



**US Army Corps  
of Engineers®**  
Portland District



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# **WILLAMETTE VALLEY SYSTEM OPERATIONS AND MAINTENANCE**

## **APPENDIX A: ALTERNATIVES DEVELOPMENT**

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**ACRONYMS**

7dADM	7-day average of daily max
AFF	Adult Fish Facility
BPA	Bonneville Power Administration
CFS	cubic Feet per Second
CTWSRO	Confederated Tribes of the Warm Springs Reservation of Oregon
DDR	Design Documentation Report
DEIS	Draft Environmental Impact Statement
DPE	Dam passage efficiency
DT	Diversion Tunnel
EIS	Environmental Impact Statement
EQ	Environmental Quality
ER	Engineering Regulation
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FWWS	Forebay Warm Water Supply
FSC	Floating Surface Collector
FSS	Floating Screen Structure
EIS	Environmental Impact Statement
ESA	Endangered Species Act
HD531	House Document 81-531
HGMP	Hatchery Genetic Management Plan
NAA	No Action Alternative
NED	National Economic Development
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
O&M	operations and maintenance

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ODFW	Oregon Department of Fish and Wildlife
OMRR&R	operation, maintenance, repair, replacement, and rehabilitation
OSE	Other Social Effects
pHOS	Proportion of hatchery origin spawners
PSM	Pre-spawn mortality
Q	Streamflow in Cubic Feet per Second
RED	Regional Economic Development
RM&E	Research, monitoring and evaluation
RO	Regulating Outlet
RPA	Reasonable and Prudent Alternative
SEIS	Supplemental Environmental Impact Statement
SWS	Selective Withdrawal Structure
TDG	Total Dissolved Gas
USACE	U.S. Army Corps of Engineers
UWR	Upper Willamette River
WATER	Willamette Action Team for Ecosystem Restoration
WRDA24	Water Resources Development Act of 2024
WUA	Wetted Usable Area
WVS	Willamette Valley System

## **CHAPTER 1 - INTRODUCTION**

This appendix describes the development of the range of reasonable alternatives analyzed in the Final Environmental Impact Statement (FEIS) and the Supplemental EIS (SEIS). The U.S. Army Corps of Engineers (USACE) was not required to supplement the FEIS under NEPA, but decided it was prudent to prepare the SEIS to evaluate “an alternative that ceases hydropower operations at the projects” as directed in the Water Resources Development Act of 2024 (WRDA 24), analyze new and updated the interim operations to reflect recent changes under adaptive management, and add actions from the National Marine Fisheries Service (NMFS) 2024 *Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Continued Operation and Maintenance of the Willamette Valley System Biological Opinion* (2024 Biological Opinion) like large woody debris and the Detroit fall drawdown for fish passage. This appendix describes the history of project alternative formulation, why alternatives or measures were screened out or retained for further analysis, and the screening criteria used to make these decisions. Detailed descriptions of all measures retained for detailed analysis are also provided. The programmatic scope of the Proposed Action is in FEIS Section 1.1, Background.

The USACE engaged with 10 Cooperating Agencies during the development and refinement of alternatives (Appendix L, Cooperating Agencies). Cooperating Agencies include tribes and Federal and state agencies that have jurisdiction by law or special expertise with respect to any environmental impact involved in a proposed alternative. As the alternatives may affect tribal trust lands and resources, the Confederated Tribes of the Grand Ronde Community of Oregon (Grand Ronde Tribe), the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO), and the Confederated Tribes of Siletz Indians are participating as Cooperating Agencies.

The Grand Ronde Tribe actively participated as a Cooperating Agency in development of the FEIS and SEIS by attending cooperator meetings, special topics meetings, and Willamette Valley System (WVS) field trips and by providing written and verbal comments. USACE and the Grand Ronde Tribe executed a Memorandum of Understanding on February 28, 2020. Also, in a letter dated June 2, 2020, the Grand Ronde Tribe provided comments to USACE acting in their role as a Cooperating Agency. The comments were specific to the alternatives and corresponding measures.

Staff from the Siletz Tribe and CTWSRO also participated in Cooperating Agency meetings. Both Tribes expressed interest in acting as Cooperating Agencies and engaged with USACE in multiple meetings, phone calls, and emails to discuss the potential but did not sign a Memorandum of Understanding with USACE. Federal agencies include NMFS, U.S. Fish and Wildlife Service, Bonneville Power Administration (BPA), Bureau of Reclamation, and Environmental Protection Agency. State agencies include Oregon Department of Fish and Wildlife, Oregon Department of Environmental Quality, Oregon Department of Water Resources, and Oregon Department of Agriculture. During the alternatives development process, USACE reached out in various ways, such as workshops, to receive input from

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cooperators. The cooperators also provided input on the scope, objectives, and measures that informed the alternatives development process.

Additionally, USACE received input from the public during a scoping process for both the FEIS and, later, for the SEIS. As part of the public scoping process for the FEIS, USACE scheduled and facilitated five public scoping meetings in June 2019 to engage with and inform the public on the development of the FEIS and to solicit input and public comments. Meetings were held throughout the Willamette Valley to provide an opportunity for interested stakeholders from different communities to attend. There were 384 unique comments received during Scoping of which 183 pertained to Alternatives (such as new suggested alternatives, changes in operations, or factors to consider when developing alternatives). As part of the public scoping process for the SEIS, USACE scheduled and facilitated four public scoping meetings in May and June 2025 to engage with and inform the public on the development of the SEIS and to solicit input and public comments. Meetings were held virtually and in person in Detroit, Oregon and Salem, Oregon to provide an opportunity for interested stakeholders from different communities to attend. There were 235 unique comments received during Scoping for the SEIS. Of the 235 unique comments, 78 pertained to Alternatives (such as suggested variations on the alternative to cease Federal hydropower, alternative fish passage measures at Detroit Dam, alternative drawdown operations at Detroit Dam, or alternative water management approaches).

With input from cooperators and the public, USACE identified a plan for the operations and maintenance of the WVS while continuing to consider impacts to the human and natural environment from the proposal. USACE has evaluated nine alternatives, including the No-action Alternative (NAA), and their environmental effects in the FEIS and SEIS, and identified a Preferred Alternative based on this analysis.

Action alternatives are distinguished from the NAA because they represent WVS management that would differ from the scope of existing operations and maintenance, as of the start of the EIS process in April 2019. Action alternatives include actions, or measures, that would modify the scope of operations and maintenance in comparison to no action – or not selecting and implementing an alternative that differs from WVS management as of April 2019. A full description of the alternatives and their effects is included in the FEIS made available for public review and comment. A summary description of the Ceasing Federal Hydropower Alternative is described in the SEIS with a detailed dam by dam description provided in this appendix. The USACE, Portland District prepared this SEIS to assess the continued operations and maintenance of the WVS, a combination of 13 multipurpose dams and reservoirs (impoundments), riverbank protection projects, fish passage facilities, adult fish collection facilities, and hatchery programs in the Willamette River Basin.

The Proposed Action is to continue operations and maintenance of the Willamette Valley System (WVS) for specific, authorized purposes. Responsibility for operating each dam and reservoir and the overall system was directed to USACE by Congress in authorizing legislation.

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Consequently, the Proposed Action is to continue to operate maintain the system in a way that complies with the ESA. The Proposed Action would be implemented over a 30-year timeframe.

The purpose and need for the continued operations and maintenance of the WVS is to operate the system in accordance with the eight Congressionally authorized purposes as detailed in Section 1.10, Congressionally Authorized Purposes, and in compliance with the ESA and all other applicable treaties, laws, and regulations. The purpose and need statement was revised slightly between the Draft Environmental Impact Statement (DEIS) and the FEIS to make explicit what was implicitly described in the DEIS. Specifically, that the actions being analyzed must comply with existing laws, treaties, and regulations.

In the FEIS, an alternative that eliminated hydropower operations was screened from further review because hydropower is an authorized purpose and analyzing an alternative that ceases hydropower does not meet the purpose and need of continuing to operate the system in accordance with its authorized purposes in a way that also meets ESA requirements. However, in WRDA 24, Congress specifically directed the USACE to analyze “an alternative that ceases hydropower operations at the projects, notwithstanding hydropower being an authorized purpose of such projects.” USACE carefully applied this language to develop the criteria and measures for a single alternative so it could analyze the effects of stopping hydropower generation at the projects in the system. This direction came six years after USACE developed the purpose and need statement, screened measures, and developed seven other feasible alternatives. USACE did not revise its purpose and need statement, because doing so would have effectively started the alternatives screening process over prolonging and already long NEPA process. Instead, the USACE is relying on the clear direction in WRDA 24 in developing and analyzing a single alternative where USACE would cease hydropower operations at its hydropower projects in the Willamette Valley System.

### **1.1 Overview of Alternatives Development**

USACE undertook a stepwise approach to development of the alternatives. These steps are:

1. Identify potential objectives for meeting the purpose and need using input from public scoping comments as well as from Cooperating Agencies.
2. Screen potential measures that were identified from public comments, internal brainstorming sessions, and input from Cooperating Agencies to ensure they met the purpose and need as well as one or more objectives and are technically feasible.
3. Build alternatives using combinations of the remaining measures around unifying themes or strategies.

The environmental consequences of each alternative in the final array resulting from this process are assessed in the EIS for their impacts to resources such as water quality, fish and wildlife, socioeconomics, recreation, etc. The environmental consequences analyses used various models and qualitative analyses based on the best professional judgement of subject matter expertise. The alternatives were then evaluated and compared utilizing the four

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formulation and evaluation criteria and the four accounts specified in USACE Planning Policy for Conducting Civil Works Planning Studies (Engineer Regulation 1105-2-103). The evaluation criteria are defined in the Principles and Guidelines as follows:

- **Effectiveness** is the extent to which the alternative plans contribute to achieving the planning objectives.
- **Efficiency** is the extent to which an alternative plan is a cost-effective means of solving the problem and achieving the objectives.
- **Acceptability** is the workability and viability of the alternative plan with respect to acceptance by state and local entities and the public and compatibility with existing laws, regulations, and public policies.
- **Completeness** is the extent to which the alternative plans provide and account for all necessary investments or other actions to ensure the realization of the planning objectives, including actions by other Federal and non-Federal entities.

The four accounts established by the Principles and Guidelines to facilitate evaluation and display the effects of alternative plans. These include:

- The **National Economic Development (NED)** account that displays changes in the economic value of the national output of goods and services.
- The **Environmental Quality (EQ)** account that displays non-monetary effects on significant natural and cultural resources.
- The **Regional Economic Development (RED)** account that registers changes in the distribution of regional economic activity that result from each alternative plan.
- The **Other Social Effects (OSE)** account that registers plan effects from perspectives that are relevant to the planning process but are not reflected in the other three accounts.

Following the alternatives evaluation and comparison phase, USACE identified the Preferred Alternative for inclusion in the DEIS (Attachment 1). Figure 1-1 summarizes this alternatives development and identification process. A discussion of each step in the formal alternatives development process is provided below, including objectives development, measures development, alternatives strategies development, and development of the final array of alternatives to be evaluated and compared in the EIS.

USACE prepared the SEIS to evaluate “an alternative that ceases hydropower operations at the projects” as directed in the WRDA 24. This alternative is hereafter referred to as the Ceasing Federal Hydropower Operations Alternative, or Alternative 6. The SEIS also updates the interim operations described in the FEIS. The following modifications to the Interim Operations include:

- Use of the 2008 *Endangered Species Act Section 7(a)(2) Consultation Biological Opinion & Magnuson-Stevens Fishery Conservation & Management Act Essential Fish Habitat*

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*Consultation on the Willamette River Basin Flood Control Project (2008 Biological Opinion) flow targets.*

- Modification to the spring spill operation at Lookout Point for downstream fish passage.
- Addition of a deep drawdown of Detroit reservoir for downstream fish passage.

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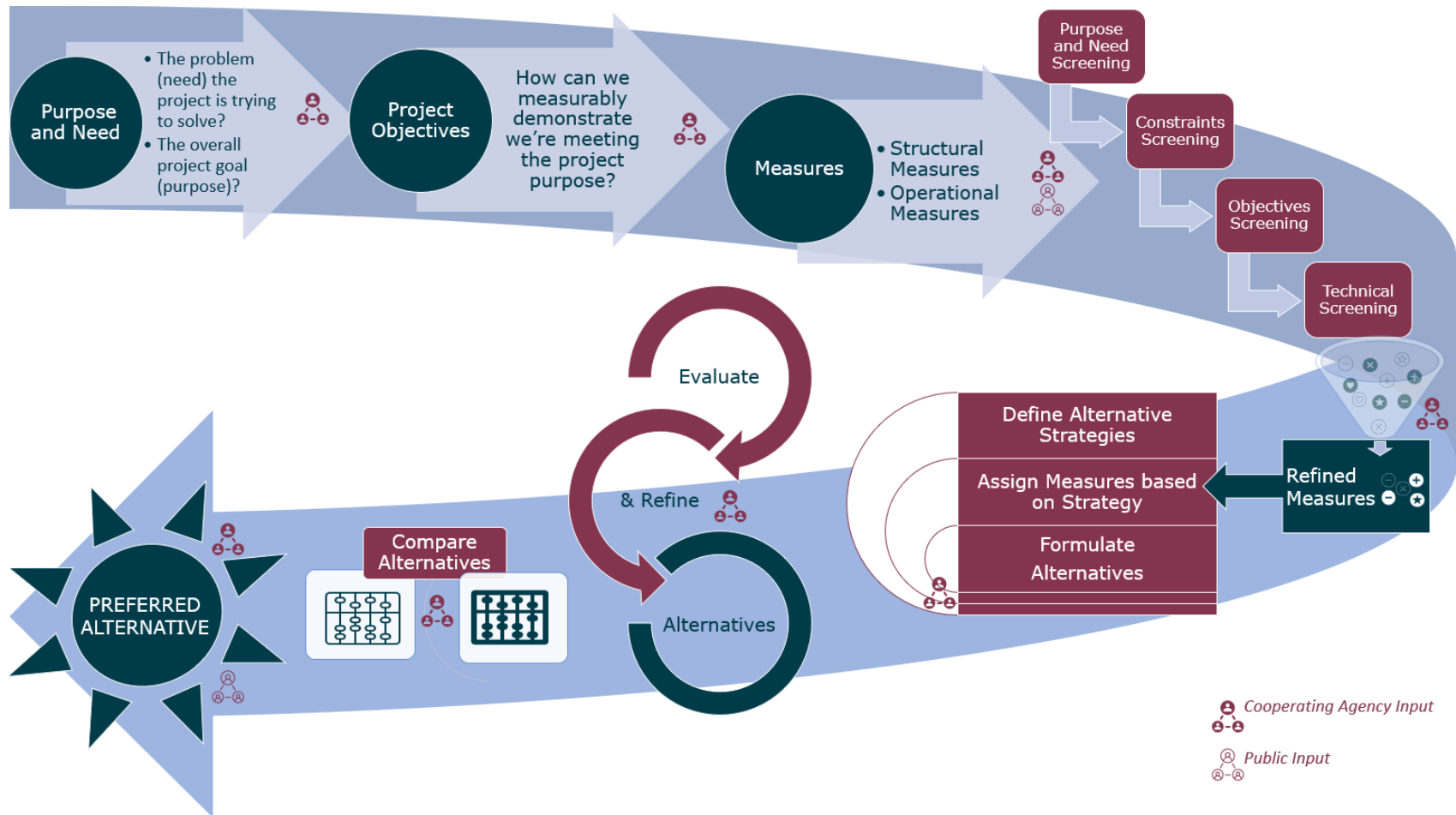


Figure 1-1. Willamette Valley System EIS Planning Process.

### **1.1.1 Objectives Development**

Objectives describe the results you want by solving the identified problems and taking advantage of opportunities. USACE held several internal and cooperating agency workshops in April 2020 to develop objectives that would help focus efforts on finding solutions to WVS operational challenges faced by the agencies. These meetings, along with a review of public scoping comments, led to the identification and development of 18 proposed objectives for alternatives formulation.

Objectives that did not meet the purpose and need for the project were determined to be outside the scope of the EIS and were removed from further consideration. The objectives that met the purpose and need were retained and refined to focus on resources required by Federal law to be protected, such as threatened and endangered species, or on regionally important resources identified during the scoping phase. The resulting seven primary objectives include:

1. Allow greater flexibility in water management (related to refill, drawdown timing, and other water management measures).
2. Increase opportunities for the creation of nature-based structures during maintenance of USACE-managed revetments (structures that help prevent bank erosion).
3. Allow greater flexibility in hydropower production.
4. Increase anadromous ESA-listed fish passage survival at WVS dams.
5. Improve water management during the conservation season to benefit anadromous ESA-listed fish and other authorized project purposes.
6. Reduce pollutant levels to restore impaired water quality associated with the WVS dams to benefit anadromous ESA-listed species.
7. Reduce spawning and rearing habitat competition caused by hatchery fish.

The identification of these objectives, along with the EIS purpose and need, guided the development of a reasonable range of alternatives.

### **1.1.2 Measures Development**

Once project objectives were identified, USACE interdisciplinary team focused on measures that would meet more than one identified objective. These measures include a range of operational and structural modifications that could be made to improve juvenile and adult fish passage operations and to increase flexibility for water management. Measures are typically specific to a discrete action in a precise location. Structural measures are those involving a physical change to the project such as installation of a feature in the spillway or construction of a temperature control tower. Operational measures are those involving a change in how water is stored or released at the projects or how juvenile fish are transported around the projects. Examples of operational measures include a change in timing of drawdown or refill of a water storage reservoir and a change in how much water is released through the spillway. An

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alternative is usually constructed from a number of measures that are combined to meet the objectives.

Measure development consisted of input from subject matter experts within USACE, public comments during the scoping process, and through workshops with Cooperating Agencies. As the development of measures and the initial array of action alternatives was being conducted, additional measures were identified either through USACE technical team or through coordination with the Cooperating Agencies.

An initial list of approximately 700 measures were compiled from those submitted during the public scoping process, cooperating agency workshops, input from Federal agencies, and through workshops with USACE subject matter experts. Measures were identified by name, project purpose, measure type, and by what agency or entity proposed the measure. Under project purpose, the identifiers were the authorized project purposes of the Willamette Valley System as well as measures focused on cultural resources and operations and maintenance. The authorized project purposes for the Willamette Valley System include hydropower, fish and wildlife, recreation, water quality, flood risk management, and water supply. Table 1-1. shows the number of initial measures identified for the different project purposes.

**Table 1-1. Project Purpose Identifier and the Number of Proposed Measures Within Each Category.**

<b>Identifier</b>	<b>Number of Proposed Measures</b>
<b>Cultural</b>	<b>2</b>
<b>Fish and Wildlife</b>	<b>260</b>
<b>Flood Risk Management</b>	<b>68</b>
<b>Hydropower</b>	<b>81</b>
<b>Operations and Maintenance</b>	<b>7</b>
<b>Water Quality</b>	<b>154</b>
<b>Water Supply</b>	<b>107</b>
<b>Recreation</b>	<b>25</b>
<b>Total</b>	<b>704</b>

USACE technical team worked through multiple rounds of screening of the initial array of measures. While each round has specific criteria for screening, the overall measures screening process is an iterative process. Measures were continually screened against all screening criteria. After the screening was completed, the remaining measures were combined to create the array of action alternatives.

### **1.1.3 Measures Screening and Alternative Consider but dismissed**

Following compilation of the submitted measures, the USACE technical team conducted several rounds of screening to reduce the number of measures to allow for the development of a reasonable range of alternatives.

Many measures were submitted from different sources but were essentially the same. For this reason, USACE started by identifying and removing duplicate measures. Following the removal of duplicate measures, USACE identified and screened out measures based on the following initial criteria:

- It is outside the scope of the WVS EIS. For example, “Eliminate/control sea lions at Willamette Falls.”
- It is a part of the NAA. For example, “Maintain current WVS water supply operations.”
- It is an objective, not a measure. For example, “Prioritize Demand.”
- It is a measure being addressed by other projects or entities. For example, “Historic Properties Management Plans at reservoirs” is being covered by Master Planning effort.
- It is a potential Mitigation Measure that could be considered for implementation of the proposed action. For example, “Fund restoration of Willamette Greenways and public access areas along the mainstem to protect intact riparian, floodplains, and off channel habitats.”

Additional screening was conducted in the following phased approach:

Step 1. Screening based on if a measure meets the project’s purpose and need.

Step 2. Screening based on if a measure violates a study constraint.

Step 3. Screening based on achieving objectives.

Step 4. Screening based on geographic location.

Step 5. Screening based on technical, environmental, and risks.

Details and examples for how these steps were implemented are provided below. A table listing all measures considered, if they were retained or eliminated, and the screening step applied for measures eliminated from further consideration are provided in Attachment 1, Attachment 2, and Attachment 3.

### **Purpose and Need Screening**

The Purpose and Need statement for the WVS EIS is the continued operations and maintenance of the WVS in accordance with authorized project purposes, while meeting ESA obligations to avoid jeopardizing the continued existence of listed species. Therefore, a measure was screened if:

- The measure does not meet the purpose and need because it eliminates or abandons one or more of the Congressionally authorized project purposes (i.e., water supply, recreation, hydropower, etc.) Elimination of a purpose was very broadly defined as being able to operate for that purpose at least one day in the period of record, as modeled.

*Example Suggested Measure: 'year-round run of river operations at all dams'*

*Decision: Removed from consideration because year-round drawdowns to run of river would remove the conservation pool eliminating operations for water supply and hydropower.*

- The measure is for a new structure for purposes other than addressing ESA obligations. The primary purpose of this EIS is for operations and maintenance of the WVS while meeting ESA obligations; new structures for purposes other than meeting ESA obligations were considered out of scope.

*Example Suggested Measure: 'Build solar panel fields.'*

*Decision: Removed from consideration because this measure includes construction of new facilities that do not help operate and maintain the system while meeting ESA obligations.*

For the SEIS however USACE is including a single alternative that does not meet the purpose and need statement so that it can formally analyze ceasing hydropower operations at WVS projects in compliance with WRDA 24.

### **Constraint-based Measures Screening**

USACE then used a decision tree to screen measures based on whether they met the project constraint, which was developed based on the purpose and need for the continued operation and maintenance of the WVS in accordance with authorized project purposes while meeting ESA obligations. In this process, measures were eliminated from consideration for the following reasons:

- The measure already has sufficient NEPA coverage to be implemented or NEPA coverage was initiated and will be completed prior to this DEIS.

*Example Suggested Measure: 'to promote and improve off-water recreation within the WVS'.*

*Decision: these activities already have sufficient NEPA coverage.*

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- Measures that would result in changes to flood risk management that would increase risks from current levels were screened out. USACE conducted preliminary hydrologic modeling for any measures that proposed operational changes with uncertain flood risk effects. Results of the preliminary modeling were used to further screen any operational measures with potential flood risk effects.

*Example Suggested Measure: ‘remove dams’*

*Decision: Removed from consideration as USACE would not be able to maintain current levels of flood risk management.*

- Documentation exists that demonstrates that the measure would compromise dam safety that could not be mitigated. USACE did a preliminary evaluation of measures for dam safety considerations, where dam safety subject matter experts eliminated measures from consideration where safety concerns could not be mitigated.

*Example Suggested Measure: ‘Fill reservoirs higher.’*

*Decision: Removed from consideration because filling reservoirs higher than elevations identified within the water control manual would compromise the structural integrity of the dam.*

### **Objectives-based Measures Screening**

USACE then reviewed each measure to ensure it met one or more objectives. Measures that did not meet any objectives were removed from further consideration. For example, as there were no objectives specific to recreation and navigation, any measures limited to recreation or navigation were screened out.

### **Geographic Location-based Measures Screening**

USACE reviewed the remaining measures and documented where each could be implemented at the 13 dam and reservoir locations or along the revetments. Measures were chosen as part of one or more of the alternatives for a specific location (e.g., dam site) based on the ability of the measure to achieve the stated objectives of the alternative or alternatives. Furthermore, any proposed operational measure must be tied directly to an existing facility, and these were located based on whether the configuration of the dam allows for the specified operational measure in addition to if the measure met the objectives of the alternative. Structural measures were similarly tied to specific facilities. For example, a fish passage structure would not be proposed at Dorena Dam as there are no listed species that require passage at that facility. There are a few measures that were not location-specific as they are basin-wide. A measure’s dependency on another measure was also considered during the geographical location process; in other words, USACE considered whether certain measures required another measure to be located adjacently to properly operate, such as juvenile fish collectors and selective withdrawal structures.

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Though most of the measures that made it to this stage in the screening process moved forward, a limited number of measures were screened out. For example, a head of reservoir fish collector was eliminated from further consideration as it was determined by USACE fish biologists to not be a preferred measure of juvenile fish passage at any of the project locations.

**Technical Screening**

USACE interdisciplinary team then developed technical screening criteria to help identify and eliminate measures with low potential to contribute to future management of the WVS. This potential was assessed using technical criteria including technical feasibility, level of environmental effect, and risk associated with implementation of the measure. USACE reviewed each measure based on these criteria and removed from further consideration any measure that would result in at least one unacceptable condition.

Table 1-2 provides a description of the technical screening criteria and the unacceptable condition by which a measure would be screened out.

**Table 1-2. Technical Screening Criteria Descriptions.**

<b>Criteria</b>	<b>Description</b>	<b>Unacceptable Condition</b>
Technical feasibility	Practicality of a proposed measure, including whether it can be implemented using available technology, techniques, skills, and resources	Available information (i.e., scientific support/consensus across several agencies) is not sufficient to support implementation of the measure or proof of concept. Available information clearly demonstrates major risk of failure with implementation of the measure. The expected benefit or change would be minimal within the study timeframe and spatial scale (not distinguishable from measures in NAA).
Level of environmental effect	Effects caused by a measure to the human or natural environment	Available information clearly demonstrates that the measure would have, or would be expected to have, unacceptable effects.
Risk associated with implementation	Potential for failure during planning, design, or after construction or initiation of measure	Available information clearly demonstrates major risk of failure or a lack of feasibility.

### **Alternatives considered but eliminated**

Measure screening reduced the number of measures, limiting the breadth of alternatives the USACE could develop. For instance, the dam breach and removal measure were screened out because they would result in the USACE inability to meet the dams' authorized purposes and would increase flood risk. Therefore, a dam removal alternative was eliminated from further consideration.

USACE considered, but ultimately dismissed, an alternative where hydropower generation did not stop but moved the responsibility for the power marketing from the current power marketer, BPA, to a private entity or USACE. USACE dismissed this alternative because the plain language of WRDA requires USACE to consider an alternative that ceases or stops hydropower operations, not transfers responsibility for marketing to another entity. USACE also dismissed alternatives that would eliminate non-hydropower purposes at the projects (i.e. water supply, irrigation, flood control, etc.).

Given the detailed and intricate operations of each project and the complexity of operating all 13 projects as a system for various purposes, USACE had to rely on its professional judgment in determining the reasonable range of alternatives to include for further analysis and to eliminate numerous iterations of the selected alternatives.

#### **1.1.4 Formulation of Alternatives**

An alternative is a set of one or more measures that work together to address the EIS objectives. Each alternative consists of different measures, or a combination of the same measures in significantly different ways. The WVS EIS evaluated and compared several action alternatives as well as a NAA. All alternatives, including the NAA, are described in Chapter 2, Alternatives.

The action alternative development process focused on creating strategies to meet more than one primary objective within individual alternatives. The alternatives were formulated to explore the tradeoffs from blending measures while continuing to emphasize specific resources. USACE interdisciplinary teams collaborated to determine where measures would be most effective ("measures siting"). These same participants then used best professional judgment to determine whether there were any operational or structural measures that could not be performed together (conflicting measures). If measures were determined to be conflicting, the team decided which measure to retain and/or modify to meet the alternative's strategy and objectives. The objectives are described in Section 1.1.1, Objectives Development.

Following the measures screening process, alternatives were formulated using the remaining measures based on different formulation strategies. Each alternative strategy places a different emphasis on the project objectives described in Section 1.1.1, Objectives Development. Table 1-3 summarizes the alternative strategies and associated project objectives.

**Table 1-3. Project Alternative Strategies and Associated Objectives.**

<b>Alternative</b>	<b>Strategy</b>	<b>Objectives<sup>1</sup></b>
No Action	Current operations and maintenance Practices	None
1	Improve Fish Passage Through Storage-Focused Measures: Increase the probability of refilling WVS reservoirs and supplemental water delivery for authorized purposes	1, 2, 3, 4, 5, 6, 7
2A	Integrated Water Management Flexibility and ESA-Listed Fish Alternative	1, 2, 4, 5, 6, 7
2B	Integrated Water Management Flexibility and ESA-Listed Fish Alternative	2, 4, 5, 6, 7
3A and 3B	Operations Focused: Improve passage of ESA-listed fish through existing structures by modifying water control operations	2, 4, 5, 6, 7
4	Structures Focused: Improve passage of ESA-listed fish by constructing fish passage and temperature control structures	1, 2, 3, 4, 5, 6, 7
5	Refined Integrated Water Management Flexibility and ESA-Listed Fish Alternative	2, 4, 5, 6, 7
6	Ceasing federal Hydropower Operations	2, 4, 5, 6, 7

<sup>1</sup>Notes:

1. Allow greater flexibility in water management (related to refill, drawdown timing, and other water management measures).
2. Increase opportunities for the creation of nature-based structures during maintenance of USACE-owned revetments (structures that help prevent bank erosion).
3. Allow greater flexibility in hydropower production.
4. Increase anadromous ESA-listed fish passage survival at WVS dams.
5. Improve water management during the conservation season to benefit anadromous ESA-listed fish and other authorized project purposes.
6. Reduce pollutant levels to restore impaired water quality associated with the WVS dams to benefit anadromous ESA-listed species.
7. Reduce spawning and rearing habitat competition caused by hatchery fish.

To begin, USACE started creating alternatives based on the strategies focused on meeting the objectives through either maximizing storage, changing operations only, or by primarily building structures. These resulted in Alternatives 1, 3A, 3B, and 4, respectively. Alternatives 3A and 3B were both built of primarily operational measures with some modification of existing infrastructure and the construction of AFFs for benefits to be realized from the proposed operational measures. Alternative 3A and 3B are very similar but propose a slightly different combination of operations. By making this distinction between Alternatives 3A and 3B, the EIS allows for the unique impacts associated with each of these operations and the tradeoffs between them to be assessed and compared.

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Preliminary analysis, particularly for hydropower, water supply, recreation, water quality and ESA-species impacts as well as preliminary costs, was completed for these initial four action alternatives. The results of this preliminary analysis were utilized to inform formulation of alternatives which integrate structural and operational measures to improve performance at meeting one or more objectives. Prior to this effort it was difficult to know which operational measures in 3A or 3B would provide suitable downstream passage results when compared to the structure focused alternative. Structural measures require significant design and engineering efforts, additional environmental compliance (such as site-specific NEPA documents), and often long construction timeframes. This can substantially delay a structural measure's implementation and substantially increase the cost of an alternative. Thus, the formulation of integrated alternatives was an effort to identify downstream fish passage measures with the highest likelihood of meeting ESA-species needs while balancing cost and managing risk and uncertainty associated with implementation timing.

USACE used the following six steps to assess the initial alternatives using preliminary data and formulate new alternatives:

1. Define metrics and thresholds based on preliminary data to assess how each measure meets the objectives.
2. De-prioritize measures by subbasin that do not meet the pre-defined thresholds, by assessing metrics outputs for each measure.
3. Qualitatively rank remaining measures according to metric results.
4. Determine measures which have at least a moderate ranking in each subbasin for each metric.
5. Assess impacts to other key missions for measures identified in step 6 not considered in the metrics defined in step 2.
6. Formulate Alternative 2 considering results of steps 5 through 6.

Table 1-4 describes each of the metrics developed to compare the initial array of alternatives. The results for the initial array of alternatives were compared and evaluated by a cross-functional team of subject matter experts who used the to rank the alternatives. Based on these rankings and best professional judgement, Alternatives 2A and 2B were formulated combining structural and operational measures to balance water management flexibility and meet ESA-listed fish obligations. Two integrated alternatives were formulated so that the operational and structural downstream fish passage measure specifically at Cougar Dam could be more quantitatively assessed. The use of structural versus operational downstream passage measures has unique environmental and operational implications.

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**Table 1-4. Integrated Alternative Formulation Metrics.**

<b>Category/ Resource</b>	<b>Formulation Metric</b>	<b>Description</b>	<b>Unit of Measure</b>
ESA-Listed Fish	Chinook Dam-Passage Survival	The probability of survival from the upstream boundary of the forebay to the downstream boundary of the tailrace for each of the North Santiam, South Santiam, McKenzie, and Middle Fork Willamette. It includes the forebay, all routes of passage, and the tailrace of a given dam. Percent survival of at least 60% is indicative of a self-sustaining population.	Average % Survival for the Period of Record
ESA-Listed Fish	Steelhead Dam-Passage Survival	The probability of survival from the upstream boundary of the forebay to the downstream boundary of the tailrace for each of the North Santiam and South Santiam. It includes the forebay, all routes of passage, and the tailrace of a given dam. Percent survival of at least 60% is indicative of a self-sustaining population.	Qualitative assessment based on best professional judgement
ESA-Listed Fish	Bull Trout Survival and Connectivity/Influence of Reservoir Change (for Alternative 2 formulation)	Qualitative criterion based on best professional judgement of fish biologists	Positive - Measure/Alternative would be beneficial to species Neutral - Measure/Alternative would not change or have negligible effect on species Negative - Measure/Alternative would adversely affect the species
ESA-Listed Fish	Performance Uncertainty	Qualitative assessment of the confidence in the modeling	High/Medium/Low

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<b>Category/ Resource</b>	<b>Formulation Metric</b>	<b>Description</b>	<b>Unit of Measure</b>
		results associated with each measure.	
Water Quality	Extreme water temperatures	Mortality Impact: Water temperature impact exceeds 25°C (Juveniles) and 24°C (Adult migration) at monitoring locations below dams	Percent of days in each year that modeled water temperature is above 25°C (juveniles) and 24°C (adult migration)
Water Quality	Stressful water temperature for fish	Increased stress, decreased growth, disease to juvenile fish; migration impaired to adult migration at monitoring locations below dams	Percent of days in each year that modeled water temperature is 21-24°C (juveniles) or 20-23°C (adult migration)
Water Quality	Optimal water temperature	Optimal water temperature conditions for fish at monitoring locations below dams	Percent of days in each year that modeled water temperature is 10-20°C (juveniles) or 12-19°C (adult migration)
Water Quality	Safe water temperature	Safe water temperature below 10°C (Juveniles) and 12°C (Adult migration) at monitoring locations below dams	Percent of days in each year that modeled water temperature is below 10°C (juveniles) and 12°C (adult migration)
Water Quality	Egg emergence (Incubation) at monitoring locations below dams	Estimated egg emergence day based on modeled cumulative water temperature below dam [Sep 20 + 1750 Accumulated thermal units (ATUs)]	Month-Day in which cumulative water temperature below dam [beginning Sep 20] exceeds 1750 ATU
Hydropower	Change in Hydropower Generation	Change from No Action in megawatts of production	Average Annual MW produced individual at each hydropower dam
Irrigation/M&I	Water in Conservation Pool Storage	Reservoir storage is adequate to meet existing irrigation contracts and M&I water supply demand from April through October.	Number of days in period of record that reservoir elevation exceeds minimum conservation pool

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<b>Category/ Resource</b>	<b>Formulation Metric</b>	<b>Description</b>	<b>Unit of Measure</b>
			individually at each dam from April 1 to October 31
Water Supply (M&I)	City of Salem water supply requirement	Storage is sufficient to provide for the City of Salem's water supply system to operate.	Number of days in the period of record that the Mehama gage exceeds 750 cfs.
Recreation	Reservoir Boat Ramp access	Reservoir elevation allows access during the summer conservation season (May 1 - Sept 1)	Number of days in each year of period of record that boat ramps are accessible:  High = all boat ramps accessible (elevation depends on each individual reservoir) Medium = at least one boat ramp is accessible elevation depends on each individual reservoir)  Low = no boat ramps accessible elevation depends on each individual reservoir)

By making this distinction between 2A and 2B, the EIS allows for the unique impacts associated with a structure vs an operation to be identified for downstream passage at Cougar and tradeoffs between to be assessed and compared.

Following the formulation of Alternative 2A and 2B, USACE assessed the environmental consequences associated with each of the seven alternatives, including the NAA. The findings are discussed in detail in Chapters 3 and 4 of the EIS and further described in the associated Appendices. Following the effects analysis, the alternatives were evaluated and compared for identification of the Preferred Alternative. While comparing the Alternatives, the USACE considered the benefits, environmental consequences, and tradeoffs of alternatives within and outside of current authorities as reflected in Chapter 3, Environmental Consequences and Chapter 4, Cumulative Effects. USACE developed multiple criteria to evaluate how effectively each alternative met the EIS objectives with consideration of cost and the economic,

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environmental, and social effects and then performed a tradeoff analysis using these criteria to compare the alternatives.

USACE included an evaluation of the environmental and social effects of the alternatives based on the effects analyses completed for wildlife, wetlands, vegetation, cultural resources, socioeconomics, and environmental justice and considered these effects in the tradeoff analysis process. However, there was not enough differentiation in the level of impact between the alternatives for the effects to these resources to inform the decisions. Therefore, criteria for these resource areas were not included in the decision-making process.

The cost to design, construct, and operate and maintain each alternative as well as impacts to recreation, hydropower production, water supply, ESA-listed fish did provide clear tradeoffs for comparing alternatives. In addition to metrics for cost and economic effects resulting from impacts to recreation, one or more metrics were developed to measure how effectively an alternative met each of the primary objectives outlined in Section 2.1 except for Objectives 2 and 7. Objectives 2, to increase opportunities for the creation of nature-based structures during maintenance of USACE-managed revetments, and Objective 7, to reduce spawning and rearing habitat competition caused by hatchery fish, are effectively met by including the revetment and hatchery measures, respectively, an alternative. As all action alternatives include these measures there is no measurable difference in how well they meet these objectives. The metrics for the remaining objectives, the economic metrics for impacts to recreation, and the metrics for costs are described below.

Where possible, USACE developed quantitative or semi-quantitative metrics to measure the criteria, otherwise a qualitative assessment based on the environmental consequences analysis (provided in Chapter 3, Environmental Consequences) was used to evaluate how well an alternative met the criteria.

Economic effects on water supply were not analyzed because water supply effects between structural and hybrid alternatives (Alternatives 1, 2A, 2B, 4, and 5) were minimal while effects between the operations-only alternatives (Alternatives 3A and 3B) were very distinct. An economic analysis would not provide additional information that was not already assessed by the quantitative NED and RED benefits analyses.

Table 1-5 defines each metric and lists the sections in Chapter 3 where the supporting information can be found in the EIS for each metric. Although absolute values provide important context, it is more relevant for decision-makers to consider the estimated differences between each of the action alternatives and the No Action Alternative (NAA). The methodology and analysis for each metric is provided in the associated resource's environmental consequences analysis in Chapter 3 and the associated Appendices and the associated sections of the EIS are listed in Table 1-5.

Based on the outcomes of the trade-off analysis (discussed in detail in Chapter 5), Alternative 2B was tentatively identified as the Preferred Alternative. However, after engaging with BPA, NMFS, and USFWS, USACE determined that the integrated temperature and habitat flow

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regime (Measure 30a as described in Section 2.1.1) proposed in Alternative 2B should be refined to improve outcomes for ESA species. Alternative 5 was formulated to be identical to Alternative 2B but for the flow measure. Different from all other alternatives, Alternative 5 includes the Refined Integrated Temperature and Habitat Flow Regime (Measure 30b as described in section 2.1.2). Alternative 5 is the Preferred Alternative

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**Table 1-5. Evaluation and Comparison Metrics.**

<b>USACE Criteria<sup>1</sup></b>	<b>Metric</b>	<b>Definition</b>	<b>Supporting Information</b>
Objective 1. Allow greater flexibility in water management	Conservation storage  Impact to Downstream Flows	The peak volume of water stored systemwide.  Flows at downstream control points. <ul style="list-style-type: none"> <li>• High Impact = downstream flows are much lower in the summer.</li> <li>• Medium Impact = downstream flows are lower in the summer.</li> <li>• Low Impact = downstream flows are about the same or higher in the summer.</li> </ul>	Section 3.2, Hydrologic Processes and Section 3.13, Water Supply in the EIS and corresponding Appendix B and Appendix J
Objective 2. Increase opportunities for the creation of nature-based structures during maintenance of USACE-owned revetments	Includes maintaining revetments using nature-based engineering or altering revetments for aquatic ecosystem restoration (9)	By including this measure, the alternative would increase the amount of nature-based materials during maintenance of USACE-owned revetments	Chapter 2, Alternatives, in the EIS, Measures Common to All Alternatives
Objective 3. Allow greater flexibility in hydropower production	Net Present Value <sup>2</sup>	Measures the impact to the economic viability of hydropower at WVS hydropower dams. Compares the expected revenue produced at each hydropower facility versus expected costs. Presented as a total for the WVS. Based on changes in generation under the alternatives and any potential effects from that on the regional energy environment, as well as the joint-use construction cost of the alternatives.	Section 3.12 in the EIS and Appendix G, Power and Transmission
Objective 4. Increase anadromous ESA-listed fish passage survival at WVS dams	Bull trout habitat gains  Downstream survival relative rank: 7=best, 1=worst	Number of bull trout populations with habitat gains (out of 3) from fish passage improvements	Section 3.8 in the EIS and Appendix E, Fish and Aquatic Habitat

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USACE Criteria <sup>1</sup>	Metric	Definition	Supporting Information
<p>Objective 5. Improve water management during the conservation season to benefit anadromous ESA-listed fish and other authorized project purposes.</p> <p>Objective 6. Reduce pollutant levels to restore impaired water quality associated with the WVS dams to benefit anadromous ESA-listed species.</p>	<p>Chinook Populations reaching replacement</p> <p>Chinook Populations persistence</p> <p>Legacy Chinook Population risk</p>	<p>Relative rankings of model results of Chinook and steelhead survival below dams as affected by flow and water temperatures.</p> <p>The number of spring Chinook populations (out of 4) modeled to achieve spawner replacement on average over a 30-year timeframe</p> <p>The number of Chinook populations (out of 4) modeled to exceed a minimum adult abundance threshold.</p> <p>Indicates if the McKenzie spring Chinook population is at a low risk of extinction.</p>	
<p>Cost</p>	<p>Estimated Total Annual Cost</p>	<p>Annual costs over the 50-year period of analysis in 2021 dollars including annualized first costs for design and construction as well as the annual cost for Operations, Maintenance, Repair, Replacement and Rehabilitation.</p>	<p>Appendix M, Costs</p>
<p>Economic Effects</p>	<p>NED Benefits - Average Annual Benefits (total for all reservoirs) in millions of dollars</p>	<p>The change from the NAA in the dollar value of reservoir recreational visitations using the recreation season (April 15 through Sept 15) availability of reservoir boat ramps and the changes in visitation across various recreation activities that are estimated to occur when boat ramps are available versus when they are not available. The higher the value, the greater the economic benefits as compared to the NAA.</p>	<p>Appendix K, Recreation Analyses and Appendix I, Water Supply Analyses</p>

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USACE Criteria <sup>1</sup>	Metric	Definition	Supporting Information
Regional economic impact from recreation effects	RED Benefits Impact	A qualitative assessment of the impact to RED considering the full-time jobs created/lost by whether an alternative makes conditions more/less conducive to water-based recreation and the regional output equal to the sum of employee compensation, proprietor income, other property type income, and indirect business taxes. The higher the impact the greater numbers projected for jobs lost and reduction in regional output. An assessment of a high impact means greater numbers of jobs lost and greater than \$100,000 annual reduction in multiple basins.	Appendix K, Recreation Analyses and Appendix I, Water Supply Analyses

<sup>1</sup> Objectives 4 through 6 prioritize the needs of ESA-listed fish species. Five metrics assess how effectively each alternative meets Objectives 4, 5, and 6. Only the UWR spring Chinook salmon modeling results were applied; metrics specific to UWR steelhead are not included. USACE reviewed the UWR steelhead results and the UWR steelhead information does not change the rankings of the alternatives.

<sup>2</sup> Net Present Value was used for the evaluation of Alternatives 1-5 but was not available for Alternative 6 and the Interim Operations. Instead USACE evaluated annual average hydropower generation.

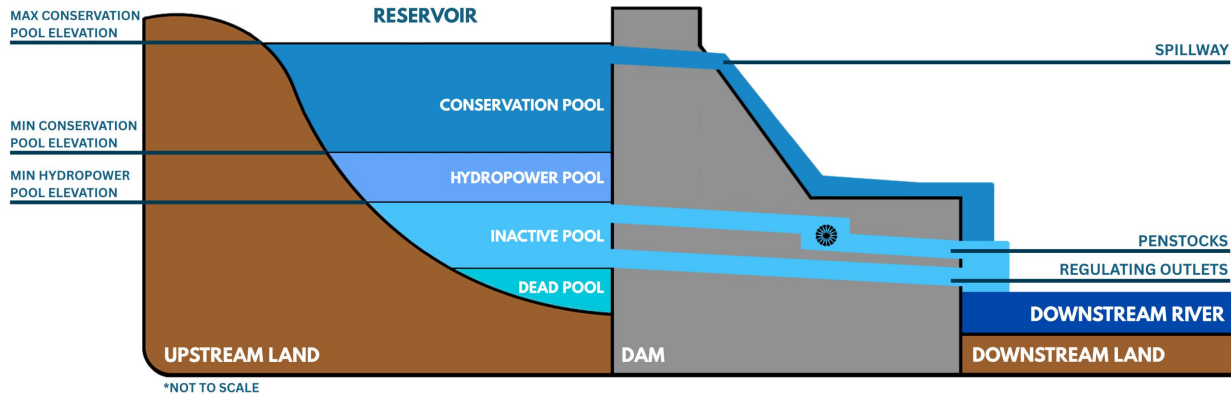
### **Alternative 6 Development Process**

For the SEIS, the development of an alternative for ceasing Federal hydropower operations included the following constraints in addition to meeting the objectives above to draw a manageable line:

- WRDA 24 specifically directs the Secretary of the Army to analyze an alternative “that ceases hydropower operations at the projects.” Based on a plain reading of the text, USACE has interpreted this to mean the alternative should include cessation of hydropower across all dams in the WVS, not a selection of dams. Therefore, USACE did not develop alternatives for ceasing Federal hydropower operation at one or some combination of the hydropower projects. Under Alternative 6, USACE assumed cessation of hydropower at all eight dams authorized for federal hydropower.
- USACE did not assess alternatives that include dam removal as dam removal would require deauthorization of all or most authorized purposes. As mentioned above, WRDA 24 requests an alternative that ceases Federal hydropower operation only. It does not request the cessation of any other authorized purposes. It does not specify an analysis of the deauthorization of any other purpose.
- USACE did not assess alternatives to cease Federal hydropower operations that include perforating the dam to create a new flow release outlet to provide the same flow capacity as the penstock outlet used for hydropower operations. Perforation of a dam to create a new flow release outlet would require extensive study due to the threat to life safety adverse impacts, would have significant costs, and could have significant adverse effects to all authorized purposes during construction, at least in the short term, requiring extensive analysis.

USACE considered but eliminated alternatives that would result in USACE’s inability to meet the other authorized purposes. For example, USACE did not assess an alternative that included prolonged drawdown operations below the designated hydropower pool during the entire conservation season. The hydropower pool elevation is located below the conservation pool designated for joint uses including M&I water supply, irrigation, and fish and wildlife. Holding a reservoir’s pool below the designated hydropower pool would mean not filling the conservation pool above it, resulting in USACE’s inability to provide stored water for M&I water supply, irrigation, or flow augmentation for meeting minimum flow requirements or water quality for ESA-listed species. USACE considered assessing operations that would deauthorize and reallocate the hydropower pool to potentially provide operational flexibility. However, this was dismissed for several reasons. The hydropower pool is designated at a vertical elevation below the conservation pool (Figure 1-1). Currently, other measures proposed in the suite of interim operations (e.g. the proposed Detroit drawdown) and other alternatives (Measure 304) allow for USACE to go below the minimum hydropower pool elevation. Therefore, deauthorization of the hydropower pool does not provide additional flexibility under drawdown operations. On the other end of the operational spectrum, during the conservation season refill, elimination of the hydropower pool space for filling purposes would result in the larger conservation pool to

drop below the spillway crest. This would not drop the pool surface enough to be within the fifty feet of the next available outlet (whether it is the penstocks or the ROs) that is needed for effective downstream fish passage but would result in dropping the pool below the spillway crest, making it unavailable for temperature control or fish passage spill operations.



**Figure 1-2. Conceptual cross section of a hydropower power dam showing the vertical layout of the outlets and pool designations.**

USACE considered a large universe of measures, like it did for the other alternatives before, using its reasoned and professional judgment to consolidate the potential measures in one alternative that met the objectives set forth for alternatives in Section 1.1.4 above and WRDA 24. USACE developed these measures based on three scenarios it developed for a different assessment of disposing of hydropower in the region. That effort was in response to Section 8220 of WRDA22, in which Congress requested “a report to the Committee on Transportation and Infrastructure of the House of Representatives and the Committee on Environment and Public Works of the Senate that describes . . . the results of the disposition study on deauthorizing hydropower as a purpose of the Willamette Valley hydropower project.” The USACE assessed hydropower deauthorization and submitted the WRDA 22 Report to the Assistant Secretary of the Army for Civil Works in June 2024 for Congressional consideration.

This prior assessment provided an initial evaluation of three different scenarios based on their feasibility from a dam safety perspective. In the assessment these were referred to as “scenarios” instead of alternatives because the analysis was narrowly constrained to the changes made at an individual dam to limit or remove hydropower capabilities and address any adverse effects to dam safety to the baseline condition. The prior assessment did not include the full breadth of environmental impacts NEPA requires. The scenarios included the following:

Scenario 1. Partial hydropower deauthorization: would maintain power generation sufficient for each project’s needs but does not include generation for distribution by BPA. In this case, “project” refers to the specific dam and any ancillary facilities such as adjacent adult fish collection facilities. Turbines would be “right-sized” to produce at-project power needs more efficiently. Small amounts of water would continue to be released through the penstocks.

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Scenario 2. Complete hydropower deauthorization with penstock decommissioning: would result in the cessation of all hydropower operations and permanently sealing the penstock outlets. This would eliminate use of the outlet (for power generation or water conveyance) completely, with the assumption that no new conduit (to replace the turbine flow) would be constructed.

Scenario 3. Complete hydropower deauthorization with penstock reconfiguration: would result in the cessation of all hydropower operations whereby the turbines would be removed, and the penstocks would be modified to allow continued use for water conveyance. This would require the penstocks to be reconfigured with new gate structures and additional features to control and dissipate the energy of water released through the penstocks. To avoid damaging the penstocks, draft tubes, and downstream channel, energy dissipation of the penstock flow from forebay to tailrace is required in the absence of a turbine.

A preliminary screening of the three scenarios for each dam was completed to determine if the scenario could be reasonably implemented without increasing dam safety risk. A scenario at a dam was screened out from further consideration if a change in operations resulting from the scenario would likely impact the ability to carry out dam safety inspections, monitoring, and maintenance as required by Engineering Regulation (ER)-1110-2-1156 Safety of Dams-Policy and Procedures without significant modifications to the dam.

USACE has maintained a dam safety program since the 1970s and it ensures that all dams and appurtenant structures are designed, constructed, and operated safely and effectively under all conditions based on the program purposes described in ER 1110-2-1156. The purposes of the dam safety program are to protect life, property, lifelines, and the environment by ensuring that all dams are designed, constructed, regulated, operated, and maintained as safely and effectively as reasonably practicable. Key elements of the dam safety program include routine inspections, surveillance and monitoring, dam safety risk assessments, development of emergency action plans, and conducting emergency exercise.

All of the dams in the WVS are classified as high hazard potential, meaning that if they were to breach, the resulting flood waters could result in downstream life loss and economic consequences. Dam safety risk is defined by the combination of hazards, expected performance of the dam when subjected to those hazards, and the potential downstream consequences in the event of a dam breach. Dam safety risk is unique to the specific set of conditions at an individual dam. Any structural or operational dam modifications cannot increase dam safety risk to upstream or downstream populations as required by ER 1110-2-1156. Proposed modifications must adhere to risk informed design principles described in Engineering and Construction Bulletin 2022-07 Interim Guidance for Risk Inform Design and provide robust engineering analyses that sufficiently document whether the modification can safely be completed. There is always the possibility that the analyses may demonstrate that there is no way to implement the modification without unacceptable increase to dam safety risk.

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The following criteria were used to identify whether a scenario crossed this screening threshold:

- The scenario impacts the ability to access outlets, outlet channels, or stilling basins for routine inspections and maintenance or repairs without reducing flow to the downstream river to levels that would violate ESA requirements. In other words, is penstock operation needed to completely shut down regulating outlets for inspection or shut off flow to the stilling basin.
- The scenario reduces the number of useable outlets and the ability to draw down the reservoir to its lowest outlet, preventing the ability to dewater and unload the structures for inspection, maintenance, or repairs following emergencies or upon detection of new distress (e.g., post-earthquake distress seen on concrete structures, will need to unload/dewater) without reducing flow to the downstream river to levels that would violate ESA requirements.

Based on the screening results of the screening analysis, all dams were screened out for both Scenarios 1 (Partial Deauthorization) and 2 (Full Deauthorization/Penstock Decommissioning). This is because water could no longer be diverted to the powerhouse to carry out stilling basin/regulating outlet channel inspections, maintenance, or repairs without reducing (Scenario 1) or eliminating (Scenario 2) outflows to the point of impacting the downstream river environment and ESA-listed fish. Under Partial Deauthorization (Scenario 1), hydropower would continue to be generated which is counter to the directive in WRDA24 to develop an “alternative that ceases hydropower operations,” further supporting its screening from further analysis. In addition, decommissioning the penstocks (Scenario 2) would reduce the number of useable outlets from two sets of outlets to one, eliminating the ability to drawdown the reservoirs for emergencies (at Hills Creek, Cougar, Dexter, Foster and Big Cliff) or inspect regulating outlet conduits (at Cougar or Hills Creek). As a result, only Scenario 3 (Reconfigure Penstock Outlets) was carried forward in the measure and alternative development process for the SEIS.

USACE then combined these measures with other measures necessary to formulate a full alternative that would meet the objectives laid out in Appendix A, Section 1.1.4. For example, Alternative 6 includes measures designed to meet the ESA objective meaning it not only includes measures for ceasing hydropower it also includes downstream structural passage measures which are described in greater detail in Chapter 2 of Appendix A. To meet the ESA objective, the same fish passage and temperature management measures in Alternative 5 were applied to Alternative 6. Unlike Alternative 5 which includes the Refined Integrated Temperature and Flow Management regime for minimum flows, Alternative 6 uses the 2008 Biological flow targets in accordance with the 2024 Biological Opinion Reasonable and Prudent Alternative (RPA) measure 2.1 though the RPA acknowledges the measure will likely be revised after the development of a flow management plan. Additional NEPA will likely be required at that time.

## **CHAPTER 2 - MEASURES CONSIDERED IN ALTERNATIVES DEVELOPMENT**

The following measures are placed into the following categories: flows, water quality - temperature, water quality - Total Dissolved Gas (TDG), downstream passage, upstream passage, measures common to all alternatives, existing operations continuing forward, and Interim Operations. These include structural and operational measures. Structural measures are those that would require the construction of new structures or physical modifications to existing structures and/or components. Operational measures use existing infrastructure to meet the proposed objective(s).

Each measure is identified by both a short title and a tracking number. The tracking number was assigned when the measure was first identified to allow the measure to be tracked throughout the screening process.

### **2.1 FLOW MEASURES**

#### **2.1.1 Measure 30a. Integrated Temperature and Habitat Flow Regime**

**Description:**

This section describes operational measures to manage streamflow on tributaries and on the mainstem Willamette River via water releases from USACE-managed dams. Physical habitat and water quality are important attributes to consider for meeting the habitat needs of aquatic biota in both flowing and impounded sections of a river system.

Temperatures conditions can annually exceed biological thresholds for native aquatic species in the Willamette River Basin regardless of streamflow conditions. Physical habitats provided by streamflow are only of value to an aquatic organism when they are within thermal biologic thresholds. Therefore, a primary objective of the fish flow management regime is to help avoid exceeding these thresholds and to improve the available habitat.

The proposed adaptive “fish flows” are based on three components:

- a. Alternative minimum flows that incorporate magnitude, seasonal variation, and annual hydrologic conditions,
- b. Opportunistic/adaptable water releases for real-time water temperature management, and
- c. Fall maximum outflows from Detroit/Big Cliff, Green Peter/Foster, Cougar, and Lookout Point/Dexter dams.

### **Tributary and Mainstem Minimum Flows**

The adult UWR spring chinook salmon species and life stage were chosen as the priority in the development of the fish flows. Pre-spawn mortality substantially constrains productivity of UWR spring Chinook salmon (e.g., Keefer et al. 2010; Zabel et al. 2015).

Two separate minimum flow regimes for the major tributaries (North Santiam, South Santiam, McKenzie, and Middle Fork Willamette) were developed for the conservation storage and use seasons, based on hydrologic conditions in any given year in Table 2-1.

The early season minimum flows in Table 2-1 correspond to flows providing greater than or equal to 90 percent Wetted Usable Area (WUA) for UWR spring Chinook salmon and UWR steelhead spawners (R2 2013; RDG 2014) below WVS dams. The 2008 Biological Opinion and RPA recognized the 2008 RPA flow targets are not always achievable in dry years. The minimum flow levels for drier years were defined based on flows corresponding to 80 percent WUA for spawners below WVS dams (R2 2013; RDG 2014). An 80 percent WUA is consistent with NMFS application of an 80 percent criteria as protective of salmonid habitat needs (NMFS and USFWS 2013).

The minimum flow regimes for both wetter and drier conditions included in increase above the lowest minimum value according to optimal hydrograph shapes determined by Peterson et al. (2022). Their work indicates that water temperature is likely driving the shape of the optimal flow regimes they identified, and the best candidate minimum flow. The appropriate minimum flow regime each year will be determined according to the storage achieved (less than or greater than 90 percent of the rule curve<sup>1</sup>) every 2 weeks between February 1 and June 1. After June 1, the flow regime applied on June 1 will be followed for the remainder of the conservation season. The flow targets from the NMFS 2008 Biological Opinion were carried forward for other dams and subbasins not listed in Table 2-1.

The mainstem Willamette River minimum flow targets at Salem (5000 cfs) and Albany (4500 cfs) would be in place in all water year types and in all months except April 1 to June 30. Minimum flows during April and May at Salem will be 10,000 cfs, and 8,000 cfs in June for purposes of water temperature management in the mainstem. The reservoirs used to provide the mainstem flow would be decided on a real-time basis depending on realized hydrologic conditions throughout the Willamette River Basin.

### **Temperature Pulses**

In addition to application of base flow targets, flow from the WVS reservoirs would also be used adaptively during April-June in each year to reduce and stabilize water temperature during important migration timeframes for UWR spring Chinook salmon and UWR steelhead,

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<sup>1</sup> A rule curve is seasonal reservoir elevation targets or restrictions, represented graphically as curves, that guide reservoir operations.

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mitigating warmer air temperatures to the extent possible. Flow in addition to meeting the base flow targets in

Table 2-1 would be released to achieve specified temperature targets. The specific flow targets within this measure are based on the observed relationship between flow, air temperature, and water temperature during 2001-2018 (Stratton, et.al., in press). The following guidelines, as measured at Keizer (USGS 14192015; water temperature), Salem (USGS 14191000; streamflow), and Salem Airport (air temperature) are proposed during April-June:

**Table 2-1. Tributary Flow Targets for Wetter (reservoir >90% of rule curve) and Drier (reservoir <90% of rule curve) Conditions.**

Dam	Detroit/ Big Cliff	Detroit/ Big Cliff	Green Peter/ Foster	Green Peter/ Foster	Cougar <sup>1</sup>	Cougar <sup>1</sup>	Lookout Point/ Dexter	Lookout Point/ Dexter
Start Date	>90%	<90%	>90%	<90%	>90%	<90%	>90%	<90%
1-Feb	1000	800	1000	700	300	250	1200	1000
15-Feb	1000	800	1000	700	300	250	1200	1000
1-Mar	1000	800	1000	700	300	250	1200	1000
15-Mar	1000	800	1000	700	300	250	1200	1000
1-Apr	1200	800	1200	700	360	250	1440	1000
16-Apr	1500	800	1500	700	450	250	1800	1000
1-May	1550	880	1550	770	465	275	1860	1100
16-May	1600	960	1600	840	480	300	1920	1200
1-Jun	1550	1040	1550	910	465	325	1860	1300
16-Jun	1500	1120	1500	980	450	350	1800	1400
1-Jul	1400	1200	1400	1050	420	375	1680	1500
16-Jul	1250	1280	1250	1120	375	400	1500	1600
1-Aug	1250	1040	1250	910	375	325	1500	1300
16-Aug	1250	960	1250	840	375	300	1500	1200
1-Sep	1250	960	1250	840	375	300	1500	1200
16-Sep	1200	960	1200	840	360	300	1440	1200
1-Oct	1200	960	1200	840	360	300	1440	1200
15-Oct	1200	960	1200	840	360	300	1440	1200
1-Nov	1200	960	1200	840	360	300	1440	1200
15-Nov	1200	960	1200	840	360	300	1440	1200

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<sup>1</sup>Where minimum flows required for dam operations are greater than flows listed in Table 2-1, those project-specific minimums will be applied in place of those minimums listed in Table 2-1. These include an operating outflow minimum limit of 1050 cfs from Detroit/Big Cliff dams, and 1350 cfs for Lookout Point/Dexter dams.

April - May

A 64°F (17.8°C) max threshold 7-day average of daily max (7dADM) water temperature would be targeted for migrating juvenile steelhead. This threshold could be met when flows are at least 10,000 cfs, and air temperatures are at most 78 °F 7dADM. At warmer air temperatures, more flow is required to meet the water temperature threshold. Flow would be augmented up to 18,000 cfs, at air temperatures of 90 °F 7dADM.

June 1-15

A 68°F (20°C) max threshold 7-day average of daily max (7dADM) water temperature would be targeted for adult chinook. This threshold could be met when flows are at least 8,000 cfs and air temperatures at most 80°F 7dADM. Flow would be augmented up to 14,000 cfs, at air temperatures up to about 89 °F 7dADM.

June 16-30

A 69°F (20.6°C) max threshold 7-day average of daily max (7dADM) water temperature would be targeted for adult chinook. This threshold could be met when flows are at least 8,000 cfs and air temperatures are at most 82°F 7dADM. Flow would be augmented up to 14,000 cfs in advance of forecasted air temperatures up to about 92°F 7dADM.

These proposed fish flow targets for temperature management are intended to reduce thermal stress on ESA-listed fish and reduce mortality during extreme heat.

The temperature pulses would be junior in priority to the minimum flow targets discussed above. The decision to pulse would be based on if there is enough stored to meet tributary and mainstem targets throughout the season. If USACE, in coordination with Willamette Action Team for Ecosystem Restoration (WATER), determines, based on event driven modeling, that there is enough stored water to provide the pulse, then USACE will release stored water to reduce excessive stream temperatures. Considerations on whether to complete the pulse include, but are not limited to water supply forecast, realized system storage, ramping rates, and biological priorities.

**Maximum Flows**

From September 1 to October 15, maximum outflows from Detroit/Big Cliff, Green Peter/Foster, Cougar, and Lookout Point/Dexter will be applied to protect against redd dewatering after the spawning season

(Table 2-3). Since high flows encourage spawning in areas of the river which could become dewatered after reservoirs have been drafted for flood risk management, reducing egg and fry

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survival, maximum flows were developed based on spawning WUA estimates developed by R2 (2013) and RDG (2016). The 75% WUA spawning flow at the upper portion of the WUA flow relationship was chosen. This flow level is higher than the 100% WUA flow estimates by R2 (2013) and RDG (2016). The 75% WUA spawning flow level was chosen to help balance the need to encourage spawning in areas that will remain wetted after reservoir drafting and the need to increase flows to draft reservoirs for flood management.

Deviations from the above approach will be considered as part of the WATER process, in coordination with the WATER Flow Management and Water Quality Team. Deviations could be expected where operational changes are necessary for project maintenance activities or emergency outages, and due to hydrologic variability requiring changes in flow management. Deviations should be developed based on the best available scientific information, with assumptions about risks, benefits, and uncertainties clearly stated and documented.

**Table 2-2. Threshold Flows at which flow augmentation could provide cooler temperatures in each timeframe and an associated water temperature threshold of which not to exceed. Flows provided in kcfs; temperature estimate in degrees F based on Stratton, et. al. (in press).**

–	Apr – May	Jun 1-15	Jun 15-30
Air Temperature Threshold (F)	Flow (kcfs) Needed to Keep Below 64°F Water Temperature	Flow (kcfs) Needed to Keep Below 68°F Water Temperature	Flow (kcfs) Needed to Keep Below 69°F Water Temperature
74	8.7	6.4	5.9
75	9	6.6	6
76	9.3	6.9	6.2
77	9.6	7.2	6.5
78	9.9	7.5	6.7
79	10.3	7.8	6.9
80	10.7	8.1	7.2
81	11.2	8.5	7.5
82	11.7	8.9	7.9
83	12.2	9.4	8.2
84	12.7	9.9	8.6
85	13.4	10.4	9
86	14	11	9.5
87	14.7	11.8	10.1
88	15.4	12.7	10.6
89	16.4	13.7	11.3
90	17.4	14.9	12
91	18.6	16.1	12.9

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–	Apr – May	Jun 1-15	Jun 15-30
<b>Air Temperature Threshold (F)</b>	<b>Flow (kcfs) Needed to Keep Below 64°F Water Temperature</b>	<b>Flow (kcfs) Needed to Keep Below 68°F Water Temperature</b>	<b>Flow (kcfs) Needed to Keep Below 69°F Water Temperature</b>
92	19.8	17.7	14
93		19.6	14.8

**Table 2-3. Maximum outflows to be achieved during the Chinook salmon spawning season, September 1 to October 15, annually. Flows based on average WUA values across study reaches for flows achieving 75% of the spawning habitat below these dams as reported by R2 Resources (2013) and RDG (2016), as averaged across study reaches.**

<b>Chinook Salmon Spawning</b>	<b>North Santiam (Big Cliff)<sup>1</sup></b>	<b>South Santiam (Foster)<sup>1</sup></b>	<b>South Fork McKenzie (Cougar)<sup>2</sup></b>	<b>Middle Fork (Dexter)<sup>3</sup></b>
Recommended Max Spawning Flow (Q) (75% WUA Q; cfs)	2175(a)	2825(a)	880(b)	3500(c)
For reference: 100% WUA Q (cfs)	1300	1500	500	1900
For reference: 2008 Biological Opinion max spawning season flows (cfs)	3000	3000	580	3500

<sup>1</sup> Average of reaches 1 and 2 from R2 2013.

<sup>2</sup> Average of mainstem S. Fork transects 1,2,3,7 from RDG 2016.

<sup>3</sup> Average of Mainstem transects 1,2,3,10 from RDG 2016.

**Purpose:** Provide biologically based flows and reduce thermal stress on ESA-listed fish and reduce mortality during extreme heat.

**Intended Benefit:** Increase fish survival

**Operational or Structural Measure:** Operational. Reduced minimum flows during early spring; higher flows during late spring and summer compared to NAA.

**Location:** Basin-wide

### 2.1.2 Measure 30b. Refined Integrated Temperature and Habitat Flow Regime

**Description:**

Measure 30b is a modification of Measure 30a, with changes to the mainstem and tributary minimum flow regimes. Salem flows are divided into two to three categories, based on the

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current water year’s percentage of the Northwest River Forecast Center’s rolling 30-year average April-September water supply forecast at Salem, as listed in

Table 2-4. Flows are subject to change throughout the season based on realized hydrology and annual water management decisions. The categories go from three to two starting in mid-June as the majority of the basin’s water supply has been realized by mid-June and flows become more stable. Minimum flow thresholds based on being above or below 90% of rule curve at Detroit/Big Cliff, Lookout Point/Dexter, and Foster dams are modified as noted in Table 2-5. See Measure 30a for the full description of the background development of the flows. Additional water releases from the projects may also occur to achieve temperature targets in the mainstem as measured at Salem, as noted in Measure 30a. The reservoirs used to provide the mainstem flow would be decided on a real-time basis depending on realized hydrologic conditions throughout the basin.

**Purpose:** Provide biologically based flows and reduce thermal stress on ESA-listed fish and reduce mortality during extreme heat.

**Intended Benefit:** Increase fish survival

**Operational or Structural Measure:** Operational. Reduced minimum flows during early spring; higher flows during late spring and summer compared to NAA.

**Location:** Basin-wide

**Table 2-4. Mainstem Minimum Flow Thresholds.**

Time Period	Water Supply Forecast Percent of 30 Year Average	Salem Minimum Flow, cfs (7 Day Moving Average)	Salem Minimum Flow, cfs (Instantaneous)	Albany Minimum Flow, cfs
April	<80%	12,000	12,000	–
–	80-100%	15,000	13,000	–
–	>100%	17,800	14,300	–
May	<80%	10,000	8,000	–
–	80-100%	13,000	12,000	–
–	>100%	15,000	12,000	–
June 1 - 15	<80%	8,000	8,000	4,500
–	80-100%	10,000	10,000	4500
–	>100%	13,000	10,500	4500
June 16 - 30	<80%	5,500	5,500	4,500
–	>=80%	7,000	7,000	4500
July	<80%	5,000	5,000	4,500

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<b>Time Period</b>	<b>Water Supply Forecast Percent of 30 Year Average</b>	<b>Salem Minimum Flow, cfs (7 Day Moving Average)</b>	<b>Salem Minimum Flow, cfs (Instantaneous)</b>	<b>Albany Minimum Flow, cfs</b>
–	>=80%	6,000	5,500	4500
August	<80%	5,000	5,000	4,500
–	>=80%	6,500	6,000	4500
September	<80%	5,000	5,000	4,500
–	>=80%	7,000	6,500	4500
October	<80%	7,500	6,000	4,500
–	>=80%	10,000	8,000	4500

**Table 2-5. Tributary Minimum Flow Thresholds.**

Dam	Detroit/ Big Cliff	Detroit/ Big Cliff	Green Peter/ Foster	Green Peter/ Foster	Blue River	Cougar <sup>1</sup>	Cougar <sup>1</sup>	Fern Ridge	Hills Creek	Lookout Point/ Dexter	Lookout Point/ Dexter	Fall Creek	Cottage Grove	Dorena
Start Date	>90%	<90%	>90%	<90%	all levels	>90%	<90%	all levels	all levels	>90%	<90%	all levels	all levels	all levels
1- Feb	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
15- Feb	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
1- Mar	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
15- Mar	1050	1050	1140	700	50	300	250	50	400	1200	1000	50	75	190
1- Apr	1200	1050	1200	700	50	360	250	50	400	1440	1000	80	75	190
16- Apr	1500	1050	1500	700	50	450	250	50	400	1800	1000	80	75	190
1- May	1550	1050	1550	770	50	465	275	50	400	1860	1100	80	75	190
16- May	1600	1050	1600	840	50	480	300	50	400	1920	1200	80	75	190
1- Jun	1550	1050	1550	910	50	465	325	50	400	1860	1300	80	75	190
16- Jun	1500	1120	1500	980	50	450	350	50	400	1800	1400	80	75	190
1-Jul	1400	1200	1400	1140	50	420	375	30	400	1680	1500	80	50	100
16- Jul	1250	1280	1250	1140	50	375	400	30	400	1500	1600	80	50	100
1- Aug	1250	1050	1140	1140	50	375	325	30	400	1500	1300	80	50	100
16- Aug	1250	1050	1140	1140	50	375	300	30	400	1500	1200	80	50	100

Dam	Detroit/ Big Cliff	Detroit/ Big Cliff	Green Peter/ Foster	Green Peter/ Foster	Blue River	Cougar <sup>1</sup>	Cougar <sup>1</sup>	Fern Ridge	Hills Creek	Lookout Point/ Dexter	Lookout Point/ Dexter	Fall Creek	Cottage Grove	Dorena
Start Date	>90%	<90%	>90%	<90%	all levels	>90%	<90%	all levels	all levels	>90%	<90%	all levels	all levels	all levels
1- Sep	1250	1050	1140	1140	50	375	300	30	400	1500	1200	200	50	100
16- Sep	1200	1050	1140	1140	50	360	300	30	400	1440	1200	200	50	100
1- Oct	1200	1050	1140	1140	50	360	300	30	400	1440	1200	200	50	100
15- Oct	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100
1- Nov	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100
15- Nov	1200	1050	1140	1140	50	360	300	30	400	1440	1200	50	50	100

<sup>1</sup> For the Preferred Alternative, Cougar Reservoir minimum would only be the <90% value due to the deep drawdown.

### 2.1.3 Measure 304. Augment Instream Flows By Using the Power Pool

#### **Description:**

Water stored in the designated power pools would be used to support biological flow targets when natural streamflows are not adequate to provide the biologically justified flows. The measure would only be implemented to meet ESA obligations and not provide water to meet consumptive needs. Due to the annual variability in hydrologic conditions throughout the basin, a set priority for use of the power pools is not possible and will be determined on an as-needed basis based on flow conditions in the tributaries. Coordination would occur through the WATER team. This measure would allow the stored water to be used when needed without additional analysis on a case by case or year by year basis. Pass inflow once elevation reaches minimum power pool elevation.

Minimum pool elevations under this measure will not conflict with a co-incident fish passage measure that requires a regulating outlet. For example, Measure 40 describes drafting the Hills Creek pool down to 25 feet above the RO (top of RO: 1421' + 25' = 1446') which is above minimum power pool specified above. In this case, the lowest elevation will be consistent with the elevation needed for the downstream fish passage measure.

**Purpose:** The water stored within the power pool would be used to augment natural streamflow to assist in meeting minimum tributary flows during the summer and late fall (June 1 – November 30).

**Intended Benefit:** The benefit of this operation is increased likelihood of meeting tributary minimum flows during the late summer through fall.

**Operational or Structural Measure:** Operational. Allows regular use of the power pool for purpose of supporting fish flows.

**Location:** Detroit, Green Peter, Lookout Point, Hills Creek, and Cougar dams. The re-regulating reservoirs, Dexter and Big Cliff, do not have power pool storage; therefore, the measure is not applied to these two reservoirs. Foster Dam has a small power pool, but this measure is not recommended for that reservoir due to the downstream passage and water quality work.

**Table 2-6. Measure 304 Category Response.**

<b>Category</b>	<b>Response</b>
Description of work	Use water stored in the power pool to meet minimum fish flow requirements.
Duration	Intended timeframe is summer through late fall, when natural flows decrease and there is increased out of stream use of natural flow.
Estimated Start Date	June 1
Estimated End Date	November 30 (modeling rule is set to end Dec 31 to ensure outflows don't drop to 0 cfs)
Recurrence Interval	Annually
Max pool elevation	Normal rule curve
Min pool elevation	Minimum power pool
Max draft rate	Max draft rate below minimum conservation pool is 3 feet/day for dam safety purposes
Outlet	The turbines will be used to draft water while in the power pool, though fish passage outlet takes priority during passage operation timing.
Estimated start of outlet restriction	Minimum turbine cavitation limits.
Duration of outlet restriction	No outlet restriction except normal use patterns for minimum turbine cavitation limits.
Max flow (cfs)	Maximum flow as described in the 2008 Biological Opinion or Measure 30.

**Table 2-7. Minimum Power Pool Elevations and Storage Volumes.**

<b>Dam and Reservoir</b>	<b>Lowest Proposed Draft Limit (Minimum Power Pool Elevation) (feet)</b>	<b>Minimum Conservation Pool Elevation (feet)</b>	<b>Power Pool Storage Volume (acre-feet)</b>	<b>Power Pool Storage (percent of total storage)</b>
Detroit	1,425	1,450	36,375	21.2
Green Peter	887	922	62,600	36.5
Lookout Point	819	825	11,377	6.6
Hills Creek	1,414	1,448	48,800	28.5
Cougar	1,516	1,532	8,700	5.1

#### 2.1.4 Measure 718. Augment Instream Flows by Using the Inactive Pool

**Description:**

The reservoirs are generally not drafted below minimum conservation pool unless hydrologic conditions result in reservoir inflows less than what is needed to provide downstream minimum flows. Water stored in the designated inactive pools would be used to support biological flow targets when natural streamflows are not adequate to provide the biologically justified flows. This measure would allow the water stored in the inactive pool to be used on a case by case or year by year basis without additional analysis.

**Purpose:** The water stored below minimum conservation pool would be used to augment natural streamflow to assist in meeting minimum flows at downstream control points during the summer and late fall (June 1 – November 30).

**Intended Benefit:** The benefit of this operation is increased likelihood of meeting tributary minimum flows during the late summer through fall.

**Operational or Structural Measure:** Operational. The lowest outlet in the reservoir would be used to draft the reservoir to the desired elevation without a need for structural modifications.

**Location:** Blue River, Fall Creek

**Table 2-8. Measure 718 Category Response.**

Category	Response
Description of work	Use water in the inactive pool to meet minimum instream flow requirements.
Duration	Intended timeframe is summer through late fall, when natural flows decrease.
Estimated Start Date	June 1
Estimated End Date	November 30
Recurrence Interval	Annually
Max pool elevation	Normal rule curve
Min pool elevation	See Additional Information below for project specific elevations.
Max draft rate	Max draft rate below minimum conservation pool is 3 feet/day for dam safety purposes.
Outlet	The ROs will be used to draft water below minimum conservation pool, except at Fern Ridge where it is the sluice gates.
Estimated start of outlet restriction	N/A

Category	Response
Duration of outlet restriction	N/A
Max flow (cfs)	Maximum flow as described in the 2008 Biological Opinion or revised targets.
Additional Information	<b>Lowest Proposed Draft Limit</b>
Blue River	1150 ft (top of RO is 1140 ft) (Min Con is 1180 ft)
Cottage Grove	735.5 ft (top of RO is 725.5 ft) (Min Con is 750 ft)
Dorena	755 ft (top of RO is 745 ft) (Min Con is 770.5 ft) Dorena Hydro min operation level is 770.5 ft
Fall Creek	790 ft (top of RO is 680 ft) (RO invert is 670 ft) (Min Con is 728 ft) Note, the reservoir currently drafts to run of river for fish passage operation in late fall, below 680 ft, which takes precedence over this measure.

**2.1.5 Measure 723. Reduce Minimum Flows to Congressionally Authorized Minimum Flow Requirements**

**Description:**

Minimum flows from the dam for downstream fisheries purpose are derived from House Document 81-531, App J (HD531). Detroit/Big Cliff and Lookout Point/Dexter have minimum operating limits, due to physical constraints, which are higher than the HD531 minimum flows. These higher minimum operating flows would take priority over the lower HD531 flows. Mainstem flow targets are the authorized minimum flow objectives from HD531.

**Purpose:** Use the HD531 authorized minimum flows for the projects and the HD531 minimum flow objectives for Albany and Salem to maximize filling of the reservoirs during the refill season.

**Intended Benefit:** Benefit reservoir refill by allowing the reservoirs to capture more spring runoff rather than passing high spring inflows.

**Operational or Structural Measure:** Operational

**Location:** Basin-wide

**Table 2-9. Measure 723 Category Response.**

Category	Response
Description of work	Spring and summer tributary flow targets are the HD531 flows. Summer mainstem targets based on HD531 objectives.
Duration (hours/days)	N/A
Est. Start Date (day/month)	June 1 (mainstem); annual tributaries
Est. End Date (day/month)	November 30 (mainstem); N/A tributaries
Recurrence Interval (X years)	Annually
Max pool elevation (ft, project datum)	Up to maximum conservation pool
Outlet (RO/spillway/etc.)	Alternative does not change outlet use
Est. start of outlet restriction (day/month)	N/A
Duration of outlet restriction (days)	N/A
Max flow (cfs)	N/A
Additional Information	See flow targets in tables below.

**Table 2-10. Mainstem Flows.**

Control Point	Date	Augmentation for Fish Habitat and Water Quality (cfs) (per HD531)
Salem	Jun 1 – Nov 30	6,500
Albany	Jun 1 – Nov 30	5,000

**Table 2-11. Tributary Flows.**

Dam	Minimum Flow(cfs)	Remarks HD531 has two distinct time periods that do not span the full year.
Detroit/Big Cliff	1000/750	1 Feb – 30 Jun = 1000 cfs 1 Jul – 30 Nov = 750 cfs
Blue River	30	1 Feb – 30 Jun = 30 cfs 1 Jul – 30 Nov = 30 cfs
Cottage Grove	75/50	1 Feb – 30 Jun = 75 cfs 1 Jul – 30 Nov = 50 cfs
Cougar	300/200	1 Feb – 30 Jun = 300 cfs 1 Jul – 30 Nov = 200 cfs
Dorena	190/100	1 Feb – 30 Jun = 190 cfs 1 Jul – 30 Nov = 100 cfs

Dam	Minimum Flow(cfs)	Remarks HD531 has two distinct time periods that do not span the full year.
Fall Creek	30	1 Feb – 30 Jun = 30 cfs 1 Jul – 30 Nov = 30 cfs
Fern Ridge	50/30	1 Dec – 30 Jun = 50 cfs 1 Jul – 30 Nov = 30 cfs
Green Peter	50	1 Feb – 30 Nov = 50 cfs HD531 was adopted prior to Foster Dam being proposed; hence the minimum flow released at Green Peter is the 50 cfs but also that needed to ensure Foster minimum flows.
Foster	800 – 400	1 Feb – 30 Apr = 800 cfs 1 May – 31 May = 750 1 Jun – 30 Jun = 600 1 Jul – 30 Nov = 400 cfs Foster was not included in HD531; therefore, minimum flow from Foster is the combined minimum for Green Peter and Cascadia <sup>1</sup> dams.
Hills Creek	100	1 Feb – 30 Jun = 100 cfs 1 Jul – 30 Nov = 100 cfs
Lookout Point/Dexter	1200/1000	1 Feb – 30 Jun = 1200 cfs 1 Jul – 30 Nov = 1000 cfs

<sup>1</sup> House Document 531 authorized Cascadia Dam on the Upper South Santiam River. This dam was never built; however, the House Document 531 flows were never adjusted. This dam is not included in the EIS analyses.

### 2.1.5 2008 Biological Opinion Flow Objectives

#### Description:

The USACE would operate the WVS dams and reservoirs consistent with minimum mainstem flow objectives (RPA 2.3), tributary flow minimums (RPA 2.4) and maximums (RPA 2.5), and ramping rates (RPA 2.6) from the 2008 National Marine Fisheries Service Biological Opinion (NMFS 2008 Biological Opinion).

Mainstem flow objectives are measured at Salem and Albany, Oregon (RPA 2.3). The USACE would continue to set operational flow targets at Salem on April 1, based on a storage forecast (i.e., adequate, abundant, insufficient, or deficit) for mid-May (May 10 to May 20). The USACE will also operate the WVS dams and reservoirs in a manner to meet or exceed minimum tributary and mainstem flow objectives (RPA 2.4) (Table 2-13 and Table 2-14) but also not to exceed the maximum tributary targets (RPA 2.5) listed in (Table 2-14).

The minimum flow objectives may not be met in water years that are not “adequate” or “abundant” as defined in Appendix B – Willamette Project Supplemental Biological Assessment. USACE will notify and coordinate with NMFS when operations are not able to meet the mainstem or tributary flow objectives.

The USACE designates the conservation season as abundant, adequate, insufficient, or deficit is based on the forecast system-wide storage for a 10-day period in mid-May (Table 2-13). The designation will lead to differing flow objectives for the mainstem at Salem.

**Intended Benefit:** This measure is intended to ensure adequate flows for UWR Chinook salmon and UWR steelhead that migrate and rear in the mainstem Willamette River, per the NMFS 2008 Biological Opinion. These flow objectives would be expected to aid downstream migration of juvenile steelhead by reducing the likelihood of disease outbreaks based on flow and water temperature relationships. Additionally, minimum flow objectives during summer months would provide water quality benefits to rearing juvenile Chinook and steelhead and upstream migrating adult Chinook. The minimum tributary flow objectives will ensure adult fish access to existing spawning habitat below USACE dams, protect eggs deposited during spawning, and provide juvenile rearing and adult holding habitat for listed salmonids and other fishes.

**Operational or Structural Measure:** Operational

**Location:** Basin-wide

**Table 2-12. Conservation Season Designation Based on Amount of Water Forecasted to be Stored in the Willamette Valley System of Reservoirs.**

Volume in Storage System-wide (MAF)	Conservation Season Designation
<900	Deficit
900 - 1.19	Insufficient
1.20 – 1.48	Adequate
>1.48	Abundant

**Table 2-13. Mainstem Willamette Flow Objectives.**

Time Period	7-Day Moving Average <sup>1</sup> Minimum Flow at Salem (cfs) <sup>3</sup>	Instantaneous Minimum Flow <sup>2</sup> at Salem (cfs) <sup>3</sup>	Deficit Season Designation Flow at Salem (cfs) <sup>3</sup>	Minimum Flow <sup>2</sup> at Albany (cfs) <sup>4</sup>
April 1 - 30	17,800	14,300	15,000	–
May 1 - 31	15,000	12,000	15,000	–
June 1 - 15	13,000	10,500	11,000	4,500 <sup>3</sup>
June 16 - 30	8,700	7,000	5,500	4,500 <sup>3</sup>
July 1 - 31	–	6,000 <sup>3</sup>	5,000	4,500 <sup>3</sup>
August 1 - 15	–	6,000 <sup>3</sup>	5,000	5,000 <sup>3</sup>
August 16 - 31	–	6,500 <sup>3</sup>	5,000	5,000 <sup>3</sup>
September 1 - 30	–	7,000 <sup>3</sup>	5,000	5,000 <sup>3</sup>

Time Period	7-Day Moving Average <sup>1</sup> Minimum Flow at Salem (cfs) <sup>3</sup>	Instantaneous Minimum Flow <sup>2</sup> at Salem (cfs) <sup>3</sup>	Deficit Season Designation Flow at Salem (cfs) <sup>3</sup>	Minimum Flow <sup>2</sup> at Albany (cfs) <sup>4</sup>
October 1 - 31	–	7,000	5,000	5,000

<sup>1</sup> An average of the mean daily flows in cubic feet per second (cfs) observed over the prior 7-day period.

<sup>2</sup> Congressionally authorized minimum flows (HD531). September flows were extended into October.

<sup>3</sup> USGS gage 14191000 Willamette River at Salem, Oregon

<sup>4</sup> USGS gage 14174000 Willamette River at Albany, Oregon

**Table 2-14. Minimum and Maximum Tributary Flow Objectives.**

Dam	Period	Primary Use	Minimum Flow (cfs) <sup>1</sup>	Maximum Flow (cfs) <sup>2</sup>
Hills Creek	September 1 - January 31	Migration and rearing	400	–
Hills Creek	February 1 - August 31	Rearing	400	–
Fall Creek	September 1 - October 15	UWR Chinook salmon spawning	200	400 through September 30, when possible
Fall Creek	October 16 - January 31	UWR Chinook salmon incubation	50 <sup>3</sup>	–
Fall Creek	February 1 - March 31	Rearing	50	–
Fall Creek	April 1 - May 31	Rearing	80	–
Fall Creek	June 1 - June 30	Rearing/adult migration	80	–
Fall Creek	July 1 – August 31	Rearing	80	–
Dexter	September 1 - October 15	UWR Chinook salmon spawning	1,200	3,500 through September 30, when possible
Dexter	October 16 – January 31	UWR Chinook salmon incubation	1,200 <sup>3</sup>	–
Dexter	February 1 – June	Rearing	1,200	–
Dexter	July 1 – August 31	Rearing	1,200	–
Big Cliff	September 1 – October 15	UWR Chinook salmon spawning	1,500	3,000 through September 30, when possible
Big Cliff	October 16 – January 31	UWR Chinook salmon incubation	1,200 <sup>3</sup>	–
Big Cliff	February 1 – March 15	Rearing/adult migration	1,000	–
Big Cliff	March 16 – May	UWR steelhead spawning	1,500	3,000
Big Cliff	June 1 – July 15	UWR steelhead incubation	1,200 <sup>3</sup>	–
Big Cliff	July 16 – August 31	Rearing	1,000	–

Dam	Period	Primary Use	Minimum Flow (cfs) <sup>1</sup>	Maximum Flow (cfs) <sup>2</sup>
Foster	September 1 – October 15	UWR Chinook salmon spawning	1,500	3,000 through September 30, when possible
Foster	October 16 – January 31	UWR Chinook salmon incubation	1,100 <sup>3</sup>	–
Foster	February 1 – March 15	Rearing	800	–
Foster	March 16 – May	UWR steelhead spawning	1,500	3,000
Foster	May 16 – June	UWR steelhead incubation	1,100 <sup>3</sup>	–
Foster	July 1 – August 31	Rearing	800	–
Blue River	September 1 – October 15	UWR Chinook salmon spawning	50	–
Blue River	October 16 – January 31	UWR Chinook salmon incubation	50	–
Blue River	February 1 – August 31	Rearing	50	–
Cougar	September 1 – October 15	UWR Chinook salmon spawning	300	580 through September 30, when possible
Cougar	October 16 – January 31	UWR Chinook salmon incubation	300	–
Cougar	February 1 – May	Rearing	300	–
Cougar	June 1 – June 30	Rearing/adult migration	400	–
Cougar	July 1 – July 31	Rearing	300	–
Cougar	August 1 – August 30	Rearing	300	–

<sup>1</sup> When a reservoir is at or below minimum conservation pool elevation, the minimum outflow would equal inflow or the Congressionally authorized minimum flows, whichever is higher.

<sup>2</sup> Maximum flows are intended to minimize the potential for spawning to occur in stream areas that might subsequently be dewatered at the specified minimum flow during incubation.

<sup>3</sup> USACE would attempt to avoid prolonged releases in excess of the recommended maximum spawning season discharge to avoid spawning in areas that would require high incubation flows that would be difficult to achieve and maintain throughout the incubation period. When maximum flow objectives are exceeded for a period of 72 hours or longer, the WATER Forum will review available monitoring information (e.g., regarding redd deposition in relation to flow rates), projected runoff, and reservoir storage, and will formulate a recommendation for an appropriate and sustainable incubation flow rate prior to the initiation of the subsequent incubation period.

### **Ramping Rates**

When project outflows are less than those in the tables below, the USACE will restrict down-ramping (the rate at which outflows are decreased) to the hourly and daily rates listed in the tables to minimize stranding of juvenile fish and aquatic invertebrates and desiccation of redds.

The goal is for down ramping rates not to exceed 0.1 ft/hour during nighttime hours and 0.2 ft/hour during daytime hours.

- When system operations or equipment limits prevent USACE from meeting ramp down rates at all projects, USACE will place priority on achieving ramping rates at those projects marked in Table 9.2-4 as high priority for fish protection.
- During active flood damage reduction operations, the USACE may deviate from the ramping rates in Table 9.2-4. However, the USACE will comply again with these ramping rates as soon as the flood risk has abated. The USACE must follow the protocol for deviations from Table 9.2-4 described in 2008 Biological Opinion RPA measures 2.2 and 4.3.

**Table 2-15. Project outflow rates: below these rates, down-ramping limits in Table 2-16 apply**

<b>PROJECT</b>	<b>PROJECT OUTFLOW (CFS)</b>
Hills Creek	1500
Dexter	3000
Fall Creek	700
Dorena	1000
Cottage Grove	800
Cougar	1200
Blue River	700
Fern Ridge	300
Foster	2000
Detroit	2000

**Table 2-16. Maximum Ramping Rates During Flow Level Changes below Upper Willamette Basin Dams (cfs) - Nighttime Rampdown Rates to Achieve 0.1 ft/hour 1, 2, 4, 5, 6**

Hills Creek <sup>5</sup>	Hills Creek <sup>5</sup>	Lookout Point <sup>5</sup>	Lookout Point <sup>5</sup>	Fallcreek <sup>5</sup>	Fallcreek <sup>5</sup>	Dorena	Dorena	Cottage Grove	Cottage Grove	Couger	Couger	Blue River <sup>5</sup>	Blue River <sup>5</sup>	Fern Ridge	Fern Ridge	Foster <sup>5</sup>	Foster <sup>5</sup>	Detroit <sup>5</sup>	Detroit <sup>5</sup>
Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change
400		1200		50				50		400		50		30		800		1000	
600	60 <sup>3</sup>	1500	125	100	20 <sup>3</sup>	100		300	30 <sup>3</sup>	500	80 <sup>3</sup>	250	30	80	20 <sup>3</sup>	900	100	1200	100
1000	75 <sup>3</sup>	2000	145	300	40 <sup>3</sup>	500	50	500	40 <sup>3</sup>	1200	100 <sup>3</sup>	500	50	150	30 <sup>3</sup>	1900	150	1500	110
1500	90 <sup>3</sup>	2500	150	500	50	100	60	800	50	2400	150	700	60	300	40	2000	155	2000	130
1700	100	3000	170	700	60	3700	100					2300	100	1000	50				

<sup>1</sup> Avoid a flow volume reduction of more than 50% per hour or the lesser of 1 foot or 50% per 24 hours. Ramping listed are decrements in release that approximately yield the resulting change in flow of 0.1 foot/hour or 0.2 foot/hour.

<sup>2</sup> Operations prevent USACE from meeting rampdown rates at all projects, USACE will place priority on achieving ramp rates at these projects noted as high priority for fish protection.

<sup>3</sup> USACE cannot achieve ramping rates at low flows due to adjustment limits of existing equipment.

<sup>4</sup> NMFS prefers using 0.1 ft/hour during all hours from January 1 through March 31 because mostly fry-aged fish are present then and are less able to avoid ramping effects.

<sup>5</sup> High priority because of the presence of ESA listed salmon and steelhead. Rates listed are for reservoir operation other than when reducing project outflow to manage for downstream flood damage reduction.

<sup>6</sup> Change in flow at flows higher than those listed are less critical for protecting ESA species because of proportionally smaller flow volume change.

**Nighttime Rampdown Rates to Achieve 0.2 ft/hour** <sup>1, 2, 4, 5, 6</sup>

**Table 2-17. Maximum Ramping Rates During Flow Level Changes below Upper Willamette Basin Dams (cfs) Nighttime Rampdown Rates to Achieve 0.2 ft/hour 1, 2, 4, 5, 6**

Hills Creek <sup>5</sup>	Hills Creek <sup>5</sup>	Lookout Point <sup>5</sup>	Lookout Point <sup>5</sup>	Fallcreek <sup>5</sup>	Fallcreek <sup>5</sup>	Dorena	Dorena	Cottage Grove	Cottage Grove	Couger	Couger	Blue River <sup>5</sup>	Blue River <sup>5</sup>	Fern Ridge	Fern Ridge	Foster <sup>5</sup>	Foster <sup>5</sup>	Detroit <sup>5</sup>	Detroit <sup>5</sup>
Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change	Q	Flow diff for 0.1' change
400		1200		50				50		400		50		30		800		1000	
600	120	1500	250	100	40 <sup>3</sup>	100		300	60	500	160	250	60 <sup>3</sup>	80	40	900	200	1200	200
1000	150	2000	290	300	80	500	100	500	80	1200	200	500	100	150	60	1900	300	1500	220
1500	180	2500	300	500	100	100	120	800	100			700	120	300	80	2000	310	2000	260
		3000	340	700	120									1000	100				

<sup>1</sup> Avoid a flow volume reduction of more than 50% per hour or the lesser of 1 foot or 50% per 24 hours. Ramping listed are decrements in release that approximately yield the resulting change in flow of 0.1 foot/hour or 0.2 foot/hour.

<sup>2</sup> Operations prevent USACE from meeting rampdown rates at all projects, USACE will place priority on achieving ramp rates at these projects noted as high priority for fish protection.

<sup>3</sup> USACE cannot achieve ramping rates at low flows due to adjustment limits of existing equipment.

<sup>4</sup> NMFS prefers using 0.1 ft/hour during all hours from January 1 through March 31 because mostly fry-aged fish are present then and are less able to avoid ramping effects.

<sup>5</sup> High priority because of the presence of ESA listed salmon and steelhead. Rates listed are for reservoir operation other than when reducing project outflow to manage for downstream flood damage reduction.

<sup>6</sup> Change in flow at flows higher than those listed are less critical for protecting ESA species because of proportionally smaller flow volume change.

## **2.2 WATER QUALITY MEASURES - TEMPERATURE**

### **2.2.1 Measure 105. Construct Selective Withdrawal Structure**

#### **Description:**

This measure assumes a Selective Withdrawal Structure (SWS) design similar to the Detroit SWS Design Documentation Report (DDR) and Floating Screen Structure (FSS) specifications (USACE, 2019a). This measure complements Measures 392 and 722 for the Adult Fish Facility.

This measure would use selective withdrawal structures to achieve Clean Water Act (CWA), total maximum daily load, and ESA water temperature requirements below each identified dam when possible. SWSs include outlet works that allow for selective withdrawal of water at various temperatures that could be blended to improve downstream water temperature. Structural fixes could allow releases from various elevations in the reservoir, send this water through the powerhouse, and continue to generate power while meeting downstream water quality targets. Water temperature simulations assume outlet details and temperature targets align with those used in previous studies (Buccola, et.al, 2012, Buccola, et.al, 2016; Buccola, et.al, 2017, USACE, 2019a; USACE 2019b). These structures could also be attached to or combined with new fish passage facilities (notably Measure 392: construct downstream passage) to more effectively meet the requirements of fish passage RPAs (NMFS 2008).

**Purpose:** Provide more normative temperatures downstream of the project.

**Intended Benefit:** Increase fish survival

**Operational or Structural Measure:** Structural

**Location:** Detroit, Lookout Point, Green Peter, Hills Creek

### **2.2.2 Measure 166. Use Regulating Outlets for Temperature Management**

#### **Description:**

Due to the strong stratification that most of the valley lakes experience during the spring, summer, and fall (before lake turnover), there is an opportunity at some projects to release relatively cool water from the regulating outlets (below the power intakes). This cooler water (compared to releases through the turbines) can provide a benefit for chinook egg incubation downstream. Projects that include various usable outlet inverts include Detroit, Green Peter, and Lookout Point dams. Actual mix between outlets depends on desired temperature targets.

**Purpose:** Provide more normative temperatures downstream of the project during fall/winter.

**Intended Benefit:** Increase fish survival

**Operational or Structural Measure:** Operational

**Location:** Detroit, Green Peter, Lookout Point

**Table 2-18. Detailed Information for Measure 166 at Detroit, Green Peter, and Lookout Point Dams.**

Category	Detroit	Green Peter	Lookout Point
Description of work	Allocate up to 60% of total outflow to ROs during fall when pool is less than 200 ft above each set of ROs (upper/lower).	Use ROs during fall to meet cooler temperature target.	Use ROs during fall to meet cooler temperature target.
Duration (hours/days)	45 days	45 days	45 days
Est. Start Date	1 October	1 October	1 October
Est. End Date	15 November	15 November	15 November
Recurrence Interval (X years)	Annually	Annually	Annually
Max pool elevation (ft, project datum)	200 ft max head restriction	-	900
Outlet Invert Elevation (RO/spillway/et c.)	1335 (2) & 1260 (2)	745	724
Min flow (cfs)	60% of total outflow to ROs during this timeframe except when combined with measure 40, where a 50/50 split between upper and lower RO will attempt to optimize fish passage (upper RO) and temperature management (lower RO).	60% of total outflow to ROs during this timeframe except when combined with measure 40, where fish passage is prioritized.	60% of total outflow to ROs during this timeframe except when combined with measure 40, where fish passage is prioritized.
Max flow (cfs)	4960 cfs	4420 cfs	13,000 cfs (all ROs full open at max con pool)
Additional Information	Current head restriction on ROs is 200 feet maximum. This	Current head restrictions on ROs are assumed for this measure.	There are no current head restrictions on ROs in the WCM.

Category	Detroit	Green Peter	Lookout Point
	measure would assume that this limitation would still exist.		
Note	This temperature operation is included in NAA. Limited to a maximum of 200 ft head pressure on RO gates.	Limited benefit at Green Peter due to RO's (745 ft elevation) close proximity to the turbines (795 ft elevation).	Limited benefit due to RO's (724 ft elevation) close proximity to the turbines (780 ft elevation).

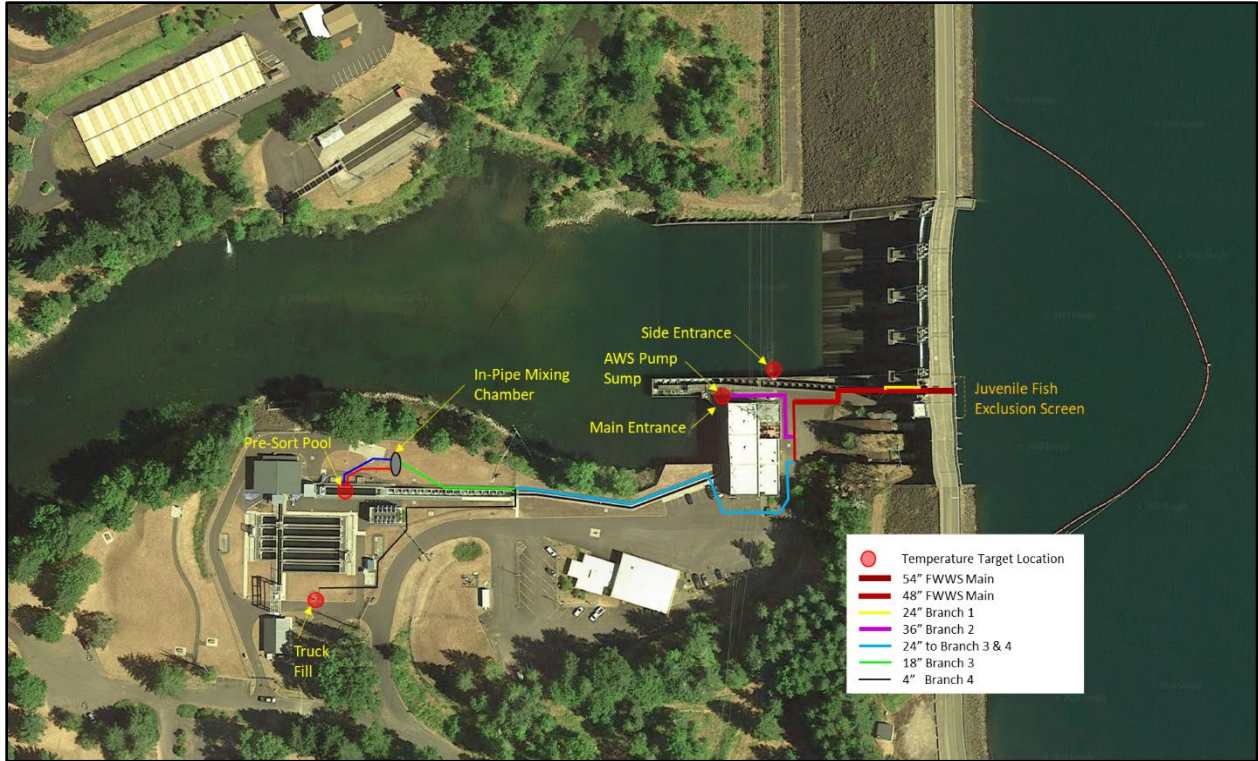
**2.2.3 Measure 479. Foster Dam Fish Ladder Temperature Improvement**

**Description:**

This measure would provide more normative temperatures at the existing Foster Dam adult fish facility. Upstream fish migration at Foster Dam has been observed to be delayed and consensus among regional fisheries managers is that the temperature of the water in the fish ladder is too cold to attract fish in the spring and early summer (May and June).

Under this measure, a structural modification to Foster Dam would be implemented to reduce delay of upstream-migrating spring Chinook salmon and winter steelhead by increasing the water temperature in the fish ladder. During the later spring and summer months, the Foster forebay is stratified in terms of temperature. The existing water supply for the fish ladder is located at the powerhouse intakes, below the thermocline, and as a result the temperature of the flow issuing from the pre-sort pool at the top of the fish ladder and from the ladder entrances is too cold compared to the historic or ambient river temperatures.

The major feature of this measure is construction of a new Forebay Warm Water Supply (FWWS) pipe that would draw warm water from above the thermocline in the Foster forebay. The existing water supply pipe would remain in use and a network of pipes and valves would allow the two water sources to be mixed to achieve desired temperatures at the side fish ladder entrance, ancillary water supply sump, pre-sort pool and truck fill location. The temperature targets were developed as a function of the upstream South Santiam River, with maximum target temperatures constrained by needs for fish health. A juvenile fish exclusion screen would be provided upstream of the FWWS intake to keep juvenile fish from entering the FWWS pipe. Figure 2-1 provides a piping schematic and identifies the four temperature target locations.



**Figure 2-1. FWWS Piping Schematic with Temperature Target Locations.**

The construction approach, feasibility, and design of the structures for the Foster Temperature Improvement measure has been developed to a 60% Plans and Specifications phase and a record of the design is described in the Design Documentation Report (DDR). For the purposes of modeling and effects analysis, the design documented in the DDR would be used. Table 2-19 shows some of the assumptions used for this measure.

**Purpose:** Provide more normative temperatures in the fish ladder and attract upstream migrant fish in a timelier manner during the spring

**Intended Benefit:** Decrease the time it takes for fish to pass the project, as well as reduce the straying of hatchery fish and the percentage of hatchery origin spawners in the wild.

**Operational or Structural Measure:** Structural

**Location:** Foster Dam

**Table 2-19. Assumptions Used for the Structural Temperature Improvement at Foster Dam.**

Category	Description
Description of work	Implement structural modifications to improve ladder water temperature at Foster Dam
Estimated Annual Start Date (day/month)	The FWWS will operate from about 01 May through 30 September, when the reservoir is at (or approaching) its maximum conservation pool <sup>1</sup> .
Duration (hours/days)	The FWWS would operate 24/7.
Pool elevation (feet)	El. 638.2 to El. 644.6 (NAVD 88)
Recurrence Interval (years)	Annually
Maximum FWWS Flow (cfs)	144 cfs

<sup>1</sup> FWWS operation requires a forebay elevation at or above El. 638.2 feet (NAVD 88). The forebay reaches El. 638.2 on 01 May assuming standard refill in accordance with the Water Control Diagram. Changes in refill timing would affect the start date for FWWS operation.

#### **2.2.4 Measure 721. Use Spillway to Release Warm Surface Water in Summer**

##### **Description:**

Use the spillway when available in the spring and summer to improve downstream water temperatures from spring through autumn. By extending the use of the spillway, a larger volume of warm surface water from the reservoir can be released and cold deep water can be reserved for later in the fall/early winter when necessary for fish incubation. In the fall, the deeper regulating outlets (ROs) can release a limited amount of cooler water at Detroit, Green Peter, Lookout Point dams.

- Detroit: Use spillway (Spillway Crest (1541 ft) as soon as available in spring to provide attraction temperatures for upstream migrant adult Chinook salmon. 60% of total outflow during specified period except, where applied and combined with measure 714. In this case, the downstream temperature target will determine the ratio of discharge between the spillway and turbines.
- Green Peter: Use spillway (Spillway Crest (969 ft) as soon as available in May to provide attraction temperatures for upstream migrant adult Chinook salmon. Use ROs in the fall to reduce temperatures for egg incubation downstream of FOS. 60% of total outflow during specified period except, where applied and combined with measure 714. In this case, the downstream temperature target will determine the ratio of discharge between the spillway and turbines.
- FOS: Night-time spillway (Spillway Crest (597 ft) operation during the spring followed by fish weir operation May-July. At the time the alternatives were analyzed, this measure had been implemented under the NAA at Foster.

- Blue River: Use spillway (Spillway Crest (1321 ft) as soon as available in spring to provide attraction temperatures for upstream migrant adult Chinook salmon. Structural modifications would be required to safely implement this measure at Blue River Dam because the spillway was not designed for frequent use; it was designed to occasionally pass fill due to flooding events. Site-specific design and environmental compliance documentation (as described in Chapter 7) would be prepared for necessary modifications at Blue River Dam.
- Lookout Point: Use spillway (Spillway Crest (888 ft) as soon as available in spring to provide attraction temperatures for upstream migrant adult Chinook salmon. 60% of total outflow during specified period except, where applied and combined with measure 714. In this case, the downstream temperature target will determine the discharge ratio of discharge between the spillway and turbines.
- Hills Creek: Use spillway (Spillway Crest (1495 ft) as soon as available in spring to provide attraction temperatures for upstream migrant adult Chinook salmon. The downstream temperature target will determine the discharge ratio of discharge between the spillway and turbines. Structural modifications would be required to safely implement this measure at Hills Creek Dam because the spillway was not designed for frequent use; it was designed to occasionally pass water due to flooding events. Site-specific design and environmental compliance documentation (as described in Chapter 7) would be prepared for necessary modifications at Hills Creek Dam.

**Purpose:** Restore normative temperatures to extent possible using existing outlets.

**Intended Benefit:** Increase fish survival.

**Operational or Structural Measure:** Operational

**Location:** Detroit, Green Peter, Foster, Blue River, Lookout Point, Hills Creek

## 2.3 WATER QUALITY MEASURES – TOTAL DISSOLVED GAS (TDG)

### 2.3.1 Measure 174. Structural Improvements to Reduce Total Dissolved Gas

**Description:**

Structural modifications to reduce TDG could include spillway deflectors, similar to those installed at Columbia River USACE-managed dams, may provide a permanent fix to TDG problems at Willamette Valley System dams. These deflectors redirect the flow from the spillway from a plunging flow that transports air bubbles deep into the stilling basin to a horizontal jet that maintains entrained air much closer to the water surface. Structural modifications could also focus on redesign of current outlets, spillways or stilling basins. Methods to reduce TDG could include, but are not limited to:

- Boulder augmentation or debris jams that create more natural riffles downstream and degas supersaturated water. Little is known regarding the design and construction of riffles and debris jams and how effective these man-made structures may be for TDG abatement below WVS dams.
- Distribute spillway flows uniformly across the entire spillway to reduce downstream TDG.
- Construct pipe extensions on the downstream side of regulating outlets to submerge releases in the stilling basin and reduce jet impact on the tailwater surface.

**Purpose:** Minimize TDG below projects

**Intended Benefit:** Increase fish survival

**Operational or Structural Measure:** Structural

**Location:** Detroit, Big Cliff, Green Peter, Foster, Hills Creek, Lookout Point, and Dexter dams.

## 2.4 DOWNSTREAM FISH PASSAGE MEASURES

### 2.4.1 Measure 40. Deeper Fall Reservoir Drawdown for Downstream Fish Passage

**Description:** This measure involves drawing down reservoirs in the fall to within 25 feet over the ROs (and 25 feet over the Cougar diversion tunnel (DT)) for downstream passage.

**Purpose:** Decrease reservoir elevation in fall to improve downstream fish passage rate and survival at WVS dams, annually.

**Intended Benefit:** Decreasing reservoir elevations to near regulating outlets will increase the number of juvenile spring Chinook salmon and juvenile winter steelhead passing and their survival rate. Juvenile salmonids are known to pass if a surface route is available, particularly in spring and fall. Fish passage survival has been demonstrated to increase as reservoir elevation is decreased over the outlet.

**Operational or Structural Measure:** Operational. Modifications of existing facilities for use of an outlet for safe fish passage may be required. Specific modifications would be determined during the design phase if the action is implemented as part of the final EIS/ROD. The operation to the DT at Cougar would require the construction of a tower at the DT and connecting bridge to facilitate access for required outlet maintenance.

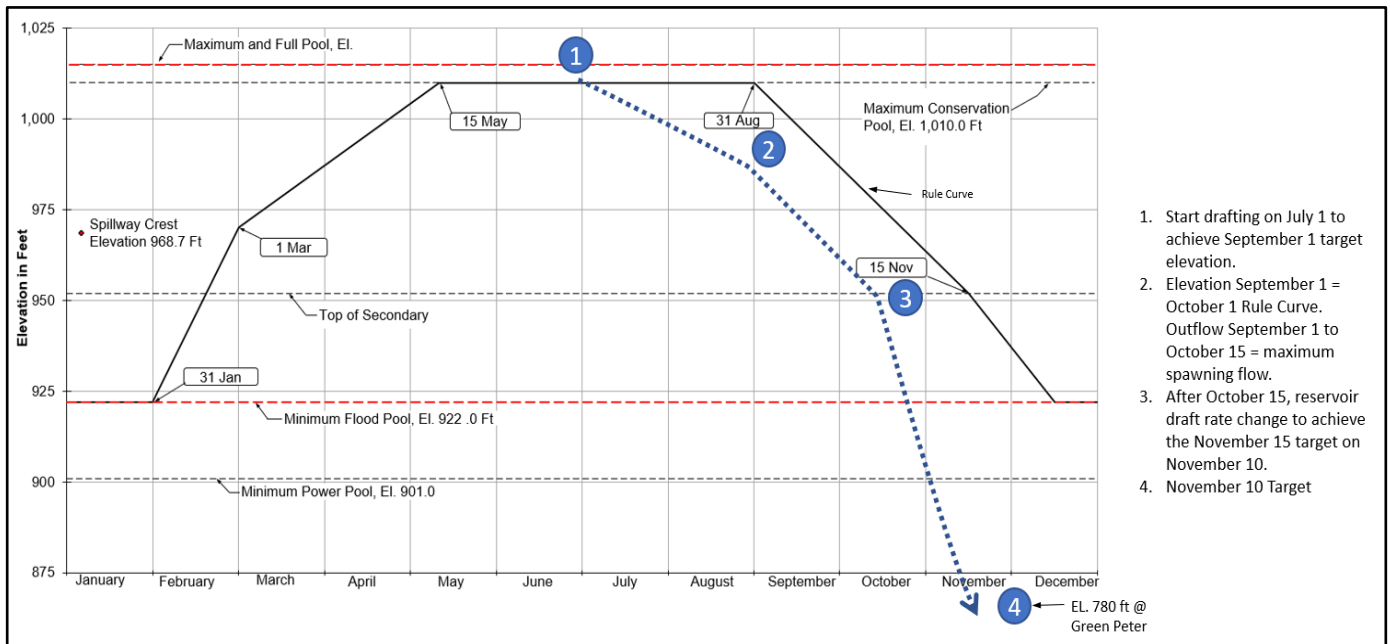
**Location:** Detroit, Green Peter, Cougar, Blue River, Lookout Point, Hills Creek

**Table 2-20. Details for Fall Reservoir Drawdown Operation for Fish Passage.**

Category	Response
Description of work	Use ROs (DT at Cougar under 3B) to pass fish in fall. Limit turbine operations to reduce fish passing via penstocks.

Category	Response
Duration (hours/days)	24 hours a day for 3 weeks
Estimated Start Date	<ol style="list-style-type: none"> <li data-bbox="634 283 1406 401">1. Drafting of each reservoir will begin July 1, annually at a rate to achieve the Oct 1 rule curve elevation on Sept 1. (See #1 on Figure 2-2).</li> <li data-bbox="634 443 1406 590">2. During the spawning season (Sept 1 to Oct 15), the total discharge from the dam will be maintained at or below the maximum flows for spawning (Table 2-8) (See #2 on Figure 2-2).</li> <li data-bbox="634 632 1406 749">3. After the spawning season ends Oct 15, the draft rate will then be revised as needed to achieve the Nov 15 target elevation (Table 2-22) (See #3 on Figure 2-2).</li> <li data-bbox="634 1346 1406 1459">4. Figure 2-2 Pool target elevations (Table 2-22) will be achieved beginning at the earliest Nov 15, and the latest Dec 15. (See #4 on Figure 2-2).</li> </ol>
Estimated End Date	Maintain target elevation as feasible for 3 weeks, but no later than Dec 15. Then refill to minimum conservation pool as feasible.
Recurrence Interval	Annually
Max pool elevation (ft, project datum)	Target elevations for each dam are included in Table 2-8 below. Twenty-five feet over the top of the RO was chosen to avoid cavitation.
Outlet (RO/spillway/etc.)	Limit turbine operations to between the hours of 1000 to 1800 whenever the reservoir elevation is at or below 50 ft over the top of the penstock and also between Oct 1 and December 15.

Category	Response
Estimated start of outlet restriction	When reservoir elevation is within 50 ft of penstock
Duration of outlet restriction (days)	21 days starting as early as November 15, or until December 15, whichever comes first
Max flow (cfs)	When combined with M479 at Detroit, assume 50/50 split between upper and lower RO to optimize fish passage (upper RO) and temperature management (lower RO). Where conflicts may occur, fish passage optional objectives of Measure 40 should be prioritized over operations for water temperatures.



**Figure 2-2. Reservoir drafting approach to achieve target elevation by Nov 15. This example shows the Green Peter rule curve.**

**Table 2-21. Maximum outflows to be achieved during the Chinook salmon spawning season, September 1 to October 15, annually. Flows based on average weighted usable area (WUA) values across study reaches for flows achieving 75% of the spawning habitat below these dams as reported by R2 Resources (2013) and RDG (2016), as averaged across study reaches.**

Chinook Salmon Spawning	North Santiam (Big Cliff) <sup>1</sup>	South Santiam (Foster) <sup>1</sup>	S Fork McKenzie (Cougar) <sup>2</sup>	Middle Fork (Dexter) <sup>3</sup>
Recommended Max Spawning Q (75% WUA Q; cfs)	2175	2825	880	3500
For reference: 100% WUA Q (cfs)	1300	1500	500	1900
For reference: 2008 Biological Opinion max spawning season flows (cfs)	3000	3000	580	3500

<sup>1</sup>Recommended max Q = Average of reaches 1 and 2 from R2 2013.

<sup>2</sup>Recommended max Q = Average of mainstem S. Fork transects 1,2,3,7 from RDG 2016.

<sup>3</sup>Recommended max Q = Average of Mainstem transects 1,2,3,10 from RDG 2016.

**Table 2-22. Drawdown reservoir target elevations. Target elevations = invert elevation + height of outlet + 25 ft over the top of the ROs and Cougar Dam DT.**

Dam	Target Elevation (feet) (25 feet above top of the outlet) <sup>1</sup>
Detroit *	1,370
Green Peter	780
Lookout Point	761
Hills Creek	1,446
Blue River	1,165
Cougar RO	1,516
Cougar DT	1,330

<sup>1</sup> Detroit target elevation was calculated based on an invert elevation of 1340', which is the RO centerline elevation, not the invert. This error was caught after modeling was complete. USACE determined this difference in elevation would not affect model results.

**Table 2-23. Elevations and Outlet Statistics.**

Elevations in NGVD 29	Hills Creek	Lookout Point	Cougar	Blue River	Green Peter	Detroit
Minimum Conservation Pool Elevation	1448	825	1532	1180	922	1450
Minimum Power Pool	1414	819	1480	–	887	1425

Elevations in NGVD 29	Hills Creek	Lookout Point	Cougar	Blue River	Green Peter	Detroit
Number of Regulating Outlets	2	4	2	2	2	4
Size of RO	6'6"x12'6"	6'9"x12'	6'6"x12'6"	4'9"x8'	5'6"x10'	5'8"x10'
RO invert (bottom) elevation (ft)	1,409	724	1,479	1,132	745	2@ 1,335 2@ 1,260
Top of penstock	1396	790	1430	N/A	817	1419
50 ft above top of penstock	1446	840	1480	N/A	867	1469
100 ft above top of penstock	1496	890	1530	N/A	917	1519

**Table 2-24. Flows achieving 100% WUA habitat area for the Chinook salmon spawning life stage (R2 2013 and RDG 2016).**

Reach	North Santiam	South Santiam	S Fork McKenzie	Middle Fork
1	1286	1140	614	2918
2	900	2400	283	1600
3	1700	920	519	1025
4	1250	–	–	–
Mean	1284	1487	472	1848

#### **2.4.2 Measure 714. Pass Water Over Spillway in Spring for Downstream Fish Passage**

**Description:** This measure involves passing water over the spillway in spring and early summer for downstream fish passage.

**Purpose:** Increase the number and the survival of juvenile salmon and steelhead passing downstream of WVS dams.

**Intended Benefit:** Spring Chinook salmon, winter steelhead. Increase the number and the survival of juvenile salmon and steelhead passing downstream of WVS dams in the spring.

**Operational or Structural Measure:** Operational. Some locations may require structural improvements to implement the operation.

**Location:** Detroit, Big Cliff, Green Peter, Cougar, Blue River, Lookout Point, Dexter, Hills Creek

**Table 2-25. Measure 714 Category and Response.**

Category	Response
Description of work	Use spillway to pass fish in spring
Duration (hours/days)	24 hours a day for 60 days
Estimated Start Date (day/month)	May 1 (or as soon as pool elevation allows)
Estimated End Date (day/month)	July 1 (or as hydrology supports)
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	<= 25 ft above spillway crest
Outlet (RO/spillway/etc.)	Spillway. No turbine operations at Foster Dam during 0600 to 1000, and 1800 to 2200 from April 15 to July 1. Operations of turbines at other dams should be secondary to spillway operations.
Estimated start of outlet restriction (day/month)	N/A
Duration of outlet restriction (days)	N/A
Max flow (cfs)	For all projects where applied and when combined with measure 721, the downstream temperature target will determine the discharge ratio of discharge between the spillway and turbines.
Additional Information	This should be paired with an outplanting measure above Green Peter. There are currently no spring Chinook salmon or winter steelhead above project. Increases chance of not refilling

### 2.4.3 Measure 720. Deep Spring Reservoir Drawdown for Downstream Fish Passage

**Description:**

This measure involves drawing down reservoirs in the spring to within 25 feet over the top of the RO (and Cougar DT) for downstream juvenile fish passage. The reservoirs would be held at this elevation for six weeks (three weeks at Green Peter). Drawdown reservoir target elevation is 25 feet over the top of the RO (target elevation = RO invert elevation + RO height + 25 feet). For alternatives using the Cougar diversion tunnel, target elevation will be 25 feet over the top of the diversion tunnel.

**Purpose:** Increase the number and the survival of juvenile salmon and steelhead passing downstream of WVS dams.

**Intended Benefit:** Increase the number and the survival of juvenile salmon passing downstream of WVS dams in the spring.

**Operation or Structural Measure:** Operational. Note, measure assumes modifications of existing facilities for use of an outlet for safe fish passage. Specific modifications would be determined during the design phase if the action is implemented as part of the final EIS/ROD. The operation to the DT at Cougar would require the construction of a tower at the DT and connecting bridge to facilitate access for required outlet maintenance.

**Location:** Detroit, Green Peter, Cougar, Blue River, Lookout Point, Hills Creek

**Table 2-26. Measure 720 Category and Response.**

Category	Response
Description of work	Use low elevation outlets to pass fish in spring by delaying refill of reservoirs. Beginning February 1 draft reservoir as needed to the target elevation by May 1 and holding elevation until June 15, except Green Peter. For Green Peter Dam, draft to the target elevation by May 1 and hold until May 21 (due to probability of refill if held at target elevation until June 15 based on initial Res-Sim modeling results). This measure would be prioritized over other operational measures for fish.
Duration (hours/days)	3-6 weeks, 24 hours a day
Estimated Start Date	1) Hold reservoir elevation at minimum conservation pool elevation from Feb 1 until Mar 1. 2) Draft reservoir between Mar 1 to May 1 to get to target elevations noted in table below as 25' above outlets. 3) Hold at target elevations until the end date of June 15 (except at Green Peter until May 21).
Estimated End Date	Green Peter May 21, all other locations June 15

Category	Response
Recurrence Interval	Annually
Max pool elevation (ft, project datum)	Target elevation: 25 ft over the top of the upper ROs and 25 ft over the Cougar diversion tunnel
Outlet (RO/spillway/etc.)	Limit turbine operations to between the hours of 1000 to 1800 between March 1 and June 15 (May 21 for Green Peter) and whenever the reservoir elevation is at or below 50 ft over the top of the penstock.
Estimated start of outlet restriction (day/month)	March 1 to June 15 (or May 21 for Green Peter).
Duration of outlet restriction (days)	Approx. 14 weeks; Green Peter approx. 10 weeks
Max flow (cfs)	N/A
Additional Information	None

**Table 2-27. Drawdown Reservoir Target Elevations.**

Dam	Target Elevation (feet) (25 feet above top of the outlet) <sup>1</sup>	Duration Held at this Elevation (weeks)
Detroit	1,370	6
Green Peter	780	3
Lookout Point	761	6
Hills Creek	1,446	6
Cougar RO	1,516	6
Cougar DT	1,330	6

#### 2.4.4 Measure 392. Construct Structural Downstream Fish Passage

**Description:** Provide downstream fish passage using a Floating Screen Structure (FSS) (gravity fed flow which may include pumps for supplementing flow) or a Floating Surface Collector (FSC) (pumped flow only). Feasibility, design, cost, and specific biological benefit of the structure will be determined during a future construction design phase. Assumes attributes of existing FSS designs (as described in the DDRs for Detroit FSS and Cougar FSS). Where a FSS is included, design assumes a temperature tower to accommodate reservoir fluctuation and gravity fed outflow (as described in the DDR for Detroit) and for mooring of the FSS. Pumps are assumed at Green Peter FSS for this measure to supplement inflows for fish attraction. Where an FSC is included as the structural solution, a pumped flow of 1000 cfs is assumed. Flows for FSS are described below.

**Purpose:** Provide downstream fish passage at various reservoir elevations.

**Intended Benefit:** Improved fish passage during normal operating reservoir levels.

**Operational or Structural:** Structural

**Location:** Detroit, Green Peter, Cougar, Lookout Point, Hills Creek

**Table 2-28. Measure 392 Category and Response/Assumptions.**

Category	Response/Assumptions
Description of work	Implement structural downstream fish passage at dams identified in each EIS alternative
Duration (hours/days)	For FSS, prioritize turbine ops at nighttime hours (dusk to dawn). Minimize power peaking (i.e., variable flows) to the extent possible during this time and adaptive management will be used to inform how to operate for power peaking and collection efficiency.
Estimated Start Date (day/month)	N/A
Estimated End Date (day/month)	N/A
Recurrence Interval (X years)	N/A
Max pool elevation (ft, project datum)	The FSS routes water to the turbines. The FSS operates within the normal turbine elevation range at each project. The FSS can operate down to 5 feet below min con before it would need to be deballasted (inoperable)
Estimated start (day/month) of targeted elevation	N/A
Duration at target elevation (days)	N/A
Restricted Outlet (RO/spillway/etc.)	N/A
Estimated. start (day/month)	N/A
Duration (days) of outlet restriction	N/A
Min, Max flow (cfs)	See Table 2-31
Additional Information	Structural design would need to accommodate predicted pool fluctuations under the proposed alternative. Measure 105 for a temperature tower at all locations where an FSS is indicated is assumed.

Minimum and maximum flows through the FSS for Detroit and Cougar were based on design flow ranges as documented in their respective Design Documentation Reports (DDR). The FSS inflow operating range for Hills Creek Dam was assumed from the Cougar Dam FSS design, given the similarity in dam configuration and turbine capacity. Total FSS inflow capacity for Green Peter and Lookout Point was determined by scaling based on the Detroit design flow. This was accomplished by dividing the Detroit total design flow by the Detroit turbine capacity and then multiplying the result with the total turbine capacity flows at Green Peter and Lookout Point. Due to the frequency at which flows can be less than 1000 cfs from Green Peter Dam, it was assumed that pumped flow would be used to supplement the FSS inflows up to 1000 cfs for the minimum FSS operating range at Green Peter.

**Table 2-29. Detroit FSS Scaler for Design Flow/Turbine Capacity.**

Dam	Max total turbine capacity at min con (cfs)	FSS V-screen design flow (cfs)	Scaler (design flow / turbine capacity)
Detroit	4960	4600 (double barrel)	0.927

**Table 2-30. FSS Inflow Operating Range.**

Dam	Max total turbine capacity at min con	Det FSS Scaler	Estimated total V-screen design flow based on scaler	Total V-screen design flow assumed for EIS	Notes
Lookout Point	8100	.927	7509	6000	Adjusted down design flow, based on Kock et al. 2019 model of FSC fish guidance efficiency indicating efficiency would be high assuming a double V-screen design of 6000 cfs.
Green Peter	4420	.927	4097	4000	

**Table 2-31. Minimum and Maximum Flows (cfs) through each FSS by Project.**

Dam	Minimum FSS flow (cfs)	Maximum FSS flow (cfs)	Notes
Detroit FSS <sup>1</sup>	1050 (equivalent to cavitation limit for BC)	5600	Per Detroit DDR
Cougar FSS <sup>2</sup>	300	1000	Per Cougar DDR
Green Peter FSS	50 cfs supplemented to 1000 cfs with recirculating pumped flow from forebay	4000	Based on Det FSS scaler * Green Peter turbine capacity (See table above)
Lookout Point FSS	1350 (equivalent to cavitation limit for DEX)	6000	Based on Det FSS scaler * Lookout Point turbine capacity, adjusted based on Kock et al. FSC model (see table above)
Hills Creek FSS	300	1000	Assumed from Cougar DDR

<sup>1</sup>Detroit FSS: There are two entrances in the FSS, capable of handling flow ranges from 1,000 cfs to 5,600 cfs. The design flow rate for fish collection operations is 4,500 cfs, with each channel operating at a flow of 2,250 cfs. Future provisions for pumped attraction flow will accommodate 1,000 cfs to drive flow through the FSS and continue attracting and collecting fish from the forebay. (Final DDR.)

<sup>2</sup>Cougar FSS: There are two entrances on the Dual Entrance Angled FSS, with the starboard collection channel sized to pass 400 cubic feet per second (cfs) and the port collection channel sized to pass 600 cfs. Including two entrances instead of only one allows for better control of hydraulic conditions over the full range of design flows (300 to 1,000 cfs). (per 90% DDR.)

**Table 2-32. FSS Single Barrel Operating Ranges.**

Dam	Single barrel operating range (cfs)	Notes
Detroit FSS	1000 to 2250	Per Detroit DDR
Green Peter FSS	1000 to 1950	Scaled Max. FSS flow based on single/total FSS flow for Detroit = $2250/4600 = 0.49$
Lookout Point FSS	1000 to 2950	Scaled Max. FSS flow based on single/total FSS flow for Detroit = $2250/4600 = 0.49$
Cougar FSS	300 to 400	Per Cougar DDR
Hills Creek FSS	300 to 400	Assumed from Cougar DDR

For Alternative 1, the FSS would be assumed to be operated consistent with the water storage theme. Therefore, it was assumed the FSS would be operated at the design flow for a single V-screen at night (12 hours) during the primary periods fish are available to pass downstream, otherwise at a min flow as designed for Detroit FSS of 1000 cfs. Juvenile Chinook salmon and steelhead are primarily available to pass from WVS reservoir forebays between May 1 and June 30, and September 15 to December 15, based on Alden, and studies summarized by USGS 2017. USACE used the most common Res-Sim outflows between April 1-July 1, and September 1-

December 1 to approximate the flows at which the collector would be most likely to operate. Due to the priority on storage in Alternative 1, the typical outflows during the fish passage season were most often around the minimum operating range of the collector. Therefore, USACE assumed the FSS would be operating with one barrel most of the time for most projects.

Modeling dam passage survival in the Fish Benefits Workbook requires estimates of dam passage efficiency (DPE). To estimate DPE, the regression model published by Kock et al. (2019) was applied, which requires estimates of the effective forebay area, FSS entrance size, and FSS flow.

From Koch 2019: "The effective forebay area (EFA) is defined as the area of the forebay that downstream migrants can access between the dam and the 500-m mark located upstream of each collector entrance (Figure 2)." Google Earth was used to estimate the EFA by drawing a 500m line from the area of the dam where a collector would likely sit, then roughly sketched in an area by drawing roughly straight line from the point 500m from the dam outlet. The estimate for effective area at Cougar may be high due to effects of the cul-de-sac. The effect of forebay size, however, was less influential than inflow through the collector.

**Table 2-33. Effective Forebay Areas where each FSS would be Operated.**

<b>Reservoir/Dam</b>	<b>Effective forebay area (Ha)</b>
Detroit	24.2
Green Peter	20.9
Foster	47.9
Cougar	27.6
Blue River	28
Lookout Point	35.4
Hills Creek	55.4

Entrance size for a conceptual FSS at Hills Creek Dam was assumed from the Cougar Dam FSS design given the similarity in dam configuration and turbine capacity. The entrance size from the Cougar FSS, based on the 90% DDR, is 57 ft wide by 34 ft tall, or 1938 sq ft.

The FSS entrance sizes for Green Peter and Lookout Point were determined by scaling the design based on the relationship of the Detroit FSS entrance area and Detroit FSS max flow from the Detroit DDR (0.317). This scaler was then applied to the estimated max FSS inflows for Lookout, Green Peter and Hills Creek dams to estimate an entrance size for FSS concepts at these dams.

**Table 2-34. Detroit FSS Entrance Sizes Scaler.**

Dam	Entrance area (total for 2 trash racks/barrels)	Max FSS inflow	Scaler
Detroit	1776 sq ft	5600	.317

**Table 2-35. FSS Entrance Areas.**

Dam	Maximum FSS flow (cfs)	Entrance area (sq ft)	Notes
Detroit FSS	5600	1776	From Detroit DDR
Green Peter FSS	4000	1268	Max FSS flow * 0.317
Lookout Point FSS	6000	1902	Max FSS flow * 0.317
Couger FSS	1000	1938	From Couger DDR
Hills Creek FSS	1000	1938	Based on Couger DDR

**LOCATION:** Foster

Current downstream passage conditions support a viable spring Chinook salmon or winter steelhead population above Foster Dam; however, improvements may be necessary for winter steelhead and spring Chinook salmon should current operations fail to maintain self-sustaining populations. To facilitate improved downstream passage, this measure would provide for a structural solution. Approach, feasibility, design, cost, and biological benefit of the structure will be determined during the construction design phase. The modified design would be consistent with a surface route structure. The design would utilize a flow rate of 500-800 cfs.

**Table 2-36. Details for Structural Passage at Foster.**

Description of Work	Structural Passage at Foster
Duration (hours/days)	<p>Fish structure operates 24/7, year-round at 600 cfs.</p> <p>No spillway operation for fish passage purposes or temperatures. (i.e., this replaces the NAA fish operations).</p> <p>Alternative 1: No turbine operational constraints. Alternative 4: Limit operating the turbine units to ½ day (i.e., same turbine limits as in the NAA).</p>
Estimated Start Date (day/month)	Fish structure: Year-round

Description of Work	Structural Passage at Foster
	Alternative 4: Limit turbine operations: March 1 (spring start) May 1 (summer start)
Estimated End Date (day/month)	Alternative 4: Limit turbine operations: April 30 (spring end) June 15 (summer end)
Recurrence Interval (X years)	Annually when the pool is within the operating elevation (winter at 615 MSL min and summer at 635 MSL max).
Max pool elevation (ft, project datum)	615 MSL (min elevation) to 635 MSL (max elevation): Foster spillway
Estimated start (day/month) of targeted elevation	N/A
Duration at target elevation (days)	N/A
Restricted Outlet (RO/spillway/etc.)	Turbines restricted between 1900 and 0700 during fish passage seasons
Estimated start (day/month)	When within operating range
Duration (days) of outlet restriction	When within operating range
Max flow (cfs)	800 cfs

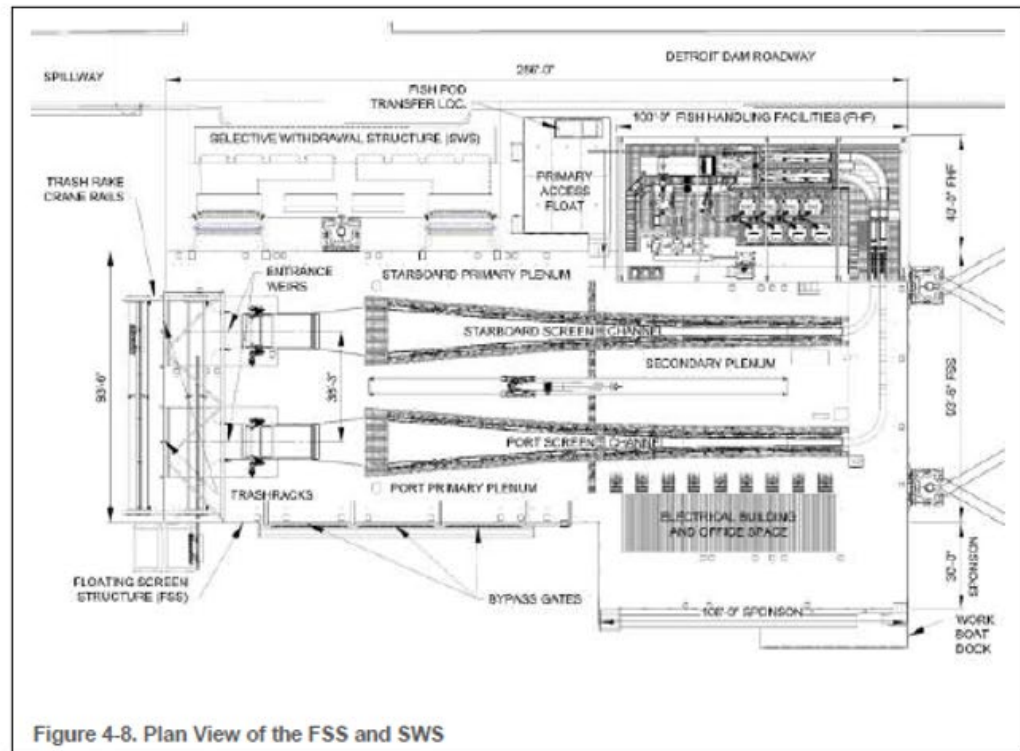
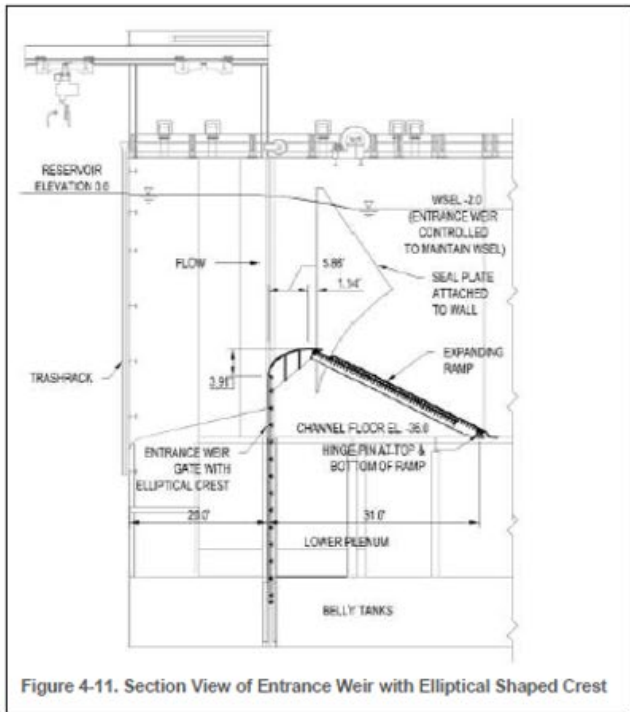


Figure 2-3. Section and Plan View of Detroit FSS (Figures from the Detroit FSS DDR).

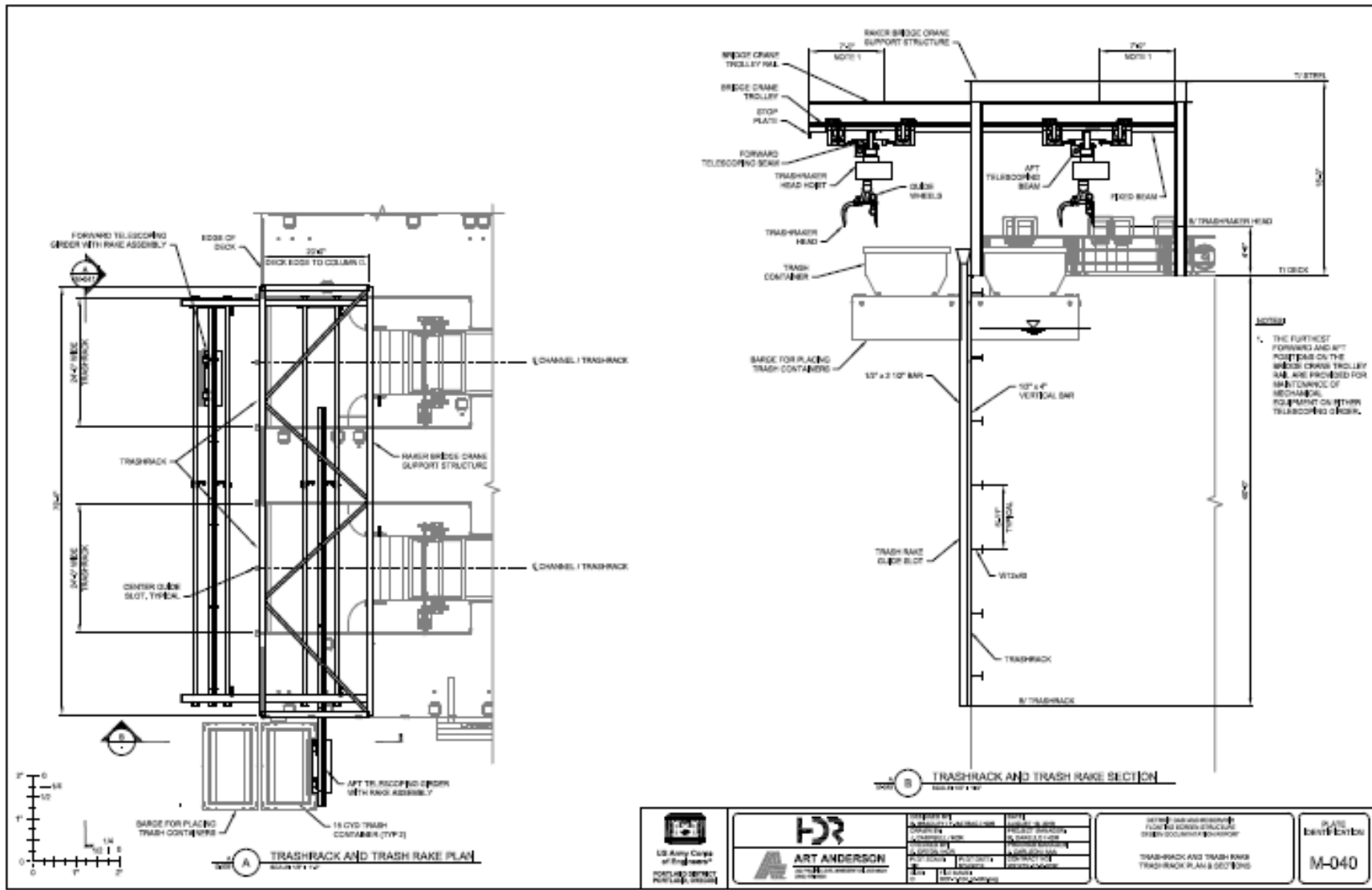
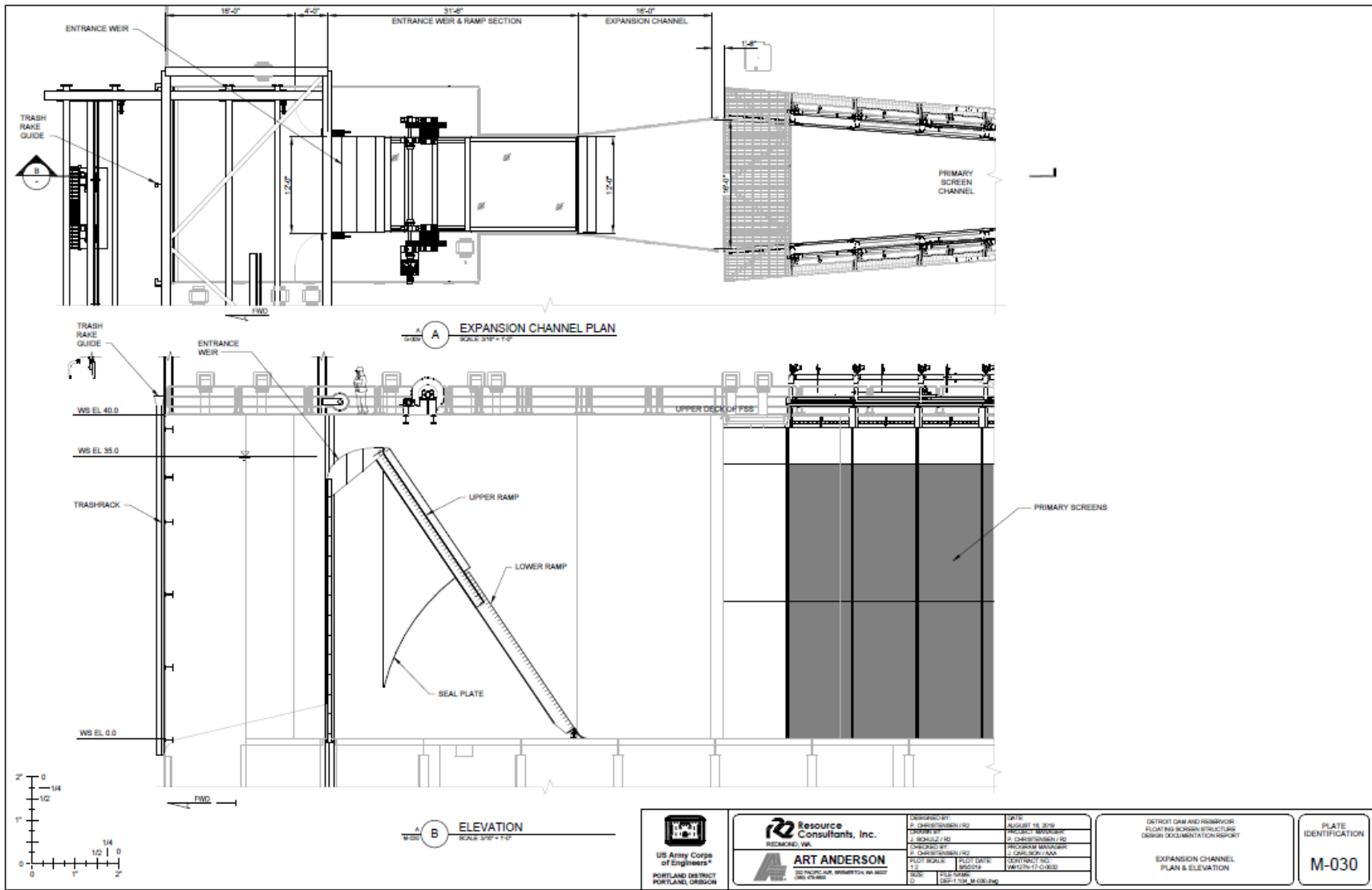


Figure 2-4. Plate M-040 from Detroit DDR Appendix A.



STATUS (FINAL)

Figure 2-5. Plate M-030 from Detroit DDR Appendix A.

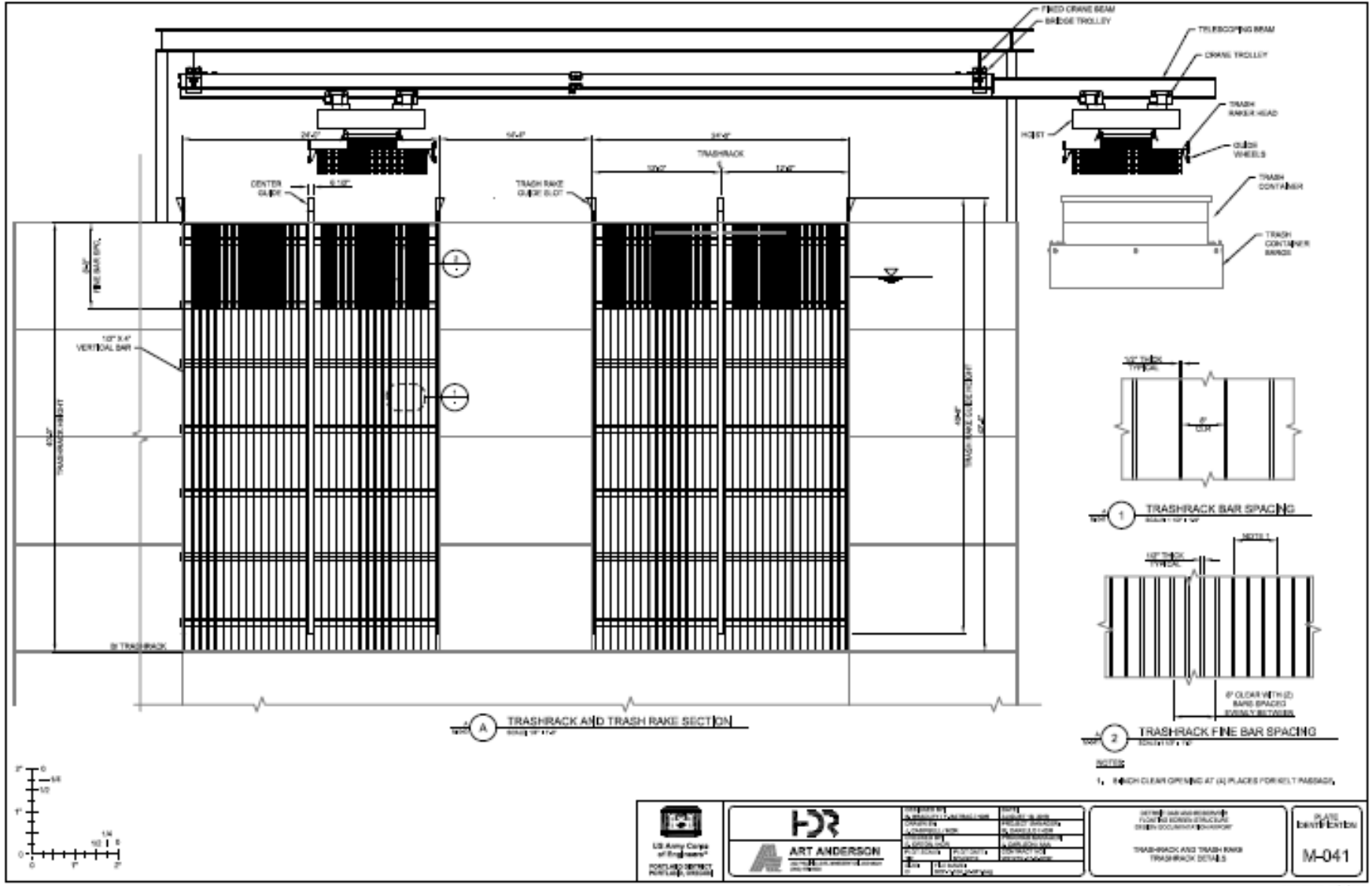
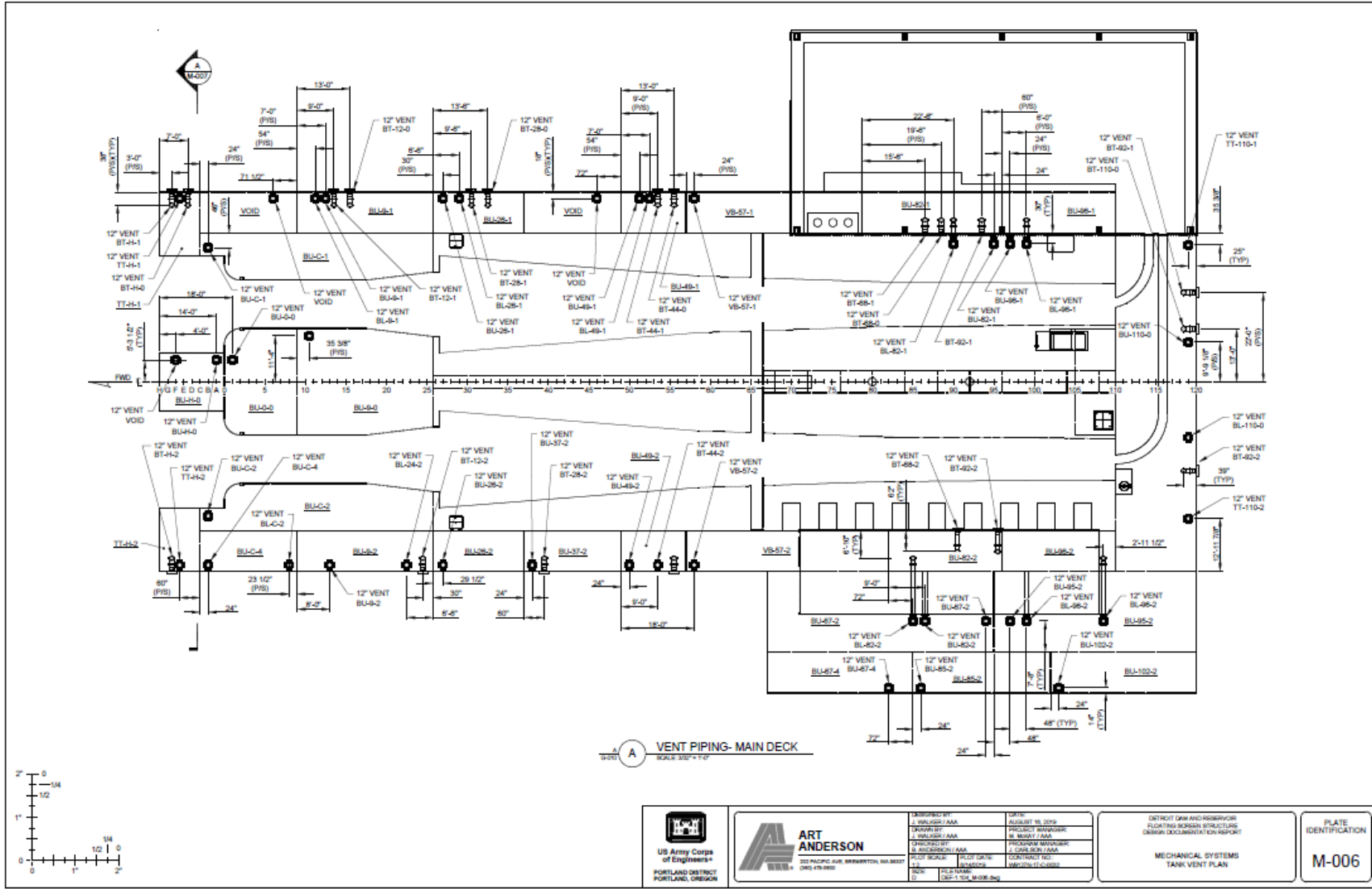
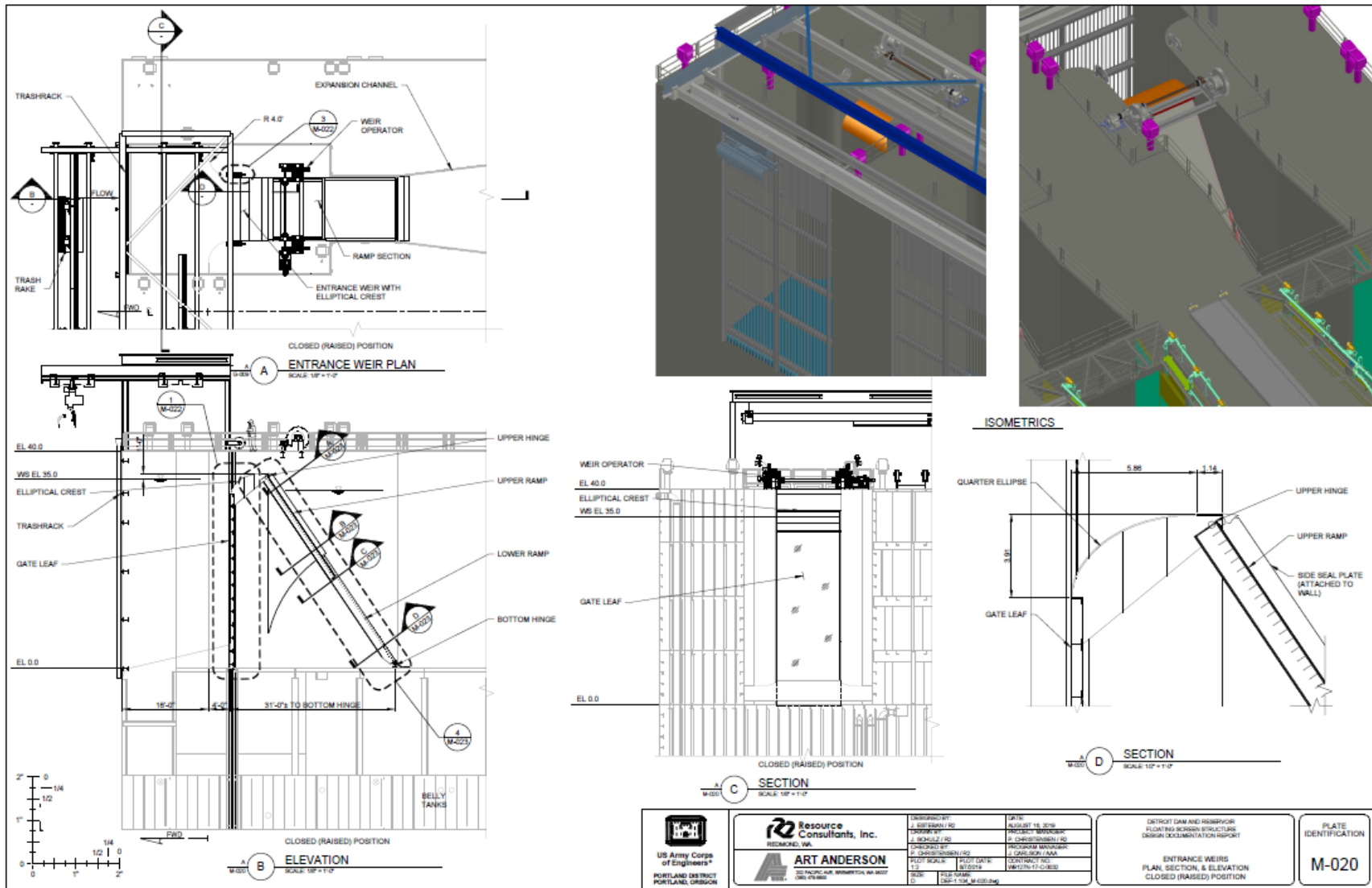


Figure 2-6. Plate M-041 from Detroit DDR Appendix A.



STATUS (FINAL)

Figure 2-7. Plate M-006 from Detroit DDR Appendix A.



STATUS (FINAL)

Figure 2-8. Plate M-020 from Detroit DDR Appendix A.

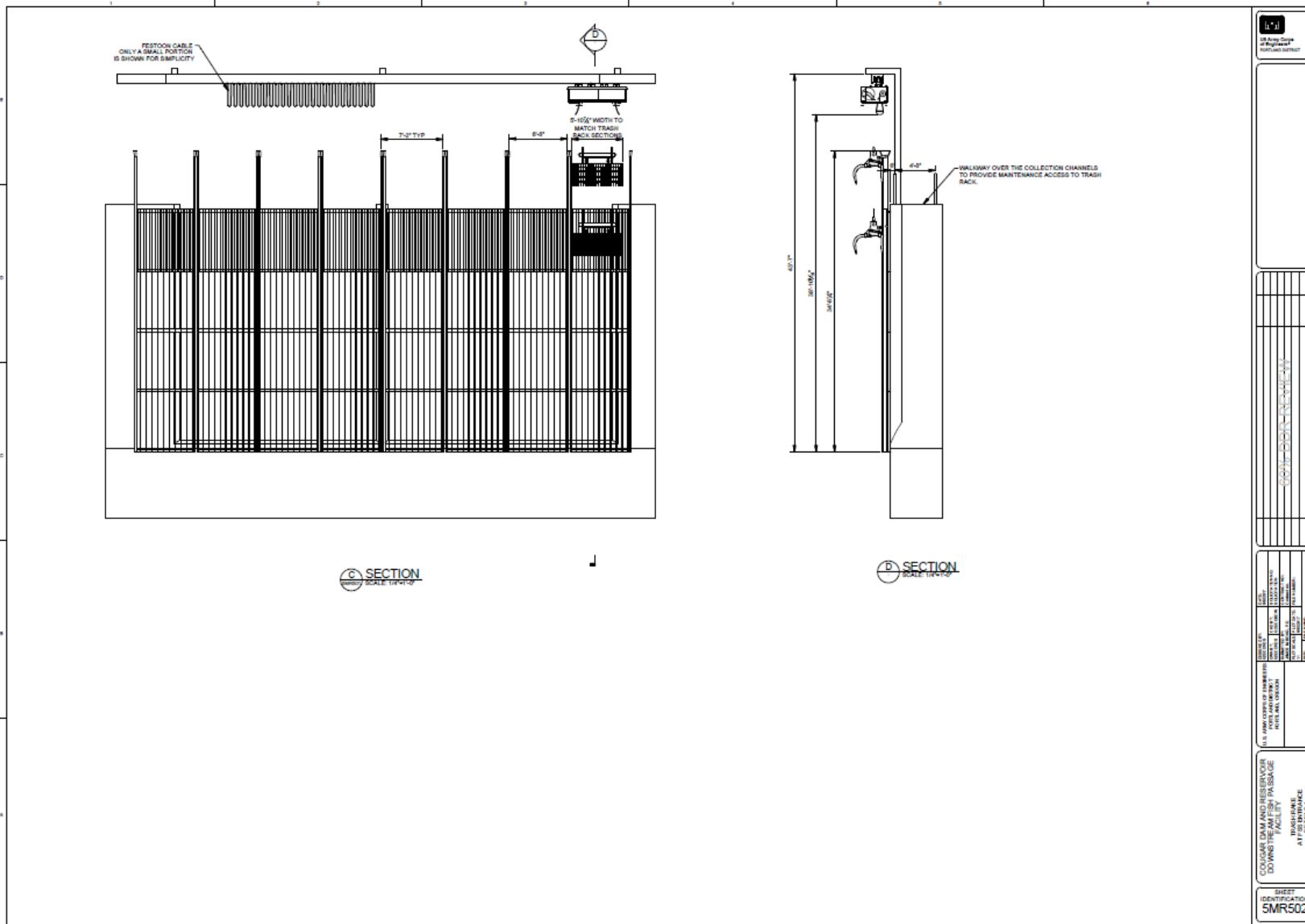


Figure 2-9. Sheet 5MR502 from Couger DDR 90% vol 5.



## 2.5 UPSTREAM FISH PASSAGE MEASURES

### 2.5.1 Measure 52. Provide Pacific Lamprey Passage Infrastructure

**Description:** Lamprey swim differently than salmon; passage facilities built for salmon present a difficult obstacle for this species. Square corners in the ladders are particularly difficult for lamprey. Lamprey will grab onto a vertical or horizontal surface then release, burst ahead, and grab on again in a near, up-ladder location. As they creep along in this way, they can lose their grip and be washed down the ladder.

Any new adult fish facilities under Measure 722, or facility modifications and upgrades for ESA-listed species, including at the drop structures under Measures 639, would include the following types of features and modifications to benefit lamprey:

- Rounded corners in turning pools
- Rounded side edges of the ladder opening
- Replacement of diffuser screens with lamprey-friendly screens
- Other nature-based features could be included in the design of ESA-listed adult fish facilities.

Site-specific design and environmental compliance documentation (as described in Chapter 7) for these features would be included in the design and environmental compliance documentation for the modifications or construction of ESA listed adult fish facilities.

**Purpose:** To assist Pacific lamprey with passage efficiencies.

**Intended Benefit:** To improve Pacific lamprey passage efficiencies.

**Operational or Structural:** Structural

**Location:** Green Peter, Blue River, Hills Creek dams

## **2.5.2 Measure 639. Restore Upstream and Downstream Passage at Drop Structures**

**Description:** Fish passage modifications at the two Long Tom River drop structures may include, but are not limited to, notching, removal, or construction of an adjoining fish ladder or bypassing the drop structures via modified culverts and using the oxbow river features (formerly the native Long Tom River channel). Available habitat would be from the confluence of the Long Tom River and Willamette River to Fern Ridge Dam. The drop structures are the Monroe, Stroda, and Cox Butte drop structures. The approach, feasibility, design, and biological benefit of the structure would be determined during the construction design phase.

**Purpose:** Provide passage for fish, including juvenile Chinook salmon, to the mainstem Long Tom River and tributaries.

**Intended Benefit:** Restored access to available habitat between the drop structures and Fern Ridge Dam.

**Operational or Structural:** Structural

**Location:** Long Tom River, downstream of Fern Ridge Dam

## **2.5.3 Measure 722. Construct Adult Fish Facility**

**Description:** Construct adult fish facilities below dams. Specifications for the facility will be determined during the engineering, design, and construction phases of implementation.

**Purpose:** Construct new AFFs to provide adult upstream passage above Willamette Valley System dams.

**Intended Benefit:** Provide access to spawning habitat upstream of USACE-managed dams.

**Operational or Structural:** Structural

**Location:** Green Peter, Blue River, Hills Creek dams

**Blue River:** This measure would be paired with a downstream fish passage measure. There is currently no fish passage at Blue River Dam for ESA-listed UWR spring Chinook salmon. A passage program at Blue River may offer a unique opportunity to create additional biological benefit to the McKenzie River spring Chinook salmon population, in addition to improving passage at Cougar Dam in the McKenzie Sub-basin. The design for purposes of this measure is assumed to be similar in scope and design to those constructed at Cougar Dam and Fall Creek Dam.

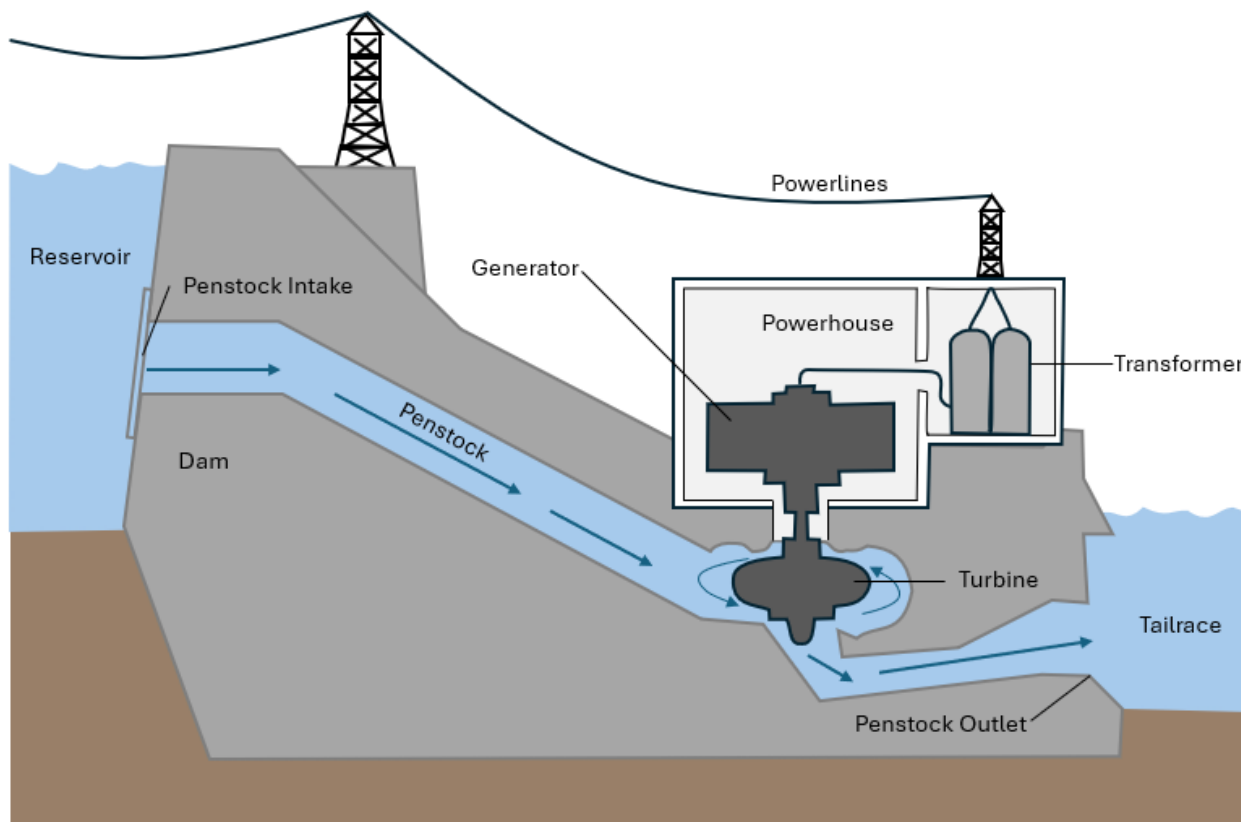
**Green Peter:** Adult upstream passage for spring Chinook salmon and steelhead through the construction of a Green Peter AFF at the base of Green Peter Dam. Design of the Green Peter AFF will consider and incorporate flow and water temperature requirements to ensure adequate fish attraction into the facility for collection and avoidance of stress and disease in

fish being collected. Lessons learned from the original AFF at Green Peter Dam will be adopted (USACE 1995). For purposes of this measure, it is assumed that the Green Peter facility would be similar in size and scope to AFFs currently operated at Cougar Dam and Fall Creek Dam. Additional design would be necessary to ensure adequate water supply (flow and temperature) into the facility, which may increase design complexities and overall cost of the Green Peter AFF above that of the two existing AFFs.

**Hills Creek:** Provide adult upstream passage spring Chinook salmon and bull trout. The measure will need to be paired with a temperature management measure at Hills Creek Dam so water temperatures in the tailrace and within the adult fish facility are adequate for fish attraction into the facility for collection and avoid stress and disease in fish being collected. For purposes of this measure, it is assumed that the facility will be similar in scope and design to AFFs currently operated at Cougar Dam and Fall Creek Dam.

## **2.6 CEASING FEDERAL HYDROPOWER OPERATIONS MEASURES**

Alternative 6 assumes USACE would stop generating and BPA would no longer market the hydropower produced at Federal hydropower dams in the WVS. USACE developed three new measures needed to safely operate the dams in the absence of hydropower operations, including removing or decommissioning all hydropower infrastructure; reconfiguring the penstocks (pipes that transfer water from the intake structure to the turbine), penstock outlets, and powerhouse systems; and replacing power required to operate the dam and auxiliary facilities. Figure 2-11 shows the configuration of a hydropower dam. The following measures are required to safely operate the dams in the absence of operations for hydropower generation. Dam specific modifications needed to implement these measures are provided in the Section 2.6.4 (Dam Specific Assumptions) below.



**Figure 2-11 Hydropower Configuration**

### 2.6.1 Removal or decommissioning of all hydropower infrastructure

Ceasing Federal hydropower operations would render much of the power train equipment and auxiliary systems obsolete. Hydropower infrastructure includes, but is not limited to, the entire turbine unit, station service systems, auxiliary systems, and powerhouse bridge cranes. The turbine units must be removed because they would generate power when water flows through the penstocks turning the turbine unit. When the turbine turns it converts the kinetic energy of moving water into mechanical energy. This mechanical energy then powers a generator, which produces electricity. Keeping the turbine units in place, results in electricity and this electricity must go somewhere. At the scale of the WVS dams, the energy must be transmitted through power lines on the power grid to homes and businesses. The only alternative would be to construct a massive "load bank" structure to absorb the energy created by the turbine unit. A load bank for excess electricity is a device that dissipates the extra energy by converting it into heat. These banks absorb and safely release the excess power, acting as a buffer to prevent grid instability. The load bank needed to dissipate the energy of any one WVS hydropower dam's generation is not feasible. Therefore, to maintain the penstock outlet for routine flow management and stop generating power, the turbines must be removed.

For each hydropower unit, USACE would need to remove the turbine, shaft, and rotor components of the unit and modify or replace the headcover to prevent turbine pit leakage.

These components form the part of the unit that spins during power generation and would be a liability. Insulation, lube, and hydraulic oil should be drained from the unit and associated oil storage systems to eliminate the risk that an oil spill after hydropower assets are abandoned.

At the Willamette Valley dams, the operating voltage for station service systems is 480V or less. Therefore, all medium-voltage generator circuit breakers, disconnects, and associated bus/cabling would be de-energized and removed or abandoned in place. The large step-up transformers that connect hydroelectric generators to BPA's high voltage transmission grid contain large quantities of insulation oil and would need to be decommissioned and removed from the project site to mitigate for the risk of an oil spill, along with any associated cooling and fire suppression water systems. Any unutilized station service switchgear, load centers, and feeders would be decommissioned or consolidated to mitigate for residual electrical safety hazards.

There are a number of auxiliary systems that support hydropower generation at each powerhouse that would be decommissioned. Generator electrical fires would no longer be a risk, so carbon dioxide-based fire suppression systems would be removed to eliminate the associated atmospheric hazard to onsite personnel. Compressed air systems for unit brakes and governor hydraulic systems would be depressurized and removed/retired in place along with associated piping and equipment. The large powerhouse station battery bank would not be necessary to sustain critical generation protective and control functions during a loss of station service power and would be replaced with smaller uninterruptable power supplies or transferred to an emergency diesel generator to eliminate safety hazards inherent to lead-acid battery cells. Cooling water systems used to prevent a hydroelectric generator from overheating would be rendered obsolete and removed. Powerhouse bridge cranes utilized to unstack a unit turbine-generator system for maintenance purposes would be decommissioned, along with load handling equipment used for installation and removal of upstream and downstream penstock bulkheads.

While the powerhouse would be largely abandoned, some facility systems would be necessary to sustain critical dam operations, prevent structural damage, and maintain the powerhouse as a habitable space. Powerhouse heating, ventilation, and air conditioning systems would be reconfigured to replace the air conditioning function that currently depends on cooling water sourced from the penstock. Normal and emergency lighting systems would largely remain intact. Since the lower levels of the powerhouse extend below the surface of the river, drainage and dewatering pumps used to prevent the facility from flooding would remain fully operational.

## **2.6.2 Reconfiguration of the penstock outlets and powerhouse systems**

Under this measure, the penstocks or intakes would be reconfigured to allow continued use of the outlet for releasing flows. Turbines dissipate the energy of the water discharged downstream and, without them, the dams would require an alternative method to reduce the energy of the flowing water. The energy of releases through the penstock/powerhouse alignment must be dissipated to make the outlet safe to use. Otherwise, the flows released

would destroy the tailrace, and low pressures and cavitation would damage the penstock and internal flow control features. It is assumed that it wouldn't be possible to keep a turbine in place to dissipate energy without substantial investment for a giant "load bank" to absorb the energy created by the turbine that wouldn't have a place to go (i.e., no access to the grid).

How to reconfigure each outlet to dissipate energy would depend on the dam and if a fish ladder downstream needs the penstock outflow for attraction flow. The options considered include a series of orifices within the penstock or a cone valve near the downstream end of the penstock.

Reconfiguration with cone valves would connect new pipes to each penstock to convey flow to a manifold of cone valves located on the tailrace deck (downstream end dam) to discharge to the downstream tailrace. Energy is dissipated in the abrupt conversion of potential to kinetic energy at the release of flow through the cone valve, resulting in a hollow cone shaped jet that is spread broadly over a large area in the tailrace. Figure 2-12 shows a standard cone valve and photos of the associated flow release. Figure 2-13 shows flow release from a hooded cone valve. Comparisons of cone valve outflow to turbine outflow include the following:

- A system of cone valves would deliver an equivalent range of flows as turbines, unless there are limitations in space on the tailrace deck or tailrace.
- Turbine discharge is ideal for adult fish facility ladder entrance attraction due to the relatively low velocity and non-turbulent conditions. Cone valves generate high turbulence, false attraction, and affect large areas of the tailrace; therefore, cone valves are not acceptable for flow releases adjacent to fish ladder entrances for adult fish collection facilities. While there are structural means to convert the cone valve discharge into outflow similar to a turbine outflow, this would require a significant structural extension into the tailrace and require large volumes of air. Cone valve systems were selected for Detroit, Hills Creek, Green Peter and Lookout Point dams as the existing turbines do not provide direct flow support for downstream adult fish facilities where turbulent flow could disrupt the adult fish facility.
- Survival of juvenile fish would be equal to or worse through cone valves than through the turbines.
- TDG through cone valves based on conventional designs is likely higher than turbines and equal to or lower than spillways or ROs (based on existing examples and best professional judgement). However, future design efforts could help reduce the occurrence of high TDG. Therefore, TDG levels were assumed to be similar to turbines.
- The cone valve discharges should be directed into the powerhouse outlet channel instead of the stilling basin. This is done to provide a bypass channel around the stilling basin (as the turbines currently do), so that the stilling basin can be more easily isolated for inspections or repairs. The cone valve energy dissipation structures would be a required adjunct to help contain the footprint of the flow within the powerhouse outlet channel.

- To minimize the large area of spray around project infrastructure (particularly where subfreezing temperatures occur), hooded cone valves are preferred (Figure 2-13); these release flow to a reduced footprint in the form of a hollow cylindrical jet. Hooded cone valves are likely to release a more concentrated energy into the tailrace, likely driving TDG exceedances even higher than existing conditions with turbines.
- Cone valves likely require less operations and maintenance (O&M) than turbines. Each cone valve would have a dedicated isolation valve upstream, so failure of one cone valve does not shut down the entire system. Most O&M would be attributed to the cone valves, and isolation valves to a lesser extent.



**Figure 2-12. Standard Cone Valve with Conical Spray at Boulder Dam, Colorado**



**Figure 2-13. Hooded Cone Valve Operations at Summersville Dam, West Virginia**

The cone valves and isolation valves connected to the existing penstocks would require electricity to operate and control the amount of flow released through the reconfigured penstocks. However, station service electricity demand is not expected to be greater than the existing powerhouse systems that would be largely abandoned. Since the cone valves replace or bypass the hydroelectric generators, some existing electrical equipment could be repurposed or replaced to supply electricity to the reconfigured penstock equipment rather than be decommissioned.

Reconfiguration using in-line orifices would consist of in-line orifices (Figure 2-14) within the penstock or intake and a series of large-holed porosity plates in the draft tube to dissipate energy over a number of smaller steps. Energy is dissipated incrementally through each orifice and plate from forebay to tailrace. Comparisons of in-line orifice outflow to turbine outflow include the following:

- Flow through an in-line system would be substantially less than the flow through a penstock with a turbine installed. Facilities that are reconfigured using in-line orifices would be limited to minimum 2008 Biological Opinion flows through each penstock/intake with about 5 - 15% upward variation per penstock depending on forebay head. Flow is adjusted with a large valve (upper middle Figure 2-14), but the valve has small effect given most energy is dissipated by the orifices. If too much energy is dissipated at the valve, then significant cavitation damage could result.
- Operation of in-line orifices would not change total discharges to meet operational objectives because each dam has outlets available, in addition to penstocks with in-line orifices, and operators have discretion on specific operations and discharge levels by route.
- Survival of juvenile fish should be equal to or worse than through the turbines.
- TDG through an inline orifice system would be similar to turbines.
- In-line orifices systems should deliver similar turbulence conditions at the outlet as turbine discharges, thereby supporting the fish ladder entrance, albeit at lower flow rates. At certain times of the year, meeting minimum 2008 Biological Opinion flow targets may not be possible using in-line orifices alone, requiring supplemental flow from spillways or ROs. At some dams, this supplemental flow can create false attraction, potentially impacting fish approach to ladder entrances at the dams where spillways or ROs discharge into channels that are separate from the fish passage facilities. However, most adult fish follow the shoreline (particularly under high events), and some fish may find refuge in the lower velocity flow path toward the fish ladder entrances.
- In-line orifices require less O&M than turbines, however access into an orifice system would likely be difficult if needed for inspection or maintenance. Holes are sized to avoid debris blockages as much as possible.



**Figure 2-14. In-line Orifice Systems inside Pipelines (Seven Oaks Dam, lower left; The Dalles Dam, upper middle and right)**

All existing turbine intakes are equipped with coarse trashracks (approximately 5 to 6-inch openings) to regulate the size of debris entering the powerhouse systems. If hydropower systems are deauthorized and repurposed for bypass flow (either cone valves or in-line orifices), the change in the current arrangement might lead to an external mandate to screen intakes for juvenile fish. Turbine intakes are very difficult environments for fish screens with the combination of depth and the general absence of sweeping flow, which would otherwise help convey fish to safety and minimize debris accumulation. Even under minimum project flow rates, the size of the intake screens would likely impose impractical O&M burdens on the projects.

The cone valves and isolation valves connected to the existing penstocks would require electricity to operate the valves and control the amount of flow released through the reconfigured penstocks. However, overall station service electricity demand is not expected to be greater than the existing powerhouse systems that would be largely abandoned as described in Section 2.6.1 Removal or decommissioning of all hydropower infrastructure.

Without hydropower, a major redesign of the integrated supervisory control and automation system would be necessary to sustain continuity of operations throughout the WVS. Each of the eight hydropower projects contains control and automation systems that extend throughout the dam, powerhouse, onsite fish facilities, and support buildings. The central point of integration for onsite supervisory controls is located within each powerhouse, where secure communication networks allow remote operation of the eight hydropower projects (as well as five non-hydropower projects) from one of three control rooms. In general, the current supervisory control network would process the changes to equipment arising from the complete deauthorization scenario as a state of catastrophic failure, inundating a control room operator with such a severe storm of alarms, missing data, and unresponsive controls so as to functionally terminate the remote operability of all 13 USACE projects in the Willamette Valley. Additionally, since non-hydropower dams in the WVS are not staffed, consolidation of control rooms would be prudent under deauthorization to right-size operator resources to the needs of the mission.

### **2.6.3 Replacement of power required to operate the dam and auxiliary facilities**

Power required to operate each dam would be pulled from the grid with backup power provided through emergency diesel generators. A utility feeder, transformer, meter, and disconnect to sustain station service loads would need to be purchased from a local utility and integrated into the remaining 480V station service systems. A backup power supply source would be required at each facility. Additionally, the power currently provided to the adult facilities at Dexter and Foster comes from hydropower produced at the respective dam, therefore replacement power for these facilities would also have to be purchased off the grid.

### **2.6.4 Dam Specific Assumptions**

The assumptions for reconfiguring each dam are below. The following general assumptions are applicable to the SEIS measures when assessing the hydropower removal and dam reconfiguration across each of the eight hydropower dams:

While flow through a given dam outlet may change, the total amount of water passed through the dam would remain as close to unchanged as possible to flows assumed under the 2008 Biological Opinion flows. Operations would attempt to maintain 2008 Biological Opinion flows in regard to flood risk management levels, annual pool fluctuations, ramping rates, and downstream flow and water quality parameters. All assumed deviations from operations under 2008 Biological Opinion flows are due to the physical constraints posed by the hydropower removal and dam reconfiguration measures (e.g., minimum gate opening releases, which in some cases are larger than baseline target releases) at a specific dam.

#### ***Detroit***

##### *Reconfiguration Assumptions*

Fixed cone (or Howell-Bunger) valves, with an energy dissipation structure to avoid scour are likely the most feasible option for passing penstock flow at Detroit Dam. The cone valves would connect to the existing penstocks and new isolation valves would be added for the pipe branches. The penstocks would need to be modified to allow the fixed cone valves to discharge to air above the tailwater elevation rather than to the draft tubes. A preliminary design at Detroit indicates a range of outflows equivalent to the existing powerhouse capacity would be feasible pending future physical modelling. Penstock outflows would need to be configured to release into the powerhouse outlet channel rather than the stilling basin to ensure dam safety inspections of the RO/spillway stilling basin can still occur.

##### *Power Supply Assumptions*

The facility lies near the boundary between Consumer Power Inc and Pacific Power's service territory. A contract with one of the electric utilities would be required to extend electric service to the powerhouse and install equipment necessary for a 480V service drop. The station

service system would require modification to ensure a back-up emergency generator powers station service loads in the event utility power is lost.

Without hydropower, the Detroit/Big Cliff 13.8kV transmission line would no longer transport station service power between Detroit and Big Cliff dams and would need to be decommissioned.

### ***Big Cliff***

#### *Reconfiguration Assumptions*

Given the low head at Big Cliff Dam, a valve controlled in-line orifice system is likely the best option to reconfigure the penstock. This solution would generate less TDG than cone valves; however, the range of flow would be capped to a flow rate of 1,500 cfs per intake structure for a total of 3,000 cfs, reducing the flow capacity through the penstock by approximately 1,000 cfs as compared to existing capacity.

#### *Power Supply Assumptions*

The facility lies near the Consumer Power Inc. and Pacific Power's service territory boundary. A contract with one of the electric utilities would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase to meet the energy needs of the new in-line orifice equipment. The station service system would require modification to ensure a back-up emergency generator to provide power station service loads in the event utility power is lost.

Without hydropower, the Detroit/Big Cliff 13.8kV transmission line would no longer transport station service power between Detroit and Big Cliff dams and would need to be decommissioned.

### ***Green Peter***

#### *Reconfiguration Assumptions*

While Alternative 6 includes construction of an adult fish facility downstream of Green Peter Dam, fixed cone valves with an energy dissipation structure are still a viable option at Green Peter Dam. This would provide similar flow ranges to the current powerhouse, providing water management flexibility beyond what would be expected from in-line orifices. However, cone valves would likely result in higher TDG than turbines and equal to or lower than spillways or ROs. If, or when, an adult fish facility is constructed downstream of Green Peter Dam, the facility should be located far enough downstream, and outside of the turbulent influence of the cone valves. It's possible that a fish barrier would also need between the adult fish facility and the dam, similar to the Minto fish facility on the North Santiam River.

### *Power Supply Assumptions*

The facility lies near the Consumer Power Inc and Pacific Power's service territory boundary. A contract with one of the electric utilities would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase to meet the additional energy needs of the new cone valve equipment. The station service system would require modification to ensure a back-up emergency generator powers station service in the event utility power is lost.

Alternative 6 could allow water to enter the 1.5MVA station service fish unit to produce electricity for onsite needs. However, since hydropower is deauthorized in Alternative 6, any means to produce electricity would be de-commissioned, to include the smaller existing fish unit.

### **Foster**

#### *Reconfiguration Assumptions*

Cone valves are not recommended at Foster Dam because excessive tailrace turbulence would impact the downstream adult fish facility. Instead, an in-line orifice system would provide more appropriate flow conditions to support the fish ladder entrance with lower expected TDG than cone valves. The range of flows would be limited to 1,500 cfs through each penstock, with upwards of a 10% flow variation; flow rates would be similar to powerhouse flows under baseline conditions.

#### *Power Supply Assumptions*

The facility lies near the Consumer Power Inc and Pacific Power's service territory boundary. A contract with one of the electric utilities would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to be higher, to meet the additional energy needs of the new in-line orifice equipment. The station service system would require modification to ensure a back-up emergency generator powers station service if utility power is lost. Purchase of power to the adult fish facility would also be required.

With water in the penstock, the fire suppression system for the onsite administration building would continue to function. An alternative source of water is not required to meet building fire codes.

Additionally, the adult fish collection facility uses water from the penstock and an alternative water source would be needed for the Foster fish ladder under Alternative 6.

## ***Cougar***

Alternative 6 includes a deep drawdown to the Diversion Tunnel for downstream fish passage after disposition of all authorized purposes that require a conservation pool, including hydropower. Under this operation, the penstocks would no longer be used for routine operations, but they are still needed for the hydraulic capacity; therefore, penstock reconfiguration is necessary.

### ***Reconfiguration Assumptions***

Cone valves are not recommended at Cougar Dam due to excessive tailrace turbulence that would impact the downstream adult fish facility. Instead, a valve controlled in-line orifice system is the recommended to provide more appropriate flow conditions to support the fish ladder entrance with lower expected TDG production than cone valves. This would entail a mix of in-line orifices within the main 10.5-ft penstock and large-holed porosity plates in the draft tube. The range of flows would be limited to approximately 300 cfs per penstock, with upwards of a 10% flow variation, effectively reducing total powerhouse discharges by half as compared to baseline. Fish screening would be infeasible due to inaccessibility inside temperature tower.

### ***Power Supply Assumptions***

The facility lies within Lane Electric Cooperative's service territory. A contract with the electric utility would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase, to meet the additional energy needs of the new in-line orifice equipment. The station service system would require modification to ensure a back-up emergency generator powers station service if utility power is lost.

The 6.9kV electric feeders powering the Cougar Adult Fish Collection Facility would be rendered obsolete with the loss of hydropower units capable of generating at 6.9kV. The fish facility electrical systems would need to be modified to receive a 480V feeder originating from either the new Lane Electric service drop or a reconfigured powerhouse station service system.

## ***Hills Creek***

### ***Reconfiguration Assumptions***

Fixed cone valves with an energy dissipation structure are recommended at Hills Creek Dam. This would provide similar flow ranges as the current powerhouse, providing water management flexibility beyond what would be expected from in-line orifices. If a downstream fish collection facility for bull trout is constructed in the future, the facility should be located far enough downstream, and outside of the turbulent influence of the cone valves.

### *Power Supply Assumptions*

The facility lies within Lane Electric Cooperative's service territory. A contract with the electric utility would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase, to meet the additional energy needs of the new cone valve equipment. The station service system would require modification to ensure a back-up emergency generator powers station service if utility power is lost.

### **Lookout Point**

#### *Reconfiguration Assumptions*

Cone valves with an energy dissipation structure to avoid scouring are the most feasible option for passing penstock flows at Lookout Point Dam. The valves would provide a similar range of outflows as the current penstock configuration. Turbulent flow would not disrupt the downstream adult fish facility, since it is located further downstream, below Dexter Dam.

#### *Power Supply Assumptions*

The facility lies within Lane Electric Cooperative's service territory. A contract with the electric utility would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase, to meet the additional energy needs of the new cone valve equipment. The station service system would require modification to ensure a back-up emergency generator powers station service if utility power is lost.

With water in the penstock, the fire suppression system for the onsite administration building would continue to function. An alternative source of water is not required to meet building fire codes.

### **Dexter**

#### *Reconfiguration Assumptions*

Cone valves are not recommended at Dexter Dam due to excessive tailrace turbulence that would impact the downstream adult fish facility. Instead, valve-controlled in-line orifices would be installed in the Dexter intakes. This would result in reduced total penstock outflows to about 1,480 cfs (baseline powerhouse releases are 4,000 cfs) but would allow for continued operation of the downstream fish facility without additional modification. Additionally, TDG associated with the in-line orifice configuration would be lower than cone valves.

### *Power Supply Assumptions*

The facility lies within Lane Electric Cooperative's service territory. A contract with the electric utility would be required to extend electric service to the powerhouse and to install equipment necessary for a utility service drop. A higher capacity utility service drop than 480V would be necessary, and overall electricity costs are expected to increase to meet the additional energy needs of the new in-line orifice equipment. The station service system would require modification to ensure a back-up emergency generator powers station service if utility power is lost.

## **2.7 MEASURES COMMON TO ALL ALTERNATIVES**

### **2.7.1 Measure 384. Gravel Augmentation Below Dams**

#### **Description:**

Develop and implement a sediment nourishment program below targeted WVS dams. Determine an appropriate sediment gradation and annual nourishment quantity to achieve desired habitat improvements for spawning adult and rearing juvenile Spring Chinook salmon and Winter Steelhead. Determine and develop an appropriate sediment injection site(s) below each targeted dam. Develop and implement a monitoring program and adaptive management plan to ensure that expected habitat gains are realized, and negative effects are minimized.

**Purpose:** Supplement sediment blocked by targeted WVS dams where it is reducing or degrading habitat for spring Chinook salmon and winter steelhead below Willamette Project dams.

**Intended Benefit:** Improve the quality or quantity of habitat for Spring Chinook salmon and winter steelhead. Adding appropriate sediment to include clean gravel increases or improves river substrate conditions for spawning and rearing of these species below WVS dams.

**Operational or Structural Measure:** Neither

**Location:** North (below Big Cliff Dam) and South Santiam (below Foster Dam) and McKenzie River Basins (Cougar and Blue River dams)

## **2.7.2 Measure 719. Adapt Hatchery Mitigation Program**

### **Purpose and Background**

The overall goal of the measure is to adjust production of WVS hatcheries for mitigation obligations and conservation needs after demonstrated improvements to fish access to habitat above dams. Each subbasin hatchery program will be considered separately according to the metrics and protocols described below.

Congress authorized USACE to mitigate for the construction of the WVS recognizing that the project dams would block access for migratory fish to habitat and inundate habitat and several existing hatcheries. USACE has historically done this by carrying out a program to produce and release hatchery salmon, steelhead trout, and game fish in the Willamette River Basin. Congress did not define detailed goals for mitigation, including the level of fish production to be achieved, leaving USACE discretion to determine how to implement the fish mitigation program in the Basin —whether that be through hatchery programs, passage improvements, or a combination thereof. Current levels of mitigation production are defined in hatchery genetic management plans (HGMPs) prepared by Oregon Department of Fish and Wildlife (ODFW) and USACE (see Table 2-38 and Table 2-39). Because USACE is providing access to blocked habitats with the implementation of WVS fish passage actions, it is proposing to reduce the hatchery production amounts needed for mitigation after demonstrated improvement to fish habitat access. The ESA, enacted after the original authorizing document, also requires that USACE consult with the Services to ensure production and release of hatchery spring Chinook salmon, summer steelhead, and rainbow trout does not jeopardize any ESA-listed species. Available science allows for further assessment of how changes to the WVS hatchery program can help avoid unacceptable risks to ESA listed species from Federal hatchery programs by accounting for potential effects like; density-dependent impacts, genetic introgression, predation, and other hatchery effects.

The purpose of WVS EIS Measure 719 is to continue the hatchery mitigation and conservation program, considering that the original requirement for the mitigation is reduced with improved fish passage and water quality, and to address hatchery effects to endangered species consistent with the 2011 UWR Chinook salmon and steelhead recovery plans (ODFW and NMFS 2011). Existing HGMPs describe how hatchery Chinook are currently being used to support reintroduction of spring Chinook salmon above WVS dams, as well as a framework for reducing or ending hatchery supplementation above WVS dams as effective fish passage is achieved and unmarked adults increase. The HGMPs recognize that Federal hatchery mitigation obligations will be reduced based upon a crediting system once fish passage is improved, but do not include a crediting system or process for establishment of that system. The HGMPs require assessing natural origin adult returns as a part of the framework for determining the need for outplanting hatchery Chinook salmon above dams. It will be necessary to assess dam effects at multiple life stages, not only adults, considering that adult Chinook salmon and steelhead

returns are affected by a range of factors (some related to the WVS dams, and others not, e.g., ocean conditions, harvest, freshwater habitat).

Brood take and juvenile production/release levels for all programs (spring Chinook salmon, summer steelhead, rainbow trout) will not be reduced in association with fish passage improvements until future negotiations between USACE, NMFS, and ODFW occur.

A proposed process for reductions in hatchery fish production is included below but would not be implemented until after future negotiations with NMFS and ODFW.

### Spring Chinook Salmon Crediting

- Before passage improvements

Hatchery juvenile spring Chinook salmon releases and outplanting of adult spring Chinook salmon hatchery fish above dams will occur according to the HGMPs and NMFS associated 2019 Biological Opinion (Biological Opinion).

- After passage is improved

After passage improvement at a dam (years 0-5), hatchery-origin returns would continue to supplement NORs outplanted to meet but not exceed the abundance thresholds as defined in the HGMPs (Table 2-37). For projects at which only natural origin fish are currently outplanted above a project (i.e., Foster Dam), this plan would remain consistent with strategies to maintain hatchery production below the dam.

(Table 2-37) provides the Adult Chinook salmon outplanting thresholds from the associated HGMPs and NMFS’ 2019 Biological Opinion with the exception of the South Santiam. When the number of natural origin (unmarked) Chinook salmon spawner returns are below these levels, hatchery origin returns will be used to supplement to achieve the thresholds\*. The South Santiam HGMP indicates 600 total, if needed, however up to 800 hatchery adult Chinook salmon will begin being outplanted above Green Peter Dam in 2022. Currently, no hatchery origin (marked) fish are outplanted above Foster so the outplant number for South Santiam in (Table 2-37) is for fish intended for reintroduction above Green Peter.

**Table 2-37. Adult Chinook salmon outplanting thresholds.**

Subbasin	Natural-origin fish threshold <sup>1</sup>	Natural-origin female fish threshold <sup>1</sup>	Natural-origin male fish threshold <sup>1</sup>
McKenzie	600	400	200
Middle Fork	2450	N/A	N/A
South Santiam	800	0	0
North Santiam	1500	750	750

<sup>1</sup>When unmarked (natural origin) adult Chinook salmon returns are below these levels, supplement with adult hatchery Chinook salmon to achieve the thresholds\*. The thresholds are taken from the

2016 HGMPs, with the exception of South Santiam. The South Santiam HGMP indicates 600 total, however up to 800 hatchery adult Chinook salmon will begin being outplanted above Green Peter Dam in 2022.

*PHASE 1 - Years 1-7 following improved fish passage conditions:*

Following the implementation of downstream fish passage improvements, hatchery spring Chinook salmon production will remain at production levels as defined in the HGMPs. Annual dam passage survival (i.e., dam passage efficiency \* dam passage survival) will be measured in two separate years which are representative of typical operating conditions (i.e., water years within 95% of normal hydrological conditions in the period of record) to evaluate fish passage efficiency and survival at the dam. The precision needed about annual dam passage survival will be determined at the time of the assessment to evaluate passage. Observed performance will be compared to downstream passage survival rates estimated to support the replacement criteria<sup>2</sup>.

*PHASE 2 - After Year 7 following a fish passage improvement – production crediting based on adult return rates:*

Recognizing several factors can affect adult Chinook salmon returns, cohort replacement rate (CRR) serves as a basis for evaluating overall population performance. CRR will be estimated as:

$$CRR = \frac{\text{Number of unmarked 3,4 and 5 year old returns produced by outplants (males and females) in Year X}}{\text{Number of spawners (marked and unmarked) in Year X}}$$

CRR is calculated using the above equation; and uses the entirety of the spawning population in the reach above the dam regardless of the origin of the parents. In other words, adults of hatchery origin used to supplement the number of spawners are considered part of the cohort parentage. Since outplanted adults will continue to be supplemented with hatchery fish until natural origin fish meet or exceed the HGMP thresholds (Table 2-37), the HGMP thresholds define the minimum abundance levels for assessing CRR above each dam.

After 7 years CRR will be calculated for three separate cohorts accounting for adult returns in years 3-5, 4-6 and 5-7. If the CRR for Chinook salmon is >1 based on a geometric mean of replacement rates for the three cohorts returning in years 3-5, 4-6 and 5-7, then the full credit for fish passage improvements will be applied to the spring Chinook salmon hatchery

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<sup>2</sup> Downstream passage survival rates needed to support replacement of sub-populations above dams will be estimated using life cycle models developed for the WVS EIS and ESA consultation.

2. “Consensus” is used instead of “effective” because using the effective number of spawners would result in a lower post-production (Ppost) value that may not result in the desired number of effective spawner returns.

production for the subbasin in which returns are being assessed. In this case Chinook salmon production will be reduced over a period of five years to a *Reduced Level of Production* (see below). This gradual reduction strategy allows economic interests to adjust and provides the State of Oregon additional time to seek funding for additional hatchery production if desired. The basin specific NOR thresholds will be the same as the outplanting thresholds indicated in the Table 2-37.

If  $CRR < 1$ , and DSP criteria not met, then mitigation credit reductions will not occur at this time and instead be re-assessed again after year 14.

After re-assessment, if the geometric mean of CRR is  $>1.0$  for cohorts returning in years 12, 13 and 14, then reductions to Chinook salmon release will be reduced over a period of five years to the *Reduced Level of Production*.

If the geometric mean of CRR is still  $<1.0$  for cohorts returning in years 12, 13 and 14, and the DSP target is met, non-project effects will be evaluated. There have been several methods proposed in similar programs for measuring quantifying non-project effects for the purpose of demonstrating reduced impact to ESA-listed salmonids. For example, the Lewis River Hydroelectric Projects M&E Plan (2010) describes the number of ocean recruits (i.e., Total Adult Production; TAP), and adult escapement to traps accounting for harvest removals. Another possible metric may include examining the ratio of adults observed at Willamette Falls to those observed at traps when enroute mortality is accounted for (e.g. Keefer et al. 2017). Extensive modeling of hydrologic conditions relative to available habitat are ongoing as part of the SWIFT project (Peterson et al. 2021), passage modeling by the University of British Columbia, among other efforts may be applied to provide assess the effect of project management on juvenile outmigration and adult returns compared to off-project effects (e.g., ocean conditions, poor hydrologic conditions, harvest, etc.). UBC<sup>3</sup> has shown that marine survival alone can impact the effects of perfect passage in poor marine years. If these available methods indicate substantial non-project effects on replacement, credit for dam fish passage improvements will be determined through further review and discussion among the State of Oregon, USACE and NMFS following the same process as outlined below under ‘reduced hatchery production’ and take into consideration the effectiveness of the dam passage conditions, other project effects, and other non-project effects. Based on this assessment, outcomes could include:

- No changes to mitigation production, with further actions to address project effects. CRR would then be reassessed after 7 years following implementation of additional action.
- Changes to mitigation production due to recognized impacts from the hatchery program constraining natural production, with alternative mitigation implemented.

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<sup>3</sup> Porteus, T, UBC (University of British Columbia). April 13, 2022. Differences in Smolt to Adult Survival Rates Between Willamette River Sub-basins and Implications for the Recovery Potential of Spring Chinook Salmon. Presentation to the Willamette Fisheries Science Review.

- Mitigation credit due to recognition of improved passage conditions and non-project effects constraining CRR. In this scenario mitigation production for passage could be fully reduced, while maintaining some *Reduced Level of Spring Chinook Salmon Production* (see below) to mitigate for any remaining, non-passage, project effects identified.

### Reduced Level of Spring Chinook Salmon Production

The purpose of the *Reduced Level of Production* is to maintain some mitigation production, to be developed with the State of Oregon and NMFS, recognizing 1) some project effects may remain that require mitigation after successful fish passage is implemented and assessed, 2) hatchery production may need to be maintained for conservation/safety net purposes recognizing uncertainty in reintroduction success, and 3) increases in natural origin returns when still below the CRR of 1 may warrant reductions in hatchery production and releases to help increase natural productivity. The Reduced Hatchery Production levels will be based on the passage assessment leading to habitat access as referenced in HD531. Alternative mitigation may also need to be considered where there are effects on ESA-listed species from the production and release of hatchery mitigation fish. If CRR is improved by passage, yet remains below a CRR of 1, brood take needed to support conservation outplanting should be assessed as part of determining reduced levels of production. The deficit in replacement value (in number of consensus spawners) will be used to calculate a potential new production level ( $P_{post}$ ) intended for meeting conservation (outplanting) needs in years 9-14<sup>2</sup>:

$$P_{Post} = \frac{\# \text{ of outplants}_y - \# \text{ of returns}_{y5}}{SAR_{harv}}$$

Where  $SAR_{harv}$  is the estimated smolt to adult return rate assuming harvest and  $y$  is the brood year and  $y5$  is all of the progeny that can reasonably be assigned to brood year  $y$ .

For purposes of calculating a new conservation production level, changes in the SAR from increased levels of natural origin brood should be considered.

### Rainbow Trout Crediting

As for spring Chinook **salmon** and summer steelhead, trout hatchery mitigation needs after fish passage improvements at WVS dams will be developed with the State of Oregon. The initial authorization for game fish mitigation related to construction and operation of the WVS was based on concerns about the productivity of resident fish given impoundment and inundation by authorized projects. Trout mitigation changes as it relates to passage improvements at WVS may be important to consider given these assumptions about productivity of resident trout in reservoirs, addressing effects of ongoing hatchery trout stocking on ESA-listed fish reintroduction and natural production (including local fisheries for hatchery stocked trout), and/or to account for other mitigation credits that have or are continuing to occur (e.g. BPA is

directly addressing the mitigation for inundation through the Wildlife Enhancement Memorandum of Agreement; BPA & ODFW 2010). Impacts to ESA-listed fish from rainbow trout is recognized and the current HGMPs describe approaches to limit overlap of rainbow trout and ESA-listed fish. USACE anticipates that further changes may need to be made once passage is implemented to limit impacts on reintroduced populations.

### Summer Steelhead Crediting

In association with improved fish passage conditions at WVS dams, any changes to the mitigation hatchery production of summer steelhead as funded by USACE will also be developed with the State of Oregon. Non-native hatchery summer steelhead are produced to mitigate for the effects of the WVS on native ESA-listed winter steelhead. Plans for any reintroduction of winter steelhead above WVS dams (including within the Winter Steelhead Distinct Population Segment) have not been developed. Summer steelhead provide no conservation value to support winter steelhead reintroduction above WVS dams and are known to have negative impacts on winter steelhead in the Willamette Basin (e.g. fitness effects associated with introgression). It also may not be feasible to assess winter steelhead CRR. *Oncorhynchus Mykiss* progeny can become either resident (rainbow trout) or anadromous (steelhead). Recent work indicates that non-anadromy may be an adaptive strategy in response to reservoir inundation with lack of adequate passage and that these strategies are plastic, i.e., anadromous females can breed with non-anadromous males with documented success of anadromous progeny as summarized in McAllister et al. (2022 in draft). Estimates of CRR for steelhead are uncertain given some offspring will remain in freshwater and mature as rainbow trout, and some adult steelhead returns will be progeny of rainbow trout.

**Table 2-38. Willamette Hatchery Mitigation Program Production Goals for UWR Spring Chinook Salmon in each Subbasin According to the Hatchery Genetics Management Plans.**

Subbasin	ESA Conservation Purpose (per HGMP)	USACE-funded Non-Conservation Release (per HGMP)	ODFW-funded Release per HGMP	Total Hatchery Release
North Santiam	630,000	74,000	0	704,000
South Santiam	350,000	289,000	382,000	1,021,000
McKenzie	604,750	0	0	604,750
Middle Fork Willamette	N/A	2,039,000	0	2,039,000

**Table 2-39. Willamette Hatchery Mitigation Program Production Goals for Summer Steelhead in each Subbasin According to the Hatchery Genetics Management Plan.**

Subbasin	USACE Release (per HGMP)	ODFW-funded Release per HGMP	Total Hatchery Release
North Santiam	0	121,000	121,000
South Santiam	0	121,000	121,000
McKenzie	0	108,000	108,000
Middle Fork Willamette/Mainstem	157,000	0	157,000

**2.7.3 Measure 9. Maintain revetments considering nature-based engineering or alter revetments for aquatic ecosystem restoration**

**Description:**

As routine maintenance of existing USACE-managed revetments on riverbanks is needed, include nature-based engineering methods; and evaluate and implement project(s) for Substantial Alterations where ecosystem restoration benefits are identified and there is a willing non-Federal cost-share sponsor.

Under all action alternatives, basin-wide maintenance would be carried out to support streambank stabilization revetments currently managed by USACE. Revetments constructed by USACE that are maintained by non-Federal sponsors within the WVS are not a Federal Action and therefore not covered in this EIS. Nature-based (bioengineering) methods would be included to the extent practicable to decrease hard surfaces (e.g., rock) within the system to provide habitat for various fish and wildlife species in the river margins and riparian zone while maintaining the authorized project purposes.

This measure would be implemented as part of maintenance actions and would include:

- Consideration of nature-based engineering options as part of any USACE maintenance activity for USACE-managed revetments.
- Following standard engineering practices for maintenance such that the revetment will still meet intended authorized purposes.

In addition, USACE will seek opportunities working with a Non-Federal Sponsor(s) to study and work through the process for a substantial alteration project. Section 1135 Project Modifications for Improvement of the Environment (WRDA 1986) under the Continuing Authority Program is the only authority that allows USACE to alter a Federal project for ecosystem restoration purposes. All requirements under this authority can be found in the Engineering Regulation 1105-2-100 Planning Guidance Notebook.

Under Continuing Authority Program studies, USACE must have a non-Federal sponsor to cost share the project, acquire all necessary real estate, and Operate and Maintain the project in perpetuity. Working with the Services, as well as local agencies and stakeholders, USACE will seek non-Federal sponsors for substantial alterations to provide ecological improvements to one or more Willamette Valley Basin Bank Protection Projects that are determined to be in the Federal Interest using the Aquatic Ecosystem Restoration metrics (cost per habitat unit).

Existing information will be used to identify projects with the greatest ecosystem restoration potential. For example, several revetment studies have been completed since the 2008 Biological Opinion that will inform the identification and prioritization of potential Section 1135 projects with the greatest potential. The annotated bibliography of these existing studies is provided below. However, additional technical analysis will likely be necessary to further evaluate potential effects of any modifications proposed by a Section 1135 project. For instance, Section 1135 projects cannot increase flood risk, therefore analyses to determine if a proposed project could increase flood risk must be performed as a part of the Feasibility Study for a Section 1135 project. Post construction monitoring will also be conducted to ensure the project performs as intended, both biologically and for bank protection. This information would also be used to investigate the implementation of future substantial alterations to revetments.

#### **Revetment Studies Annotated Bibliography**

West Consultants Inc. 2020. Willamette River Bank Project FY19 Routine Inspections Consequence Assessment. Prepared for the US Army Corps of Engineers. Contract No. W9127N18D0002

A consequences assessment for all 193 WVRBPP structures. The purpose of this work is to develop a reconnaissance-level assessment of the consequences associated with the removal or failure of the WVRBP revetments. This study classified the majority of revetment reaches, and most individual revetments as High Consequence, described as “Critical infrastructure is located within the revetment reach query zone and is located within the buffer zone. Failure of these revetments to prevent channel migration, overflows, or channel avulsions could result in significant near-term (engineering time scale) impacts to critical infrastructure. “Only 8% of individual revetments and none of the revetment reaches are classified as Low Consequence, described as “Critical infrastructure is not located within the revetment reach query zone and non-critical infrastructure is not located within the buffer zone. Failure of these revetments to prevent channel migration, overflows, or channel avulsions is not expected to result in impacts to critical infrastructure and it is unlikely to put non-critical infrastructure at risk in the near term.”

River Design Group. 2018. Revetment Alternatives Concepts - Willamette River Bank Protection Program Prepared for the US Army Corps of Engineers. W9127N-12-D-0006 Task Order 0010.

Goal is to develop revetment concepts for 24 revetment locations. The alternative concepts are intended to provide USACE with a starting point for prioritizing future revetment repair or

replacement designs in response to revetment erosion and destruction. Previous WRBP Program revetment evaluation reports completed by CH2M HILL (2011) and Hulse et al. (2013) were reviewed to assess revetments that were previously identified for repair, removal, or replacement. In addition to revetments included in these two reports, USACE identified other revetments during project scoping and following the 2017 revetment inspection. These structures are either in degraded condition, are located at high risk profile sites, and/or USACE is responsible for structural maintenance. Lastly, revetments with a potential conservation benefit were highlighted. Conservation benefits may include altering revetments to restore river-floodplain processes such as mainstem-side channel connections for fish use, or to enhance riparian vegetation and terrestrial habitat conditions. Several revetments satisfy more than one of these categories. Conservation opportunity was used as the primary reason for inclusion for seven of the 24 revetments assessed.

USACE contracted with WEST Consultants, Inc. (WEST) as a subcontractor to Alden Research Laboratory, Inc. (Alden), to conduct a consequences assessment for all 193 USACE and local Sponsored revetments. Alden provided contract and project management, and WEST conducted the technical analysis. The purpose of this work is to develop a reconnaissance-level assessment of the consequences associated with the removal or failure of the WRBP revetments. In contrast to the 2013 study previously discussed, the scope of services for this work does not include any detailed engineering analysis of hydraulics, hydrology, scour, or erosion. The purpose of this study is to develop an inventory of critical infrastructure within the area of influence of the revetments (or grouping of revetments) and use that information to assign the revetment reach (or individual revetment) a consequence classification rating. This information is intended to help the USACE with future decision-making regarding maintenance priorities.

Hulse, D.W., Branscomb, A., Brehm, C., Enright, C., Gregory, S., and Write, S. 2013. Assessment of potential for improving ESA-listed fish habitat associated with operations and maintenance of the Corps Willamette Project: an approach to revetment prioritization for removal or modification to restore natural river function. Prepared for the US Army Corps of Engineers. Cooperative Agreement W912HZ-11-2-0045

Beginning in 2011, a team from the University of Oregon, Oregon State University and River Design Group developed and demonstrated a three-phase approach to prioritizing the system of USACE maintained Willamette Project revetments for future consideration for removal or modification to enhance natural river function. From this effort, four USACE-maintained revetments were recommended for further, more detailed consideration regarding removal or modification to restore natural river function. However, additional good sites likely exist. The resulting prioritization tool can be actively updated as additional information is obtained to refine the reported prioritization of revetment zones or conduct completely new prioritizations.

River Design Group, Inc., and HDR Engineering, Inc. 2013. Potential Consequences of Failure Analysis, Corps Maintained Revetment Projects. Prepared for US Army Corps of Engineers

A hydraulic, hydrologic, and geomorphic investigation of consequence for 60 USACE maintained revetment projects on the Row River, McKenzie River, and Coast Fork, Middle Fork, and mainstem Willamette River. The remaining 28 USACE maintained revetments were excluded from the study because they were either destroyed or located significantly off the main channel and are no longer serving their intended purpose. No prior consequence assessment had been conducted for the 105 locally sponsored projects. The 2013 study included a detailed hydrologic and hydraulic analysis to consider revetment failure consequences. HEC-RAS hydraulic models were developed and used to simulate several annual exceedance-probability discharges. These models were then modified to represent “without revetment” conditions. Model results were used to develop inundation maps for with- and without revetment conditions. Additionally, bank scour calculations were conducted to understand erosion potential at the sites.

CH2MHILL. 2011. Willamette River Basin, Oregon, Bank Protection and Channel Improvement Damage Assessment and Maintenance Repair. Prepared for the US Army Corps of Engineers.

A reconnaissance study that encompasses 18 damaged Willamette River Basin, Oregon, Bank Protection and Channel Improvement Project (WRBP Project) revetments maintained by USACE. The revetments examined by this study were identified as damaged during annual USACE maintenance inspections performed since 2001. The purpose of the reconnaissance study was to develop maintenance or repair proposals for each site. The study included field reconnaissance, documentation of reconnaissance-level review of damages, evaluation of repair options, prioritization of revetment repairs, cost estimates for recommended actions, and identification of environmental permitting requirements. The planning objectives are to stabilize riverbanks to protect life and public and private property, protect revetments from further damage, prevent revetment failures and potential ecological impacts of the failures, reduce riverbank erosion, and restore beneficial functions of revetments. Maintenance and repair proposals included natural and nature-based features such as using large wood material and vegetated riprap.

**Purpose:** Decrease hard surfaces (e.g., rock) within the system of revetments.

**Intended Benefit:** Provide habitat for various fish and wildlife species in the river margins and riparian zone while maintaining the authorized project purposes.

**Operational or Structural:** Structural

**Location:** Basin-wide

#### **2.7.4 Measure 726. Maintenance of existing and new fish release sites above dams**

**Description:** New sites will be developed, or existing ones maintained to provide access for outplanting of adult fish. Several outplanting sites were evaluated to facilitate maximum productivity of adults and compared to the most current Willamette Fish Operations Plan. Sites were selected based on higher ranking. Where the evaluation report proposed upper and lower release sites, only the lower sites were chosen per NMFS comments on self-sorting, with the exception of Blue River. There are few habitat data available for outplanting above Blue River. Any fish outplanting implemented would necessitate a habitat evaluation above Blue River. Note: An outplanting site is assumed “active” if passage is implemented at the corresponding dam. The sites in Table 2.6.4a are currently used or have been proposed due to high quality habitat.

**Purpose:** Provide access to outplant adult fish for natural spawning.

**Intended Benefit:** Increased access to high quality spawning habitat.

**Operational or Structural:** Structural

**Location:** Detroit, Foster, Green Peter, Cougar, Blue River, Lookout Point, Fall Creek, Hills Creek. Table 2.6.4a includes details on the new and proposed outplanting sites.

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**Table 2-40. Comprehensive List of New and Proposed Out Planting Sites.**

<b>Dam</b>	<b>Description</b>	<b>Ownership</b>	<b>Lat</b>	<b>Long</b>	<b>Existing or New?</b>
Detroit	Atiyeh property	Private	44.808	-122.409	New
Detroit	Breitenbush USGS Gauge Site (#14179000)	USFS	44.7512	-122.132	New
Detroit	Parrish Lake Road (Upper)	USFS	44.5243	-121.997	Existing
Detroit	Cooper's Ridge (Lower)	USFS	44.6928	-122.05	Existing
Minto	North Santiam River upstream of Minto	USFS	44.7578	-122.36	Existing
Foster	Gordon Road (Upper)	Private	45.1718	-122.384	Existing
Foster	River Bend A (Lower)	Linn County	44.407625	-122.57	Existing
Foster	Caulkins Marina (reservoir release) <sup>1</sup>	Linn County	44.413	-122.625	New
Cougar	Hardrock campground (lower)	USFS	44.0363	-122.203	Existing
Cougar	Homestead campground (upper)	USFS	43.967	-122.159	New
Lookout Point	Site 1 (lower)	USFS	43.8929	-122.316	Existing
Lookout Point	Site 3 (upper)	USFS	122.2465	43.8848	New
Fall Creek	Gold Creek Confluence (upper)	USFS	43.981	-122.407	Existing
Fall Creek	Site C (lower)	USFS	43.968	-122.63	Existing
Hills Creek	Construction site (spur road)	USFS	43.505	-122.422	Existing
Hills Creek	Paddy's Valley	USFS	43.443	-122.193	Existing
Blue River	Lower release site 2-5 miles above head of reservoir	USFS	TBD	TBD	New
Green Peter	Lower release site 2-5 miles above head of reservoir in Quartzville Creek	USFS	TBD	TBD	New
Green Peter	Lower release site 2-5 miles above head of reservoir in Middle Santiam	USFS	TBD	TBD	New

<sup>1</sup>Caulkins Marina is only active in alternatives with passage at Green Peter

## **2.8 EXISTING OPERATIONS CONTINUED FORWARD**

### **2.8.1 Fall Creek Drawdown for Fish Passage**

Fall Creek reservoir is currently and will continue to be drawn down to its lowest outlet, elevation 690, for a few weeks in November lasting sometime into December. The actual operation varies based on when fish are present and are passing. The NAA analyzes this operation as a deep fall drawdown to elevation 690 from November 15th to December. This measure would occur under all action alternatives as well.

### **2.8.2 Continued Operation of Existing Adult Fish Facilities**

Under all alternatives, USACE would continue to operate and maintain the existing adult fish collection facilities located at Dexter, Foster, Fall Creek, Minto (downstream of Big Cliff), and Cougar dams (Figure 1 22) in accordance with the Willamette Fish Operations Plan, the operational plan noted in Section 1.10.2. The Willamette Fish Operations Plan is developed annually by USACE in coordination with the BPA as well as regional Federal, state, and Tribal fish agencies and other partners through the Willamette Fish Passage Operations & Maintenance coordination team. Generally, adult fish collection facilities are operated annually between April and October. However, the Willamette Fish Operations Plan describes year-round operations and maintenance activities of the adult fish collection facilities as coordinated through Willamette Fish Passage Operations & Maintenance to protect and enhance anadromous and resident fish species listed as endangered or threatened under the ESA, as well as non-listed species of concern including lamprey. The Willamette Fish Operations Plan guides USACE actions related to fish protection and passage at the 13 Willamette projects.

### **2.8.3 Operation, Maintenance, Repair, Replacement and Rehabilitation**

Once construction of the water resources project, like the facilities that make up the WVS, is complete, the operation, maintenance, repair, replacement, and rehabilitation (OMRR&R) phase begins. During this phase, ongoing activities are conducted to support the function of the project. The OMRR&R phase is made of a spectrum of activities including everything from regular maintenance activities, such as the repainting a rusty guardrail or replacement of lightbulbs, to major maintenance and rehabilitation activities such as the repair, replacement, or rehabilitation of entire facility components, e.g., the replacement of the slide gate seals or repair of hydraulics in a dam. OMRR&R activities occur at all facilities in the WVS including within and around the dams and powerhouses, the adult fish facilities, and the hatcheries. This section describes the distinction between regular and major operation, maintenance, repair, replacement, and rehabilitation and outlines how activities under each will be addressed in this EIS.

### ***Scheduled/Routine Maintenance***

Routine maintenance is defined as the maintenance, repair, or replacement of existing fixtures or parts in which no changes to original design or purpose to ensure WVS facilities run safely either through preventive maintenance or repairs. Routine maintenance includes activities that are predictable and repetitive, but not activities that would constitute major repairs or rehabilitation of a capital asset. This type of preventative and corrective maintenance is coordinated and planned to occur at regular intervals and is referred to as scheduled, or routine, maintenance. Routine maintenance is performed at regular intervals on all hatcheries, fish facilities, spillway components, generating units, and supporting systems to ensure project reliability and to comply with North American Electric Reliability Corporation/Western Electricity Coordinating Council regulatory requirements. Routine maintenance is coordinated through the regional forum, such as the Willamette Fish Passage Operations & Maintenance and WATER, to minimize effects to ESA-listed fish species. The routine maintenance program allows staff at USACE, Bureau of Reclamation, and BPA to proactively plan and schedule capital improvement programs based on equipment condition and degradation to ensure system operations remain safe, reliable, and in compliance with applicable laws and regulations.

These activities are described in the Operations and Maintenance Manuals for each facility. The library of Operations and Maintenance Manuals is incorporated here by reference. An annotated bibliography of these manuals is provided below. These activities will continue and are included in all alternatives, including the NAA. It is assumed that these actions will not result in impacts to the environment as they are mostly sited within existing structural facilities. However, each action is routinely assessed for environmental compliance prior to implementation.

#### **Annotated Bibliography of Operations and Maintenance Manuals, dated 06/15/2022**

*Operation and Maintenance Manual: Blue River Dam, Blue River Lake, South Fork McKenzie River, Oregon. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1972.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Blue River Dam for flood control and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Cottage Grove Reservoir Project, Coast Fork Willamette River. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1968.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Cottage Grove Dam for flood control and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Cougar Reservoir Project, South Fork of the McKenzie River, Oregon, General, Sections 1.00 - 1.22, Dam and Equipment, Sections 2.01 - 2.14, Powerhouse Switchyard and Equipment, Sections 3.01 - 3.29, Fishway Facilities and Equipment,*

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*Sections 4.01 - 4.04, Buildings and Grounds, Sections 5.01 - 5.04, Reservoir and Reservoir Areas, Sections 6.01 - 6.05. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1964.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Detroit Dam and Powerhouse and Big Cliff Dam and Powerhouse for flood control, power generation, and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Facility Operations and Maintenance Manual: Cougar Adult Fish Collection Facility. Portland, Oregon: Portland District, U.S. Army Corp of Engineers, 2017.* This manual will work in conjunction with the Contractor's Operation and Maintenance Manual, which consists of twelve volumes that contain detailed product and maintenance information for every component of the system. The manuals are intended to provide the overall framework and guidance on how to identify, operate, maintain and troubleshoot components.

*Operation and Maintenance Manual: Detroit Project, Detroit Dam and Powerhouse, Big Cliff Dam and Powerhouse, Part I - Description, Part II – General, Part III - Operation. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1954.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Detroit Dam and Powerhouse and Big Cliff Dam and Powerhouse for flood control, power generation, and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Dorena Reservoir, Row River, Oregon. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1968.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Dorena Dam for flood control and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Fall Creek Reservoir, Fall Creek, Oregon. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1968.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Fall Creek Dam for flood control and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*System Operation and Maintenance Manual: Fall Creek Dam and Reservoir, Adult Fish Facility Upgrade, Willamette River Basin, Middle and South Santiam River, Working Final. Portland, Oregon: Portland District, U.S. Army Corps of Engineers, 2018.* This manual is intended to provide a complete and concise depiction of the provided equipment, product, or system, stressing and enhancing the importance of system interactions, troubleshooting, and long-term preventative maintenance and operation.

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*Operation and Maintenance Manual: Fern Ridge Reservoir, Long Tom River, Oregon. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1968.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Fern Ridge Dam for flood control and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*System Operation and Maintenance Manual: Foster Dam and Reservoir, Adult Fish Facility Upgrade, Middle and South Santiam River, Portland, Oregon: Portland District, U.S. Army Corps of Engineers, October 2017.* Oregon Department of Fish and Wildlife and the Willamette Valley Project will be responsible for the operation and maintenance of the Foster Dam and Reservoir Adult Fish Facility Upgrade. The new facility is a complex system with many interacting mechanical, electrical, and structural components. In addition, the hydraulic performance must be carefully controlled so that the system operation meets NOAA Fisheries criteria and provides effective fish passage. The System Operation and Maintenance manual provides the necessary guidance in the general system operation and describes the specific operation and maintenance of each component in the system.

*Operation and Maintenance Manual: Green Peter Dam, South Santiam River, Foster Oregon, Dam and Powerhouse. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1970.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Green Peter Dam and Powerhouse and Foster Dam and Powerhouse for flood control, power generation, and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Hills Creek Reservoir Project, Middle Fork Willamette River Oregon, Volume I, Volume II, and Volume III. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1965.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Hills Creek Dam and Powerhouse for flood control, power generation, and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*Operation and Maintenance Manual: Lookout Point Dam and Powerhouse, Dexter Dam and Powerhouse, Part I - Description, Part II – General, Part III - Operation. Portland, Oregon: Portland District, Corps of Engineers, U.S. Army, 1953.* The purpose of this manual is to present detailed information pertinent to the operation and maintenance of Lookout Point Dam and Powerhouse and Dexter Dam and Powerhouse for flood control, power generation, and other conservation uses. This manual is designed for use by operating and maintenance personnel and includes the physical description, operation and maintenance of the equipment and systems.

*System Operation and Maintenance Manual: Minto Fish Collection Facility, Willamette River Basin, North Santiam River, Oregon. Portland, Oregon: Portland District, U.S. Army Corps of*

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*Engineers, September 2017.* Oregon Department of Fish and Wildlife and the Willamette Valley Project will be responsible for the operation and maintenance of the rebuilt Minto Fish Collection Facility. The new facility is a complex system with many interacting mechanical, electrical, and structural components. In addition, the hydraulic performance must be carefully controlled so that the system operation meets NOAA Fisheries criteria and provides effective fish passage. The System Operation and Maintenance manual provides the necessary guidance in the general system operation and describes the specific operation and maintenance of each component in the system.

In addition, USACE utilizes five fish hatcheries to meet mitigation goals for the construction and operation of the WVS. Hatcheries include Marion Forks, South Santiam, McKenzie, Leaburg, and Willamette Hatchery. Operations and maintenance actions include (but are not limited to) fish production, feed, chemical use, grounds maintenance, janitorial services, and more. The facilities and their operations are summarized below:

**Marion Forks Hatchery:** “Marion Forks Hatchery is located along Marion and Horn Creeks (Santiam River tributaries in the Willamette Basin) about 17 miles east of Detroit, Oregon, along Highway 22. The site is at an elevation of 2,580 feet above sea level, at latitude 44.6125 and longitude -122.9472. The site area is 15 acres, owned by the US Forest Service Willamette National Forest.” (ODFW 2021, 2022, 2022). All structures are managed by USACE.

“There are two water rights: 15,257 gpm from Marion Creek and 14,368 gpm from Horn Creek. Water is supplied from Marion Creek from April through September, and from Horn Creek from October through March. All rearing units use single-pass water.” (ODFW 2021, 2022, 2022).

Structures and Equipment: “The hatchery has 34 stacks of Heath stack incubators. Fish rearing facilities include 12 Canadian style troughs (21’ x 2.6’ x 1.75’), 4 Reiff rearing troughs (16’ x 3.25’ x 2.7’), 8 raceways (20’ x 80’ x 3’) and 48 circular ponds (24’ diameter x 2.5’ depth).

Marion Forks has a flatbed truck with a 1,000-gal tank equipped with two aerator pumps. The hatchery also uses regional trucks, which have a 1,600-gal tank equipped with recirculation pump and oxygen pumps, to haul both adults and juveniles.

The hatchery also uses a 400-gallon slip tank in their pickup for hauling fingerling fish.

The hatchery has a 1983 Nielsen Fish Pump.” (ODFW 2021, 2022).

**South Santiam Hatchery:** “South Santiam Hatchery and the Foster Fish Collection Facility are located on the South Santiam River just downstream from Foster Dam, 5 miles east of downtown Sweet Home. The facility is at an elevation of 500 feet above sea level, at latitude 44.4158 and longitude -122.6725. The site area is 12.6 acres [and most structures] are managed by USACE.

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The hatchery currently receives water from Foster Reservoir. A total of 8,400 gpm is available for the rearing units. An additional 5,500 gpm is used in the adult holding pond. All rearing ponds receive single-pass water.

The incubation room is approximately 18-ft by 24-ft and contains 30 16-tray vertical incubators and two six-foot fiberglass picking troughs. All incubators and both troughs are plumbed with reservoir and well water.

Early rearing at the South Santiam Hatchery takes place in three 3-ft x 3-ft x 14 ft and two 4-ft x 4-ft x 20 ft fiberglass rearing tanks. Continued rearing takes place in ten 17-ft x 75-ft x 4-ft Burrows raceways and four 21-ft x 75-ft x 4-ft Burrows raceways. A middle walkway provides access for feeding and other tasks. Water is supplied at both ends of each raceway via 4-inch valves. In addition, the former adult holding pond was retrofitted into a large rearing pond with enough capacity to rear 300,000 spring Chinook salmon.

South Santiam Hatchery has a 1200-gallon tanker truck for fish transportation.” (ODFW 2021, 2022).

**McKenzie Hatchery:** “McKenzie River Hatchery is located along the McKenzie River approximately 22 miles east of Springfield, Oregon. The site is at an elevation of 700 feet above sea level, at latitude 44.1167 and longitude -122.6361. The site area is 16 acres.” (ODFW 2021, 2022). All structures and land are owned by USACE.

“Water rights total 31,500 gpm from two sources: the McKenzie River and Cogswell Creek. All raceways are supplied with gravity-fed, single-pass water. Adult holding ponds are supplied with single-pass water or can be supplied with reuse water from the raceways in an emergency.” (ODFW 2021, 2022).

Structures and Equipment: “Broodstock enter the McKenzie Hatchery fish ladder from the river and navigate 12 jump steps where they then advance 100 ft. to the next 5 jumps, allowing passage under Greenwood Drive. From this point they move upstream 50 yards and make a final jump over a finger weir into the collection channel. The collection channel is located at the downstream end of the holding ponds. From there the fish are crowded into the spawning building using a power crowder. A lift brings the fish up to two holding tanks where they can be anesthetized. The fish then can be handled for sorting, inoculation, transport, or placement into the holding ponds for broodstock.

McKenzie Hatchery has a liberation tank truck with a 1,500-gallon capacity. While broodstock is generally collected and spawned on-site, this unit can haul up to 130 adults.

Incubation facilities consist of 38 full stacks of vertical tray incubators (640 trays). Dual water supplies are available from either the McKenzie River (Leaburg Canal) or Cogswell Creek and can be isolated from each other. The two water supplies are used independently for incubation. A water chiller cools a limited amount of water for otolith marking. Rearing facilities include

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eight Canadian troughs of 89 cubic ft. each, and 30 concrete raceways with a volume of 3,338 cubic feet each.” (ODFW 2021, 2022).

In 2018, the water supply at McKenzie Hatchery was compromised due to structural integrity issues in Leaburg Canal that supplies the hatchery. To continue fish production, fish are being collected from two locations on the McKenzie River. The primary source of collection is a fish trap at Leaburg Hatchery. Fish are also being collected from a fish sorter located at the top of the left bank ladder, though in lower numbers. In the past fish were collected at the McKenzie Hatchery, however due to current water conditions, collection the last several seasons has been in the single digits and is ineffective. Broodstock are being held at Leaburg Hatchery and at Foster Fish Facility. The raceways at Leaburg are designed for juvenile fish and are not deep enough for adults. Covers are placed over the raceways to avoid sunburn. Foster has superior adult holding facilities and thus some of the fish are held there. Incubation of this year's juveniles occurred entirely at McKenzie Hatchery. Leaburg does not physically have the capacity to incubate the number of fish that are required. Early stages of rearing are taking place at McKenzie Hatchery. Once water conditions degrade, fish are moved to Leaburg where they are reared until release. This hybrid operation using both McKenzie and Leaburg Hatchery is ongoing and will continue until a solution is implemented.

**Willamette Hatchery/Dexter Fish Facility:** “Willamette Hatchery is located along Salmon Creek (Middle Fork of the Willamette River tributary in the Willamette Basin) about 2 miles east of Oakridge, Oregon, off Highway 58. The site is at an elevation of 1,217 feet above sea level, at latitude 43.7436 and longitude -122.4425. The site area is 108 acres, owned by the US Forest Service Willamette National Forest.” (ODFW 2021, 2022). Structures are owned by both the Oregon Department of Fish and Wildlife and USACE. “There are six water rights: 82.5 cfs from Salmon Creek and 500 gpm from underground well. All rearing units use single-pass water.” (ODFW 2021, 2022).

Structures and Equipment: “Broodstock are collected at the Dexter Ponds Facility, a satellite to Willamette Hatchery. The fish voluntarily swim up a fish ladder located at the base of Dexter Dam, then swim through a "V" notched weir into the adult trap. There is a single adult collection pond at the Dexter Pond Fish Facility. The concrete pond has a volume of 3,848 cubic ft and dimensions of 74 ft long by 13 ft wide by 4 ft high. The pond can accommodate a flow rate of up to 18,000 gpm.

The Willamette Hatchery and Dexter Ponds Fish Facility utilize four liberation trucks, with capacities varying from 250 to 3,000 gallons. These trucks are equipped with oxygen and aeration pumps.

Adults are collected at Dexter Dam and transported to the adult Chinook salmon holding facility at the Willamette Hatchery until spawning. The holding facility was constructed in a former earthen rearing pond from the original hatchery. It is inadequate for current adult holding needs at the Willamette Hatchery. Consequently, the adults are overcrowded in the pond, not easily captured, and overly stressed which contributes to high pre-spawn mortality of collected broodstock. The earthen pond is 25 ft wide by 275 ft long and has a depth of approximately 1.5

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ft. The flow rate is approximately 1,500 gpm. The existing pond has a design capacity for 800 adults. However, due to current hatchery production levels and high pre-spawn mortality of broodstock, approximately 3,000 adults over-summer in the broodstock pond. Improving the broodstock pond would dramatically increase the survival of this ESA-listed broodstock needed for conservation/recovery efforts in the Middle Fork Willamette River, reduce annual transportation costs of adults to the hatchery from Dexter trap, and reduce annual operation costs at the hatchery (i.e., antibiotic treatments).” (ODFW 2021, 2022). Rehabilitation of the adult brood holding pond is a requirement in the 2019 Hatchery Biological Opinion issued by the National Marine Fisheries Service.

“Eggs are incubated in vertical heath style incubator trays. There are 67 stacks of incubators cumulatively allowing for the incubation of 9 million eggs. There are 1,005 units, each of which can accommodate 8,000 eggs. Two water sources (Salmon Creek and well water) are available to each stack of incubators at a flow rate of 5 gpm. All incubators are equipped with alarms.

Willamette Hatchery has 40-20x80x3-foot raceways, 10-20x100x6-foot raceways, 13 Canadian style starter troughs, and 2 show ponds. The Dexter Pond Fish Facility has 4-18x135x8-foot raceways and a 172x64x8-foot asphalt pond. The Dexter Ponds are also used for acclimation. Dexter Pond, located 33 miles downstream of the hatchery, is operated as a satellite facility. The site is at an elevation of 654 feet above sea level, at latitude 43.9248 and longitude - 122.8072.” (ODFW 2021, 2022).

All facilities undergo the maintenance activities summarized below:

**Hatchery Production Levels and Activities:** Hatchery Production Levels and Activities can be found in respective Hatchery and Genetic Management Plans and annual/biannual reports.

**Feed and Chemical Use:** Feed and chemical use data can be found in annual/biannual hatchery reports.

**Grounds Maintenance:** The grounds maintenance is performed for USACE-owned property at the seven (7) Willamette Valley Facilities: Marion Forks Hatchery, Minto Fish Facility, South Santiam Hatchery, Foster Fish Facility, Willamette Hatchery, and Dexter Fish Facility.

Frequency of maintenance fluctuates throughout the year. Table 2-41 lists the acreage of grounds for mowing, grass height standards, and lists the acreage of grounds maintained at each facility.

The grounds maintenance services include, but are not limited to:

- Removal of weeds in flowerbeds, parking lots, or along fence lines. Application of herbicides.
- Mowing of grass areas to the standard identified in Table 2-41. Trimming and maintaining trees and shrubs to prevent obstruction and present an aesthetic appearance.

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- Preparing soil and plant annuals and/or perennials in flowerbeds
- Removing all debris, trash, grass clippings, and ice/snow from all parking areas, sidewalks, driveways, or other areas which prevent an unsafe passage of employees.

**Table 2-41. Size and Area of Grounds Maintenance.**

Facility	Mowing (Acres)	Mowing (Standard)	Acres of Grounds Maintained
Marion Forks	2	3"	8
Minto	0	N/A	2.5
South Santiam	3	3"	4
Foster	0.75	3"	1
Willamette	7	3"	30
Dexter	2	3"	10

**Janitorial:** Periodic housekeeping of Government facilities (i.e., Marion Forks Hatchery, Minto Fish Facility, South Santiam Hatchery, Foster Fish Facility, Willamette Hatchery, and Dexter Fish Facility) is done in a manner and frequency that results in a clean and healthy environment. These services include office space, restrooms, break areas, windows, floors, and carpets with sufficient frequency to provide a safe and healthy environment for users of the facilities.

Janitorial services include, but are not limited to:

- Vacuum carpeted areas where applicable, including floor mats or rugs
- Sweep and mop linoleum, vinyl, laminate or concrete work surfaces
- Clean restrooms
- Includes mirrors, toilets, urinals and floors
- Restock toilet paper, paper towels, soap, etc. as needed
- Clean drinking fountains
- Clean tables, counter tops and other work surfaces
- Clean window and door glass
- Clean and dust light fixtures.

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**Table 2-42. Type and Frequency of Maintenance at Each Facility.**

Facility	Floor Surface (Sq Ft)	Flooring Type	Floor Surfaces Freq.	Trash Cans #	Trash Cans Freq.	Recycle Bins #	Recycle Bins Freq	Office Toilets #	Office Toilets Freq.
Marion Forks	25,000	Laminate, concrete, vinyl, carpet, wood	1x/ week	8	1x/ week	2	monthly	4	1x/ week
Minto	9,350	Laminate, concrete	1x/ week	5	1x/ week	2	as needed	1	1x/ week
South Santiam	780	Linoleum	1x/ week	3	1x/ week	3	Bi-weekly	1	1x/ week
Foster	390	Tile	1x/ week	2	1x/ week	0	N/A	1	1x/ week
Willamette	4,500	Concrete, carpet laminate	1x/ week	20+	1x/ week	7	2x/ month	3	2x/ week
Dexter	75	Laminate	1x/ week	3	1x/ week	0	N/A	1	2x/ month

**Universal Waste Management:** Universal Waste is managed to the standards set forth below or by reference:

**Manage the following categories of universal waste in accordance with Federal, state, and local requirements:** Batteries as described in 40 CFR 273., Lamps as described in 40 CFR 273.5, and Mercury-containing equipment as described in 40 CFR 273.4 Dumping of mercury-containing materials and devices such as mercury vapor lamps, fluorescent lamps, and mercury switches, in rubbish containers is prohibited. Remove without breaking, pack to prevent breakage, and transport out of the activity in an unbroken condition for disposal as directed.

**Electronics End-of-Life Management:** Recycle or dispose of electronics waste, including, but not limited to, used electronic devices such computers, monitors, hard-copy devices, televisions, mobile devices, in accordance with 40 CFR 260-262, state, and local requirements.

**Releases/Spills of Oil and Hazardous Substances:** Response and Notifications. Exercise due diligence to prevent, contain, and respond to spills of hazardous material, hazardous substances, hazardous waste, sewage, regulated gas, petroleum, lubrication oil, and other substances regulated in accordance with 40 CFR 300. Maintain spill cleanup equipment and materials at facility. In the event of a spill, take prompt, effective action to stop, contain, curtail, or otherwise limit the amount, duration, and severity of the spill/release.

**Mercury Materials:** Manage mercury containing materials as a hazardous waste for disposal.

**Disposal of wastewater:** Do not allow wastewater from activities to enter waterways or to be discharged prior to being treated to remove pollutants.

**Surface Discharge:** Surface water is managed to the standards set forth below or by reference: Surface discharge in accordance with the requirements of the Clean Water Act – NPDES – Summary of the Clean Water Act, US EPA.

**Used Oil Management:** Used is managed to the standards set forth below or by reference: Manage used oil generated on site in accordance with 40 CFR 279. Determine if any used oil generated while onsite exhibits a characteristic of hazardous waste. Used oil containing 1,000 parts per million of solvents is considered a hazardous waste and disposed of at the Contractor's expense. Used oil mixed with a hazardous waste is also considered a hazardous waste. Dispose in accordance with paragraph regarding Hazardous Waste.

**Oil Storage Including Fuel Tanks:** Oil storage is managed to the standards set forth below or by reference: Provide secondary containment and overflow protection for oil storage tanks. Use drip pans during oil transfer operations. Cover tanks and drip pans during inclement weather. Provide procedures and equipment to prevent overfilling of tanks.

**Rainwater Accumulation:** Rainwater is managed to the standards set forth below or by reference: Monitor and remove any rainwater that accumulates in open containment dikes or berms. Inspect the accumulated rainwater prior to draining from a containment dike to the environment, to determine there is no oil sheen present.

**Drinking Water:** Drinking water is managed to the standards set forth below or by reference: Drinking water systems must meet Federal, state, and local requirements. If applicable, must maintain all registrations, operator certifications, and training.

**Future Facility Actions:** Future facility actions include but are not limited to replacement/rehabilitation of roofs, siding, building interiors, water supply intakes, water supply gates, raceways/tanks, pipes, valves, other plumbing, electrical systems, fish lifts/pumps, and other items (e.g., asphalt parking lot). See Operational Condition Reports for additional information.

### **Unscheduled and Non-Routine Maintenance**

Unscheduled maintenance is reactive maintenance that addresses issues as they arise. It can occur any time there is a problem, unforeseen maintenance issue, or emergency that requires a project feature, such as a generating unit, be taken offline to resolve the problem. The timing, duration, and extent of these events are unforeseeable. Unscheduled maintenance events are coordinated through the appropriate teams under a regional forum, such as the Willamette Fish Passage Operations & Maintenance and WATER, to minimize negative effects on fish.

Non-routine maintenance is proactively planned but not performed at regular intervals (e.g., unit overhauls, major structural modifications, or rehabilitations). Non-routine maintenance includes tasks that may be more significant in nature than routine maintenance and these tasks may or may not constitute major maintenance and rehabilitation.

Major maintenance and major rehabilitation are defined in Engineering Circular 11-2-222. Major maintenance is defined as a non-repetitive item of work or aggregate items of related work for which the total estimated cost exceeds the limit set forth by Engineering Circular 11-2-222, and which does not qualify as major rehabilitation. Major rehabilitation is defined as structural modifications to restore or ensure continuation of an existing facility's functions or outputs. This does not include normal maintenance of existing capabilities or prevention of deterioration. Examples of non-routine maintenance include power plant modernization and major upgrades of project features.

Non-routine maintenance and major maintenance and rehabilitation may be considered major Federal actions. Each action would be assessed for environmental compliance prior to implementation, and any action that may result in impacts to the human environment would undergo additional analysis under the tiered NEPA process described in Chapter 7.

#### **2.8.4 Large Woody Debris**

The collection and removal of large woody debris was not included in the FEIS but is included in the SEIS as part of ongoing operations. WVS dams block large wood from upstream. USACE collects and removes large wood and other debris from reservoir forebays. USACE would continue to collect large wood that accumulates at dams during annual maintenance operations and make it available for habitat restoration projects. USACE would store material on USACE land for up to one year and make it available to watershed councils or other appropriate entities after USACE determines the material is suitable for restoration projects. Watershed Councils, or other entities, are responsible for moving the staged woody material from USACE lands and installing material into habitat restoration projects. These entities are also responsible for complying with all applicable laws and permit requirements for disposal of woody debris at restoration sites.

### **2.9 INTERIM OPERATIONS**

#### **2.9.1 Overview 2021 Court Ordered Interim Injunction**

On September 1, 2021, the U.S. District Court for the District of Oregon issued an interim injunction directing USACE to implement interim injunction measures intended to improve conditions for fish passage and water quality in the WVS to avoid irreparable harm to ESA-listed salmonids during the interim period until completion of the reinitiated ESA consultation. These include measures that require changes to how one or more of the WVS dams are operated and three measures that modify existing structures. These 16 measures are described in Chapter 2, Alternatives.

The Court assigned an Expert Panel to define implementation plans of specific measures, which are then to be implemented by USACE until the WVS EIS and associated ESA consultation Biological Opinion are implemented. If an injunction measure is superseded by one or more measures under the implemented alternative, then the injunction measure will be carried out until the superseding WVS EIS/ Biological Opinion measure is implemented; otherwise, the

injunction measure will be carried out through the 30-year implementation timeframe. Chapter 2, Alternatives, details what measures under each Alternative would supersede an injunction measure.

The Interim Operations were not developed as a complete, stand-alone practicable alternative because these measures would not contain sufficient fish survival and passage rates as demonstrated in modeling efforts under Alternative 3A and Alternative 3B. Operational passage and survival measures such as deep drawdowns and fish collection and transport were incorporated into the reasonable range of alternatives based on modeling results, which presents a more realistic implementation scenario targeting fish impact issues than would occur under an alternative comprised solely of Interim Operations.

Chapter 3, Affected Environment and Environmental Consequences, includes an analysis of the direct, indirect, and cumulative effects of the 16 operational interim injunction measures. Although these measures could potentially be superseded immediately by measures under the implemented alternative, there may be unforeseen complexities to their implementation that need to be addressed over an unknown period. Therefore, the effects analyzed in Chapter 3, for the Interim Operations are assumed to occur over the 30-year implementation period to ensure all possible impacts are adequately addressed.

In addition to the immediate implementation of the operational interim injunction measures, the Court order included consideration of three structural measures (Table 2.8.1a). Any structural injunction measure that is constructed will undergo a separate NEPA review that will assess the direct, indirect, and cumulative impacts of their effects on the human environment. As the direct and indirect effects of these structural measures will be fully assessed under tiered NEPA reviews, they are generally not included in the analyses (Chapter 3, Affected Environment and Environmental Consequences).

**Table 2-43. Three Structural Injunction Measures.**

Dam	No	Description
Dexter	18	Design and Construct upgrades to the Dexter adult fish facility.
Big Cliff	10b	Determine whether operational measures alone are sufficient to maintain acceptable TDG levels below Big Cliff Dam and, if not, develop a schedule for the design and construction of a structural solution for mitigating excess TDG levels during spill operations.
Cougar	15b	Determine whether structural improvements/modifications need to be made to Cougar Dam’s ROs to ensure safer fish passage and reduce TDG.

### **2.9.2 Summary of Interim Operations**

Table 2-44 explains the interim operations including the location, the duration of the operation during a year, the outlet priorities for use to release flow through the dam, the target elevation of the reservoir for the operation, and the equivalent action alternative or measure. The more

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detailed descriptions are also provided after the table, copied from the resources referenced in the table. These operations would be implemented while the long-term management measures are being developed and cease when the long-term operations and/or structures are fully operational. The interim operations have been revised as part of adaptive management based on input from Cooperators and now include a deeper fall drawdown to improve passage conditions for juvenile fish at Detroit Dam.

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**Table 2-44. Interim Operations.**

<b>Description</b>	<b>WVS Dam</b>	<b>Duration of Operation</b>	<b>Priority Outlet</b>	<b>Target Elevation</b>	<b>Description provided</b>	<b>Action Alternative Equivalent</b>
Spring downstream fish passage and operational downstream temperature management	Detroit	mid-March - Fall	Spillway/ Turbines/ ROs (ties in with 10a)	n/a	2/28/22 Biannual Report	No Equivalent, check Biannual Report
Nighttime RO prioritization for improved downstream fish passage	Detroit	Winter	Upper ROs/Lower ROs	< El. 1500 ft.	2/28/22 Biannual Report	3A, 3B: measure 166
Fall drawdown to 50 feet above the upper regulating outlets for improved downstream fish passage	Detroit	Fall/Winter	Upper Regulating Outlets	1,395 feet	NMFS 2024 Biological Opinion detailed implementation plan will be developed with WATER.	No equivalent.
Spread spill across spillways to reduce downstream TDG exceedances	Big Cliff	Year-Round	Spillway	Discharges > Powerhouse Capacity	2/28/22 Biannual Report	No Equivalent, check Biannual Report
Outplanting plan for the reintroduction of adult Chinook salmon above Green Peter Dam	Green Peter	Summer	n/a	n/a	2/28/22 Biannual Report	Measure common to all: Maintenance of existing and new fish release sites above dams

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<b>Description</b>	<b>WVS Dam</b>	<b>Duration of Operation</b>	<b>Priority Outlet</b>	<b>Target Elevation</b>	<b>Description provided</b>	<b>Action Alternative Equivalent</b>
Utilize spillway for improved downstream fish passage in the spring; perform spill operation until 01 May or for 30 days, whichever is longer	Green Peter	mid-March – April/May	Spillway	> El. 971 ft. (spillway crest)	2/28/22 Biannual Report – focus on 2023	2A and 2B; measure 714
Deep drawdown and RO prioritization for improved downstream fish passage	Green Peter	Early September - mid-December	RO	El. 780 ft.	3/23/22 Draft Implementation Plan	2A, 2B, 3A, 3B; measure 40
Delay refill and utilize spillway in the spring for improved downstream fish passage; use the fish weir in the summer for improved downstream temperature management and upstream fish migration/passage	Foster	01-February - 15-June; 16 June - ~late-July	FOS Spillway (spring) Fish Weir (summer)	El. 613 ft. (Feb - May); 637 ft. (May - Jul)	2/28/22 Biannual Report	No Equivalent, check Biannual Report

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<b>Description</b>	<b>WVS Dam</b>	<b>Duration of Operation</b>	<b>Priority Outlet</b>	<b>Target Elevation</b>	<b>Description provided</b>	<b>Action Alternative Equivalent</b>
Utilize the spillway for improved downstream fish passage in the fall	Foster	01-October - 15-December	Spillway	min con (El. 613 ft.)	2/28/22 Biannual Report	No Equivalent, check Biannual Report
Deep drawdown and RO prioritization for improved downstream fish passage	Cougar	early Nov - 15 Dec	RO	El. 1505 ft.	2/28/22 Biannual Report	3A; measure 40
Delayed reservoir refill and RO prioritization for improved downstream fish passage	Cougar	February - May/June	RO	El. 1520-1532 ft.	2/28/22 Biannual Report	No Equivalent, check Biannual Report
Nighttime RO prioritization for improved downstream fish passage (downstream fish passage)	Hills Creek	~November - March	RO	< El. 1460 ft.	2/28/22 Biannual Report	No Equivalent, check Biannual Report
Utilize spillway for improved downstream fish passage in the spring; RO use in the fall for downstream	Lookout Point	mid-March - May/June (spring); July - 15-October (RO)	Spillway/RO	El. 890-893 ft. (spring spill); < El. 887.5 ft. (late summer/fall RO)	2/28/22 Biannual Report	Spillway Op: No Equivalent, check Biannual Report  RO Op: 3A; measure 166

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<b>Description</b>	<b>WVS Dam</b>	<b>Duration of Operation</b>	<b>Priority Outlet</b>	<b>Target Elevation</b>	<b>Description provided</b>	<b>Action Alternative Equivalent</b>
temperature management						
Deep drawdown and RO prioritization for improved downstream fish passage	Lookout Point	15 November – 15 December	RO	El. 750 ft.	No Implementation Plan – modeling results with assumed drawdown	3A: measure 40

### 2.9.3 North Santiam River Interim Operations

#### ***Detroit Fall Downstream Passage Measure (2024 NMFS Biological Opinion RPA 4.12.2)***

**Description:**

Fall reservoir drawdowns to 25 ft. over the regulating outlets (RO) for downstream passage

**Purpose:** Decrease reservoir elevation in fall/winter to improve downstream fish passage rate and survival at Detroit Dam.

**Intended Benefit:** Decreasing reservoir elevation near to the upper ROs will increase the number of juvenile spring Chinook and juvenile winter steelhead passing and their survival rate. Juvenile salmonids are known to pass if a surface route is available. Fish passage survival has been demonstrated to increase as reservoir elevation is decreased over the outlet.

The 2024 NMFS Biological Opinion RPA includes an interim measure for a fall drawdown of Detroit Reservoir to El. 1395 feet, or 55 feet below typical winter conservation pool elevation to improve volitional downstream fish passage (RPA 4.12.2). This is an interim action that will be carried out until a long-term structural downstream fish passage solution is constructed. A stepwise process will be used to meet the requirements to draw down Detroit Reservoir to el. 1395 feet and dampen the expected initial elevated turbidity response from sediment erosion. Detroit Reservoir will be lowered incrementally to the target deep drawdown, instead of drawing the reservoir to its target all at once in the first year. Once the target elevation is achieved, USACE would draft the reservoir down to 1395 feet in each subsequent year, subject to flood risk management operations.

#### ***Detroit Fall/Winter Downstream Fish Passage***

**Description:** Prioritize flow releases through the upper ROs during the fall/winter once Detroit Reservoir elevation is less than 100 feet over the turbine intakes (1419 ft); target el. 1450 -1500 ft. The timing of the operation results in approximately 60% of the daily flow going through the upper regulating outlet and approximately 40% through the penstock and turbines.

**Purpose:** Provide downstream passage for juvenile chinook and steelhead, during the fall and winter months.

**Intended Benefit:** Improved downstream fish passage

**Table 2-45. Detroit Dam Fall/Winter Downstream Fish Passage Interim Operation.**

Dam	Detroit Dam
Duration (hours/days)	6pm to 7am (dusk to dawn)
Est. Start Date	Fall (when rule curve reaches 1500 ft; or Sep 21)
Est. End Date	Spring (when rule curve reaches 1500 ft)

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<b>Dam</b>	<b>Detroit Dam</b>
Recurrence Interval	Annually
Max pool elevation (ft, project datum)	1500 ft; start using upper RO once the Detroit Reservoir elevation is less than 100 feet over the turbine intakes (1419 ft)
Outlet (RO/spillway/etc.)	Upper RO (when reservoir 1500 ft – 1450 ft)
Min flow (cfs)	N/A
Max flow (cfs)	N/A
Additional Information (ex., head restrictions)	N/A

This operation prioritizes flow releases through the URO during the fall/winter, once the Detroit Reservoir elevation is less than 100 feet over the turbine intakes (1419 ft), with a target elevation 1450 -1500 ft. Operate the turbines during the day (unless otherwise dictated by downstream water temperature conditions), while the URO is prioritized to pass flow at night (from dusk until dawn), with no turbine operation (no power generation) during this period, except for station service<sup>4</sup> if needed for emergencies or for downstream TDG management. When the Detroit Reservoir reaches 1500 ft. elevation in the fall (September timeframe) continue using the Upper ROs to release flow for downstream water temperature management.

The upper and lower ROs at Detroit Dam produce elevated levels of TDG downstream of the dam. One challenge during implementation of this operation will be balancing the RO operations with downstream TDG. During implementation of the fall downstream passage operation and the spring downstream passage operation (details below), holding downstream TDG levels below the state water quality standard of 110% TDG saturation while trying to comply with, and maximize the benefits of, the operation may pose some difficulties.

Depending on whether sensitive life-stages of fish are present, USACE with input from NMFS will consider how exceedances to the State water quality standard compare to benefits of the temperature reduction operations. In instances where less sensitive salmonid life history stages are present below Detroit and Big Cliff dams, then elevated TDG is likely a lower risk. However, if sensitive species are present below Detroit and Big Cliff dams, then RO use will be reduced or temporarily curtailed until the TDG levels decline. Curtailment should primarily be considered when sac-fry are present in the reach between Big Cliff and the Minto Fish Facility. ATUs should be closely tracked to identify the timing of the emergence of sac-fry, and during this period, RO releases should be modified so as not to exceed 110% as measured downstream of Detroit and Big Cliff dams.

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<sup>4</sup> Station Service outflow varies by elevation, but averages ~300 cfs when the reservoir is at or near minimum conservation pool elevations.

***Detroit Spring Downstream Fish Passage and Temperature Management***

**Description:**

Provide downstream fish passage in the spring and water temperature management throughout late spring and summer at Detroit and Big Cliff dams through strategic use of the spillway, turbines and regulating outlets. Spillway operations will start when the reservoir reaches spillway crest elevation (El. 1541.0 ft) and continue until the reservoir is drafted below the spillway crest. From there, a combination of turbine and regulating outlet (RO) discharges will be implemented until water temperature management is no longer possible due to reservoir turnover. With adaptive management, the spill ratio will be adjusted so water temperature releases (as measured at the USGS gage downstream of Big Cliff) can best meet targets. This is a split spill operation for passage where water is released through the turbines to generate during the day and over the spillway at night until the reservoir gets too low to use the spillway. The split outlet operation is expected to result in approximately 60% of the daily flow going over the spillway (or RO once within 100' and 40% through the penstock and turbines).

Total dissolved gas (TDG) conditions downstream of Detroit and Big Cliff dams will also be used to shape spill operations, and elevated TDG should be avoided when sensitive species (e.g., sac-fry) are present below Detroit and Big Cliff dams.

**Purpose:** Strategic use of the spillway and turbines for downstream fish passage and temperature management.

**Intended Benefit:** to provide downstream fish passage in the spring.

**Table 2-46. Detroit Dam Downstream Fish Passage and Temperature Management Interim Operation.**

Dam	Detroit
Duration (hours/days)	Dusk to dawn
Estimated Start Date	1 Apr (when rule curve rises to 1541')
Estimated End Date	15 Nov (End of conservation season) or when reservoir turns over and temperature management is no longer possible.
Recurrence Interval	Annually
Max pool elevation (ft, project datum)	Rule curve
Outlet (RO/spillway/etc.)	Spillway
Min flow (cfs)	–
Max flow (cfs)	–
Additional Information (ex. head restrictions)	Minimum gate opening of 1.5 ft (this isn't included in the ResSim model)

***Big Cliff Spread Spill for TDG Abatement***

**Description:**

Spread spill across multiple spill bays at Big Cliff Dam, when operating the spillway, to reduce TDG levels. When spill is necessary at Big Cliff Dam, some benefit can be realized from spreading spill across the spillway, using multiple spill bays; however, minimum gate opening constraints preclude USACE from spreading spill under many flow regimes. Additionally, TDG is also generated by Detroit Dam operations, particularly when a non-turbine unit is used to discharge water. In this case, spreading spill at Big Cliff Dam does not prevent/abate TDG levels that are generated by Detroit Dam.

**Purpose:** Spread spill across spillways

**Intended Benefit:** reduce downstream TDG exceedances

**Table 2-47. Big Cliff Interim Operation.**

Dam	Big Cliff
Duration (hours/days)	24/7
Estimated Start Date	–
Estimated End Date	–
Recurrence Interval	Annually
Max pool elevation (ft, project datum)	1182 ft (min. conservation pool); 1206 ft (max. conservation pool)

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Dam	Big Cliff
Outlet (RO/spillway/etc.)	Spillway
Min flow (cfs)	4740
Max flow (cfs)	5070
Additional Information (ex. head restrictions)	The minimum gate opening for spill operations of each spill bay at Big Cliff is 0.75 feet.
Notes	Operation is to spread spill when spillway flows are above 4,740 cfs; no change in amount spilled, just number of bays. Therefore, not modeled.

Elevated TDG is generated when water is passed through the non-turbine outlets at Detroit and Big Cliff dams. The turbine units at either project are not known to produce increased levels of TDG. The Big Cliff turbine is less harmful on fish and downstream water temperature and should be utilized to the extent possible to reduce downstream TDG levels. When spill is necessary at Big Cliff Dam, due to maintenance activities or involuntary high flow events (when outflow exceeds the capacity of the turbine), spreading spill across multiple spill bays at Big Cliff Dam will reduce TDG.

Implementation: The total volume of water that can pass through the turbine intakes varies by reservoir elevation and ranges from 2810 – 3200 cfs. Flows that exceed this range must be split between the powerhouse and spillway and are generally observed during high flow, or involuntary spill events.

The minimum gate opening for spill operations of each spill bay at Big Cliff is 0.75 feet. This equates to discharges that range from 770 cfs – 1130 cfs for reservoir elevations of 1182 ft. (min. conservation pool) and 1206 ft. (max. conservation pool), respectively. Under the lowest of reservoir elevations, flows cannot be spread between two bays until the total outflow is greater than 4740 cfs, which is the sum of the discharge from two spill bays at minimum gate opening plus powerhouse capacity [(770 cfs + 770 cfs = 1540 spill) + (3200 cfs powerhouse) = 4740 cfs total flow]. Under the highest reservoir elevations, flows cannot be spread between two bays until the total outflow is greater than 5070 cfs, which is the sum of the discharge from two spill bays at minimum gate opening plus powerhouse capacity [(1130 cfs + 1130 cfs = 2260 cfs spill) + 2810 cfs (powerhouse) = 5070 cfs (total flow)]. Without large flow conditions, spreading spill is limited at Big Cliff Dam.

#### **2.9.4 South Santiam River Interim Operations**

##### ***Green Peter Outplanting Plan***

##### **Description:**

Adult fish, captured at the Foster adult fish facility, will be outplanted above Green Peter from May –September. Offspring from these adult salmon are expected to emerge and pass Green

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Peter Reservoir and dam. Potential outplanting sites have been identified. USACE is working with the U.S. Forest Service, Bureau of Land Management, and private landowners.

**Purpose:** Reintroduction (outplanting) of adult Chinook salmon in the watershed upstream of Green Peter

**Intended Benefit:** benefit the salmon population in the South Santiam basin due to large areas of spawning habitat.

***Green Peter Spring Downstream Fish Passage***

**Description:**

Flows of 800 to 1,000 cfs have been shown to successfully pass juvenile fish at other projects in the region and therefore, are expected to successfully pass fish in the Green Peter reservoir from the spillway for downstream passage. Begin spill once the reservoir reaches spillway crest, or El. 971 ft. and implement continuous spill release until May 1 or for at least 30 days, whichever is longer. Reservoir elevations during this operation are expected to range from 971 ft. to 1005 ft. and spill is expected to range from a minimum of 460 cubic feet per second (cfs) to 3,000 cfs, based on the Green Peter spillway rating table, with a minimum gate opening of 1.5 feet. Based on optimal gate openings, 60% of the daily flow will be passed over the spill when the reservoir is between elevations 971' and 985'. Once the reservoir is at 986' or higher, then the spillway will be used to pass all flow.

**Purpose:** continuous spill

**Intended Benefit:** improved fish passage

**Table 2-48. Green Peter Spring Interim Operation**

Dam	Green Peter
Duration (hours/days)	Continuous
Estimated Start Date	Begin spill once the reservoir reaches spillway crest, or El. 971 ft.
Estimated End Date	May 1 or for at least 30 days, whichever is longer.
Recurrence Interval (X yrs)	Annually
Min pool elevation (ft, project datum)	971 ft
Max pool elevation (ft, project datum)	Rule curve
Outlet (RO/spillway/etc.)	Spillway
Min flow (cfs)	800
Max flow (cfs)	2,825 cfs
Additional Information (ex. head restrictions)	Flows based on the Green Peter spillway rating table, with a minimum gate opening of 1.5 feet

***Green Peter Fall Downstream Fish Passage***

**Description:**

In early September, begin drawing Green Peter Reservoir down to reach a targeted elevation of 780 ft. by early- to mid-November. This targeted elevation is approximately 35 feet over the ROs at Green Peter Dam. As soon as the reservoir is drawn down below minimum power pool (El. 887 ft.), all water will be discharged through the ROs exclusively unless downstream water quality and/or high flow events dictate otherwise. The reservoir will be held at El. 780 ft. until 15 December. On 16 December, refill will begin and continue, according to rule curve for the spring spill operation. When refilling Green Peter, outflows may be very low, if not zero.

**Purpose:** Draw down Green Peter Reservoir to approximately 35 feet over the ROs (780 ft).

**Intended Benefit:** improved fish passage.

**Table 2-49. Green Peter Fall Interim Operation.**

Duration (hours/days)	Continuous
Estimated Start Date	Early September
Estimated End Date	15 December
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	780 ft
Outlet (RO/spillway/etc.)	RO
Min flow (cfs)	800 during spillway fish spill operations
Max flow (cfs)	2,825 (1 Sep – 15 Oct)
Additional Information (ex. head restrictions)	Flows based on the Green Peter spillway rating table, with a minimum gate opening of 1.5 feet

To supply power to the dam during this operation, electricity will be pulled from the grid to power the regulating outlets and auxiliary systems as much as possible. In addition, a backup power source is required to ensure redundancy in the event that the primary power source is unavailable and will be supplied by back-up diesel generators. Although the dam has an emergency backup diesel generator, the cooling water supply is located about 100 ft above the targeted elevation for this fall drawdown, so the current generator will not be useable. This generator is also undersized for this project and is not reliable at remote start. Therefore, a temporary diesel generator will be installed at the powerhouse to supply backup to the line.

Also, because of previously identified issues with north side of Spillway/RO stilling basin, priority usage of the south (#2) RO gate is recommended. Under high flow events, spreading spill is acceptable to Dam Safety, but to the extent possible avoid use of the north (#1) regulating outlet and/or spillway gate.

Minimum gate openings will be observed at all times to avoid gate vibrations.

***Foster Spring Downstream Fish Passage***

**Description:** From February 1 – May 15, delay the refill of Foster Reservoir and hold at minimum conservation pool (El. 613-615 ft.). The spillway will be operated at night from one hour before sunset to one-half hour after sunrise; one turbine unit will be operated for station service (~300 cfs), and to reduce/balance TDG levels created by the spill operation. From May 16 – June 15, Foster Reservoir will refill using storage from Green Peter Reservoir and South Santiam inflow. The night spillway-only operations will continue with flows from one turbine as described above.

The fish weir provides warmer surface water from the reservoir to raise river temperatures and aid in attracting adult salmon to the Foster Adult Fish Facility (AFF) for collection, from June 16

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to mid/late July. The fish weir will be operated at a 300 cfs flow with the duration of operation depending on storage in both Green Peter and Foster Reservoirs, and biological need (i.e., numbers of adult Chinook salmon collected at the AFF). Close coordination with the Flow Management and Water Quality Team (FMWQT) and the Foster Fish Facility manager will be necessary for the intra-seasonal management of this operation.

**Purpose:** Delayed Refill followed by fish weir flow.

**Intended Benefit:** Improved fish passage.

**Table 2-50. Foster Spring Interim Operation.**

Dam	Foster
Duration (hours/days)	4pm – 8am (at night from one hour before sunset to one-half hour after sunrise)
Estimated Start Date	Delayed Refill start: 1 February Operate Fish Weir: 16 June
Estimated End Date	Delayed Refill end: 16 May Operate Fish Weir: Mid/late July - the duration of operation depending on storage in both Green Peter and Foster Reservoirs and biological need
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	minimum conservation pool (El. 613-615 ft.) until refill starts on 16-May
Outlet (RO/spillway/etc.)	Spillway at night, one turbine unit will be operated for station service (~300 cfs), and to reduce/balance TDG levels created by the spill operation.
Min flow (cfs)	Fish weir flow: 300
Max flow (cfs)	N/A

***Foster Fall Downstream Fish Passage***

**Description:** Starting just after Labor Day weekend, gradually draw down Foster reservoir to target a forebay elevation of 620-625 ft by October 1. Beginning on October 1, utilize the spillway to pass fish at night, while generation occurs during the day. Carry out through December 15.

**Purpose:** Fall drawdown and night-time spillway operation.

**Intended Benefit:** Improved fish passage.

**Table 2-51. Foster Fall Interim Operation.**

<b>Dam</b>	<b>Foster</b>
Duration (hours/days)	Drawdown: continuous Spillway Operation: at night Turbines: day
Estimated Start Date	1 October
Estimated End Date	15 December
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	620-625 ft by October 1
Outlet (RO/spillway/etc.)	Spillway at night
Min flow (cfs)	N/A
Max flow (cfs)	N/A
Additional Information (ex. head restrictions)	–
Notes	–

### **2.9.5 McKenzie River Interim Operations**

#### ***Cougar Fall and Spring Drawdown for Downstream Fish***

**Description:**

*Fall Operation:* Draw down Cougar Reservoir below minimum conservation pool (El. 1532 ft.) to provide a surface-oriented flow through the regulating outlets. This drawdown targets an elevation of El. 1505 +/- 5 ft in the fall, or approximately 27 ft below normal winter reservoir elevation.

Prioritize the ROs throughout the implementation of this operation. However, some station service (a 150 cfs release through the turbine unit) may be required early on to ensure no loss of remote flood risk management capability due to issues with the operability of the emergency diesel generator, which is the only automatic back-up power source for the facility in the event of an unanticipated loss of line power. Refill begins in December and operations will transition to nighttime RO releases and daytime generation.

During storms and flood risk reduction events, USACE and NMFS may jointly decide to allow the reservoir to fill rather than use the turbines to increase outflows out of Cougar Dam and develop a strategy to manage water releases following this and future storm events. Once the

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storm passes, RO discharges will be increased to draw the reservoir back to the targeted elevation of 1505 ft. as quickly as possible.

The ROs at Cougar Dam are known to produce elevated downstream TDG when releases are in excess of 800 cfs. Modest increases in downstream TDG are expected to be less detrimental to the life history stages in the reach downstream of Cougar at that time of year than passing juvenile fish through the turbine units.

Cougar will be allowed to refill back to El. 1532 ft. starting on December 15, along with nighttime RO usage and daytime generation.

*Spring Operation:* On February 01, the refill of Cougar Reservoir will be delayed until May or June depending on water conditions (i.e., wet, average, dry). In dry years, Cougar Reservoir may be refilled as early as May 01, while in wet years, refill may not begin until June 01. The goal is to start refill early enough that the reservoir can reach El. 1571 ft. by summer so that the Cougar Water Temperature Control Tower (WTCT) weirs can be used for downstream water temperature management.

On June 2, switch to all powerhouse flow.

Cougar Reservoir should not be drawn down below the elevation of the saddle dam during fish passage operations.

**Table 2-52. Cougar Dam Fall and Spring Interim Operations.**

Dam: Cougar	Fall	Spring
Duration (hours/days)	Continuous RO	
Est. Start Date	1 September	Drawdown starting 1 March; reach target elevation by 1 April
Est. End Date	15 December Post refill Nighttime RO/Daytime Turbine Operation ends: continue through early summer and while the spring delayed refill operation is being implemented. 16 Dec refill to min con (1532) hold until 1 March	15 May; refill as high as possible with min flow of 300 cfs
Recurrence Interval (X yrs)	Annually	Annually
Max pool elevation (ft, project datum)	Drawdown: 1505 ft +/- 5 ft (November target date)	1520 ft
Outlet (RO/spillway/etc.)	Prioritize RO for drawdown RO (night) and Turbine (day) during refill	Prioritize RO for drawdown

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Dam: Cougar	Fall	Spring
		RO (night) and Turbine (day) during refill
Min flow (cfs)	N/A	–
Max flow (cfs)	880 cfs (spawning Sep - Dec) 750 cfs RO max	–
Additional Information (ex. head restrictions)	Add turbines if flow above 800 cfs	–

**Purpose:** Fall and Spring Drawdowns to below minimum conservation pool.

**Intended Benefit:** Improved downstream fish passage.

### 2.9.6 Middle Fork River Interim Operations

#### *Hills Creek Dam Downstream Fish Passage*

**Description:** USACE will implement regulating outlet spill operations daily from 6:00 PM to 10:00 PM at Hills Creek Dam once the reservoir elevation is 50 feet or less above the regulating outlets in the fall through March 1.

**Purposed:** Prioritize discharges through the RO at night rather than through the turbines.

**Intended Benefit:** To improve downstream passage conditions for juvenile Upper Willamette River Chinook salmon by encouraging juvenile fish passage through the ROs instead of the turbines during periods when juvenile fish are most likely to be migrating downstream.

**Table 2-53. Hills Creek Dam Fall Interim Operation.**

Dam	Hills Creek
Duration (hours/days)	daily from 1800 to 2200 (equates to ~17% of daily flow)
Estimated Start Date	once the reservoir elevation is 50 feet or less above the regulating outlets in the fall
Estimated End Date	March
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	1,459 ft or below
Outlet (RO/spillway/etc.)	RO
Min flow (cfs)	N/A
Max flow (cfs)	N/A
Additional Information (ex. head restrictions)	N/A

**Lookout Point Fall Downstream Passage Operations**

**Description:** Drawdown the reservoir, starting in July, to reach target elevation of 761’ in mid-November.

**Purpose:** Deep drawdown and RO prioritization for improved downstream fish passage

**Intended Benefit:** To improve downstream passage conditions for juvenile Upper Willamette River Chinook salmon by encouraging juvenile fish passage through the ROs instead of the turbines during periods when juvenile fish are most likely to be migrating downstream.

**Table 2-54. Lookout Point Dam Fall Interim Operation.**

Dam	Lookout Point
Duration (hours/days)	24/7
Estimated Start Date	1) Draft reservoir beginning July 1, at a rate to achieve the Oct 1 rule curve elevation on Sept 1. 2) During the spawning season (Sept 1 to Oct 15), the total discharge from the dam will be maintained at or below the maximum flows for spawning (3500 cfs). 3) After the spawning season ends Oct 15, the draft rate will then be revised as needed to achieve the Nov 15 target elevation of 761 ft on November 10. 4) Pool target elevation will be achieved beginning at the earliest Nov 15, and the latest Dec 15.
Estimated End Date	Maintain target elevation as feasible for 3 weeks, but no later than Dec 15. Then refill to minimum conservation pool as feasible.
Recurrence Interval (X yrs)	Annually
Max pool elevation (ft, project datum)	761 ft
Outlet (RO/spillway/etc.)	RO Limit turbine operations to between the hours of 1000 to 1800 between July 1 and December 15 whenever the reservoir elevation is at or below 50 ft over the top of the penstock
Min flow (cfs)	N/A
Max flow (cfs)	N/A
Additional Information (ex. head restrictions)	N/A

***Lookout Point Spring Downstream Passage and Summer/Fall Temperature Management  
Operations***

**Description:**

Use storage from Hills Creek Reservoir to begin refilling Lookout Point Reservoir in early March. Once Lookout Point Reservoir elevation is 2.5 feet over spillway crest (El. 890 ft.), start continuous, ungated spill using as many gates (5 are available) as needed to approximate the rate of inflow to maintain the reservoir level between El. 890-893 ft. for as long as water conditions allow, for at least 30 days at both Lookout Point and Dexter dams. Operate the Lookout Point powerhouse only as needed to remain within the desired reservoir elevation limits, or to control downstream TDG. After that initial 30-day period, refill pool as hydrology allows and spill (gated) at night at both projects, with generation during the day, for as long as water is available and downstream conditions allow. Then manage Lookout Point Reservoir to achieve elevation 887.5 ft by July 15 and operate the regulating outlets as needed to reduce downstream water temperatures when water temperatures downstream of Dexter Dam near 60 degrees.

**Purpose:** Utilize spillway for improved downstream fish passage in the spring; use RO in the summer and fall for downstream temperature management

**Intended Benefit:** To improve downstream passage conditions for juvenile Upper Willamette River Chinook salmon by encouraging juvenile fish passage through the ROs instead of the turbines during periods when juvenile fish are most likely to be migrating downstream and improve water temperatures downstream of Lookout Point Dam.

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**Table 2-55. Lookout Point Spring Downstream Passage and Summer/Fall Temperature Interim Operations.**

–	<b>Spring Fish Passage (Spillway)</b>	<b>Spring Fish Passage (Spillway)</b>	<b>Summer/Fall Temperature (ROs)</b>
Duration (hours/days)	24 /7	Spillway: 50% (daily) Turbine: 50% (daily)	–
Estimated Start Date	15 March	1 May	15 July
Estimated End Date	1 May (or until reservoir is below 890')	31 May (or until reservoir is below 890')	~15 October
Recurrence Interval (X yrs)	Annually	Annually	Annually
Min pool elevation (ft, project datum)	890 ft	890 ft	
Max pool elevation (ft, project datum)	893 ft	926 ft	887.5 ft
Outlet (RO/spillway/etc.)	Spillway (ungated)	Spillway (gated) Turbine	RO (with turbine use)
Min flow (cfs)	N/A	N/A	–
Max flow (cfs)	N/A	N/A	–

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