We will expect and reinforce leadership behaviors that contribute to that culture. Our workforce is the foundation upon which we achieve our public service goals and will reflect the diversity of the community we serve.

We strive to improve quality of life by understanding and answering the needs of our customers. We aim to provide more opportunities to those with fewer resources and will protect the well-being and safety of the public.

We aspire to be the nation's greenest utility by fulfilling our mission in an environmentally and socially responsible manner.

OUR VALUES

Safety, Environmental Stewardship, Innovation, Excellence, Customer Care

THE NATION'S GREENEST UTILITY SINCE 1905 SEATTLE CITY LIGHT

Seattle City Light

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Workshop No. 2
September 23, 2021, 12:00pm – 4:00pm

DRAFT Meeting Summary

Disclaimer: These notes serve as a high-level summary of the meeting and as a communication tool for the benefit of committee continuity. They are not intended as a formal record of the meeting.

Attendance

Licensing Participants (LPs):
Alphabetical by last name

Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Stuart Beck, Swinomish Tribal Community
Blaine Chesterfield, City of Mount Vernon
Steve Copps, National Marine Fisheries Service (NMFS)
Jeff Garnett, United States Fish and Wildlife Services (USFWS)
Rick Hartson, Upper Skagit Indian Tribe USIT (Upper Skagit Indian Tribe)
Damodar Khadka, Ts'elxwéyeqw (Chilliwack) Tribe
Grant Kirby, Sauk-Suiattle Indian Tribe
Keith Kirkendall, NMFS
Jonathan Kohr, WDFW
Brian Lanouette, USIT
Stephen Lewis, NMFS (I'm with USFWS...S. Lewis comment)
Jim Meyers, NMFS
Logan Negherbon, NMFS
Jim Pacheco, Washington Department of Ecology (Ecology)
Duncan Pfeifer, WDFW
Dave Price, NMFS
Ashley Rawhouser, National Park Service (NPS)
Dudley Reiser, Swinomish Tribal Community
Kara Symonds, Skagit County
Erik Young, Skagit Fisheries Enhancement Group (SFEG)

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowrey, City Light
Chris Townsend, City Light
Matt Love, Cascadia Law Group (Legal Counsel)

Consultant Team:
Jenna Borovansky, Consultant Team
Mike Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Nicole Loo, Consultant Team
Theo Malone, Consultant Team
Jacob Vernard, Consultant Team
Matt Wiggs, Consultant Team

Facilitation Team:
Betsy Daniels, Facilitation Team
Greer Maier, Facilitation Team
Olivia Smith, Facilitation Team

Meeting Materials

Materials were sent in advance (available upon request):

- FA-04 Fish Passage meeting agenda
- FA-04 Fish Passage presentation
- FA-04 Preliminary Draft Fish Passage Conceptual Design Criteria Document (DCD)

Action Items

Action	Responsibility	Deadline
Licensing Participants (LP) Action Items		
LPs to reach out to Becky Holloway (becky.holloway@hdrinc.com) if interested in joining bi-weekly Agency Work Session (AWGS) meetings. LPs can also review AWS	LPs	Ongoing

meeting materials in the Triangle folder on the project SharePoint site.		
LPs to provide one set of consolidated comments by organization or agency on the Design Criteria Document (DCD) (with an emphasis on high level issues/flags for further discussion). Upload comments to the Triangle SharePoint by Oct. 7. • [*PDF of DCD sent out 9/18; Word version available by request*]. • Email Greer Maier (gmaier@triangleassociates.com) if you are unable to access the SharePoint upload function.	LPs	October 7th
LPs to update the Consultant Team [Becky Holloway - Becky.Holloway@hdrinc.com] if their organization/agency will not be able to meet the Oct. 7th deadline. Please indicate when you expect to have comments complete.	LPs	October 7th
Facilitation Team Action Items		
Discuss future meeting topics listed below with CL and HDR to get necessary workshops/meetings on the calendar.	Triangle	Week of October 4th
Prepare draft meeting summary and send to participating LPs, City Light, and other attendees for review.	Triangle	October 7th
Topics for Future Meetings or Workshops		
Management of the upper basin as a single panmictic population or multiple populations. Note this topic to be discussed at future AWS bi-weekly meetings.		
~~CFD/hydraulics/3D modeling to look at reservoir/forebay flow dynamics in support of design.~~		
Relationship to other studies- Specifically FA-07 (Tributary Habitat Assessment) and FA-03 (Reservoir Fish Stranding and Trapping Risk) among others.		
Downstream adult movement of bull trout and steelhead and implications for design		
Adequacy and appropriate use of fish data in development of goals, objectives, and alternatives.		
Evaluating how other systems responded before and after fish passage (e.g., Elwha).		

Commented [GU1]: This item can be deleted given that it was addressed in the workshop and at the first AWS meeting. CFD modeling and reservoir hydraulics will not be a part of this phase of study. It may be recommended as a course of action should any of the fish passage measures be determined feasible and move forward into further concept development.

Summary of Issues Discussed, Action Items, and Decisions

Welcome, Introductions, Meeting Objectives and Agenda Overview

Greer Maier, Triangle Associates, introduced herself as the new facilitator for the Fish Passage group meeting. Mike Garello, HDR, introduced the City Light and Consultant Team and reviewed the meeting agenda. Mike explained that the purpose of this meeting was to discuss the design basis and criteria needed to begin development of upstream and downstream passage facility alternatives to the concept level and to begin discussing any initial feedback on the first FA-04 Study deliverable: *Preliminary Draft Fish Passage Conceptual Design Criteria*

Document (DCD) (slides 4-5*)*. Mike gave a general overview of the FA-04 Fish Passage Study schedule highlighting where we are in the process and noting which meetings have already occurred, including bi-weekly Agency Working Sessions (AWS) and FA-04 Workshop #1.

Overview of Preliminary DCD

The *Preliminary Draft Fish Passage Conceptual Design Criteria Document (DCD)* was sent a week prior to this meeting on Friday September 17th. Mike Garello, HDR, explained the timeline for finalizing the draft document. After this initial draft and review process there will be a revised draft released in December 2021 and final draft DCD is due January 2022 (slides 7-8).

Next, Mike reviewed the process for developing the fish passage facilitates assessment overall. Workshop #1 was focused on gathering information, and the study is now moving to the defining objectives phase. After that it will move to exploring strategies, formulating alternatives, and evaluating and developing concepts. As part of the feasibility and design process, the FA-04 study team is looking to the ~~Fish Passage Work Group~~LPs that participate in the AWS to establish the initial range of goals, objectives, criteria, and expectations (slides 9-10). Further iterations of the Design Criteria Document outlining the initial goals developed with the AWS will be submitted to the larger group of LPs at the study milestone dates established for the FA-04 study.

The goal of the DCD is to document key factors describing the existing ~~Project~~ operating environment for potential fish passage facilities, formulate a range of potential fish passage goals, objectives, and alternatives, and provide~~as~~ a vehicle to share information with LPs throughout the FA-04 study. Mike also shared the list of objectives for development of the DCD and gave an overview of the content included in the first/preliminary draft (slide 13-14). He walked through in detail each section included in the draft – physical setting, biological setting, technical design criteria and guidelines, design criteria for concept development, performance of PNW fish passage facilities at high head dams, and an overview of potential fish passage strategies and technologies to be used in alternative formulation. Lastly, he shared how this group will provide feedback, comments, and suggestions to be incorporated into the revised DCD.

- In response to a comment about the short time frame to agree on goals and objectives (December-January), Mike explained how feedback is happening in the bi-weekly AWS meetings (USIT, Swinomish, Skagit River System Cooperative) and resource~~Fish A~~ agencies (USFWS, NOAA, NPS, WDFW). Mike added they will hopefully have information to share at the next Fish Passage Workshop ~~Group meeting~~ and will collect any remaining feedback for the next iteration of the DCD. Even if feedback is provided on the final version of the DCD, the study team can incorporate it into the next stage of Fish Passage evaluation in the RSP. They will incorporate data as it becomes available from other studies and adjust as needed.
- In response to a request for clarity on the project boundaries, Mike showed the overview of the Upper Skagit system map (slide 75) and explained how the boundary is shown in the red line and extends from Gorge Dam into the Upper Ross Reservoir and British Columbia. The project area includes the tributaries that feed into the Ross, Diablo and Gorge Lakes. Mike added the FA-07 Trib. Habitat & Food Web study is happening concurrently. Any future tributary habitat sampling in Canada will require collaboration with Canadian entities. ~~to study habitat in Canadian tributaries and the mainstem Skagit into Canada.~~
- There was a question about how FA-07 will address fish passage impediments and tributary barriers at the mouth of Ross Lake based on current project operations. Mike responded that this falls under the Reservoir Work Group and will be considered under evaluation of fish habitat potential.
- A suggestion was made to look at how reservoir bathymetry and changes in reservoir geomorphology limits fish passage in migration corridors.
- Given the discussion a discussion topic related to integrated between FA-07 and FA-04 was noted.
- There was general discussion about how this study and the reservoir studies (FA-03 and FA-07) address habitat in Canada. The consultant group and City Light responded that these studies ~~do~~will address Canadian tributaries and fish habitat to some extent and the future of assessments in these areas will be evaluated after initial data collection.
- In response to a question about Section 5.0 in the DCD, specifically about reservoir operations and stage fluctuation and 3D modeling (CFD) to understand fluid dynamics, Mike responded this is an important topic, but they had not scoped doing CFD ~~from a modeling standpoint~~ modeling within the reservoirs at

this stage of study. He added that concepts are being developed based on existing knowledge of where major outflows/intakes of facilities are. CFD modeling would be a recommended activity if fish passage was identified as technically feasible and moved forward to the next phase of planning and design at some point beyond the conclusion of this study.

- There was a brief discussion about using CE-QUAL W2 modeling as part of FA-01. Andrew Bearlin commented that this level of modeling is not appropriate at this timemodel would not provide similar results on CFD or reservoir hydraulics and would only provide insight on water quality parameters.
- In response to a question about data availability for completion of the DCD, Mike responded this is a common topic in AWS meetings. Some information may not be available for FA-04 until later in 2022, but the Consultant Team is committed to circling back frequently to incorporate available information, evaluate what is still needed, and adjust the DCD.
- In response to a question about downstream adult passage for steelhead kelts and bull trout, Mike responded that downstream adult passage is not currently evaluated but couldwould be included if that is an objectiveis identified as part of the goal and objective setting process.
- There was a brief discussion about periodicity and migration timing. Periodicity results from habitat suitability curve (HSC) meetings will need to feed into this study when they are available (expected November). Mike added this is part of the biological information data needed, and they are currently relying on general Skagit information.
- In response to a question about if there will be characterization of swimming and leaping of different species, Mike responded that that information is related to the second half of the study related to evaluation of potential fish passage in the Gorge Bypass Reach and would be included in that portion of the study documentation.

Action item: LPs to reach out to Becky Holloway (becky.holloway@hdrinc.com) if interested in joining bi-weekly Agency Work Session (AWGS) meetings. LPs can also review AWS meeting materials in the Triangle folder on the project SharePoint site.

Discuss Data Gaps and Identify Data Sources and Timeline to Receive

Mike Garello, HDR, led a discussion of data gaps and information needs related to development of the DCD. He reviewed the Request for Information (RFI) that was sent out and related Tracking Table for three categories of data: biological factors, operational requirements, and physical characteristics. He then gave an overview of the data collected and information needs (slides 25-26).

- A suggestion was made to contact the regional WDFW office to see if they have additional data related to stock assessment.
- In response to a question about including summer steelhead in the assessment, Mike responded they are using annual data, which are summarized in Section 3 of the DCD, and are focusing on closing data gaps before moving into setting goals and objectives. Mike added once data gaps, goals, and objectives are outlined the discussion will move into bracketing metapopulations and will incorporate data like this from FA-07 as it becomes available.
- In response to a question about incorporating data from FA-07 to inform target size and number of species, Mike responded yes that is their plan and information from FA-07 will help to shape the objectives.
- In response to a question about the source of bull trout abundance data, Erin Lowery responded the bull trout estimate was from February 2008 and is not a population estimate, but wintertime standing stock.

Next, Mike reviewed next steps for DCD development, which will include feedback on the draft preliminary DCD and discussion on a range of different topics to inform future drafts. Comments on the preliminary DCD are due by October 7th (slides 27-28).

Action item: LPs to provide comments by organization or agency on the Design Criteria Document (DCD) (with an emphasis on high level issues/flags for further discussion). Upload comments to the Triangle SharePoint by Oct. 7.

- [*PDF of DCD sent out 9/18; Word version available by request*].
- Email Greer Maier (gmaier@triangleassociates.com) if you are unable to access the SharePoint upload function.

Action item: LPs to update the Consultant Team [Becky Holloway -Becky.Holloway@hdrinc.com] if their organization/agency will not be able to meet the Oct. 7th deadline. Please indicate when you expect to have comments complete.

Jacob Ve~~r~~nard, HDR, went into more detail on what additional data is needed, including estimated adult and juvenile run sizes, and run timing, abundance information (including placeholders for future data to be obtained from other studies), and fish size and condition factors. Jacob went into detail on the type of data that is being used in the assessment and how it informs design criteria (e.g., application of reservoir fluctuation on fish passage facility type, size, and complexity). He presented on upstream and downstream passage efficiency requirements, and other design criteria necessary to assist with the layout and configuration of concept-level alternatives (see slides 40-70).

- In response to a question about how the team is planning to break the data up, i.e., by drainage, Mike shared they are trying to obtain high level production data to help guide how to best break up the data by different areas and basins.
- In response to a question on how the team envisions using existing abundance data below the dams, Mike responded the annual basin-wide information is not very informative and there are a lot of scientists currently working to understand the stock. Mike suggested using an estimate for the range that may occur as a reasonable way to bracket when extrapolation is necessary.
- In response to a question about how information on fish response to fish passage from other systems could be used, Mike replied that that could be incorporated.
- In response to a question about looking at production potential in the Upper Basin, Jacob Ve~~r~~nard reiterated that data from FA-07 will be key to answering this question when it is available.
- A suggestion was made to look at the data on Bull Trout and Summer Steelhead in the Elwha River.

Review and Assemble Potential Range of Fish Passage Strategies and Technologies that May be Considered for Evaluation

Mike Garello, HDR, gave an overview of potential fish passage strategies and technologies, and how they will be combined at a later stage of the study to formulate concept alternatives based upon biological goals and objectives.

Mike went into detail on several potential fish passage strategies and discussed how they will be refined further through future goal setting discussions. In the last phase of the study they will take the selected alternatives and develop basic illustrations and drawings, map out the costs, outline lifecycles, and plan implementation strategies (slides 73-83).

- An LP posed the question whether one wants to manage the Upper Basin as a single panmictic population or multiple populations, several members of the consultant team agreed this will need to be addressed and inform goal setting. This discussion topic was added to the discussion tracking document.

Mike then gave a broad overview on several types of fish passage technologies - including both directive (requires a high level of human intervention like trap and transport) and non-directive technologies (fish my volitionally pass without human intervention like fish ladders or nature-like fishways) (slides 85-106).

- In response to a question about the vertical heigh of the “Whooshh” system being used in the Big Bar slide area of British Columbia, Canada, Mike shared that particular system was designed for ~30 feet, about 9 vertical meters, and the actual transport length was over 1,100 ft.

Existing Biological Performance Information at PNW Fish Passage Facilities and Discussion on the Development of Performance Criteria for Project

The last part of the meeting was dedicated to a review of the biological performance of existing facilities and a brief discussion of how this informs the development of potential performance criteria for the Skagit. Mike Garello, HDR, shared how performance criteria can be developed from measurable fish passage program objectives, fish program performance standards, and standards for experimental populations. He showed the types and range of existing data on biological performance indicators (e.g. adults transported, upstream and downstream passage survival, and collection efficiency) from different facilities (slides 109-111).

Action Items, Next Steps

After comments are received on the preliminary DCD document the Consultant Team will evaluate the need for a meeting on October 28th to discuss comments received. ~~C~~High-level comments will also be discussed at the bi-weekly AWS meetings. The November meeting may be cancelled, and the December meeting will need to shift.

***Action Item*:** Triangle to discuss future meeting topics listed below with CL and HDR to get necessary workshops/meetings on the calendar.
***Action Item*:** Triangle to prepare draft meeting summary and send to participating LPs, City Light, and other attendees for review.

FP-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

ATTACHMENT D

FISH PASSAGE STUDY AGENCY WORK SESSION DISCUSSION SUMMARIES

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Agency Work Session[1]
Meeting Date – August 9, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Duncan Pfeifer, WDFW
Kevin Lautz, WDFW
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Jon-Paul Shannahan, USIT
Stephen Lewis, U.S. Fish and Wildlife Service (FWS)
Jared McKee, FWS
Jeff Garnett, FWS
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)

Seattle City Light (City Light):
Erin Lowery, City Light
Andrew Bearlin, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Introductions: Affiliation, Project Role, Relevant Experience
2. Agency Work Session (AWS) Goals and Objectives
    a. Goal of work session is to provide a collaborative forum to review activities, discuss next steps, and solicit feedback regarding the technical details involved in FA-04 efforts
    b. Discussed additional items that participants would like discussed in these meetings
3. Study Plan Progress and Schedule Update
    a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 2
    b. Reviewed current tasks already in progress
    c. Discussed concerns relating to the study plan timeline, data availability and usage, and forum for greater LP participation

Agreements

1. Consultant Team will prepare next meeting's agenda to include:
    a. Review of what the fish passage study development process entails from the ground up (general info/data required, evaluation process, etc.)
    b. Present outline of the Preliminary Draft Fish Passage Conceptual Design Criteria Document

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

   c. Discussion of data needs (gaps, availability, assembly, etc.) and how/where data requested will be incorporated into FA-04 reports and efforts
2. Agency Work Sessions (AWS) are not one-off check-in meetings and are meant to serve as recurring, collaborative work sessions used to discuss the technical details that will aid in the development of FA-04 tasks/deliverables
3. Summary meeting notes will be made available after each AWS. Notes will be posted to SharePoint maintained by Triangle.
4. An agenda will be sent out to the group prior to each AWS

Ongoing Discussion Topics

1. Next AWS call will discuss the Preliminary Draft Fish Passage Conceptual Design Criteria Document
2. City Light and Triangle are preparing a comprehensive Gantt chart that displays milestones of other on-going studies that are connected to FA-04. This chart will be provided to the LPs when complete, and discussions are planned to occur in Q4.
3. Ongoing discussion of data needs (gaps, availability, assembly, etc.) and how/where data requested will be incorporated into FA-04 efforts

Action Items

1. Consultant Team will extend all future AWS meetings from 1 hour to 1.5 hours
2. Consultant Team will reschedule the September 6th AWS meeting from Labor Day to another day that week
3. Consultant Team will provide draft agenda for next AWS meetings and solicit feedback

FA-04 Look-Ahead Schedule

Milestone / Activity	Date
Continue developing Preliminary Draft Fish Passage Conceptual Design Criteria Document	Draft delivered to LPs 9/17/2021
AWS Meeting No. 2	8/23/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Agency Work Session[1]
Meeting Date – August 23, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Ashley Rawhouser, National Park Service (NPS)

Seattle City Light (City Light):
Andrew Bearlin, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greeting, Attendance, and Agenda Review
    a. Mike began the meeting with roll call and a brief overview of the anticipated agenda
    b. No new topics were added or requested
2. Fish Passage Assessment Approach
    a. Provided overview of fish passage study approach based upon Final FA-04 RSP
    b. Discussed data linkages and how available data can influence the development of fish passage strategies and facility concepts
        i. Biological data has significant influence on facility type, size, location, configuration, and operational requirements
        ii. As applicable, rationale will be provided for why specific data was used/not used
    c. Discussed approach to filling data gaps when needed
        i. Placeholders will be created for data gaps/uncertainties in the current narrative; data that later becomes available can be folded in and concepts/strategies can be reevaluated in an iterative process
        ii. Assumptions can be discussed/evaluated in the AWS group; additional feedback will be solicited from the LPs when they review the interim reports
    d. Discussed general approach to developing strategies and concepts
        i. Potential alternatives can be scaled to consider a range of biological and physical conditions as well as management strategies
3. Study Plan Progress and Schedule Update
    a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 2
    b. Reviewed current tasks already in progress and next steps
        i. Continue developing Preliminary Draft Design Criteria Document (DCD)

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

    ii. Continue gathering and synthesizing data to address remaining data gaps
    iii. Establish preliminary technical, operational, and biological goals, criteria, and constraints
4. Future Discussion Topics/Agenda Items for Next Meeting
    a. Discuss lists of inputs/data sources for the DCD and assumptions used when we don't have data
        i. Review full data needs list and biological data needs list
        ii. Present the data we have and discuss data gaps and how we can work together to fill those gaps
    b. Updates on on-going work on the Gorge Bypass Reach
        i. Attendees requested that we include updates on the Gorge Bypass Fish Passage Evaluation
        ii. Opportunity for updates: FA-05 Workshop #3 on Thursday, 8/26/21. This workshop will provide detailed updates on data collection activities performed to date for the Gorge Bypass Fish Passage Evaluation

Agreements

1. Consultant Team will prepare next meeting's agenda to include:
    a. Discussion of the list of inputs/data sources for the DCD and assumptions to use when we don't have data
        i. Review full data needs list and biological data needs list (e.g., run-timing, outmigration timing, reservoir curves)
        ii. Present the data we have and discuss data gaps and how we can work together to fill those gaps
        iii. Discuss what data means to a specific passage concept/strategy
2. AWS will serve as a forum to discuss assumptions and the rationale for using/not using data
3. AWS participants serve as liaisons to the greater LP group/data co-managers and will relay information, feedback, questions, and concerns to the AWS group to be addressed at subsequent workshops

Ongoing Discussion Topics

1. Use of assumptions and data
    a. Data needs (gaps, availability, assembly, etc.) and how/where data requested will be incorporated into FA-04 efforts
    b. Rationale for using/not using data and assumptions
2. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available (e.g., reservoir temperature studies)

Action Items

1. Consultant Team to share copy of today's presentation
2. Consultant Team to share lists of info/data needs
    a. Detailed list of greater information needs
    b. List of biological information needs
3. Consultant Team to include study name/number on emails

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Preliminary DCD development	7/16/ 2021 - 9/17/2021
Workshop #2 PPT Presentation Development	8/27/2021 – 9/17/2021
Workshop # 2 LP Agenda Review	9/7/2021
AWS Meeting #3	9/8/2021
Submit Agenda, Workshop PPT Presentation, and Preliminary Draft DCD to LPs	9/17/2021
AWS Meeting #4	9/20/2021
Workshop #2	9/23/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Agency Work Session[1]
Meeting Date – September 8, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jared McKee, U.S. Fish and Wildlife Service (FWS)
Jeff Garnett, FWS
Logan Negherbon, National Marine Fisheries Service (NMFS)
Ashley Rawhouser, National Park Service (NPS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Duncan Pfeifer, WDFW

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowery, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Attendance, Agenda, and Action Items Review
    a. Mike began the meeting with roll call and a brief overview of the anticipated agenda
    b. No new topics were added or requested
    c. Action items from previous meeting were reviewed and all were noted as completed
2. Data Collection and Information Needs
    a. Provided a high-level overview of the Request for Information (RFI) Tracking Table
        i. Discussed development of the tracking table and how it is an evolving list that will continually be refined as the study progresses and more information becomes available
        ii. Discussed how tracking list could be improved with fields and placeholders for linkages to other concurrent studies
        iii. Co-managers are working on a response to the biological data RFI
    b. Provided a summary of data collected and data gaps identified thus far
        i. Discussed the need for more specific data on fish abundance, fish size, peak migration timing, reservoir transit behavior, and survival of juvenile outmigrants
        ii. Habitat Suitability Curves (HSC) group for FA-02 is beginning to discuss species periodicity this month and their findings would be useful for FA-04 efforts
    c. Presented examples of how data is used to inform concept development

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

    i. Demonstrated how abundance data along with peak migration data and periodicity influences facility size and complexity
    ii. Demonstrated how reservoir fluctuation data influences facility size, location, and complexity
  d. Discussed how information from other concurrent studies will be tracked and evaluated at a future check-in point
    i. Information from other studies with be evaluated and incorporated at a later date as it becomes available and necessary updates to the FA-04 study will be incorporated accordingly
    ii. Upcoming deliverables will utilize the information currently available and placeholders and ranges for values will be incorporated for results of other ongoing studies
  e. Discuss real estate issues/limitations within NPS boundary
    i. Cultural and recreational uses

3. Study Plan Progress and Schedule Update
  a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 2
  b. Reviewed current tasks already in progress and next steps
    i. Continue gathering and synthesizing data to address remaining data gaps
    ii. Establish preliminary technical, operational, and biological goals, criteria, and constraints
    iii. Prepare Preliminary Draft Design Criteria Document (DCD)
    iv. Prepare Workshop No. 2 PPT
4. Future Discussion Topics/Agenda Items for Next Meeting
  a. Continue discussion of RFI Tracking Table with focus on biological data needs and data gaps to fill
  b. Discuss target/focal species for passage and the different strategies/technologies that may be employed to accommodate selected species

Agreements

1. Consultant Team will prepare next meeting's agenda to include:
  a. Continuing discussion of RFI Tracking Table with focus on biological data needs and data gaps to fill
  b. Discussion of target species for passage and the different strategies/technologies that may be employed to accommodate selected species
    i.
2. RFI Tracking Table is an evolving list that will continually be refined as the study progresses and more information becomes available
3. Consultant Team will add the following to RFI list:
  a. Coordination with NPS cultural and recreational staff required to refine development constraints
  b. Column for linkages to on-going studies, and how they may inform biological data

Ongoing Discussion Topics

1. Use of assumptions and data
  a. Data needs (gaps, availability, assembly, etc.) and how/where data requested will be incorporated into FA-04 efforts
  b. Rationale for using/not using data and assumptions
2. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. Consultant Team to share copy of today's presentation
2. Consultant Team to update RFI Tracking Table with suggested feedback and reshare and solicit questions:
    a. Line-item placeholders for data from other ongoing studies
    b. Column showing linkage to other studies for each line item, as applicable
3. Consultant Team to include Pacific Lamprey on periodicity chart and share chart with AWS group to request feedback

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Preliminary DCD development	7/16/ 2021 - 9/17/2021
Workshop #2 PPT Presentation Development	8/27/2021 – 9/17/2021
Submit Agenda, Workshop PPT Presentation, and Preliminary Draft DCD to LPs	9/17/2021
AWS Meeting #4	9/20/2021
Workshop #2	9/23/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Agency Work Session[1]
Meeting Date – September 20, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jared McKee, U.S. Fish and Wildlife Service (FWS)
Jeff Garnett, FWS
Stephen Lewis, FWS
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Duncan Pfeifer, WDFW

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowery, City Light

Consultant Team:
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings and Agenda Review
    a. Becky began the meeting with a brief overview of the anticipated agenda
    b. No new topics were added or requested
2. Data Collection and Information Needs
    a. Continued discussing the RFI Tracking Table
        i. Discussed how FA-04 will incorporate results from FA-08 Fish Entrainment Study
            1. Discussed potential data gap of entrainment potential for smaller classes of fish. City Light to reach out NPS and USGS for available gill net data.
            2. Desktop portion of entrainment study (FA-08) to be completed with the ISR. These results should be available to incorporate in the next FA-04 deliverable (Conceptual Design Report) in spring/summer 2022.
3. Target/Focal Species for Passage
    a. Discussed development of species list—list was approved by LPs at Workshop 1
    b. Clarification needed on the differentiation, if any, between “focal” vs. “target” species.
        i. AWS group suggested to choose one term and use that term moving forward—“target” would be preferred terminology to use.
    c. Discussed that upstream and downstream passage considerations will vary by species
        i. Vertical distribution of species varies greatly and will need to be considered

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

   d. Discussed available information for target species
      i. Lamprey—Consultant Team has guidelines and best management documents for passage, but welcomes any data specific to the upper Skagit River basin and occurrence/run sizes
      ii. Salish Sucker—Discussed need for more information specific to the upper Skagit River
   e. Periodicity chart will be continually refined and updated accordingly per HSC developments e.g., peak timing for each species, inclusion of post-spawning kelts
4. Study Plan Progress and Schedule Update
   a. Preliminary Draft DCD sent out to LPs on 9/17/21 for review
      i. Comments/feedback requested by 10/7/21. More specifics will be discussed at Workshop 2 on 9/23/21 along with any preliminary comments on the DCD
5. Future Discussion Topics/Agenda Items for Next Meeting
   a. Progress check on Preliminary Draft DCD comments
   b. Initiate discussions on biological goals and objectives for each target species

Agreements

1. Consultant Team will prepare next meeting's agenda to include:
   a. Progress check on Preliminary Draft DCD comments
   b. Discussion of biological goals and objectives for each target/focal species
2. Species periodicity chart will be continually refined and updated per HSC developments

Ongoing Discussion Topics

1. Data collection and information needs
2. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available
3. Species periodicity chart

Action Items

1. Erin Lowery (City Light) to reach out to USGS and NPS regarding availability of gill net data on smaller fish size classes for entrainment study
2. Consultant Team to follow up with definitions for "target" and "focal" species and which term will be used moving forward
3. Consultant Team to continually update species periodicity chart per HSC developments
   a. Peak timing for each species
   b. Remove duplicate Skagit Sockeye
   c. Inclusion of information for post-spawning kelts (tasked to FA-02 team)

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Preliminary Draft DCD Review by LPs	9/17/2021 – 10/7/2021
Workshop #2	9/23/2021
AWS Meeting #5	10/4/2021
Preliminary Draft DCD LP Comments Due	10/7/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Agency Work Session[1]
Meeting Date – October 4, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Duncan Pfeifer, WDFW

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowery, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Mike began the meeting with a brief overview of the anticipated agenda
        i. No new topics were added or requested
    b. Action Item Review (from 9/20/21 meeting)
        i. Species selected for fish passage design will be termed “target species” in documents
        ii. Periodicity table has been updated in DCD and will continually be updated as table is refined by HSC group. Additional periodicity meetings will occur in October.
        iii. Erin L. to reach out to USGS and NPS regarding gill net data – Eric clarified that fish collection data using gill nets in Ross reservoir won’t provide info on abundance but may provide insight on presence/absence and fish size. Recognize that the nets exhibit larger mesh sizes and won’t capture smaller fish size classes and may not be useful for the entrainment study (FA-08).
2. Progress Check on Preliminary Draft DCD Comments
    a. High-level discussion on review progress
    b. Comments requested by 10/7/21 as preferably one consolidated set of comments per affiliation.

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

        i. Not a hard deadline, but comments received after may not be incorporated in time for the next iteration of the DCD (Revised DCD).

3. Setting Biological Goals and Objectives for Target Species
    a. Reviewed the Fish Passage Facilities Assessment Process. Current stage of study: Defining Goals and Objectives
        i. This stage of the study process will develop a range of fish passage alternatives that meet an initial range of established biological goals and objectives determined through AWS meetings and feedback from the LPs
        ii. Per NMFS, USFWS, WDFW, USIT, and NPS Study Requests for Feasibility Analysis of Fish Passage, objectives include:
            1. *Development of criteria for determining feasibility of passage concepts based on biological needs and engineering feasibility*
            2. *If passage concepts are determined feasible, additional studies will be necessary to support validation and design of the concept, including but not limited to, biologic studies, hydrodynamic modeling, and associated engineering studies*
    b. Discussed the proposed process for setting goals and objectives
        i. Next AWS meetings will be dedicated to the individual discussion of:
            1. Goals—establish goals for fish passage
            2. Objectives—develop measurable objectives to meet each goal
            3. Benefits—identifying benefits will help determine if the project is consistent with its goals and objectives and provides a "check-in" point to see if a project is appropriate to pursue and whether changes might be required to meet goals
            4. Risks (e.g., genetic implications introduction of invasive species/disease)
            5. Constraints (e.g., reservoir conditions for passage, identification of source population)
        ii. Theo presented the web-based 'Mural' platform to be used in the Goal Setting Brainstorm Exercise to be conducted at the next AWS meeting on 10/18/21
            1. Results from this brainstorm session will be summarized, shared, and discussed at subsequent AWS meetings
            2. Similar brainstorm sessions will be conducted for Objectives, Benefits, Risks, and Constraints at subsequent AWS meetings
    c. Discussed fish passage goals, objectives, benefits, risks, and constraints
        i. Presented case studies to demonstrate that goal/objective setting is an important, long-term, iterative process that is unique to each project
        ii. Range of alternatives are formulated based upon initial goals and objectives.
        iii. As shown in other case studies, the process can take multiple iterations over decades. This study will be an initial step, but further study and collaboration will be required if a fish passage program were to move forward.
4. Study Plan Progress and Schedule Update
    a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 3
        i. FA-04 Workshop No. 3 tentatively set for 12/16/21
    b. Reviewed current tasks already in progress and next steps
        i. Define goals, objectives, benefits, risks, and constraints
        ii. Prepare Revised Draft DCD
        iii. Prepare ISR report
5. Future Discussion Topics/Agenda Items for Next Meeting
    a. Subsequent AWS meetings will be focused individually on goals, objectives, benefits, risks, and constraints, with the next meeting on 10/18/21 focused on goal setting.
    b. Participants noted that more than one meeting per topic may be desired.

Agreements

1. Consultant Team will prepare next meeting's agenda to include:
    a. Goal Setting
        i. Brainstorm Session using Mural
        ii. Discussion

Ongoing Discussion Topics

1. Goals, objectives, benefits, risks, and constraints
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. Consultant Team to share copy of today's presentation
2. AWS participants to come ready to share ideas during goal setting brainstorm exercise that will occur during the next AWS meeting on 10/18/21

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Preliminary Draft DCD LP Comments Due	10/7/2021
Consultant Team incorporates LP comments on DCD	10/8/2021 – 11/18/2021
AWS Meeting #6	10/18/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – October 18, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the anticipated agenda
        i. No new topics were added or requested
    b. Action Item Review (from 10/4/21 meeting)
        i. Erin L. to reach out to USGS and NPS regarding gill net data—Erin on PTO this week. Note to follow up with him next meeting.
2. Progress Check on Preliminary Draft DCD Comments Received to Date
    a. NMFS Comments
        i. Discussed comment on Bell 1991 estimates of fish size and fishery sources for average weights (p. 3-19)
            1. Becky asked the group for guidance on available data sources on average weights. AWS participants to explore their sources for this data—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)
        ii. Discussed and clarified comment on characterization of dams (p. 6-1)
            1. Logan clarified that the intent of this comment was to point out that characterizing high head dams by the hydraulic differential exceeding 100 feet excludes relevant technologies applied at lower head systems. Criteria should be a bit more generalized/flexible to ensure the inclusion of analogous dams in the study

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

        2. Mike agreed and noted that criteria language will be softened to be more flexible to include a wider range of facilities that are analogous to ones that may be considered on the Skagit Project
   b. USIT and FWS to provide comments on DCD this week
3. Individual/Group Goal Setting Exercise and Discussion
   a. Mike reviewed general definitions of goals and objectives and the goal/objective setting process
   b. Theo led sample mind mapping/word cloud exercise to demonstrate the Poll Everywhere tool using "Goals when buying a new car" as the sample prompt
   c. Theo initiated the individual mind mapping/word cloud exercise for setting goals for the Fish Passage Study
      i. Stan expressed concerns with participating in the biological goal setting exercise—stated that comanagers of the fisheries resources in the basin need to have policy-level discussions before developing goals. Thus, goal setting should not occur as part of FA-04, but rather will be informed by concurrent studies and agency/tribal discussions in the future.
      ii. Many AWS participants concurred (Logan, Brian, Jeff) and echoed sentiments that discussions about biological goals and objectives were premature.
      iii. The consensus of participants was that AWS group discussions should focus on the technical feasibility of fish passage and that the study outcome is not "is passage feasible and how should it be conducted" but "is it feasible and by what methods" (per NMFS comments on the preliminary draft DCD)
      iv. AWS participants indicated they wanted to shift focus to technical fish passage goals (e.g., range of passage operating conditions, attracting fish at a range of flows, attracting fish at range of full pool elevations) and wanted to explore the whole suite of passage options that are physically possible at each dam
   d. Mike pivoted the discussion to what technical fish passage goals may look like and reviewed alternative formulation and strategies from Workshop No. 2
      i. Fish Passage Strategies—3 main ideas with numerous permutations possible in between
         1. Reservoir Bypass Strategy
         2. Reservoir Tributary Strategy
         3. Reservoir Transit Strategy
      ii. Mike proposed to rearrange the study development process in which passage alternatives (strategies and technologies) are formulated first, then discussions on what biological parameters for each target species are/are not met are brainstormed for each alternative
         1. AWS participants expressed preference for this approach
4. Study Plan Progress and Schedule Update
   a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 3
      i. FA-04 Workshop No. 3 set for 12/16/21
         1. Revised Draft DCD to be sent to LP's the week prior (12/9/21)
   b. Reviewed current tasks already in progress and next steps
      i. Fish passage alternatives formulation
      ii. Prepare Revised Draft DCD
      iii. Prepare ISR report
5. Future Discussion Topics/Agenda Items for Next Meeting
   a. Fish passage alternatives formulation—brainstorm strategies and technologies

Agreements

1. Establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of FA-04, but rather will be informed by concurrent studies and agency/tribal discussions in the future with consideration of recovery planning targets and current and future harvest objectives. Therefore, FA-04 will not establish biological goals and objectives for fisheries resource management but will rather consider biological requirements of target species within the anticipated operating environments of the Gorge, Diablo, and Ross developments. These factors will inform a range of upstream and downstream passage facility alternatives that may be evaluated as part of the study.
2. Consultant Team will prepare next meeting's agenda to include:
    a. Fish passage facilities alternatives formulation—brainstorm strategies and technologies

Ongoing Discussion Topics

1. Formulation of fish passage facility alternatives for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. LPs to review Preliminary Draft DCD and upload comments to the LP Comments to DCD folder on the Triangle SharePoint
2. AWS participants to look for available data on average fish weights—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)
3. Erin L. to reach out to USGS and NPS regarding gill net data

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Consultant Team incorporates LP comments on DCD	10/8/2021 – 11/18/2021
AWS Meeting #7	11/1/2021

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – November 1, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Stephen Lewis, FWS
Ashley Rawhouser, National Park Service (NPS)
Keith Kirkendall, National Marine Fisheries Service (NMFS)
Logan Negherbon, NMFS
Stan Walsh, Skagit River System Cooperative (SRSC)
Amy Trainer, Swinomish Indian Tribe
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)

Seattle City Light (City Light):
Andrew Bearlin, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the anticipated agenda
    b. Action Item Review (from 10/18/21 meeting)
        i. Data on average fish weights—USIT looking into available data, will keep action item open for other LPs to continue research as well
2. Preliminary Draft DCD Comments
    a. Becky provided a brief overview of comments received to date: NMFS, USFWS, USIT
        i. Comment responses are being tracked in a comment-response matrix and applicable responses are being incorporated into the Revised Draft DCD
    b. Comments received after 11/5/2021 may be deferred to the next iteration of the DCD
3. Fish Passage Alternatives Formulation—Gorge Development
    a. Alternative Brainstorming and Formulation—Mike presented the goals and objectives for the alternative brainstorming and formulation process:
        i. Reboot of the brainstorming process for fish passage alternatives development
        ii. Focus on range of technical options, criteria, and design considerations that influence alternative formulation
        iii. Provide an open forum for brainstorming, discussion, and feedback with AWS participants
    b. Overview of FERC Skagit Project Area and Gorge Development

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

i. Mike presented maps, illustrations, aerial figures, and profile figures to provide an overview of the FERC Skagit Project Area and Gorge Development

c. Joint Brainstorming Session of the Gorge Development
   i. Theo introduced and demonstrated the use of the MURAL platform to kick off the brainstorming exercise. AWS participants were encouraged to participate using the shared web link.
   ii. Mike guided and facilitated the Mural brainstorm session for the Gorge Development, posing questions and generating discussion amongst AWS participants
      1. Brainstorming topics included (where: US - Upstream Fish Passage; DS – Downstream Fish Passage)
         a. Fish Collection Locations (US/DS)
         b. Fish Release Locations (US/DS)
         c. Key Considerations (US/DS)
         d. Risks or Concerns (US/DS)
         e. Potential Technologies (US/DS)
         f. Data Gaps
         g. Other
   iii. AWS participants shared their thoughts, ideas, and concerns for the range of brainstorming topics
   iv. The consensus amongst AWS participants was that because we are in the early stages of the alternative formulation and development process, a more comprehensive range of alternatives and strategies should be considered and documented.
   v. AWS participants stressed the importance of including consistent notation for upstream (US) and downstream (DS) when placing sticky notes during the exercise.
   vi. See **Attachment A** for brainstorm results and discussion

4. Study Plan Progress and Schedule Update
   a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 3
      i. Revised Draft DCD submitted to LPs on 12/9/2021
      ii. FA-04 Workshop No. 3 on 12/16/2021
   b. Reviewed current tasks already in progress and next steps
      i. Continue formulating fish passage alternatives
      ii. Prepare Revised Draft DCD
      iii. Prepare ISR report
5. Future Discussion Topics/Agenda Items for Next Meeting
   a. AWS 8 (11/15/2021):
      i. Review results of alternatives setting exercise and discussion for the Gorge Development
      ii. Alternatives formulation for the Diablo Development
   b. AWS 9 (11/29/2021):
      i. Review results of alternatives setting exercise and discussion for the Diablo Development
      ii. Alternatives formulation for the Ross Development

Agreements

1. Establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of FA-04, but rather will be informed by concurrent studies and agency/tribal discussions in the future with consideration of

recovery planning targets and current and future harvest objectives. Therefore, FA-04 will not establish biological goals and objectives for fisheries resource management but will rather consider biological requirements of target species within the anticipated operating environments of the Gorge, Diablo, and Ross developments. These factors will inform a range of upstream and downstream passage facility alternatives that may be evaluated as part of the study.

2. A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up-front and eliminated in subsequent stages as feasibility is assessed.
3. Consultant Team will prepare next meeting's agenda to include:
    a. Review results of alternatives setting exercise and discussion for the Gorge Development
    b. Fish passage alternatives formulation for the Diablo Development

Ongoing Discussion Topics

1. Formulation of fish passage facility alternatives for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. AWS participants to look for available data on average fish weights—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Requested comments on Preliminary Draft DCD	10/7/2021
Consultant Team incorporates LP comments on DCD	10/8/2021 – 11/15/2021
AWS Meeting #8	11/15/2021

Attachment A: Gorge Development Brainstorm Results and Discussion

The brainstorm session results and discussion for the Gorge Development are depicted in **Figure 1** and summarized in **Table 1**.

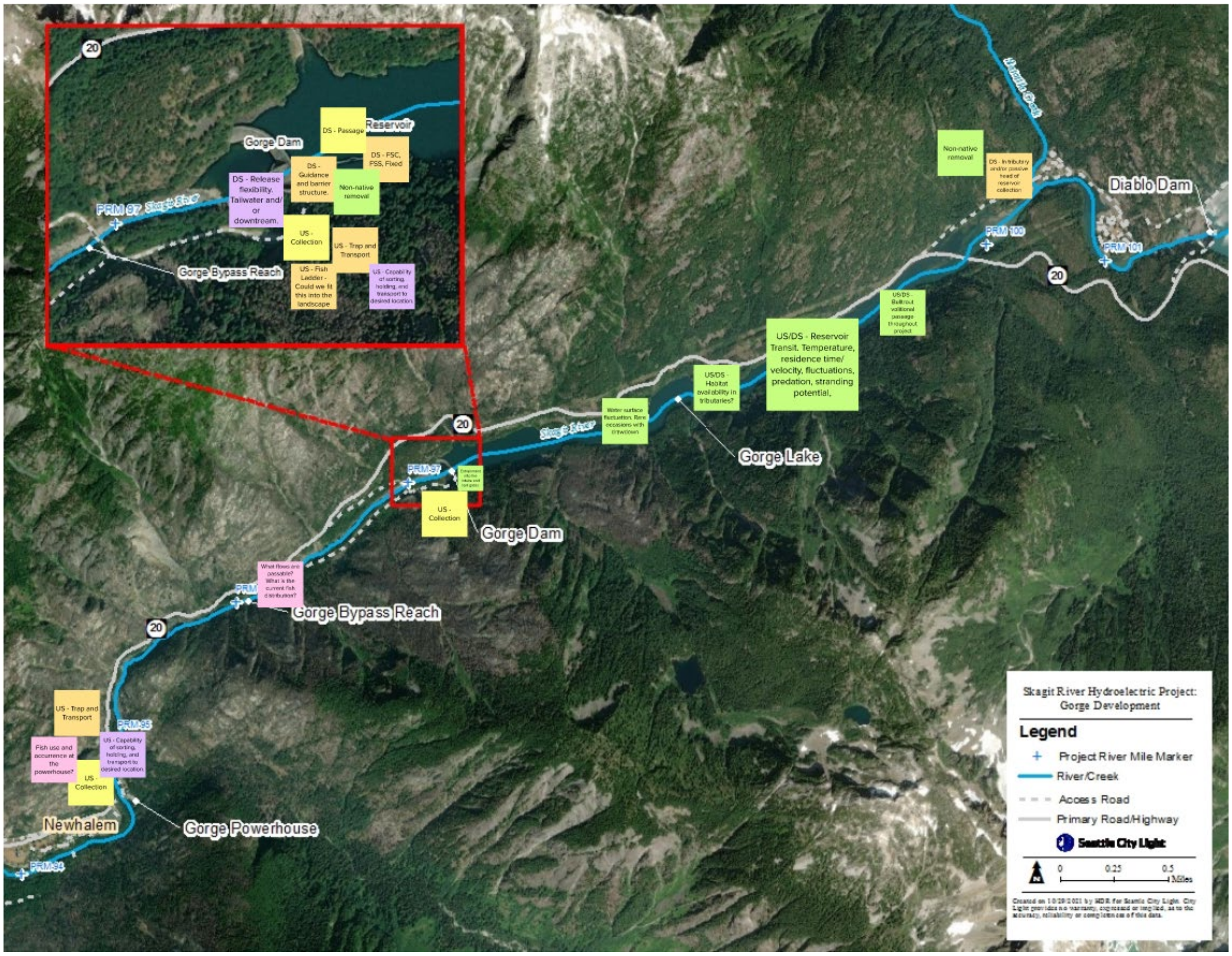


Figure 1. Mural Brainstorming Results for the Gorge Development

Table 1. Mural Brainstorming Results for the Gorge Development

Sticky Color	**Brainstorming Topic**	**Comment**
Green	Key Considerations	A key consideration for Downstream Fish Passage at Gorge Dam is the risk of entrainment into the intake and spill gates.
Green	Key Considerations	A key consideration for all fish passage facilities would be to consider the need for non-native species removal.
Green	Key Considerations	A key consideration for upstream and downstream passage throughout the project is allowing Bull trout volitional passage through the reservoir systems to promote foraging and natural migration into available tributary habitat.
Green	Key Considerations	A key consideration for upstream and downstream passage is the estimation of habitat availability in tributaries. The availability and quality of habitat available in key tributaries may influence the need and desire to

		use a reservoir transit strategy and/or emphasize methods to promote access to and production in specific tributaries.
Green	Key Considerations	Key considerations for upstream and downstream passage within the reservoir transit strategy are water temperature, residence time/velocity, water surface fluctuations, predation, and stranding potential. Reservoir transit should be evaluated to the extent possible as part of the fish passage feasibility assessment process.
Green	Key Considerations	A key consideration for fish passage is the water surface fluctuation within Gorge Reservoir with rare occasions of drawdown (for maintenance). The influence on reservoir fluctuation of technology selection should be evaluated as part of the fish passage feasibility assessment process.
Orange	Potential Technologies	Potential downstream passage technologies at the Gorge Dam include Floating Surface Collector, Floating Screen Structure, and a Fixed Collector.
Orange	Potential Technologies	Potential downstream passage technologies at the Gorge Dam should consider the need for guidance and barrier structures to reduce the potential for entrainment.
Orange	Potential Technologies	Potential downstream passage technologies in the Gorge Reservoir include in-tributary and/or passive head of reservoir collection at Stetattle Creek.
Orange	Potential Technologies	A potential upstream passage technology at the Gorge Dam is a Technical Fish Ladder. Fitting this into the landscape is a consideration for use of this technology.
Orange	Potential Technologies	A potential upstream passage technology at the Gorge Dam is Trap and Transport.
Orange	Potential Technologies	A potential upstream passage technology at the Gorge Powerhouse is Trap and Transport.
Pink	Data Gaps	Data gaps at the Gorge Powerhouse include a characterization of fish use and occurrence.
Pink	Data Gaps	Data gaps within the Gorge Bypass Reach include an estimation of what flows are passable and a determination of the current fish distribution.
Purple	Fish Release Locations	For downstream release, there is interest in retaining the flexibility to release into the Gorge Bypass Reach, downstream of Gorge Dam into dam tailwater.
Purple	Fish Release Locations	For upstream fish passage at Gorge Dam using trap and transport technologies, there is interest in the capability of sorting, holding, and transporting fish to desired locations within Gorge Reservoir or elsewhere in the Project as required based upon future management goals not yet determined.
Purple	Fish Release Locations	For downstream fish passage at Gorge Dam using a trap and transport technology, there is interest in the capability of sorting, holding, and transporting fish to desired locations within the Skagit River system based upon future management goals not yet determined.
Yellow	Fish Collection Location	For downstream collection from within the Gorge Reservoir, there is opportunity to site potential downstream fish passage facilities on left (south) side of the reservoir in front of the intake structure.
Yellow	Fish Collection Location	For upstream collection, there is opportunity at Gorge Dam within the Gorge Bypass Reach.
Yellow	Fish Collection Location	For upstream collection, there is opportunity at the Gorge Powerhouse the Skagit River mainstem.

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – November 15, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Ashley Rawhouser, National Park Service (NPS)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Amy Trainer, Swinomish Indian Tribe
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Duncan Pfeifer, WDFW

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the anticipated agenda
        i. No new topics were added or requested
    b. Action Item Review (from 11/1/21 meeting)
        i. Data on average fish weights—No new updates from LPs. Will keep action item open for LPs to continue looking into.
2. Preliminary Draft DCD Comments
    a. Comments received from NMFS, USFWS, USIT, and Swinomish
        i. Comment responses are being incorporated into the Revised Draft DCD
        ii. USIT comments on temperature data—Info/data from FA-01 will be incorporated into the Final DCD or future deliverables, as the information from FA-01 becomes available
3. Review of Results of Alternatives Setting Exercise and Discussion for the Gorge Development
    a. Mike reviewed the process and results of the brainstorming exercise and discussion for the Gorge Development
        i. Results were summarized in a figure and table in 11/1/21 meeting notes
    b. Mike presented figures demonstrating potential fish passage facility locations and options for the Gorge Development resulting from brainstorm session during previous AWS.
        i. Upstream Fish Passage Options at Gorge Dam
            1. Fish ladder
            2. Trap and transport

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

    ii. Upstream Fish Passage Options at Gorge Powerhouse
        1. Fish ladder to Gorge Dam
        2. Trap and transport
    iii. Downstream Fish Passage Options at Gorge Dam
        1. Forebay collectors
        2. Gravity bypass
            a. To stilling basin and Gorge Bypass Reach
            b. To point downstream of Gorge Bypass Reach
        3. Tributary collection
            a. In-tributary collection weir(s)
            b. Head of reservoir passive collection system(s)

4. Fish Passage Options Formulation—Diablo Development
    a. Fish Passage Options Brainstorming and Formulation—Mike presented the goals and objectives for the options brainstorming and formulation process:
        i. Continuation of the brainstorming process for fish passage alternatives development
        ii. Focus on range of technical options, criteria, and design considerations that influence alternative formulation
        iii. Provide an open forum for brainstorming, discussion, and feedback with AWS participants
    b. Review of Existing Conditions
        i. Mike presented maps, illustrations, aerial figures, and profile figures to provide an overview of the Upper Skagit System and the Diablo Development
            1. Elevations for development profile figures are in NAVD 88
    c. Potential Fish Passage Options for the Diablo Development
        i. Mike presented figures demonstrating potential fish passage facility locations and transport options for the Diablo Development
            1. Upstream Fish Passage Options at the town of Diablo
                a. Fish ladder to Diablo Dam
                b. Trap and transport
            2. Downstream Fish Passage Options at Diablo Dam
                a. Forebay collectors
                b. Gravity bypass
                    i. To point of release near Diablo Powerhouse
                c. Tributary collection
                    i. In-tributary collection weir(s)
                    ii. Head of reservoir passive collection system(s)
    d. Joint Brainstorming Session of the Diablo Development
        i. Theo shared the web link to the Mural platform to kick off the brainstorming exercise. AWS participants were encouraged to participate using the shared web link.
        ii. Mike guided and facilitated the Mural brainstorm session for the Diablo Development, posing questions and generating discussion amongst AWS participants
            1. Brainstorming topics included:
                a. Fish Collection/Entrance Locations (US/DS)
                b. Fish Release/Exit Locations (US/DS)
                c. Key Considerations (US/DS)
                d. Risks or Concerns (US/DS)
                e. Potential Technologies (US/DS)
                f. Data Gaps

        g. Other
    iii. AWS participants shared their thoughts, ideas, and concerns for the range of brainstorming topics
    iv. See **Attachment A** for brainstorm results and discussion
5. Study Plan Progress and Schedule Update
    a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 3
        i. Revised Draft DCD submitted to LPs on 12/9/2021
        ii. FA-04 Workshop No. 3 on 12/16/2021
    b. Reviewed current tasks already in progress and next steps
        i. Continue formulating fish passage alternatives
        ii. Prepare Revised Draft DCD
        iii. Prepare ISR report
6. Future Discussion Topics/Agenda Items for Next Meeting
    a. Agenda Items for AWS 9 (11/29/21)
        i. Review results of alternatives setting exercise and discussion for the Diablo Development
        ii. Alternatives setting exercise and discussion for the Ross Development
    b. Future Discussion Topics/Requests/Questions
        i. AWS participants requested summary of passage options for Diablo and Ross developments before the next meeting
        ii. AWS participants asked if there will be a discussion of decision-making criteria to determine feasibility
            1. A discussion of factors influencing fish passage facility feasibility will be part of FA-04 Workshop No. 3

Agreements

1. A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up-front and eliminated in subsequent stages as feasibility is assessed.
2. Consultant Team will prepare next meeting's agenda to include:
    a. Review results of alternatives setting exercise and discussion for the Diablo Development
    b. Fish Passage Options brainstorming exercise and discussion for the Ross Development

Ongoing Discussion Topics

1. Formulation of fish passage facility alternatives for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. AWS participants to look for available data on average fish weights—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)
2. Consultant team reiterated previous request for available data on Salish sucker and Pacific lamprey in the Skagit River, specifically in the bypass reach
3. Consultant Team to provide summary of passage alternatives for Diablo and Ross Developments before the next AWS meeting in preparation for the discussion; summary for Diablo will be in the form of meeting notes from AWS #8; summary for Ross will include a pre-view of the presentation for AWS #9

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
AWS Meeting #9	11/29/2021
Consultant Team to submit Revised Draft DCD to LPs	12/9/2021
AWS Meeting #10	12/13/2021
FA-04 Workshop No. 3	12/16/2021

Attachment A: Diablo Development Brainstorm Results and Discussion

The brainstorm session results and discussion for the Diablo Development are depicted in **Figure 1** and summarized in **Table 1**.

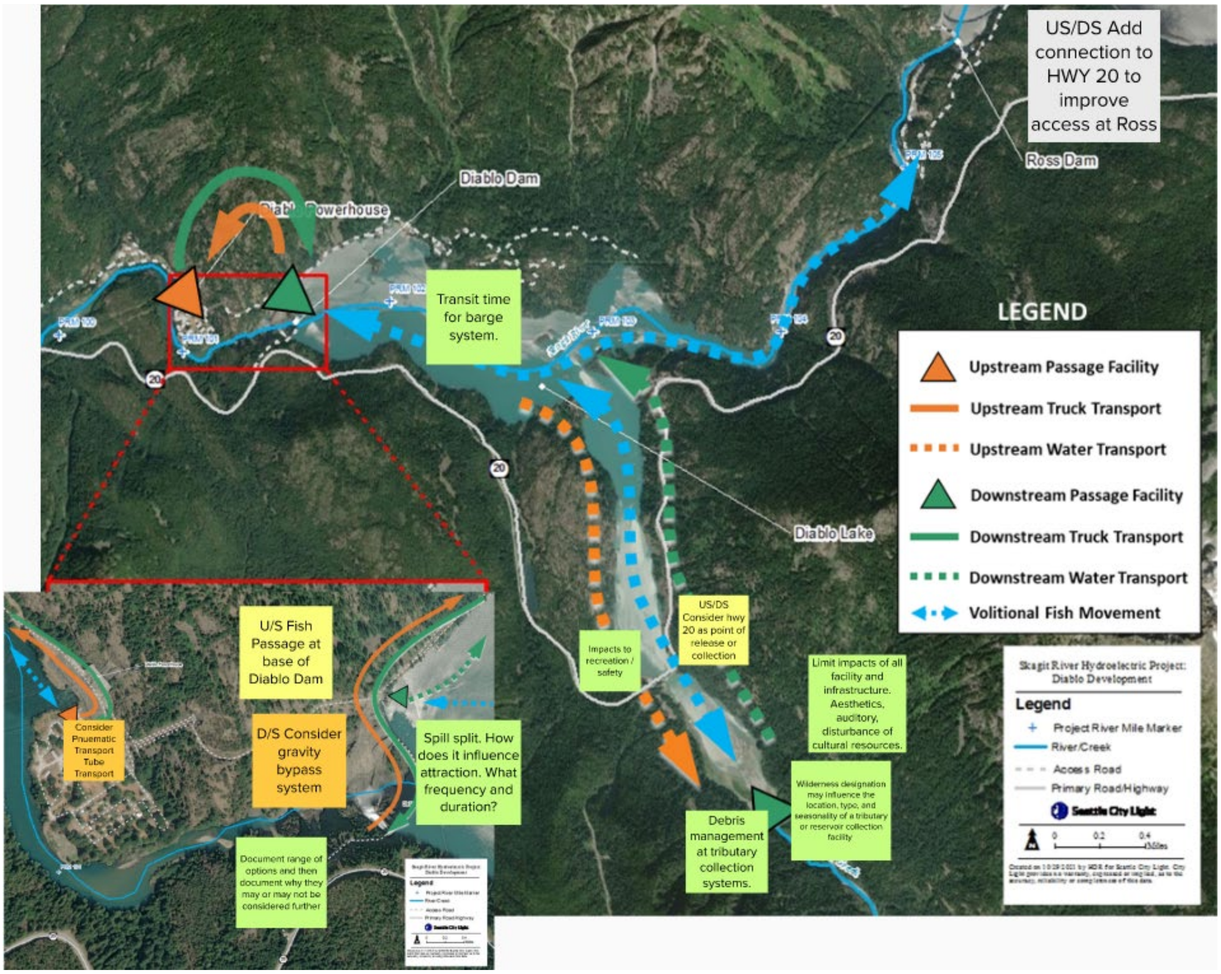


Figure 1. Mural Brainstorming Results for the Diablo Development

Table 1. Mural Brainstorming Results for the Diablo Development

Sticky Color	**Brainstorming Topic**	**Comment**
Green	Key Considerations	A key consideration for all passage options is to document the range of all options and provide justification for removal of options not considered further in the alternative formulation process.
Green	Key Considerations	A key consideration for passage within Diablo Reservoir is transit time for the barge system. Existing road infrastructure does not exist to Ross Dam.
Green	Key Considerations	A key consideration for passage at Diablo Dam is how spill is split between the spill gates, spill frequency and duration, and how attraction would be influenced by these operational patterns.
Green	Key Considerations	A key consideration for a potential tributary or reservoir collection system at Thunder Creek is debris management. There are potentially high magnitude, frequency, and duration of debris events that may negatively influence fish passage facility operation at the tributary level.
Green	Key Considerations	A key consideration for a potential tributary or reservoir collection facility at Thunder Creek is wilderness designation. This may influence the allowable location, type, and seasonality of the facility.

Green	Key Considerations	A key consideration for all potential passage facilities and infrastructure is to limit disturbance to cultural resources (aesthetics, auditory, etc.)
Green	Key Considerations	Key considerations for a potential tributary or reservoir collection facility at Thunder Creek are safety and impacts to recreation (e.g., boat launch and campgrounds located in the Thunder Arm vicinity).
Yellow	Fish Collection Location	For upstream transport collection, there is opportunity at the base of Diablo Dam.
Yellow	Fish Collection Location	For upstream and downstream transport, there is opportunity to site a facility at Hwy 20 crossing of Thunder Arm as a point of release or collection.
Orange	Potential Technologies	For upstream transport in the town of Diablo, consider the use of pneumatic transport tubes (Whooshh).
Orange	Potential Technologies	For downstream transport at Diablo Dam, consider a gravity bypass system.
Grey	Other	For upstream and downstream transport at the Ross Development, consider adding a connection to Hwy 20 to improve access.

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – November 29, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

<u>Licensing Participants (LPs):</u>
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Amy Trainer, Swinomish Indian Tribe
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Kevin Lautz, WDFW

<u>Seattle City Light (City Light):</u>
Andrew Bearlin, City Light
Erin Lowery, City Light

<u>Consultant Team:</u>
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the agenda
        i. No new topics were added or requested
    b. Action Item Review (from 11/15/21 meeting)
        i. Data on average fish weights—No new updates from LPs. Will keep action item open for LPs to continue looking into.
        ii. Data on Salish Sucker and Pacific Lamprey—No new updates from LPs. Will keep action item open for LPs to continue looking into.
2. Preliminary Draft DCD Comments
    a. Comments received from NMFS, USFWS, USIT, and Swinomish
        i. Comment responses are being incorporated into the Revised Draft DCD
        ii. Comment response matrix will be provided with the Revised Draft DCD to LPs on 12/9/21 (1 week before Workshop No. 3 on 12/16/21)
3. Review of Results of Options Setting Exercise and Discussion for the Diablo Development
    a. Mike reviewed the process and results of the brainstorming exercise and discussion for the Diablo Development
        i. Results were summarized in a figure and table in 11/15/21 meeting notes
    b. Mike presented figures demonstrating potential fish passage facility locations and options for the Diablo Development resulting from brainstorm session during previous AWS
        i. Upstream Fish Passage Options at the town of Diablo
            1. Fish ladder to Diablo Dam

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

2. Trap and transport
ii. Downstream Fish Passage Options at Diablo Dam
1. Forebay collectors
a. Fixed forebay collector likely given low reservoir fluctuation
2. Gravity bypass
a. To point of release near Diablo Powerhouse
3. Tributary collection
a. In-tributary collection weir(s)
b. Head of reservoir passive collection system(s)

4. Fish Passage Options Formulation—Ross Development
   a. Options Brainstorming and Formulation—Mike reviewed the goals and objectives for the options brainstorming and formulation process:
      i. Continuation of the brainstorming process for fish passage options development
      ii. Focus on range of technical options, criteria, and design considerations that influence alternative formulation
      iii. Provide an open forum for brainstorming, discussion, and feedback with AWS participants
   b. Review of Existing Conditions
      i. Mike presented maps, illustrations, aerial figures, profile figures, and water surface fluctuation figures to provide an overview of the Upper Skagit System and the Ross Development
      ii. Ross Reservoir exhibits high water surface fluctuation
         1. Stan expressed concern that if facility is not designed for an absolute minimum water surface elevation, there could be extended periods of time where fish are not being passed
         2. Mike responded that additional investigation is needed at each reservoir to understand why the minimum water surface elevation occurred. This investigation will occur at all dams. Regardless, floating surface collectors (FSC) are designed to operate over the range of anticipated conditions, including minimum water surface elevations
   c. Potential Fish Passage Options for the Ross Development
      i. Mike presented figures demonstrating potential fish passage facility locations and transport options for the Ross Development
         1. Upstream Fish Passage Options at Ross Powerhouse
            a. Fish ladder to Ross Dam
            b. Trap and transport
         2. Downstream Fish Passage Options at Ross Dam
            a. Forebay collectors
               i. FSS or FSC likely given high reservoir fluctuation
            b. Gravity bypass
               i. To point of release near Ross Powerhouse
            c. Tributary collection
               i. In-tributary collection weir(s)
               ii. Head of reservoir passive collection system(s)
   d. Joint Brainstorming Session for the Ross Development
      i. Theo shared the web link to the Mural platform to kick off the brainstorming exercise. AWS participants were encouraged to participate using the shared web link.
      ii. Mike guided and facilitated the Mural brainstorm session for the Ross Development, posing questions and generating discussion amongst AWS participants

1. Brainstorming topics included:
    a. Fish Collection/Entrance Locations (US/DS)
    b. Fish Release/Exit Locations (US/DS)
    c. Key Considerations (US/DS)
    d. Risks or Concerns (US/DS)
    e. Potential Technologies (US/DS)
    f. Data Gaps
    g. Other

iii. AWS participants shared their thoughts, ideas, and concerns for the range of brainstorming topics

iv. See **Attachment A** for brainstorm results and discussion

5. Study Plan Progress and Schedule Update
    a. Reviewed Look-Ahead Schedule and Milestones for Workshop No. 3
        i. Revised Draft DCD and comment matrix submitted to LPs on 12/9/2021
        ii. AWS No. 10 on 12/13/21
        iii. FA-04 Workshop No. 3 on 12/16/2021
    b. Reviewed current tasks already in progress and next steps
        i. Continue formulating fish passage options
        ii. Prepare Revised Draft DCD
        iii. Prepare ISR report
        iv. Prepare for Workshop No. 3
        v. Prepare for next AWS
6. Future Discussion Topics/Agenda Items for Next Meeting
    a. Agenda Items for AWS 10 (12/13/21)
        i. Review results of options setting exercise and discussion for the Ross Development
        ii. Discuss factors that influence the feasibility of potential fish passage options and alternative selection
        iii. Discuss methods for alternative development and selection

Agreements

1. A comprehensive range of fish passage options and strategies should be considered and documented at this stage; all options should be considered up-front and eliminated in subsequent stages as feasibility is assessed.
2. Consultant Team will prepare next meeting's agenda to include:
    a. Review results of options setting exercise and discussion for the Ross Development
    b. Discuss factors that influence the feasibility of potential fish passage options and alternative selection
    c. Discuss methods for alternative development and selection

Ongoing Discussion Topics

1. Formulation of fish passage facility options for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. AWS participants to look for available data on average fish weights—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)

2. Consultant team reiterated previous request for available data on Salish sucker and Pacific lamprey in the Skagit River, specifically in the bypass reach

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Consultant Team to submit Revised Draft DCD and comment matrix to LPs	12/9/2021
AWS Meeting #10	12/13/2021
FA-04 Workshop No. 3	12/16/2021

Attachment A: Ross Development Brainstorm Results and Discussion

The brainstorm session results and discussion for the Ross Development are depicted in **Figure 1** and summarized in **Table 1**.

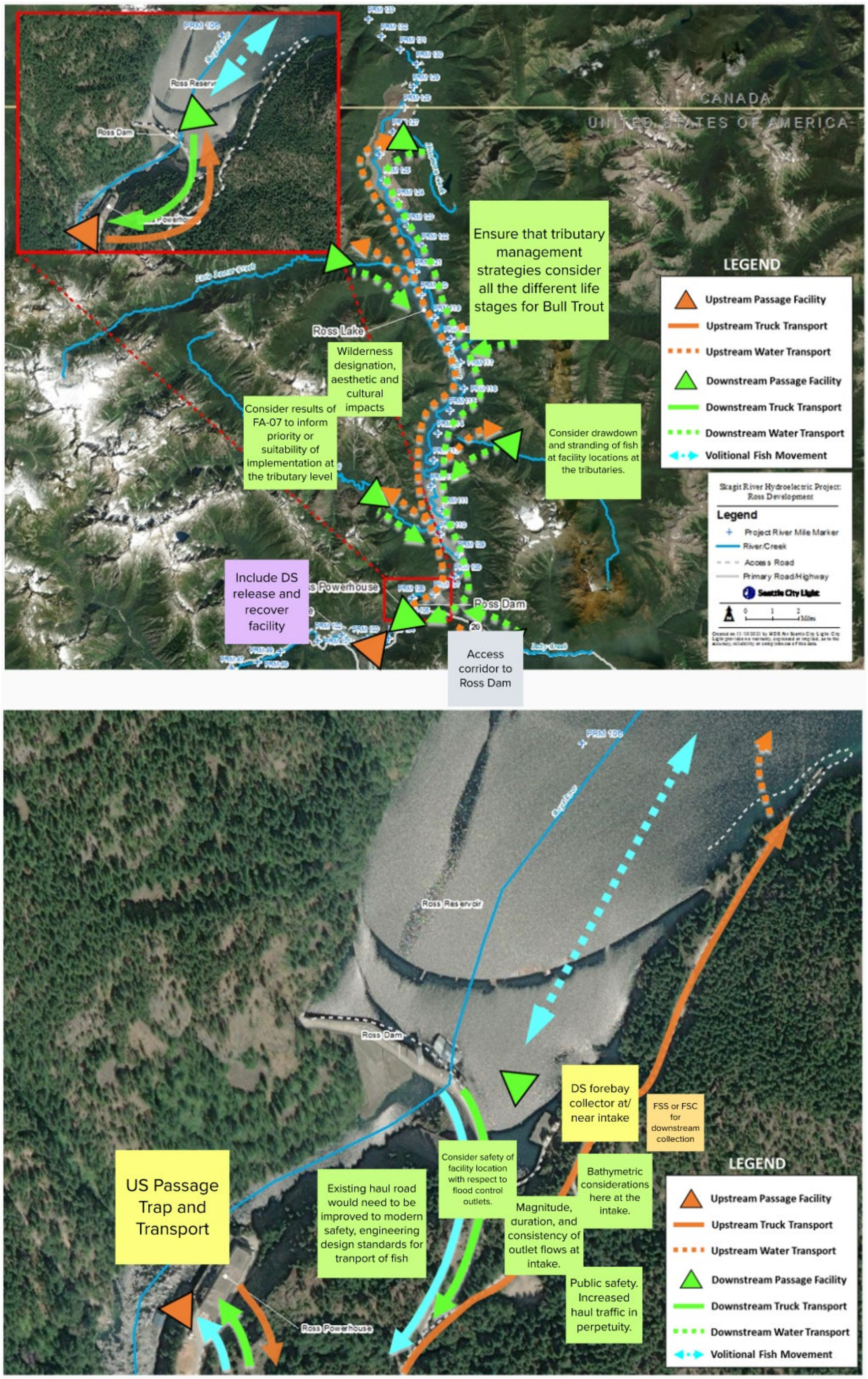


Figure 1. Mural Brainstorming Results for the Ross Development

Table 1. Mural Brainstorming Results for the Ross Development

Sticky Color	**Brainstorming Topic**	**Comment**
Green	Key Considerations	A key consideration for potential tributary facilities is wilderness designation. This may influence the allowable location, type, and seasonality of the facility.
Green	Key Considerations	A key consideration for all potential passage facilities and infrastructure is to limit disturbance to cultural resources (aesthetics, auditory, etc.)
Green	Key Considerations	Key considerations for potential tributary facilities are the results of FA-07. These results will inform the priority or suitability of implementation at the tributary level.
Green	Key Considerations	A key consideration for potential tributary facilities is the drawdown and stranding of fish at the tributaries.
Green	Key Considerations	A key consideration for tributary management strategies are all the different life stages of bull trout.
Green	Key Considerations	A key consideration for downstream passage at Ross Dam is the magnitude, duration, and consistency of outlet flows at the intake structure.
Green	Key Considerations	A key consideration for downstream passage at Ross Dam is the bathymetry at the intake.
Green	Key Considerations	A key consideration for downstream passage at Ross Dam is the safety of the facility location with respect to the flood control outlets.
Green	Key Considerations	A key consideration for both upstream and downstream passage at the Ross Development is that the existing haul road would need to be improved to modern safety, engineering, and design standards for the transport of fish.
Green	Key Considerations	A key consideration for both upstream and downstream passage at the Ross Development is public safety on the haul road. Haul traffic would be increased in perpetuity.
Yellow	Fish Collection Location	For downstream transport collection, there is opportunity at/near the intake structure in the Ross Reservoir forebay.
Yellow	Fish Collection Location	For upstream transport collection, there is opportunity in the vicinity of Ross Powerhouse.
Purple	Fish Release Location	A downstream release and recover facility should be included downstream of Ross Dam.
Orange	Potential Technologies	For downstream transport at Ross Dam, consider the use of a Floating Screen Structure (FSS) or Floating Surface Collector (FSC)
Grey	Other	For upstream and downstream transport at the Ross Development, consider adding a connection to Hwy 20 to improve access.

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – December 13, 2021

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Jeff Garnett, U.S. Fish and Wildlife Service (FWS)
Logan Negherbon, National Marine Fisheries Service (NMFS)
Ashley Rawhouser, National Park Service (NPS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Brock Applegate, Washington Department of Fish and Wildlife (WDFW)
Kevin Lautz, WDFW
Duncan Pfeifer, WDFW

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowery, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the agenda
        i. Discussion topics for today's meeting are meant to serve as a precursor for discussions to be had and continued during Workshop 3 on Thursday, 12/16/21
    b. Action Item Review (from 11/29/21 meeting)
        i. Data on average fish weights—No new updates from LPs. Will keep action item open for LPs to continue looking into.
            1. Stan Walsh provided some information on target species on 12/14/21
        ii. Data on Salish Sucker and Pacific Lamprey—Will keep action item open for LPs to continue looking into.
            1. Ashley R. provided Salish Sucker collection locations in the Skagit Basin via email shortly after the meeting on 12/13/21
2. Revised Draft DCD Comments
    a. Revised Draft DCD and comment matrix submitted to LPs on 12/9/21
    b. Comments requested back from LPs by 1/6/22
    c. Feedback on Revised Draft DCD and from Workshop 3 and 1/10/22 AWS discussions will be incorporated into Final DCD

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

    d. Becky encouraged AWS participants to review **Attachment E: Comment Response Table** of the Revised Draft DCD before Workshop No. 3 for a good overview on how LP comments were incorporated and responded to
3. Review Potential Fish Passage Options Resulting from Previous Brainstorming Exercise for the Ross Development
    a. Mike reviewed the process and results of the brainstorming exercise and discussion for the Ross Development
        i. Results were summarized in a figure and table in 11/29/21 meeting notes
    b. Mike presented figures demonstrating potential fish passage facility locations and options for the Ross Development resulting from brainstorm session during previous AWS
        i. Upstream Fish Passage Options at Ross Powerhouse
            1. Fish ladder to Ross Dam—likely not an option that can be implemented without a complex ladder exit system due to high headwater fluctuation
            2. Trap and transport
        ii. Downstream Fish Passage Options at Ross Dam
            1. Forebay collectors
                a. FSS or FSC likely given high reservoir fluctuation
            2. Gravity bypass
                a. To point of release near Ross Powerhouse
            3. Tributary collection
                a. In-tributary collection weir(s)
                b. Head of reservoir passive collection system(s)—likely not feasible due to reservoir drawdown
    c. Mike discussed key considerations, data gaps, and themes influencing fish passage option selection and development and presented summary tables for potential options for the Ross, Diablo, and Gorge Developments that depict various combinations of facility locations, fish passage strategies, and fish passage technologies
4. Factors that Influence the Technical Feasibility of Potential Fish Passage Options
    a. Mike presented feasibility factors used to evaluate whether physical and operational characteristics of a particular fish passage option will meet specific objectives
        i. Feasibility Factor 1: Ability to Meet Engineering, Constructability, and Operational Constrains
        ii. Feasibility Factor 2: Ability to Operate in conjunction with Existing Uses
        iii. Feasibility Factor 3: Ability to Meet Usual and Customary Fish Passage Performance Standards
        iv. Feasibility Factor 4: Adaptability
    b. These factors are based on previous experience from developing high dam fish passage at other facilities
    c. This discussion of feasibility factors is meant to help narrow the full list of options considered to date for each facility to those that are likely to be technically feasible to build and operate
    d. These feasibility factors will be further discussed during Workshop 3
5. Methods for Alternative Development and Selection
    a. Mike provided an overview of the option review and selection process
        i. Review suitability for all upstream and downstream technologies considered
        ii. Technologies that are suited to known operational environments at each development will advance to the next phase of study
        iii. Qualitatively winnow options down to those that best represent the range of fish passage facilities and fish management strategies
    b. Mike provided a preview of the upstream and downstream fish passage technology suitability tables that will be further discussed during Workshop 3

   c. Mike asked the AWS group to share their thoughts on the option selection process/development of the range of options
      i. AWS participants reiterated that they would like the rationale behind the elimination of options from consideration to be explained and documented
6. Study Plan Progress and Schedule Update
   a. Reviewed Look-Ahead Schedule and Milestones
      i. FA-04 Workshop No. 3 on 12/16/2021
      ii. Initiate Final Draft DCD and Concept Development Report (December 2021 – January 2022)
      iii. AWS Meeting No. 11 on 1/10/2022
      iv. AWS Meeting No. 12 on 1/24/2022
      v. Final Draft DCD delivered to LPs on 1/31/2022
7. Future Discussion Topics/Agenda Items for Next Meeting
   a. Agenda Items for AWS 11 (1/10/22)
      i. Discuss Revised Draft DCD Comments received to date
      ii. Review fish passage options and discussion from Workshop 3
      iii. Refine fish passage options to be carried into Stage 2 of the Fish Passage Facilities Alternatives Assessment
         1. Refine and gain consensus on passage technologies and facility locations
         2. Discuss options that will likely be eliminated from further consideration

Agreements

1. A comprehensive range of fish passage alternatives and strategies should be considered and documented at this stage; all options should be considered up-front and eliminated in subsequent stages as feasibility is assessed.
2. Consultant Team will prepare next meeting's agenda

Ongoing Discussion Topics

1. Formulation of fish passage facility options for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. AWS participants to look for available data on average fish weights—Stan (SRSC), Logan (NMFS), Rick and Brian (USIT), Brock (WDFW)
2. Consultant team reiterated previous request for available data on Salish sucker and Pacific lamprey in the Skagit River, specifically in the bypass reach

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
FA-04 Workshop No. 3	12/16/2021
Initiate Final Draft DCD and Concept Development Report	December 2021 – January 2022
AWS Meeting No. 11	1/10/2022
AWS Meeting No. 12	1/24/2022
Final Draft DCD submitted to LPs	1/31/2022

Skagit River Hydroelectric Project
Seattle City Light (City Light)
FA-04 Fish Passage Study Agency Work Session[1]
Meeting Date – January 10, 2022

Summary of Discussion Topics, Agreements, Ongoing Discussions, and Action Items

Attendance

Licensing Participants (LPs):
Ashley Rawhouser, National Park Service (NPS)
Stan Walsh, Skagit River System Cooperative (SRSC)
Amy Trainer, Swinomish Indian Tribe
Jeff Garnett, U.S. Fish and Wildlife Service (USFWS)
Brian Lanouette, Upper Skagit Indian Tribe (USIT)
Rick Hartson, USIT
Kevin Lautz, WDFW

Seattle City Light (City Light):
Andrew Bearlin, City Light
Erin Lowery, City Light

Consultant Team:
Michael Garello, Consultant Team
Becky Holloway, Consultant Team
Bao Le, Consultant Team
Jacob Venard, Consultant Team
Theo Malone, Consultant Team
Nicole Loo, Consultant Team

Summary of Discussion Topics

1. Greetings, Agenda Review, and Previous Action Items
    a. Becky began the meeting with a brief overview of the agenda
    b. Action Item Review (from 12/13/21 meeting)
        i. Data on average fish weights—Received from Stan Walsh
        ii. Data on Salish Sucker and Pacific Lamprey—Received data from Ashley Rawhouser
2. Revised Draft DCD Comments
    a. Revised Draft DCD and comment matrix submitted to LPs on 12/9/21
    b. Comments requested back from LPs by 1/6/22
    c. Feedback on Revised Draft DCD and from Workshop 3 and 1/10/22 AWS discussions will be incorporated into Final DCD
    d. Comments received to date: WDFW responded and indicated that they have no comments. USFWS and NPS provided comments for consideration.
3. Review of Fish Passage Options and Discussion from Workshop 3
    a. Mike reviewed the results and conclusions of the fish passage option development process presented during Workshop 3
    b. Mike reviewed and summarized the 3 potential fish passage options from Workshop 3
        i. Option 1: Multi-Objective—Robust arrangement of a broad range of facilities that is highly adaptable to numerous biological goals and fish management strategies
            1. Upstream Passage

[1] Note that Agency Work Sessions are not facilitated by Triangle and Associates. In general, these meetings are technically focused discussions comprised of a small group of City Light/Consultant Team and LP technical staff. The intent of these meetings is to address high priority technical action items to ensure the larger Triangle-facilitated meetings can occur on schedule. Summaries are informal and only capture any agreements, remaining issues, and action items resulting from discussions. These notes are not intended to be formal records of the meeting.

            a. Trap and transport at each development
        2. Downstream Passage
            a. Forebay collector at each development
            b. Head of reservoir tributary collector(s)—TBD
            c. Trap and transport fish transit
    ii. Option 2: Reservoir Bypass—Focused strategy using available habitat upstream of Ross Dam
        1. Upstream Passage
            a. Trap and transport at Gorge Powerhouse only
        2. Downstream Passage
            a. Forebay collector at Ross intake forebay only
            b. Trap and transport fish transit
    iii. Option 3: Volitional—Emphasis on volitional upstream and downstream fish migration and self-selection with potential for inter-project reservoir transit; limits trap and haul
        1. Upstream Passage
            a. Fish ladder at Gorge and Diablo Dams
            b. Trap and transport at Ross Dam
        2. Downstream Passage
            a. Forebay collector at each development
            b. Downstream bypass pipe

4. Reformulation of Fish Passage Options
    a. Mike re-emphasized that the options selected to be carried into the Concept Development Report (Stage 2 of the Fish Passage Facilities Alternatives Assessment) are meant to bracket the range of possibilities and that options not selected for further evaluation will be documented with explanations as to why.
    b. Effectively, options selected for further evaluation are captured in the original Multi-Objective option, plus two separate sub-options to accommodate fish ladders at Gorge and Diablo Dams as well as a trap and transport facility at the base of Gorge Dam.
    c. Based upon feedback and discussions with LPs during Workshop 3, Mike proposed to move forward with Option 1: Multi-Objective with several renditions/sub-options:
        i. Option 1A: Multi-Objective as presented
            1. Upstream Passage Facilities (trap and haul)
                a. Gorge Powerhouse
                b. Diablo Powerhouse
                c. Ross Powerhouse
            2. Downstream Passage Facilities (trap and haul)
                a. Gorge
                    i. Fixed forebay collector at dam intake
                    ii. Hwy 20 at Stetattle Creek
                b. Diablo
                    i. Fixed forebay collector at dam intake
                    ii. Hwy 20 at Thunder Creek
                c. Ross
                    i. FSC/FSS at forebay of dam intake
                    ii. Various tributary collectors
        ii. Option 1B: Multi-Objective with an upstream collection option near the base of Gorge Dam
            1. Upstream Passage Facilities
                a. Same as Option 1A, but instead of collection at Gorge Powerhouse, collection facility at Gorge Dam

2. Downstream Passage Facilities
    a. Same as Option 1A
iii. Option 1C: Multi-Objective with fish ladders at Gorge and Diablo with downstream bypass pipes/channels at each dam
    1. Upstream Passage Facilities
        a. Fish ladders at Gorge and Diablo
    2. Downstream Passage Facilities
        a. Bypasses at all dams

d. Mike opened the discussion to the group for their comments/thoughts on the proposed approach of moving forward with Options 1A-C
    i. General consensus amongst AWS participants was that they liked the comprehensiveness of this approach and the broad range of options that could be pieced together like an "a la carte menu"
    ii. Ashley R. asked about how considerations on the broad range of species and life histories would be incorporated into the options. Mike responded that a lot of that discussion would go under performance and suitability and how compatible the options are with fish species based on past performance history at other similar facilities. The final deliverable for the Fish Passage Study (Fish Passage Assessment Report, to be initiated in summer 2022, as stated in the RSP) will assess the ability of each option to meet each of the four feasibility factors discussed in the DCD and at length in Workshop 3.

e. Mike summarized technologies not yet considered as part of future evaluation and asked AWS participants if those technologies should be added, such as:
    i. Pneumatic Fish Transport Tube – Whooshh
    ii. Fish Passes – Fish lifts, fish elevators, or hydraulic locks.

f. AWS participants responded with acknowledgement the challenges associated with these two technologies and requested that the reason for elimination be documented in the Final DCD.

g. Mike presented options and technologies recommended to be eliminated from further consideration based upon apparent fatal flaws or conditions that posed significant feasibility concerns:
    i. Technologies recommended for elimination from further consideration:
        1. Turbine passage
        2. Surface spill
        3. Fixed In-Tributary Collectors
    ii. Options recommended for elimination from further consideration:
        1. Upstream:
            a. Fish ladder at Ross
        2. Downstream
            a. Fixed collector at Ross
    iii. Mike asked the group if there were any objections to elimination of these technologies and options
        1. No objections from AWS participants, but participants reiterated that justification for the elimination of options/technologies from further evaluation must be provided and documented

h. Mike asked the group for concurrence to move forward with the evaluation of Options 1A-C in Concept Development Report (Stage 2 of the Fish Passage Facilities Alternatives Assessment)
    i. AWS participants did not express any objections—concurrence gained
    ii. Several "thumbs up" emojis were posted to the WebEx virtual meeting

5. Study Plan Progress and Schedule Update

    a. Reviewed Look-Ahead Schedule and Milestones
        i. Complete Final Draft DCD and start Concept Development Report (December 2021 – February 2022)
        ii. AWS Meeting No. 12 on 1/24/2022
        iii. Final Draft DCD delivered to LPs on or about 2/11/2022
6. Future Discussion Topics/Agenda Items for Next Meeting
    a. Agenda Items for AWS 12 (1/24/22)
        i. Discuss Revised Draft DCD comments received
        ii. Review outline and schedule for Concept Development Report
        iii. Review process for development of concept designs for fish passage facilities
        iv. Progress report on Fish Passage Assessment of Existing Features in Bypass Reach

Agreements

1. Options 1A-C are to move forward and be evaluated as part of the Concept Development Report (Stage 2 of the Fish Passage Facilities Alternatives Assessment).
2. Options and technologies that were eliminated from further consideration will be documented with explanations in the Final DCD.

Ongoing Discussion Topics

1. Refinements of fish passage facility options for each passage strategy
2. Data collection and information needs
3. Linkages to other on-going studies to FA-04; study will be iterative and incorporate relevant information from other studies as it becomes available

Action Items

1. Becky to circle back with Ash regarding provided information on *O. mykiss*
2. Consultant Team to send out a copy of today's presentation
3. Consultant Team to prepare and send out next meeting's agenda

FA-04 Look-Ahead Schedule

Milestone/Activity	Anticipated Schedule
Complete Final Draft DCD and start Concept Development Report	December 2021 – February 2022
AWS Meeting No. 12	1/24/2022
Final Draft DCD submitted to LPs	2/11/2022

FP-04 FISH PASSAGE TECHNICAL STUDIES PROGRAM
FISH PASSAGE FACILITIES ALTERNATIVES ASSESSMENT
CONCEPTUAL DESIGN CRITERIA DOCUMENT
FINAL DRAFT

ATTACHMENT E

PRELIMINARY AND REVISED DRAFT DCD COMMENT RESPONSE TABLE

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

Comment Number	Review Item	Comment Reference Location	PDF Page Number	Comment Author	Comment	Resp. By	Acceptance Code	Status	Comment Response
1	Preliminary Draft DCD	General	-	NMFS	This study is a technical feasibility assessment to identify and provide cost opinions for passage solutions at the Skagit River Hydroelectric Project. This is not intended to provide a recommended passage solution but all solutions deemed technically feasible. Formulation of fish passage strategies first presupposes varied value of access to each reservoir in the system. Value of access is currently being determined through various other studies. Strategies may be assembled based on the technically feasible passage methodology/technology but will not be considered prior to exploration of passage facility assessments.	B.Holloway	2	A	Understood and concur regarding the intent of the study. This statement has been added to the Revised Draft DCD under section 1.2 purpose.
2	Preliminary Draft DCD	General	-	NMFS	Much of the information delivered was from the PAD. While useful, it should be further refined to support passage technology assessment. Site description yielded very little in terms of characterization for passage aside from the conclusion that temperature was not limiting to fish passage.	B.Holloway	2	A	The Revised Draft DCD has been updated to include additional discussions in Section 2 and new subsections in Section 5 that discusses site-specific information to inform each of the potential passage strategies. Section 2 has been updated to include reservoir profiles, to scale, and locations/depths of intakes and spillways at all developments. This information will continue to be refined as the Fish Passage Study progresses to the next stages of development, and concept alternatives.
3	Preliminary Draft DCD	General	-	NMFS	While there are a number of projects included in the data synthesis, numerous projects need additional context for consideration in this study and several projects in the northwest omitted including FERC and Federal projects completed or in design.	J.Venard/B.Holloway	2	A	The consultant team has reached out to Tacoma Power to obtain passage efficiency information at Cowlitz Falls Dam and incorporated the information into Section 6 and Appendix B. The consultant team respectfully requests a list of additional projects completed or in design that NMFS desires to include in the summary. That information can be incorporated into the Final DCD and considered, as applicable, in future study stages.
4	Preliminary Draft DCD	2-41	57	NMFS	Where are the river operations description for the bypass reach? Although, this may be subject to change per commitments/prescription/etc., please provide baseline	T.Malone/N.Loo	2	A	Added Information in Section 2.3.2 for operation of the Gorge Bypass Reach
5	Preliminary Draft DCD	Section 2	17	NMFS	There are determinations or conclusions within this section that should be highlighted or carried forward to summary points (i.e. that reservoir temperatures are not passage limiting.) Much of this is copy/paste from the PAD and needs rendered into useful characteristics for passage analysis.	N.Loo/B.Holloway	1	A	Concur and have added project-specific information for each dam to inform future assessments of feasibility. Have added the following sentences at the beginning of Section 2: Considered with the biological data currently available for each of the selected target species (Section 3.0 of this document), the physical environment of each Project development will establish the setting that is used to assess the technical feasibility of developing alternative upstream and downstream fish passage facilities. Although feasibility will be assessed for selected passage alternatives during future stages of this study, and, per the RSP is not part of the DCD stage, Section 5.0 provides development-specific information that will be used to inform more in-depth analyses of feasibility.
6	Preliminary Draft DCD	3-13	83	NMFS	River-type sockeye are also found in the Sauk River	J.Venard	2	A	Comment implemented
7	Preliminary Draft DCD	3-18	88	NMFS	As was pointed out – downstream abundances may not relate to potential upstream abundances – in this case we have no pre-dam estimates. Calculating the intrinsic potential of upstream habitat may provide a capacity estimate – from which one might use 50-60% of capacity as an average abundance	J.Venard	2	A	Concur that relationships between potential upstream abundances and potential production are a function of a number of factors. The FA-07 Reservoir Tributary Habitat Assessment Study and the Food Web Study are next step in informing the potential production. As indicated, designs will be revised based on additional information as it becomes available.
8	Preliminary Draft DCD	3-19	89	NMFS	Bell 1991 estimates of size do not seem to fit the Skagit – some of the averages seem high (maybe not Chinook which might be low for upper basin fish). I am sure that there are fishery sources for average weights.	B.Holloway	2	D	Size information for each species was requested as part of the biological information RFI submitted to the LPs, and was also requested during AWS meeting No. 6. Several LPs indicated that they would review their information and update the AWS group, as documented in the meeting summary. This information will be updated as it becomes available.
9	Preliminary Draft DCD	4-5	95	NMFS	The bullet indicating approval potential by NMFS Hydro Program staff may be dated or reserved for different facilities. Please revise to read "may be approved by NMFS staff" as these assessments will occur with this licensing effort	N.Loo	2	A	Concur. Revised as requested.
10	Preliminary Draft DCD	6-1	103	NMFS	Characterizing high head dams by the hydraulic differential exceeding 100 feet results in inclusion of many Columbia and Snake river main stem dams but also excludes some relevant technologies applied at lower head systems	T.Malone	2	A	Concur. This statement was revised to include a broader range of conditions with like facilities. Added language describing that technologies used at dams on the order of 100 ft but are also used at dams with less hydraulic differential.
11	Preliminary Draft DCD	6-2	104	NMFS	Overall downstream fish passage efficiency is not preferred, recommend using total or overall project survival instead as fish not passed are generally assumed not to survive. Passage efficiency is closely tied to facility design and performance, passage survival a performance metric of the facility passage, and reservoir transit efficiency a more inherent characteristic of the reservoir – all result in a total project survival	J.Venard	2	A	Term "overall efficiency" revised to "overall survival"; Concur and thank you for the comment. A new Section 5.1.1 has been added to address the issue of compounding effects on passage from multiple dams specific to the Skagit Project. This section may be moved to new Section 7.3.
12	Preliminary Draft DCD	6-3	105	NMFS	The table 6.1-1 appears to be missing some FERC projects (Cowlitz) and other Federal projects with applicable standards	T.Malone/M.Garello	2	A	Added Cowlitz Falls Dam to table
13	Preliminary Draft DCD	6-3	105	NMFS	Cougar Dam portable floating fish collector line includes no values to support this table. The PFFC should be further explained as proof of concept and characterized by the nature of implementation. Many of the listed projects will require additional context	N.Loo/J.Venard	2	A	Concur. This line was removed from the table
14	Preliminary Draft DCD	6-6	108	NMFS	The Kock et al. 2019 study provides a good overview of high head dam facilities – some of the data provided is incomplete. Not included is data for the Baker facility for Chinook salmon, there were numerous attempts to pass sub yearling Chinook salmon, but the collection efficiency was very poor. They also included the Cougar collector which was an undersized floating collector that was poorly sited (only 100 cfs flow), included this "outlier" could bias the overall interpretation. One should also note the absence of juvenile life history stage for Chinook salmon results, as different life history stages have very different downstream migratory behaviors. The collector on the Lewis River (Swift) is still being modified and results, while initially poor have improved a little. Additionally, other researchers have used the logistic equation to estimate the parameters for collection designs, as mentioned above, missing or inappropriate data might bias the results of the equation	J.Venard/M.Garello	2	A	Concur that Kock et al. 2019 provides as summary, although not completely comprehensive of all passage facilities installed in the Pacific Northwest, it does summarize the fish passage facilities at projects with water storage or flood substantial that result in reservoir fluctuation, similar to that occurs at the Skagit Project Dams. At the Baker River Project, while numbers of Chinook Salmon (1,000s of juveniles) were passed prior to installation of the modern floating surface collectors, have not been transported to the basin since 2010, and no numbers of note since 2006. No study of juvenile Chinook Salmon fish passage was ever conducted at the Baker River Project (Nick Verretto, pers. comm 2021). A footnote was added to Table 6.2-1 indicating that the Cougar collector is a prototype facility to provide context to the results. A footnote was added to the table indicating that Chinook Salmon juvenile life-history type is not distinguished in Table 6.2-1. The collection efficiency values for the Swift collector were from 2020 study year to indicate current results in Table 6.3-1; documentation of the iterative changes in collection effectiveness are provided in the attached Summary of Performance Standards and Evaluations. Regarding use of logistic equations or other methods of estimating facility success: we agree that the use of logistic equations or other estimation methods may bias results, however, the values provide are those reported by the facility owners; methods for calculating effectiveness vary from site to site and need to be considered in the actual application of the efficiency values to anticipated effectiveness and application at potential future facilities.
15	Preliminary Draft DCD	7-1	109	NMFS	Formulation of fish passage strategies prior to understanding the technical feasibility of a passage methodology is not advisable and a fish passage program goal. It is recommended that formulation and evaluation of passage methodologies per project be conducted prior to assembling fish passage strategies to ensure that no methodology is overlooked and not strategy is omitted due to lack of examination. This study outcome is not "Is passage feasible and how should it be conducted" but "is it feasible and by what methods." As noted, many interconnected studies are occurring at the same time which may have bearing on preferred fish passage strategies	B.Holloway	2	A	The following text was added to this section: One of the benefits of the upstream reservoir transit strategy is that it allows fish to sort themselves to find their natal stream. This strategy could be used as one tool to address future genetic objectives that may be established by fisheries co-managers for each of the Project reservoirs. Although this strategy would require more adult handling, the alternative of transporting fish, potentially to the wrong reservoir, could result in a high fallback rate as fish search for olfactory cues in natal tributaries that may be downstream of the transfer location.
16	Preliminary Draft DCD	7-2	110	NMFS	In discussing adult collection (and other aspects of fish passage), it would be useful to have a better understanding of how the dams are "plumbed". A table outlining elevations for the outlet valve intakes would be useful rather than needing to dig it out of the diagrams in the appendices. For adult collection this would be useful in understanding potential differences between ambient river temperature and reservoir temperature at the intakes; at Cougar Dam prior to the installation of a temperature control tower deep cold water was the only source available for the ladder. Adult attraction to the ladder in the spring and early summer was very poor	T.Malone	2	A	This information is included in Table 2.2 1. Illustrative profiles are added for each development. Added cross reference to Section 7.0.
17	Preliminary Draft DCD	7-5	113	NMFS	One of the benefits of the reservoir transit strategy is allowing the fish to sort themselves in finding their natal stream. Although this requires more adult handling, the alternative of transporting fish, potentially to the wrong reservoir, could result in a high "attempted" fallback rate. The transit options are discussed from an engineering standpoint, but the genetic and behavioral consequences of each strategy should also be discussed	B.Holloway	2	A	One of the benefits of the upstream reservoir transit strategy is that it allows fish to sort themselves to find their natal stream. This strategy could be used as one tool to address future genetic objectives that may be established by fisheries co-managers for each of the Project reservoirs. Although this strategy would require more adult handling, the alternative of transporting fish, potentially to the wrong reservoir, could result in a high fallback rate as fish search for olfactory cues in natal tributaries that may be downstream of the transfer location. In addition to the above, a qualitative discussion on suitability of transit through each reservoir has been added to Section 5.

HDR

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

18	Preliminary Draft DCD	7-19	127	NMFS	Most floating surface collectors with less than 1000 cfs do not provide very high collection efficiencies. Further, the reservoirs have different rule curves which would require different collector requirements	T.Malone	2	A	Concur. This section is presenting the range of technologies available. Added text to 7.2.3.1 referring to this comment and indicating that each reservoir would have different requirements for FSC, if feasible.
19	Preliminary Draft DCD	Attachment B	149	NMFS	Missing Cowlitz and need to add context to the PFFC project	M.Garello/T.Malone	2	A	Fish passage results from the Cowlitz Falls Dam were added to Attachment B and Table 6.3-1 Summary of Pacific Northwest downstream juvenile forebay fish collectors estimated fish collection efficiency.
20	Preliminary Draft DCD	General	-	USFWS	This document is lacking the analysis that I was hoping for/expecting. Instead of solely describing the lay of the Skagit landscape (which is mostly covered in the PAD) and then all of the general strategies for fish passage, I was hoping for a more in-depth synthesis of how the fish passage strategies would look at the Skagit and get an initial assessment of feasibility based upon current operations and physical constraints. I understand that there are many unknowns still to consider, but I feel like such an analysis would allow us to gain a better sense of truly feasible strategies (or help to at least identify what pieces of information are needed to make a more informed decision about feasibility). I've tried to highlight a few examples of such an analysis below, but it is by no means exhaustive.	B.Holloway	2	A	The Consultant Team respectfully refers the reviewer to the Revised Study Plan for FA-04 (Fish Passage Study)., which was reviewed by the LPs, with minor adjustments as presented in the Notice of Certain Agreements. Regarding the content of the DCD, the RSP states (P. 2-6): The Fish Passage Conceptual Design Criteria Document will include maps and drawings of existing facilities, reservoir rule curves and operating limits, historical operations data, debris accumulation information, and data on thermal regimes of the reservoirs. To the extent practical, a draft list of concept-level passage alternatives will also be issued in advance of the Workshop. Assessments of feasibility based on current operations and physical constraints will be developed in the next major deliverable, the Fish Passage Concept Development Report. As stated on p. 2-6 of the RSP: Following finalization of the Fish Passage Conceptual Design Criteria Document, City Light will proceed with developing concept-level upstream and downstream fish passage alternatives and their estimated costs. City Light will develop functional site layouts, process descriptions and diagrams, facility sizing, general design parameters, expected fish capture and survival efficiencies, and opinions of probable costs for select fish passage alternatives. The AWS meetings beginning in November will begin discussions on fish passage options at each Project development and will inform the next deliverable. As applicable, the Revised Draft DCD and Final Draft may contain information to reflect these discussions, which will be used to develop the Fish Passage Concept Development Report
21	Preliminary Draft DCD	1-3	15	USFWS	Add linkage to FA-08 Entrainment. It also may be helpful to identify throughout the document what information/study result is needed to better inform feasibility of a particular structure/strategy	B.Holloway	2	A	The following statement has been added to page 15: FA-08: Entrainment Study – Will provide information on potential entrainment at each Project development, which may inform design criteria for downstream juvenile and adult (e.g., kelts) passage designs.
22	Preliminary Draft DCD	2-26	42	USFWS	Is it worth discussing the topography surrounding each of the dams to assess the feasibility (or at least lay the groundwork for doing so) of building fish passage structures on the landscape? Seems like a discussion of elevation delta needed to achieve passage and what kind of footprint that would/could require would be advantageous (e.g., does providing volitional passage via a fishway mean a 2-mile-long ladder?). Probably also worth considering nearby infrastructure (towns, roads, etc.). Maybe that's to come?	N.Loo/M.Garello	2	B	Additional narrative and figures were added for each development in Section 2.2, expanding the description of the existing facilities, accessibility, and constraints for each site. Section will be refined in Final DCD.
23	Preliminary Draft DCD	2-41	57	USFWS	Can't speak to the history of USFWS involvement, but we are currently engaged as a member of the FCC.	B.Holloway	2	A	Comment noted and USFWS was added to the text.
24	Preliminary Draft DCD	3-1	71	USFWS	As mentioned in previous meetings, we should probably stick with the term "target."	B.Holloway	2	A	Agreed, and the term "focal" has been replaced with "target" throughout the document.
25	Preliminary Draft DCD	3-19	89	USFWS	This table omits Dolly Varden, lamprey, and Salish sucker.	J.Venard	2	A	Revised as suggested
26	Preliminary Draft DCD	4-6	96	USFWS	I'd like to see an evaluation of the effectiveness of different passage strategies for lamprey. A discussion of a lamprey-specific flume system versus a ladder or trap-and-haul would be advantageous, for example. Not sure this is the appropriate location, but regardless I believe it would be worthwhile.	J.Venard/M.Garello	2	A	A summary of lamprey passage technologies with examples and reported effectiveness was added to the document.
27	Preliminary Draft DCD	7-3	111	USFWS	Please describe the metrics that would have to be collected at each tributary for consideration of feasibility. Are the tributaries currently suitable for these facilities? In what operational ranges, run sizes, etc. would they be feasible?	T.Malone/M.Garello	3	D	Concur. During this iteration, we have added an additional narrative describing purpose of FA-07 and information that may come from that study. However, additional metrics needed for siting facilities near the mouth of each tributaries can be added in future deliverables under this study when additional information becomes available.
28	Preliminary Draft DCD	7-12	120	USFWS	This is the beginnings of the analysis I was hoping to see throughout this document. What constraints are there to build fish ladders at each dam? What side of the river would be most feasible and why? How long would it have to be? Can it effectively operate with current reservoir fluctuations, or what is the range of reservoir fluctuation that a ladder could be effective? Etc., etc.	B.Holloway	3	D	As discussed in response to the first USFWS comment, this type of information will be part of the Fish Passage Concept Development Report, to be initiated in Q1 of 2022.
29	Preliminary Draft DCD	7-18	126	USFWS	I don't see a discussion of reservoir fluid dynamics or bathymetry in the context of supporting any of these downstream strategies. I would think this would be an important factor in determining feasibility. Can the Skagit reservoirs currently support these strategies/facilities?	M.Garello	2	A	Concur. Section 5.6 was added providing a qualitative assessment of reservoir transit suitability. The current narrative provides the information that is available and will be expounded as additional information is generated through concurrent studies. At this time, detailed CFD modeling of the reservoir is not within the scope of this study
30	Preliminary Draft DCD	7-23	131	USFWS	Given this knowledge, is this a feasible option at each Skagit dam (at least initially speaking)?	B.Holloway/M.Garello	2	D	Comment noted, and it may be that this option is not carried forth into the next stage of the fish passage study. The feasibility of selected fish passage options will be discussed during November/December AWS meetings, and the DCD will be revised to reflect those that the AWS LPs determine infeasible.
31	Preliminary Draft DCD	7-25	133	USFWS	What was/is the cost of retrofitting the dams with these turbines?	B.Holloway	2	A	Comment noted. If turbine retrofitting is carried forth as an alternative to be evaluated in the Fish Passage Concept Development Report, to be developed beginning in Q1 of 2022, costs will be estimated at that time.
32	Preliminary Draft DCD	General	-	USIT	Overall, the FA-04 Fish Passage Draft Conceptual Design (DCD) generally addresses the criteria for fish passage alternatives. However, there are areas that need to be expanded upon. Outside of the comments made directly to the document, USIT has the following suggestions. First, background information on the facility needs to include a more in-depth synthesis of Project infrastructure (e.g., "plumbing" and "critical energy" infrastructure) pertinent to the various fish passage alternatives discussed. That is, the background information needs to be customized to fish passage alternatives. Expanding upon site specific characteristics, outside what has been presented in the PAD, for both operations and infrastructure. will allow for a more complete understanding on what is feasible, and what the range of alternatives. For example, related to Project operations, more information is needed related to the reservoir elevations and reservoir flows (i.e., residence times) throughout the year to accurately gauge and build out the various passage alternatives. Specifics regarding information to be expanded upon can be found throughout USIT's comments to the DCD.	B.Holloway	2	A	Concur. Additional illustrations, figures, and narratives added to describe infrastructure pertinent to potential fish passage facilities. Subsections to Section 5.0 have been added to correlate existing conditions with potential suitability of siting specific fish passage facilities at a range of locations. Temperature, bathymetric, and flow information will be added as additional information becomes available.
33	Preliminary Draft DCD	General	-	USIT	A second important component to expand throughout the DCD is the relatedness of FA-04 to the other studies. While section 1.4 outlines connections to other studies it would be helpful to weave the "inter-study relatedness tapestry." In other words, if other Relicense studies are pertinent to the section, weave the connection that will aid in characterizing the feasibility option (e.g., OM-01 detailing Project operations related to residence time and pool levels; FA- 01's CE-QUAL-W2 temperature modeling detailing physical characteristics). USIT has suggested several areas where this should occur. A primary inter-study link isFA-07 in providing input on fish abundances expected to be seen at passage facilities (rather than abundances of fish populations below the Project).	B.Holloway	2	A	Agreed and additional cross-references have been added throughout the document when concurrent studies will yield additional information to inform future stages of this study.

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

34	Preliminary Draft DCD	General	-	USIT	USIT sees the primary goal of FA-04 to develop a range of fish passage alternatives, for which recommended strategies and biological-based goals can be incorporated later, after the results of other, related studies can aid in a more through discussion between LPs and the Skagit comanagers. This would mean detailing what is possible, then going into strategies of how it will be done after more data from other studies are available. In this synthesis, FA-04 should detail all solutions considered, those deemed technically feasible, with refinement on recommended solutions later.	B.Holloway	2	A	Agreed, and this language has been added throughout the document, in response both to the USIT comments and NMFS comments. Specifically, the commentor is referred to Section 3.3, 5.1, and the introduction to Section 7
35	Preliminary Draft DCD	Section 1.2	14	USIT	NPS is not on this list	B.Holloway	2	A	NPS added
36	Preliminary Draft DCD	Section 1.4	16	USIT	FA-08 is missing from this list	B.Holloway	2	A	The following statement has been added to page 15: FA-08: Entrainment Study – Will provide information on potential entrainment at each Project development, which may inform design criteria for downstream juvenile and adult (e.g., kelts) passage designs.
37	Preliminary Draft DCD	Section 1.4	16	USIT	The link with FA-02 and periodicity is also missing from this list.	B.Holloway	2	A	FA-02 added
38	Preliminary Draft DCD	Section 1.4	17	USIT	"will provide" not "may provide" one of the fundamental goals of FA-07 is to provide productivity estimates for anadromous salmonids above Ross. More weight, therefore, needs to be placed on FA-07 in providing abundance inputs for FA-04	B.Holloway	2	A	Modified to "intended to"
39	Preliminary Draft DCD	Section 2.2	21	USIT	Info on residence times/detention should be included, as it stands, only Diablo detention times are listed. For a complete evaluation, detention times, and operations that result in those times need to be included.	T.Malone	2	A	Agreed. Added approximated detention times in days at peak gross storage and maximum hydraulic output for all three reservoirs.
40	Preliminary Draft DCD	Section 2.2.3	36	USIT	These species should be listed (regarding similar focal species)	J.Venard	2	A	Statement revised for clarification that result of FA-05 study will investigation of potential flow conditions that may offer fish passage for the FA-04 fish passage study target species.
41	Preliminary Draft DCD	Section 2.2.7	43	USIT	Does not include? "The Project Boundary does not include the bypass reach between Gorge Dam and Powerhouse or the Skagit River downstream of Gorge Powerhouse except for areas that overlap the transmission lines and Trail of the Cedars"	B.Holloway	2	A	Under the existing license, the bypass reach is not entirely within the Project Boundary, with the exception of a few areas where a transmission line crosses the reach, at locations within the upstream portion, about halfway, and at the downstream terminus of the reach. The rationale for exclusion from the existing Project Boundary defined under the current license is unknown, but likely considers a combination of factors (e.g., factors related to the settlement agreement, FERC-required mitigation measures at the time of licensing, etc.). At this time, the Gorge bypass reach is included in several relicensing studies and may be considered for inclusion in the Project boundary under any future license; however, City Light cannot comment further on this decision at this time.
42	Preliminary Draft DCD	Section 2.3	45	USIT	It would be beneficial to list these in order of importance according to the Project's overall goals	B.Holloway	2	A	Added information from the Skagit PAD Executive Summary (and consistently carried forward in PSP and RSP ESs): The operational priorities for the Project are, in descending order of importance: flood control, downstream fish protection, recreation, and power production.
43	Preliminary Draft DCD	Section 2.3	45	USIT	Would be a good spot to highlight/reference other re-license studies that relate to fish passage	B.Holloway	2	A	Agreed, added cross-references to relevant WQ studies
44	Preliminary Draft DCD	Section 2.3.1.1	45	USIT	For the readers that are not aware, what is a stage-duration analysis?	T.Malone/M.Garello	2	A	Agreed. Statement added to explain what stage-duration curves are and their purpose.
45	Preliminary Draft DCD	Section 2.3.1.1	45	USIT	"A stage-duration analysis was performed using the daily average water surface elevation in Ross Lake for the period 1999-2020.": Why not do this from 1991-2020 to maintain consistency in years analyzed with the previous two figures?	T.Malone/N.Loo	2	A	Figures and analyses have been updated to 1997-2020 per the most continuous data set we have (Oracle data) and to maintain consistency with water surface elevation figures
46	Preliminary Draft DCD	Section 2.3.1.1	47	USIT	To make comparing with Fig 2.3-1 easier, suggest inserting the year for the max/min points.	T.Malone/N.Loo	2	A	Comment implemented, figures revised
47	Preliminary Draft DCD	Section 2.3.1.1	49	USIT	Where is this figure referenced within the text?	B.Holloway	2	A	Corrected cross-referencing error
48	Preliminary Draft DCD	Section 2.3.1.1	50	USIT	Providing number of spills during the previous license would be more informative (as the previous figured did)	T.Malone/N.Loo	2	A	Added spill events chart for 1997-2020
49	Preliminary Draft DCD	Section 2.3.1.2	50	USIT	Why not continue to 2020?	T.Malone/N.Loo	2	A	Figure has been updated to 1997-2020 per the most continuous data set we have (Oracle data)
50	Preliminary Draft DCD	Section 2.3.1.2	50	USIT	As with Ross, why not conduct this analysis for 1991-2020?	T.Malone/N.Loo	2	A	Figure and analysis have been updated to 1997-2020 per the most continuous data set we have (Oracle data) and to maintain consistency with water surface elevation figures
51	Preliminary Draft DCD	Section 2.3.1.2	50	USIT	Wrong figure number	B.Holloway	2	A	Thank you. Corrected figure number.
52	Preliminary Draft DCD	Section 2.3.1.2	52	USIT	Figure 2.3-6 - As with Ross, providing the years here would be useful.	T.Malone/N.Loo	2	A	Comment implemented
53	Preliminary Draft DCD	Section 2.3.1.2	53	USIT	Include number of spills throughout the license to depict all operating conditions, not just 'typical'	T.Malone/N.Loo	2	A	Added spill events chart for 1997-2020
54	Preliminary Draft DCD	Section 2.3.1.2	54	USIT	Figure 2.3-8 figure reference missing	B.Holloway	2	A	Corrected cross-referencing error
55	Preliminary Draft DCD	Section 2.3.1.3	54	USIT	As with Ross and Diablo, why only include last 5 years for spill?	T.Malone/N.Loo	2	A	Added spill events chart for 1997-2020
56	Preliminary Draft DCD	Section 2.3.1.3	57	USIT	Figure 2.3-10: As with Ross and Diablo, please provide years	T.Malone/N.Loo	2	A	Comment implemented
57	Preliminary Draft DCD	Section 2.3.2.1	58	USIT	I understand that these redd protection flows are based on the Revised FSA flow plan, mention of the need of redd protection for the other target species needs to be included here	B.Holloway	2	A	Our understanding of this comment is that it is a request for a discussion of potential future flows for additional target species identified for passage analysis in the bypass reach. The existing redd protection flows are summarized in the DCD; however, City Light cannot predict future needs and interests and this information. If future flows are established for additional species in the bypass reach, the Fish Passage Assessment of Existing Features in the Bypass Reach could be revisited at that time; however, speculation of future flows and influences on passage or collection facilities are not possible at this time.
58	Preliminary Draft DCD	Section 2.4.2.2	65	USIT	USIT does not agree with this estimate. According to this estimate, wood has been accumulating between 74 and 296 years. There are inconstancies with the wood loading estimates. Please see USIT's comments to the PAD pg. A1-7.	B.Holloway	2	A	Thank you for the comment. The statement relates to annual contributions only, not contributions over life of Project. If the USITs can provide an estimate for the quantity of wood over the life of the Project, we can consider it for DCD incorporation.
59	Preliminary Draft DCD	Section 2.5	67	USIT	Water Temperature Conditions: Having an isopleth or similar figure to show the nature of stratification/thermocline development during the season is needed to supplement the discussion in the test. An isopleth figure is preferred as it is standard in the limnological realm.	T.Malone	3	D	Comment noted and response deferred to next iteration of this study. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.
60	Preliminary Draft DCD	Section 2.5	67	USIT	Why display such a limited amount of temp data here? Is there more temp data available? If so, it should be included to gain a better understanding of inter-annual variability	T.Malone	3	D	Comment noted. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.
61	Preliminary Draft DCD	Section 2.5	67	USIT	Please list this measurement period	N.Loo	2	A	Measurement period is listed above within the same paragraph: fall 2014 through fall 2015/spring 2016
62	Preliminary Draft DCD	Section 2.5	68	USIT	As mentioned in a comment at the beginning of section 2, it is important to discuss the detention/retention times of water in the 3 reservoirs. With that, it is important to discuss in this section how Project operations affecting reservoir flow (drawdowns, retention times, etc.) impact water temperature conditions. Lastly, this would be a good place to crosswalk with the CE-QUAL-W2 modeling as part of FA-01.	T.Malone/N.Loo	2	A	Added approximated detention times in days at peak gross storage and maximum hydraulic output for all three reservoirs.
63	Preliminary Draft DCD	Section 2.5	68	USIT	Water temp figures: For all these figs, mean temp is great, but does not tell us of the variance in the data, which is needed. Also, although these figures are good, an isopleth or other vertically stratified figure by depth would also be helpful displaying where the thermocline lies. As it stands, it is difficult to discern the thermocline in these figures	T.Malone	3	D	Comment noted and response deferred to next iteration of this study. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.

HDR

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

64	Preliminary Draft DCD	Section 2.5.1	69	USIT	Where is the thermocline in relation to the Project infrastructure? i.e., where does it sit vertically when compared to the intake, etc. This information will be important.	T.Malone	3	D	Comment noted and response deferred to next iteration of this study. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.
65	Preliminary Draft DCD	Section 2.5.1	69	USIT	In response to the previous comment, this sentence is helpful, but providing a figure or language in the paragraph detailing how the thermocline and high temps. relate to the Project infrastructure would be helpful and provide a little more meat to the bones here. As it is, it is unclear if temps would be limiting fish passage because little is said about the Project infrastructure.	T.Malone	3	D	Comment noted and response deferred to next iteration of this study. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.
66	Preliminary Draft DCD	Section 2.5.2	69	USIT	As with Ross, a wider range in temp data is required for a complete picture.	T.Malone	3	D	Comment noted and response deferred to next iteration of this study. The consultant team refers the USIT commentor to study FA-01 and the ISR report that will be forth-coming in 2022 for this data. The team expects that some of this information will be available for incorporation into the Final DCD (e.g., temp profile data for all three reservoirs and forebays using information from the FA-01 Interim study report). Currently, data available under FA-01 is provisional in nature and cannot be incorporated until the ISR report review is completed in December 2021.
67	Preliminary Draft DCD	Section 2.5.2	70	USIT	How do these depths relate to Project infrastructure?	T.Malone/M.Garello	2	A	Added language describing depth of intake to Section 2.5.2
68	Preliminary Draft DCD	Section 2.5.3	70	USIT	How do these depths relate to Project infrastructure?	T.Malone/M.Garello	2	A	Added language describing depth of intake to Section 2.5.3
69	Preliminary Draft DCD	Section 2.5.3 (footnote)	70	USIT	If this data are a-typical, then why use them? Why not use from another year? Suggest using from other years	B.Holloway	1	A	This is the information available to us at the time the Preliminary Draft of the DCD was prepared. We continue to monitor the information made available through concurrent studies. As additional information on the reservoir thermal regimes becomes available, we will incorporate it into subsequent versions of study documentation.
70	Preliminary Draft DCD	Section 3.1.2	74	USIT	Please include the observations of Coho in the bypass reach (cited in USIT RSP comments pg. 35)	J.Venard	2	A	Comment implemented; Coho Salmon are distributed throughout the upper Skagit Basin and accessible tributaries (WDFW 2021), and have been observed in the bypass reach (USIT 2020). Reference: Upper Skagit Indian Tribe (USIT). 2020. Natural Resources Department Memorandum titled "Bypass Survey Compilation." Sedro-Woolley, Washington.
71	Preliminary Draft DCD	Section 3.1.3	75	USIT	It should be noted and added to this document that riverine Sockeye are observed in the Upper Skagit River & Newhalem	J.Venard	2	A	Comment implemented
72	Preliminary Draft DCD	Section 3.1.4.1	76	USIT	Migration of kelts needs to be added to this	J.Venard	2	A	Comment implemented; added: Steelhead kelts out-migrate immediately after spawning (Shapalov and Taft 1954).
73	Preliminary Draft DCD	Section 3.1.5.1	78	USIT	Given concerns regarding this analysis, it is suggested to remove statements comparing upstream reservoir genetics to genetics below Gorge Dam. Rather, note the crosswalk with FA-06. The concerns were noted in USIT's PAD comments pg. A1-18 - A1-21.	J.Venard	4	A	Language indicating the genetic differentiation of populations above and below Gorge Dam were not removed because it is based on the best available information and describes patterns of the population genetic structure and the biological setting. The crosswalk with FA-06 was added indicating that the study will supplement the existing information for Bull Trout in the study area.
74	Preliminary Draft DCD	Section 3.1.5.2	79	USIT	Given concerns regarding this analysis (i.e., Smith 2010), it is suggested to remove statements comparing upstream reservoir genetics to genetics below Gorge Dam. Rather, note the crosswalk with FA-06. The concerns were noted in USIT's PAD comments pg. A1-18 - A1-21.	J.Venard	4	A	Language indicating the genetic differentiation of populations above and below Gorge Dam were not removed because it is based on the best available information and describes patterns of the population genetic structure and the biological setting. The crosswalk with FA-06 was added indicating that the study
75	Preliminary Draft DCD	Section 3.1.5.2	80	USIT	This would be a good spot to crosswalk with FA-06	J.Venard	2	A	The on-going and concurrent Reservoir Fish Genetics Study is collecting data to determine the genetic population structure within and among target species populations, including Bull Trout and Dolly Varden. Results from the study will be used to determine the number of fish populations within and among Project reservoirs, and will supplement previous analyses completed for the study area.
76	Preliminary Draft DCD	Section 3.1.5.2	81	USIT	What about from 2011 to current? It is my understanding this is not the same story. More current data should be provided, too.	J.Venard/B.Holloway	3	D	Subsequent sentences describe a potential reverse or plateau of this trend. However, City Light will continue to track this issue and update the DCD in the final version. Added text about cross-walk with FA-07 and how that data will better inform BT population estimates.
77	Preliminary Draft DCD	Section 3.2	86	USIT	Does this date need to be updated?	B.Holloway	2	A	Updated to reflect current status of periodicity meetings (table dated 10/29/21). May require additional updates in final.
78	Preliminary Draft DCD	Section 3.2	87	USIT	Steelhead kelts need to be added to this list, and in doing so, adult migration for steelhead should be for much of the year.	B.Holloway	3	D	Steelhead kelt data is included in draft form and will be updated to reflect on-going discussions among LPs during HSC meetings that are on-going to refine periodicities. Footnote added to table. City Light requests input on the draft timing included in the table and acknowledges a comment from the Skagit River System Cooperative on the 10/29/21 table indicating kelt timing needs to be defined.
79	Preliminary Draft DCD	Section 3.3	88	USIT	As discussed during the 10/18/21 AWS, this is a topic that the Co-managers need to discuss further down the line. Please remove for now and focus on developing engineering options which can guide future discussion on biological objectives/goals.	B.Holloway	2	A	Concur. Have replaced text with standing paragraph on this issue.
80	Preliminary Draft DCD	Section 3.3.1	89	USIT	As mentioned in one of the AWS meetings, how is there an average without displaying min/max values?	J.Venard	2	A	Concur. Table 3.3-1 revised to indicate that the Bull Trout abundance value is for one year of data.
81	Preliminary Draft DCD	Section 3.4	90	USIT	Suggest including upper Skagit Bull Trout size information, too as Bull Trout below Gorge may be different than Ross	J.Venard	2	A	Concur. Table 3.4-1 revised to indicate that size information
82	Preliminary Draft DCD	Section 3.4	90	USIT	Do these fit Skagit Specifics? As discussed at the 10/18/21 AWS meeting, we will work on providing more information on this front.	J.Venard	3	D	We recognize that the general size information provided in Bell 1991 may not exactly match th sizes of fish that occur in the Skagit River. Specific size information for Skagit River stocks of the target species was requested as part of the biological RFI distributed to the LPs. Size information will be updated in this or
83	Preliminary Draft DCD	Section 5.0	100	USIT	Completing this section will require input from USIT policy. The technically focused AWS meetings are not an appropriate venue for these discussions.	M.Garello	2	A	Section 5 was revised and now indicates that overall biological, ecological, and fisheries management goals will require future policy level decisions among fisheries co-managers.
84	Preliminary Draft DCD	Section 5.3	101	USIT	Abundance and Peak Rates of Migration: It is not clear how this section can be completed without results from FA-07 and related studies.	M.Garello	2	A	Section 5.4 was revised to describe the linkage to FA-07 and how the results may inform future stages of this study occurring in 2022.
85	Preliminary Draft DCD	Section 5.3	101	USIT	Data from the project vicinity will be of limited use for estimating abundance and production potential in the areas upstream of the dams. This will require results from FA-07 and related studies	M.Garello	2	A	Section 5.4 was revised to describe the linkage to FA-07 and how the results may inform future stages of this study occurring in 2022.
86	Preliminary Draft DCD	Section 5.5	101	USIT	How might any potential changes in Project operations as a result of the re-license studies be incorporated here? This would be a good spot to note that other studies might result in the suggestion for altered operations (which might impact Factor 1) and highlight the connection between Factor 1 and other studies examining operations such as OM-01 and FA-01	M.Garello	2	A	The study team intends to incorporate additional information relative to any potential change in operations, should those change become available within the current Fish Passage Study timeframe. At this point, Feasibility Factor No. 4 was added to account for the need and desire of facilities and technologies to be
87	Preliminary Draft DCD	Section 5.5	102	USIT	Will there be a mechanism to determine what constitutes a high level of confidence?	M.Garello	2	A	This study will address how well each alternative meets the level of feasibility defined by each individual feasibility factor. The level of feasibility will be determined in comparison to physical site characteristics, known engineering principals, historical performance of like facilities, and the level of unknowns and uncertainties identified during analysis.
88	Preliminary Draft DCD	Section 5.5	102	USIT	Is the assumption correct that alternatives deemed "not feasible" will still be included in reports to LPs for review?	M.Garello	2	A	Concur. Options, technologies, and alternatives not selected for further analysis or those deemed less feasible will be discussed and documented in future documentation of the study process.
89	Preliminary Draft DCD	Section 7.0	110	USIT	USIT is looking for a range of alternatives for which the LPs can evaluate based on management objectives after the alternatives are developed. Additionally, we advise understanding what methods/infrastructure are technically feasible, then formulate passage strategies from there. As other studies will feed into this (and discussions of strategies), it is suggested to keep that in mind.	M.Garello	2	A	Concur and this comment is addressed throughout this document, including the revised opening of Section 7.
90	Preliminary Draft DCD	Section 7.1.2	113	USIT	What about fish destined for Canada?	B.Holloway	2	A	Fish that elect to spawn in tributaries originating in Canada would not be precluded from migrating upstream. However, such management strategies would require future coordination with the Canadian government before the effort takes place and such coordination is not included as part of this study.
91	Preliminary Draft DCD	Section 7.2.3.6	135	USIT	This would be a good time to highlight connection to other studies examining reservoir drawdown/Project operations (e.g., FA-01, FA-03, OM-01) as those study connections will be important when considering this option.	J.Venard	2	A	Language added that indicates that a number of factors would need be considered for reservoir drawdown as a potential passage method and related relicensing studies may help inform these considerations.
92	Preliminary Draft DCD	Section 1.4	15	Swinomish	SCL still needs to provide a road-map of how different studies will be explicitly linked rather than just indicating they will be	B.Holloway	3	A	It is our understanding that City Light will discuss these linkages among studies using the full-project GANTT chart developed for the project, and posted on Triangle's website: https://triangleassociates.sharepoint.com/sites/SkagitRelicensingSharedLocationforLicensingParticipantandCit/Calendars Gantt Charts Reference Documents/Forms/AllItems.aspx?id=%2Fsites%2FSkagitRelicensingSharedLocationforLicensingParticipantandCit%2FCalendars Gantt Charts Reference Documents%2FGantt

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

93	Preliminary Draft DCD	Section 1.4	15	Swinomish	Will different gate levels be examined in terms of temperature control?	B.Holloway	3	D	It is our understanding that temperature profiles have been prepared for each of the three forebays, and will be made available in the ISR to be prepared for the project relicensing process in March 2022. This information will be considered in the next stage of the Fish Passage Study, when diving deeper into feasibility analyses for downstream passage and collection bays associated with options that consider reservoir fluctuations during downstream migration periods. No change made to text of DCD.
94	Preliminary Draft DCD	Section 1.4	15	Swinomish	Not sure how this will influence fish passage assessment as this addresses more of an in-reservoir issue of water level operational effects (regarding FA-03)	B.Holloway	2	A	Comment noted. This information might be applicable to strategies that include collection weirs at the mouths of tributaries, but the results of the analysis will determine if they are useful to inform the design any passage alternatives. Added this strategy as an example of potential applicability.
95	Preliminary Draft DCD	Section 1.4	16	Swinomish	Productivity analysis = food webs. Dave Beauchamp? (regarding FA-07)	B.Holloway	2	A	Have provided clarification on the objectives for FA-07, and cited linkages to on-going food web studies being conducted by City Light outside of relicensing study efforts.
96	Preliminary Draft DCD	Section 3.2	85	Swinomish	Yes - will be updated with new information (regarding periodicities)	B.Holloway	1	A	Agreed and incorporated
97	Preliminary Draft DCD	Section 3.2	86	Swinomish	Just for ease of reading - break into multiple pages (Figure 3.2-1 Periodicity Table)	B.Holloway/N.Loo	1	A	Completed, table revised and updated.
98	Preliminary Draft DCD	Section 5.5	101	Swinomish	However, there may be some operational changes that could be considered (Factor 3)	B.Holloway	2	A	Factor 4 added to accommodate the need to accommodate future changes to goals, operational environments, and strategies.
99	Preliminary Draft DCD	Section 7.1.1	109	Swinomish	Suggest assigning a numeric or alphanumeric number to the each of the different strategies for ease of reference and to facilitate addition of other strategies.	B.Holloway	2	A	Added A, B, C to each strategy type.
100	Preliminary Draft DCD	Section 7.1.2	111	Swinomish	Should mention basis for identification of tributaries selected in the figure and also that final selection of tributaries would be made based on consideration of the reservoir productivity studies and in consultation with agencies and stakeholders. Also - what about tributaries that enter in Canada?	B.Holloway	2	A	Added information from the FA-07 study plan: These tributaries were selected for intrinsic habitat evaluation under the Reservoir Tributary Habitat Assessment Study because they were identified by NMFS in its Study Request 3 (NMFS 2021) as those that are "…reasonably large enough to support populations of anadromous fishes…"… It should be noted that, while the results of the Reservoir Tributary Habitat Assessment Study will be considered in future management strategies, the final selection of tributaries for this strategy, if selected, will be determined during consultations among resource agencies and co-managers. Fish that elect to spawn in tributaries originating in Canada would not be precluded from migrating upstream. However, such management strategies would require future coordination with the Canadian government before the effort takes place and such coordination is not included as part of this study. It should be noted that, while the results of the Reservoir Tributary Habitat Assessment Study will be considered in future management strategies, the final selection of tributaries for this strategy, if selected, will be determined during consultations among resource agencies and co-managers. Fish that elect to spawn in tributaries originating in Canada.. They would be allowed to migrate upstream. Such strategies would likely require future coordination with the Canadian government before the effort takes place and that won't happen as part of this study.
101	Preliminary Draft DCD	Section 7.1.2	111	Swinomish	Not sure of purpose of DS collection facilities at Stetattle Creek (and to a lesser extent Thunder Creek) since adult passage largely focused on Above and Into Ross Lake.	B.Holloway	2	A	Comment noted. At this time, all potential passage strategies and options are currently being evaluated.
102	Preliminary Draft DCD	Section 7.2.2	117	Swinomish	Whoosh technology?	B.Holloway	2	A	Yes, Whoosh is the proprietary name.
103	Preliminary Draft DCD	Section 8.0	135	Swinomish	At this time, it seems like this will be one if not the most important aspects of this assessment, and one, absent some reasonable estimates of production potential based on the reservoir assessment will be wrought with uncertainty. Basing targeted run sizes on existing post-dam data could lead to grossly underestimating/overestimating what the actual production potential might be in the above Ross watershed. Having stated the obvious, some "gaming" of run sizes based on available data will still be useful in sorting out differences in alternative strategies and advancing engineering concepts.	B.Holloway	3	A	Comment noted. The commenter has not likely participated in AWS discussions regarding goals and objectives and is referred to the opening of Section 7.0. While City Light concurs that goals and objectives are critical for this assessment, we also acknowledge that on-going, concurrent studies are required to inform abundance estimates for habitat upstream of the Project developments, which will directly influence goals and objectives. For this study, fish passage technologies will be assessed based on engineering feasibility in future stages of this study. However, engineering feasibility is similarly influenced by the range of numbers of fish that are required for passage and some technologies may need additional consideration
104	Preliminary Draft DCD	Section 8.0	135	Swinomish	Development of some type of biological performance tool may be useful for comparing concepts and strategies.	B.Holloway	3	A	Concur; however, use of the BPT was not an anticipated element of this RSP and therefore will not be accomplished as part of this study. The BPT – Biological Performance Tool is a method developed by R2 Resources Associates (now Kleinschmidt) to incorporate numerous reservoir transit factors and forebay collection characteristics to calculate potential fish passage collection efficiencies. It is a useful tool to organize and compile multiple knowns and unknowns into a standardized simulation methodology and compare alternatives against one another. The tool is a very capable tool that would require incorporation of Kleinschmidt on the fish passage evaluation team. The tool would be difficult to replicate without extensive development time and effort.
105	Revised Draft DCD	1-1	22	USFWS	Suggest added a statement that although this study is not addressing the first element, passage feasibility is being assessed at both Gorge Powerhouse and Gorge Dam to account for all outcomes for FA-05.	B. Holloway	2	A	Footnote added: The Fish Passage Facilities Alternatives Assessment will include options for upstream passage at both the Gorge Dam and the Powerhouse addressing the potential outcomes of the Fish Passage Assessment of Existing Features in the Gorge Bypass Reach, which will be informed by analyses completed under both FA-04 and FA-05 in 2022.
106	Revised Draft DCD	3-1	101	USFWS	Consider adding an additional criteria for the number and distribution/location of local populations. This will be pertinent when considering Bull Trout and Dolly Varden collection and release sites.	B. Holloway	3	A	The Fish Passage Study is intended to evaluate the technical feasibility of constructing facilities that can be used to meet passage strategies to be determined in the future by responsible agencies and co-managers. A generic head of reservoir collection system design will be evaluated in Stage 2 of this study. Designs for specific tributaries that address the management of local BT populations can be tailored from a typical design, but will not be evaluated for specific tributaries under this study. Given that this comment speaks to fisheries management strategies that will be selected at some point in the future, it is currently beyond the scope of the DCD. However, if future fish passage strategies determine the need for head of reservoir collectors at specific tributaries, site specific designs could be developed and should consider the specific biological goals and physical operating environment of each tributary. Such site-specific designs are to be based on future management strategies that will be developed by others and is therefore, beyond the scope of this Fish Passage Study.
107	Revised Draft DCD	3-7	107	USFWS	This is incorrect. There are 21 core areas (and four historic core areas) within the Coastal RU.	J. Venard	2	A	It is correct that there are 21 core areas in the Coastal RU, five of which are in the Puget Sound region. The text has been revised to indicate this more clearly.

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

108	Revised Draft DCD	Section 3.1.5	107-113	USFWS	It is unclear why such an in-depth description of Bull Trout is included in this document when compared to the other species. We suggest that much of this text be removed, and include only what is pertinent for designing fish passage structures. The information included for each species of fish should be standardized as described as need on page 3-1: 1) Occurrence and distribution; 2) Migration timing; 3) Abundance; 4) Size/Biomass; 5) Number and Distribution/Location of local populations (see page 3-1 comment). We acknowledge that Bull Trout are a special case given their high fidelity to natal streams and subsequent population structure, but it is premature to discuss or hypothesize what the population structure of these fish are at this time; FA-06 should shed light on this.	J. Venard	2	A	The additional population information provided for Bull Trout compared to other species was included in the document because it reflects the current available information for the species. Further, because Bull Trout occur both upstream and downstream of the Project developments, additional information is available and included for a comprehensive presentation. The information characterizes their occurrence, distribution, and population structure as it is known at the time of the study, which helps inform the size, type, and complexity of passage options, and may inform future phases of design and biological goals and objectives. The organization of the report was maintained, as described in the response provided in comment 132. We agree that FA-06 will further inform the population structure; however, the information will not be available for inclusion in the DCD within the study plan deliverables schedule. Such information would be included for other species if it were available.
109	Revised Draft DCD	Section 5.2.1.2	134	USFWS	This section only discusses downstream performance of juvenile fish. Evaluation of downstream passage for subadult and adult fish (e.g. kelts, foraging bull trout) should also be considered.	J. Venard	2	A	Paragraph revised to indicate that performance requirements and evaluation for downstream passage facilities at high-head dams in the Pacific Northwest has historically focused on juvenile anadromous species and established by USFWS and NMFS Section 18 prescriptions. Performance and evaluation of other and life stages (i.e., adult Bull Trout, steelhead kelts) may be established as part of the design process or future agency consultation.
110	Revised Draft DCD	5-4	136	USFWS	USFWS requests that upstream and downstream performance be evaluated independently for each reservoir as well as on a cumulative basis.	J. Venard	2	A	Revised as suggested.
111	Revised Draft DCD	5-12 (Table 5.5-1)	144	USFWS	Adding a column of reservoir detention times would provide a helpful comparison. Also, are there dams/large reservoirs in British Columbia, Idaho, or Montana that could provide a useful comparison, especially those within a similar climate and landscape (e.g. heavily glaciated)?	T. Malone/J. Venard	2	A	Added estimated detention times for each project. Detention time is estimated using known 'storage capacity' with 'maximum hydraulic output' to provide an order-of-magnitude comparison between projects. Regarding additional reservoirs, see response to similar comment by USIT, comment #175.
112	Revised Draft DCD	5-13	145	USFWS	What is meant by "available information?" Is it based solely on the reservoirs listed in Table 5.5-1, or is there literature that was referenced? Is there information available from other reservoirs where juvenile migration was studied and downstream fish passage facilities were not installed (or were installed and failed) because of high reservoir related mortality, residualization, etc.? This also does not address the distance between the tributary mouth and the collector, which is likely an important consideration.	J. Venard/M. Garello	2	A	There is a substantial base of literature studying reservoir transit and passage at dams at a wide range of reservoirs and fish passage facilities. The literature spans from the pre-introduction phase through implementation of the latest technology. The intent of this section was to provide a lateral comparison of the Project reservoirs to other locations with like fish passage technologies as a reference for assessing factors influencing fish passage. The introductory narrative indicates that this is a qualitative characterization of the physical conditions and potential influence on reservoir transit, and that site specific conditions and biological responses are not known and can be highly variable. Distance from each specific tributary to the collector is an important factor, however comparison of specific travel distances for fish emigrating from the various tributaries was not conducted as part of this assessment and may be part of subsequent biological study beyond the scope of this assessment. This section was revised to indicate that the physical comparison to other reservoirs suggests that juvenile migration in Ross Lake may be more challenging.
113	Revised Draft DCD	Section 7.1	160	USFWS	USFWS cautions that formulation of fish passage strategies not occur without also considering feasibility at a more granular level at individual locations. It seems reasonable to us that components of fish passage should be evaluated for feasibility before entire strategies are adopted, as the components are integral to strategy development. Therefore, we'd like to see further discussion/analysis of the various strategies (upstream and downstream) described in Section 7 applied to each dam (see comments on Tables 7.3-1 and 7.3-2).	B. Holloway	1	A	This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occurring in December and January 2022. The organization and structure of the potential fish passage options and technologies selected for further development in Stage 2 of this study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accommodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration received concurrence during our January AWS meetings and has subsequently been incorporated into the Final DCD.
114	Revised Draft DCD	7-21	179	USFWS	There are many examples where "Technical Fish Ladders" at mid-Columbia River hydro projects have been successfully modified for lamprey passage. Please include relevant projects in this section.	J. Venard	2	A	A summary of modifications to the fishways at Rocky Reach, Priest Rapids, and Wanapum Dams to improve lamprey passage has been added to the Final DCD.
115	Revised Draft DCD	Section 7.2.3.3	194	USFWS	This section appears to be luke warm to the idea of surface spill for certain fish species. Surface spill has been successfully implemented at Wanapum Dam and should be discussed in the context of this section.	B. Holloway/M. Garello	1	A	Concur that surface spill technologies have been successful and numerous run-of-river dams along the Columbia with total hydraulic differentials less than 100 feet and minimal water surface fluctuation less than 20 feet. Surface spill technologies will not be considered further because such passage technologies are not biologically appropriate for high-head dams such as Gorge, Diablo, and Ross with hydraulic head differentials much greater than 100 feet. Section 8.1.1 in the DCD provides additional rationale to explain the recommended removal of this technology from further evaluation. As stated in Section 7.2.3.3, downstream passage via surface spill is only pragmatic in conditions where surface water elevations fluctuate up to 10 to 20 feet; otherwise, water control equipment becomes increasingly complex and expensive to operate. Although surface spill facilities are successfully used on the run-of-river dams along the Columbia River, the use of such technologies on high-head dams like Gorge, Diablo, and Ross are likely neither technically nor biologically feasible.
116	Revised Draft DCD	Section 7.2.3.5	195	USFWS	This is the only location in the report where turbine passage is discussed. It is not evaluated as a potential strategy at each dam or carried forward in an passage option in Section 8 (see comments below related to a lack of analysis). Clarification as to whether or not City Light SCL is considering minimum gap turbine replacements, or have already done so, would be helpful.	B. Holloway/M. Garello	1	A	As discussed during the 1/10/22 AWS call, turbines retrofits will not be considered because 1) high-head differential will result in deleterious pressure levels that could result in barotrauma injury or death for target species, and 2) this type of passage technology, while successful at lower-head, run-of-river systems on the Columbia River, has no precedent in high-head systems as its success relies on relatively low-head pressure differentials and limited water surface elevation differences between the tailrace and upstream reservoir forebay. For these reasons, this technology is not likely not appropriate or feasible for Gorge, Diablo, and Ross Dams, and will not be considered further in this assessment. Please see Section 8.1.1 for additional narrative and rationale regarding this technologies removal from further consideration in future stages of the fish passage assessment.
117	Revised Draft DCD	Section 7.3 (Tables 7.3-1 and 7.3-2)	197-199	USFWS	The tables are helpful to provide a summary, but a narrative is needed to discuss and evaluate the potential options for upstream/downstream passage. What are the merits/faults of each strategy in the context of the locations presented? In other words, what is the rationale used to determine the level of shading in the fish graphics? Furthermore, is there flexibility to change project operations to facilitate a certain fish passage alternative and enhance (or reduce) its operational suitability?	M. Garello	2	A	Concur. Additional narratives were added to define suitability, how it was used to qualitatively asses technologies, and describe the relative suitability of the range of technologies to each of the three Project developments.
118	Revised Draft DCD	7-40 (Table 7.3-2)	198	USFWS	We suggest adding 'Adult Downstream Passage' and 'Juvenile Downstream Passage' to the table.	J. Venard/M. Garello	2	A	Additional tables were added that indicate the passage suitability for all target species and the technologies types.
119	Revised Draft DCD	Section 7.3 (Tables 7.3-1 and 7.3-2)	197-199	USFWS	Lamprey passage should be incorporated into these tables (with an accompanying narrative).	J. Venard/M. Garello	2	A	Additional tables were added that indicate the passage suitability for all target species and the technologies types.
120	Revised Draft DCD	Section 8.0	201	USFWS	Within the options presented, there are several potential strategies discussed in Section 7 that are not considered/included. There is no justification presented (see comment related to Tables 7.3-1 and 7.3-2) as to why certain strategies have not been incorporated into the options.	B. Holloway/M. Garello	1	A	This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occurring in December and January 2022. The organization and structure of the potential fish passage options and technologies selected for further development in Stage 2 of this study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accommodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration received concurrence during our January AWS meetings and has subsequently been incorporated into the Final DCD. Section 8 has been updated to reflect each of the technologies that are not being advanced to the next stage of the study. Conversely, Sections 8.1.1, 8.2.1, and 8.3.1 provide additional rationale for technologies eliminated from further consideration at each development.
121	Revised Draft DCD	8-21 (5th bullet)	221	USFWS	This should be the case for all fish passage facilities, not just tributary (i.e. downstream passage strategies should also consider sub-adults and adults). This should not be conflated with the consideration that tributary collection strategies should account for adfluvial bull trout, that should probably not be passed below a dam and be allowed to remain in the reservoir (at the same time allowing for bull trout kelts to migrate downstream).	B. Holloway	1	A	This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occurring in December and January 2022. The organization and structure of the potential fish passage options and technologies selected for further development in Stage 2 of this study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accommodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration received concurrence during our January AWS meetings and has subsequently been incorporated into the Final DCD.

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

122	Revised Draft DCD	8-21	221	USFWS	It's important to minimize holding times for fish species when discussing trap and haul concepts. This needs to be considered/evaluated moving forward.	B. Holloway	1	A	Concur. Holding times and considerations for transport will be evaluated in Stage 3 of the study. As part of Stage 3, each passage option will be evaluated for its ability to meet the four feasibility factors presented in the DCD. The ability to meet biological performance standards is assessed as one component of Factor 3.
123	Revised Draft DCD	9-1	223	USFWS	We are concerned that, since there has not been any feasibility analysis completed at a granular level (or at least thoroughly described) of the various strategies presented within this document at each location, moving forward with select options presented in Section 8 is premature. Furthermore, adopting certain options without providing rationale for inclusion/omission of particular strategies lends toward selections being (or at least appearing as) management-based; and, as stated within this document, the consensus was that management goals would not influence the feasibility analysis ("not how should it be conducted, but is it feasible and by what methods"). Therefore, we request that a more robust analysis of the various passage strategies at each location be conducted and documented prior to formulating and adopting system-wide passage options.	B. Holloway	2	A	This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occurring in December and January 2022. The organization and structure of the potential fish passage options and technologies selected for further development in Stage 2 of this study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accommodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration received concurrence during our January AWS meetings and has, subsequently been incorporated into the Final DCD.
124	Revised Draft DCD	9-1	223	USFWS	We understand SCL intends to incorporate data/findings from other studies into the feasibility analysis as it becomes available, however we still have some concern that finalizing the document may unintentionally eliminate fish passage alternatives due to the lack of information these remaining relicensing studies may provide, potentially resulting in considerable backtracking and subsequent delays. Our recommendation would be to finalize the DCD once the remaining studies have been completed.	B. Holloway	2	A	The USFWS recommended to delay finalizing the DCD until relevant relicensing studies are completed that may inform future fisheries management strategies. However, as presented during the 1/10/22 AWS call, the suite of options to be advanced to the next stage of the study, if mixed and matched, will allow for implementation of a broad range of potential future management strategies. A small number of options are recommended for elimination based primarily on physical constraints, challenging technical feasibility, and lack of precedent at similar high-dam facilities. As requested, Section 8 of the DCD now provides rationale for the elimination of certain passage technologies. The eliminated options would not facilitate passage strategies that are not addressed under the suite of options to be advanced. Based on the AWS's consensus on the fish passage options to be advanced to the next stage of this study, as discussed during the 1/10/22 AWS call, we do not propose to delay completion of the DCD.
125	Revised Draft DCD	9-1	223	USFWS	We suggest the Fish Passage Concept Development Report also include a discussion of pertinent status updates for the outstanding relicensing studies that still need to completed and may have relevance to the fish passage concepts.	J. Venard	3	D	Salient information that becomes available from concurrent relicensing studies will be incorporated into the Conceptual Design Report and/or via Errata to the Design Criteria Report.
126	Revised Draft DCD	2-12	46	NPS	Additional potential facility locations should include the Skagit River.	B. Holloway	1	A	Reference to Skagit River added to narrative.
127	Revised Draft DCD	2-19	53	NPS	Consider deleting since tributary habitat will be part of FA-07	B. Holloway	1	A	Removed sentences providing baseline conditions for several Ross Lake tributaries and added statement that FA-07 is reviewing tributary habitat and stream functions in detail.
128	Revised Draft DCD	2-25	59	NPS	Consider deleting or revising. "Significant" is ambiguous. Gorge has 3 tributaries that could support spawning fish Gorge Ck, Pyramid Ck, and Stetattle Ck.	B. Holloway	1	A	Agreed. Have revised to state the Stetattle is the "largest" tributary.
129	Revised Draft DCD	Section 2.3.2	85	NPS	It would be helpful to include a description (min, avg, max) of the estimated monthly unregulated flows in the Bypass Reach.	T. Malone/M. Garello	2	D	Additional discussion regarding unregulated flows will be added as part of the Assessment of Fish Passage Flows in the Bypass Reach documentation.
130	Revised Draft DCD	2-62	96	NPS	Detention times differ from what is stated in the PAD. For example, in the PAD, Ross Reservoir detention time is stated as being 189.4 days. What is the significance of specifying detention time in terms of max hydraulic output?	T. Malone	2	A	Updated to value provided in the PAD.
131	Revised Draft DCD	2-65	99	NPS	Detention time in DCD does not agree with PAD.	T. Malone	2	A	Updated to value provided in the PAD.
132	Revised Draft DCD	Section 3.0	101	NPS	It would help if the information presented in this section was done using a standardized format with the description for each fish should including the 5 criteria. See below.	J. Venard	4	A	The organization of the report was not changed. The level of information available for each species varies greatly and the narrative provided in the current DCD attempts to provide as much pertinent information as available. Therefore, there are some areas that receive more information than others. Standardized presentation of the information as suggested could be improved if the information from each species was uniform, but it is not. The information was presented largely in this manner as narrative for each species and migration timing, abundance, and size information was summarized in a combined manner in specific sections as these cumulatively inform the type, size, and complexity of passage facilities.
133	Revised Draft DCD	3-1	101	NPS	Consider adding an additional criteria for the number and distribution/location of local populations. This will be pertinent when considering Bull Trout and Dolly Varden collection and release sites.	B. Holloway	2	A	The Fish Passage Study is intended to evaluate the technical feasibility of constructing facilities that can be used to meet passage strategies to be determined in the future by responsible agencies and co-managers. A generic head of reservoir collection system design will be evaluated in Stage 2 of this study. Designs for specific tributaries that address the management of local BT populations can be tailored from a typical design, but will not be evaluated for specific tributaries under this study. Given that this comment speaks to fisheries management strategies that will be selected at some point in the future, it is currently beyond the scope of the DCD. However, if future fish passage strategies determine the need for head of reservoir collectors at specific tributaries, site specific designs could be developed and should consider the specific biological goals and physical operating environment of each tributary. Such site-specific designs are to be based on future management strategies that will be developed by others and is therefore, beyond the scope of this Fish Passage Study.
134	Revised Draft DCD	3-1	101	NPS	Revise to: Of the target species, O. mykiss, Bull Trout, and Dolly Varden are the only native fishes known to **currently** occur upstream of the dams.	J. Venard	2	A	Revised as suggested.
135	Revised Draft DCD	3-1	101	NPS	Mountain Whitefish (Prosopium williamsoni) are present in the Skagit immediately below the project and the NPS request that they be considered. This species was included as part of our initial Study Request to FERC. Similarly, Largescale Sucker (Catostomus macrocheilus) occur in the Skagit River up to Bacon Ck and should be considered in the future and perhaps lumped into a single taxa as Catostomus.	B. Holloway	4	A	The target species for this assessment include those documented in the RSP, and three additional species (Dolly Varden, Pacific Lamprey, and Salish Sucker) that were requested for consideration in the bypass reach in the June 9, 2021 Notice of Agreements for FA-02 and FA-05. These additional species were agreed to be added into the FA-04 study as incidental for passage (i.e., Salish Sucker), or considered for additional analysis (e.g., Pacific Lamprey). However, neither species (Mountain Whitefish and Largescale Sucker) have been the basis of design in any previous high-dam fish passage facility development and such designs would therefore be considered experimental. City Light may consider Mountain Whitefish and Largescale sucker as incidental, non-target species for passage.
136	Revised Draft DCD	Section 3.1.5	107	NPS	It is unclear why such an in-depth description of Bull Trout is included in this document when compared to the other species. Suggest that much of this text be removed. Include only what is pertinent for designing fish passage structures. The information included for each species of fish should be standardized as described as need on page 3-1: 1) Occurrence and distribution; 2) Migration timing; 3) Abundance; 4) Size/Biomass; 5) Number and Distribution/Location of local populations (See Previous comment). We acknowledge that Bull Trout are a special case given their high fidelity to natal streams and subsequent population structure but it is premature to discuss or hypothesize what the population structure of these fish are at this time. Wait until the results of FA-06 are available.	J. Venard	4	A	The organization of the report was not changed. The level of information available for each species varies greatly and the narrative provided in the current DCD attempts to provide as much pertinent information as available. Therefore, there are some areas that receive more information than others. Standardized presentation of the information as suggested could be improved if the information from each species was uniform, but it is not. The information was presented largely in this manner as narrative for each species and migration timing, abundance, and size information was summarized in a combined manner in specific sections as these cumulatively inform the type, size, and complexity of passage facilities.
137	Revised Draft DCD	3-16	116	NPS	Strike: "and it is likely individuals above Gorge Dam are the result stocking of Westslope Cutthroat Trout and Coastal Cutthroat Trout in areas upstream of Gorge Dam in the early 1990s". Unless data is available to support this claim. At this point it seems premature to state this until we have the results of FA-06. An interesting side note: Trotter thinks that WCT could be native to the upper Skagit (Personal communication).	J. Venard	2	A	Have removed the statement as requested. Results of FA-06 may inform historic data on this species and future management decisions by co-managers. Future management decisions are outside of the scope of this study.
138	Revised Draft DCD	Section 3.1.10	117	NPS	NPS cited positive detections for P. Lamprey eDNA in the Skagit and Sauk in our RSP comments and included a map. Source: https://usfs.maps.arcgis.com/apps/webappviewer/index.html?id=b496812d1a8847038687ff1328c481fa	J. Venard	2	A	Text revised to indicate Pacific Lamprey eDNA detection in the Sauk River; Pacific Lamprey eDNA positive samples not indicated in the mainstem Skagit River or tributaries upstream of the Sauk River on the Aquatic eDNAthlas Project map that was provided. Review of comments on RSP by the NPS did not result in reference to Pacific Lamprey eDNA information or presence in the Skagit River.
139	Revised Draft DCD	Section 3.2	118	NPS	The presentation of this information is unclear. Suggest following the format outlined on page 3-1 and with addition NPS criteria. NPS also sent data related to O mykiss and char spawning surveys which aren't included. Seems like it would be better to fold this section into the previous species descriptions.	J. Venard	2	A	See Response to same comment from USFWS, Comment #108 regarding the suggested report outline. Additional native char spawner abundance in reservoir tributaries from the NPS Native Char Spawning Survey Data Summaries was added to Section 3.1.5.2. Rainbow Trout spawning and escapement information from Ross Lake tributaries and abundance information from Triton (2020) was added to section 3.2
140	Revised Draft DCD	Section 3.1.9	117	NPS	NPS sent information related to native char spawning that could be used to provide more detail.	J. Venard	2	A	Native char information provided by the NPS was incorporated to other sections for Bull Trout because abundance and spawning information did not differentiate between the two species.
141	Revised Draft DCD	3-23	123	NPS	NPS provided spawning survey data that could be used.	J. Venard	2	A	Additional native char spawner abundance in reservoir tributaries from the NPS Native Char Spawning Survey Data Summaries was added to Section 3.1.5.2.
142	Revised Draft DCD	Section 5.2.1.2	134	NPS	Section only discusses downstream performance of juvenile fish. Presumably we will be allowing Bull Trout, Dolly Varden, and O mykiss to express fluvial and anadromous life history strategies. If so, downstream passage of subadult and adult fish needs to be evaluated along with iteroparity.	J. Venard	2	A	See response to same comment from USFWS, comment #109
143	Revised Draft DCD	5-4	136	NPS	Unclear on what is meant by standardizing performance on a cumulative basis. NPS requests that upstream and downstream performance be evaluated independently for each reservoir as well as on a cumulative basis. Perhaps that is implied since that is how one would determine the cumulative basis?	J. Venard	2	A	See response to similar comment from USFWS, comment #110
144	Revised Draft DCD	Section 5.3	136	NPS	Agree Salish Sucker (and Large Scale Sucker) will be a special case that will require adaptive management. Request that we also include Mountain Whitefish.	B. Holloway	4	A	See Response to same comment 135. City Light may consider Mountain Whitefish and Largescale sucker as incidental, non-target species for passage. However, facilities will not be designed for passage of these species because they have not been studied for passage, and any designs would be experimental in nature and beyond the scope of this study.

HDR

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

145	Revised Draft DCD	Section 5.5.1-5.5.3	139-141	NPS	Stage duration curves are plotted on an annual basis. It would be informative to have this information broken out on a seasonal basis especially during the spring and summer when juvenile outmigration will be peaking. However, I acknowledge that this might not be important information in the overall design criteria and may not be relevant. Maybe a topic of discussion for future meetings.	T. Malone/ N. Loo	4	A	Minimum, maximum, and average water surface elevation by month is reported in Section 2.3.1 of the current document using mean daily data over the period of record evaluated illustrating seasonal variation. Further, mean daily data was added into the annual water surface fluctuation plots, also providing insight on annual and seasonal variation. Although, monthly stage-duration curves are another appropriate method of demonstrating seasonal variability, facilities are expected to operate year-round for the full range of reservoir stage fluctuation. As such, seasonal stage-duration curves would not further differentiate or advance preliminary development of the technologies presented in the DCD and are therefore not included in this document. Future reports may contain seasonal stage-duration curves to inform operational needs of specific facilities if required.
146	Revised Draft DCD	Table 5.5-1	144	NPS	Are there dams in British Columbia that could also be used as a comparison? That would give us a better boundary condition for larger sized reservoirs and WQ conditions are probably more representive of the Skagit's climate and glacial influence. This seems like it will be important for Ross since that is the largest reservoir in the table. Ultimately however, we will need reservoir specific data on fish outmigration timing and habitat use to make a final decision (See NPS Study Requests 5, 6, 7, and 9).	J. Venard	2	A	There may be dams and reservoirs in British Columbia that physically compare to Ross Lake, but none are known to have similar fish passage facilities to those being considered in this analysis. The intent of this is to provide a lateral comparison of reservoirs with fish passage facilities to provide relative context of fish passage performance. The table heading was revised to clarify the purpose of the table. We agree that that the specific conditions of Ross Lake will need to be considered for design of any potential fish passage facilities at the site; however, this level of analysis would occur at future phases of design.
147	Revised Draft DCD	5-13	145	NPS	Can you describe the literature search that was conducted to compile the available information. What species of "juvenile fish"? This should be defined as it will be species specific. Is it based solely on the reservoirs listed in Table 5.5-1?. Seems like it might also be useful to look at natural lakes in terms of residualization, predation etc. Is there information available from other reservoirs where juvenile migration was studied and downstream fish passage facilities were not installed (or were installed and failed) because of high reservoir related mortality? It also seems that the distance between the tributary mouth and the collector is an import factor that is not addressed.	J. Venard	2	A	The last statement in the last sentence of paragraph was revised from "available information" to "physical comparison to reservoirs with existing surface collectors". The literature search and comparison to other reservoirs was limited to those hydroelectric projects and reservoirs with existing passage facilities to provide a lateral comparison that informs the type, size, and complexity of facilities considered in this assessment. Further literature review of species specific information request is well outside of the scope of the Fish Passage Study. As emphasized by NMFS during review of the Preliminary Draft DCD, This study is a technical feasibility assessment to identify and provide cost opinions for passage solutions at the Skagit River Hydroelectric Project. This is not intended to provide a recommended passage solution, but all solutions deemed technically feasible. Formulation of fish passage strategies first presupposes varied value of access to each reservoir in the system. Value of access is currently being determined through various other studies. Strategies may be assembled based on the technically feasible passage methodology/technology but will not be considered prior to exploration of passage facility assessments. Further, as stated in the RSP, "The results of the Fish Passage Study and/or the Reservoir Tributary Habitat Assessment may include the identification of next steps or additional studies that are warranted to further evaluate factors which may affect the efficacy of providing safe, timely, and effective fish passage at the Project, such as those referenced in NMFS's study plan request in Sections 3.4.5 and 3.4.7 (e.g., juvenile reservoir transit and mortality) and those raised in Anderson et al. (2014)."
148	Revised Draft DCD	5-13	145	NPS	Would the CE-QUAL-W2 model that is being developed as part of FA-01 help fill this information gap? This also seems pertinent because conditioning water temperatures in Diablo and Gorge Reservoirs are being considered as part of the next license.	T. Malone/M. Garello	2	D	Yes, the CE-QUAL-W2 modeling effort is intended to provide temperature data for all three reservoirs and can be used fill this informational gap.
149	Revised Draft DCD	Section 7.1	160	NPS	Suggest that a series of fish passage strategies be formulated with LPs	B. Holloway	4	A	As discussed in November 2021 AWS meetings and reiterated during Workshop 3, LP consensus was that discussions regarding fish passage management strategies will be conducted outside of the scope of this study among co-managers and responsible resource agencies. Although the DCD presents typical fish passage strategies, no recommendations for strategies will be made as part of this study, as the study focuses on reviewing the technical feasibility of implementing a suite of fish passage technologies at each development and throughout the Project.
150	Revised Draft DCD	Section 7.2.3.6	196	NPS	Can CE-QUAL-W2 from FA-01 and/or CHEOPS from OM-1 be used to help determine how reservoir drawdown could be used as an operational change to facilitate fish passage? What variables, parameters, metrics, and/or model outputs are needed to help evaluate this as a management option?	T. Malone/M. Garello	1	A	Added verbiage stating viability of this fish passage alternative.
151	Revised Draft DCD	Tables 7.3-1 and 2	197-199	NPS	A description should be included about how the suitability was determined. This should be included for each option in the previous sections that relate to these tables.	M. Garello	2	A	Concur. Additional narratives were added to define suitability, how it was used to qualitatively asses technologies, and describe the relative suitability of the range of technologies to each of the three Project developments.
152	Revised Draft DCD	Table 7.3-2	198-199	NPS	Suggest adding Adult Downstream Passage Juvenile Downstream Passage to the Capability and Characteristics of Operating Environment for salmonids and lamprey.	J. Venard/M. Garello	2	A	Additional tables were added that indicate the passage suitability for all target species and the technologies types.
153	Revised Draft DCD	Tables 7.3-1 and 2	197-199	NPS	Lamprey need to be added to the tables or an additional table for lamprey should be included with an accompanying narrative.	J. Venard/M. Garello	2	A	Additional tables were added that indicate the passage suitability for all target species and the technologies types.
154	Revised Draft DCD	Section 8.0	201	NPS	A narrative justification should be included about why certain strategies from Section 7 have not been incorporated as options.	B. Holloway/M. Garello	1	A	As stated in response to comment #120 from the USFWS: Section 8 has been updated to reflect each of the technologies that are not being advanced to the next stage of the study. Refer to Sections 8.1.1, 8.2.1, and 8.3.1 for an explanation of technologies eliminated from further consideration at each development.
155	Revised Draft DCD	Section 8.0	201	NPS	This section should include a discussion of how fish from Ross, Diablo, and Gorge that get entrained downstream into Diablo, Gorge, and Skagit River will be collected and passed back to their natal reservoir/stream.	J. Venard/M. Garello	2	A	Comment noted; see response to same comment from USIT, comment #186 and 191: With a downstream passage facility in place and operational, collected fish may considered to be attempting to migrate downstream. Fish passed via spill may be unknown. Agree that this will be a future fish management and policy decision The re-location of entrained fish to reservoirs of their origin is a fisheries management issue that is outside the scope of the Fish Passage Study.
156	Revised Draft DCD	Tables 8.2-1 and 8.3-1	208, 215	NPS	The Reservoir Bypass option will eventually need to be species specific and require results from other studies.	B. Holloway	2	A	Section 8 of the DCD has been updated in the Final draft to reflect the options selected for advancement to Stage 2 of the study. The fish passage options advanced to the next stage, as discussed during AWS meeting No. 11 held on January 10, 2022, offer a suite of options that can be mixed and matched to address any future fish management objectives to be determined by others outside of the scope of this study. This study is evaluating technical feasibility only. Fish management strategies, including the reservoir bypass strategy, will be determined at a later date. However, the full suite of fish passage options that will be advanced to Stage 2 of this study will support this management strategy. Section 7, Table 7.3-3 compares qualitative suitability of each technology to fish species and life stages considered for fish passage. Additional development of fish passage technologies, site specific applications, and species specific provisions and performance will be advances as part of Stage 2 of the fish passage study and documented in future iterations of the Conceptual Design Report and Fish Passage Assessment.
157	Revised Draft DCD	Section 8.4	221	NPS	The full life-histories of Bull Trout, Dolly Varden, and O mykiss should be considered for all fish passage facilities, not just tributary (i.e. downstream passage strategies should also consider sub-adults and adults). Consideration should be given to tributary collection strategies that account for adfluvial "resident" fish, that should probably not be passed below a dam and be allowed to remain in the reservoir and also allow for kelts to migrate downstream. Volitional passage should also be considered for these species. The final stage of the Fish Passage Facilities Alternatives Assessment will evaluate how each passage option meets the feasibility factors addressed in the DCD.	J. Venard	2	A	This comment is addressed in the last bullet of this section, indicating that facilities include accommodations for moving fish to desired locations based on future management goals. Details of species and life stage specific transport strategies, methods, and requirements would be incorporated into later phases of design
158	Revised Draft DCD	Section 8.4	221	NPS	Include bullets for other studies that could help refine design options. This will help with study integration. For example: CE-QUAL-W2, CHEOPs, FA-06 etc.. For example, how will providing flow in the Bypass Reach influence design criteria.	J. Venard	2	A	This comment is largely addressed in Section 1.4 Linkages. An additional bullet is provided referencing this section and indicating that the outcomes of these studies may further inform the elements of the Fish Passage Study.

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

159	Revised Draft DCD	9-1	223	NPS	At this point it, we have not been provided enough information to make determinations about about the feasability for many of the methods. Including a broader range of existing fish passage facilities in the PNW that include MT, ID, and BC not just WA and OR would help. See also previous comments for Section 7. Rather than removing options, developing a prioritized list of options and working through those priorities could be a path forwad until the results from other studuies become available.	T. Malone/ M. Garello/J. Venard	2	A	The Revised Study Plan stated that the DCD includes a list of conceptual alternatives to be evaluated and moved forward into concept development. The list of options moved forward are those viewed as suitable technologies at the various Project locations and described by the analysis presented in this document. While a broader comparison to other dams and passage facilities throughout the Northwest and British Columbia may be useful, this assessment focused on providing a lateral comparison of PNW sites where likely similar fish passage conditions and facilities to those anticipated to be suitable at the Project. This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occuring in December and January 2022. The organazation and structure of the potential fish passage options and technologies selected for further development in Stage 2 of ths study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accomodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration recieved concurrence during our January AWS meetings and has, subsequently been incorporated into the Final DCD.
160	Revised Draft DCD	9-1	223	NPS	We share similar concerns with USFWS and are concerned that finalizing the document may unintentionally eliminate fish passage alternatives due to the lack of information these remaining relicensing studies may provide, potentially resulting in considerable backtracking and subsequent delays. Our recommendation would be to finalize the DCD once the remaining studies have been completed. This being said, we understand that the consultant team probably doesn't have the capacity to continue to evaluate all the options that are being considered. Perhaps an option for moving forward would be to work with the LPs on prioritizing options for concept-level designs and not removing options.	B. Holloway	1	A	This comment has been resolved as the result of additional discussion and collaboration during several recent AWS engagements occuring in December and January 2022. The organazation and structure of the potential fish passage options and technologies selected for further development in Stage 2 of ths study was revised to include a single alternative and a broad range of potential technologies implemented at numerous potential sites. This 'a-la'carte' approach is intended to accomodate a very broad range of potential fish passage management strategies that could be considered in the future by fisheries co-managers. This approach and the technologies selected for further consideration recieved concurrence during our January AWS meetings and has, subsequently been incorporated into the Final DCD.
161	Revised Draft DCD	9-1	223	NPS	NPS shares the concern of USFWS and suggest the Fish Passage Concept Development Report also include a discussion of pertinent status updates for the outstanding relicensing studies that still need to completed and may have relevance to the fish passage concepts.	J. Venard	2	A	See response to same comment from USFWS, comment #125
162	Revised Draft DCD	9-2	224	NPS	The determination of what is "significantly interfering" will need to be determined with input from several different disciplines and will likely need to be resolved in the Technical Steering Committee and with the Partners.	B. Holloway	1	A	We concur. Statement added to this section. Note that feasibility factors will be refined during future AWS meetings prior to the initiation of Stage 3 of the Fish Passage Facilities Alternatives Assessment. The consultant team will solicit feedback on these factors from LPs to better define each of the factors and provide site-specific context for Project and non-Project uses.
163	Revised Draft DCD	General	-	NPS	In general, the DCD seems largely focused on passing adult fish (mostly Pacific Salmon) upstream and juvenile fish downstream and seems focused on semelparious life-histories. More detail is needed about upstream and downstream passage of subadult and adult Bull Trout, Dolly Varden, and O mykiss and potentially suckers and whitefish.	J. Venard/M. Garello	2	A	We agree that much of the information presented is based on passage of salmon and steelhead. This is largely because the body of knowledge, literature, and facilities in the Pacific Northwest are focused on these species. In addition, passage at high-head dams in the Pacific Northwest is typically focused on upstream passage for adults and downstream passage of juveniles because of the relative abundance that they occur at the respective facilities. While other species and life stages (e.g. sub-adults and kelts) may be passed at these facilities, designs and accommodations for these are typically site specific and dependent on the biological objectives at the site. The study and the DCD are a high-level assessment of the type, size, complexity, and estimate cost of passage facilities at each dam to inform the feasibility of passage at the Project. The assessment does address passage of all the target species, but does not provide the specific facility details that support passage of each species, which would occur at later stages in design and would be guided by the technical fish passage engineering and design guidelines identified in the document. In addition, the consensus among AWS participants was that establishing biological, ecological, and fisheries resource management goals for fish passage is a co-manager, policy-level discussion that should not occur as part of the Fish Passage Study. Therefore, passage options and concepts were identified based on overall likely function at each site and were not species or life-stage specific. The applicability, required design elements, and potential performance of selected passage technologies will be further evaluated as part of fish passage study stage (Stage 2 - conceptual development of potential fish passage facilities).
164	Revised Draft DCD	Section 3.1	101	USIT	Documents from existing license indicate steelhead and possibly chinook have been documented to Stetattle. Recently, coho have been observed to the base of Gorge Dam. Upstream extent of all species is not known due to lack of available information from pre-project.	J. Venard	2	A	Additional text has been added indicating that steelhead were documented to Stetattle Creek and that Coho Salmon have been observed in the Gorge Bypass Reach. Text added indicating that the upstream extent of distribution described for the target species is based on post-project information.
165	Revised Draft DCD	Section 3.1	101	USIT	Please see previous comment in 3.1 section header. Text should be added to note that those species are the only target fish known to *presently reside* upstream upstream of the dams.	J. Venard	2	A	Text revised to state "known to currently occur".
166	Revised Draft DCD	Section 3.1.4	106	USIT	This is not accurate, as we have explained numerous time previously, including in comments on the RSP. Upstream extent of anadromy is uncertain, but steelhead made it at least to Stetattle Creek. Please remove/edit accordingly.	J. Venard	2	A	Revised to indicate steelhead migrated to Stetattle Creek.
167	Revised Draft DCD	Section 3.1.5	107	USIT	The level of detail here is not needed. Only include relevant information to include: 1) occurrence and distribution; 2) migration timing; 3) abundance; and 4) fish size (as detailed on page 3-1)	J. Venard	2	A	See Response to same comment from USFWS, Comment number 108.
168	Revised Draft DCD	Section 3.1.5.2	109	USIT	Is adfluvial behavior considered in "freshwater resident"? "Freshwater resident was not included as one of the life history types defined in foot note 17 on page 3-8. Suggest clarifying this distinction- as it is understood (using the definition in the footnote above) fish in the Project reservoirs should be considered both resident and migratory (i.e. adfluvial) given many migrate downstream to larger rivers or reservoirs (i.e. from the Project's reservoir's tributaries to the Project's reservoirs). It should also be noted that the Project's infrastructure make it difficult for Bull Trout in the reservoirs to fully express the full suite of migratory life history behaviors (i.e. fluvial, anadromous).	J. Venard	2	A	Statement removed because migratory patterns (resident, fluvial, and adfluvial) are described in subsequent paragraphs and the sentence does not pertain to the main subject of the paragraph.
169	Revised Draft DCD	Section 3.1.8	116	USIT	Unless a reference can be provided for this statement, it should be removed as speculation.	J. Venard	2	A	Have removed the statement as requested. Results of FA-06 may inform historic data on this species and future management decisions by co-managers. Future management decisions are outside of the scope of this study.
170	Revised Draft DCD	Section 3.2	118	USIT	The description of target species upstream of the project should be removed because there is not adequate available information for pre-project fish distribution. Alternatively, it could describe what is known, that steelhead and likely Chinook were observed in Stetattle and Reflector Bar area, present-day observations have coho at the base of Gorge Dam, and upstream extent for all species is unknown. Additionally, see comment on page 3-1 relevant to the second to last sentence in this paragraph.	J. Venard	2	A	The description of the fish assemblage above the Project Dams was included and retained as it characterizes the fish populations above the Project dams and informs the need, size, type, and complexity of passage options at each of the Dams that would support intra-basin connectivity and passage. The known extent of steelhead, Chinook Salmon, and Coho Salmon is provided in the respective species description sections.
171	Revised Draft DCD	Table 3.3-1	120	USIT	Winter steelhead adult migration should extend into April/May, and Kelt migration should extend into August. Consider potential for summer run steelhead populations.	J. Venard	2	A	The periodicity remains as-is until updated by the Habitat Suitability Criteria team to provide consistent information.
172	Revised Draft DCD	Section 5.2.1.2	134	USIT	Section needs to include downstream passage performance of subadult and adult to allow for evaluation of fluvial/adfluvial migration patterns in addition to iteroparity (i.e. Bull Trout, Dolly Varden, and O. mykiss full life history expression).	J. Venard	2	A	See response to same comment from USFWS, comment #109
173	Revised Draft DCD	Section 5.4	137	USIT	Populations below Gorge could be useful for informing migration periods, though it would be important to also consider the potential loss of unique runs and/or run-timing caused by construction of the Project. For instance, summer run steelhead.	J. Venard	2	A	Comment noted: Additional text included that includes additional suggested considerations. abundance estimates for areas upstream of the Project may be informed by on-going Intrinsic Potential studies being conducted under FA-07.
174	Revised Draft DCD	Section 5.6	142	USIT	This section is largely focused on the difficulties/impediments to salmonid outmigration (which is useful in passage option development), yet there are numerous cases throughout the west of examples where outmigration is successful at storage/high-head dams. This section is therefore considered incomplete without including examples of where/how outmigration is possible. Failing to include how reservoir transit difficulties are overcome will result in incomplete discussions later.	M. Garello	2	A	Among many factors, the physical conditions that exist in a reservoir, such as overall complexity, length, volume, depth, hydrologic and hydraulic conditions, velocities, and temperatures are factors that affect the survival, transit, and potential success of fish passage through the reservoir which significantly influences overall fish passage efficiency and facility success. Table 5.6-1 provides a sample list of Pacific Northwest reservoirs where downstream migration of juvenile salmonids have been studied. The success and related passage performance of each example (with the exception of Detroit and Cougar Dams which do not yet have full scale downstream collection facilities) are provided in Appendix B - Summary of Pacific Northwest Hydropower Projects Downstream Fish Passage Facilities Performance Standards and Evaluation. In each of these cases, reservoir transit is a function of the reservoir itself and the associated operations. The reservoir passage efficiency is known based upon monitoring fish movement through the reservoir. Fish passage facility elements, location, orientation, attraction flow, etc., are arranged and optimized (to the extent possible) to accomodate knowledge of that fish movement.

Skagit FA-04: Conceptual Design Criteria Report

Date: February 14, 2022

Project: Skagit Relicensing
Study/Lead: B. Le
HDR Design Lead: M. Garello / B. Holloway
Review Item: Preliminary and Revised Draft D

Acceptance Codes
1 - Accepted, already implemented
2 - Accepted
3 - Deferred
4 - Not Addressed

Comment Status Codes
A - Resolved
B - Resolution pending
C - Unresolved
D - Rolled over to next submittal

175	Revised Draft DCD	Table 5.5-1	144	USIT	This table needs to be expanded to include more relevant Projects, and those additional Projects/comparisons should be added to the related tables in section 5 & 6 detailing performance criteria, as appropriate. Projects to add include: reservoirs in BC; NF Clackmas; Howard Hanson Dam; Merwin and Yale on the Lewis River; Box Canyon; Albani Falls, and Boundary Dams(operated by SCL) on the Priest River; Rocky Reach, Rock Island, and Wells Dams on the Columbia (due to their run-of-the-river nature); Cle Elum Dam (passage near completion); Thomposn Falls Dam; and Cabinet Gorge Dam. Including the listed relevant hydropower facilities throughout the northwest will allow for a more complete evaluation and comprehensive evaluation of how passage facilities are operated under a variety of conditions (thereby preventing the analysis/comparison from being short-changed)	J. Venard/M. Garello	2	A	We agree that a comprehensive summary reservoir and passage conditions from dams in the northwest and British Columbia may be informative. The intent was to provide a lateral comparison of dams and reservoirs with similar conditions to those at the Project that provides relative context of fish passage performance and inform the type, size, and complexity of facilities that are perceived as feasible at the Project and, by-in-large, performance has been evaluated to indicate relative success and lessons learned. The examples included were from facilities of similar scale, operational condition, and that used (or are intending to use) technologies that are anticipated to reasonably apply at the Skagit Project dams. An exception to including those that have been fully designed or implemented is the inclusion of the Detroit Dam/Reservoir in the comparison of reservoirs (Table 5.6-1) because conceptual design of a floating screen structure at the dam is an example of the scale and complexity of such a passage technology and fish behavior and transit in the reservoir has been extensively studied. The suggested examples do provide a broader range of potential facilities and technologies to considered and were or were not included for the following reasons. The NF Clackamas project is included in the evaluation (North Fork Dam). Howard Hansen Dam was not included because the adult trap and haul facility has not been used for passage of fish above the dam and until reintroduction of salmon upstream of Howard Hanson Dam occurs, is only used for collecting fish for research or hatchery broodstock collection; also, while downstream passage options have been developed at some level, a feasible facility has not been fully designed and/or constructed. Passage facilities were included for the Lewis River Project, including upstream passage (Merwin Dam) and downstream passage (Swift Dam); however, downstream passage had not been designed or implemented at the Merwin or Yale dams and has only recently been required for study and evaluation. The mid-Columbia Dams were not included in the comparison because they are not high head dams, the scale and footprint are substantially larger, upstream passage is via technical fish ladders (which is not typical at high-head facilities). Downstream passage at Rocky Reach is via a fish bypass that does not provide a comparative application at the Skagit Project dams; downstream passage at Rock Island is via turbines (Kaplan style) or spill. Downstream passage at Wells Dam uses a hydrocombine system that is unique to that dam and not suitable at the Skagit Project dams. The Cle Elum Dam facilities were not included because the upstream trap and haul facilities are typical of many others already in place, the existing fish passage weir is not applicable at the high-head dam conditions, and the helix downstream fish passage facility is unique to accommodate the site conditions. Inland dams, such as Box Canyon Albany Falls, Thompson Falls, and Cabinet Gorge dams were not included because the projects are low-head dams, upstream passage is provided by typical fishways or trap and haul facilities, and downstream passage is via the powerhouse or spill. Boundary Dam was not included because there are efforts to
176	Revised Draft DCD	Table 5.7-1	146	USIT	Should be table 5.6-1; see comment to table 5.5.-1 regarding including additional examples.	J. Venard	2	A	Table numbering corrected. Regarding additional examples: see response to comment to table 5.5-1, comment #175
177	Revised Draft DCD	Section 6.0	155	USIT	Question for legal/policy: is it SCL's position to determine/question how well the technology will perform? Is this just not about feasibility? Seems a little out of scope.	B. Holloway/M. Garello	1	A	As stated in the FA-04 Fish Passage Study RSP, Stage 3 of the Fish Passage Facilities Alternatives Assessment, includes the development of a "Fish Passage Assessment". This deliverable, to be initiated in the summer of 2022, will assess each of the fish passage concepts advanced to Stage 2 of the study to determine how each option meets each of the four feasibility factors outlined in the DCD. The feasibility factors are presented in Section 5.8 of the DCD. As related to this comment, the Fish Passage Assessment will evaluate each option's ability to meet Factor 3: Ability to Meet Usual and Customary Fish Passage Performance Standards: alternatives must be able to achieve the usual and customary performance standards established for similar facilities, such as collection efficiency, survival through a passage facility, and overall passage efficiency.
178	Revised Draft DCD	Table 6.1-1	156	USIT	see comment to table 5.5.-1 regarding including additional examples.	J. Venard	2	A	See response to comment to table 5.5-1, comment #175
179	Revised Draft DCD	Table 6.1-2	156	USIT	see comment to table 5.5.-1 regarding including additional examples.	J. Venard	2	A	See response to comment to table 5.5-1, comment #175
180	Revised Draft DCD	Section 6.2	157	USIT	For this statement to hold weight, details regarding "breaking points" where residence time becomes an issue is needed (i.e. what residence times provide too little current for fish to cue in on). Also, seems as though this would change as Project ops change during drawdowns. Lastly, residence times vary greatly between the 3 reservoirs making a blanket statement like this problematic. More information is needed, including how these issues are overcome in some of the examples of other fish passage facilities.	J. Venard/M. Garello	2	A	We concur that there is a range of conditions and related responses that influence residence time, operating conditions, and the associated transit conditions at the three dams. More information may be needed as the study progresses. However, further analysis of these conditions is beyond the scope of this stage of the assessment and may be part of next phases of concept development. The statement was revised to indicate that these are factors that provide challenges for downstream fish passage at high head dams and contributed to the relatively recent advancement of surface collectors as a passage technology and introduces the subsequent discussion.
181	Revised Draft DCD	Table 6.2-1	158	USIT	see comment to table 5.5.-1 regarding including additional examples.	J. Venard	2	A	See response to comment to table 5.5-1, comment #175
182	Revised Draft DCD	Figure 7.1-1	161	USIT	Per the third bullet above, provide a second orange triangle at the gorge powerhouse, or, include that information in the figure capture. This would make the figure more stand alone.	B. Holloway	1	A	Agreed. A second orange triangle has been added at the Gorge Powerhouse.
183	Revised Draft DCD	Figure 7.1-2	163	USIT	Per the third bullet above, provide a second orange triangle at the gorge powerhouse, or, include that information in the figure capture. This would make the figure more stand alone.	B. Holloway	1	A	Agreed. A second orange triangle has been added at the Gorge Powerhouse.
184	Revised Draft DCD	Section 7.1.5	166	USIT	USIT maintains, and recommends that, Gorge Dam removal be included as a passage option. When evaluating the options to vet the most appropriate passage configuration, it will be important to be able to have Gorge Dam removal on the table in the event the 17-factor criteria test yield data such that removal would be more beneficial than the other passage options.	B. Holloway/M. Garello	1	A	Thank you for the comment. City Light will progress with the proposed 17-factor test independent from the Fish Passage Study, and re-evaluate this issue pending the results of that assessment.
185	Revised Draft DCD	Table 7.3-1	197	USIT	These tables (7.3-1 & 7.3-2) are very helpful, however more details as to how suitability criteria were vetted as low, moderate, or high are needed.	M. Garello	2	A	Concur. Additional narratives were added to define suitability, how it was used to qualitiatively asses technologies, and describe the relative suitability of the range of technologies to each of the three Project developments.
186	Revised Draft DCD	Section 8.0	201	USIT	Not included in this section, or discussions AWS meetings is how fish entrained will be passed back up-stream to reservoirs of their origin. Suggest discussing here or putting a place holder in this section for futire AWS talks.	B. Holloway/M. Garello	4	A	Comment noted. With a downstream passage facility in place and operational, collected fish may considered to be attempting to migrate downstream. Fish passed via spill may be unknown. However, presence of upstream fish passage technologies could provide passage back upstream if fish are motivated to do so. The re-location of entrained fish to reservoirs of their origin is a fisheries management issue that is outside the scope of the Fish Passage Study.
187	Revised Draft DCD	Section 8.1.1	207	USIT	Look forward to this update. Please include a complete description as to why options were not included (relevant to comment on Table 7.3-1)	B. Holloway/ M. Garello	1	A	Narratives have been added to Section 8.5 to provide rationale for the elimination of fish passage technologies from further consideration.
188	Revised Draft DCD	Section 8.2.1	214	USIT	Look forward to this update. Please include a complete description as to why options were not included (relevant to comment on Table 7.3-1)	B. Holloway/M. Garello	1	A	Narratives have been added to Section 8.5 to provide rationale for the elimination of fish passage technologies from further consideration.
189	Revised Draft DCD	Section 8.3.1	220	USIT	Look forward to this update. Please include a complete description as to why options were not included (relevant to comment on Table 7.3-1)	B. Holloway/M. Garello	1	A	Narratives have been added to Section 8.5 to provide rationale for the elimination of fish passage technologies from further consideration.
190	Revised Draft DCD	Section 8.4	221	USIT	Evaluation will need to consider potential operational changes that may influence reservoir conditions (e.g. affect of flow releases on reservoir residence time and fish movement or temperature conditioning for Diablo and Gorge). (cross-walk with flows studies, FA-01, OM-01	M. Garello	2	A	This was added as another key consideration associated with concept development and may be addressed in future stages of the fish passage assessment as information from concurrent studies becomes available.
191	Revised Draft DCD	Section 9.0	223	USIT	Not included/discussed during workshops/AWS meetings: status update regarding current relicense studies that FA-04 will rely upon for information. Such a status update/discussion will be necessary to ensure adequate cross-walking between the studies. (USIT shares this concern with NPS and USFWS).	M. Garello	2	A	Comment noted. The fish passage study team will identify future scheduled engagement opportunities to incorporate updates on other concurrent relicensing studies that may have bearing on FA-04. As the information becomes available, previous documentation (such as the DCD) may be modified through errata, and/or new information may be incorporated into future documentation associated with this study.