Chehalis Basin Strategy

Proposed FRE Mitigation Plan

Reducing Flood Damage and
Restoring Aquatic Species Habitat

July 3, 2024

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ACRONYMS AND ABBREVIATIONS

7-DADMax	7-day consecutive mean daily max temperature
Applicant	Chehalis River Basin Flood Control Zone District
ASRP	Aquatic Species Restoration Plan
BMPs	Best Management Practices
BPG	Biogeographic Population Groups
CBS	Chehalis Basin Strategy
CE-QUAL-W2	two-dimensional temperature model
cfs	cubic feet per second
Corps	U.S. Army Corps of Engineers
CWA	Clean Water Act
dbh	diameter at breast height
DEIS	Draft Environmental Impact Statement
DO	Dissolved Oxygen
Ecology	Washington State Department of Ecology
EDT	Ecosystem Diagnosis and Treatment
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
ESA	Endangered Species Act
FCU	Forest Conversion Units
FCZD	Chehalis River Basin Flood Control Zone District
FEMA	Federal Emergency Management Agency
FFPF	Flood Fish Passage Facility
FIRP	Forest Industry Research Program
FPA	Forest Practices Act
FPAMT	Forest Practices Application Mapping Tool
FPHCP	Forest Practices Habitat Conservation Plan

FR	Forest Road
FRE	Flood Retention Expandable Facility
ft^2	square feet
GHLE	Grays Harbor County Lead Entity Habitat Work Group
GIS	Geographic Information System
HARP	Habitat Assessment and Restoration Planning
HCP	Habitat Conservation Plan
HEC-RAS	Hydrologic Engineering Center River Analysis System
HGM	Hydrogeomorphic
km	kilometer
LCC	Lewis County Code
LiDAR	Light Detection and Ranging
LWM	Large Wood Material
m	meter
M&AMP	Monitoring and Adaptive Management Plan
mi^2	square miles
MSL	Mean Sea Level
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NEPA	National Environmental Policy Act
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NTU	Nephelometric Turbidity Unit
OHW	Ordinary High Water
OHWM	Ordinary High-water Mark
PALS	Post-assisted Log Structures
PLSS	Public Land Survey System
PSU	Portland State University
RCC	Roller-Compacted Concrete

RM	River Mile
RMP	Revised Mitigation Plan
RMZ	Riparian Management Zones
RPDR	Revised Project Description Report
SASSI	Salmon and Steelhead Stock Inventory
SEPA	State Environmental Policy Act
SMP	Shoreline Management Plan
SOC	Species of Concern
SRKW	Southern Resident Killer Whales
SWIFD	Statewide Washington Integrated Fish Distribution
TBD	To Be Determined
TMDL	Total Maximum Daily Load
TOPSIS	Technique for Order Preference by Similarity of Ideal Solution
TTT	Temporary Trap-and-Transport
USDA	United States Department of Agriculture
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VMP	Vegetation Management Plan
WAC	Washington Administrative Code
WA DNR	Washington Department of Natural Resources
WDFW	Washington Department of Fish and Wildlife
WMZ	Wetland Management Zone
WRIA	Water Resource Inventory Area
WRIA 22	Lower Chehalis Watershed Resource Inventory Area
WRIA 23	Upper Chehalis Watershed Resource Inventory Area
WSDOT	Washington State Department of Transportation
WSE	Watershed Science & Engineering
WSEL	Water Surface Elevation

EXECUTIVE SUMMARY

The Chehalis River Basin Flood Control Zone District (Applicant) is proposing the construction of a Flood Retention Expandable (FRE) facility (Proposed Action) on the upper Chehalis River (river mile [RM] 108.4), near the town of Pe Ell, Washington. The FRE facility would operate to temporarily store floodwaters only during major and catastrophic floods when river flows are forecasted to reach 38,800 cubic feet per second (cfs) or greater as measured at the United States Geological Survey (USGS) Chehalis River Grand Mound gage. At all other times, the proposed FRE facility would allow normal river flow through the dam and would not store water. To offset potential environmental impacts from the construction and operation of this action the Applicant also proposes the impact avoidance, minimization and mitigation measures described in this Flood Retention Expandable Facility Revised Mitigation Plan (RMP).

The Draft Environmental Impact Statement (DEIS) prepared by the Washington Department of Ecology (Ecology 2020) under the State Environmental Policy Act (SEPA) and the DEIS prepared by the U.S. Army Corps of Engineers (Corps 2020) under the National Environmental Policy Act (NEPA) (hereinafter, DEISs) identified potential impacts to aquatic resources in the Chehalis River Basin that may result from the construction and operation of the FRE facility as originally proposed. Principal among these impacts would be effects on aquatic habitat, fish spawning habitat, water quality (temperature and turbidity), and terrestrial habitat. While many of these impacts were quantified, the quantification in the DEISs was not to a level that would inform development of targeted species- and site-specific mitigation requested by regulatory agencies. After publication of the DEISs, the Applicant prepared a Draft Mitigation Plan (Kleinschmidt 2020a) that presented its approach for mitigation of potential impacts identified in the DEISs. The Applicant has also proposed to realign the FRE facility upstream of the original site to minimize impacts to an identified Traditional Cultural Property. While revising the FRE facility design to accommodate the new alignment, the Applicant incorporated design aspects that would avoid or minimize potential environmental impacts. The revised project design layout was completed in the spring of 2024 (HDR 2024).

As the project design was being updated, the Applicant also worked to revise the Draft Mitigation Plan. The resulting RMP (this document) covers potential impacts refined from those identified in the DEISs, incorporates agency feedback on the Draft Mitigation Plan, and advances species- and site-specific mitigation. Mitigation committed to by the Applicant in this RMP would avoid, reduce and mitigate impacts identified in the DEISs. The mitigation would also address the Applicant's obligations under Section 404 of the Federal Clean Water Act, and would minimize and offset any effect of the Proposed Action on species listed under the Endangered Species Act. Accordingly, this RMP describes mitigation measures that the Applicant is proposing to implement and demonstrates how the Applicant intends to fulfill its commitment to avoid, minimize, and mitigate potential impacts to achieve no net loss of habitat function due to project-related impacts.

The Applicant has systematically reviewed avoidance, minimization, and mitigation actions, and identified appropriate actions in the context of the proposed project. The principal actions proposed to avoid and minimize impacts include:

1. Realigning the FRE location upstream away from the identified Traditional Cultural Property;
2. Eliminating the need for a bypass tunnel and a temporary trap and transport facility thereby allowing for volitional fish passage with phased construction;
3. Limiting tree removal within the FRE inundation area to approximately 42 acres associated with temporary construction disturbance; and
4. Accelerating conversion of existing vegetation within the inundation area to flood-tolerant vegetation community before initial operation through implementation of the Vegetation Management Plan (VMP), thus maintaining some shade and erosion protection.

Mitigation actions proposed to offset unavoidable impacts are described under six mitigation categories Fish and Aquatic Habitat Restoration and Enhancement; Riparian and Stream Buffer Expansions; Wildlife Habitat Conservation; Large Wood Material Recruitment and Placement; Surface Water Quality Protection; and Wetland Enhancement.

Specific mitigation measures include:

1. Construction of aquatic habitat features to promote habitat diversity, habitat complexity, enhance spawning and rearing habitat;
2. Removal of fish passage barriers to expand fish access to tributary habitat;
3. Enhancement of streamside vegetation and reforestation with native vegetation to re-establish natural processes such as stream shading, soil retention, nutrient cycling;
4. Enhancement of wildlife habitat by converting commercial timberlands to native woodlands and forests that restore native forest processes and support a more species-rich wildlife and terrestrial community;
5. Enhancement of large wood material in the mainstem river to provide habitat for aquatic species and restore related stream processes; and
6. Measurement of streamside revegetation actions on water quality to ensure compliance with goals and regulations.

In addition, Monitoring and Adaptive Management Plans (M&AMPs) are proposed to ensure the long-term viability of the avoidance, minimization, and mitigation measures.

The mitigation proposed in this plan would not only address the estimated impacts put forth in the DEISs but would also help to alleviate existing habitat limiting factors in the basin and thereby generate overall improvement in the ecological conditions and habitat functions in the upper Chehalis River. The Applicant's proposed mitigation measures focus on improving the following limiting factors previously identified for the upper Chehalis River Basin, including warm summer water temperatures, altered riparian habitat, lack of aquatic and terrestrial habitat complexity, and lack of large wood. In this way, the Applicant's combination of minimization and mitigation measures would go beyond no net loss of habitat function to provide additional ecological lift, or functional habitat benefit, for aquatic and wildlife species in the upper Chehalis River.

Proposed Action

As described in Section 2, the proposed FRE facility would be located at approximately RM 108.4, about two miles south and upstream of the town of Pe Ell. The facility would operate temporarily to reduce flood damage and minimize transportation disruption during major floods as described below. The Proposed Action would reduce flooding originating in the Willapa Hills during major and catastrophic flood events; however, the proposed FRE facility would not be operated during lesser floods such that environmentally beneficial flooding would still occur.

Permanent features of the Proposed Action include: the proposed FRE facility; a fish collection, handling, transfer, and release facility for use when the FRE is in operation; aggregate quarries and access road improvements; improvements to the town of Pe Ell water system; and improvements to an existing levee. Temporary features required for construction of the proposed FRE facility include: a concrete batch plant; materials handling equipment; work and storage (staging) areas; temporary roads; and a temporary bypass channel. A temporary water supply would also be required during construction. Construction of all infrastructure would be completed in approximately 4-5 years.

The proposed FRE facility would only operate when river flows are forecasted to reach 38,800 cfs or greater as measured at the USGS Chehalis River Grand Mound gage (USGS Gage No. 12027500) located at RM 59.9 in Thurston County. Under the current hydrologic regime, floods of this magnitude are projected to have a 15% probability of occurrence in any one year, or statistically occur every 7 years on average. The facility would be operated to temporarily retain peak floodwater flows for up to 27 days for a major flood event to 32 days for a catastrophic flood event similar in magnitude to the 2007 flood event. When the proposed FRE facility is not operating, the Chehalis River would flow freely through the structure’s low-level outlets at its normal flow rate and volume, and no water would be retained behind the facility. Thus, when the proposed FRE facility is not operating, sediment transport and fish passage would occur as they do under current conditions.

Existing Baseline Conditions

An assessment of Existing Baseline Conditions is provided in Section 3, including a description of the physical environment, the current status of aquatic and terrestrial species, and factors currently limiting ecosystem function for purposes of developing appropriate reach level mitigation. Data were compiled from many reports by Washington Department of Fish and Wildlife (WDFW), Ecology, Corps, National Oceanic and Atmospheric Administration (NOAA) Fisheries, USGS, Anchor QEA, LLC, Kleinschmidt Associates, and HDR Engineering, as well as peer-reviewed literature and regional white papers.

The study area for existing conditions covers the upper Chehalis River from the headwaters in the Willapa Hills downstream to the town of Chehalis. Given the location of the proposed Project at approximately RM 108.4, the area under consideration for implementation of mitigation actions (i.e., Mitigation Area) extends from the confluence of the East and West forks of the Chehalis River at RM 118.0 downstream to the Adna bridge at approximately RM 81.0 and includes tributary drainages.

Land use practices in the basin include agriculture, livestock grazing, and urban development in low-elevation areas and timber production in higher-elevation areas. Road building throughout the basin has included construction of numerous culvert barriers that limit access to suitable upstream habitats for aquatic species. The mainstem Chehalis River is a predominantly entrenched single channel with limited floodplain connectivity in the upper basin and limited riparian corridor vegetation lower down. Portions of the Impact Area are designated as Clean Water Act Section 303(d) Impaired Waters or Water of Concern for parameters including turbidity, nutrients, fecal coliform, dissolved oxygen, and temperature. Increased water temperature has been documented widely in the Chehalis River Basin as a particular concern during low-flow summer months, and has been identified as a key limiting factor for spring-run Chinook salmon (*Oncorhynchus tshawytscha*) spawning in the upper Chehalis River since the 1970s. Stream temperature increases have been attributed to the loss of riparian vegetation along stream channels causing increased solar heating of the water, and more recently to climate change. This, combined with low summer flows, limits suitable available habitat for native cool water fish species.

There are no Endangered Species Act-listed salmon populations in the Chehalis River. However, Chinook salmon are a critical prey species for endangered Southern Resident killer whales. Essential Fish Habitat has been designated for Chinook salmon and coho salmon (*O. kisutch*) in the Chehalis River, encompassing all accessible water bodies including the mainstem river and tributaries. Additional fish species that may rear or spawn in the Impact Area include steelhead (*O. mykiss*), Pacific lamprey (*Entosphenus tridentatus*), mountain whitefish (*Prosopium williamsoni*), western brook lamprey (*Lampetra richardsoni*), resident trout species (*Oncorhynchus* sp.), and Olympic mudminnow (*Novumbra hubbsi*), which is a Washington State designated sensitive species. Other aquatic species of interest that may be found in or near the Impact Area include the still-water breeding western toad (*Anaxyrus boreas*), a candidate for state listing, and the Dunn's salamander (*Plethodon dunni*) and Van Dyke's salamander (*P. vehiculum*) which are both candidates for state listing. The federally- and state-listed marbled murrelet (*Brachyramphus marmoratus*) has also occurred in the basin.

Potential population limiting factors in the upper Chehalis River Basin were reviewed to identify mitigation actions that would provide site-specific ecological lift against potential project impacts while also helping to improve overall watershed health. Limiting factors include lack of structurally complex mature and old-growth forests, degraded riparian conditions, seasonally high and low flows, degraded water quality, degraded stream channel and floodplain conditions, barriers to fish spawning and rearing habitat, and invasive species including riparian shrubs and wetland plants, bullfrog, and warmwater piscivorous fishes. Each of these elements affects the quality of habitat, as summarized below, and has the potential to limit population growth for native fish, amphibians, and terrestrial species. Mitigation was developed that would help to ameliorate these factors and provide the greatest ecological benefit to the species and habitats.

Potential Impacts

The DEISs were published by Ecology under the Washington SEPA in February 2020 (Ecology 2020) and by the Corps under NEPA in September 2020 (Corps 2020). Both documents reported findings that the Proposed Action would have probable, unavoidable, and adverse impacts on aquatic and terrestrial habitats and species. At that time, no mitigation plan for the project was available for the agencies to consider so neither document assessed reducing potential impacts via avoidance, minimization or mitigation measures and the agencies assumed that harvest of trees would occur within 600 acres of the inundation area during construction. In general, impacts described in both SEPA and NEPA DEISs were very similar, and where they differed, the SEPA DEIS (hereinafter, DEIS) identified greater magnitude of impact and/or impact across a broader geographical area; therefore, this mitigation plan describes mitigation in terms of the more conservative DEIS impact level.

The DEIS impacts were used to anticipate potential mitigation obligations. The impacts were conservative without consideration of avoidance, minimization, and mitigation measures that the Applicant has committed to implement to reduce Proposed Action effects. For purposes of the RMP development, DEIS impacts were categorized by Proposed Action phase (construction, operation) and duration (episodic/temporary, permanent). In general, construction impacts were defined more specifically than were operation impacts which were characterized more qualitatively. A brief description of categorized impacts determined by Ecology is as follows:

- Temporary Construction – Related impacts include temporary dewatering, fish passage interruption, and increased sediment load during construction.
- Permanent Construction – Related impacts include vegetation clearing in the inundation area and site clearing for physical infrastructure, and loss of river channel and floodplain associated with the proposed FRE facility and associated facilities.
- Temporary Operations – Related impacts include episodic inundation; water temperature increases from loss of shade and corresponding dissolved oxygen decreases; episodic increases in turbidity with storm events; increased sediment loading during flood pool drawdown; interruption in sediment transport and Large Wood Material delivery to habitats downstream of the FRE facility; reduced groundwater recharge due to decreased floodplain engagement; and decreased wildlife habitat function and mortality of non-mobile terrestrial species during inundation.
- Permanent Operations – Related impacts include degraded stream channels and buffers associated with inundation; water temperature increases from loss of shade and corresponding dissolved oxygen decreases; degradation of salmon and native fish habitat; degradation of riparian function; indirect mortality to wildlife species and decreased distribution due to loss of upland, wetland, and riparian habitat; and increased habitat suited for invasive species colonization.

Proposed Mitigation

The mitigation described in Sections 6 through 8 of this RMP meet federal and state regulatory requirements and mitigation guidance. Standard mitigation sequencing is a process for avoiding, minimizing, or compensating for the potential effects of an action on the environment. Avoidance and minimization measures proposed under this RMP include measures that would avoid impacts to migratory aquatic species and minimize impacts associated with loss of shade trees upstream of the FRE facility.

Mitigation measures are identified that prioritize actions that are on-site and in-kind wherever feasible followed by actions that are off-site or out-of-kind. All proposed mitigation measures are widely accepted, have been implemented successfully in the Pacific Northwest and are feasible in the upper Chehalis River.

Regulatory agencies apply mitigation ratios, typically during permitting, for a variety of purposes aimed at ensuring no net loss of ecological functions and values. Mitigation ratios use a multiplier of unit measure for mitigation versus impact to result in a larger area, or amount, of mitigation compared to the area or amount of impact. There is no set of standardized mitigation ratios for aquatic or terrestrial impacts. Bradford suggested that a multiplier of 1.5:1 or 2.5:1 is sufficient for addressing uncertainty when offsetting impacts on freshwater fish productivity (Bradford 2017). However, for wetlands, mitigation ratios are prescribed by regulation and vary depending on wetland and mitigation categories. Since no mitigation ratio requirement has been determined for the Proposed Action at this time, the Applicant proposes variable mitigation ratios by resource that range from 1:1 for wetland and stream buffers to 2.5:1 for fish and aquatic habitat impacts to 3:1 for enhancement of Category III wetlands.

Key Avoid and Minimize Measures

- Avoid impacts associated with temporary trap and transport and a diversion tunnel by maintaining an open natural bypass channel for unimpeded river flows and volitional fish migration during construction.
- Implement a Vegetation Management Plan that includes pro-actively planting native, flood-tolerant species prior to initial operation and maintain these habitats over time.

The Applicant's proposed mitigation plans include mainstem aquatic habitat enhancements, tributary habitat enhancements, riparian and stream buffer expansion, wildlife habitat conversion, large wood material recruitment and placement, surface water quality, and wetland enhancements, each of which is summarized in the sections below.

Mainstem Aquatic Habitat Enhancements

These mitigation measures focus on impacts on aquatic species and their habitats and how the existing stream condition could be enhanced to the benefit of rearing and spawning life stages of anadromous fish and aquatic amphibians (see Section 8.1.1). Conceptual designs were developed for 13 mitigation projects where project function and persistence were compatible with reach-scale flooding and sediment transport processes. The proposed mitigation is designed to offset potential impacts on fish habitat and productivity via the construction of instream habitat complexity and gravel retention structures; enhancing and/or providing access to off-channel habitats that provide complexity and thermal refuge; and a loose large wood management plan (see below). Actions were also identified to enhance floodplain connectivity and thereby contribute towards riparian buffer expansion, providing future habitat complexity and enhancing access to off-channel habitats.

Proposed Mitigation

- Enhance fish and aquatic habitat complexity and diversity with 16 separate measures totaling 3.36 miles of mainstem and 2.3 miles of tributary habitat and 71,600 sq ft of spawning habitat.
- Improved fish access to 39.3 miles of suitable stream habitat.
- Riparian/stream buffer expansion along 21.3 miles of stream channel downstream of the proposed FRE facility location to create shade and restore riparian processes to create shade and restore riparian processes.
- Riparian/stream buffer expansion along 23 miles, 362 acres of non-fish streams upstream of the FRE to restore riparian processes including reducing erosion and capturing runoff.
- Upstream of the FRE location, transition 1,558.5 acres of commercial timberlands to successional old growth forest and enhance wildlife habitats, forest, and wetland functions.
- Placement of large wood structures to create habitat for the near term and riparian enhancements for future wood recruitment over the long term.
- Establishing shade along 21.3 miles of river to reduce potential for thermal loading from the sun would reduce mainstem water temperature X degree Fahrenheit. Enhancement of riparian habitat and processes across 44 stream miles would improve water quality.

Tributary Habitat Enhancements

This action type involves enhancing habitat complexity within and/or improving access to significant, smaller perennial tributaries connected to the mainstem Chehalis River. Enhancement measures (Section 8.1.2) involve the construction of habitat features in the perennial wetted channel to enhance, restore, induce, or create habitat-forming processes and habitat elements such as complexity, cover, hydraulic diversity, pool formation, summer thermal refugia from the mainstem, and spawning gravel retention. Example instream modifications include installing large wood material in the banks for habitat complexity, excavating new channels, constructing inset floodplains in tributary channels entrenched in the Chehalis River floodplain, and restoring degraded riparian buffers with trees and shrubs that provide bank stability and temperature regulation. The RMP also proposes six barrier removals to improve habitat access to 39.3 miles (63.3 kilometers) of fish bearing streams (Section 8.1.3). This is more than three times the length of impacted fish bearing streams upstream of the FRE facility.

Riparian/Stream Buffer Expansion

The Riparian and Stream Buffer Expansion Plan (Section 8.2) would improve riparian habitats through two mitigation action types, Riparian Enhancement and Forest Conversion. Riparian Enhancement would occur along the mainstem Chehalis River and some tributary streams to mitigate residual impacts related to loss of riparian trees and shade reduction in the inundation area, degradation of aquatic habitat, degradation of wildlife habitat, and degraded water quality associated with the construction and operation of the FRE facility. The current condition of the riparian habitat within the Mitigation Area is degraded as it has been impacted by agriculture practices, tree clearing, and the establishment of invasive species for decades. Reforesting and enhancing these habitats would result in a variety of benefits to both aquatic and terrestrial species that occupy them. A primary objective of this action is shade-related reduction in summer water temperatures. Implementation of the VMP will reduce the loss of shade trees by active planting of flood tolerant species, which combined with riparian planting across 131 parcels, 21.3 miles of stream bank, would provide sufficient shade for mitigation.

Wildlife Habitat Conservation

The Applicant proposes the following mitigation treatments (see Section 8.3) to offset potential impacts to wildlife and terrestrial species:

- Purchasing private commercial timberlands adjacent to and upstream of the proposed FRE inundation area and setting them on a plant succession path towards diverse, old-growth forests. Forest treatments would include protecting large, older trees, selective cutting/tree thinning to promote tree and understory growth, in-planting a diversity of native trees and shrubs, and girdling trees to create snags and downed Large Wood Material (LWM).
- Improving and protecting riparian habitat along those sections of non-fish bearing streams in the Forest Conversion area that do not have protections under the Fish Protection Act. In these areas, planting rapidly growing riparian trees and shrubs would increase stream shading and create wildlife habitat directly and through the production of downed LWM over time.
- At a large mitigation site located between RM 89.3-87.6, expansion of off-channel flow-path and perennial tributary habitat, creation of depressional palustrine wetlands in historic floodplains, converting agricultural fields to native wetland and riparian forest habitats, and increasing forest structure and plant species diversity through tree and shrub plantings.
- Protection and expansion of instream and riparian habitats along the Chehalis River and tributary streams downstream of the proposed FRE facility at the RM 89.3-87.6 and Bunker Creek sites.

These proposed mitigation measures would benefit a broad diversity of forest dwelling and riparian wildlife, amphibians, and insects including many species of concern such as marbled murrelets, bald eagles and other raptors, and Dunn’s and Van Dyke’s salamanders.

Large Wood Material Recruitment and Placement

Mitigation includes relocating transient trapped wood from upstream of the proposed FRE facility to the river downstream as part of the Large Wood Management Plan, installing fixed wood pieces along the length of the river as part of the Fish and Aquatic Species and Habitat Plan, and planting native trees along 21.3 miles of streambanks under Riparian/Stream Buffer Expansion (Section 8.4). The objectives of this mitigation action type are to provide future LWM recruitment through the conservation and expansion of riparian buffers and increase in-stream LWM through translocation of supply and installations downstream of the FRE facility. The placement and stabilization of LWM with installations would provide an immediate increase in instream habitat structure and cover; facilitate the enhancement, restoration, inducement, or creation of habitat-forming processes; and promote hydraulic diversity, substrate diversity, high flow refugia, pool formation, and gravel retention in suitable reaches.

Surface Water Quality

The Applicant is proposing several mitigation actions to address water quality impacts including: i) minimizing loss of riparian vegetation and associated impacts through implementation of the VMP (see Section 6); ii) riparian enhancement and reforestation along the mainstem Chehalis River between the proposed FRE facility and the town of Adna (see Sections 7.3.4 and 8.2); iii) forest conversion of 1,558 acres of commercial timberlands to native structurally diverse forest; and iv) riparian buffer enhancement along 23 miles of stream under forest conversion (see Sections 7.3 and 8.2).

Riparian planting plans include use of native vegetation to encourage development of multi-canopied riparian forests and shrublands working towards restoration of natural processes including capture of run-off and reduced erosion, increased bank stabilization, modulation of local air and stream temperature. Riparian enhancement also would mitigate for potential shade related temperature increases both within and downstream of the FRE. Shade loss after implementation of the VMP would be is estimated as an increased thermal load reaching the river. This loss will be offset by riparian enhancement across 131 land parcels downstream of the FRE that would reduce thermal load reaching the stream.

Wetland Enhancement

The proposed mitigation under the Wetland Enhancement Plan will comprise three primary components to mitigate for DEIS impacts to 17.66 acres of wetlands and 381 acres of wetland buffers from the construction and operation of the proposed FRE facility (Section 8.6) and the levee. These include wetland conservation and buffer enhancement for 27 wetlands within the 1,921 acres proposed for Forest Conversion, opportunistic enhancement of any existing wetlands within the riparian enhancements along the mainstem Chehalis River downstream of the FRE, and development of 42.5 acres of depressional wetlands on the Chehalis River floodplain. All wetland mitigation will include fully vegetated buffers, and that buffer area will constitute a component of the mitigation for the wetland buffer impacts resulting from the Proposed Action.

Monitoring and Adaptive Management

The Applicant is proposing a three-tiered approach to addressing uncertainty in mitigation performance. First, mitigation would be designed conservatively to account for changing hydrology and channel adjustments that might be expected under varying future hydrology. This will ensure project resiliency in the face of changing climate conditions. Second, the Applicant is proposing to apply mitigation ratios developed to incorporate uncertainty with mitigation performance. Third, the Applicant proposes to develop M&AMPs for each of the six categories of mitigation described above to address uncertainties that may arise after mitigation implementation that could affect ecological function. The Applicant has committed to implementing both the mitigation actions and implementation of the M&AMPs, including any necessary corrective actions or contingency measures, as an integral part of the Proposed Action. Moreover, both mitigation actions and M&AMPs implementation will become binding obligations on the Applicant under the Proposed Action's various federal, state and local approvals and environmental reviews.

The proposed monitoring framework for M&AMPs (Section 9) identifies i) mitigation-specific performance metrics that would be monitored to evaluate how successful the mitigation is in meeting goals and objectives; ii) monitoring sampling design and timeframes; and iii) the adaptive management process within which monitoring results would be evaluated with respect to project success or triggering potential corrective actions or implementation of contingencies required. As proposed, each of the six M&AMPs would be developed in consultation with an Adaptive Management Committee composed of staff from the Applicant's organization and representatives as appropriate, agency representatives, and basin stakeholders during the permitting phase of the project. The Applicant proposes to begin implementing the M&AMPs at Year 1 of proposed FRE facility construction and continue implementing it through the life of the project.

1 INTRODUCTION

1.1 Background

The Chehalis River Basin Flood Control Zone District (Applicant) is proposing construction of the Flood Retention Expandable (FRE) facility (Proposed Action) on the upper Chehalis River (river mile [RM] 108.4), near the town of Pe Ell, Washington, and levees located in the downstream developed areas between the cities of Centralia and Chehalis, Washington (Figure 1.1-1).

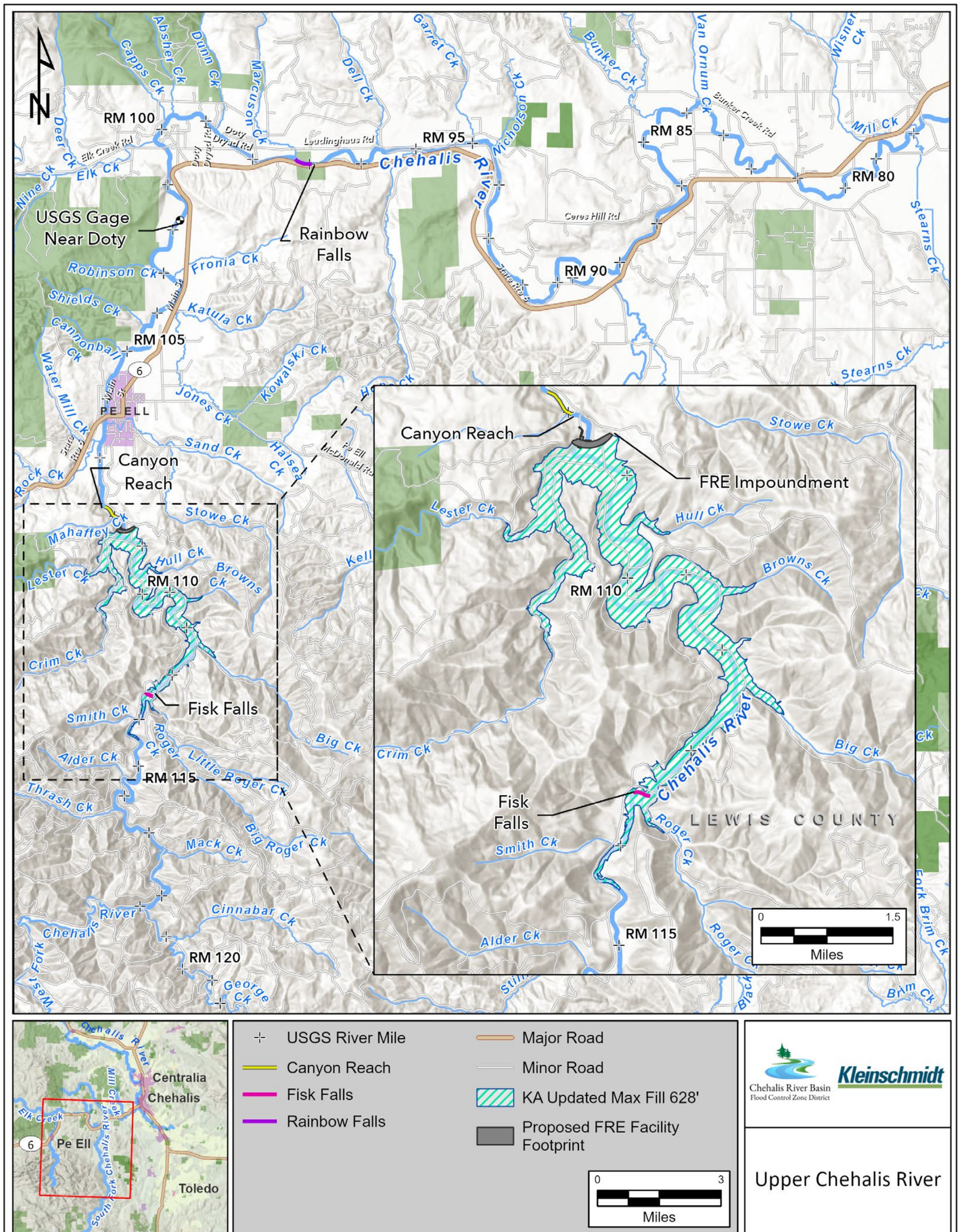
The Proposed Action is currently under environmental review. Washington State Department of Ecology (Ecology) published a Draft Environmental Impact Statement (DEIS) under the Washington State Environmental Policy Act (SEPA) in February 2020 (Ecology 2020). The United States Army Corps of Engineers (Corps) published a DEIS under the National Environmental Policy Act (NEPA) in September 2020 (Corps 2020). Both documents (DEISs) initially reported findings that the Proposed Action would have unavoidable, adverse impacts on aquatic and terrestrial resources. Subsequently the Applicant has undertaken several studies to better understand these potential impacts at a scale relevant for mitigation. The Applicant also has revised the project design and devised numerous avoidance, minimization and mitigation measures to address the DEIS identified impacts.

The Flood Retention Expandable Facility Revised Mitigation Plan (RMP) describes the existing and potential future conditions of the aquatic and terrestrial species and habitats in the area potentially affected by the construction and operation of the proposed FRE facility (Impact Area) as well as the area considered for mitigation (Mitigation Area). The Mitigation Area includes the upper Chehalis River Basin from the confluence of the East and West forks downstream to the Adna Bridge (RM 81.0).

Existing conditions are described relative to the species and habitats that were identified in the DEISs as potentially impacted by the Proposed Action. This document summarizes the potential impacts of the Proposed Action on these resources, describes avoidance and minimization measures, and identifies mitigation to offset unavoidable impacts. These conceptual mitigation measures will be further refined following field evaluation of potential mitigation sites to determine project feasibility, and consultation with state and federal agencies during project permitting. Affirmative commitments are enforceable and may be given full consideration by federal and state reviewing and permitting agencies.

The resources used to develop this mitigation plan incorporate the DEISs which include analyses of existing conditions and potential effects associated with the Proposed Action and the Chehalis Basin Strategy (CBS) Programmatic Environmental Impact Statement (EIS) (CBS 2017). Additional data on the presence, distribution, and status of aquatic and terrestrial habitat and species was gathered from numerous reports by Washington Department of Fish and Wildlife (WDFW), Ecology, Corps, National Oceanic and Atmospheric Administration (NOAA), United States Geological Survey (USGS), Anchor QEA, LLC (Anchor QEA), Kleinschmidt Associates (Kleinschmidt), and HDR Engineering (HDR), as well as peer-reviewed literature and regional white papers. These data are summarized in Section 3.

Figure 1.1-1
Map of Chehalis River Including the Location of the Proposed FRE Facility, and Important Landmarks and River Mile Markers.



1.2 Purpose and Scope

The purpose of this RMP is to provide the basis for demonstrating the reasonable feasibility of avoiding, minimizing, and mitigating potential project impacts and achieving no net loss of aquatic and terrestrial habitat function due to the construction and operation of the Proposed Action in the upper Chehalis River Basin. The RMP may be used by state and federal agencies when evaluating potential impacts of the Proposed Action on aquatic and terrestrial habitats under state and federal laws and regulations. The plan includes the detail necessary to inform environmental review under SEPA and NEPA as well as local permitting (e.g., shorelines, critical areas, land use), Clean Water Act (CWA) Sections 401 and 404, Endangered Species Act (ESA) Section 7 consultation, Hydraulic Project Approval, and other related permits and reviews.

2 PROPOSED ACTION DESCRIPTION

2.1 Project Objective and Siting/Location

The Proposed Action is described in the report "Revised Project Description: Flood Retention Expandable Structure" (HDR 2024) (RPDR). This section summarizes relevant information from the RPD that pertains to avoidance, minimization, and mitigation of the potential environmental effects of the Proposed Action.

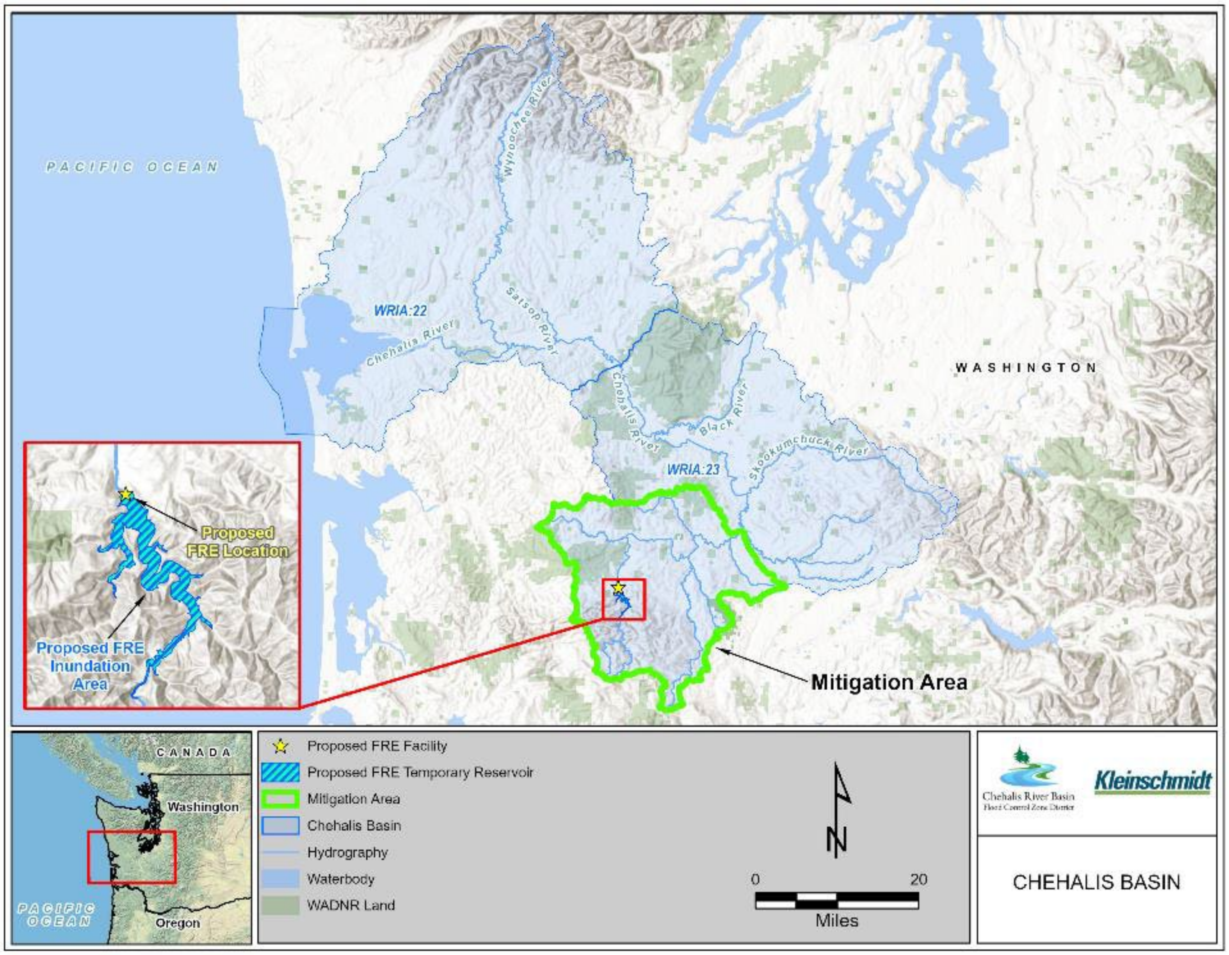
The proposed FRE facility would be located at RM 108.4, about two miles south of the town of Pe Ell, and would operate to reduce flood damage and minimize transportation disruption during major floods as described below (Figure 2.1-1). The Proposed Action would reduce flooding originating in the Willapa Hills during major and catastrophic flood events; however, the proposed FRE facility would not be operated during smaller floods.

The proposed FRE facility would only operate when river flows are forecasted to reach 38,800 cubic feet per second (cfs) or greater as measured at the USGS Chehalis River Grand Mound gage (USGS Gage No. 12027500) located at RM 59.9 in Thurston County. Under the current hydrologic regime, floods of this magnitude are projected to have a 15% probability of occurrence in any one year, or statistically occur every 7 years on average. The facility would be operated to temporarily retain peak floodwater flows and then release retained water following the flood peak. Inundation pool drawdown operations would depend on inflows and the need to hold water to relieve downstream flooding.

When the proposed FRE facility is not operating, the Chehalis River would flow freely through the structure's low-level outlets at its normal flow rate and volume, and no water would be retained in the inundation area. Thus, when the proposed FRE facility is not operating, sediment transport and fish passage would occur as they do under current conditions.

The preliminary design of the proposed FRE facility, construction, and operations were presented in the engineering design report (HDR 2024) and are summarized below. Once permitted, the proposed FRE facility construction is anticipated to begin in 2030 and would be ready for operation in 2035.

Figure 2.1-1
Study Area for the Chehalis River Basin Including Location of the Proposed FRE Facility, and Planned Mitigation Area.



2.2 Proposed Flood Retention Expandable Facility and Construction Phasing

The proposed FRE facility would be constructed along the mainstem Chehalis River at RM 108.4, just downstream from the Crim Creek confluence. The proposed FRE facility would extend across the river channel and upslope on both river banks into the floodplain. The construction footprint would include a combination of permanent and temporary (i.e., removed after construction) features. The design, construction methods, and operations plans summarized below are subject to updates during future design phases.

The proposed FRE facility would be constructed in phases to minimize disturbance to aquatic habitat and life stages. The river valley cross-section at the FRE facility site allows for a portion of the project, including the outlet and conduit structure, to be constructed in the dry while the river is diverted to a previously constructed adjacent river bypass channel. In a second phase, the river would be rerouted into a realigned permanent channel and through the fish passage conduits allowing the remainder of the FRE facility would then be constructed. This construction phasing allows for continuous upstream and downstream fish migration through an open channel.

2.2.1 Permanent Features

Permanent features of the Proposed Action include the proposed FRE facility; a fish collection, handling, transfer, and release facility; aggregate source quarries and access road improvements; and improvements to the town of Pe Ell water system. These and other permanent features are described below.

2.2.1.1 Flood Retention Expandable Facility

The proposed FRE facility (Figure 2.2-1) would be designed to impound water temporarily during major and catastrophic floods. The primary permanent components of the FRE include the following:

- A roller-compacted concrete (RCC) flood retention structure capable of retaining up to 62,000 acre-feet of flood water. It would have an estimated maximum structural height of 240 feet (intake channel) and a flood storage elevation of 628 feet mean sea level (MSL). It would be approximately 2,250 feet in length from abutment to abutment.
- An overflow spillway, designed to pass flood flows up to and including the Probable Maximum Flood, estimated to be 69,800 cfs at the Grand Mound gage (Mauger et al. 2016), without structure overtopping, as required under the Washington State Dam Safety Office guidelines (Ecology 1992a, 1992b, 1992c, 1992d, 1992e, 1992f). The 255-foot-wide spillway would include an uncontrolled crest structure, stepped spillway chute, and stilling basin.
- A 9-foot-diameter evacuation conduit for release of minimum flows during FRE flood event operations and evacuation of retained floodwaters during temporary inundation pool drawdowns.
- Five 320-foot-long, lighted conduits would pass through the bottom of the FRE structure to convey normal river flow, to provide for upstream and downstream volitional fish passage, and allow downstream movement of sediments and wood material (passing through trashrack with 24-inch clear spacing between bars). The conduits would be gated for flood flow retention during operation.
- A fish collection, handling, transfer and release facility (i.e., Flood Fish Passage Facility [FFPF]) designed for assisted fish passage during flood retention and inundation pool evacuation periods.
- A concrete apron for fuel tank unloading and fuel storage containment areas.
- A permanent maintenance facility, including vehicle parking, mechanical/electrical building, and storage building.

Figure 2.2-1
Rendering of Proposed FRE Facility Roller-Compacted Concrete Gravity Structure, with Crest Length of 2,250 Feet and Structural Height of 240 Feet, and Flood Fish Passage Facility (Foreground). Proposed In-Situ Location at Chehalis RM 108.4.

Notes:
Source: HDR (2024).

2.2.1.2 Flood Fish Passage Facility

During flood retention operations of the proposed FRE facility and subsequent inundation pool evacuation and wood removal operations, the low-level conduits would be closed with minimum instream flows maintained via the evacuation conduit. At these times, volitional fish passage would be restricted so a FFPF would be constructed and operated to minimize upstream fish passage delays. The FFPF would be located along the left bank (looking downstream) adjacent to the conduit stilling basin (Figure 2.2-1; HDR 2024). The facility would collect fish, and operations personnel would transport them to release sites upstream of the proposed FRE facility.

Concepts for the FFPF were developed in 2023 in collaboration with multi-agency resource specialists from the CBS Fish Passage Technical Subcommittee. The FFPF would be designed to pass all life stages of resident, anadromous, and lamprey species that are currently present in the construction area.

A half-Ice Harbor-type adult fish ladder was selected as one component of the FFPF; in part, because of its ability to accommodate passage of aquatic species with a wide range of swimming and jumping capabilities. The current design features meet NOAA Fisheries passage criteria for adult salmonids (NOAA Fisheries 2023). The juvenile fish ladder would be nearly identical to the adult fish ladder except for minor differences (e.g., no turning pools, only one resting pool entrance, additional pool in the ladder, overall fish ladder slope, and floor slope across each pool) that meet NOAA Fisheries passage criteria for juvenile salmonids (NOAA Fisheries 2023). A Bonneville-style steel flume lamprey ramp with resting boxes would be located adjacent to the west wall of the juvenile fish ladder. A gravel area would provide an access path adjacent to the lamprey ramp for its full length.

A fish lift would be located at the upstream end of the ladder and would consist of a trap, hopper, and lift. A vee-trap would be built into the hopper to allow fish to volitionally enter but not exit. The lift system would vertically transport fish approximately 80 feet to a sorting and handling area. The fish lift would carry fish to respective holding tanks with separate water supplies and drainage systems. Each gallery would be equipped with a sprinkler system and a false weir at the upstream side of the structure. Netting would be provided over galleries holding juvenile fish. Both adult and juvenile holding galleries would meet NOAA Fisheries criteria for holding (NOAA Fisheries 2023). Fish would be hand-sorted by operators and sent through automatic diverter gates to the appropriate holding tanks, and eventually into haul trucks for upstream release.

The FFPF would require water for operations. Water for some of the FFPF elements would be supplied via gravity flow while water for others would be pumped. The FFPF pump station would draw water from the conduit stilling basin through a set of fish screens designed to meet NOAA Fisheries juvenile screening criteria (NOAA Fisheries 2023). A prefabricated or concrete masonry unit building would be constructed adjacent to the sorting building to house mechanical and electrical equipment, and provide storage for equipment and materials associated with the FFPF.

2.2.1.3 Aggregate Source Quarries

Construction of the proposed FRE facility would require the development of a quarry to source aggregate materials for concrete production, road base, and construction laydown area substrate. The Applicant's goal is to obtain all required construction aggregate materials from a single quarry; however, until the preliminary and final design stage when more detailed geotechnical information regarding suitable subsurface conditions becomes available, three potential areas for development of 1-2 quarry sites have been identified. Each of these site areas is 65 acres in total size and approximately 40 acres would be developed for a quarry. The 40-acre quarry site would constitute the disturbed area of the quarry including over-burden storage, the quarry excavation and equipment marshaling, and materials storage areas. If geotechnical investigations of the potential sites determine that one quarry is insufficient to meet project needs, then a second quarry would be developed. No more than two quarries will be used. All three potential quarry sites are accessible from existing roads which would be upgraded to a service level necessary to support heavy equipment.

Proposed quarry operations are anticipated to end with completion of the FRE facility construction and prior to first operation. Following operations, the Surface Mine Reclamation permit issued by the Washington Department of Natural Resources (WA DNR) would require restoration of the quarry site addressing soil stability and proper water conditions and vegetation.

2.2.1.4 Improved Construction Access Roads – Flood Retention Expandable Facility Site

To the extent possible, the Applicant would minimize disturbance and new impervious surfaces by using existing roads to provide access to and around the construction site. Permanent road improvements would be necessary to provide sufficient load bearing for construction equipment. Access road improvements would likely use quarry spalls and may require ongoing maintenance activities during construction. Designed improvements would require the implementation of applicable measures to minimize erosion and sediment inputs to the river.

2.2.1.5 Long-Term Vehicle Access Around Inundation Area

To the extent possible, the Applicant proposes using existing roads to provide permanent access around the inundation area; however, a bypass may be required for Forest Road (FR) 1000, which is a main access road for Weyerhaeuser forestry operations in the upper basin. Up to 4 miles of FR 1000 would be inundated during peak flood retention, at which time a detour could be used consisting of FR 1000D and FR 1000D2 upstream of the inundation area. Future designs will inform the nature of proposed upgrades and long-term vehicular access.

2.2.1.6 Power/Data Lines

The FRE facility and FFPF would require an electrical supply during construction for the operation of pumps, conduit gates, fish holding tanks, and other equipment. The permanent electrical service would be provided by installation of an overhead or buried distribution power line to the electrical grid. The location of the interconnection and route of the interconnecting distribution line would be determined in coordination with the local power utility. At this time, the Applicant anticipates that overhead or buried lines would be installed along existing roads within 6 months of year 1 of the construction schedule.

2.2.1.7 Debris Management Staging and Storage Areas

Following flood retention events, the temporary inundation pool would be drawn down, and accumulated wood would be removed. A debris management sorting yard would be constructed with an appropriate surface (e.g., rock or gravel) to allow vehicular access and use following drawdown. Debris management storage and staging areas would support the deployment of project-related watercraft from existing access roads. Debris would be stockpiled in a log sorting yard located between RMs 109.6 and 109.9 for later use in habitat enhancement activities.

2.2.1.8 Improvements to the Town of Pe Ell Water System

The primary water source for the town of Pe Ell is Lester Creek, which flows into Crim Creek just upstream of its confluence with the Chehalis River, and upstream of the proposed FRE facility at approximately RM 108.4 (Ecology 2020). This primary water supply system includes the water intake and reservoir system on Lester Creek, more than 10,000 linear feet of 8-inch-diameter water line, a pump station, a water treatment facility, and a distribution system. The water line spans the Chehalis River on an existing bridge. During low-flow periods, the town uses the Chehalis River as a secondary (backup) water intake, but its use is limited. The Chehalis River intake is approximately 2,500 feet south of and approximately 180 feet lower in elevation than the water treatment facility.

Based on their location in relation to anticipated construction areas, Pe Ell's water treatment facility and the Lester Creek intake would not be affected by FRE facility construction; however, the water supply pipeline may be affected since approximately 8,000 feet of the pipeline are located within the modeled FRE inundation area. Therefore, portions of the pipeline may require improvement or relocation. In addition, improved access to the Lester Creek intake could potentially be necessary to allow for long-term inspections and maintenance during FRE facility operations, which may temporarily inundate the lower portion of Lester Creek and associated access areas. At approximately 640 feet MSL in elevation, the Lester Creek withdrawal point is located upstream of and outside of the maximum flood pool elevation of 628 feet MSL (based on the spillway elevation). The water treatment facility and pump station would be outside of the area of modeled inundation and are therefore not anticipated to be affected by the Proposed Action.

Although the Applicant acknowledges that improvements to Pe Ell's surface water system (e.g., intake on Lester Creek and the water transmission line) may be necessary to construct and operate the proposed FRE facility, specific improvements have not yet been defined. The Applicant will coordinate with the town of Pe Ell in future design phases to determine what is required. For the purposes of this assessment, however, the Applicant assumes that improvements to or relocation of the existing water line are part of the Proposed Action.

In addition, for the purposes of this assessment, the Proposed Action includes improvements to or replacement of the Lester Creek intake, improved access to the Lester Creek intake, and possible upgrades at the Chehalis River intake. Designs for any renovation or replacement of existing intake structures would meet current NOAA Fisheries and WDFW screening criteria for the protection of fish (WDFW 2009).

2.2.2 Temporary Features

Temporary features required for construction of the proposed FRE facility include a concrete batch plant, materials handling equipment, work and storage (staging) areas, and temporary roads. A temporary water supply would also be required during construction. Following construction these would be removed, and the areas would be restored to their pre-construction habitat function.

2.2.2.1 Concrete Batch Plant

To produce concrete for construction, a concrete batch plant would be assembled along the right bank (looking downstream) of the Chehalis River. It would produce both RCC and conventional concrete and include the following:

- RCC batch plant;
- Conventional concrete batch plant;

- Aggregate crushing and screening;
- Aggregate storage;
- Fly ash storage; and
- Cement storage.

2.2.2.2 Diversion Channel and Water Management Facilities and Materials

The construction sequence has been designed to provide both upstream and downstream volitional fish passage throughout the entirety of the construction program. This would be accomplished by the construction of a temporary bypass channel along the right bank of the river starting upstream of the confluence of Crim Creek and the Chehalis River and extending downstream of the construction site. To the extent practicable, the bypass channel would be constructed to mimic the hydraulic and geomorphic conditions of the main channel in this reach. Once the bypass has been constructed, flows from Crim Creek and the main channel would be diverted into the bypass channel while simultaneously dewatering the main channel and recovering fish located in the channel being dewatered. Volitional upstream and downstream fish passage would continue uninterrupted throughout construction, including during the in-water work period. With the main channel dewatered, excavation and construction of the left abutment and the fish passage conduit structure, evacuation conduit, gates, and control equipment would be undertaken. Excavation of that portion of the foundation and lower levels of the facility outside the bypass channel on the right bank would also be initiated. Upon completion of the left portion of the facility, Crim Creek and the Chehalis River would be diverted into the permanent river channel and conduits. During the in-water work window, the Chehalis River would be diverted into the permanent river channel and fish passage conduits while simultaneously dewatering the bypass channels and recovering fish in the channels being dewatered. Once the diversion of the river into its permanent channel is complete, the temporary bypass channels would be filled in and restored. After flows are returned to the permanent channel, the right side of the facility including the spillway and stilling basin structure would also be completed. Using this construction sequence, flows would only be temporarily relocated between the two channels twice, both occurring within the approved in-water work window.

2.2.2.3 Temporary Construction Access Roads

To the extent possible, the Applicant proposes to use existing roads to provide temporary access to and around the construction site. Approximately 2 miles of temporary gravel roads would be developed within the active construction site for construction access. Temporary construction roads would provide access for various planned work activities, equipment and material storage, and construction administration. Temporary roads would also provide access to and from the selected quarry site to material processing and production areas. Currently, the Applicant proposes to decommission all temporary roads in the active construction site following construction, and to restore habitats to preconstruction condition.

2.2.2.4 Staging Areas

Six primary staging areas would be established near the construction site and would include construction offices, areas for material processing and storage, parking for construction vehicles, and fuel storage and containment. Material excavated from the proposed FRE facility structure footprint and abutments would be permanently relocated, stabilized, and revegetated at site mobilization and staging activity areas. Staging and construction laydown areas would be prepared with appropriate site grading, surfacing, and drainage provisions that allow for construction equipment and materials to be stored, secured, and utilized.

2.2.2.5 Construction Water Supply

Construction water would be required for dust control, aggregate processing, concrete production, embankment fill, offices, warehouses, shops, tunneling operations, and various unlisted uses. Dam projects require a considerable amount of water with usage varying due to concrete specifications, aggregate in-situ properties, aggregate processing specifications, embankment compaction requirements, seasonal climate, number of on-site workers/staff, and various other project requirements. Based on other project experiences, water demand requirements are estimated to be 2,000,000 gallons per day (3 cfs) during construction activities. A water demand evaluation will be performed during the final design to refine the estimate. The Applicant is committed to avoiding impacts on existing water supplies and water quality for local water withdrawals such as the town of Pe Ell while using water during construction.

The demand flow rate for construction water would vary throughout the course of construction as activities vary. Seasonal influences would also affect water demand. For example, construction water consumption for dust control would be reduced during rainy months. Water storage tanks would likely be utilized by the construction contractor to help buffer some of the short-term peak demands and facilitate continuous construction. Construction water would likely be obtained through surface water withdrawals from the Chehalis River. Fish screens meeting state and federal fish screening requirements would be employed for surface water withdrawals. The withdrawal location on the Chehalis River would likely be in the vicinity of the construction to minimize the temporary water supply infrastructure footprint. The temporary water supply infrastructure, including the withdrawal location, would be designed, installed, and operated in accordance with federal, state, and local laws and regulations. The proposed location of the construction water withdrawal will be identified as the design is further developed. Temporary water supply pipeline(s) would be installed to carry water to specific locations on the construction site, including water storage tanks and the concrete batch plant. All temporary water supply infrastructure such as water lines, pumps, and storage tanks would be removed upon completion of construction.

A feasibility study will be performed to identify water rights requirements for construction following Ecology guidelines. Water may be pulled directly from the Chehalis River, from a well drilled to obtain water, or a combination of both sources. Public water supply lines within the area for project construction use are assumed to be unavailable.

2.3 FRE Facility Construction

Construction of all project infrastructure would be completed in approximately 4.5 years and would begin as early as spring 2025. The proposed FRE facility engineering design report (HDR 2024) contain conceptual design drawings including details of all proposed facilities.

2.3.1 Access, Mobilization, and Staging

Trips to and from the proposed FRE facility site from regional locations where materials are sourced have not been directly evaluated. No new access roads would be required, as all construction related vehicular trips would use existing roadways. Construction related vehicular use is expected to be indistinguishable from background levels of traffic.

Access to the proposed FRE facility construction site would be provided from Muller Road and FR 1000. The Applicant anticipates that construction workers would park off-site in existing lots and be shuttled to the construction area to limit construction-related traffic and vehicles. A rough range of two-axle truck off-site round trips would be between 100,000 and 180,000 loads, and three-axle or larger off-site truck round trips would be between 16,000 and 26,000 loads over the 4.5-year duration of construction activities. Based on this estimate, between 10 and 40 truck trips are expected for a typical workday.

2.3.2 Construction Equipment

Construction equipment would include the following, to be refined during final design of the proposed FRE facility:

- Bulldozers, excavators, front-end-loaders, off-road fixed wheel and articulated haul-trucks, integrated tool carriers, and rollers;
- Cranes ranging up to 250 tons or larger;
- Quarry and FRE facility project site material processing equipment including pneumatic drills, blasting product transfer and storage, concrete production equipment, generators, utility buildings, electrical control, and large vehicles; and
- Support equipment (trucks, water trucks, vacuum trucks, boom trucks, vans), shipping containers, and temporary buildings.

2.3.3 Pile Driving: Foundation and Flood Fish Passage Facility

Impact pile driving is not an expected construction activity but has been identified as a potential method to provide temporary excavation support within the proposed project construction area. At the current stage of design, the number and size of piles that may be required is unknown, and the duration of pile driving is also unknown. If required, all impact-driven piles would be installed “in the dry.”

2.3.4 Site Clearing

Site preparation for upland construction would require establishing erosion and sedimentation control measures, as well as clearing and grubbing. As much as 245.3 acres of upland forest vegetation of varying sizes and age classes would be cleared for construction of the FRE facility, temporary facilities and staging areas, and up to two quarry sites. Within this cleared area, approximately 32.8 acres of upland forest vegetation would be permanently replaced by the proposed FRE facility, access roads, and other features required for FRE operations. The Applicant would restore and revegetate all areas cleared for construction staging and access that are not part of the permanent facility footprint. Plants selected for revegetation within the inundation area would be flood tolerant.

2.3.5 Quarry Site Preparation and Blasting

Site preparation for quarry site development at up to two of the three sites under consideration (see Section 2.2.1.3) would require site clearing, excavation, and blasting to mine aggregate rocks, and development of temporary access roads and staging areas. Considering the current (conceptual) level of design, quarry blasting is expected to continue for up to 3 years during the total construction period and would occur one to four times per week, up to several times per day, during active development of the quarries. Quarry development and rock extraction would follow best management practices (BMPs) established by the WA DNR (Norman et al. 1997).

2.3.6 Slope Stabilization

In addition to implementing the Vegetation Management Plan (VMP) and BMPs, additional stabilization of steep slopes in the inundation area could include the introduction of horizontal drainage into vulnerable slopes or the placement of berms at the toes of steep slopes.

2.3.7 Site Dewatering

The proposed FRE facility in-water construction area would occupy 4.83 acres of habitat within the ordinary high water mark (OHWM), including adjacent areas isolated by cofferdams. Construction of all facilities within the river channel would occur under dewatered conditions. Dewatering the river channel would be accomplished by installing a series of cofferdams and diversion of the river through a bypass channel. FFPF construction below the OHWM would require approximately 4.5 years based on the proposed sequencing.

2.3.8 Aquatic Species Salvage

Fish, and potentially other aquatic species of concern (SOC), such as amphibians and mussels, would be present in the Chehalis River during all phases of in-water construction. The Applicant would coordinate with WDFW during future permitting phases to develop fish and aquatic species salvage plans for those stages of in-water work that involve the diversion of Crim Creek and the main flow of the Chehalis into the bypass channel. Salvage would be accomplished by experienced biologists using a combination of netting, electrofishing, and progressive pumping down of the water level. Fish salvage would be conducted in accordance with fish exclusion protocols developed by the Washington State Department of Transportation (WSDOT 2016). Electroshocking would occur in accordance with NOAA Fisheries electrofishing guidelines (NOAA Fisheries 2000).

2.3.9 In-Channel and Near-Channel Blasting

In-channel or near-channel blasting would be required for preparation of the proposed FRE facility structure foundation (waterward of OHWM) and bypass and permanent river channel excavation. Blasting for preparation of the proposed FRE facility structure foundation could occur as often as four times per week over approximately 12 months.

2.4 Operations and Maintenance Phase

During non-flood retention periods, the proposed FRE facility would function as a run-of-river facility, where all five conduits would remain open, allowing unregulated flows through the facility. During these periods, most of the natural hydrologic, geomorphic, and hydraulic stream processes would be maintained. Water and sediment are expected to freely pass through the proposed FRE facility, upstream and downstream fish passage would be provided via the conduits, and wood material passing through trashrack with 24-inch clear spacing between bars would be routed through the conduits and transported downstream.

During typical seasonal flow (e.g., 2-year flood of 3,000–6,000 cfs) and flows up to 12,500 cfs (approximately a 10-year event) at the proposed FRE facility, water would pass through the low-level conduits without surcharging (i.e., backwatering/ponding upstream). The proposed FRE facility would operate when flood forecasts predict a major or greater flood. The proposed FRE facility conduit gates would begin to close and start retaining water approximately 48 hours before flows at the Grand Mound gage were predicted to exceed 38,800 cfs. Once conduit gates begin to close, flows would be initiated through the evacuation conduit and be increased to a flow of 300 cfs as the conduit gates are completely closed. A 300-cfs flow is a naturally occurring winter low flow on the Chehalis River. The outflow rate would be adjusted based on observed flows and revised predictions. The proposed FRE facility would be operated to keep river outflow at a reduced rate until the peak flood passes the Grand Mound gage.

FRE facility operation would cause the inundation area to fill with stored flood water. The extent of the flood pool depends on the peak of the flood flow and its duration; the maximum extent would be 825 acres for the maximum storage pool and would have a maximum depth of 201 feet (measured at conduit invert elevation of 427 feet MSL). Peak flood flows for major or greater floods are predicted to last about 2 to 3 days. Once the peak flood flow has passed, a three-stage evacuation operation would be implemented to release the stored water. The duration of flood pool evacuation would depend on the magnitude of the flood and the volume of the flood pool. For catastrophic floods of 75,100 cfs or greater, it is estimated that from the closing of conduit gates through final flood pool evacuation, inundation would last a maximum of 32 to 35 days.

2.4.1 Fish Passage

Across the range of normal flows and smaller flood conditions, fish would pass both upstream and downstream through the five conduits in the proposed FRE facility concrete. The conduits would be designed to mimic current passage conditions through the reach of the Chehalis River immediately upstream and downstream of the project site. Depending on river flows, conduit gates would be operated to maintain optimum fish passage conditions. Most of the time, when no retention is occurring, aquatic species passing upstream would be able to move from the river, into the conduit stilling basin, through the conduits, and back into the river upstream of the FRE facility. Fish passing downstream would follow the same path in the opposite direction. The proposed FRE facility conduits would be designed to provide year-round, volitional upstream and downstream passage for migrating adult salmon and steelhead, resident fish, and lamprey for the full range of flow conditions up through the high fish passage design flow as required by NOAA Fisheries criteria (NOAA Fisheries 2023). During low-flow periods, the conduits would be managed to concentrate flow through one or more conduits to meet minimum design passage requirements.

2.4.1.1 Flood Fish Passage Facility Upstream Fish Passage During Flood Retention Expandable Facility Operations

During major floods that trigger FRE facility operation, the conduits would be closed and minimum instream flows (300 cfs) would be maintained via the evacuation conduit. During these periods, upstream fish passage would be provided by the FFPF. The FFPF would collect migrating adult salmon and steelhead, juvenile salmon and steelhead, resident fish, and lamprey moving upstream during an impoundment event and operators would safely transport them upstream of the proposed FRE facility structure. Attraction water would draw fish passing upstream from the river into the conduit stilling basin and into the fish ladders. Water supplied to the fish ladders and lamprey ramp would attract fish and lamprey to the traps. The conceptual designs for the juvenile/resident fish ladder and lamprey ramp are based on the best available science, including studies published as recently as 2018 (HDR 2018a). Once trapped, fish would be sorted or passed into transport tanks and moved upstream of the proposed FRE facility structure. The upstream release sites will be determined during future design or construction phases.

Although adult salmon and steelhead only pass upstream during certain periods of the year, the FFPF would be capable of operating at any time of year to accommodate resident fish, lamprey, juvenile salmon, and steelhead that currently traverse this reach of the Chehalis River and volitionally move upstream. Based on an evaluation of historic monthly flows at the Grand Mound gage, floods that would have triggered FRE facility operation occurred primarily from November through February. The months of December through February have the highest probability of FRE facility operation and subsequent FFPF operation.

The FFPF would begin operations as soon as the proposed FRE facility conduit gates begin closing and would continue to operate until the temporary inundation pool is emptied and run-of-river operations resume. At the beginning of FFPF operations, river flow through the conduits would be well above the high fish passage design flow (2,200 cfs; HDR 2018b). Although NOAA Fisheries and WDFW guidelines do not require that fish passage be provided during these periods (i.e., conduit passage at flows above the high fish passage design flow), the FFPF would operate during this period to provide upstream passage. Operation of the FFPF would continue through impoundment of flood water behind the proposed FRE facility structure and subsequent evacuation of the stored flood water until the last remaining water is released. This process may last several weeks.

Once the temporary inundation pool is evacuated and the proposed FRE facility structure would return to normal run-of-river operation through the conduits, the FFPF would be shut down. As part of the shutdown of the FFPF, any remaining fish would be safely removed and returned to the river, the fish ladder entrance gates would be closed, and the water supply would be turned off. The FFPF would be cleaned, prepared for the coming extended dormant period, and secured.

2.4.2 Downstream Fish Passage During Flood Retention Expandable Facility Operations

Downstream passage of out-migrating fish would be delayed during flood water storage events coincident with FRE facility operations. During FRE facility operation and impoundment, the conduits' gates would be closed and a 300-cfs release to maintain minimum downstream flows of 300 cfs would be routed through the evacuation conduit and spillway stilling basin. Subsequently, any out-migrating fish entering the impoundment at this time would be temporarily retained in the temporary inundation pool. Downstream fish passage would become available through the proposed FRE facility conduits as flood retention operations cease and the temporary pool drawdown is initiated.

2.4.3 Temporary Inundation Pool Evacuation

During FRE facility operations and resultant creation of a temporary inundation pool, release rates would be maintained at 300 cfs until unregulated flow at the Grand Mound gage is less than 38,800 cfs. After flood flows decrease, the stored water would be evacuated over a period of up to 27 to 32 days, depending on the volume of water stored. To empty the pool, the evacuation conduit would be opened, and outflow increased from 300 cfs to approximately 6,000 cfs for a very large flood. Inundation pool drawdown rates during the release of stored water would be limited to 10 feet per day (5 inches per hour) from the maximum pool elevation down to water surface elevation (WSEL) 528 feet MSL.

When the temporary inundation pool is drawn down to WSEL 528 feet MSL, the drawdown rate would decrease to 2 feet per day to accommodate debris-handling activities in the inundation area. A reduction in the drawdown rate during this period would cause a corresponding reduction in outflow. Debris management operations would occur for approximately 2 weeks. Following debris management, and when the temporary inundation pool has reached WSEL 500 feet MSL, drawdown rates would increase again to 10 feet per day (5 inches per hour) until the temporary pool is emptied. At an approximate pool elevation of 510 feet MSL, the fish passage conduit gates would open and pool drawdown would continue through the fish passage conduits. The temporary inundation pool would be empty when the conduit gates are completely opened, and the Chehalis River returns to a free-flowing, open-channel state.

2.4.4 Post-Flood Retention Sediment Transport

Following a flood-retention event, any sediment that had deposited within the conduits prior to gate closure would be swept through the conduits and deposited in the stilling basin or downstream in the natural channel.

2.4.5 Large Wood Material Management

Wood and vegetation debris from surrounding tributaries and hillslopes would be transported into the temporary inundation pool during major floods. Following initial drawdown (10 feet per day), the drawdown rate would slow to 2 feet per day when the pool level reaches WSEL 528 feet MSL. Boats would be used to remove floating debris to a designated sorting yard on the west bank between RMs 109.6 and 109.9 that is accessible from existing roads for reuse in downstream habitat enhancement projects.

Debris would be cut up and disposed of, and wood suitable for instream mitigation actions would be sorted and trucked out of the sorting yard. The removal of stockpiled material would occur after the inundation pool is drained and once the ground dries out enough to allow heavy equipment into the sorting yard. Debris management would end when the water surface elevation of the inundation pool falls to WSEL 500 feet MSL, which is the ground elevation at the sorting yard.

3 EXISTING AND FUTURE CONDITIONS

3.1 Proposed Mitigation Area

The Chehalis River Basin has a drainage area of 2,700 square miles (mi^2) and includes more than 3,300 miles of streams that drain the Willapa Hills and foothills of the Cascade and Olympic mountains. The 125-mile-long mainstem Chehalis River originates in the Willapa Hills of Lewis County where the East and West forks converge. From the forks, the mainstem river flows north and east, then north and west, in a large curve, before emptying into Grays Harbor, an estuary of the Pacific Ocean. The Chehalis River Basin is divided for management purposes into Watershed Resource Inventory Areas (WRIAs) 23 (upper Chehalis) and 22 (lower Chehalis). The upper Chehalis (WRIA 23) drains 1,294 mi^2 and includes the upper reaches of the Chehalis River and four major tributaries: South Fork Chehalis (RM 88.1), Newaukum (RM 75.2), Skookumchuck (RM 67.0), and Black (RM 47.0) rivers.

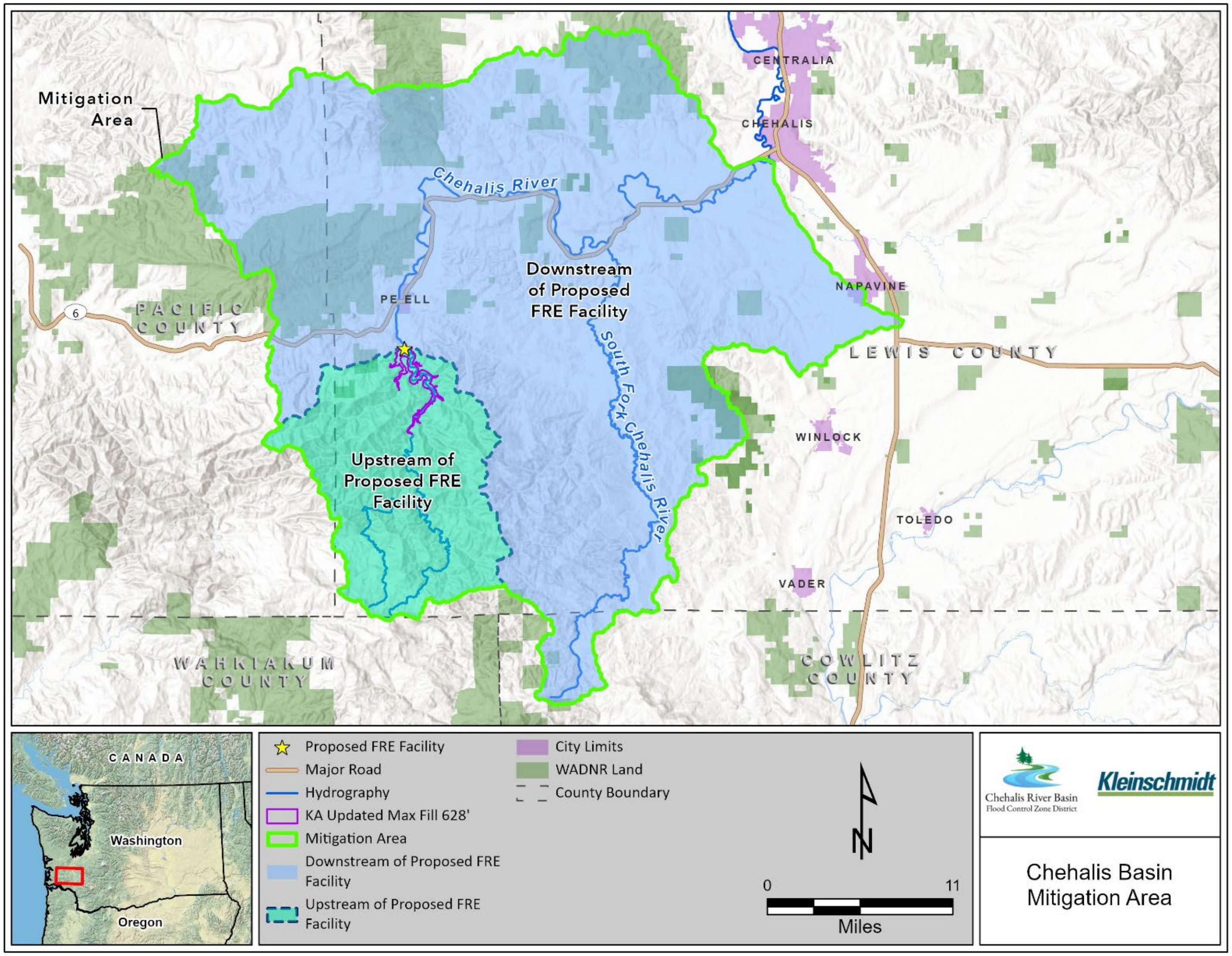
In the DEISs impacts from the Proposed Action were contained within to the following river reaches:

- The mainstem Chehalis River and tributary reaches upstream of the proposed FRE facility location (RM 108.4) within the temporary inundation pool;
- The mainstem Chehalis River channel 20 miles downstream of the proposed FRE facility to the South Fork Chehalis River confluence at RM 88.1 (Figure 3.1-1); and
- Chehalis River floodplain down to RM 33.

To mitigate unavoidable impacts, the Applicant considered the upper Chehalis River Basin, including its tributaries, from the confluence of the East and West forks downstream to the Newaukum River (RM 75.2) for implementation of mitigation actions (i.e., Mitigation Area) to encompass sufficient opportunities to provide meaningful ecological lift and achieve no net loss. To develop a feasible and specific plan to mitigate potential impacts and create ecological lift, the Applicant completed a technical review of the existing baseline conditions in the Mitigation Area related to aquatic and terrestrial habitat and species. Data was compiled from numerous reports by WDFW, Ecology, Corps, NOAA, USGS, Anchor QEA, Kleinschmidt Associates, and HDR Engineering, as well as peer-reviewed literature, regional white papers, and both field and desktop assessments of pertinent resource areas and processes during 2023.

This Existing Conditions assessment provided a comprehensive understanding of the upper Chehalis River including the physical environment and status of aquatic and terrestrial species and their habitats, and identifies habitat factors thought to be limiting local populations, including consideration of how thermal regimes are likely to change under future climate conditions. Changes to the status of aquatic and terrestrial habitats and species associated with climate change were also considered during this analysis. This assessment provided the basis for the site-specific mitigation actions that could feasibly be implemented to provide functional lift and species benefits that would offset the potential impacts of the Proposed Action. The following sections summarize the land use, water, water quality, geology and

Figure 3.1-1
Proposed FRE Impact and Mitigation Area and Existing Conditions Analysis Study Areas.



geomorphology, aquatic habitat, terrestrial habitats, wetlands, wetland and stream buffers, aquatic species, wildlife species, and limiting factors present in the Chehalis River Mitigation Area.

3.2 Land Use

The predominant land uses in the upper Chehalis River Basin are commercial forestry in upper reaches and agriculture with some urbanization in the low-gradient valley reaches. The Chehalis River floodplain has been heavily influenced and degraded by these land uses since the late 1800s. Historic and current land use practices have contributed to existing conditions of channelization, channel incision, loss of floodplain storage, and loss of riparian forest that provide shade, recruitment of large wood, and habitat for native species. Under current conditions, agriculture, including livestock grazing and farming, dominates land use while timber production and recreational land use follow closely behind (Table 3.2-1). Land use in the floodplain has resulted in a paucity of large wood material and riparian vegetation, making the streambank more susceptible to erosion, and allowing the water to be warmed by direct sunlight, both of which reduce aquatic habitat quality.

Table 3.2-1
Predominant Land Uses in the Chehalis River Floodplain.

LAND USE	CHEHALIS RIVER FLOODPLAIN AREA (%)
Agriculture (livestock grazing, farming)	41.0
Timber production (commercial timberlands) and recreational land use	39.0
Urban development	11.5

The entire Chehalis River Basin upstream of the proposed FRE facility is actively managed for commercial timber harvest of Douglas fir (*Pseudotsuga menziesii*), with an estimated rotation age of 40 to 50 years based on aerial imagery and stand height data. Upland habitat is dominated by commercial timberlands in various stages of growth and density. Riparian forests upstream of the proposed FRE facility are consistent with the current Forest Practices Act and support a mix of native deciduous and evergreen tree species and shrubs. Harvest is completely excluded within the 50-foot-wide core riparian management zone on each side of the Chehalis River OHWM and its fish-bearing tributaries, while some harvest or thinning is allowed within the adjacent inner and outer riparian management zones. Consistent with forestry needs, various access roads exist in the upper basin including FR 1000 that runs along the right bank of the mainstem and on the hillslopes, with bridges spanning both the mainstem and inflowing tributaries.

Land use in the floodplain of the Chehalis watershed downstream of the proposed FRE facility includes predominantly agriculture and rural development. Much of the riparian corridor consists of patches of forested riparian habitat or narrow strips of trees such as Douglas fir, western red cedar (*Thuja plicata*), Oregon ash (*Fraxinus latifolia*), bigleaf maple (*Acer macrophyllum*), red alder (*Alnus rubra*), and black cottonwood (*Populus trichocarpa*) or willow scrub-shrub habitat interspersed with reaches dominated by invasive species such as Himalayan blackberry (*Rubus armeniacus*) and reed canary grass (*Phalaris arundinacea*). A lack of large wood material and riparian forest makes the riverbank susceptible to erosion and allows the water to be warmed by more direct sunlight, both of which have degraded aquatic habitat quality.

3.3 Water

The Chehalis River Basin has a maritime climate characterized by cool, wet winters and warm, dry summers (Gendaszek 2011). Average annual precipitation varies from 46 to 50 inches in the low-lying valleys near Centralia and Chehalis, to 140 inches in the Willapa Hills, and more than 200 inches in the Olympic Mountains (Gendaszek 2011; WSE 2014). Most of the Chehalis River Basin, including the Mitigation Area, is rain-dominated (79%), while only limited portions are snow-dominated (Perry et al. 2016).

Over the past decades, the Chehalis River Basin has experienced extreme flooding as well as drought, both of which impact the physical characteristics of aquatic habitat and water quality. Major floods have been associated with winter (November–March) precipitation events known as atmospheric rivers that have produced high rates of rainfall in the upper Chehalis River Basin (Neiman et al. 2011). In contrast, summer months experience low rainfall or drought that results in very low-flow summer conditions. Low summer flows have been proposed as a potential limiting factor for salmon populations in the upper Chehalis River since the 1970s (Phinney et al. 1975).

The mainstem Chehalis River and tributaries upstream of the proposed FRE facility are primarily steep gradient, single-channel streams constrained by the steep valley walls of the Willapa Hills mountain range (Hayslip and Herger 2001). The streams range from large fish-bearing systems (Table 3.3-1) to both perennial and seasonal primary and secondary non-fish-bearing tributaries of these systems, to isolated channels that flow subsurface before reaching a flowing channel. The mainstem channel has limited potential for lateral channel migration (CBS 2017).

Table 3.3-1
Water Resources in the Chehalis River Basin FRE Mitigation Area.

MITIGATION AREA	PERENNIAL STREAM LENGTH (RIVER MILE)	CATCHMENT SIZE (SQ. MILE)	INFLOWING TRIBUTARIES
Mainstem Chehalis River and tributaries upstream of the proposed FRE facility (RM 108.4)	11.5 mainstem 157.5 tributary	76.2	Lester, Crim, Hull, Browns, Big, Roger, Smith, Alder, Thrash, Mack, Cinnabar, George, Sage, East Fork and West Fork Chehalis
Tributaries and mainstem Chehalis River from the proposed FRE facility (RM 108.4) to Elk Creek confluence (RM 100.2)	8.7 mainstem 98.6 tributary	57.1	Mahaffey, Rock, Stowe, Cannonball, Shields, Jones, Fronia, Robinson
Tributaries and mainstem Chehalis River from Elk Creek (RM 100.2) to South Fork Chehalis River (RM 88.1)	12.6 mainstem 223.2 tributary	100.5	Elk, Capps, Absher, Dunn, Marcuson, Dell, Hope, Garret, Nicholson
Tributaries and mainstem Chehalis River from South Fork Chehalis River (RM 88.1) to the Newaukum River (RM 75.2)	13.5 mainstem 517.5 tributary	215.8	South Fork Chehalis River, Bunker, Van Ornum, Stearns, Mill

3.4 Water Quality

The upper Chehalis River, upstream of the proposed FRE facility, does not include any water quality impairments for temperature, dissolved oxygen (DO), or other parameters. However, the headwaters of the Chehalis are warmer than other western Washington headwater areas due to their relatively lower elevation. Upstream of the proposed FRE facility, the Chehalis River has an intact riparian buffer consistent with Washing Forest Practices. The riparian habitat contains large deciduous and coniferous trees which contributes to the slightly lower summer high temperatures observed by WDFW relative to unshaded reaches downstream of Pe Ell. Some tributaries to the Chehalis River in this area also provide cooler water input to the mainstem (Winkowski et al. 2018).

Consistent with degraded aquatic and riparian habitat downstream of the proposed FRE facility, water quality downstream is impaired as indicated by CWA Section 303(d) and Water of Concern listings for several parameters including turbidity, nutrients, fecal coliform, DO, and temperature. Total maximum daily load (TMDL) plans are in place in the upper Chehalis River for DO (Jennings and Pickett 2000), temperature (Ecology 2001), and bacteria (Ahmed and Rountry 2004). While a TMDL load plan has not been developed for turbidity, it is often lower than 2 nephelometric turbidity units (NTUs) in summer months and increases from winter storm-induced runoff with measurements as high as 610 NTUs (Ecology 2020). The section of the mainstem Chehalis River between Stearns Creek and the Newaukum River is 303(d) listed for turbidity for the designated use of Aquatic Life – Salmonid Spawning, Rearing, and Migration.

Water quality issues in the Chehalis River downstream of Rainbow Falls (RM 97.0) are compounded by water rights concerns. Low base flows below Washington State's requirements for minimum instream flow have resulted in curtailment of junior water rights, cessation of recreational fishing, and further concern related to instream temperature which is considered impaired throughout this reach. Summer temperatures frequently exceed the preferred temperature range criteria for salmon and steelhead (Ecology 2020) (Washington Administrative Code [WAC] 173-201A).

3.4.1 Water Temperature

Elevated stream temperatures in the Chehalis River have been attributed to canopy loss and low summer flows (Phinney et al. 1975; Ecology 2020). The water frequently exceeds maximum temperature thresholds in summer for salmon and steelhead including the 7-day consecutive mean daily max temperature (7-DADMax) criterion of 16°C in stream reaches designated as core summer salmonid habitat in WAC 173-201A-602 and the 13°C criteria applied September 15 to July 1 in stream reaches designated with supplemental spawning/incubation criteria (Anchor QEA 2014). Data have also shown acute impairment that exceeds the State of Washington's lethality guidelines (Anchor QEA 2014).

WDFW completed temperature monitoring in 2022 and 2023 at 117 locations throughout the basin and modeled results to generate basin-scale thermalscapes Results indicated that warm stream temperatures (i.e., over 20°C) are sustained in the mainstem of the Chehalis River in the reach between the Newaukum and Skookumchuck Rivers relative to other reaches in June, July, and August (Figure 3.4-1 January–June; Figure 3.4-2 July–December; Figure 3.4-3 August only) (Winkowski and Zimmerman 2018). Temperatures in the lower reaches of major tributaries including the South Fork Chehalis River have also been documented above the 20°C mark in July and August. Extreme upper tributary reaches remain cool throughout the year while the entire basin is cool in the winter and spring months (November–March) (Winkowski and Zimmerman 2018).

Figure 3.4-1
Thermalscapes of Mean Monthly Temperatures from January–June of 2022–2023 WDFW Temperature Monitoring and Thermalscape Modeling Report (Figure 2 in Winkowski and Zimmerman 2018).

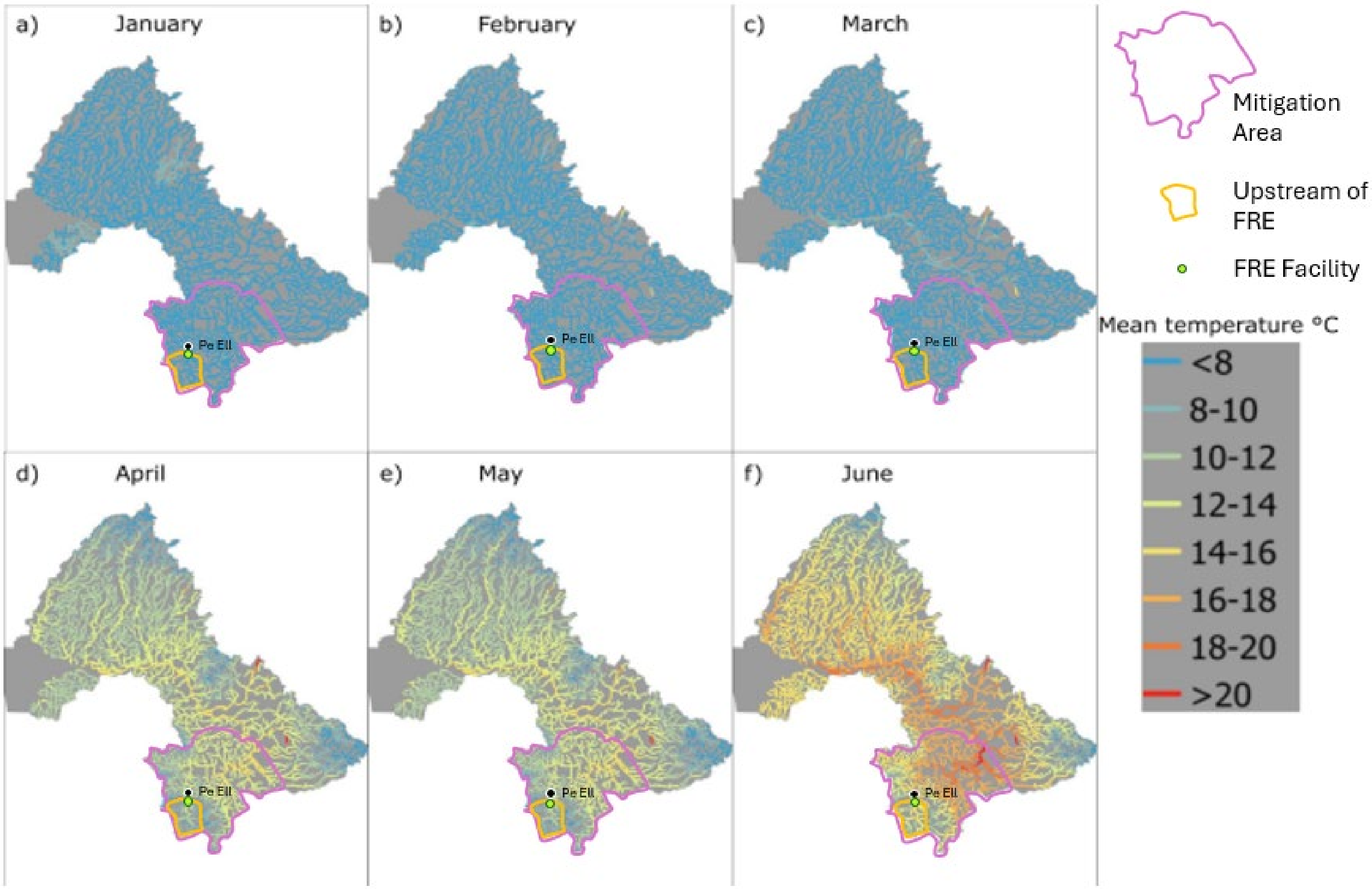


Figure 3.4-2
Thermalscapes of Mean Monthly Temperatures from July–December of 2022–2023 WDFW Temperature Monitoring and Thermalscape Modeling Report (Figure 3 in Winkowski and Zimmerman 2018).

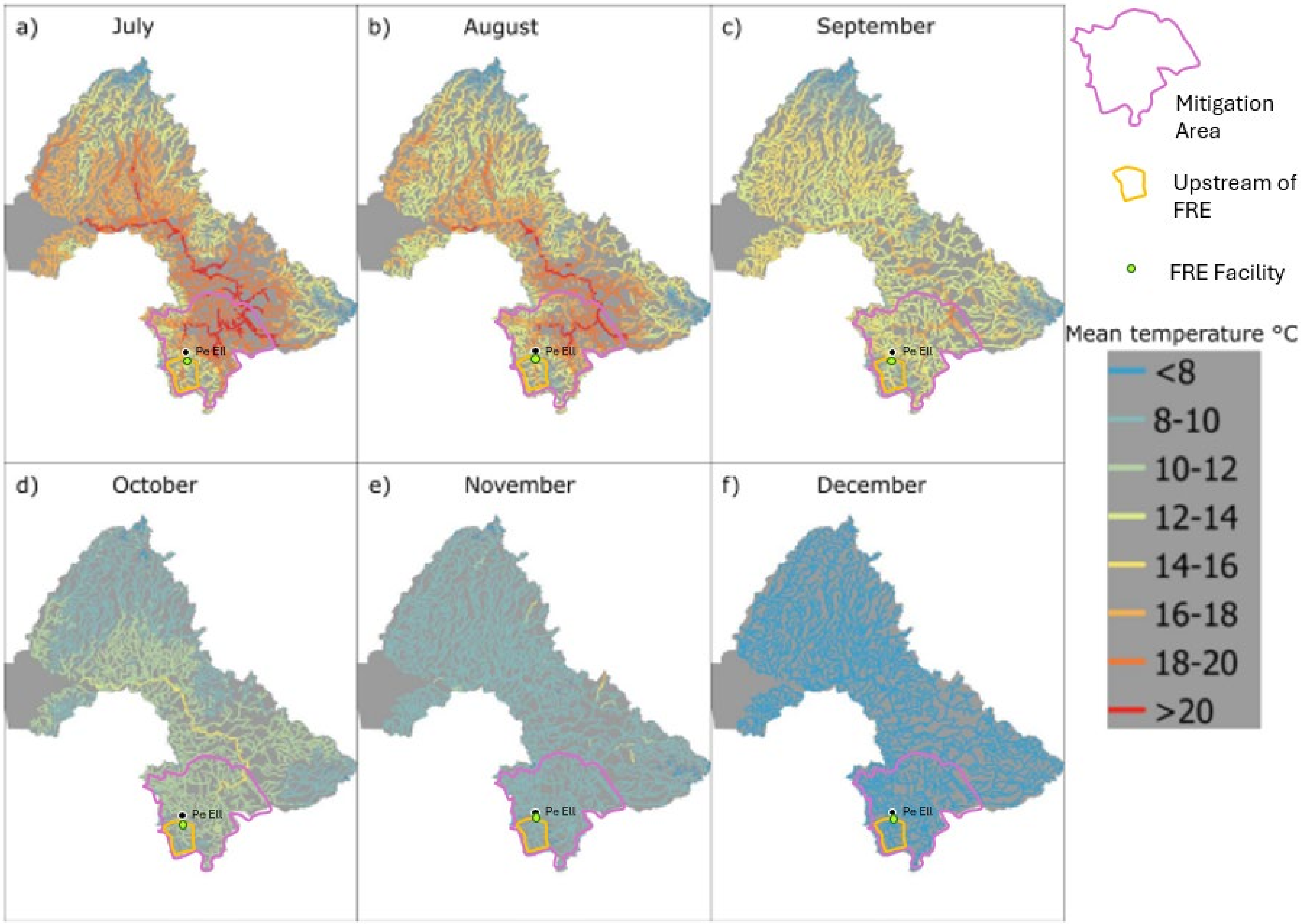
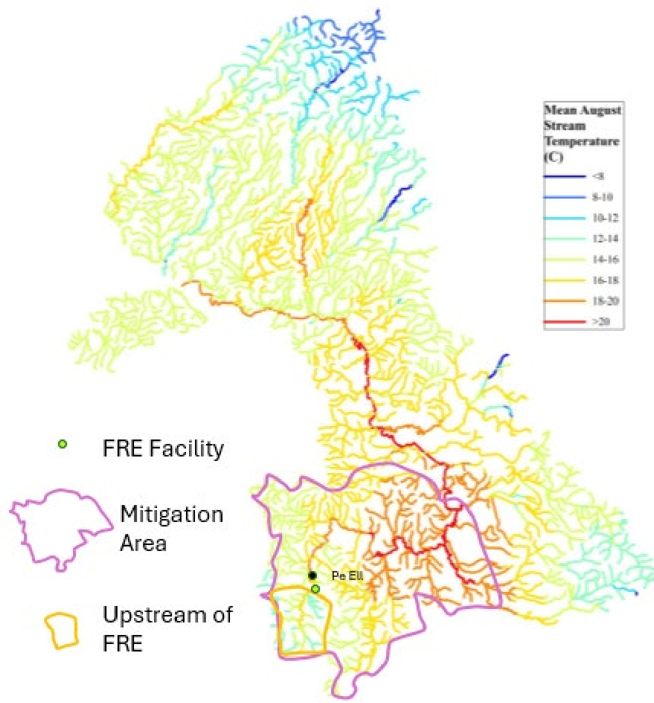
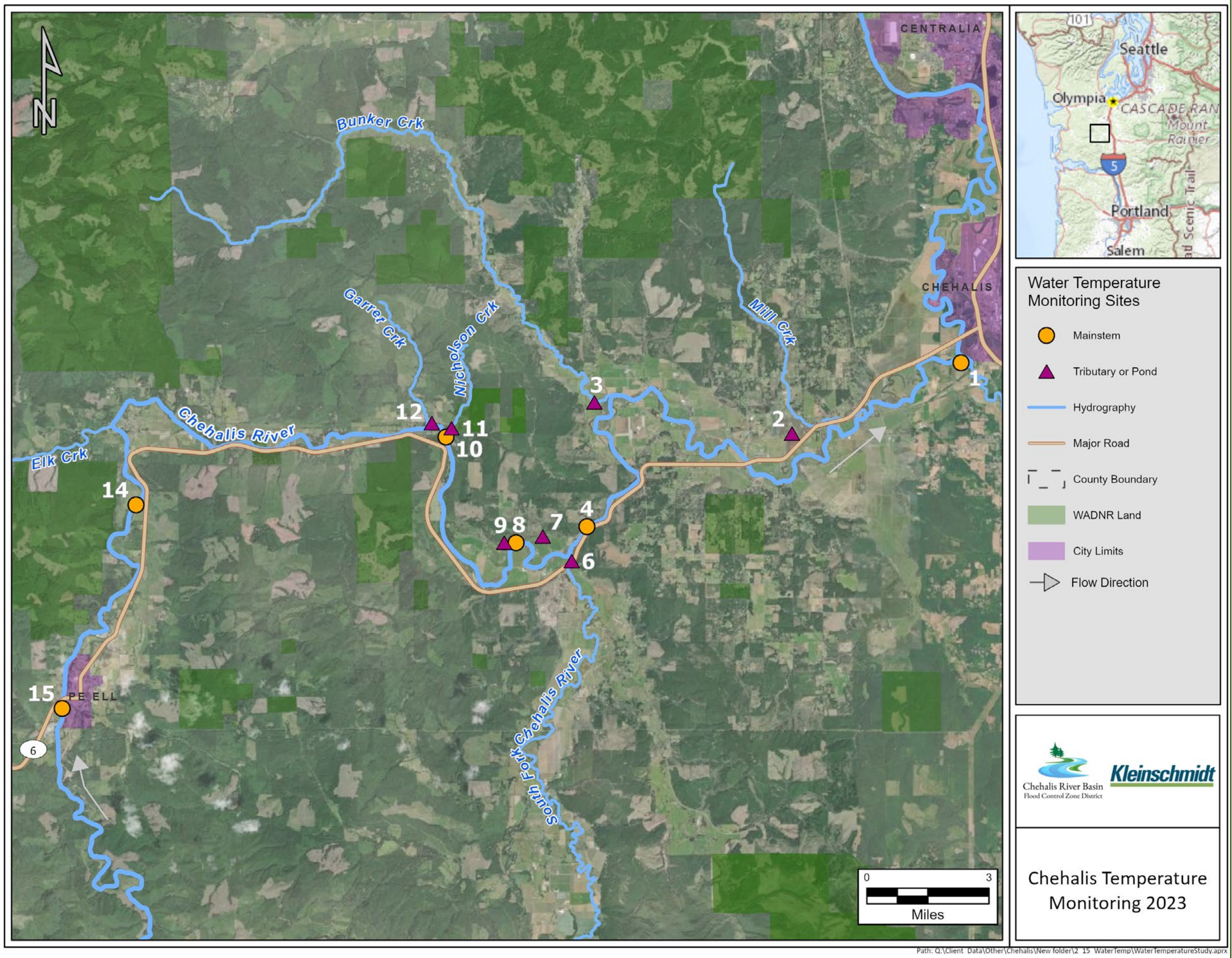


Figure 3.4-3
Thermalscape of Mean Monthly Temperature from August of 2022–2023 WDFW Temperature Monitoring and Thermalscape Modeling Report (Figure 4 in Winkowski and Zimmerman 2018).



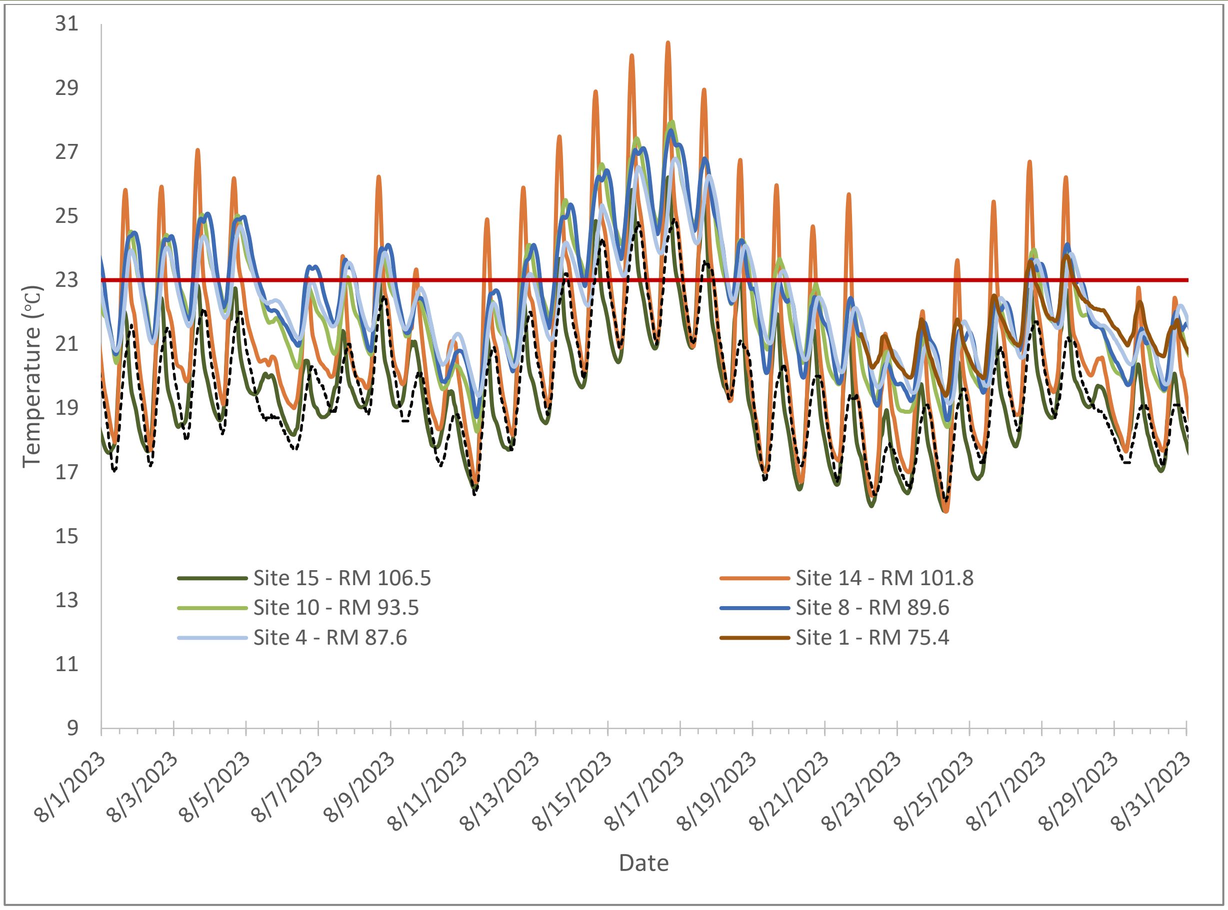
In addition, the Applicant conducted site-specific monitoring of water temperature in the mainstem Chehalis River between RM 75.4 and 115.8 in 2023 to supplement existing temperature data specific to mitigation planning. Figure 3.4-4 indicates the location of monitoring sites where stream temperature was monitored from June 8 to October 24, 2023. Monitoring Sites 1, 4, 8, 10, 14, and 15 documented water temperatures in the mainstem between Alexander Park in Chehalis, Washington (Site 1 at RM 75.4) and Pe Ell, Washington (Site 15 at RM 106.5). Water temperature was also monitored at select tributaries to the Chehalis River. These included: Mill Creek, Bunker Creek, South Fork Chehalis River, Nicholson Creek, and Garret Creek.

Figure 3.4-4
Applicant's 2023 Water Temperature Monitoring Sites.



Summer water temperatures in the mainstem Chehalis River ranged from 10.7°C to 30.4°C. All mainstem temperatures peaked on August 16, 2023. Site 14 had the highest recorded temperature at 30.4°C on August 16, 2023 and a 7-DADMax of 28.4°C; this site was within a very shallow glide with an open canopy and exhibited maximum daily peaks in summer months as depicted for August in Figure 3.4-5 Throughout the summer months, temperatures at all mainstem monitoring sites exceeded criteria for salmonid spawning, rearing, and migration (13.0°C in June, 17.5°C July-August), and salmonid summer habitat (16.0°C, June 15–September 15). The 7-DADMax temperatures at sites 1, 4, 8, 10, and 14 rose above the lethal limit for adult and juvenile salmonids (22.0°C) between June 27–29, 2023 and continued to exceed this limit until September 1–3, 2023. Site 15, the coolest monitoring site on the mainstem, was the only site to maintain 7-DADMax temperatures below the lethal limit, but still exceeded the lethal limit twice, between July 15–22, 2023 and between August 11–19, 2023 for a total of 17 days.

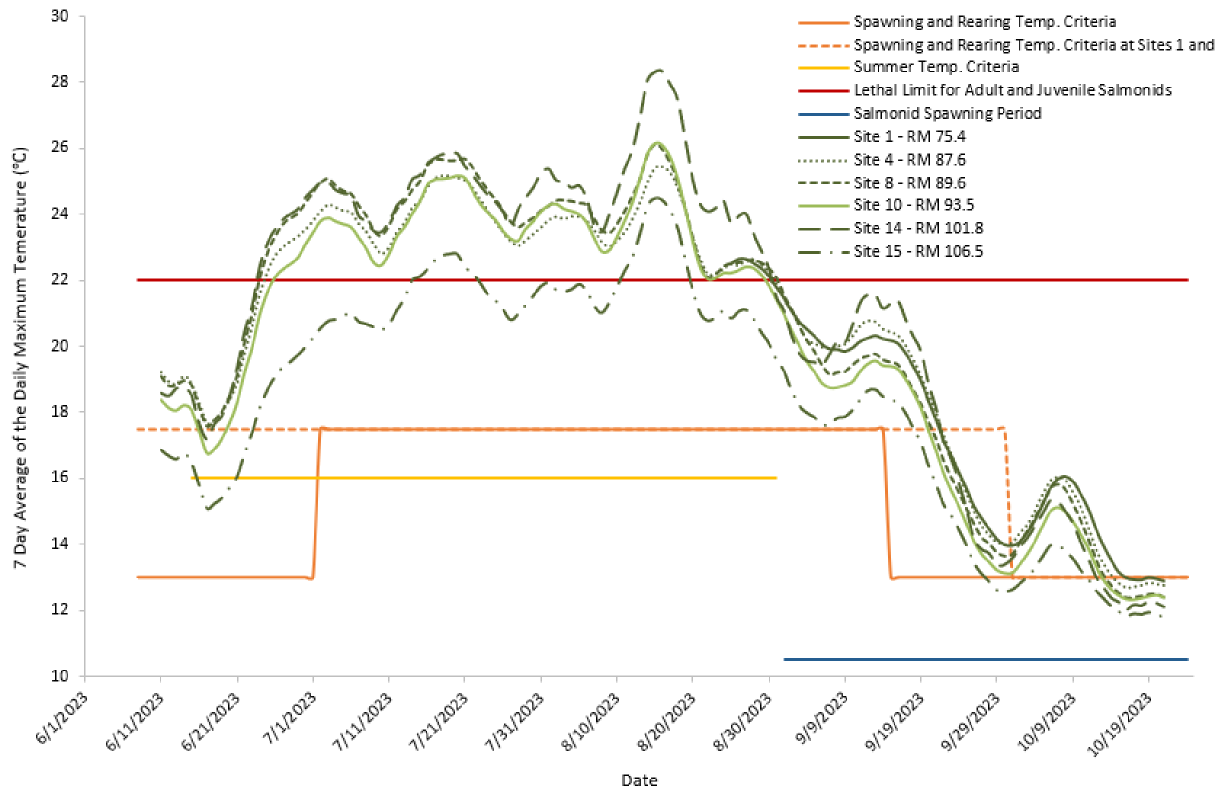
Figure 3.4-5
August 2023 Daily Temperatures Across All Monitoring Sites. The Red Line Indicates the Level Above Which 1-Day Maximum Temperatures Are Lethal to Salmonids.



At all mainstem sites, the 1-day maximum temperature was greater than the lethal level of 23.0°C (WAC 173-201A) for a minimum of 2 but up to 59 days in which the single-day maximum temperatures exceeded lethal limits. Figure 3.4-6 displays seasonal temperature dynamics of the 7-DADMax at mainstem sites along with temperature criteria related to anadromous salmon life history and periodicity.

These recent field data, in combination with past data sets, indicate that current temperature conditions in the mainstem Chehalis, and within the Mitigation Area, some areas of the mainstem being unsuitable for certain life stages of salmonids during warm summer months. These warm summer water temperatures have influenced fish distribution in the Chehalis River to the extent that fish species assemblage in the basin has been consistently associated with August stream temperatures rather than physical habitat characteristics (Winkowski et al. 2018). The temperatures are sufficiently warm to limit both rearing, spawning, and incubation potential for salmonids. Temperature has been implicated as a limiting factor for spring-run Chinook salmon in the upper basin (Winkowski and Zimmerman 2017).

Figure 3.4-6
Stream Temperature Reported in 7-DADMax at Mainstem Monitoring Sites on the Chehalis River from June 8–October 24, 2023. Summer Rearing and Spawning Thermal Maximum Temperature Criteria Are Indicated by Yellow and Blue Limit Lines, As Well As the Lethal Limit for Core Summer Salmonid for Adults and Juveniles According to WAC 173-201A.



3.4.1.1 Shade Supply Analysis

To support the Aquatic Species Restoration Plan in the Chehalis River Basin, the NOAA developed a process-based analysis for quantifying historical, current, and future habitat conditions (Beechie et al. 2021). NOAA segmented the stream network into 200-meter (m) (656-feet) segments and calculated a variety of metrics for each stream segment, including a model of riparian shade based on Seixas and others (Seixas et al. 2018). Seixas and others (Seixas et al. 2018) used light detection and ranging (LiDAR) data to measure the canopy opening angle, the angle formed between the channel center and trees on both banks, and then assumed historical tree heights and calculated the change in canopy angle relative to historical conditions. Reductions in riparian vegetation correspond with increases in canopy opening angle.

The Applicant conducted a reanalysis of the NOAA data to identify stream reaches below the proposed FRE facility where the riparian canopy has undergone considerable change. For this analysis, a threshold of a 30-degree change in angle opening was used to indicate degradation from historic conditions.

NOAA data show that a change of canopy angle of 30 degrees was associated with stream temperature increases of over 1°C.

Current canopy opening angles ranged between 0° (canopy completely closed) and 180° (both banks bare) in the Chehalis River Basin (Seixas et al. 2018). The Applicant summarized the distribution of changes in the canopy opening angle downstream of the proposed FRE facility in the mainstem Chehalis River. Tributary segments were distinguished and further divided based on bankfull widths into large rivers (>20 meters [m] [>66 feet]) and small streams (<20 m [<66 feet]) within NOAA's data (Beechie et al. 2021).

Table 3.4-1 summarizes the changes in canopy opening angle in mainstem and tributary habitats upstream and downstream of the proposed FRE facility. The Mitigation Area downstream of the proposed FRE facility included approximately 34.77 miles of stream segments in the mainstem Chehalis River, 335.42 miles of tributary segments classified by NOAA Fisheries as small streams, and 39.65 miles of tributary segments classified as large rivers. Canopy opening angle changes ranged from 105 degrees to less than 1 degree in segments downstream of the mainstem Chehalis River, with approximately 15.39 miles with canopy opening angle changes over 30 degrees. Canopy opening angle changes ranged from 133 degrees to less than 1 degree in segments classified as large rivers, with approximately 22.28 miles with canopy opening angle changes over 30 degrees. Canopy opening angle changes ranged from 179 degrees to 0 degrees in small streams, with approximately 130.28 miles with canopy opening angle changes over 30 degrees. These data demonstrate the extent and locations of riparian loss within the Mitigation Area.

Table 3.4-1
Summary of Changes in Canopy Opening Angle for the Mainstem Chehalis River and Tributaries Upstream and Downstream of the Proposed FRE Facility Based on NOAA Data (Beechie et al. 2021).

			CANOPY OPENING CHANGE >30 DEGREES	
IMPACT AREA	**HABITAT TYPE**	**STREAM MILES**	**SEGMENT COUNT**	**STREAM MILES**
Upstream of Inundation Area	Large River	13.26	43	5.37
	Small Stream	28.20	78	9.70
Within Inundation Area	Small Stream	11.69	26	3.24
Upstream of FRE Subtotal		**53.15**	**147**	**18.31**
Downstream Mainstem	Large River	34.77	124	15.39
Downstream Mainstem Subtotal		**34.77**	**124**	**15.39**
Downstream Tributaries	Large River	39.65	179	22.28
	Small Stream	335.42	869	130.28
Downstream Tributary Subtotal		**375.07**	**1,048**	**152.56**
Total		**462.99**	**1,319**	**186.26**

3.5 Geology and Geomorphology

3.5.1 Landslides

The Willapa Hills were formed from the volcanic Crescent and sedimentary MacIntosh rock formations. The Crescent formation is characterized by highly erodible pillow basalts, breccia, interbedded siltstone, and massive columnar basalts that will weather to boulder, cobble, gravels, and finer particles. (Ward and Weyerhaeuser 1994). Near the proposed FRE facility, the hillslopes are steep and the Crescent formation, specifically the basalt subunit, has been subject to landslides.

There are three types of landslide-prone areas identified near the proposed FRE facility and inundation area: deep-seated, shallow, and rapid debris flows. While many factors contribute to the initiation of landslides, past triggers in the upper Chehalis River Basin have included prolonged or intense precipitation, geology, thin soils, impermeable bedrock, steep topography, timber stand age, and roads (WA DNR 2008). In addition, a historic mass wasting analysis of non-road related landslides showed that on Crescent formation slopes >40%, root strength may have played a major role in slope stability in the past (Ward and Weyerhaeuser 1994).

The SEPA DEIS indicated that the majority of the 1,940 landslide processes that occurred in the Chehalis River Basin during the December 2007 storm event were small shallow debris avalanches and flows that slid above the bedrock interface. Further, Shannon & Wilson (2015) indicated that 23 landslide-prone areas occurred near the proposed FRE facility and the inundation pool. Of those, eight were identified as shallow, rapid landslides that were either within or near deep-seated slide areas. Only one site was identified as a debris flow area.

3.5.2 Sediment Transport

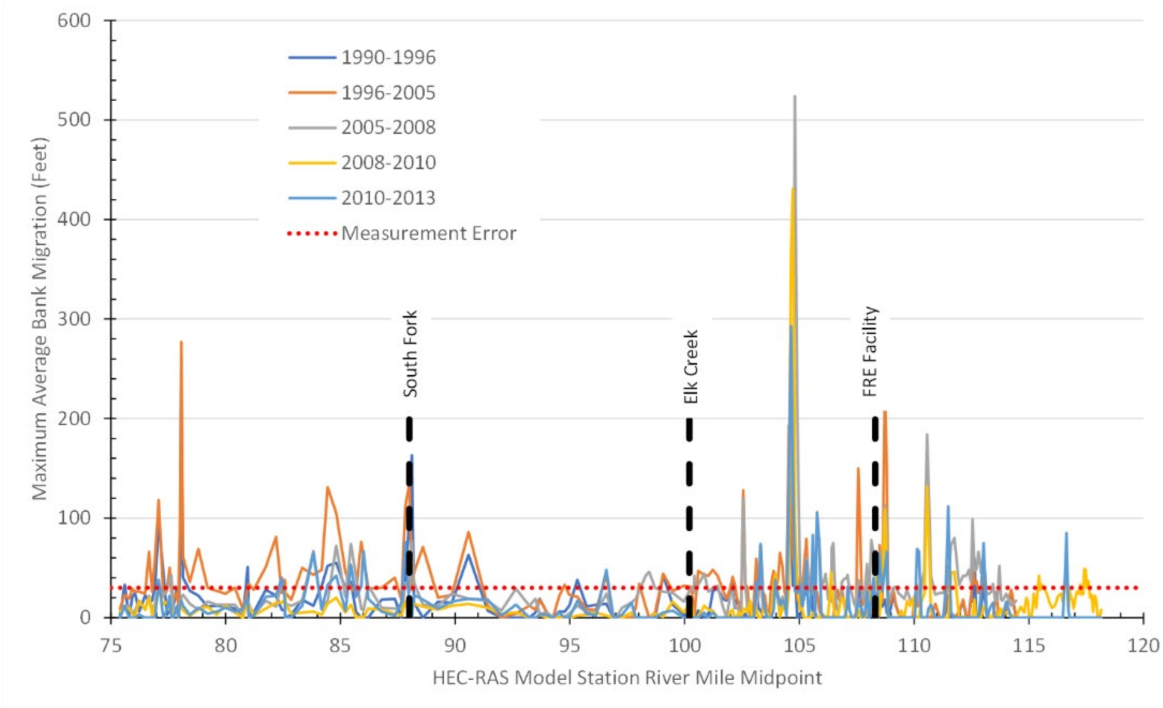
Similar to other coastal basins in Washington, storm-related landslides, debris flows, and other mass wasting events are the primary sources of sediment to the upper reaches of the Chehalis River Basin. The frequency of mass wasting has increased over natural levels in response to historic timber harvest activities, but future sediment delivery to the channel may be reduced as the effects of current improved harvest practices are realized. The immense volume of rain that fell in the Chehalis River Basin during the catastrophic December 2007 flood resulted in the delivery of an estimated 5.7–8.7 million tons of sediment into the Chehalis River headwaters (Sarikhan et al. 2008; Ecology 2020). This material has been gradually transported downstream over time. There is relatively little floodplain storage and reworking of alluvial deposits upstream of the confluence with the South Fork Chehalis River because of the confined, bedrock nature of the channel. Most channel migration, bank erosion, and resulting sediment exchange between floodplain storage and the channel occurs in the vicinity of RM 104, upstream of the confluence with Elk Creek, and downstream of RM 85 (Figure 3.1-1; CBS 2017) in less confined valley reaches with broader alluvial floodplains.

Recent studies by the Applicant indicate that upper Chehalis River has a high sediment transport capacity relative to supply. Based on the Applicant's modeling, predicted transport rates were found to be highest in magnitude in the canyon reach above Pe Ell and the vicinity of the proposed FRE facility location, and upstream of Fisk Falls. Lower (albeit still high) transport rates were predicted within two miles downstream of Fisk Falls and in the Pe Ell valley, reaches that are located respectively downstream of two large-scale breaks in channel gradient where deposition would be most expected to occur over the long term (Appendix A). These two reaches are also where historical spawning by spring-run Chinook has typically occurred. Recent spawning habitat mapping performed in 2023 (Appendix B) indicates that there may be less spawning gravel available presently than during the studies performed for the DEIS, which appears related to the remained of more extensive gravel deposits from the catastrophic 2007 flood event that have washed downstream over time. Importantly, all reaches appear to be consistently subject to a high risk of deep scour during larger floods (Light and Herger 1994; WG and Anchor 2017; provisional Kleinschmidt data).

3.5.3 Channel Migration

Channel migration in the Chehalis River Basin is driven by geomorphic processes including sediment transport, deposition, and flow. Generally, channel migration and interaction of the mainstem river with the floodplain has been more pronounced in the lower reaches of the Chehalis mainstem below approximately RM 85 and around RM 104.5 where floodplain alluvial deposits are more extensive. Elsewhere, channel migration has been more restricted to erosion of transient deposits confined within an entrenched channel. In the vicinity of the proposed FRE facility, the maximum average bank migration ranged from 25–150 feet with peaks of over 200 feet in 1996 and 2008, following the catastrophic flood event in 2007. Other significant channel migration events occurred between 1996–2005. Figure 3.5-1 shows Chehalis mainstem channel migration mapping results between 1990 and 2013. An approximate estimate of mapping error is also depicted because not all aerial photographs used in the digitizing were of high resolution nor appeared to have been accurately georeferenced to identical horizontal datum.

Figure 3.5-1
Measurements of Historic Channel Migration Distances in the Chehalis River Mainstem Upstream of the Newaukum River, Derived from Aerial Photographs. Digitized Traces of Left and Right Bank Locations Used in the SEPA DEIS (Ecology 2020) Analyses Were Reanalyzed in Geographic Information System, and the Maximum of the Average Values Computed for Each Bank Were Plotted in the Graph. Note: Hydrologic Engineering Center-River Analysis System Model River Miles Differ from USGS Values.



3.5.4 Scour

Field observations made in 2023 during spawning gravel mapping (Appendix B) suggested scour risk may be higher upstream of the FRE location than downstream based on visual assessment of the balance between local supply and transport of spawning sized substrates. As corroboration, Weyerhaeuser's watershed analysis characterized scour risk to salmon intragravel survival as high in the mainstem Chehalis River in the reach below Fisk Falls in the early 1990s (Light and Herger 1994). Preliminary data from scour monitors placed by Kleinschmidt over the 2023-2024 flood season indicate that deep scour down to Chinook salmon egg pockets, and subsequent fill above the original riverbed elevation, can occur at redd locations in both core spawning reaches during a small flood (~2.5 year recurrence interval at the Doty gage). It is expected that scour depths would be deeper in larger floods because of the patchiness of spawning habitat and high sediment transport capacity in the impact reaches (Appendix A).

3.5.5 Large Wood Material (LWM)

Large wood material (LWM) is defined by Ecology, as dead fallen wood at least 2 meters long and 10 cm in diameter at its center (Wolfe 2019). LWM is categorized as small when it has a diameter of 10–30 cm at its mid-point, and large when the diameter exceeds 30 cm at its mid-point. Upstream of the proposed FRE facility, LWM is primarily recruited during extreme precipitation events that cause root failure, landslides, and debris torrents in the headwaters of the watershed. The 2007 flood resulted in significant input of LWM to the basin due to landslides, hillslope failure, and bank erosion (CBS 2017). This material can be carried from upstream of the proposed FRE facility as far downstream as RM 88.1 at the South Fork Chehalis River confluence. Consistent with historic commercial timber harvest practices, large wood recruitment into the mainstem Chehalis River is less than in unmanaged river systems (Fox and Bolton 2007).

LWM recruitment from within the mainstem downstream of the proposed FRE facility comes from small-scale bank erosion more than major floods (Collins et al. 2002). Many of the riparian areas in these reaches lack mature vegetation, decreasing the potential for local LWM recruitment. A 2023 drone-based survey of LWM present in the mainstem Chehalis River between RM 84.2 and 106.7 was conducted during low flow conditions. LWM densities of less than five pieces per 100 m were documented in the mainstem (Table 3.5-1). This value is significantly lower than is typically observed in unmanaged systems of similar size in Washington State (Fox and Bolton 2007) but consistent with the 1.3–10 pieces per 100 m reported in the DEIS (Ecology 2020). Watershed GeoDynamics and Anchor QEA, LLC (WG and Anchor 2017 estimated that large inputs of LWM occur during 10- to 25-year floods while smaller flow events (9,000–10,000 cfs measured at Grand Mound) can displace and redistribute LWM already in the system.

Table 3.5-1
Summary of LWM and Jams Documented Within Combined Reaches of the Mainstem Chehalis River During 2023 LWM Drone Surveys.

COMBINED REACH ID	COMBINED REACH LENGTH (KILOMETERS)	TOTAL LWM	MEAN DENSITY (LWM PER 100 M)	NATURAL JAMS (ENGINEERED JAMS)
RM 84.2 – 85.1	2.0	64	3.1	0(0)
RM 88.1 – 100.2	16.2	390	2.4	5(4)
RM 100.2 – 106.7	10.1	277	2.7	6(0)
Total	**28.3**	**731**	**2.6**	**11(4)**

3.6 Aquatic Habitat

While the aquatic and riparian habitat conditions in the upper Chehalis River Basin upstream of the proposed FRE facility have been degraded by historic, and to a lesser degree, current land use, this area supports relatively high-quality spawning and rearing habitat for salmonids and other native species. The riparian buffer is relatively intact and the water temperature is cooler than in downstream reaches. Yet, the mainstem Chehalis River and tributaries upstream of the proposed FRE facility are primarily steep gradient, single-channel streams constrained by the steep valley walls of the Willapa Hills mountain range (Hayslip and Herger 2001). The mainstem channel has limited potential for lateral channel migration (CBS 2017) due to confinement by FR 1000 on one side and steep-grade commercial forest lands on the other. The area is characterized by low permeability basal bedrock including Tertiary basalt and sedimentary rock which limits groundwater storage capacity (CBS 2017). The habitat is composed of pools and riffles with gravel, cobble, fine substrate, and areas of bedrock (Winkowski et al. 2018).

The upper Chehalis River downstream of the proposed FRE facility has been highly degraded by historic timber harvest, agriculture, and rural development. Channelization of the mainstem has occurred from the use of splash dams in the early 1900s and has reduced braiding and channel complexity and limited floodplain interactions. This single-thread channel has suffered from changes that affect the normal river processes that allow it to dissipate floodwater and energy resulting in channel incision and widening and low summer flows over time. Currently, this reach can be characterized as having low channel complexity, an incised channel that is largely disconnected from the floodplain, a paucity of large wood and instream structure, degraded riparian habitat, very low summer flows, and extreme water temperatures– all features that contribute to reduced habitat quality for native fish rearing, foraging, and finding refuge from thermal stress and/or predators.

Between the proposed FRE facility and Elk Creek, the Chehalis River is a single-thread channel confined by a narrow canyon. The habitat is comprised of pools and long riffle habitats, with an average gradient of 0.21%. The riverbed in this section consists largely of a thin layer of alluvial substrate over bedrock. Mixed gravel substrate can be found throughout this reach. In addition to Elk Creek, fish-bearing streams entering this reach include Mahaffey, Rock, Stowe, Cannonball, Shields, Jones, Fronia, and Robinson creeks. Relatively small tributaries enter the Chehalis between Elk Creek and Rainbow Falls including Capps, Absher, Dunn, Marcuson, Dell, Hope, Garret, and Nicholson creeks. Below Rainbow Falls (RM 97.0), channel straightening and floodplain alteration have increased the mainstem river's susceptibility to erosion and direct thermal inputs. The result is a mainstem segment with one predominant incised channel that is disconnected from its floodplain, has more fine-grained sediment, and warmer water temperatures relative to historic conditions. The South Fork Chehalis River is the most significant tributary entering this area. Other fish-bearing tributaries include Bunker, Van Ornum, Stearns, and Mill creeks.

Numerous man-made fish passage barriers (e.g., culverts, dams, and fishways) limit fish access to potential spawning and rearing habitat. A total of 252 non-WSDOT culverts and other barriers to salmonid fish habitat have been identified in the Mitigation Area (WDFW 2022). Of these, 228 barriers were assessed and prioritized by WDFW using the Fish Passage Inventory, Assessment, and Prioritization Manual (WDFW 2019a), which includes a survey of physical habitat characteristics upstream of and downstream of the barrier, condition of riparian vegetation, potential quantity of fish habitat available for reconnection, water quality metrics, completeness of barrier, and landowner data.

Salmon spawning habitat occurs throughout the Mitigation Area upstream of the Elk Creek confluence into the East and West forks and large tributaries. Fall-run Chinook salmon spawning habitat is distributed throughout the mainstem and East and West forks, while coho salmon and steelhead spawning habitat occurs in the tributaries. Spring-run Chinook spawning habitat occurs in the mainstem Chehalis and lower reaches of the forks. The suitability of habitat for spring-run Chinook salmon is strongly influenced by summer flows over spawning gravels and water temperatures that limit suitable holding and migrating habitat conditions.

To help evaluate suitable spawning habitat and potential enhancement opportunities within the Mitigation Area, the Applicant conducted spawning gravel surveys in 2023. The survey documented numerous patches of spawning gravels throughout the 16.5 miles of river surveyed between Fisk Falls (RM 113.5) and Rainbow Falls (RM 97.0) (Table 3.6-1; Appendix B). Mapping also indicated that many locations where salmon and steelhead redds had been documented in the past were now lacking in suitable gravel and water depth during August and early September.

While the patchiness of spring-run Chinook spawning habitat observed in 2023 is consistent with the Applicant's sediment transport analysis, the locations of patches indicated a lack of suitable habitat where redds were documented in past spawning surveys (WDFW). This indicates that spawning gravels are being transported downstream without equivalent levels of replenishment. It has been suggested that the lack of wood and other in-channel structures limits gravel retention in this headwater reach (Phinney et al. 1975; Hiss and Knudsen 1993). Most spawning habitat upstream of the proposed FRE facility was mapped within two miles downstream of Fisk Falls. Downstream of the proposed FRE facility, most of the suitable habitat was mapped in a 4-mile reach downstream from Pe Ell (Appendix B).

Table 3.6-1
Count and Density of Suitable Spring-Run Chinook Salmon Spawning Gravel Patches Mapped in the Mainstem Chehalis River During the 2023 Survey.

REACH (RM)	NUMBER OF PATCHES	NUMBER/MILE
113.5 – 111.5	27	13.5
111.5 – 108.5	11	3.7
108.5 – 106.8	3	1.8
106.8 – 101.8	56	11.2
101.8 – 97.0	10	2.1

Gravel supply in moderate gradient confined streams in the Washington/Oregon coastal range is controlled by mass wasting in the long term via landslides and debris flows in headwaters. Bedrock is a prevailing surface and substratum feature throughout most of the spawning reach over which gravel deposits form a mantle. Distribution of gravels is consistent with reach locations downstream of large-scale breaks in channel slope. In 2023, gravel patch area estimates ranged from 15–3,052 square feet (ft^2) with 98 patches less than 1,000 ft^2 in area. More sidebar spawning habitat and less riffle spawning habitat exists upstream of the proposed FRE facility than downstream of it. More spawning habitat exists in the 4-mile spawning reach within the Pe Ell valley than in the reach downstream of Fisk Falls.

Spawning habitat in Pe Ell valley and downstream had a greater portion of habitats with large wood or pool cover nearby. Habitat in the downstream reach also may have a lower risk of deep scour (Appendix B). Long-term gravel and cobble deposition is expected in two reaches – downstream of the slope break at Fisk Falls and downstream of the slope break where the river enters Pe Ell valley.

3.7 Terrestrial Habitats

The diversity of vegetation and geology in the Chehalis River Basin provides a variety of habitats for wildlife species to breed, feed, rest, and overwinter. Based on the USGS National Land Cover Database (NLCD) (Dewitz 2019), there are 15 different vegetative community cover types present in the upper Chehalis watershed (Ecology 2020; Corps 2020).

Upstream of the proposed FRE facility, the watershed is entirely managed for commercial timber harvest. Harvest typically occurs when trees reach 40-50 years of age by clearcutting followed by dense replanting of Douglas fir trees within a few years following harvest. The commercial timberlands are dominated by even-aged, single-story Douglas fir stands ranging from <5 years old to about 50 years old distributed in a patchwork pattern. The NLCD classifies this cover as either evergreen forest or scrub-shrub (<10 years old) depending on the tree height. The harvested stands reach a stem exclusion phase early on with little if any understory development.

Forest Practices Regulations (WAC 222-30-021) limit tree harvest within Riparian Management Zones (RMZs). The total RMZ width adjacent to fish-bearing streams upstream of the proposed FRE facility ranges from 90 to 170 feet depending on site class. No tree harvest is permitted within the first 50 feet adjacent to fish-bearing streams (i.e., core zone) while limited harvest is allowed within the adjacent inner and outer zones as stand requirements are met. For non-fish-bearing streams, harvest is not permitted within 50 feet of the stream for at least 50 percent of its length, at confluences of streams or headwater springs. There are also 50-foot no-harvest boundaries around perennially saturated headwall and side wall seeps. There are also other limited harvest areas to protect certain wetlands and other sensitive areas. Where harvest is limited, the vegetation can range from evergreen forest dominated by Douglas fir, western hemlock, and western red cedar to a mixed forest cover type or a deciduous cover type with red alder, bigleaf maple, and Oregon ash. These limited harvest areas have more edge and sunlight leading to a more developed understory. Other cover types present upstream of the proposed FRE facility include developed or barren areas (logging roads and quarry sites), herbaceous areas (adjacent to roads and recent clearcuts <5 years old), scrub-shrub areas (clearcuts 5–10 years old), and wetlands (discussed in Section 3.8).

The upper Chehalis watershed downstream of the proposed FRE facility is dominated by evergreen forests in some of the upper tributary reaches where commercial timber management occurs, and in the low-lying areas by cultivated crops, hay/pasture, and developed areas of varying intensity followed by wetlands. A small amount of land in the Chehalis floodplain is made up of mixed forest, deciduous forest, and scrub-shrub cover types, primarily as narrow strips along streams.

Collectively, the vegetative communities present support a wide range of bird species, including the marbled murrelet, listed species under the Endangered Species Act, in the forested headwaters where suitable old-growth structure occurs. The greater Chehalis River Basin has the highest species diversity of amphibians in Washington State. Small mammals associated with forest habitat include shrew mole, Townsend's vole, masked shrew, and striped skunk. Larger mammals such as elk, black-tailed deer, black bear, cougar, bobcat, and coyote also occur in forest habitats. Wetlands and areas near rivers and streams provide habitat for North American beaver, mink, water shrew, and raccoon.

Priority habitats have been established by WDFW and are critical for wildlife species, with unique characteristics. There are four priority habitats upstream of the FRE including herbaceous bald, freshwater pond, freshwater emergent wetlands, and freshwater forested/shrub wetland (WDFW 2024a, 2024b, 2024c, 2024d, 2024e). The Mitigation Area above the proposed FRE facility includes priority habitat for Western toad, Dunn's salamander, Northern goshawk, cutthroat trout, steelhead, rainbow trout, coho salmon, Chinook salmon, marbled murrelet, elk, Sandhill crane, golden eagle, and northern spotted owl (WDFW 2024a, 2024b, 2024c, 2024d, 2024e). The Chehalis River floodplain area between the proposed FRE facility and the Newaukum River includes four priority habitats including freshwater emergent wetlands, freshwater forested/shrub wetlands, riverine, and oak woodland. The Mitigation Area downstream of the proposed FRE facility includes priority habitat for Western toad, Pacific lamprey, Olympic mudminnow, Eastern wild turkey, Dunn's salamander, coho salmon, Chinook salmon, rainbow trout, steelhead, cavity-nesting ducks, wild turkey, elk, Trumpeter swan, big brown bat, northern spotted owl, golden eagle, and waterfowl (WDFW 2024a, 2024d, 2024e). Plants with ESA status as threatened or endangered species and state-protected threatened and endangered species are potentially found in the study area. More than 30 rare plant species could potentially occur in the study area, based on information from WA DNR's Natural Heritage Program though, actual presence is unknown).

3.8 Wetlands

3.8.1 Chehalis River Basin Upstream of the Proposed FRE Facility and FRE Facility Footprint

Anchor QEA, LLC delineated wetlands and OHWM of regulated waterbodies in 2017 and 2018 within a 1,709-acre study area that encompassed the proposed FRE facility and inundation area (Anchor QEA 2018). Delineated wetlands were classified based on the dominant vegetation types present and hydrogeomorphic type, and rated as Category I, II, III or IV using Ecology's wetland rating methods for Western Washington (Hruby 2014). Anchor QEA (2018) delineated 123 wetlands within the study area, totaling approximately 13.9 acres. The most common wetland type was a combination of palustrine scrub-shrub/palustrine emergent class wetlands (42), followed by palustrine emergent (40), palustrine forested/palustrine scrub-shrub (16), palustrine forested/palustrine emergent (11), palustrine forested/palustrine scrub-shrub/palustrine emergent (7), palustrine scrub-shrub (4), and palustrine forested (3) wetland types. The most common hydrogeomorphic (HGM) class wetlands were slope wetlands (95), followed by depressional (24) and riverine (4) wetlands.

The slope wetlands were typically small and primarily associated with drainages, forming in areas where water moving downslope slows as the slope levels out and inundates or saturates the soils. Vegetation present in slope wetlands was dominated by red alder (*Alnus rubra*) in the overstory, with Western red cedar (*Thuja plicata*) present to a lesser extent; and the shrub layer was dominated by salmonberry (*Rubus spectabilis*), vine maple (*Acer circinatum*), devils club (*Oplopanax horridus*), and red alder. Herbaceous plants occurred in mounded areas above areas of flowing water and included piggyback plant (*Tolmiea menziesii*), oxalis (*Oxalis oregana*), Pacific bleeding heart (*Dicentra Formosa*), Pacific waterleaf (*Hydrophyllum tenuipes*), Pacific golden-saxifrage (*Chrysosplenium glechomifolium*), and seaside bittercress (*Cardamine angulata*).

Depressional wetlands were generally not associated with any channelized flow or waters and were typically located in topographic depressions on side slopes or in the valley bottom. Vegetation of depressional wetlands included red alder, salmonberry, and piggyback plant. The herbaceous plants were more diverse than found in slope wetlands and included western lady fern (*Athyrium angustum*), Pacific golden-saxifrage, skunk cabbage (*Lysichiton americanus*), and water parsley (*Oenanthe sarmentosa*).

Riverine wetlands occurred adjacent to flowing channels where they were occasionally inundated by overbank flows. Dominant vegetation consisted of red alder, salmonberry, creeping buttercup (*Ranunculus repens*), reed canarygrass (*Phalaris arundinacea*), and colonial bentgrass (*Agrostis capillaris*). Other commonly observed species included Western red cedar, California black currant (*Ribes bracteosum*), Pacific waterleaf, stinging nettle (*Urtica dioica*), and oxalis.

Under the Washington wetland rating system, wetlands are rated as low, moderate, or high based on i) water quality improvement functions; ii) hydrologic functions; and iii) habitat functions. Within each of these functions, each wetland is further rated as low, moderate, or high based on i) site potential; ii) landscape potential; and iii) value. All of the wetlands within the study area were rated as Category II (15) or Category III (108).

3.8.2 Airport Levees

Existing wetlands within the airport levee survey area were documented by the delineation of wetlands, waters, and OHWM conducted in 2018 (Anchor QEA 2019). Wetland cover class and HGM classes of delineated wetlands in the airport levee area include a total of three Category II wetlands covering 6.26 acres, and three Category III wetlands covering 0.37 acres for a total of 6.63 acres of identified wetlands.

3.8.3 Chehalis River Floodplain Downstream of the Proposed FRE Facility

Ecology evaluated the wetlands within the Chehalis River 100-year floodplain from the proposed FRE facility downstream 101 river miles to approximately RM 9 at Montesano extending into the lower reaches of the following major tributaries: South Fork Chehalis River, Newaukum River, Skookumchuck River, Black River, Stearns Creek, Dillenbaugh Creek, Salzer Creek, Lincoln Creek, Independence Creek, Garrard Creek, Cedar Creek, Porter Creek, Satsop River, and Wynoochee River (Appendix O in Ecology

2020). Ecology summarized the potential wetland habitat within this area using the Modeled Wetlands Inventory (Ecology 2020) associated with the late-century major and catastrophic flood events (Table 3.8-1). Most of the modeled wetlands are located within a few hundred feet of the river shoreline. About 8% of the modeled wetlands are located between the major flood and catastrophic flood boundaries while 92% occur within the major flood area boundary.

Table 3.8-1
Area of Potential Wetland Habitats Occurring Downstream of the FRE Facility.

WETLAND COVER CLASS	AREA OF POTENTIAL WETLANDS (ACRES)	PERCENTAGE OF POTENTIAL WETLANDS
Potentially Disturbed Wetlands	4,186	24
Palustrine Forested	3,517	20
Palustrine Scrub-Shrub	3,744	21
Palustrine Emergent	5,727	33
Palustrine Unconsolidated Shore	302	2
Palustrine Aquatic Bed	68	<1
Emerald Ash Borer	<1	<1
Total	**17,545**	**100**

Notes:
Source: Ecology (2020), Appendix O, Table O-9.

3.9 Wetland and Stream Buffers

3.9.1 Wetland Buffers

The current land designation of the temporary inundation area and the surrounding land is Forest Reserve Land, and its primary use is commercial forestry. Wetland buffer widths are managed under Forest Practice Regulations. Wetland Management Zones (WMZs) have variable widths based on the size and type of wetland. No WMZ is required for forested wetlands or Type B wetlands less than 0.5 acres in size. Only four of the wetlands documented during wetland delineation surveys upstream of the proposed FRE facility are larger than 0.5 acres, and all are Type B wetlands smaller than 5 acres in size. Based on the size and wetland type, these four wetlands would have a minimum WMZ width of 25 feet. Limited harvest is allowed within WMZs. Where WMZs overlap with RMZs, the most restrictive regulations apply. Under RMZ regulations, there are 50-foot no-harvest buffers around perennially saturated headwall and side wall seeps.

At the airport levee site, wetland buffer widths are determined under Lewis County Code (LCC) Chapter 17.38. A total of 44.2 acres of wetland buffer habitat occurs within the footprint of the proposed levee changes and wetlands within approximately 200 feet of the proposed footprint based on visual observations. The affected wetlands do not include Category I wetlands and are already highly disturbed. Four of the wetlands have moderate habitat function scores and four have low habitat function scores. Three of the eight wetlands also have high water quality function scores. These types of wetlands are common within the Chehalis River Basin in general.

3.9.2 Stream Buffers

As previously noted, the current land designation of the temporary inundation area and the surrounding land is Forest Reserve Land, and its primary use is commercial forestry. As such, stream buffer widths are managed as RMZs under Forest Practice Regulations (WAC 222-30-021). RMZ widths vary depending on the stream type, site class, and the projected basal area of the future mature forest. The total RMZ width adjacent to fish-bearing streams (Type S and Type F Waters) upstream of the proposed FRE facility ranges from 90 to 170 feet depending on site class. No tree harvest is permitted within the first 50 feet adjacent to fish-bearing streams (i.e., core zone) while limited harvest is allowed within the adjacent inner and outer zones as stand requirements are met. For non-fish-bearing stream systems (Type Np, Ns, and Nu Waters), harvest is not permitted within 50 feet of the stream for at least 50 percent of its length, at the confluence of streams, or at headwater springs. There are also 50-foot no-harvest limits around perennially saturated headwall and side wall seeps. Streams that have no surface water connection to a downstream Type S, Type F, Type Np, or Type Ns water have no stream type classification and, therefore, have no designated protective stream buffer.

3.10 Aquatic Species

The following section summarizes the aquatic species, including fish, shellfish, and amphibians that occur in the upper Chehalis River Basin with an emphasis on those species identified in the SEPA DEIS as being potentially affected by the Proposed Action.

3.10.1 Fish

There are no ESA-listed, threatened, or endangered fish species in the upper Chehalis River Basin (Corps 2020). Pacific lamprey, a federal SOC, is identified as a Species of Greatest Conservation Need under the Washington State Wildlife Action Plan, and as a Priority Species under the WDFW Priority Habitat and Species Program (WDFW 2019b, 2019c). Priority species require protective measures for their survival due to their population status, sensitivity to habitat alteration, and/or recreational, commercial, or tribal importance. In addition, Native American tribes regard Pacific lamprey as a highly valued resource, both for their ecological and cultural importance and for food and spiritual sustenance. Chinook salmon and steelhead are Washington State Candidate Species and coho salmon are a State Priority Species.

The Olympic mudminnow (*Novumbra hubbsi*), designated as a state-listed Sensitive Species, is the only resident fish with special status in the upper basin. It is also identified as a Species of Greatest Conservation Need and a WDFW Priority Species (WDFW 2019b). Mudminnow habitat includes slow-moving water bodies with mud substrate and an abundance of aquatic vegetation, such as wetlands or ponds.

Although there are no listed salmon populations in the Chehalis River, Essential Fish Habitat (EFH) has been designated for Chinook salmon (*O. tshawytscha*) and coho salmon (*O. kisutch*). Salmon EFH in the Chehalis River covers all accessible waterbodies, including the mainstem river and tributaries in the Proposed Action area.

Fish Species potentially affected by the Proposed Action include both the anadromous and resident species listed in Table 3.10-1. The list also includes non-native warm-water species which may indirectly affect native species under future conditions of changing water quality and temperature.

Table 3.10-1
Fish Species of Interest in the Proposed FRE Facility Impact Area.

COMMON NAME	SCIENTIFIC NAME	SPECIES PRESENCE* UPSTREAM OF PROPOSED FRE	DOWNSTREAM OF PROPOSED FRE
ANADROMOUS			
Spring-run Chinook Salmon	*Oncorhynchus tshawytscha*	S, R	S, R
Fall-run Chinook Salmon	*Oncorhynchus tshawytscha*	S, R	S, R
Coho Salmon	*Oncorhynchus kisutch*	S, R	S, R
Steelhead	*Oncorhynchus mykiss*	S, R	S, R
Pacific Lamprey	*Entosphenus tridentatus*	S, R	S, R
RESIDENT			
Mountain Whitefish	*Prosopium williamsoni*	S, R	S, R/A
Western Brook Lamprey	*Lampetra richardsoni*	S, R	S, R
Rainbow Trout	*Oncorhynchus mykiss*	S, R	S, R
Cutthroat Trout	*Oncorhynchus clarkii*	S, R	S, R
Olympic Mudminnow	*Novumbra hubbsi*		S, R
NON-NATIVE			
American Shad	*Alosa alosa*		S, R
Bass Species	*Micropterus* spp.		S, R

Notes:
S = spawning; R = rearing A = assumed present.

Fish-bearing streams upstream of the proposed FRE facility are categorized under the WDFW Fish Passage Inventory database for waters of Washington State. There are 15 named tributaries to the Chehalis River upstream of the proposed FRE facility, not including the East and West forks of the Chehalis River, all but two of which (Little Roger Creek and Smith Creek) have been documented as fish-bearing, primarily for coho salmon and winter-run steelhead. Table 3.10-2 indicates the fish-bearing status of tributaries upstream of the proposed FRE facility.

Table 3.10-2
Status of Fish Populations in Streams Upstream of the Proposed FRE Facility from WDFW Statewide Washington Integrated Fish Distribution (SWIFD) Integrated Distribution Database (WDFW 2024c).

CREEK NAME	FISH BEARING (Y/N)	ANADROMOUS SPECIES	RESIDENT SPECIES
Mainstem Chehalis River	Yes		
Lester Creek	Yes	Coho, Winter-run Steelhead	
Crim Creek	Yes	Coho, Winter-run Steelhead	
Hull Creek	Yes	Coho	
Browns Creek	Yes	Coho	
Big Creek	Yes	Coho, Winter-run Steelhead	
Roger Creek	Yes	Coho, Winter-run Steelhead	
Little Roger Creek	No		
Smith Creek	No		
Alder Creek	Yes	Coho, Winter-run Steelhead	
Thrash Creek	Yes	Coho, Winter-run Steelhead	
Mack Creek	Yes	Coho, Winter-run Steelhead	
Cinnabar Creek	Yes	Winter-run Steelhead	
George Creek	Yes	Coho, Winter-run Steelhead	
West Fork Chehalis River	Yes	Coho, Winter-run Steelhead, Spring-run and Fall-run Chinook	Coastal Cutthroat
Sage Creek	Yes	Coho, Winter-run Steelhead	
East Fork Chehalis River	Yes	Coho, Winter-run Steelhead, Fall-run Chinook	

Notes:
Fish presence is only presented for streams with a species status of "documented," and not those where the status is listed as "presumed."

3.10.1.1 Anadromous Fish

A portion of all of the anadromous species that spawn in the Chehalis River do so upstream of the proposed FRE facility; however, salmon spawning habitat potential upstream of the proposed FRE facility as a proportion of the entire basin is estimated to be less than 1% for fall-run Chinook and coho salmon, 2.5% for steelhead, and 3% for spring-run Chinook salmon (Ecology 2020). Of the 3% spring-run Chinook salmon spawning habitat that occurs in the upper basin (upstream of RM 98), most (97%) occurs within 6 miles upstream of the proposed FRE facility site (Ecology 2020). While coho salmon and steelhead spawning occurs within the proposed FRE inundation area, the majority of suitable habitat for these species is located upstream of the inundation zone or in tributaries. The percentage of coho salmon and steelhead spawning habitat in the inundation area is less than 35%, because suitable spawning habitat extends further upstream for these species.

3.10.1.1.1 Spring-run Chinook Salmon

The current distribution of spring-run Chinook salmon in the Mitigation Area includes 11.2 miles of habitat upstream of the proposed FRE facility and 8.0 miles downstream of the proposed FRE facility. Original native salmon stocks of spring-run Chinook salmon along with coho salmon and steelhead were thought to be eradicated from the upper Chehalis River Basin due to logging dams that blocked the river before the 1930s (Phinney et al. 1975). While populations of all three of the salmon runs were re-established, the spring Chinook salmon run has remained relatively small in number. WDFW spawning surveys from 1982 to 1991 showed the peak count of spring-run Chinook salmon redds was 40 (in 1983) and counts of 0 to 16 redds in the remaining nine survey years (Light and Herger 1994). Subsequent surveys have documented a similar pattern with redd counts ranging from 1 to 25 between 2013 and 2019 (Ronne et al. 2020).

In October 2018, a peak-spawning supplemental survey for spring-run Chinook salmon redds was conducted on the mainstem Chehalis from upstream of the proposed FRE facility downstream to the Newaukum River. A total of 39 redds were evenly distributed from the proposed FRE facility downstream to RM 78.5, downstream of the town of Adna (Ronne et al. 2020). Additional information on the distribution, abundance, and spawning of Spring-run Chinook is presented in Tables 3.10-3, 3.10-4, and 3.10-5.

Ronne and others estimated the contribution of spring-run Chinook salmon upstream of the proposed FRE facility to be 1.25% of the entire Chehalis River Basin spawner abundance (Ronne et al. 2020) (Table 3.10-4). Of the spring-run Chinook salmon redds observed upstream of the proposed FRE facility from 2015 through 2019, 50% were found in the inundation area in the mainstem (four redds) and Crim Creek (one redd), and 2 redds (25%) were found in the mainstem Chehalis River upstream of the inundation area (Ronne et al. 2020) (Table 3.10-5).

Throughout the Chehalis River Basin, the abundance of spring-run Chinook salmon has been declining in recent years (Lestelle et al. 2019). Temperature is the primary limiting factor for spring-run Chinook salmon during holding, spawning, and rearing, likely due to riparian loss, increased sedimentation resulting in channel changes, and decreased summer flows in the mainstem and tributaries (Smith and Wenger 2001). Lack of habitat complexity and low stream flows have decreased the availability of cold water holding and staging refugia, and further increases spring-run Chinook salmon vulnerability to increased stream temperature.

Outmigration of Chinook smolts in the Upper Chehalis occurred primarily between late May and late-June, according to 2021 smolt abundance from WDFW mark-recapture studies (Litz et al. 2023). Genetic identification of spring- vs. fall-run Chinook smolts indicated that spring-run Chinook smolts accounted for less than 1% (n=1,073) of the total Upper Chehalis River outmigrants while about 10.1% (n=11,819) were heterozygous hybrids and the remainder were fall-origin fish (n=104,294) (Litz et al. 2023).

3.10.1.1.2 Fall-run Chinook Salmon

A fall run of Chinook salmon was not documented historically. No fall-run Chinook salmon were documented in WDFW's 1982 to 1991 surveys (Light and Herger 1994). However, in the subsequent decades, a fall Chinook salmon run has been identified with counts ranging from 86 in 2013 to 221 in 2018 (Ronne et al. 2020). Fall-run Chinook salmon spawn throughout the mainstem Chehalis River between the Satsop River near Elma (RM 28.0) and the Skookumchuck River (RM 67.0), and from the South Fork Chehalis River (RM 88.1) to upstream of the proposed FRE facility though not the headwater basin (Salmon and Steelhead Stock Inventory [SASSI]). Within the Mitigation Area, fall-run Chinook salmon spawning also occurs in the South Fork Chehalis River and in lower Elk Creek. Information on the distribution, abundance, and spawning of fall-run Chinook is presented in Tables 3.10-3, 3.10-4, and 3.10-5.

During October 2018, a peak-spawning supplemental survey for fall-run Chinook salmon redds was conducted from upstream of the proposed FRE facility downstream on the mainstem Chehalis River to the Newaukum River. A total of 480 redds were observed in the mainstem between the proposed FRE facility and the Newaukum River, while 221 redds were observed upstream of the proposed FRE facility at RM 108.5 (Ronne et al. 2020). As noted above, smolt outmigration peaks in May and June, with about 90% of outmigrants being of fall-run Chinook genetic origin (Litz et al. 2023).

3.10.1.1.3 Coho Salmon

Coho salmon are widely distributed throughout the Chehalis River Basin, including the major tributaries in the upper Chehalis River. The coho stock in the Chehalis River is derived from mixed origins with a composite of hatchery and wild production (SASSI). Hatchery releases of fingerling coho in tributaries of the Chehalis River Basin began in the 1950s and continued into the early 1990s when approximately half of the total escapement to the Chehalis River was hatchery origin (Hiss and Knudsen 1993). Information on the distribution, abundance, and spawning of Spring-run Chinook is presented in Tables 3.10-3, 3.10-4, and 3.10-5.

During December 2018, a peak supplemental survey for coho salmon redds was conducted in the mainstem Chehalis River and the tributaries upstream of the proposed FRE facility down the mainstem Chehalis River to Rainbow Falls (RM 97.0). A total of five redds were observed in the mainstem between the proposed FRE facility and approximately RM 103 (about 2.7 miles upstream of the Elk Creek confluence) (Ronne et al. 2020). Between 2013 and 2019, a range of 45–270 redds were observed in the mainstem and tributaries both within and upstream of the inundation area (Ronne et al. 2020). Of the five documented redds in the mainstem Chehalis River downstream of the proposed FRE facility, four were located near the town of Pe Ell downstream of Stowe Creek and one was located near the Shields Creek confluence.

3.10.1.1.4 Winter-run Steelhead

In the upper Chehalis River, most documented winter-run steelhead spawning occurs in the mainstem Chehalis upstream of the South Fork Chehalis River confluence and in the Skookumchuck, Newaukum, and South Fork Chehalis rivers as well as other medium and small tributaries. Information on the distribution, abundance, and spawning of spring-run Chinook is presented in Tables 3.10-3, 3.10-4, and 3.10-5.

During April 2019, a peak-spawning supplemental survey for winter-run steelhead redds was conducted in the mainstem Chehalis River and the tributaries upstream of the proposed FRE facility and in the mainstem Chehalis River from the Pe Ell bridge downstream to the Newaukum River confluence (RM 75.2). A total of 53 redds were observed in the mainstem between the Pe Ell bridge and the Newaukum River while 399 redds were observed in the mainstem and tributaries both within and upstream of the proposed FRE inundation area (Ronne et al. 2020). Of the 53 documented redds in the area of the mainstem Chehalis River surveyed, all but two were located upstream of the Elk Creek confluence with a higher density occurring near Pe Ell. No winter-run steelhead redds were observed downstream of RM 97.0. Steelhead have been observed upstream of barriers in Big, Thrash, Cinnabar, and Sage creeks during spawning surveys in the 1980s (Beechie 2018).

Table 3.10-3

Distribution of Chinook and Coho Salmon and Steelhead Habitat in the Proposed FRE Facility Mitigation Area.

MITIGATION REACH	WATERBODY	DISTRIBUTION (MILES)		
		CHINOOK SALMON	COHO SALMON	STEELHEAD
Upstream of FRE	Mainstem Chehalis River	11.2	11.5	11.5
	Tributaries	8.0	34.8	36.9
Downstream of FRE	Mainstem Chehalis River	47.5	186.1	239.3
	Tributaries	91.8	350.6	425.6
TOTAL		**158.5**	**583**	**713.3**

Notes:
Source: SWIFD portal, updated April 2018.

Table 3.10-4

Estimated Historical and Current Abundance of Adult Salmon and Steelhead for the Entire Basin Upstream of RM 9 and Headwater Basin Upstream of the Proposed FRE Facility.

SPECIES	ABUNDANCE UPSTREAM OF RM 9[1]			ABUNDANCE UPSTREAM OF PROPOSED FRE[2]		
	AVERAGE (YEAR)	HIGH (YEAR)	LOW (YEAR)	AVERAGE (YEAR)	HIGH (YEAR)	LOW (YEAR)
Spring-run Chinook Salmon	2,095 (1991–2018)	5,034 (2,004)	496 (2018)	5 (2015–2018)	8 (2017)	3 (2015, 2018)
Fall-run Chinook Salmon	5,352 (1971–2018)	9,951 (2018)	2,862 (1994)	395 (2015–2018)	578 (2018)	239 (2017)
Coho Salmon	24,190 (1987–2017)	46,398 (2010)	8,966 (2007)	1,070 (2013–2018)	2,128 (2018)	174 (2013)
Winter-run Steelhead	2,650 (1983–2018)	4,604 (2004)	1,164 (2011)	1,214 (2013–2018)	1,850 (2014)	870 (2017)

Notes:
1. Sources: Scharpf (2019); WDFW (2019c). Describes total estimated number of fish that were spawned naturally; excludes fish caught in downstream fisheries.
2. Source: Ronne et al. (2020). Data were collected from return years 2013 through 2018. Includes winter-run steelhead that spawn before and after the March 15 date used for discerning hatchery-origin "early" stock from the wild "late" stock.

Table 3.10-5
Results of the 2018 Spawning Survey for the Number of Redds Observed in the Area Upstream of the Proposed FRE Facility Versus the Areas Downstream.

LOCATION	SPRING-RUN CHINOOK	FALL-RUN CHINOOK	COHO	WINTER-RUN STEELHEAD
Upstream of FRE	1	221	961	589
Downstream of FRE – Newaukum	39	480	5	53

3.10.1.1.5 Pacific Lamprey

Pacific lamprey appear to be broadly distributed in the mainstem Chehalis River and major tributaries. They have been documented in the mainstem upstream of and downstream of the proposed FRE facility site (USFWS 2011) and were observed in every sub-basin sampled (Jolley et al. 2016). Spawning population size and run timing of Pacific lamprey have not been documented in the Chehalis River Basin, though spawning distribution was surveyed by WDFW from 2013 through 2018. Spawning was concentrated in the mainstem Chehalis River between the Stearns Creek and the South Fork Chehalis River, from Pe Ell upstream to the proposed FRE facility, and within the area upstream of the proposed FRE facility.

3.10.1.2 Resident Fish

Summer stream temperatures in headwaters and the upper mainstem Chehalis River are cooler than downstream areas and support a cold-water fish assemblage dominated by salmonids compared to reaches downstream from Rainbow Falls (RM 97.0) that are dominated by native cyprinids (minnows) (Winkowski et al. 2018).

Both rainbow (*O. mykiss*) and cutthroat trout are widely distributed throughout the upper mainstem Chehalis River and the larger tributaries. Like anadromous salmonids, resident trout also prefer clean, cold-water habitats with mesohabitat features including riffles and pools, especially key for spawning. Mountain whitefish (*Prosopium williamsoni*) have been documented throughout the mainstem Chehalis River within several miles both downstream of and upstream of the proposed FRE facility. Whitefish prefer clear, cold water and large deep pools, and spawn in the fall in areas of coarse or smaller gravel. Olympic mudminnow only occurs in streams with little or no flow, wetlands, and ponds. They are known to occur in low densities in off-channel habitat adjacent to the Chehalis River between the confluences of the Black River and the South Fork Chehalis River (RM 47.0 to 88.1; Hayes et al. 2016, 2019).

3.10.1.3 Non-native Fish

Largemouth bass and smallmouth bass are warm-water non-native species that present the greatest threat to native fish. Bass are opportunistic predators, and large individuals can prey heavily on juvenile salmon where their distributions overlap (Wydoski and Whitney 2003). The presence of invasive predators, including bass, is a potential limiting factor for the sustainability of some salmon populations in the Chehalis River Basin (Litz et al. 2023). Bass thrive in the warmer reaches and slow-moving off-channel habitats of the mainstem. The upstream extents of bass invasion into salmonid-dominated river habitats are associated with warm water temperatures above 10°C and are projected to increase under future climate scenarios (Wydoski and Whitney 2003; Rubenson and Olden 2019). Bass have not been observed upstream of the confluence of the mainstem Chehalis River with the South Fork Chehalis River at RM 88.1 (Winkowski et al. 2018).

3.10.2 Marine Mammals

The outlet of the Chehalis River flows into Grays Harbor, then the Pacific Ocean near Aberdeen, Washington, a marine area within the feeding range of the Southern Resident Killer Whale (SRKW). This resident population of marine mammals has higher requirements for salmon than northern residents, with about 70% of their total diet being made up of Chinook salmon, and close to 90% of their summer (July–August) diet being made up of Chinook salmon (Ford et al. 2010) with secondary species preference being coho and steelhead. Declines in prey availability was identified by NOAA Fisheries as a threat to SRKW populations.

3.10.3 Freshwater Mussels

Three species of native freshwater mussels have been documented in the Chehalis River: western floater (*Anodonta* spp.), western pearlshell (*Margaritifera falcata*), and western ridged mussel (*Gonidea angulata*) (Waterstrat 2013). In addition to the native mussels, Asian clams, a non-native species, have been documented in Bunker Creek. The western ridged mussel is a candidate for federal listing under the ESA (Blevins et al. 2020).

Native freshwater mussels have been observed throughout the upper Chehalis River; however, little is known about their distribution and habitat use. During WDFW surveys conducted in 2020 and 2021, freshwater mussels were found to be numerous in the mainstem Chehalis River from about RM 101 just upstream of the confluence with Elk Creek near the community of Doty, downstream to the Newaukum River confluence (RM 75.2). They appear to be more common between Rainbow Falls (RM 97.0) and the confluence with the Newaukum River than reaches upstream of Rainbow Falls. Mussel densities in some reaches were so high that they were the major substrate (Winkowski et al. 2018). No mussel beds were observed in the vicinity of the proposed FRE facility or the inundation area during freshwater mussel surveys conducted by WDFW in 2020 (Douville et al. 2021).

3.11 Wildlife Species

The upper Chehalis River Basin provides habitat for a wide array of wildlife species and has the highest diversity of amphibians in Washington State. The following sections address priority terrestrial-breeding amphibians, birds, and mammals that may occur in the Mitigation Area or are indirectly affected by potential impacts associated with the Proposed Action. Attributes of native species that are described in the following sections include their federal and state special status and ecological role in the Chehalis River Basin.

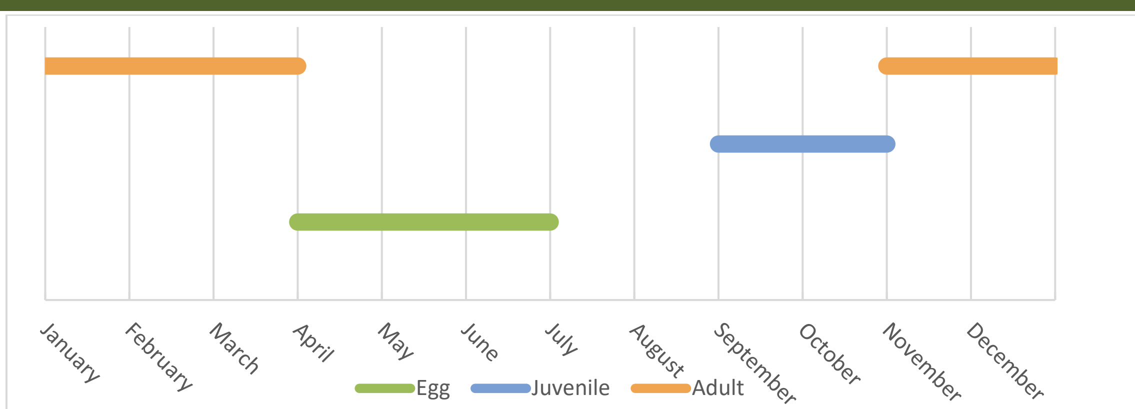
3.11.1 Amphibians

Amphibian species can be grouped into categories according to their breeding habitat: still-water breeding, stream breeding, and terrestrial breeding. Still-water breeding amphibians in the Mitigation Area are often associated with off-channel floodplain habitats including oxbows and ponds. Stream-breeding amphibians utilize flowing water in rivers and streams, while terrestrial-breeding amphibians are often associated with riparian habitats and moist cool forests.

Priority terrestrial-breeding amphibian species in the Mitigation Area include Dunn's salamander (*Plethodon dunni*) and Van Dyke's salamander (*Plethodon vehiculum*) which are both candidates for state listing. Amphibian surveys were conducted by WDFW in the vicinity of the FRE facility and inundation area between 2014 and 2017. Terrestrial-breeding amphibians detected include ensatina (*Ensatina eschscholtzii*), western red-backed salamander (*Plethodon vehiculum*), Dunn's salamander, and Van Dyke's salamander (Hayes et al. 2017).

Dunn's and Van Dyke's salamanders inhabit cool, moist microclimates in forested habitats (Larsen 1997). The Willapa Hills region is one of three disjunct distributional centers for Van Dyke's salamander, which is endemic to western Washington (Olson and Crisafulli 2014). Dunn's salamanders' range extends from northeastern California to western Oregon and the Willapa Hills in southwestern Washington. Both species occupy wet, rocky substrates or wood with several inches of duff. Occupied sites are heavily shaded and can include seeps and stream banks. Both species are often found in riparian zones but have been documented further upslope in appropriate, stable microclimates (Larsen 1997). Several amphibian species inhabit the Chehalis River watershed, and climate change is expected to impact those species. Life history for both Dunn's and Van Dyke's salamanders are presented in Figure 3.11-1 including egg, juvenile, and adult phases.

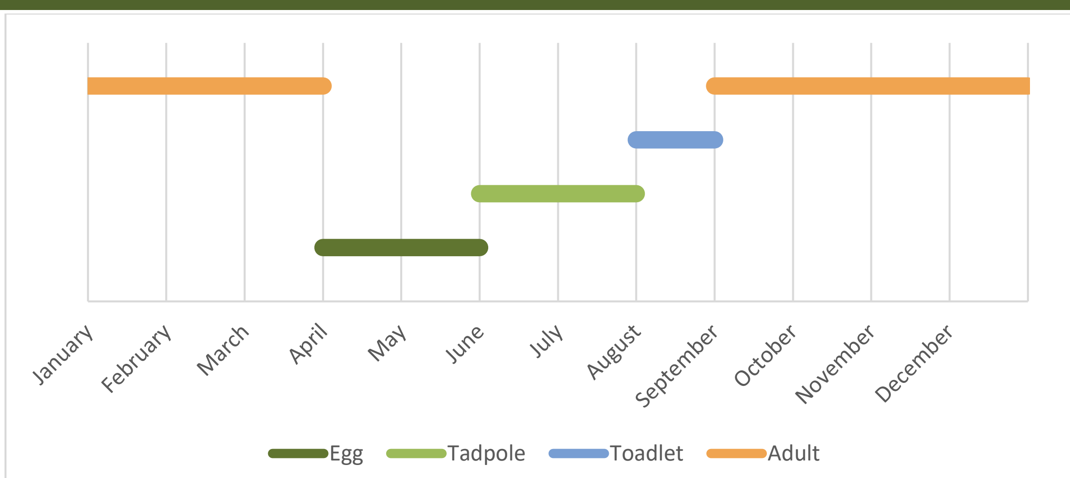
Figure 3.11-1
Dunn's and Van Dyke's Salamander Life History Periodicity for Egg, Juvenile, and Adult Life History Strategies.



Priority aquatic amphibian species found in the Mitigation Area include the western toad (*Anaxyrus boreas*), a candidate for state listing. The western toad is a still-water breeding species that is known to breed in the mainstem Chehalis River and larger tributaries in the inundation area (Hayes et al. 2016). Western toad spawning and incubation occurs in standing water, including ponds, lakes, slow-moving reaches of streams, springs, reservoirs, canals, and roadside ditches. Adults have been observed as far as 1.6 miles from breeding sites. Hibernation occurs in terrestrial locations, but little else is known about it (WA DNR 2013). In addition to being documented in the inundation area, the western toad has also been documented in areas both upstream and downstream of the proposed FRE facility (Hayes et al. 2017).

The sensitivity of the western toad to climate change is primarily driven by its dependence on intermittent and permanent aquatic habitats (e.g., streams, seeps, wetlands, ponds) that may be lost or degraded due to changes in precipitation and altered hydrology. A significant portion of western toad breeding in western Washington occurs in low-gradient portions of rivers, such as the Chehalis and its tributaries, after the hydrographs have dropped to a level that is unlikely to scour off unattached eggs. Greater, more variable, and episodic rainfall (all current predictions of climate change in the Pacific Northwest) are likely to put these river-breeding populations at risk. High-elevation populations may be at risk because of reduced hydroperiods in breeding habitats that result either in reproductive failure or failure of annual cohorts to reach metamorphosis. The periodicity for the western toad is presented in Figure 3.11-2 including egg, tadpole, toadlet, and adult phases.

Figure 3.11-2
Western Toad Life History Periodicity Including Egg, Tadpole, Toadlet, and Adult Phases.



The desiccation of streams and pools along dispersal routes may create barriers to movement. Synergistic impacts such as climate change combined with disease outbreaks increase the sensitivity of this species. The physiological sensitivity of this species is uncertain, some references cite sensitivities to temperature and moisture conditions, while others cite high adaptability to changes in these conditions (WDFW 2024d). Western toads have a moderate to high sensitivity to climate change and with changes to habitat occurring due to the construction and operation of the proposed FRE facility, protecting western toads will become more challenging.

3.11.2 Birds

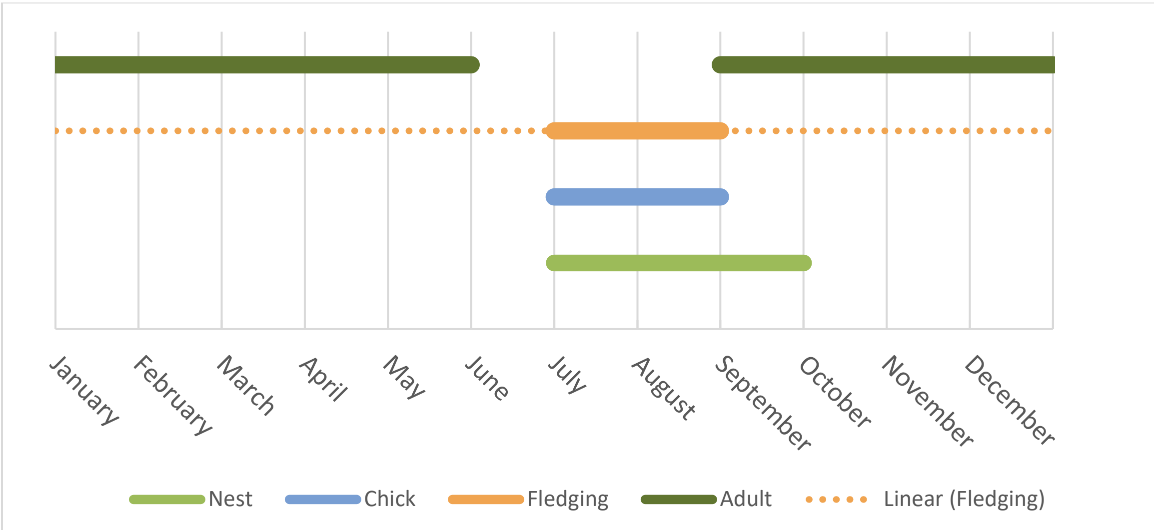
There are two bird species of note found in the impact/Mitigation Area. The marbled murrelet (*Brachyramphus marmoratus*) is a federally- and state-listed species that occurs in upland habitats upstream of the proposed FRE facility. It is primarily an ocean-dwelling species that spends more than 90 percent of its life at sea, but nests inland in old-growth conifer-dominant stands from central California to the Aleutian Islands of Alaska. Suitable nesting habitat for marbled murrelets consists of mature conifers (>15) inches diameter at breast height (dbh) situated in contiguous conifer-dominant (>60 percent) stands with at least one suitable nesting platform at least 33 feet off of the ground (Hamer and Nelson 1995).

As coastal forests undergo clear-cutting and development, marbled murrelets are forced to search further inland for suitable nesting habitats. Timber harvest, development, and an overall increase in wildfires also increase habitat fragmentation and the creation of edge habitat that can lead to an increase in nest predation by predators like corvids (Hamer and Nelson 1995). These and other threats like changes in oceanic conditions have caused a rapid decline in the species' population thus resulting in marbled murrelets being listed as state-endangered in Washington, Oregon, and California and threatened under the federal ESA.

Within the Mitigation Area, pockets of suitable marbled murrelet nesting habitat with potential nesting platforms are present within patches of mature coniferous forest in the headwater areas of the upper Chehalis River Basin and may be present within the vicinity of the proposed FRE inundation area. While much of the area is in timber production and no old-growth forest is present, mature forest is present in linear patches along the stream corridors which may provide nesting habitat for marbled murrelets. Marbled murrelet activity has been documented in the upstream portions of the inundation area. Additionally, circling marbled murrelets, which are indicative of nesting activity, were documented within a mile of the inundation area within the sub-canopy of forested habitat (Ecology 2020).

The periodicity of murrelet life history stages is presented in Figure 3.11-3 including those life history phases that happen within the proposed FRE facility Impact Area (nesting, hatching, fledgling) and those that do not (adult foraging). Impacts associated with clear-cutting and development in the watershed are prominent.

Figure 3.11-3
Marbled Murrelet Life History Periodicity for Nesting, Hatching, and Fledgling (Within the Proposed FRE Facility Impact Area) and Adult Phases (Not Within the Proposed FRE Facility Impact Area).



Northern spotted owl is a federally- and state-listed species that is strongly associated with old-growth forest and requires large patches of suitable habitat for nesting. Based on the results of several surveys conducted during the last 17 years, the presence of the northern spotted owl in upper Chehalis headwaters is extremely low and was limited to dispersing and foraging individuals.

3.11.3 Mammals

Mammals with federal or state threatened, endangered, or proposed status are not likely to occur in the Mitigation Area. Priority species that are not state- or federally-listed that may potentially occur in the area include Columbia black-tailed deer (*Odocoileus hemionus columbianus*), Roosevelt elk (*Cervus canadensis roosevelti*), Keen's myotis (*Myotis evotis keenii*), Townsend's big-eared bat (*Corynorhinus townsendii*), and roosting concentrations of big brown bats (*Eptesicus fuscus*) and myotis bats (*Myotis spp.*) (Ecology 2020).

In addition to priority species, other mammal species likely to occur throughout the basin include those common to western Washington such as Douglas squirrel (*Tamiasciurus douglasii*), racoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), beaver (*Castor canadensis*), coyote (*Canis latrans*), and various bat species.

3.12 Limiting Factors

Based on available documents and site-specific data collected by the Applicant, potential population limiting factors in the upper Chehalis River Basin were evaluated to identify mitigation actions that would provide site-specific ecological lift as related to potential project impacts while also helping to improve overall watershed health. Limiting factors include degraded riparian conditions (Seixas et al. 2018), seasonally high and low flows (Phinney et al. 1975), degraded water quality (Jennings and Pickett

2000; Ecology 2001; Ahmed and Rountry 2004), degraded stream channel and floodplain conditions (Phinney et al. 1975; Hiss and Knudsen 1993), barriers to fish spawning and rearing habitat (WDFW 2020), and invasive species including riparian shrubs and wetland plants, bullfrog, and warmwater piscivorous fishes (GHLE 2011). Each of these elements affects the quality of habitat, as summarized below, and has the potential to limit abundance, fitness, and persistence for native fish, amphibians, and terrestrial species.

1. **Degraded Riparian Conditions** are related to riparian forest clearing and establishment of non-native species (i.e., reed canarygrass and Himalayan blackberry) as the predominant vegetation in some reaches of the mainstem Chehalis River and tributaries. These non-native species have reduced riparian function with respect to providing shade and overhead cover, nutrient cycling, soil retention, bank stability, a source of large wood, prey inputs for aquatic species, and complex habitat structure for native wildlife species.
2. **Seasonal High and Low Flows** are related to the loss of floodplain, channelization, and a reduction in both channel complexity and structure, but potentially limit salmon populations in different ways. Flood flows in winter scour out substrates and create unstable stream beds for incubating or very early life stages of salmon. Low summer flows cause thermal barriers for adults holding or migrating to cooler upper reaches and limit suitable rearing habitat for juvenile Chinook and coho salmon as well as other native fish species.
3. **Degraded Water Quality** has resulted from land uses that increase run-off, degraded riparian habitat structure, lack of shade, and bank erosion. Poor water quality limits access to suitable habitats and the suitability of existing habitats (high summer temperature and low DO relative to Ecology standards) for support of native aquatic species.
4. **Degraded Stream Channel and Floodplain Conditions** are related to past human activities such as historic logging practices, filling, channel straightening, armoring, diking, and road construction. These activities limit natural floodplain processes such as periodic inundation, lateral channel movement, flood water storage, sediment, large wood, and creation and maintenance of off-channel habitats such as sloughs, side-channels, and other features that provide important spawning and rearing habitat and refugia from high flow and temperature. A lack of in-channel structure is related to overwinter scour risk to salmon redds.
5. **Barriers to Fish Spawning and Rearing Habitat** include man-made barriers that prevent native fish from reaching suitable spawning and/or rearing habitat. Additional factors that may restrict access include low stream flow and/or temperature conditions that constitute seasonal barriers for native fishes.
6. **Invasive Species** are found in the upper Chehalis River including aquatic invasives such as largemouth bass, smallmouth bass, and bullfrogs that are more tolerant to stagnant, warm water conditions, and may displace, out-compete, or prey on juvenile salmonids, lamprey, and native aquatic amphibians (GHLE 2011). Invasive riparian species including Himalayan blackberry (*Rubus armeniacus*) and reed canarygrass (*Phalaris arundinacea*) are also prevalent in riparian areas downstream of Pe Ell. These plant species reduce riparian function including shade, overhanging cover, and soil retention as compared to native riparian shrubs and trees.

The current condition of the Chehalis River also affects its ability to respond to natural flood dynamics. The highly entrenched, straightened, single-thread channel is disengaged from the floodplain while the floodplain itself has been converted for agriculture or urban uses. Thus, the river's ability to absorb and adjust to the natural seasonal hydrograph has been reduced and extensive flooding has and will continue to exacerbate habitat limitations. For example, similar to other west coast river systems (Appendix A), storm-related landslides benefit the upper Chehalis subbasin with episodic input of spawning gravels; however, because there is limited structure in the channel to hold these gravels in place, they are transported downstream. Consistent with the 1974 Chehalis River Watershed Assessment for the headwaters subbasin, the Applicant's sediment transport modeling indicated that even 2-year floods are capable of transporting gravels and cobbles downstream, and that routine winter flows pose scour risk to salmon redds in the headwater subbasin (Appendix A; Phinney et al. 1975; Hiss and Knudsen 1993). Similarly, downstream of Pe Ell, channelization and incision have affected the ability of the river to engage with its floodplain and thus absorb the energy associated with major and greater flood events. Instead, these larger floods have resulted in exacerbated bank erosion, channel entrenchment, and mainstem channel widening which in turn has led to shallow water habitats with open riparian canopies and excessively warm water temperatures that limit salmon rearing, holding, and spawning habitat during summer months.

To evaluate the type and extent of habitat corrections within the Chehalis River that may need to be implemented to benefit salmon populations, NOAA Fisheries has completed detailed modeling of the Chehalis River that documents habitat changes over time and predicts which of these habitat factors, if corrected, could potentially increase salmon abundance (Beechie et al. 2023). This modeling estimated that the Chehalis River has lost 90% of its floodplain; largely side-channel, marsh, and beaver pond habitat. Additionally, model results indicate that spawning gravel has decreased between 23–68% across subbasins related to a loss of in-channel wood, shade loss related to riparian habitat alteration has occurred resulting in increased summer temperatures, fine sediment has increased an average of 4% across the basin and 5–10% in the upper basin, and barriers now prevent access to 18–20% of steelhead and coho salmon spawning habitat (Beechie et al. 2023).

The Chehalis River models predicted that restoring habitat function is likely to elicit different responses from different species (Beechie et al. 2023). For example, spring-run Chinook salmon were predicted to respond most strongly to temperature reduction from restoring shade and wood, while beaver ponds and floodplain re-engagement were predicted to be drivers for coho salmon. Furthermore, while some actions had no basin level population response, they were important at a local scale. Barrier removal was an example of this with predicted positive benefits to local populations of steelhead and coho salmon. A reduction in fine sediments was one attribute that showed positive results for all species but was associated with a high level of uncertainty associated with sources and distribution (Beechie et al. 2023).

3.13 Future Conditions Without the Proposed Action

Physical processes that contribute to habitat quality and quantity as well as aquatic species use of habitat within the upper Chehalis River are dynamic. Some processes are human driven such as water rights, forest practices and harvest schedules, infrastructure development, and other land uses, while others, such as stream flow, temperature, and associated habitat suitability, occur on a continuum that will be affected by climate change.

Climate change models for the Puget Sound that have been scaled to the Chehalis River Basin predict increased winter precipitation and flows combined with decreased summer flows (Mauger et al. 2016). The model developers indicated that warmer winter temperatures would mean less snow and more frequent heavy rain events which are expected to increase the risk of winter flooding and related landslides, erosion, sediment transport, and scouring of substrate. With less snowpack from the highest elevations and less summertime precipitation expected, lower summer stream flows and warmer water temperatures are predicted for the Chehalis River Basin. This section summarizes the best available data on future conditions within the Mitigation Area without consideration of Proposed Action. Modeling efforts provide predicted future scenarios for stream flow, in-river temperature and habitat suitability for salmon.

Climate models predict high stream flow from increased winter precipitation and lower summer flows for Pacific Northwest rivers. All climate models contained high degrees of uncertainty, and even more so for rain-dominated systems such as the Chehalis River. The maritime climate has a strong influence on Chehalis River Basin storm events and climate modeling predicts that ocean cycles, such as the Pacific Decadal Oscillation may have a stronger influence on weather patterns in this system as compared to snow-pack influenced rivers. This suggests that the overall pattern of increased winter precipitation and flows will be overlain with decadal patterns of more and less precipitation.

Model predictions are for increased winter storms both in number and intensity of precipitation which will equate to higher flow conditions in the Chehalis River during winter months. Models also predict increased risk of flooding which will lead to more bank failure, storm-related landslides, erosion and run-off, storm-related turbidity events, and scouring of streambeds. For the upper Chehalis River Basin, peak flow increases due to climate change were estimated to range from 12% at mid-century to 26% by late-century (WSE 2019). Stream flow outside of peak flow periods was analyzed by Watershed Science & Engineering (WSE) to determine the change in average monthly flows throughout the modeled period of record, projecting that flows will increase by 4% and 5% during winter months (November–April) and will decrease by 11% and 16% during summer months (May–October) based on mid- and late-century models, respectively.

With more rain concentrated in winter months, summers are projected to be drier and air temperature warmer. Thus, low summer flows will be subject to warming due to increases in air temperature and changes in dew point temperature (Mauger et al. 2016). Lower flows also mean shallower rivers depths that expose more of the water column to warming from solar radiation. The number of reaches within the Chehalis River Basin with August stream temperature over 20°C is predicted to increase substantially and will result in a loss of suitable habitat for salmon rearing and spawning (Winkowski and Zimmerman 2017).

3.13.1 Stream Flow

The information contained in the Chehalis River Basin Hydrologic Modeling technical memorandum combined with USGS flow records were used to develop flow predictions under future climate change conditions. The flows were input into the RiverFlow2D model to estimate flooding conditions under future climate change conditions. Peak flow increases due to climate change were estimated to range from 12% at mid-century to 26% by late-century (WSE 2019). The SEPA DEIS presents an analysis of increased flows under climate change scenarios to predict the likelihood of major (>38,800 cfs) and catastrophic (>75,100 cfs) floods as measured at the Grand Mound USGS Gage. These flood likelihood calculations, presented in Table 3.13-1, are important for considering likely frequency of operation of the proposed FRE facility under future stream flow conditions, and potential impacts to aquatic habitats and species.

Table 3.13-1
Modeled Future Baseline Conditions for Flood Occurrence Frequency Under Mid-Century and Late-Century Timeframes.

QUALITATIVE FLOOD CATEGORY (DEIS)	TIMEFRAME	CHANCE OF ANNUAL OCCURRENCE[1]	ASSOCIATED FLOOD-YEAR TERM	FLOW (GRAND MOUND)	REFERENCE FLOOD
Major Flood	Current	14%	7-year	38,800 cfs	2009
	Mid-century	20%	5-year		
	Late-century	25%	4-year		
Catastrophic Flood	Current	1%	100-year	75,100 cfs	1996
	Mid-century	2%	44-year		
	Late-century	4%	27-year		

Notes:
Source: Ecology (2020), Appendix N, Table N-5.
1. Percent chance a flood of this size would occur in any given year.

Stream flow outside of peak flow periods was analyzed by WSE to determine the change in average monthly flows throughout the modeled period of record, projecting that flows will increase by 4 and 5% during winter months (November–April) and will decrease by 11% and 16% during summer months (May–October) based on mid- and late-century models, respectively.

3.13.2 Stream Temperature

Future-conditions modeling for the SEPA DEIS (PSU 2017) include predicted changes to hydrological and meteorological conditions associated with climate change. Climate change is projected to increase stream temperatures because of increases in air temperature, changes in dew point temperature, changes in hydrology, and lower summer flows throughout Washington State, including the Chehalis River (Mauger et al. 2016). The SEPA DEIS included the influence of climate change in the estimate of the Proposed Action's impacts on water temperature; however, it did not report what portion of the increase in water temperature could be attributed to climate change without the Proposed Action.

The Applicant used the existing two-dimensional CE-QUAL-W2 temperature model to project long-term climate change effects on stream temperature in the Impact Area without the Proposed Action (FCZD 2021). Accounting for climate change, the model results suggest that surface water temperatures in the headwaters subbasin, would be warmer than under current conditions, with an increase in water temperatures proportional to the increase in air temperatures and associated decreases in summer stream flow (FCZD 2021). These changes in baseline climate result in water temperatures that are 3°C to 5°C higher than current conditions.

3.13.3 Future Habitat and Salmon Populations

Two habitat-based models have been developed to help evaluate how habitat improvements in the Chehalis River Basin might benefit future salmon populations. Both models evaluated the degree of change from historic habitat conditions to current conditions and used these relationships as well as empirical data from the basin to inform the potential for future changes. The Ecosystem Diagnosis and Treatment (EDT) model is a tool that has been used for salmon recovery planning throughout the Pacific Northwest and compares a degraded condition to the desired healthy one to identify actions for recovery. The NOAA model was developed in concert with the Aquatic Species Restoration Plan (ASRP) program for the Chehalis River Basin and includes a combination of distinct analyses/models on landscape changes, flows, water temperature, and other items to inform NOAA life cycle models. NOAA's Habitat Assessment and Restoration Planning (HARP) model is a stochastic life cycle model that can account for interannual variability of flow and temperature over time.

The EDT was used in the SEPA and NEPA environmental impact assessments, to evaluate the potential of the Chehalis River Basin to support spring- and fall-run Chinook salmon, coho salmon, chum salmon, and steelhead at basin and subbasin scales with flood damage reduction and habitat restoration actions in the future. The first step in this modeling was to evaluate current and future baseline conditions. The EDT model (McConnaha et al. 2017) reported the following principal findings relative to the baseline and future conditions of aquatic habitat in the Chehalis River Basin.

- Future climate greatly reduced habitat potential for all modeled species throughout the Chehalis River Basin independent of the FRE facility options or ASRP.
- Under future climate conditions, the habitat potential for most local populations of spring-run Chinook salmon was eliminated under a low climate scenario with only 85% of existing habitat remaining by the year 2040. Under a high climate change scenario, all habitat potential for spring-run Chinook salmon would be gone, affecting all local populations in the basin. These model results suggest that this species may not be viable under future climate conditions without substantial habitat restoration.

- Under a high climate change scenario, all habitat potential for coho salmon upstream of the South Fork Chehalis was eliminated.
- For fall-run Chinook salmon, habitat potential was eliminated for three subbasins under the high climate change scenario. However, due to increased winter flow and channel width, fall-run Chinook salmon habitat potential increased for five of the local population downstream of the confluence with the Skookumchuck River.
- As modeled, the negative effect of future climate conditions depended on the length of a species' exposure to the conditions in the Chehalis watershed, in particular to increased summer water temperatures for spawning salmon. Chum salmon and fall-run Chinook salmon spend the least amount of time in the watershed and experience substantially less exposure to warmer water. Steelhead and coho salmon spawn higher in the system where projected future temperature increases were less. Spring-run Chinook salmon spend months in the mainstem river as pre-spawners and spawners, and will have the greatest exposure to lower summer flow and warmer summer temperatures.

The HARP model was developed by NOAA fisheries (Beechie et al. 2023) to look at climate-related flow effects on the abundance of Chehalis salmonid spawners. The model predicted that increased flood flows would harm all four salmonid species ranging from a low of -4% for steelhead to a high of -15% for spring-run Chinook salmon, with coho and fall-run Chinook both at -9%. The temporal overlap of redd incubation and peak flow caused species-specific prediction in spawner response (Nicol et al. 2023). High variability was noted for spring-run Chinook and coho salmon with nearly a 50% decline in some years; however, the model predicted coho to recover after low abundance years while spring-run Chinook did not due to limitations of high pre-spawning mortality during summer (Nicol et al. 2023).

The predicted consequences of lower and warmer water temperatures on salmon spawner abundance also varied by species, related to their life histories and run timing. Fall-run Chinook salmon have the lowest overall impact predicted with a 12% reduction in the number of spawners while spring-run Chinook salmon would have the greatest impact with predicted losses of 87% by late century. Coho salmon and steelhead were similar at 23% and 20% reduction, respectively. Similar to the EDT, the high temperature effect predicted for spring-run Chinook salmon is related to adults returning to the river during the hot summer months of August and September.

3.13.4 Forest Practices

Forest Practices including road construction and timber harvest can have wide-spread impacts on the landscape, receiving waters, and habitats and species therein, but also on larger ecosystem functions that support the productive capacity of streams for fish and other wildlife. Removal of vegetation near streams increases solar radiation contributing to increased water temperature, primary production, and re-radiation while decreasing input of organic matter to streams, bank stability, and wood supply that can serve as a substrate for invertebrates, trap sediment, and factor in the formation of meso-scale habitat (Richardson and Béraud 2014).

Much of the land use in the higher elevation portions of the Mitigation Area is managed timber harvest, including the entire watershed upstream of the proposed FRE facility. These forestlands are owned by entities including private companies (industrial, non-industrial, and tribal) and agencies such as the WA DNR, United States Forest Service, and the Bureau of Land Management that manage forestlands on behalf of the public. In Lewis County, an average of 393,200 thousand board feet have been harvested annually over the past 20 years with an average of 45% harvested by private timber companies (FIRP 2022).

Most of the land within the Proposed Action area around the FRE facility and inundation area is a privately-owned commercial timberlands that have been managed for decades on a 40- to 50-year harvest cycle. Based on vegetation cover analysis in the vicinity of the inundation area, approximately 22% of the uplands have been clearcut in the last 5 years, about 21% have been harvested in the last 5-20 years, and about 57% have not been harvested within the last 20 years. Planned timber harvest activities above the proposed FRE facility will likely continue to impact aquatic and wildlife habitat, water quality, LWM input, and other ecosystem processes.

Forest Practices rules were put in place in the mid-1990s to protect riparian areas and promote the development of the riparian forest and ecological processes to maintain stream shade and recruitment of LWM. Under WAC 222-30-021, RMZs are protected along fish-bearing streams with varying dimensions based on the site class of the land, type of timber harvest, and bankfull width of the stream. RMZs are divided into three buffer zones (core, inner, and outer), with the core zone closest to the stream and the outer zone furthest from the stream. No harvest is allowed within the first 50-feet immediately adjacent to the OHWM (i.e., core zone), limited harvest may be permitted in the inner zone, and outer zone harvest requires 20 leave trees per acre. Within the FRE and inundation area, the total width of the RMZ (all three zones combined) ranges from 90 to 170 feet on either side of fish-bearing streams. To protect riparian areas along non-fish bearing streams, a 50-foot-wide no-harvest RMZ is designated along either side of the stream for at least 50% of its entire length(WAC 222-30-021). While not all riparian areas are fully functioning, within the core zone, they are on a trajectory to mature and become a source of LWM in the future.

4 REGULATORY AND NON-REGULATORY CONTEXT

4.1 Permits and Approvals

The Proposed Action is subject to federal, state, and some local jurisdictions for permitting and approval for project construction, operation, and maintenance. Federal and state agencies with jurisdiction must also comply with SEPA and NEPA by preparing an environmental review of the Proposed Action. The following sections describe federal, state and local approvals and environmental reviews that may apply to the Proposed Action as they relate to environmental impact mitigation.

4.1.1 Federal

The Corps must issue a CWA Section 404 permit for the Proposed Action and is the lead agency for purposes of complying with NEPA. On September 28, 2020, the Corps issued its DEIS, which identified potential impacts on terrestrial and aquatic resources for the Proposed Action. Other federal cooperating agencies may rely on the Corps NEPA document.

The Corps is also the lead agency for purposes of complying with Section 7 of the ESA. ESA Section 7 requires that the Corps ensure that any action it authorizes does not jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of designated critical habitat for such species. The Corps must consult with NOAA Fisheries and/or United States Fish and Wildlife Service (USFWS) if the agency determines that the action may affect ESA-listed species or designated/proposed critical habitat. Further, the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires an assessment of project-related effects on designated EFH for Chinook and coho salmon.

The following federal permits, licenses, and approvals may be required for the Proposed Action.

Section 404 CWA Permit (Corps): Section 404 requires discharges of dredged/fill material to waters of the U.S. be done only under the authorization of a permit. Section 404 of the CWA establishes that mitigation is required for impacts to waters of the U.S. to mitigate for unavoidable impacts to ecological functions associated with those waters. Note that the need for a Section 404 CWA Permit triggers the requirement for a Section 401 CWA water quality certification. In the state of Washington, the United States Environmental Protection Agency has delegated jurisdiction over that permit to the Washington State Department of Ecology (Ecology). That permit is discussed in Section 4.1.2 below under state permits.

ESA Consultation (NOAA Fisheries and USFWS): The Proposed Action may affect listed species or designated critical habitats under the jurisdiction of NOAA Fisheries and USFWS. The Corps may consult with NOAA Fisheries and USFWS regarding the effects of the Proposed Action on listed and proposed species and critical habitats. Under the ESA implementing regulations, NOAA Fisheries and USFWS may impose reasonable and prudent measures including conditions to offset (or mitigate) for unavoidable take of listed species.

Federal Explosives License/Permit (Federal Bureau of Alcohol, Tobacco, and Firearms): This permit may be required for blasting activities during construction.

Letter of Map Revision, Conditional Letter of Map Revision, or Physical Map Revision (Federal Emergency Management Agency [FEMA]): To comply with 44 Code of Federal Regulations 65.3, National Flood Insurance Program, participating communities must provide FEMA with technical information related to changes to the Special Flood Hazard Area. The proposed project might require conditional approvals by FEMA before construction, extending from the area inundated in the FRE facility temporary reservoir downstream to near the city of Montesano.

Magnuson-Stevens Fishery Conservation and Management Act Provisions; EFH: Federal agencies are required to consult with NOAA Fisheries on activities that may affect EFH. NOAA Fisheries may recommend conservation measures and the federal agency must explain whether it is adopting those measures.

Section 106 of the National Historic Preservation Act (Corps): Section 106 requires federal agencies to consider the effects of the Proposed Action on historic properties as part of the federal permitting process. This includes consultation with interested and affected tribes, and the State Historic Preservation Officer at the Washington State Department of Archaeology and Historic Preservation.

4.1.2 State

Ecology prepared a DEIS issued on February 28, 2020, in compliance with the SEPA requirements in WAC 197-11. Ecology's DEIS evaluates the probable significant adverse impacts on the environment that would result from the Proposed Action as originally proposed and alternatives and considers the future conditions when the project is proposed to be constructed and operated.

The following state permits, licenses, and approvals may be required for the Proposed Action.

Application for Exploration Reclamation Permit (WA DNR): This permit may be necessary for the exploration and reclamation of exploration sites for the FRE facility structure site and the potential quarry sites, as trees removal and disturbance to the forest floor could potentially occur.

Aquatic Lands Lease and Use Authorization (WA DNR): Construction of the FRE facility may require a lease from WA DNR and use authorization for construction and operation.

Coastal Zone Management Program Consistency (Ecology): Construction and operation of the FRE facility may be subject to the federal consistency provision of the Coastal Zone Management Act and Washington State's Coastal Zone Management Program.

Dam Safety Construction Permit (Ecology): This permit may be necessary before constructing, modifying, or repairing any dam or controlling works for storage of 10 or more acre-feet of water at the dam crest elevation.

Fish Transport Permits (WDFW): This permit may be required to transfer live fish as part of the trap-and-transport process during construction and operation.

Forest Practices Applications (WA DNR): Activities related to the construction and operation of the FRE facility occurring on private or state forestland, such as timber harvest, quarry development, and the expansion, maintenance, or abandonment of roads, may fall under the jurisdiction of the Washington State's Forest Practices Act.

Hydraulic Project Approval (WDFW): Compensatory mitigation may be necessary because the Proposed Action would use, divert, obstruct, and change the natural flow and bed of freshwaters of Washington State, along with work within and adjacent to waters of the state. WDFW has the authority to potentially require compensatory mitigation for impacts to aquatic species and their habitats as part of considering issuing a Hydraulic Project Approval. The determination of the nature and extent of mitigation could be influenced by consultation with tribes possessing treaty rights associated with the affected waters. Tribes may play a role as co-managers with WDFW concerning aquatic species populations and their habitats, thereby informing the mitigation process.

National Pollutant Discharge Elimination System (NPDES) Construction Stormwater Permits (Ecology): An NPDES permit may be required due to the construction of the FRE facility and alterations to the airport levee, potentially resulting in ground disturbance exceeding 1 acre. These activities could lead to stormwater discharges into surface waters, along with operational activities that may entail landslides and erosion of slopes and roads.

NPDES Industrial Stormwater Permit (Ecology): This permit may be necessary because operation of the FRE facility would result in releases of water. All wastewater and stormwater generated from the Proposed Action would potentially be subject to evaluation and characterization by Washington State. If discharged, the NPDES Industrial Stormwater Permit could apply to point source discharge(s) where stormwater or wastewater is released into waters of the state.

NPDES Sand and Gravel Permit (Ecology): This permit may be required due to the construction of the FRE facility, which would entail quarry development to supply aggregate. If required, the permit would mandate a Stormwater Pollution Prevention Plan and BMPs to mitigate pollutants from process water, mine dewatering water, and stormwater generated at the quarry sites.

Scientific Collection Permit (WDFW): This permit may be required for the relocation or collection of wildlife species, as well as for handling or collection of fish species.

Section 401 CWA Water Quality Certification (Ecology): If a federal permit (Corps Section 404) is deemed necessary for constructing the Proposed Action, a Section 401 CWA Quality Certification from Ecology would be required. This certification would signify Washington State's evaluation of the project and potential concurrence that the Applicant has demonstrated compliance with state water quality standards.

Shoreline Conditional Use Permit (Ecology): It is conceivable that the FRE facility could be classified as an in-water structure within Lewis County's Shoreline Management Plan (SMP), potentially necessitating a conditional use permit within the Rural Conservancy shoreline environment designation. Ecology holds final approval for these permits.

Surface Mining Reclamation Permit (WA DNR): This permit may be required for the establishment and reclamation of the 1-2 potential quarries (Northwest Quarry, West Quarry, or South Quarry).

Washington State Explosives License (Department of Labor and Industries): This license may be required for blasting with explosives.

Water Rights Permits (Ecology): This permit may be required due to the Proposed Action's potential temporary withdrawals of water from the Chehalis River for the FRE facility construction and its involvement in storing Chehalis River flows during major floods as part of facility operations.

4.1.3 Local and Regional

The following local and regional permits, licenses, and approvals would be required for the Proposed Action.

Air Discharge Permit (Southwest Clean Air Agency): This permit may be required for quarrying, rock processing, operation of the concrete batch plant, or blasting during the construction of the FRE facility.

Building Permit (Lewis County): This permit may be required if any activities were undertaken to construct, enlarge, alter, repair, move, demolish, or change the occupancy of a building or structure.

Comprehensive Plan Update and Rezone (Lewis County): May be required to address any inconsistency with the current Forest Resource Lands land use designation and zoning district for the construction and operation of the FRE facility. This could potentially involve a rezone for the affected area. As noted above, such a rezone could affect the need for a Forest Practices Application with WA DNR.

Critical Areas Review (Lewis County, Pacific County, and City of Chehalis): May be required if the Proposed Action is within, abutting, or likely to adversely affect a critical area or buffer.

Earth-moving Permit (City of Chehalis): This permit may be necessary to construct the airport levee changes.

Fill and Grade Permit (Lewis County): This permit may be required for excavating soil and rock for the proposed FRE facility foundations and related structures and quarries, as well as placing waste materials designated locations.

Flood Hazard Zone Permit (Lewis County): This permit may be required since the construction of the proposed FRE facility and airport levee changes are in an area of special flood hazard.

Local Land Use and Development Permits (Lewis County and City of Chehalis): The proposed FRE facility's potential impact on water-related resources regulated by Lewis County and the airport levee changes' potential impact on water-related resources regulated by the City of Chehalis under SMPs, Critical Areas Ordinances, and floodplain and stormwater management codes could lead to the need for these permits from both entities.

Open Burning Permit (Southwest Clean Air Agency): This permit may be required for burning debris after land clearing during construction of the proposed FRE facility.

Permit for Nonroad Engines (Southwest Clean Air Agency): This permit may be required for operation of nonroad engines exceeding an aggregate of 500 horsepower and construction work lasting 1 year or more.

Shoreline Substantial Development Permit, Including Shoreline Critical Areas Review (Lewis County): May be required for development of the FRE facility as it would occur within shorelines of Washington State.

Shoreline Conditional Use Permit (Lewis County): The proposed FRE facility could be considered as an in-water structure within Lewis County's SMP, which is a conditional use within the Rural Conservancy shoreline environment designation. Ecology holds final approval for these permits.

Storm Drainage Approval (Lewis County): Approvals may be necessary for any construction activities that would change the point of discharge of surface waters, discharge surface waters at a higher velocity and/or quantity than that prior to development, or increase pollution of surface waters.

4.2 Tribal Consultation

The Corps engages in government-to-government consultation with tribal governments when a proposed project may affect a tribe or its resources. In addition, the Corps consults with Indian tribes under Natural Historic Preservation Act Section 106 when an undertaking may affect tribal lands or historic properties of significance to the tribes.

Washington's salmon and steelhead fisheries are managed cooperatively in a co-management relationship. Co-management of fisheries occurs through government-to-government cooperation. One government is the State of Washington, and the other is individual sovereign Indian tribes whose rights were preserved in treaties signed with the federal government in the 1850s.

4.3 Regulatory Compatibility

There are several complementary programs and developed plans that are currently operating or implemented within the Chehalis River Basin that share not only regulatory responsibility and permitting requirements, but long-term strategies for restoration, conservation, mitigation, and benefit to the public. These programs include, in part:

Aquatic Species Restoration Plan: The ASRP is a key component of the CBS and is a science-based plan designed to help restore aquatic habitat and enhance local economies.

Salmon Recovery Funding Board: Chehalis River Basin lead entity that directs the process for salmon recovery funding in the basin to implement restoration and protection projects for healthy salmon habitat.

Brian Abbott Fish Barrier Removal Board: This program provides funding to identify and remove impediments to salmon and steelhead migration.

Family Forest Fish Passage Program: This program assists private forest owners in removing culverts and other fish barriers.

Washington Wildlife and Recreation Program: This program provides matching funds to create new parks, protect wildlife habitat, and preserve working lands.

Washington Coast Restoration and Resiliency Initiative: This programs funds projects that address priority ecological protection and restoration needs while stimulating economic growth and creating jobs in coastal communities.

Chehalis River Basin Partnership Stream Flow Restoration Plan: This plan focuses on offsetting future impacts to instream flow through the acquisition of water rights, promoting conservation, and implementing habitat projects in areas where projected development may impact shallow groundwater resources.

Growth Management Act (1971, WAC 365-196-202): Requires all countries and municipalities to plan for and manage population growth by identifying and protecting critical areas and natural resource lands, designing urban growth areas, and preparing and implementing comprehensive land use and zoning plans.

Forest Practices Habitat Conservation Plan (FPHCP): Covers state and private forestlands in Washington State to ensure compliance with the federal ESA to protect habitat, support healthy and economically viable forests, and create regulatory stability for landowners.

4.4 Mitigation Policy Goal

The Applicant has made a formal commitment to achieve no-net-loss of aquatic and terrestrial habitat function due to the construction and operation of the Proposed Action in the upper Chehalis River Basin. This commitment was approved by the Applicant's Board of Supervisors on August 19, 2021. The commitment would apply to effects attributable to the construction and operation of the proposed FRE facility and temporary reservoir.

The Kleinschmidt team has assessed and estimated potential Proposed Action effects on aquatic and terrestrial habitats based on the Existing Baseline Conditions Assessment and limiting factors in the proposed Mitigation Area. Based on this assessment, the Applicant proposes mitigation that is technically feasible and economically practicable and has documented that sufficient opportunities are available to mitigate the anticipated Proposed Action effects on aquatic and terrestrial habitats and species.

Habitat in the Chehalis River Basin has been degraded due to past and ongoing land practices including forestry, agriculture, and rural development. As described in Section 3 (Existing Conditions), the stream corridor lacks channel complexity and instream structure, and large reaches have been scoured down to bedrock. Extensive reaches of the riparian corridor contain only shrubs or herbaceous plants including aggressive invasive species such as reed canary grass and Himalayan blackberry. Other reaches lack vegetation in the riparian corridor due to roads, agricultural crops, and impervious surfaces, all of which limit riparian habitat values.

The water quality in the upper basin is also impaired, with warm summer temperatures above thermal tolerance for cold water species, including for salmon spawning and incubation, and associated low DO conditions during summer. As described in detail within this plan, the Applicant is proposing site-specific mitigation that will generate ecological lift for impacted specific species and life stages. In addition, when implemented as a collective, these mitigation actions can improve the overall health of the upper Chehalis River Basin and will help to ensure a net ecological gain for native species and their habitats.

4.5 Connection to Broader Chehalis River Basin Strategy

The CBS is a collaborative, science-based process that was created to address the dual challenges of extreme flooding and degraded aquatic habitat. The CBS goal is to make the Chehalis River Basin a safer place for families and communities impacted by flooding, and to improve aquatic habitat. Three approaches have been developed to meet this goal: i) habitat restoration for salmon and other species through projects identified in the ASRP, ii) local landowner and community projects to adapt to and limit flooding impacts, and iii) large-scale measures to reduce significant flood damage from major and catastrophic floods in the Chehalis River Basin.

The Proposed Action achieves a primary goal of the CBS by providing feasible actions to limit flood impacts. Further, the implementation of the proposed RMP would provide substantial opportunities to improve aquatic and terrestrial habitat to support a variety of species. The RMP would operate in concert with the ASRP to remove barriers and improve fish passage, implement floodplain reconnection projects, and improve overall aquatic, riparian, and vegetative habitat in the upper Chehalis River.

5 UPDATED POTENTIAL EFFECTS

Since issuance of the state and federal DEISs, the Applicant has refined the Proposed Action to minimize potential impacts to a traditional cultural property and to avoid, minimize and mitigate for construction-related impacts to stream and terrestrial habitat and migrating fish species. To develop adequate avoidance and minimization measures and mitigation actions that would achieve no net loss of aquatic and terrestrial habitat function, the Applicant updated the potential impacts presented in the DEISs based on the Proposed Action and information that has become available since the DEISs were developed. This includes regulatory changes and updated available data since 2019 that would change potential impacts on streams and habitat This section summarizes the potential impacts that have been updated by the Applicant and does not address all of the impacts presented in the DEISs. It is important to note that the potential project effects on stream and terrestrial habitat in the Action Area, as proposed in the DEISs were based on the previous project design and available information as of 2019. The potential impacts identified in the DEISs also were characterized as conservative to account for the inherent uncertainty of determining actual impacts during the environmental review and did not take into consideration the limitations that would be required by various state and federal regulatory standards for avoidance, minimization, and mitigation measures. Since the release of the SEPA DEIS, the Applicant has revised the project design and completed a significant body of work to assess potential effects and develop and refine appropriate avoidance, minimization, and mitigation measures.

In general, impacts described in both SEPA and NEPA DEISs were very similar, and where they differed, the SEPA DEIS identified greater magnitude of impact and/or impact across a broader geographical area; therefore, this mitigation plan describes mitigation in terms of the more conservative SEPA DEIS impact level. The potential effects presented in this section also reflect effects that would occur before implementation of any avoidance and minimization measures or mitigation. A summary of the avoidance and minimization measures is provided in Section 6. Implementation of these measures, which includes changes to the previous FRE facility design and operations, will reduce the potential effects of the Proposed Action and reduce the Applicant's mitigation requirement. The proposed mitigation actions to address the remaining unavoidable effects are described in Section 8. Tables that provide a crosswalk from the SEPA and NEPA DEIS impacts to the Applicant's unavoidable effects and previous mitigation-related information submittals are provided in Appendix C.

5.1 FRE Project Features

5.1.1 Construction

The permanent features of the project described in Section 2.2.1 include the FRE facility and FFPF, new roads, improvements to existing roads, the Chehalis River and Crim Creek engineered channel, 1 to 2 aggregate source quarries, the debris management staging and storage area, long-term vehicle access around the inundation area, and improvements to the town of Pe Ell water system. The FRE facility including the FFPF and stilling basin would permanently disturb about 27.3 acres with another 6.1 acres of new permanent road (assuming a width of 30 feet), 1.0 acre of which would occur within the inundation area (Table 5.1-1). Construction and maintenance of the project would require permanent improvements to and widening of about 1.9 miles of existing roads in the vicinity of the FRE facility to provide sufficient load bearing for construction equipment and access to the facility. The Chehalis River and Crim Creek engineered channel leading to the FRE facility (7.4 acres) and debris management staging and storage area (4.6 acres) would be constructed within the inundation area and access would be provided by existing roads.

Three potential quarry permitting areas (Northwest, West, and South) have been identified to source aggregate materials for concrete production, road base, and construction laydown area substrate. Each of the quarry permitting areas is approximately 65 acres in size, of which 40 acres from one quarry is anticipated to be disturbed. If two quarries are needed, 40 acres from each of the two quarries would be disturbed (80 acres total). The disturbed area includes areas needed for excavating aggregate materials, and storage of over-burden, equipment, and materials. The Applicant's goal is to obtain all of the necessary aggregate from a single quarry site. A second site would be used if the first site was insufficient to provide the necessary aggregate. Access between any of the quarry sites and the construction area would require improvements to existing roads to accommodate the weight of equipment.

As described in Section 2.2.2 above, temporary features related to construction of the project would include a concrete batch plant; materials handling equipment, work and storage (staging) areas; and temporary roads. Excluding the quarries, the temporary disturbance limits for construction outside of the inundation area would encompass a total of 98.1 acres. The temporary construction disturbance limit within the proposed inundation area, including the temporary Chehalis River and Crim Creek bypass channel, would be approximately 53.1 acres.

Table 5.1-1
Impact Area of FRE Facility Project Features.

IMPACT TYPE	FEATURE	AREA (ACRES) OUTSIDE INUNDATION AREA	WITHIN INUNDATION AREA
Permanent Construction	FRE Facility[1]	27.3	
	New Roads	5.1	1.0
	Improvements to Existing Construction and Access Roads	4.6	2.4
	Chehalis River and Crim Creek Engineered Channel		7.4
	Debris Sorting Yard		4.6
	Total Permanent Features	**37.0**	**15.4**
Temporary Construction	Northwest Quarry	40.0	
	West Quarry	40.0	
	South Quarry	40.0	
	Construction Disturbance Area[2]	98.1	53.1
	Total Temporary Disturbance Area[3]	**178.1**[3]	**53.1**
Operations	Inundation Area[4]		**824.9**

Notes:
1. FRE facility includes the structure, stilling basin, and FFPF.
2. The Construction Disturbance Area includes a concrete batch plant, work and storage (staging) areas, and temporary roads that would be removed and restored following construction.
3 Each quarry permitting area is approximately 65 acres of which up to 40 acres for one to two quarry areas would be disturbed.
4. The Inundation Area calculations represent the inundation area at 628 MSL and includes the permanent features and temporary construction disturbance area that would occur within the inundation area.

5.1.2 Inundation Area

Under the current design, the FRE facility would be located at approximately RM 108.4, about 0.25 miles upstream from the location of the project analyzed in the DEISs (Ecology 2020; Corps 2020) and the spillway elevation would remain at 628 feet MSL. The maximum extent of the inundation area for the currently proposed project would be 824.9 acres.

5.2 Land Use

The Applicant assumed that the current land designation within the Mitigation Area downstream of the FRE facility would remain similar in the future. The current land use designation of the inundation area and the surrounding land is Forest Reserve Land. Under this classification, commercial forestry is a primary use (LCC17.30.450(1)) and permitted accessory uses include “watershed management facilities, including but not limited to diversion devices, impoundments, dams for flood control, fire control, and stock watering” (17.30.460(7)). These lands are currently used for commercial forest production and as such are administered by the WA DNR under the Forest Practices Act. If the proposed FRE facility project moves forward, the Applicant would purchase the land for the FRE facility, inundation area and proposed Forest Conservation Mitigation Area and does not intend to continue commercial forest operations on these lands. As such, these lands would be subject to LCC Chapter 17.38 which pertains to critical areas (i.e., wetlands, wetland buffers, and Fish and Wildlife Habitat Conservation Areas). In updating the potential impacts of the proposed project, the Applicant applied the LCC Chapter 17.38 criteria as was done by the Corps and Ecology in developing the DEISs.

5.3 Water

To estimate the potential impact of the current project on streams, the Applicant used the OHWM delineation completed by Anchor QEA (2018). This dataset covers the entire inundation area, much of the current proposed FRE facility footprint and new access roads, and a portion of the temporary construction facilities, staging areas, and clearing limits that lie outside of the proposed inundation area. For areas that were not previously surveyed by Anchor QEA, including the three potential quarries, the Applicant used WA DNR Water Type Maps available on the Forest Practices Application and Review System mapping website (WA DNR 2024a). These maps show both field-verified and non-field-verified streams and are updated as data is collected, reviewed and approved by the WA DNR. The associated Geographic Information System (GIS) data was used to estimate the number of streams, Water Type Classification, and lengths of the streams potentially impacted by the current project design in areas beyond the Anchor QEA survey. In addition, the Water Type Classifications of the Anchor QEA dataset were reviewed and updated as needed. This analysis was conducted with the most recent Lewis County Shoreline Management Plan (Lewis County 2021) and the WAC 173-18-250 list of Shorelines of the State, approved February 20, 2023.

Under Revised Code of Washington 90.58.030, segments of streams where the mean annual flow is more than 20 cfs and lakes and reservoirs at least 20 acres in size are classified as Shorelines of the State. The WA DNR classifies Shorelines of the State as Type S Waters. Within the proposed Mitigation Area, Type S Waters and their associated buffers (shoreline buffers) are regulated under the Lewis County Shoreline Master Program. Streams that are not classified as Shorelines of the State are regulated under LCC Chapter 17.38 as Aquatic Priority Habitat. Type F Waters are streams and waterbodies either known to be used by fish or that meet the physical criteria to potentially be used by fish. Type F Waters can be perennial or seasonal. Type N Waters are streams that do not meet the physical criteria for fish habitat or have been proven not to contain fish using approved sampling methods. Type Np Waters can be perennial or have intermittent dry reaches downstream of perennial flow. Type Ns Waters do not have surface flow at least some time during the year and do not meet the criteria for fish habitat. Many streams are classified as Type Nu indicating that the hydrologic regime is unknown. Streams classified as Type U represent unknown water features that need to be verified. These are typically first order headwater drainages that may or may not be classified as Type N Waters. For purposes of this analysis, drainages designated as U were assumed to be Type N Waters.

5.3.1 Construction

Approximately 0.25 miles (2.65 acres) of the Chehalis River channel would be permanently replaced with the FRE facility conduits and stilling basin and up to approximately 170 feet of a Type N stream would potentially be permanently impacted by construction of the facility (Table 5.3-1). The proposed new roads and improvements to existing roads could potentially impact another 0.31 acres of the Chehalis River and Crim Creek channel based on their current alignment and 0.01 acres of Type N Chehalis River tributaries (Table 5.3-1). Approximately 0.17 acres of the Chehalis River and Crim Creek channel potentially impacted by new roads would occur within the FRE inundation area.

A permanent Chehalis River and Crim Creek engineered channel would be developed near the current alignment of the streams to route the stream flow through the FRE facility conduit structure. Based on the current alignment of the streams, approximately 2.48 acres of the mainstem Chehalis River and Crim Creek within the proposed temporary inundation area would be permanently replaced with engineered stream channel.

Approximately 0.12 miles (1.46 acres) of the Chehalis River runs through the temporary construction disturbance limits downstream of the proposed FRE facility, and 1.33 miles (0.48 acres) of non-fish-bearing Type N and Type U Waters would potentially be impacted within this area during construction (Table 5.3-1).

The construction disturbance limits within the proposed inundation area could temporarily impact up to 0.44 miles (2.10 ac) of fish-bearing streams and 0.04 miles (0.02 acres) of non-fish-bearing streams. As described in Section 2.2.2.2, a temporary bypass channel would be excavated and the lower portion of Crim Creek and the Chehalis River would be diverted to flow through and around the construction site until the west side of the FRE facility has been constructed. After completion, the streams would be diverted into the permanent Chehalis River and Crim Creek engineered river channel and through the FRE conduits and stilling basin. The temporary bypass channel would be designed to accommodate the 25-year flood event and maintain continuous low flow to provide for volitional fish passage.

Based on a desktop review of the Forest Practices Application Mapping Tool (FPAMT) (WA DNR 2024b), each of the three quarry permitting areas includes 0.42 to 0.63 miles (0.15 to 0.23 acres) of non-fish-bearing Type N and Type U streams. No fish-bearing streams are present within any of the three potential quarry sites (Table 5.3-1).

Table 5.3-1
Stream Area Potentially Impacted During Construction of the FRE Facility.

IMPACT TYPE	FEATURE	STREAM AREA (ACRES) OUTSIDE FRE INUNDATION AREA		WITHIN FRE INUNDATION AREA	
		FISH-BEARING	NON-FISH-BEARING[1]	FISH-BEARING	NON-FISH-BEARING[1]
Permanent Construction	FRE Facility	2.65	0.01		
	New Roads	0.05	0.00	0.11	0.00
	Improvements to Existing Construction Access Roads	0.09		0.06	
	Permanent Chehalis River and Crim Creek Engineered Channel			2.48	
	Debris Sorting Yard	0	0	0	0
	Total Permanent Features	**2.80**	**0.01**	**2.66**	**0**
Temporary Construction	Northwest Quarry		0.15		
	West Quarry		0.19		
	South Quarry		0.23		
	Construction Disturbance Area	1.46	0.48	2.10	0.02
	Total Temporary Disturbance Area[2]	**1.46**	**0.902**	**2.10**	**0.02**

Notes:
1. Where WA DNR FPAMT GIS data was used to estimate the lengths of Type N and Type U Waters potentially impacted in areas beyond the Anchor QEA 2018 survey, a stream width of 3 feet was used to conservatively estimate stream area.
2. The total temporary construction disturbance area conservatively assumes use of the two quarries with the most area of Type N Waters.
Source: Anchor QEA 2018; WA DNR 2024b; Lewis County 2021.

5.3.2 Inundation Area

Under the current design, the FRE facility would be located at approximately RM 108.4, about 0.25 miles upstream from the location of the project analyzed in the DEISs (Ecology 2020; Corps 2020) which would shorten the temporary pool length by this distance. The maximum pool elevation and inundation area boundary upstream of the FRE would not change. Within the maximum potential extent of the temporary pool, there are 115 regulatory waterbodies with a total stream length of 16.67 miles and total area of 109.89 acres (Table 5.3-2). Since the DEISs were developed, additional streams have been designated as Shorelines of the State and fish have been documented in the lowermost reaches of three tributaries. There are currently 15 fish-bearing streams within the inundation area, with a total length of 11.79 miles and total area of 106.95 acres.

Table 5.3-2
Streams Within the Maximum Extent of the Proposed FRE Inundation Area (628 Feet MSL Elevation) by Drainage Basin.

SUBBASIN	FISH-BEARING[1]			NON-FISH-BEARING[1]		
	COUNT	LENGTH (MILES)	AREA (ACRES)	COUNT	LENGTH (MILES)	AREA (ACRES)
Chehalis River[1]	1	6.60	87.11			
Chehalis River Tributaries	4	0.49	0.47	58	3.15	1.96
Crim Creek[1]	1	2.18	12.25			
Crim Creek Tributaries	3	0.09	0.06	26	1.12	0.61
Lester Creek	1	0.61	2.57			
Lester Creek Tributaries	0		0	7	0.29	0.21
Hull Creek	1	0.51	0.59			
Hull Creek Tributaries	0		0	4	0.19	0.10
Browns Creek	1	0.32	0.64			
Browns Creek Tributaries	0		0	3	0.08	0.03
Big Creek	1	0.49	1.21			
Big Creek Tributaries	1	0.06	0.07	0	0	0
Rogers Creek	1	0.44	1.98			
Rogers Creek Tributaries	0		0	1	0.02	0.01
Smith Creek	0		0	1	0.02	0.02
TOTAL	**15**	**11.79**	**106.95**	**100**	**4.87**	**2.94**

Notes:
1. Includes river reaches that would be permanently or potentially temporarily impacted during construction.

5.4 Geology and Geomorphology

5.4.1 Sediment Dynamics

The Applicant conducted sediment transport analyses to refine our understanding of bedload erosion, transport, and deposition processes operating at reach scales in the upper Chehalis River basin, both with and without the proposed FRE facility. This information was necessary to understand the feasibility of species and life-stage specific mitigation actions that would compensate for any impacts associated with effects of the facility on sediment transport processes. Further, because of the limited habitat available for them in the upper river basin, the primary focus of the analyses was on reach level dynamics that would affect the feasibility, location and potential sustainability of spawning habitat mitigation actions for Chinook salmon.

In addition, to develop appropriate mitigation it was important to refine current knowledge of potential changes in sediment dynamics by substrate size class associated with FRE operations, the Applicant's refined sediment t analysis evaluate transport by size class. The refined analysis simulated channel morphology, hydrology, hydraulics, and sediment dynamics in the Chehalis River between a point about two miles upstream of the FRE inundation area (approximately RM 116) downstream to RM 85. The Applicant's model (Appendix A) used the same one-dimensional Hydrologic Engineering Center River

Analysis System (HEC-RAS) sediment transport model as was used in the DEISs with modifications to assumptions and inputs as described in Appendix A.

The Applicant's analyses indicated that the river has the capacity to transport large volumes of fine and coarse sediment, including at flows when the FRE facility would not be operated. This capacity is maintained during floods up to the FRE facility gate closure and once the gates are open for evacuation of the pool; however, while the gates are closed coarse and fine sediment will be deposited within the inundation area. In between FRE operational events, flows during small and moderate floods that do not trigger FRE operation would rework coarse sediment that were deposited during operation and sediments would be transported downstream. Fine sediments would likely be deposited within the temporary inundation pool and post-operation would take days to weeks to be cleared out depending on location within the pool. Deposits closer to the FRE facility would be expected to be greater and take longer to be completely flushed downstream. The time required for flushing of fine sediments also would be influenced by the occurrence of flood events and flow evacuation rates of the FRE facility. Erosion and transport of any fine sediments deposited in the inundation area may cause changes in the timing and severity of turbidity at points downstream, but most likely primarily during pool drawdown.

5.4.2 Channel Migration

The DEISs projected that the reduced magnitude of large peak floods with FRE operation would reduce natural channel migration processes in unconfined reaches between the FRE and the South Fork Chehalis River and negligible effect was expected farther downstream. In this context, reduction in channel migration extent was taken to be an impact on natural processes, where channel migration was thus viewed as a positive natural process. Indirect impacts were then assigned to aquatic habitat and fish. No analyses of the mechanisms relating to FRE operation and channel change were provided, however. To understand the potential for this impact relative to mitigation, the Applicant performed desktop reviews and analyses of sediment transport dynamics and mainstem Chehalis River channel migration over time.

Hooke (2015) emphasized "the uncertainty and the inconstancy of the magnitude–impact relation" between flood strength and channel form, and this is likely true in the case of FRE operations and the upper Chehalis River physical setting. For example:

- Channel migration is naturally limited by bedrock in most of the river between the FRE location and the South Fork Chehalis River. Review of channel migration tracings prepared for the DEIS indicate that the first location downstream with significant natural channel migration under existing conditions is at the big bend downstream of Pe Ell at around RMs 104.6-104.8 where channel meandering appears to be controlled by bedrock constriction, grade downstream, and sediment deposition in a wider flow expansion zone. The next significant location is in the vicinity of the confluence with the South Fork Chehalis River where the DEIS projected impacts are expected to have been attenuated.

- While FRE operation would reduce the peak flow magnitude of the biggest flood events downstream, it extends the duration of flows between about the 5 percent exceedance and 5-year flood. These are bedload transporting flows that can be expected to have a greater geomorphic significance to channel form over the long term than the largest magnitude events (Wolman and Miller 1960; Schmidt and Potyondy 2004). As corroboration, detailed sediment transport analyses performed for the Applicant indicate that flows lower than those that would trigger FRE facility operation cumulatively transport more sediment downstream of the FRE (Appendix A).

The DEIS also projected that FRE operations would increase sediment deposition within the inundation area that in turn would result in shallower channel depths and increased widths over time. The size and gradient of the upper Chehalis River within the inundation area is such that channel morphology in sections not bounded by bedrock is controlled primarily by a gravel and cobble framework. Fine sediments are effectively transient and do not control channel geometry. The detailed sediment transport modeling performed for the Applicant indicates that gravel and cobble deposited during an operation event would be readily transported downstream again in subsequent floods, with negligible potential for long-term deposition because of the high transport capacity in the river.

The additional analyses conducted by the Applicant suggest that impacts of FRE operation related to changes in channel migration or width and their effects on habitat are likely to be equivocal and indeterminate.

5.5 Aquatic Habitat

5.5.1 Construction

5.5.1.1 Fish-bearing Streams

Approximately 1.1 miles of the Chehalis River and 0.3 miles of Crim Creek flow adjacent to or through the construction area. Construction of the FRE facility would permanently impact approximately 0.6 miles (5.46 acres) of fish-bearing stream habitat and another 0.25 miles (3.56 acres) would potentially be impacted during construction. Approximately, 0.25 miles of the Chehalis River (2.65 acres) occur within the FRE facility footprint (Table 5.3-1). The proposed new roads would potentially impact 0.31 acres of channel based on the current alignment of the Chehalis River and Crim Creek, 0.17 acres of which occurs in the inundation area. Based on the current alignment of the streams, approximately 0.27 miles of the mainstem Chehalis River (2.11 acres) and 0.07 miles of Crim Creek (0.37 acres) within the proposed temporary inundation area would be permanently replaced with engineered stream channel.

Approximately 0.12 miles (1.46 acres) of the Chehalis River (Type S Waters) runs through the temporary construction disturbance limits outside of the permanent construction features and the inundation area. Mahaffey Creek (Type F Waters) runs nearby this temporary construction disturbance area but would not be directly impacted during construction.

The temporary construction disturbance limits within the proposed inundation area could temporarily impact up to 0.38 miles of the Chehalis River (4.16 acres) and 0.06 miles of Crim Creek (0.5 acres). This area includes both the temporary bypass channel and the permanent Chehalis River and Crim Creek engineered channel. The temporary bypass channel would be designed to accommodate the 25-year flood event and maintain continuous low flow to provide for volitional fish passage. During this time, permanent Chehalis River and Crim Creek channels would be developed near their current alignment to route the stream flow through the FRE facility conduit structure, the stilling basin, and the Chehalis River downstream of the structure. After the first phase of construction is completed, the Chehalis River and Crim Creek flows would be permanently rerouted through the engineered channel, and the temporary bypass channel would be recontoured and restored with appropriate flood-tolerant native riparian plants.

5.5.1.2 Non-fish-bearing Streams

Construction of the FRE facility would permanently impact up to a total of 0.03 miles (0.01 acres) of non-fish-bearing stream habitat. Approximately 1.37 miles (0.5 acres) of non-fish-bearing Type N and Type U Waters within the temporary construction disturbance limits would potentially be impacted during construction, 0.04 miles (0.02 acres) of which occurs within the inundation area (Table 5.3-1). Development of each of the quarries would impact up to an additional 0.42 to 0.63 miles (0.15 to 0.23 ac) of non-fish-bearing Type N and Type U streams that have not been field verified. For purposes of establishing mitigation goals, potential impacts to non-fish-bearing streams in quarries was estimated to be up to 0.42 ac if the two quarries with the most streams (South and West) were both developed (Table 5.3-1).

5.5.2 Inundation Area

5.5.2.1 Fish-bearing Streams

There are currently 15 fish-bearing streams within the inundation area, with a total length of 11.79 miles and total area of 106.95 acres, including 6.60 miles (87.11 acres) of the mainstem Chehalis River (Table 5.3-2). Since the DEISs (Ecology 2020; Corps 2020) were prepared, three additional Chehalis River tributaries have been designated as Shorelines of the State, and fish or fish habitat have been documented in lower Hull Creek (0.51 miles) and the lowermost reaches of three Crim Creek tributaries (0.09 miles total). Shorelines of the State (Type S Waters) within the inundation area currently include the Chehalis River (6.60 miles) and Crim (2.18 miles), Lester (0.61 miles), Big (0.49 miles) and Rogers (0.44 miles) creeks.

5.5.2.2 Non-fish-bearing Streams

There are 100 non-fish-bearing streams (Type N Waters) within the inundation area with a total estimated length of 4.87 miles and total area of 2.94 ac (Table 5.3-2). More than half of these tributaries are small, first order unnamed tributaries to the Chehalis River.

5.5.3 Spawning Habitat Analysis

The DEIS indicated impact to 2-3 acres of priority instream habitat and aquatic habitat degradation within the inundation pool but did not quantify specifically the potential impact to spawning salmon habitat. Thus, to refine these potential impacts to the level of spawning habitats and identify potential mitigation, the Applicant conducted additional analysis, relying on the results of sediment transport model and field studies of suitable spawning gravels. The sediment transport model analyses and spawning gravel assessments are provided in Appendices A and B, respectively.

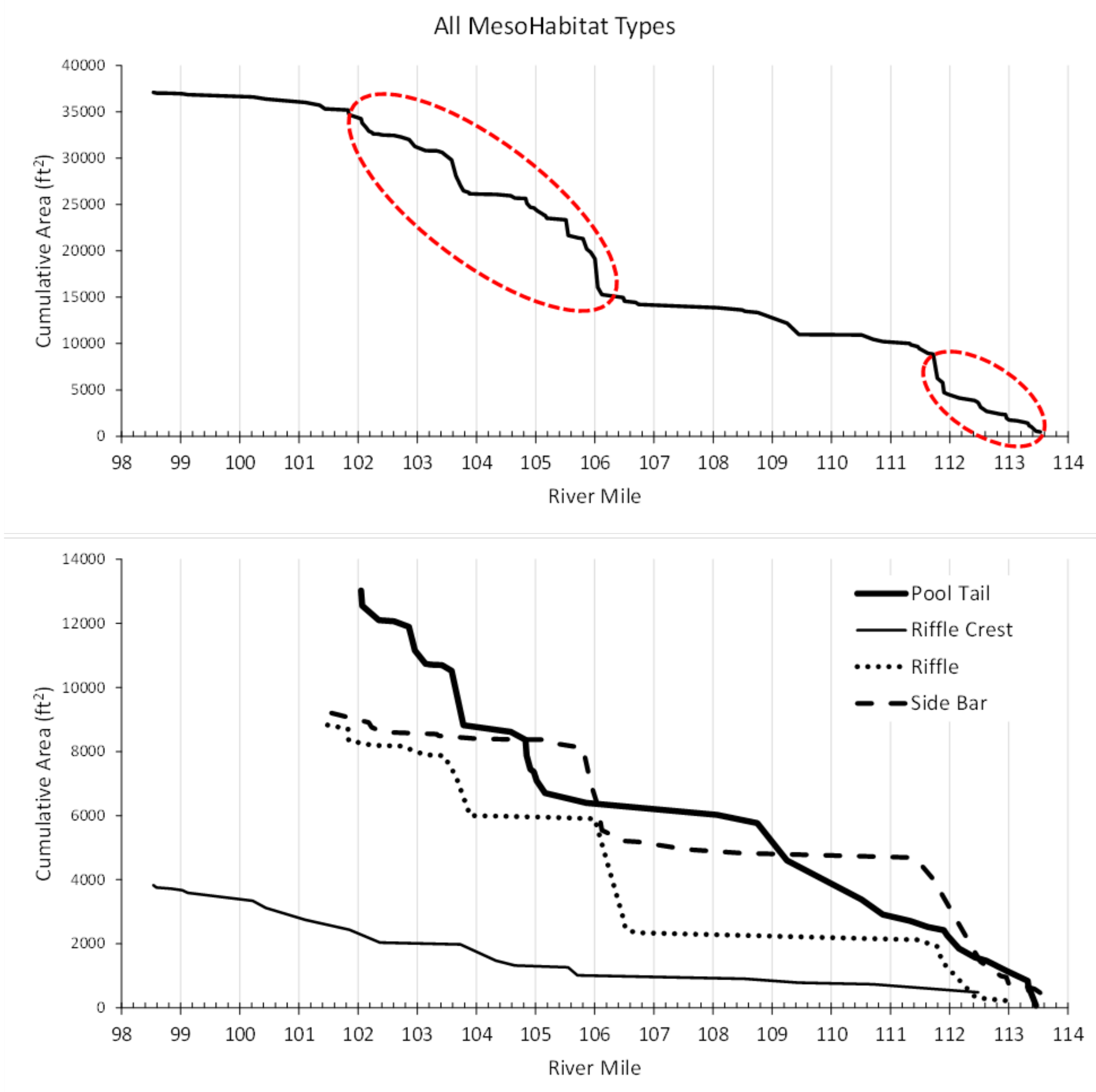
The amount and location of suitable spawning habitat susceptible to inundation and fine sediment impacts varies substantially over time. Results of sediment transport modeling (Appendix A) suggests that similar to other coastal rivers in Washington, the amount of suitable spawning habitat available is likely controlled by the frequency and magnitude of mass wasting inputs in the upper basin that are the primary source of suitable spawning gravels, and the high transport capacity in the river that subsequently moves that material downstream overtime. In years immediately following mass wasting events, there can be more spawning habitat available in the rest of the impounded reach, but the substrates forming that habitat are lost over time and transported downstream of the FRE location. Consistent with this, the results of spawning habitat mapping in 2023, which are representative of long-term post-mass wasting conditions, indicated that most long-term Chinook salmon spawning habitat in the impounded reach occurs in the first two miles below Fisk Falls (Figure 5.5-1). This is the reach where redds are most likely to be impacted by FRE operations over the long term and is thus the focus of avoid or minimize measures.

Similarly, spawning activity downstream of the FRE location has occurred most consistently over time in a core spawning reach within the Pe Ell valley downstream of a second large-scale slope break. The 2023 spawning habitat mapping data indicate that there is more spawning habitat for spring Chinook salmon over the long term downstream of the FRE, within a roughly 4-mile-long reach between RM 106.4 and RM 102 (Figure 5.5-1). Coarse sediment transport analyses (Appendix A) indicate that the gravel supply is not expected to be affected significantly by FRE operations over the long term.

Importantly, spawning habitat distributions are “patchy” within the upper Chehalis River mainstem, where they are generally small in area and are spaced widely apart, especially downstream of the 2-mile reach below Fisk Falls to the FRE facility. This characteristic is associated with a high risk of deep scour because of the higher potential for local sediment transport imbalances to occur during flood events compared with more closely spaced spawning habitat areas. Moreover, more spawning areas with suitable substrates are located in pool tails and side bars, which are more susceptible to deep scour than riffle crests and riffles, which are more limited in number and area (Appendix B).

Preliminary results from the Applicant’s scour study indicate that some suitable spawning gravel patches experienced scour to 1 foot of depth or greater (Appendix B). The susceptibility of suitable spawning habitat to scour under current conditions suggests that the FRE operation which would reduce scour potential upstream may offer a benefit to gravel stability and enhance the value of these gravel patches for spawning salmon. The Applicant will be continuing scour studies in 2024 to further evaluate this potential.

Figure 5.5-1
Cumulative Area of Chinook Salmon Spawning Habitat Mapped in the Chehalis River Mainstem in Fall 2023 Moving Downstream Between Fisk Falls and Rainbow Falls, Summed for All Mesohabitat Types (top) and the Four Most Common Mesohabitat Types (bottom) (Appendix B). Red Dashed Ovals Delineate Majority of Spawning Habitat Available.



5.6 Vegetation Cover and Terrestrial Habitat

The potential change to vegetation cover from construction and operation of the proposed FRE facility was updated to reflect the footprint of the currently proposed FRE facility, construction disturbance limits, and inundation area, and proposed removal of trees within the inundation area during construction. The Applicant classified the vegetation cover types as described below. This section addresses potential impacts to vegetation cover types. Potential impacts to water (i.e., streams), wetlands, and wetland and stream buffers are discussed in Section 5.3, Section 5.7, and Section 5.8, respectively. The Applicant will implement the VMP presented in Appendix D to avoid and minimize potential impacts to vegetation communities from project operations and implement the proposed wildlife mitigation (Section 8.3) to compensate for unavoidable impacts.

5.6.1 Vegetation Cover Types

To characterize the vegetation community cover types, Ecology (2020) primarily used the NLCD (Dewitz 2019). The NLCD is a widely used valuable resource that provides nationwide data on land cover and land cover change every 2-3 years. The NLCD has a 30-meter resolution that may not be suitable for local-scale assessments and its temporal resolution may not be applicable to rapid land cover changes. Accordingly, Ecology substituted the quantities of wetlands delineated by Anchor QEA (2018) for the NLCD wetland cover type to be consistent with the wetlands impact analysis presented in the Wetlands Discipline Report (Appendix O in Ecology 2020). However, the NLCD open water cover type (0.7 acres) was significantly inconsistent with the OHWM delineation of streams (Anchor QEA 2018) and the quantity of these regulatory waterbodies (113.43 acres) presented in the Wetlands Discipline Report. As a result, approximately 113 acres of open water within the impact area were mis-characterized as one of the vegetated land cover types in the analysis. Along the mainstem Chehalis River and most of its tributaries, the delineated streams were primarily classified in the NLCD as evergreen forest, followed by mixed and deciduous forest types while Crim and Lester creeks were primarily classified as wetland (Appendix P in Ecology 2020, Figures P-13, P-14, and P-15). As the NLCD wetland cover type was not used in Ecology's analysis, it is unclear what vegetation cover types these delineated streams were classified as in their analysis.

To provide more accurate reach-level data to support mitigation development, the Applicant conduct a refined analysis of the potential FRE project impacts on vegetation cover and wildlife habitat using GIS data from the Conceptual VMP (HDR 2020a). The delineations of vegetation cover types presented in the Conceptual VMP were developed by HDR using digital surface models showing tree canopy height (WA DNR 2020a); digital terrain models representing the ground elevation (WA DNR 2020b); logging road data (WA DNR 2020c); the delineated streams, wetlands, and ditches mapped by Anchor QEA, LLC (Anchor QEA 2018); and aerial imagery from 1990 through 2018 (Google 2019). As the potential impact area is actively managed for commercial timber harvest, the Applicant updated and amended the vegetation cover types using 2023 aerial imagery and Global Land Analysis & Discovery Forest Gain (2000-2012) and Forest Loss (2000-2020) data as analogs for stand age. The vegetation cover types were also amended as described below to reflect the primary use of the area for commercial timber harvest.

5.6.1.1 Commercial Timberland

The entire watershed surrounding the FRE facility and the inundation area is composed of timberland that has been managed for decades to optimize the commercial harvest of Douglas fir (*Pseudotsuga menziesii*). In this area, the method of harvest is clearcutting, with harvested areas typically replanted within 1-2 years of harvest. Douglas fir is a fast-growing species that reaches maturity for harvest in about 40-50 years. Stands may be commercially thinned beginning at about 25 years to further enhance the growth of the remaining trees prior to final harvest of the stand. These commercial stands of Douglas fir have been characterized as commercial timberland rather than evergreen forest (NLCD) or coniferous forest (HDR 2020b) because they consist of monotypic, even-aged, dense stands of Douglas fir trees with little species or structural diversity. These shade intolerant trees grow very rapidly and densely allowing little light to enter the ground beneath, limiting the growth and development of a diverse herbaceous ground cover, shrub layer, understory, or multi-canopied structure with lateral branches typical of a natural forest as it matures. The Commercial Timberland class was further divided into the following stand age class groupings to better characterize baseline conditions, functional values, and potential impacts:

- 20-40+ years – Douglas fir stand of trees about 50 to 120 feet tall;
- 10-20 years – Douglas fir stand of trees about 25 to 50 feet tall;
- 5-10 years – Douglas fir shrub-saplings; and
- Less than 5 years – Douglas fir seedlings dominated by sun-tolerant grasses and forbs.

5.6.1.2 Mixed Forest

The Mixed Forest class consists of a relatively equal distribution of coniferous and deciduous trees at least 20 feet tall, dominated by Douglas fir, red alder (*Alnus rubra*), and bigleaf maple (*Acer macrophyllum*). Mixed forests are typically located in areas within no harvest or limited harvest such as riparian areas along streams.

5.6.1.3 Deciduous Forest

The Deciduous Forest cover type is dominated by deciduous trees (>75% cover) at least 20 feet in height, with scattered conifers commonly observed. Species typically found in this cover type include red alder, Western red cedar (*Thuja plicata*), Western hemlock (*Tsuga heterophylla*), bigleaf maple, black cottonwood (*Populus balsamifera*), cascara (*Frangula purshiana*), willows, red elderberry (*Sambucus racemosa*), and snowberry (*Symphoricarpos albus*). Deciduous forests are typically located in areas within no harvest or limited harvest in riparian areas along streams.

5.6.1.4 Deciduous Scrub-shrub

The Deciduous Scrub-shrub class consists of shrubs and young trees <20 feet tall and are generally located in close proximity (generally within 200 feet) to mapped streams and aquatic areas. Common species include various willows (*Salix* spp.), red-osier dogwood (*Cornus alba*), vine maple (*Acer *circinatum*), Indian plum (*Oemleria cerasiformis*), thimbleberry (*Rubus parviflorus*), salmonberry (*Rubus spectabilis*), and red alder saplings.

5.6.1.5 Herbaceous/Grass

The Herbaceous/Grass class consists of upland areas dominated by grasses and forbs that are not wetlands. This class is commonly found adjacent to wetlands, riparian corridors, recently disturbed areas, bare ground, roads, and other developed areas. Typical species include reed canarygrass *(Phalaris arundinacea*), colonial bentgrass (*Agrostis capillaris*), sword fern (*Polystichum munitum*), western lady fern (*Athyrium angustum*), piggyback plant (*Tolmiea menziesii*), and creeping buttercup (*Ranunculus repens*).

5.6.1.6 Wetland

The Wetland cover type includes various combinations of palustrine emergent, palustrine scrub-shrub, and palustrine forested wetlands as delineated by Anchor QEA in 2017 and presented in the Wetland, Water, and Ordinary High Water Mark Delineation Report (Anchor QEA 2018).

5.6.1.7 Developed

The Developed cover type consists of bare ground that lacks vegetation over multiple growing seasons and is typically associated with wide logging roads and equipment staging areas.

5.6.1.8 Open Water and Sand/Gravel Bar

The Open Water and Sand/Gravel Bar cover type represents the delineated OHWM of streams presented in the Wetland, Water, and Ordinary High Water Mark Delineation Report (Anchor QEA 2018) with minor adjustments made by HDR (2020b) based on the spatial extent of streams visible on aerial photography.

5.6.2 Construction

Potential construction impacts on vegetation cover and wildlife habitat include temporary and permanent removal or disturbance of vegetation or habitats during construction activities such as land clearing, excavation, grading, and fill placement. The vegetation cover types potentially impacted by construction of the FRE facility are shown in Table 5.6-1.

Table 5.6-1
Vegetation Community Cover Types Associated with Construction of the FRE Facility.

VEGETATION COVER TYPE	PERMANENT FEATURES[1]		TEMPORARY CONSTRUCTION AREA		QUARRIES[2]		
	FRE FACILITY AREA	WITHIN INUNDATION AREA	OUTSIDE INUNDATION AREA	WITHIN INUNDATION AREA	NORTH-WEST	SOUTH	WEST
Timberlands by Stand Age							
0 to 5 Years	0.1	3.6	1.7	0.0	8.2	29.3	8.0
5-10 Years	0.2	0.0	0.4	0.3	27.2		13.2
10-20 Years	10.3	0.3	59.5	7.2	2.8	31.0	
20-40+ Years	11.0	2.6	22.8	30.4	21.9	1.3	41.6
Mixed Forest	3.0	0.8	0.6	6.6			
Deciduous Forest	1.6	3.1	0.6	4.7			
Deciduous Scrub-shrub	0.6	0.1	2.0	0.2			
Herbaceous/Grass	1.2	0.5	2.6	0.1			0.2
Wetland	1.0	0.1	0.6	0.2	0.0	0.0	0.0
TOTAL VEGETATED COVER	**29.0**	**11.1**	**90.9**	**49.7**	**60.1**	**61.6**	**62.9**
TOTAL VEGETATED COVER WITH TREES	**26.3**	**6.9**	**83.6**	**49.0**	**24.7**	**32.3**	**41.6**
Developed (bare ground/roads)	5.4	1.7	5.9	1.3	4.6	3.6	2.3
Open Water and Sand/Gravel Bar	2.7	2.6	1.3	2.1			
TOTAL AREA	**37.0**	**15.4**	**98.1**	**53.1**	**64.8**	**65.2**	**65.2**

Notes:
1. Includes the FRE facility and stilling basin, FFPF, new roads and improvements to existing roads to access the facility, the Chehalis River and Crim Creek engineered channel and the debris sorting yard.
2. Each quarry permitting area is approximately 65 acres of which up to 40 acres for one to two quarry areas would be disturbed.

A total of 52.5 acres would be permanently altered by construction of the currently proposed FRE facility, including Developed (7.0 acres), Open Water (5.4 acres), and Wetland (1.1 acres) cover types. With the exception of the Chehalis River and Crim Creek engineered channel, the cover types within this area would be permanently converted to a Developed cover type, with the Chehalis River flowing through the FRE facility. Forested cover types, Commercial Timberland older than 10 years, Mixed Forest, Deciduous Forest, and Wetland that is completely or partially classified as palustrine forest comprise approximately 33.2 acres of the permanent construction impact area. The quarry permit areas are comprised of Developed cover, ranging from 2.3 to 4.6 acres, and Commercial Timberland, ranging from 60.1 to 62.7 acres of varying stand ages.

The remaining temporary construction area outside of the proposed inundation area encompasses a total of 98.1 acres, including 90.9 acres of vegetated land cover types, 5.9 acres of Developed cover, and 1.3 acres of Open Water. The temporarily disturbed vegetation communities would be graded and planted following construction and monitored over time. More than 90 percent of the vegetated land cover types consists of Commercial Timberland (84.4 acres). Combined, the Deciduous Scrub-shrub (0.2

acres), Herbaceous/Grass (2.6 acres), palustrine emergent or scrub-shrub Wetland (0.6 acres), and replanted clearcuts less than 5 years old (1.7 acres) account for a total of 6.9 acres. These areas are expected to be restored to their current structure or scrub-shrub within a couple of years after planting with native vegetation and will improve over time as succession toward natural forest conditions continues. The disturbance of forested cover (1.2 acres) and Commercial Timberland with Douglas fir trees >50 feet (82.4 acres) would temporarily reduce the amount of forest habitat, converting it to Scrub-shrub for several years after restoration until natural forest conditions develop.

Construction within the inundation area would temporarily disturb approximately 49.7 acres of vegetated land cover types, 1.3 acres of Developed and bare ground cover, and 2.1 acres of Open Water. Construction activities within this area include temporary roads, excavation and construction of the bypass channels, storage and staging areas, and vegetation clearing limits. Non-forested vegetated cover types account for 0.6 acres or about 1 percent of the construction disturbance area and consist of emergent or scrub-shrub Wetland (0.1 acres), Commercial Timberland less than 10 years old (0.3 acres), Deciduous Scrub-shrub (0.2 acres), and Herbaceous/Grass (0.1 acres). The remaining disturbance area includes a total of 11.4 acres of forested cover types (Deciduous, Mixed, and palustrine forest Wetland combined) or Commercial Timberland with Douglas fir trees greater than 10 years old (37.6 acres). After construction, the temporarily disturbed area would be graded and planted with appropriate flood tolerant species and monitored over time. The 49.7 acres of vegetated land cover types would be restored to a scrub-shrub structure within a couple of years after planting with native vegetation.

5.6.3 Inundation Area

There is currently a variety of vegetation cover types within the 824.9-acre temporary inundation area, including 683 acres of vegetated land cover, 28.3 acres of Developed area, and 113.6 acres of Open Water (Table 5.6-2). Within the temporary inundation area, a total of 6.2 acres of vegetated land cover would be permanently replaced with Developed cover type and 49.7 acres of vegetated land cover would be temporarily disturbed during construction and restored with plantings of native flood-tolerant species as summarized above in Section 5.6.2. For purposes of differentiating construction-related impacts from potential impacts to vegetation communities from FRE facility operations, the vegetated cover within the temporary construction disturbance area was assumed to be restored to Deciduous Scrub-shrub cover prior to initiation of operations. Table 5.6-2 provides a summary of the baseline cover types as well as the anticipated post-construction pre-operations cover types assumed to be present.

Post-construction vegetation cover types would be composed of about 493 acres of cover types with trees including 270 acres of Deciduous and Mixed Forest types, 196 acres of Commercial Timberland >20 years old, and 22 acres >10 years old. Approximately 184 acres would be comprised of vegetation cover types without mature tree cover consisting of Commercial Timberland less than 10 years old (122 acres), Deciduous Scrub-shrub (45 acres), and about 14 acres of Herbaceous/Grass. Vegetation would continue to grow prior to initiation of operations. The Herbaceous/Grass cover would be maintained adjacent to the FRE facility.

Table 5.6-2
Vegetation Community Cover Types Associated with the FRE Inundation Area[1] (628 Feet MSL Elevation).

VEGETATION COVER TYPE	PRE-CONSTRUCTION BASELINE	PERMANENT CONSTRUCT-ION[2]	TEMPORARY CONSTRUCT-ION	NO CONSTRUCT-ION	POST-CONSTRUCTION AND PRE-OPERATIONS
Commercial Timberland by Stand Age					
0 to 5 Years	73.4	3.6	0.0	69.8	69.8
5-10 Years	51.9	0.0	0.3	51.7	51.7
10-20 Years	29.3	0.3	7.2	21.7	21.7
20-40+ Years	228.9	2.6	30.4	195.9	195.9
Mixed Forest	147.8	0.8	6.6	140.3	140.3
Deciduous Forest	137.4	3.1	4.7	129.6	129.6
Deciduous Scrub-shrub	3.6	0.1	0.2	3.4	45.3
Herbaceous/Grass	1.5	0.5	0.1	0.9	13.6
Wetland	9.2	0.1	0.2	8.9	8.9
TOTAL VEGETATED COVER	**683.0**	**11.1**	**49.7**	**622.2**	**676.8**
Developed (bare ground/roads)	28.3	1.7	1.3	25.3	34.5
Open Water and Sand/Gravel Bar	113.6	2.6	2.1	108.9	113.6
TOTAL AREA	**824.9**	**15.4**	**53.1**	**756.3**	**824.9**

Notes:
1. The inundation area represents the maximum potential inundation area for a catastrophic flood event with a <1 percent probability of occurring and includes the permanent features and temporary construction disturbance area that would occur within the inundation area.
2. Includes new roads and improvements to existing roads to access the facility, the Chehalis River and Crim Creek engineered channel and the debris sorting yard.

The Applicant's updated construction impact to vegetation cover types is significantly less than the construction-related impacts identified in the DEISs, because i) use of the NLCD resulted in erroneous application of vegetation cover for open water habitat within the inundation area as described above; and ii) the analyses in the DEISs assumed that all non-flood tolerant trees and all trees greater than 6 inches dbh would be removed within the lowermost 600 acres of the inundation area (below elevation 584 feet MSL) (Ecology 2020; Corps 2020). The Applicant is not proposing to remove any trees within the inundation area prior to operations except those necessary within the 11.1-acre vegetated area of permanent FRE features (new permanent access roads improvements to existing access roads, Chehalis River and Crim Creek engineered channel, and debris sorting yard) and the 49 acres of forested or Commercial Timberland cover types within the construction disturbance area.

When the FRE facility would be operated to temporarily store flood waters, trees and shrubs, especially flood-intolerant species such as Douglas fir, are expected to perish where subjected to prolonged periods of inundation. In the lower elevation portions of the temporary pool that would be flooded more frequently, trees may not have adequate time to re-establish beyond seedlings or saplings prior to a subsequent flood event. The upper elevations of the reservoir would only be subject to inundation during catastrophic flood events with an expected probability of occurring once every hundred years or more under the current hydrologic regime. In these areas, trees are expected to grow to full height following a flood event. As discussed in Section 6, the Applicant intends to implement the VMP to minimize impacts to vegetation cover within the inundation area.

5.7 Wetlands

For purposes of this mitigation plan, the Applicant used the wetland delineation completed by Anchor QEA in 2017 and 2018 (Anchor QEA 2018) to estimate potential impacts to wetlands. This dataset covers most of the current proposed FRE facility footprint and new access roads, the entire inundation area, and a portion of the temporary construction facilities, staging areas, and clearing limits that lie outside of the proposed inundation area. The Anchor QEA survey area did not include the proposed quarry sites. The Applicant intends to complete a comprehensive wetland delineation in all areas potentially affected by the project, including the quarry sites, prior to permitting.

Based on the available information, the overall impacts to wetlands would be similar between the current design and the former project, but the mechanism and timing of impacts would vary. A total of 94 wetlands (approximately 10.84 acres) would potentially be impacted by the Proposed Action, consisting of 13 Category II and 81 Category III wetlands. Under the Washington rating system, wetlands are rated as low, moderate, or high based on their water quality improvement functions, hydrologic functions, and habitat functions. The functional value of Category II wetlands is moderately high while Category III wetlands are rated as moderate. Many of the Category III wetlands potentially affected by the Proposed Action had high habitat function scores attributed to the interspersion of different habitats (Anchor QEA 2018). Most of the wetlands documented in the project area are small, with an average size of 0.12 acres and ranging in size from less than 100 ft^2 to 1.09 acres.

Sixteen Category III wetlands totaling approximately 1.85 acres would be permanently impacted by the FRE facility, new and improved roads, and temporary construction disturbance limits. The proposed inundation area would potentially impact up to 85 Category II (13) and Category III (72) wetlands for a total area of 9.21 acres, including seven of the Category III wetlands (total of 0.22 acres) noted above that would be impacted during construction. The Applicant is not proposing to remove trees from the inundation area prior to operations beyond the construction clearing limits. Wetlands within the inundation area would be subject to recurring inundation during operations.

5.8 Stream and Wetland Buffers

The Applicant updated the potential impacts to stream and wetland buffers based on the Proposed Action and best available information as described below.

5.8.1 Buffer Widths

5.8.1.1 Stream Buffer Widths

For the stream buffer analysis, the Applicant used WA DNR Water Type Maps (WA DNR 2024b), the most recent Lewis County Shoreline Management Plan (Lewis County 2021), and the WAC 173-18-250 list of Shorelines of the State, approved February 20, 2023, to update the stream types and associated stream buffers. To determine the potential impact of the proposed FRE project on stream buffers, the Applicant adhered to LCC 17.38.420 and applied the following criteria:

- Type S Waters: 200-foot-wide buffer on either side of the OHWM;
- Type F Waters >10-feet wide: 150-foot-wide buffer on either side of the OHWM;
- Type F Waters <10-feet wide: 100-foot-wide buffer on either side of the OHWM; and
- Type Np, Ns, Nu and U Waters: 75-foot-wide buffer on either side of the OHWM.

At the time of the SEPA DEIS and NEPA DEIS analyses, the only Type S Waters (Shorelines of the State) within the inundation area were the Chehalis River, Crim Creek, and the lower reach of Rogers Creek; and Type F Waters consisted of Lester Creek, Brown Creek, the lower reach of Big Creek, and the upper reach of Rogers Creek. Since the SEPA and NEPA DEIS analyses were completed, Lester, Roger and Big creeks have been designated as Shorelines of the State (Lewis County 2021). Accordingly, the Applicant increased the buffer width to 200 feet on either side of these streams.

In addition, Hull Creek and the lowermost portions of three Crim Creek tributaries that were classified as N Type Waters in the DEISs have since been classified as F Type Waters. Based on the stream width data documented by Anchor QEA (2018) or publicly available WA DNR Forest Practices Water Type Modification Forms, the Applicant determined that these streams are less than 10 feet wide and therefore applied a 100-foot-wide buffer per LCC 17.38.420.

Streams that have no surface water connection to a downstream water body that is classified as an F, Np, or Ns stream type, have no designated protective stream buffer. However, for this analysis to be consistent with the SEPA and NEPA DEIS analyses, all Type N and U Waters and streams noted by Anchor QEA during their 2017 surveys as lacking a surface connection with the Chehalis River or its tributaries were assumed to have a 75-foot-wide stream buffer.

5.8.1.2 Wetland Buffer Widths

The land within and surrounding the inundation area is Forest Reserve Land currently used for commercial forest production administered by the WA DNR under the Forest Practices Act. Four of the 94 wetlands potentially impacted by the project meet the type and size criteria requiring a no-harvest or limited tree harvest WMZ buffer (WAC 222-30-020 (8)). The four wetlands are non-forested (at least partially) Type B wetlands ranging in size between 0.6 and 1.3 acres. The WMZ for each of these wetlands has a minimum width of 25 feet. The remaining 90 wetlands are either non-forested Type B wetlands <0.5 acres in size or forested wetlands, neither of which meet the Forest Practices criteria requiring a WMZ. When the proposed FRE facility project moves forward, the Applicant would purchase the land encompassing the inundation area and the Forest Conversion Area (Section 7.3.1) and would cease commercial forest operations on these lands. As such, management of the land would then be subject to Lewis County critical areas code Chapter 17.38.

Under LCC 17.38.270, the width of required wetland buffers is determined by the wetland function (Category I, II, III, or IV) (LCC 17.38.230) and the proposed land use intensity (low, moderate, or high) (LCC 17.38.260). In general, required buffer widths increase as the functional value of a wetland increases or the proposed land use intensity and level of impact increases. LCC Chapter 17.38 does not list the level of impact specifically associated with the construction and operation of a temporary flood retention facility such as the Proposed Action. However, as a point of reference, Lewis County code identifies the level of impact associated with forestry (cutting of trees only) as low, the building of logging roads as moderate, and urban and industrial/institutional development as high.

As described in Section 5.7, all of the wetlands potentially impacted by the Proposed Action are either Category II or Category III moderate to moderately high functioning wetlands. The Proposed Action includes a range of use intensities from recurring temporary inundation to vegetation clearing and replanting, to construction of new access roads, to construction of the FRE facility. Based on the Anchor QEA (2018) wetland classification and habitat function ratings, the required wetland buffer width associated with the Category II and Category III wetlands potentially impacted by the Proposed Action would range from 75-150 feet for low level impacts to 150-260 feet for high level impacts depending on the habitat function of the associated wetland (LCC 17.38.270).

In the SEPA DEIS analysis, Ecology assumed a high level of impact for all wetlands potentially affected and applied wetland buffer widths of 260 feet around all Category II and III wetlands with high habitat value and 150 feet around all Category II and III wetlands with moderate habitat function (Appendix O in Ecology 2020). In completing the NEPA DEIS impact analysis, the Corps used 75 to 150-foot-wide wetland buffer widths as would be required for a low-level land use impact such as forestry (tree cutting only) (Appendix J in Corps 2020). The Applicant anticipates that the required wetland buffer widths, which would be determined during permitting, would vary across affected wetlands depending on the actual level of impact from the Proposed Action. For purposes of developing this RMP and ensuring the feasibility of achieving no net loss of function, the Applicant conservatively used a 150 to 260-foot wetland buffer width that would be applicable for a high level of impact under LCC 17.38.260 such as would be required for urban, industrial, institutional, or commercial development. However, more than 80% of the wetlands and buffers would only be impacted by the Proposed Action through recurring temporary inundation and replanting as needed, likely considered a low-level impact requiring buffer widths of 75 to 150 feet. In addition, buffer widths may be averaged (LCC 17.38.290) or reduced (LCC 17.38.280) where the intensity of the land use impacts would be reduced (e.g., decommissioning of logging road) or where existing roads lie within the buffer.

5.8.2 Stream and Wetland Buffer Area

The amount of stream and wetland buffers potentially impacted by construction and operation of the Proposed Action were calculated using the Anchor QEA (2018) delineated wetland and stream OHWM data, WA DNR data in areas outside of Anchor QEA survey, and the widths described above. As previously noted, most of the wetlands documented in the project area are small, ranging in size from less than 100 ft^2 to 1.09 acres, with a mean size of 0.12 acres. The LCC wetland buffers for high-level impacts are large (150 to 260 feet) relative to the size of most of the wetlands found in the area. In addition, many of the wetlands are in close proximity to streams. As a result, there is significant overlap between stream buffers, wetland buffers, wetlands, and regulated waterbodies (i.e., streams).

Quantifying the acreages independently without considering where these different jurisdictional areas intersect overestimates the total area of impact. When these jurisdictional areas overlap, the most restrictive regulations or requirements that best protect public resources typically apply. Accordingly, the Applicant calculated the area of streams within wetland buffers and the area of wetlands within wetland buffers or stream buffers and would mitigate for these as streams and wetlands, respectively. After the streams and wetlands were removed from the buffer areas, the remaining stream buffer and wetland buffers were merged with the overlapping areas noted.

A total of 585.5 acres of combined stream-wetland buffer excluding overlapping wetlands (7.4 acres) and streams (44.6 acres) would potentially be impacted by the Proposed Action, not including the potential quarries sites. The combined stream-wetland buffers are comprised of 295.3 acres of stream buffer, 91.1 acres of wetland buffer, and 199.2 acres of overlapping stream and wetland buffers. The Applicant's analysis of stream-wetland buffers indicates a greater impact than was identified in the Corps analysis presented in the NEPA DEIS. The Applicant conducted the same analysis as the Corps but some of the stream buffer widths have increased since the NEPA DEIS was developed and the Applicant conservatively used a high-level of impact in determining the wetland buffer widths where the Corps applied a low-level impact wetland buffer width. In the SEPA DEIS analysis, wetland buffers and stream buffers were quantified independently. Ecology found that a total of 333.3 acres of wetland buffers and 462.9 acres of stream buffers would be impacted by the construction and operations of the previous FRE design (Appendix O in Ecology 2020).

5.8.2.1 Construction

There are a total of 33.4 acres of combined stream-wetland buffers excluding wetlands (0.6 acres) and streams (2.8 acres) that would be permanently impacted by construction of the FRE facility (Table 5.8-1). Of this area about 21% is stream buffer only, 41% is wetland buffer only, and 38% is both stream buffer and wetland buffer. About 3.8 acres of the combined stream-wetland buffer is developed (e.g., logging roads). Assuming that removal of vegetation during construction followed by restoration is considered a high-level impact to wetland buffers, another 78.2 acres of combined stream-wetland buffer would be temporarily impacted during construction, comprised of approximately 54% stream buffer, 28% wetland buffer, and 18% overlapping stream-wetland buffer. Of the total 78.2 acres, 45.9 acres occur outside the inundation area and 32.3 occur within the inundation area.

Table 5.8-1
Area of Overlapping Wetland Buffers and Stream Buffers Associated with Construction of the FRE Facility.

OVERLAPPING JURISDICTIONAL COVER TYPES	PERMANENT FEATURES[1]		TEMPORARY CONSTRUCTION AREA		QUARRIES[2]			TOTAL AREA (ACRES)
	FRE FACILITY AREA	WITHIN INUNDATION AREA	OUTSIDE INUNDATION AREA	WITHIN INUNDATION AREA	NORTH-WEST	SOUTH	WEST	
Stream Buffer Only with No Overlap	3.2	3.9	28.3	14.0	9.5	10.8	12.9	82.5
Stream Buffer and Wetland Buffer Overlap	8.9	3.7	4.8	9.3				26.7
Wetland Buffer Only with No Overlap	9.5	4.1	12.8	9.0	2.0			37.5
Overlap with Streams	2.1	0.6	0.3	1.1				4.1
Overlap with Wetlands	0.6	0.0	0.1	0.1	0.0	0.0	0.0	0.8
TOTAL BUFFERS	24.4	12.4	46.3	33.5	11.4	10.8	12.9	151.6
TOTAL BUFFERS WITHOUT STREAMS AND WETLANDS	**21.7**	**11.7**	**45.9**	**32.3**	**11.4**	**10.8**	**12.9**	**146.7**

Notes:
1. Permanent features include the FRE facility, new roads, improvements to existing access roads, the Chehalis River and Crim Creek engineered channel, and the debris sorting yard.
2. Each quarry permitting area is approximately 65 acres of which up to 40 acres of one to two quarries would be disturbed.

5.8.2.2 Inundation Area

The 824.9-acre inundation area includes a total of 518 acres of combined stream-wetland buffer, including 11.7 acres that would be permanently impacted by construction of the FRE facility access roads and 32.3 acres that would temporarily be disturbed during construction and subsequently restored with the planting of native flood-tolerant plant species. Post-construction of the FRE, about 32.2 acres of the combined stream-wetland buffer would be comprised of developed areas. Of the 506.3 acres of stream-wetland buffer, 51% (263.8 acres) is stream buffer only, 13% (68.7 acres) is wetland buffer only, and 36% (185.5 acres) is both stream buffer and wetland buffer (Table 5.8-2). This analysis assumed a high-level of impact in determining the wetland buffer width. This area would be impacted by recurring temporary inundation during operations to varying degrees depending on the magnitude and duration of storm events, which may be considered a low-level impact. The actual level of impact would be established during permitting.

Table 5.8-2
Area of Overlapping Wetland Buffers and Stream Buffers Within the Inundation Area[1].

OVERLAPPING JURISDICTIONAL COVER TYPES	PERMANENT CONSTRUCTION AREA (ACRES)[2]	TEMPORARY CONSTRUCTION AREA (ACRES)	NO CONSTRUCTION DISTURBANCE (ACRES)	TOTAL INUNDATION AREA (ACRES)
Stream Buffer Only with No Overlap	3.9	14.0	245.9	263.8
Overlap with Wetland Buffer	3.7	9.3	172.5	185.5
Wetland Buffer Only with No Overlap	4.1	9.0	55.6	68.7
Overlap with Stream	0.6	1.1	40.5	42.2
Overlap with Wetlands	0.0	0.1	6.6	6.7
TOTAL BUFFERS	12.4	33.5	521.1	566.9
TOTAL WITHOUT STREAMS AND WETLANDS	**11.7**	**32.3**	**474.0**	518.0

Notes:
1. The Inundation Area calculations represents the maximum pool elevation at 628 MSL and includes the permanent features and temporary construction impacts that would occur within the inundation area.
2. Permanent features include the FRE facility, new roads, improvements to existing access roads, the Chehalis River and Crim Creek engineered channel, and the debris sorting yard.

5.9 Summary of Updated Impacts

Updates to the applicable impacts described above are summarized in Table 5.9-1 and Table 5.9-2. Details supporting these updated potential impacts can be found in Appendices A, B and C. These impacts do not take into account avoidance and minimization measures the Applicant intends to implement, such as the VMP and Fish Passage Plan, or consider the sensitivity analysis of thermal potential effects of the Proposed Action, which allows various SEPA DEIS-identified impacts to be updated in terms of scale, duration, and severity.

Table 5.9-1
Summary of Areas Potentially Affected by the Proposed Action.

VEGETATION COVER TYPE	PERMANENT FEATURES[1]		TEMPORARY CONSTRUCTION AREA		QUARRIES[2]			TOTAL INUNDATION AREA[3]
	FRE FACILITY AREA	WITHIN INUNDATION AREA	OUTSIDE INUNDATION AREA	WITHIN INUNDATION AREA	NORTH-WEST	SOUTH	WEST	
Stream	2.8	2.7	1.9	2.1	0.2	0.2	0.2	109.5
Wetland	1.0	0.1	0.6	0.2				9.2
Combined Stream-Wetland Buffer	21.7	11.7	45.9	32.3	11.4	10.8	12.9	518.0
Non-buffer Upland	11.5	1.0	49.7	18.5	53.3	54.2	52.1	188.2
TOTAL AREA	**37.0**	**15.4**	**98.1**	**53.1**	**64.8**	**65.2**	**65.2**	**824.9**

Notes:
1. Includes the FRE facility and stilling basin, FFPF, new roads and improvements to existing roads to access the facility, the Chehalis River and Crim Creek engineered channel and the debris sorting yard.
2. Each quarry permitting area is approximately 65 acres of which up to 40 acres would be disturbed for one to two quarry areas.
3. Total inundation area up to spillway elevation of 628 feet MSL.

Table 5.9-2

Crosswalk Between the Greatest Impacts Presented in the SEPA DEIS (Ecology 2020) and/or NEPA DEIS (Corps 2020) for the Original FRE Facility and the Applicant's Updated Potential Effects[1] of the Proposed Action.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
CONSTRUCTION PHASE			
Construction	Impeded upstream fish passage at the proposed FRE facility site via temporary trap-and-transport (TTT) system; downstream fish passage via bypass tunnel during 32-month construction period.	• Reduced upstream fish passage survival for salmon and steelhead and resident fish above the proposed FRE facility site.	• Avoid survival impacts to fish as the temporary bypass channel eliminates the need for a TTT system and will provide full volitional passage.
Development of proposed FRE	Clearing, excavation, grading and fill to construct the FRE facility.	• Permanent loss of 0.32 acres of the Chehalis River channel under FRE facility.	• Permanent loss of 2.7 acres of the Chehalis River natural channel under the FRE facility and stilling basin. • Permanent replacement of 2.48 acres of stream habitat with Chehalis River and Crim Creek engineered channel. • Permanent replacement of 1.64 acres of stream habitat with engineered channel downstream of FRE facility.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
Development of proposed FRE	Clearing, excavation, grading and fill to construct the FRE facility.	• Permanent loss of 10.79 acres stream buffer.	• Permanent loss of 19.7 acres of stream buffer (including 12.6 acres of overlapping stream and wetland buffer). • Temporary loss of 56.6 acres of stream buffer (including 14.1 acres of overlapping stream and wetland buffer) in construction disturbance area. This habitat will be restored following Washington State BMPs.
Development of proposed FRE	Clearing, excavation, grading and fill to construct the FRE facility.	• Permanent loss of 1.08 acres of wetlands: – 0.65 acres within the FRE structure and construction areas outside the inundation area – 0.43 acres within the inundation area	• Permanent loss of 1.85 acres of wetlands consisting of 16 Category III wetlands: – 0.82 acres within the FRE facility footprint – 0.81 acres within temporary construction disturbance areas outside the inundation area – 0.22 acres within temporary construction disturbance areas in the inundation area
Development of proposed FRE	Clearing, excavation, grading and fill to construct the FRE facility.	• Permanent loss of 30.14 acres of wetland buffer.	• Permanent loss of 13.7 acres of wetland buffer (excluding 12.6 acres of overlapping stream and wetland buffer accounted for under stream buffer). • Temporary loss of 21.8 acres of wetland buffer (excluding 14.1 acres of overlapping stream and wetland buffer accounted for under stream buffer) within the construction disturbance area.
Development of proposed FRE	Clearing, excavation, grading and fill to construct the FRE facility.	• Permanent loss of 3.78 acres of upland habitat.	• Permanent loss of 13.3 acres of uplands (excluding buffers and wetlands accounted for elsewhere). • Temporary loss of 90.0 acres of uplands (excluding buffers and wetlands accounted for elsewhere) in construction disturbance area. This will be restored following Washington State BMPs.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
Tree removal prior to operations	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 acres).	• Loss of stream buffer tree cover/shade and ground disturbance in riparian and stream buffers in Zones 1 and 2: – 18.2 miles stream buffer (both sides of stream): ▪ 11.51 miles Chehalis River ▪ 6.69 miles tributaries – 312.8 acres stream buffer: ▪ 252.6 acres along fish-bearing streams • Loss of trees/shade along 11.44 miles of stream: – 5.79 miles Chehalis River – 5.65 miles of tributaries – 8.79 miles are fish-bearing	• Loss of stream buffer tree cover/shade and ground disturbance in the inundation area would be limited to the construction disturbance area accounted for above under Development of the FRE facility: – 0.5 miles of stream: ▪ 0.38 miles Chehalis River ▪ 0.06 miles of Crim Creek and non-fish-bearing tributaries – 23.3 acres of stream buffer (including 9.3 acres of overlapping stream and wetland buffer): ▪ 22.3 acres along fish-bearing streams
Tree removal prior to operations	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 acres).	• Loss of wetland and wetland buffer tree cover and ground disturbance in Zones 1 and 2: – 6.5 acres of wetlands: ▪ 2.76 acres Category II wetlands ▪ 3.74 acres Category III wetlands – 213.85 acres of wetland buffer	• Loss of wetland and wetland buffer tree cover and ground disturbance in the inundation area would be limited to the construction disturbance area accounted for above under Development of the FRE facility: – 0.22 acres of Category III wetlands – 18.3 acres of wetland buffer (excluding 9.3 acres of overlapping stream and wetland buffer accounted for under stream buffer)
Tree removal prior to operations	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 acres).	• Permanent removal of 90% of tree cover in 600 acres of the inundation area within Zones 1 and 2. • 426 acres of upland forest and forested wetland convert to scrub-shrub dominated by young alder, willows, dogwood, elderberry, salmonberry: – Douglas fir or mixed forest (369.4 acres) – Deciduous forest (50.5 acres) – Wetlands (6.5 acres)	• Tree removal within the inundation area would be limited to the 53.1-acre construction disturbance area: – 49.0 acres of upland forest and forested wetland may convert to scrub-shrub: ▪ Commercial Douglas fir timberlands or mixed forest (44.2 acres) ▪ Deciduous forest (4.7 acres) ▪ Wetlands (0.22 acres)

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
OPERATIONS			
Periodic flood retention of major or greater floods and vegetation management	Inundation of up to 16.8 miles of stream habitat for up to 35 days.	• Periodic and temporary conversion of stream channel to pool during a catastrophic flood event up to the spillway elevation of 628 feet MSL with increased water surface elevation, depth, and surface water area. • 16.83 miles/113.43 acres of stream: – 6.79 miles mainstem Chehalis River – 10.04 miles of tributaries – 11.74 miles are fish-bearing • Includes the 11.44 miles of stream impacted by tree removal in Zones 1 and 2 prior to operations.	• Periodic and temporary conversion of stream channel to pool during a catastrophic flood event up to the spillway elevation of 628 feet MSL with increased water surface elevation, depth, and surface water area. • 16.6 miles/109.89 acres of stream: – 6.6 miles mainstem Chehalis River – 10.0 miles of tributaries – 11.8 miles are fish-bearing – Includes 0.48 miles temporarily affected by construction disturbance: ▪ 0.38 miles of the Chehalis River ▪ 0.06 miles of Crim Creek ▪ 0.04 miles of non-fish-bearing tributaries.
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Mortality of flood-intolerant trees and other vegetation in stream buffer from inundation and ground disturbance from tree removal and planting of young flood-tolerant plants. • 25.5 miles (along both sides of the stream)/441.3 acres of stream buffer: – Includes 18.2 miles/312.8 acres of stream buffer impacted by tree removal in Zones 1 and 2 prior to operations – 13.51 miles mainstem Chehalis River – 12.04 miles of tributaries – 348.29 acres along fish-bearing streams	• No tree removal outside of construction disturbance area as described above and no management of tree size proposed. • Mortality of some flood-intolerant trees and other vegetation in stream buffer from inundation and ground disturbance from planting of young flood-tolerant plants. • 16.6 miles of stream/441.7 acres of stream buffer (including 181.8 acres of overlapping stream and wetland buffer): – Includes 23.3 acres of stream buffer within construction disturbance area characterized above under Development of FRE facility that would be restored and planted with flood-tolerant species – 6.6 miles mainstem Chehalis River – 10.0 miles of tributaries – 11.8 miles of fish-bearing streams

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Mortality of flood-intolerant trees and other vegetation in wetlands and wetland buffers from inundation and ground disturbance from tree removal and planting of young flood-tolerant plants. • 85 wetlands (9.76 acres): – 13 Category II wetlands (2.81 acres) – 72 Category III wetlands (6.95 acres) – Includes 62 wetlands disturbed during tree removal construction activities Zones 1 and 2: ▪ 11 Category II wetlands (2.76 acres) ▪ 51 Category III wetlands (3.74 acres). – Includes 23 wetlands in Zones 3 and 4: ▪ 2 Category II wetlands (0.5 acres) ▪ 21 Category III wetlands (3.21 acres). • 303.15 acres of wetland buffer: – 213.85 acres wetland buffer in Zones 1 and 2 impacted by tree removal – 89.30 acres wetland buffers in Zones 3 and 4 that will be inundated during 100-year and greater than 100-year flood events, respectively.	• Mortality of flood-intolerant trees and other vegetation in wetlands and wetland buffers from inundation and ground disturbance from planting of young flood-tolerant plants. • 85 wetlands (9.21 acres): – 13 Category II wetlands (2.80 acres) – 72 Category III wetlands (6.41 acres) – Includes 7 Category III wetlands (0.22 acres) disturbed during construction activities accounted for under Development of FRE facility. • 64.6 acres of wetland buffer (excluding 181.8 acres of overlapping stream and wetland buffer included above as stream buffer): – Includes 9.0 acres of wetland only buffer within temporary construction disturbance area characterized above under Development of FRE facility.
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Mortality of flood-intolerant trees and other vegetation from inundation in non-buffer uplands (area not quantified) and ground disturbance from tree removal and planting of young flood-tolerant plants.	• Mortality of flood-intolerant trees and conversion to younger, earlier successional stages of flood-tolerant plant species in non-buffer uplands (187.2 acres) from inundation would depend on the frequency and duration of inundation.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	DEIS DIRECT IMPACT OF ORIGINAL PROJECT	UPDATED POTENTIAL EFFECT OF PROPOSED ACTION
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• 847 acres would be submerged during operations: approximately 63% scrub-shrub as a result of the tree removal that would occur during construction and existing shrub areas; approximately 1% wetlands; 31% forested; 5% herbaceous areas and roads. • 600 acres in Zones 1 and 2 convert to scrub-shrub (dominated by young alder, willows, dogwood, elderberry, salmonberry): – Forested habitat (426 acres total: ▪ Douglas fir forest or mixed forest (369.4 acres) ▪ Deciduous forest (50.5 acres) ▪ Wetlands (6.5 acres). • 247 acres in Zone 3 and Zone 4 convert to young mixed deciduous and evergreen forest (154 acres) and young Douglas fir dominated forest (~94 acres): – Forested habitat (180.5 acres total: ▪ Douglas fir forest or mixed forest (164.5 acres) ▪ Deciduous forest (12.3 acres) ▪ Wetlands (3.2 acres).	• Up to 824.9 acres would be submerged during operations that post-construction and pre-operations would be comprised of: approximately 21% scrub-shrub as a result of vegetation clearing during construction in up to 53.1 acres; 60% forested; 6% herbaceous and developed area; and 14% open water. • Conversion of up to 676.8 acres of vegetated cover to younger, earlier successional stages of flood-tolerant plant species would depend on the frequency and duration of inundation.
Flood retention of major or greater floods at FRE and subsequent drawdown operations	Retention of sediment upstream of FRE during flood retention operations.	• Retention of sediment upstream of FRE during flood retention operations; changes to sediment transport (including fining of bed substrate over time, increases in fine sediment delivery and reduction in delivery of spawning gravels).	• Analysis indicates that the FRE facility will not affect 2-year flood flows which are capable of moving more sediments over time than greater flood flows.

Notes:
1. The Applicant only updated potential effects that would change with the Proposed Action prior to any avoidance or minimization measures or mitigation.

6 MITIGATION APPROACH

6.1 Mitigation Sequencing Approach

The Applicant will follow a standard mitigation sequencing approach of first avoiding and minimizing likely impacts, then mitigating for any unavoidable potential effects through this RMP. Mitigation sequencing began during the conceptual design for the project as the Applicant made every effort to select a location and develop a design that would avoid impacts on critical areas as much as possible. Further development of the Proposed Action considered any opportunities to avoid or minimize potential effects on stream and terrestrial habitat associated with the construction or operation of the Proposed Action, as well as identifying opportunities for preemptive restoration or rehabilitation of the affected environment before implementation of construction phases. Finally, this RMP present mitigation and monitoring for all potential impacts that could not be avoided. The Applicant developed mitigation to offset the refined impacts as presented in Section 5.0.

6.2 Avoidance and Minimization Measures

6.2.1 Summary of Measures

During siting and conceptual design of the FRE, the Applicant has identified various measures for avoiding or minimizing certain potential effects from construction and operation of the FRE facility. These measures will minimize the following direct impacts identified in the DEIS: temporary loss of stream habitat due to dewatering during construction; reduced upstream and downstream fish passage and fish survival; permanent loss of riparian area/stream buffers; loss of tree cover, shade reduction and associated water temperature increases, and ground disturbance and degradation in riparian, stream buffer, and upland habitat; reduced in-channel large wood; periodic and temporary conversion of stream to reservoir pool habitat; reduction in peak flows downstream of the proposed FRE facility from operation; and retention of sediment during proposed FRE facility operation.

Most notably. the FRE design and construction plan provides for construction of the facility "in the dry" while always maintaining an open natural bypass channel for unimpeded river flows and full volitional fish migration during construction. This eliminates the construction and operation of a diversion tunnel during construction, associated excavation and blasting, and potential for pooling of water at higher flows. The natural bypass channel will eliminate the need for a temporary trap and transport facility, thereby avoiding potential survival impacts that were identified in the DEIS for the previous design. The location of the new proposed FRE facility also eliminates the need for a cofferdam below Mahaffey Creek, which avoids disruption of movements of aquatic organisms into or out of that tributary.

A complete summary of avoidance and minimization measures to address specific potential effects is provided in Table 6.2-1. Details for construction and fish passage design measures are summarized in Section 2 (Project Description) and can be found in more detail in the 2024 project description (HDR

2024). Minimization measures associated with the VMP and operational flows are summarized below. Specific BMPs to protect natural resources from potential construction impacts such as erosion, excess clearing, pollutant discharge, noise pollution, as well as those required for surface mine reclamation (Appendix E) will be employed that minimize long-term impacts to the environment.

Table 6.2-1

Avoidance and Minimization Measures Associated with the Construction and Operation of the FRE Facility (i.e., Proposed Action).

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Construction	Construction noise, blasting, ground disturbance, dewatering, temporary and permanent removal or disturbance of vegetation or habitats during construction activities.	• Disturbance/Injury/ mortality to low-mobility individuals of aquatic and terrestrial species from dewatering, ground disturbing activities, blasting, and tree removal. Disturbance to species from noise and blasting; potential decreased production from sensitive species such as marbled murrelets, bald eagles and other raptors.	• Minimize timing-related impacts by following WDFW guidelines for in-water work. • Minimize the duration of the overall construction impact due to a phased approach that allows for work in the dry and reduces in-water work to cofferdam install and removal. • Minimize area of impact as the new design incorporates phased construction that supports working in the dry and minimizes the need for temporary dewatering less than 0.5 miles of the mainstem (RM 108.26 to 108.62). • Follow BMPs for protection of fish and wildlife species from noise and blasting. • Ongoing maintenance of complex habitats within the inundation area (under the VMP) to support wildlife needs.	• Potential temporary effect on mortality of individuals of low-mobility species.
Construction	Temporary dewatering of proposed FRE facility site during construction and in-water work.	• Temporary loss of Chehalis River stream habitat in dewatered area during construction.	• Minimize timing-related impacts by following WDFW guidelines for in-water work. • Minimize the duration of the overall construction impact due to a phased approach that allows for work in the dry and reduces in-water work to cofferdam install and removal. • Minimize area of impact as the new design incorporates phased construction that supports working in the dry and minimizes the need for temporary dewatering less than 0.5 miles of the mainstem (RM 108.26 to 108.62). • Fish salvage plan.	• Potential temporary effect, mortality small and sedentary individuals of aquatic species.
Construction	Impeded upstream fish passage at the proposed FRE facility site via temporary trap-and-transport (TTT) system; downstream fish passage via bypass tunnel during 32-month construction period.	• No construction effect expected as no TTT system in Proposed Action. • Volitional passage for all species all the time provided during construction period.	• Avoid survival impacts to fish as the temporary bypass channel eliminates the need for a TTT system and will provide full volitional passage.	• No unavoidable effects associated with fish passage.
Construction	Temporary disturbance of the floodplain and uplands from construction activities.	• Temporary effects are quantified below under Development of FRE facility.	• Minimize the duration of the overall construction effect due to a phased approach that allows for work in the dry and reduces in-water work to cofferdam install and removal. • Restoration of all temporarily disturbed habitats after construction.	• Effects to wetlands are unavoidable due to construction duration and are addressed under Development of the FRE.
Construction	Use of construction diversion tunnel with capacity to convey flows up to the 2.8-year flood event.	• No construction effect expected as no tunnel in Proposed Action.	• Avoided effects associated with pooling water, and operate to minimize pooling.	• No mitigation anticipated as no tunnel in Proposed Action.
Development of FRE facility	Excavation, grading, and fill to construct the proposed FRE facility.	• Permanent loss of 2.7 acres of the Chehalis River natural channel under the FRE facility and stilling basin. • Permanent replacement of 2.48 acres of stream habitat with Chehalis River and Crim Creek engineered channel.	• Minimize impact of final design by minimizing FRE facility footprint. • Minimize the duration of impact to stream habitat within engineered channel by using reach design that mimics natural channel and substrate.	• 2.7 acres of stream habitat.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Development of FRE facility	Excavation, grading, and fill to construct the proposed FRE facility.	• Permanent loss of 19.7 acres of stream buffer (including 12.6 acres of overlapping stream and wetland buffer). • Temporary loss of 56.4 acres of stream buffer in construction disturbance area (including 14.1 acres of overlapping stream and wetland buffer).	• Minimize impact of final design by minimizing FRE facility footprint. • Minimize the duration of impact to stream habitat within engineered channel by using reach design that mimics natural channel and substrate.	• Permanent loss of 19.7 acres of stream buffer (including 12.6 acres of overlapping stream and wetland buffer).
Development of proposed FRE facilities	Excavation, grading, and fill to construct the proposed FRE facility.	• Permanent loss of 13.7 acres of wetland buffer (excluding 12.6 acres of overlapping stream and wetland buffer accounted for under stream buffer). • Temporary loss of 21.8 acres of wetland buffer (excluding 14.1 acres of overlapping stream and wetland buffer accounted for under stream buffer) within the construction disturbance area.	• Use of BMPs to minimize disturbance. • Restoration to 35.9 acres of wetland buffer (excluding 14.1 acres of overlapping stream buffer accounted for under stream buffer) post-disturbance following Washington State BMPs.	• Permanent loss of 13.7 acres of wetland buffer (excluding 12.6 acres of overlapping stream and wetland buffer accounted for under stream buffer).
Development of proposed FRE facilities	Excavation, grading, and fill to construct the proposed FRE facility.	• Permanent loss of 13.3 acres of uplands (excluding buffers and wetlands accounted for elsewhere). • Temporary loss of 90.0 acres of uplands (excluding buffers and wetlands accounted for elsewhere) in construction disturbance area. This will be restored following Washington State BMPs.	• Use of BMPs to minimize disturbance. • Restoration to 90.0 acres of upland habitat post-disturbance following Washington State BMPs.	• Permanent loss of 13.3 acres upland habitat.
Development of proposed FRE facilities	Impeded upstream and downstream fish passage through volitional passage facilities at the FRE facility outside of flood retention events.	• No effects are anticipated with passage conduits designed to meet NOAA Fisheries and WDFW passage criteria.	• Avoid effect as volitional upstream and downstream passage will be provided with new bypass that will be designed to meet NOAA Fisheries and WDFW passage criteria.	• No unavoidable effects.
Pre-operation tree removal	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 ac).	• Loss of stream buffer tree cover/shade and ground disturbance in the inundation area would be limited to the construction disturbance area accounted for above under Development of FRE facility: – 0.5 miles of stream: ▪ 0.38 miles mainstem Chehalis River ▪ 0.06 miles of Crim Creek and non-fish-bearing tributaries. – 23.3 acres of stream buffer (including 9.3 acres of overlapping stream and wetland buffer): ▪ 22.3 acres along fish-bearing streams.	• Minimize the extent and severity of impact by removing only those trees required for construction and staging or inspection of the FRE facility. • Minimize the extent and severity of the impact through the implementation of the revised VMP pre-operations: – Initiate planting of native, flood-tolerant species within the 60-ft zone as early as possible in the permitting period to allow to maximize years of growth prior to the proposed FRE facility operation – Conduct invasive species management during construction and pre-operation as needed – Leave stumps and standing dead wood for wildlife. • Restoration of stream buffer along 0.38 mi of Chehalis River and 0.06 miles of Crim Creek; and 0.04 miles of non-fish-bearing tributaries (total of 23.4 acres) following Washington State BMPs.	• No unavoidable effects due to restoration.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Pre-operation tree removal	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 ac).	• Tree removal within the inundation area would be limited to the construction disturbance area (accounted for above under Development of FRE facility construction disturbance area): – 0.22 acres of wetlands of Category III wetlands – 18.3 acres of wetland buffer (including 9.3 acres of overlapping stream and wetland buffer accounted for under stream buffer).	• Minimize the extent and severity of effect by removing only those trees required for construction and staging or inspection of the FRE facility. • Minimize the extent and severity of the effect through the implementation of the revised VMP pre-operations: – Initiate planting of native, flood-tolerant species within the 60-ft zone as early as possible in the permitting period to allow to maximize years of growth prior to the proposed FRE facility operation – Conduct invasive species management during construction and pre-operation as needed – Leave stumps and standing dead wood for wildlife. • Restoration of 18.3 acres of wetland buffer following Washington State BMPs.	• No additional unavoidable effect (0.22 acres of wetlands already accounted for under Development of FRE facility construction disturbance area).
Pre-operation tree removal	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 ac).	• Tree removal within the inundation area would be limited to the 53.1-acre construction disturbance area: – 49.0 acres of upland forest and forested wetland may convert to scrub-shrub: ▪ Commercial Douglas fir timberlands or mixed forest (44.2 acres) ▪ Deciduous forest (4.7 acres) ▪ Wetlands (0.22 acres).	• Minimize extent and severity by removing only those trees required for construction and staging or inspection of the proposed FRE facility. • Minimize the extent and severity of the impact through the implementation of the revised VMP pre-operations: – Initiate planting of native, flood tolerant species within the 60-ft zone as early as possible in the permitting period to maximize years of growth before FRE facility operation – Conduct invasive species management during construction – Leave stumps and standing dead wood for wildlife. • Restoration and replanting of 49.0 acres of forested areas with flood-tolerant tree species following Washington State BMPs.	• No additional unavoidable effect to wetlands (loss of 0.22 acres of wetlands already accounted for under Development of FRE facility construction disturbance area). • Conversion of 49.0 acres of forested habitat to earlier successional stage and native flood-tolerant plant community.
Pre-operation tree removal	Pre-operations tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 ac).	• Reduced large wood material.	• Minimize the extent and severity by removing only those trees required for construction and staging or inspection of the FRE facility. • Minimize the extent and severity of the impact through the implementation of the revised VMP pre-operations: – Initiate planting of native, flood tolerant species within the 60-ft zone as early as possible in the permitting period to maximize years of growth before FRE facility operation – Leave stumps and standing dead wood for wildlife.	• Reduced large wood material.
Pre-operation tree removal	Pre-operation tree removal and implementation of VMP in inundation area Zones 1 and 2 (600 acres).	• Injury/mortality to low-mobility individuals of aquatic and terrestrial species from ground-disturbing activities, and tree removal. Disturbance to species from noise.	• Minimize the extent and severity by removing only those trees required for construction and staging or inspection of the FRE facility. • Minimize the extent and severity of the impact through the implementation of the revised VMP pre-operations: – Initiate planting of native, flood tolerant species within the 60-ft zone as early as possible in the permitting period to maximize years of growth before FRE facility operation – Conduct invasive species management during construction – Leave stumps and standing dead wood for wildlife.	• Some injury/mortality to individuals of sessile or low mobility species.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Periodic flood retention of major or greater floods and vegetation management	Inundation of up to 16.8 miles of stream habitat for up to 35 days.	• Periodic and temporary conversion of stream channel to pool during a catastrophic flood event up to the spillway elevation of 628 feet MSL with increased water surface elevation, depth, and surface water area. – 16.66 miles/109.89 acres of stream: ▪ 6.6 miles mainstem Chehalis River ▪ 10.0 miles of tributaries ▪ 11.79 miles are fish-bearing. – Includes 0.48 miles effected by temporary construction disturbance: ▪ 0.38 miles of the Chehalis River ▪ 0.06 miles of Crim Creek ▪ 0.04 miles of non-fish-bearing tributaries.	• Minimize the extent of impact with new alignment an approximate 0.25-mile reduction in the length of the inundation area, total stream miles inundated will be reduced to 16.7 miles, 11.6 miles of which are fish bearing and 5.1 of which are non-fish-bearing streams. • Minimize extent of salmon spawning and rearing habitat impacted through operations that minimize inundation volume and the duration that the upper 2 miles of the pool are inundated. • Minimize operational events, inundation volume, and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event. • Minimize sediment transport and erosion risk with operational flow releases that maintain sediment transport capacity, clear out potential fine sediment deposits upstream of the FRE facility, and reduce the potential for shoreline erosion during evacuation. • Minimize erosion and water quality impacts by minimizing tree clearing to the immediate area around the FRE facility and in-planting of flood-tolerant vegetation during the pre-operation period. • Minimize erosion and water quality impacts with continual in-planting of native plant species suited to the inundation duration/depths experienced during flood event operations.	• Total stream miles inundated will be reduced to 16.7 miles, 11.6 miles of which are fish bearing and 5.1 of which are non-fish-bearing streams. • After VMP implementation, thermal load associated with shade loss will be reduced by 112,019,000 average kcal/day or 24%, for a minimized effect of 360,048,000 average kcal/day.
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation, post-inundation removal of dead trees, management of tree size in some zones of inundation area, and planting of flood-tolerant species	• No tree removal outside of construction disturbance area as described above and no management of tree size proposed. • Mortality of some flood-intolerant trees and other vegetation in stream buffer from inundation and ground disturbance from planting of young flood-tolerant plants. • 16.6 miles of stream/441.7 acres of stream buffer (including 181.8 acres of overlapping stream and wetland buffer): – Includes 23.3 acres of stream buffer within construction disturbance area characterized above under Development of FRE facility that would be restored and planted with flood-tolerant species – 6.6 miles mainstem Chehalis River – 10.0 miles of tributaries – 11.8 miles of fish-bearing streams.	• Minimize inundation impact on trees and vegetation associated with riparian and stream buffer through operational measures: – Minimize inundation volume and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project – Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event – Manage the Proposed FRE facility outflows to minimize the amount of time the upper 2 miles of the inundation pool is flooded. • Implement Revised VMP Pre- and Post-Operations including minimizing tree and vegetative loss in riparian and stream buffer habitats across 441.7 acres: – Continual in-planting of native, flood-tolerant plant species – Minimize tree removal to only trees necessary to protect the structure and health and safety of personnel, invasive species management – Minimize shade-related temperature impacts. • Minimize impacts to soil erosion and sediment or pollutant delivery to wetlands during tree removal activities by implementing standard BMPs.	• Change in vegetation composition to flood-tolerant species and younger seral stage within 441.7 acres of stream buffer.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Mortality of flood-intolerant trees and other vegetation in wetlands and wetland buffers from inundation and ground disturbance from planting of young flood-tolerant plants. • 85 wetlands (9.21 acres): – 13 Category II wetlands (2.80 acres) – 72 Category III wetlands (6.41 acres) – Includes 7 Category III wetlands (0.22 acres) disturbed during construction activities accounted for under Development of FRE facility. • 64.6 acres of wetland buffer (excluding 181.8 acres of overlapping stream and wetland buffer included above as stream buffer): – Includes 9.0 acres of wetland only buffer within temporary construction disturbance area characterized above under Development of FRE facility.	• Minimize inundation impact on trees and vegetation associated with wetlands and wetland buffers through operational measures: – Minimize inundation volume and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project – Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event – Manage the Proposed FRE facility outflows to minimize the amount of time the upper 2 miles of the inundation pool is flooded. • Implement Revised VMP Pre- and Post-Operations in wetland and wetland buffer habitats on 64.4 acres: – Continual in-planting of native, flood-tolerant plant species – Minimize tree removal to only trees necessary to protect the structure and health and safety of personnel, invasive species management – Minimize shade-related temperature impacts. • Minimize impacts to soil erosion and sediment or pollutant delivery to wetlands during tree removal activities by implementing standard BMPs for wetland protections. • Restoration of 9 acres of wetland buffer within the temporary construction disturbance area.	• Loss of 8.99 acres of wetlands (loss of 0.22 acres of wetlands already accounted for under Development of FRE facility construction disturbance area). • Conversion of 64.6 acres of wetland buffer to earlier successional stage and native flood-tolerant plant community.
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Mortality of flood-intolerant trees and conversion to younger, earlier successional stages of flood-tolerant plant species in non-buffer uplands (187.2 acres) from inundation would depend on the frequency and duration of inundation.	• Minimize inundation effect on trees and vegetation associated with uplands through operational measures: – Minimize inundation volume and retention duration to what is necessary to reduce effects from major or greater floods downstream of the project – Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event – Manage the Proposed FRE facility outflows to minimize the amount of time the upper 2 miles of the inundation pool is flooded. • Implement Revised VMP Pre- and Post-Operations including minimizing tree and vegetative loss in 187.2 acres of non-buffer upland habitats: – Continual in-planting of native, flood-tolerant plant species – Minimize tree removal to only trees necessary to protect the structure and health and safety of personnel, invasive species management – Minimize shade-related temperature effects. • Minimize effects to soil erosion and sediment or pollutant delivery to wetlands during tree removal activities by implementing standard BMPs.	• 187.2 acres of non-buffer uplands.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Periodic flood retention of major or greater floods and vegetation management	Prolonged inundation; post-inundation removal of dead trees and management of tree size in some zones of inundation area and planting of flood-tolerant species.	• Up to 824.9 acres would be submerged during operations that post-construction and pre-operations would be comprised of: approximately 21% scrub-shrub as a result of vegetation clearing during construction in up to 53.1 acres; 60% forested; 6% herbaceous and developed area; and 14% open water. • Conversion of up to 676.8 acres of vegetated cover to younger, earlier successional stages of flood-tolerant plant species would depend on the frequency and duration of inundation.	• Minimize inundation impact on trees and vegetation through operational measures: – Minimize inundation volume and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project – Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event – Manage the Proposed FRE facility outflows to minimize the amount of time the upper 2 miles of the inundation pool is flooded. • Implement Revised VMP Pre- and Post-Operations including minimizing tree and vegetative loss: – Continual in-planting of native, flood-tolerant plant species – Minimize tree removal to only trees necessary to protect the structure and health and safety of personnel, invasive species management – Minimize shade-related temperature impacts. • Minimize impacts to soil erosion and sediment or pollutant delivery to wetlands during tree removal activities by implementing standard BMPs.	• Conversion of up to 676.8 acres of vegetated cover to younger, earlier successional stages of flood-tolerant plant species to varying degrees depending on the frequency and duration of inundation.
Post-flood retention vegetation management	Removal of dead trees and management of tree size post-flood retention operations in some zones of inundation area.	• Reduced large wood supply from post-operations tree removal.	• Implement the revised VMP during non-operational periods to minimize the impact on wood supply: – Continual in-planting of native, flood-tolerant tree species as needed between operating events. • Minimize downstream wood impacts with a new fish passage channel that will pass some wood pieces through a trash rack with 24-inch bar spacing during non-operational periods. • Minimize sediment transport and erosion risk with operational flow releases that maintain sediment transport capacity, clear out potential fine sediment deposits upstream of the FRE facility and reduce the potential for shoreline erosion during evacuation. • Minimize impacts to soil erosion and sediment or pollutant delivery to wetlands during tree removal activities by implementing standard BMPs for wetland protections.	• Reduce large wood supply.
Post-flood retention vegetation management	Removal of dead trees and management of tree size post-flood retention operations in some zones of inundation area.	• Reduced large wood supply from post-operations tree removal.	• No management of tree size proposed. Removal of dead trees would be limited to maintain the safety of the FRE facility structure and staff.	• Reduced large wood supply.
Periodic flood retention of major or greater floods and vegetation management	Implementation of the VMP: in-planting of flood-tolerant species; removal of dead trees and management of tree size in some zones of inundation area.	• Injury/mortality to low-mobility individuals of aquatic and terrestrial species from inundation, ground-disturbing activities, and tree removal. Disturbance to species from noise; potential decreased production from sensitive species such as marbled murrelets, bald eagles and other raptors.	• No management of tree size proposed. Removal of dead trees would be limited to maintain the safety of the FRE facility structure and staff. • Follow BMPs for protection of fish and wildlife species from noise.	• Some mortality of individuals with low mobility.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Fish passage during flood retention operations	Impeded upstream fish passage at the FRE facility site via the collection, handling, transfer, and release trap-and-transport system during flood retention and volitional downstream fish passage through the FRE facility outlet tunnel(s).	• Temporary reduced upstream fish passage survival for salmon and steelhead and resident fish above the FRE site during flood retention; and delayed downstream fish passage during flood retention.	• Minimize inundation-related impacts to fish passage: – Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event – Minimize inundation volume and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project. • Minimize impact to upstream fish passage with design of the FFPF to meet all NOAA Fisheries and WDFW passage criteria.	• No unavoidable effects.
Flood retention of major or greater floods at the FRE facility and subsequent drawdown operations	Inundation during major or greater flood event.	• Direct disturbance/injury/ mortality of some individuals of species with low mobility from inundation.	• Minimize inundation volume and retention duration to what is necessary to reduce effects from major or greater floods downstream of the project. • Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event.	• Some mortality of individuals with low mobility.
Flood retention of major or greater floods at the FRE facility and subsequent drawdown operations	Periodic temporary inundation of slopes and forest roads.	• Increased risk of landslides during impoundment event; increased slope instability and risk in erosion potential during drawdown of temporary pool; increased instability of forest roads.	• Implement temporary pool draw down rates to minimize risk. • Restoration of decommissioned roads used for construction includes slope stabilization, armoring, and drainage slope engineering to minimize erosion and sediment input to watershed. • Minimize erosion and water quality effects with continual in-planting and maintaining of native plant species suited to the inundation duration/depths experienced during flood event operations under the VMP.	• Some risk of landslides associated with roads.
Flood retention of major or greater floods at the FRE facility and subsequent drawdown operations	Reduction in peak flows downstream of the FRE facility during major and larger floods.	• Reduction in peak flows downstream of the FRE facility during major and larger floods.	• Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event. • Minimize inundation volume and retention duration to what is necessary to reduce effects from major or greater floods downstream of the project.	• Reduction in peak flows during major or greater floods as described in the Project's Purpose and Need.
Flood retention of major or greater floods at the FRE facility and subsequent drawdown operations	Retention of sediment upstream of the FRE facility during flood retention operations.	• Analysis indicates that the FRE facility will not affect 2 year flood flows which are capable of moving more sediments over time than greater flood flows.	• Minimize unnecessary flood retention by improving flow projection information, relying on an increased number of stream gages, and improving storm monitoring at the onset of a flood event. • Minimize inundation volume and retention duration to what is necessary to reduce impacts from major or greater floods downstream of the project. • Minimize sediment transport and erosion risk with operational flow releases that maintain sediment transport capacity, clear out potential fine sediment deposits upstream of the FRE facility, and reduce the potential for shoreline erosion during evacuation: – Minimize erosion and water quality effects with continual in-planting of native plant species suited to the inundation duration/depths experienced during flood event operations under the VMP.	• Unavoidable effect to fine sediment transport.
Earthquake	Earthquake greater than the design occurs at same time FRE Facility is impounding water.	• Adverse effect on communities, environment, and infrastructure downstream of the FRE facility.	• The facility design standard is Maximum Credible Earthquake. • The probability of a catastrophic earthquake co-occurring with a flood-retention at full pool is 1:2,500,000,000.	• Adverse effect on communities, environment, and infrastructure downstream of the FRE facility if earthquake greater than the design standard occurs during FRE flood retention.

ACTION	DEIS ENVIRONMENTAL DISTURBANCE	POTENTIAL EFFECT OF PROPOSED ACTION	AVOIDANCE AND MINIMIZATION MEASURES	POTENTIAL UNAVOIDABLE EFFECTS OF PROPOSED ACTION
Levee development	Loss/disturbance of habitat under levee.	• Permanent loss of wetlands (6.6 acres) and wetland buffer (44.2 acres).	• Avoid impacts as levee construction would be limited to the existing disturbed area.	• No unavoidable effects.

Notes:
The DEIS Environmental Disturbance is from the SEPA DEIS (Ecology 2020) and/or NEPA DEIS (Corps 2020) for the original FRE facility design and is intended to provide a crosswalk to the Applicant's proposed avoidance and minimization measures for the Proposed Action.

6.2.2 Vegetation Management Plan for the Temporary Inundation Pool

The VMP (Appendix D) was developed to minimize the loss of trees in the temporary reservoir area associated with construction and operation. The proposed FRE facility would be a 'flow-through' dam where the natural river flow always passes through the structure, except when it is operating to hold back flood water. In such a circumstance, clearing trees in the inundation area will not be required. The area of clearing immediately upstream of the proposed FRE facility will be only those required for routine inspection of the facilities and for the staging area for naturally downed wood material that would be collected and removed from the pool after a flood event. The revised VMP was developed after additional research and with a conservative approach to evaluating flood-related impacts on tree growth and survival based on currently understood maximum depths, durations, and extents within the three pool evacuation areas (Appendix D).

The existing forest condition upstream of the proposed FRE facility reflects the commercial harvest of Douglas fir, a tree species that would not be expected to exhibit high survival with flooding. Thus, the Applicant is proposing a VMP using other species more tolerant of temporary inundation to facilitate the maintenance of healthy streamside and upland vegetation and also minimize potential aquatic impacts, including shade loss and associated increased thermal input to rivers, loss of large wood material, increased runoff and erosion that might affect water quality, and reduction and/or degradation of habitat for a variety of terrestrial wildlife species including birds, mammals, and amphibians. More than 60 percent of the current habitat within the reservoir footprint consists of commercial timberlands, including about 16 percent of the inundation area that has been clear-cut within the past 10 years. Thus, the potential exists, through pre-project interventions, for some of these areas to be converted to flood-resistant habitats in advance of construction that will provide more value for wildlife than the current industrial forest condition.

The VMP focuses on i) accelerating the resilience of vegetation to flooding and ii) promoting the development of pre-inundation plant communities that will benefit the aquatic environment in the Chehalis River and its tributaries, maintain wetland functions, stabilize the soil surface to reduce erosion and runoff, and provide habitat value for terrestrial wildlife. During the construction and pre-operation periods, the VMP would allow for in-planting of native plant species. Stumps and standing wood would be left in place if it does not pose a risk to personnel and operations. Native flood-tolerant species would be planted, and invasive species would be managed to facilitate the establishment of a flood-tolerant riparian buffer.

The three evacuation areas (Initial Evacuation Area, Debris Management Evacuation Area, and Final Reservoir Evacuation Area) would be treated separately, as flooding depth and duration will vary considerably among these areas.

6.2.2.1 Key Elements of the VMP

The VMP includes the following avoidance and minimization measures.

- Maximize the retention of flood-tolerant trees and shrubs within the temporary inundation area.
- Limit initial tree and shrub removal to only areas necessary for construction access and staging areas and near the proposed FRE facility for inspection purposes.
- Proactively plant 71 acres of the Final Reservoir Evacuation Area and 144 acres of the Debris Management Evacuation Area to enhance resilience and recovery of deciduous riparian woodland and shrubland communities. Fast growing, flood-tolerant shrub and tree species will be planted at the onset of construction to allow them to grow and begin producing shade prior to proposed FRE facility operations. Deciduous riparian shrubs and trees such as willow species would be expected to take hold and grow rapidly in these areas. Herbaceous species will also be seeded to help stabilize soil and reduce runoff and erosion.
- Proactively plant 324 acres of the Initial Evacuation Area to attain mixed deciduous transitional, mixed coniferous, deciduous riparian forest and shrubland communities. Many trees in this area are expected to survive inundation, but there may be an opportunity for inplanting during the pre-operation period due to the recent timber harvest. Planting tree species that are more tolerant of flooding such as black cottonwood, red alder, and red cedar will facilitate conversion to a more flood-tolerant forest before the first flood event.
- Fast-growing, flood-tolerant shrub and tree species, such as willow species, will be planted at the onset of construction to allow them to grow and begin producing shade before FRE facility operations.
- Plant a variety of species expected to have success at each inundation level and monitor the success of those species.
- Over time, transition to exclusive use of native, site-adapted, and flood-tolerant species for planting, potentially with seeds or cuttings sourced from the site.
- Survey and monitor the temporary reservoir area following flood retention events and replant areas with high mortality as needed during the planting season (October-March).
- Retain select trees that do not survive inundation as legacy habitat components (i.e., snags, root wads, LWM).
- Retain the slash generated from tree removal on-site where practical to augment habitat enhancement efforts.
- Remove dead trees supplemental to wildlife habitat needs for the construction of instream aquatic habitat mitigation measures.
- Implement an adaptive management plan to provide for the ongoing monitoring of vegetation succession to ensure the survival of plants and desired canopy cover.

Where tree removal is required for construction staging it would be guided by the following BMPs to avoid and minimize the potential effect on aquatic and riparian functions, wetland functions, and temporal loss of tree canopy.

- Retention of snags where feasible.
- Leave any retained trees with large root systems embedded in the bank.
- Remove trees while retaining stumps, minimizing ground disturbance and potential sedimentation.
- Avoid disturbing stumps and root systems and any logs embedded in the bank.
- Leave high stumps as necessary to prevent felled and bucked large wood material from entering the water.
- Avoid disturbing understory wetland, riparian, and upland vegetation.
- Use reasonable care during timber yarding to minimize damage to any vegetation providing shade to the stream or open water areas, and to minimize disturbance of understory vegetation, stumps, and roots.
- Minimize the release of sediment to waters downstream from the yarding activity.
- Conduct tree removals from existing access roads to the greatest extent feasible to avoid potential effect on adjacent understory vegetation.
- Avoid burning removed trees.

Implementation of the VMP following the above measures will minimize the number of trees cut as well as reduce tree mortality associated with inundation during FRE facility operation. Maintaining trees in riparian and upland habitat will reduce potential impacts associated with shade loss and subsequent increased solar input to the Chehalis River and its tributaries in the inundation area.

In addition to reducing potential thermal impacts on water temperature, implementation of the VMP would help to minimize impacts associated with run-off, erosion, turbidity, and wildlife habitat, as well as terrestrial and aquatic habitat degradation. The Applicant would begin planting flood-tolerant species at the start of construction, allowing the flood-tolerant trees and shrubs to grow before FRE facility operations to reduce impacts before they occur. The VMP would transition large blocks of commercial forest that are maintained to maximize the short-term growth of one species, Douglas fir, to more complex and diverse forest habitats (Table 6.2-1). These native forest habitats would include both structural and plant diversity and would minimize wildlife habitat degradation (Table 6.2-1). The presence of diverse native plants in the understory would improve capture and retention of water and reduce erosion. The complex forest condition would support increased faunal biodiversity and associated nutrient cycling that occurs on the forest floor. These native forests, with a multi-layered canopy, would provide localized temperature reductions compared to clear cuts and commercial stands with stand-age less than 10 years that currently occupies about 16 percent of the current landscape upstream of the proposed FRE facility.

With the implementation of the VMP, wildlife habitat types would improve as compared to the DEIS impact condition that assumed 90 percent tree removal. Following the VMP, the Final Evacuation Area would be dominated by open herbaceous habitats and shrublands, the Debris Management Area would be dominated by shrublands, and in the Initial Evacuation Area flood-tolerant tree species would be expected to survive and maintain forested habitats, though tree survival would be dependent on flood depth and duration (Appendix D). These future habitats, which provide numerous additional functions beyond wildlife habitat, would primarily benefit wildlife species associated with open areas, shrublands, and open-canopy mixed forests (Appendix D). Efforts would be made to reestablish vegetation as quickly as possible after inundation events by planting fast-growing species, and to the extent possible, downed logs, stumps, and snags would be retained for wildlife habitat, though these features are likely to be from younger trees.

With the implementation of the VMP, 29 percent of species-by-habitat combinations assessed in the wildlife habitat evaluation for the FRE reservoir would be considered moderate or high value (Appendix D). Elk, spotted skunks, and black-tailed deer would be expected to see benefit with the expansion of open, shrubby, and mixed forest habitats. Birds that benefit from open habitats and open-canopy forests, such as western bluebirds and rufous hummingbirds, could see some improvements in overall habitat value, while a species like the golden eagle which can benefit from both clear-cuts and herbaceous meadows/agricultural land, may not see a big change in habitat value. Mitigation activities would also prioritize the creation of downed terrestrial LWM, which would benefit amphibians and western spotted skunks (Appendix F).

6.2.2.2 Effectiveness of the VMP

The DEIS attributed increased summer water temperatures within the Chehalis River upstream of the FRE and in Crim Creek to tree mortality and the loss of shade. In turn, shade restoration is an accepted method for water temperature reduction in thermally impacted rivers (Dugdale et al. 2018; Trimmel at al. 2018) including locations throughout the Pacific Northwest (Fuller et al. 2022). The potential for effective shade cooling is related to the interception of solar input that would otherwise increase water temperatures. For rivers, the effectiveness is limited by the relationship between maximum tree height and the river bankfull width, tree height needs to be 1.4 times the width (Ecology 2007). A haphazard check on bankfull width of the Chehalis River channel in the mitigation area indicates that this condition can be meet for the mainstem as well as major tributaries based on native riparian species present along the river.

To evaluate how the VMP would likely affect riparian shade and solar input to the river, an analysis of current and future with-VMP riparian conditions has been completed by the Applicant. The Applicant developed a shade model for the Mitigation Area using the Shade-a-lator modeling tool developed by the Oregon Department of Water Quality (Boyd and Kasper 2003). The model predicted the solar input reaching streams in the inundation area under five scenarios: i) existing conditions analyzed in the SEPA DEIS; ii) 2023 conditions that update the SEPA DEIS by including recent timber harvest; iii) a with-project condition that assumed a 100 percent loss of trees and shade (SEPA DEIS impact); iv) a with-project condition of riparian vegetation maintained through implementation of the VMP 1 year after initial operation; and v) a with-project condition of riparian vegetation maintained through implementation of the VMP 5 years after initial operation. The model calculated thermal units in terms of average kcal/day between July 15 and August 31 as a measure of the amount of heat from the sun that reaches the river. Based on seasonal sun angle, the slope of the canyons around the reservoir, riparian tree heights, and the river's width and orientation, the model calculated how much shade would block solar input to the river. Project impacts were characterized as the difference in shade among these scenarios (Table 6.2-2). The model estimated shade within 82-foot-long (25-meter) river reaches, a resolution finer than that of the DEISs' CE-QUAL-W2 temperature model, which evaluated shade across reaches ranging from 492 feet to 1,312 feet (150 to 400 meters). The results of the model are presented in Table 6.2-2, and the model framework is described in detail in Appendix G. The model predicted that the shade maintained with the implementation of the VMP will appreciably minimize any increase in the solar thermal load to the river due to riparian vegetation changes and associated shade losses.

The shade model results indicated that shade loss impact 5 years after initial operation would be greater than 1 year after; thus, that is the VMP scenario used in further analysis. Model results from the VMP-5 scenario indicated a minimization of shade-related thermal load by 112,019,000 average kcal/day, a 24% reduction from the SEPA DEIS clear cut scenario. With the VMP in place the shade related thermal impact to the river would be reduced to 360,048,000 average kcal/day. Results of the shade model downstream of the FRE facility demonstrated an estimated shade supply of 1,555,393,767 average kcal/day available from the mainstem Chehalis River between the FRE facility and town of Chehalis with more than 3 billion average kcal/day supply available when Bunker Creek, South Fork Chehalis River and the Newaukum River are included in the analysis.

This minimization of shade loss, and associated water temperature increases, achieved by the VMP will be evident both before and after FRE facility operation. Specifically, modeling confirms that implementing the VMP and re-establishing intact riparian corridors along the river downstream period would minimize loss of shade, the potential for increased thermal solar input to the river, and potential for downstream temperature increases caused by tree mortality within the inundation area.

Table 6.2-2
Change in Modeled Solar Input Immediately Downstream of the FRE Facility Associated with Shade Scenarios. Bold Font Indicates Modeled Residual Impact for Mitigation.

	SHADE SCENARIO	MODELED THERMAL LOAD AT FRE FACILITY (RM 108.4)
COMPARISON	ASSUMPTIONS	CHANGE IN AVERAGE KILOCALORIES/DAY (JULY 15-AUGUST 31)
SEPA DEIS	100% loss of trees for shade compared to DEIS baseline	503,925,000
Updated DEIS	100% loss of trees for shade, compared to 2023 harvest conditions	472,067,000
Vegetation Management Plan-1	1 year post-operation, compared to 2023 harvest conditions	349,666,000
Vegetation Management Plan-5	5 years post-operation, compared to 2023 harvest conditions	**360,048,000**

Notes:
Thermal impact presented in DEIS included both the FRE facility and climate change.

6.2.3 FRE Operation Timing and Flow Releases

As described in Section 2, full operation of the FRE would fill the temporary reservoir to for a period of up to 32 days. During this period redds within the Chinook salmon spawning habitat would be inundated, particularly the habitat just downstream of Fisk Falls. The Applicant is developing inundation measures to reduce the duration of inundation in this area. Two sets of sensitivity analyses were performed to evaluate potential operational modifications to minimize these effects. First, Kleinschmidt evaluated alternative operations that involved simply increasing the minimum controlled release flow and keeping it steady until the reservoir was drained. Different levels of flow releases were simulated, and the duration of inundation was computed at different locations within the primary spawning reach below Fisk Falls. Next, HDR modified the proposed operations plan to evaluate the effect of raising the initial 300 cfs minimum controlled release flow to larger values before resuming operations after the flood peak. These analyses indicated a potential reduction in inundation time within the core spawning reach by 2-3 days.

In addition, the operations would be designed to avoid impacts to multiple year cohorts of salmon returning to spawn from the same production year class. This will be accomplished by evaluating operational refinements to maximize the number of years between operations. The number to be specified is uncertain at present. Based on various conceptual frameworks developed for Chinook salmon, coho salmon, and steelhead population viability criteria and recovery strategies, the interval is expected to be somewhere between 5 and 10 years (e.g., Lindley et al. 2007; Wainwright et al. 2008;

Williams et al. 2016; Capelli 2024). The intervening time will depend on various considerations including particularly:

- The extent to which: i) FRE facility operations reduce redd scour mortality downstream; and ii) impacts to spawning habitat upstream with operation are offset by scour mortality in the absence of operation.
- Whether fish returning to spawn in the upper Chehalis River would be classified as a "Core 3" (low intrinsic potential, does not meet all NOAA Fisheries viability criteria) versus "Core 2" (intermediate intrinsic potential and does meet all criteria) subpopulation (NOAA Fisheries 2012; Boughton et al. 2022). Given the consistently small fraction of returning spawners within the broader Chehalis River watershed and apparent greater vulnerability to scour mortality because of the confined, high energy, gravel-poor hydraulic-geomorphic setting, there is uncertainty regarding the upper Chehalis spawners classification and may not meet criteria as an independent population (cf. Ruckelshaus et al. 2006).
- The minimum number of subpopulations in a given year required to not be affected significantly by a catastrophic event. For example: i) Capelli (2024) reported that a minimum number (3 to 4) of steelhead subpopulations within southern California Biogeographic Population Groups (BPGs) was needed to withstand catastrophic event threats to; and ii) WDFW (2021) noted the Puget Sound Chinook Salmon Recovery Plan calling for two to four populations being at low risk of extinction and at least one population from each major genetic and life history group being present within a BPG. Spawner escapement data from WDFW indicate there are at least two to three spring Chinook and four to five fall Chinook subpopulations in the Chehalis River basin, with smaller numbers distributed across the rest of the basin (Litz et al. 2023), which may potentially offset periodic impacts to upper Chehalis River spawning success.

6.3 Restoration

The Applicant proposes to restore and revegetate all areas cleared for construction staging and access that are not part of the permanent FRE facility, including quarries. The restoration area includes approximately 56.6 acres of stream buffer, approximately 90 acres of upland habitat, and 7,803 linear feet (1.48 miles) of temporary gravel access roads that would be built on the active construction site. Temporary roads would also provide access to the selected quarry site and material processing and production areas. This section briefly summarizes the Applicant's proposed plans for restoration. A more detailed description of proposed restoration plans is presented in Appendix H.

Vegetation communities that would be disturbed during road building, quarry operations, or construction would be graded, topsoiled, and replanted following construction. More than 90% of the affected area is currently commercial timberlands, which would be restored to shrub-scrub within a few years of planting with native species, and to a natural forest as succession progressed through time.

During construction, the Chehalis River and a portion of Crim Creek will be rerouted into a temporary channel to bypass stream flow around the construction area and provide volitional fish passage. Post-construction, the temporary channel would be re-graded, backfilled, and armored to form the permanent engineered channel, as described in Appendix K of HDR's RPDR (HDR 2024). Riparian plantings would immediately follow stream channel restoration during Phase 3 of the construction schedule (Appendix K of HDR 2024), and consist of the same suite of native vegetation described in the VMP (Appendix D) with initial plantings of fast-growing species followed by successional plantings of slower growing, shade providing species.

Road decommissioning of roads is proposed for all temporary roads including restoration to pre-construction condition. The priority for restoration of disturbed ground is to control the input of sediment to waterways by returning soils to pre-disturbance conditions and establishing vegetation. Decommissioning of roads outside of the inundation pool includes the following steps: i) excavation and grading to match topography and drainage; ii) scarification to reduce runoff and retain topsoil; iii) placement of fabric coir and topsoil; iv) hydroseed and planting of native species; and v) addition of roughness features such as downed logs to minimize erosion. For temporary roads within the inundation pool, the process is the same except that fast-growing flood-tolerant species would be planted.

Where decommissioned roads cross streams or drainage areas, the implementation of additional measures to stabilize the area to avoid both point-source and non-point-source runoff. To reduce this risk, all temporary and unstable fill must be removed along with the culvert to prevent these materials from being delivered into the stream through slope failure, and the remaining slopes must not exceed a 50% gradient, be able to pass a 100-year flood without erosion and be planted with native vegetation to offer further slope stability. Guidelines for road abandonment provided by United States Department of Agriculture will be followed (USDA 2018).

Quarry site restoration is proposed for all quarries developed during the construction phases of the FRE and will include an assessment of options for developing specific habitat types that will provide valuable impact mitigation. Reclamation planning will follow BMPs for surface mining for Oregon and Washington (Norman et al. 1997), and will focus on the development of depressional wetlands, coniferous forests, and shrubland.

6.4 Mitigation

For potential impacts that cannot be avoided or minimized, site-specific mitigation actions are proposed as part of this MP. These mitigation actions correspond directly to potential effects identified in Section 5 and can be categorized by the five mitigation plans requested by Ecology: Fish and Aquatic Species and Habitat, Riparian and Stream Buffer Expansion, Large Wood Material Recruitment and Placement, Wildlife Habitat Conservation, and Surface Water Quality. In turn, the Applicant's proposed mitigation action types correspond directly to mitigation plans (Table 6.4-1). The following two sections of this document, Section 7 – Mitigation Site Selection and Section 8 – Mitigation Plan, provide further detail on the site-specific mitigation measures that are being proposed under each mitigation plan and action type.

Table 6.4-1
Descriptions of Mitigation Action Type Categories Used in Mitigation Plans.

MITIGATION PLAN	ACTION TYPE	DESCRIPTION
Fish and Aquatic Species and Habitats	Off-Channel Enhancement	Off-channel habitat enhancements including side channel and floodplain actions to reconnect, enhance, and expand off-channel habitat
	Floodplain Connectivity and Reforestation	Measures to increase the frequency and duration of overbank flows onto the floodplain
	Spawning Habitat Enhancement	Instream wood/rock structures designed to provide hydraulic roughness and promote accumulation and retention of salmonid spawning gravels
	Tributary Habitat Enhancement	Improvements to enhance in-channel and riparian complexity of tributaries where access impediments are removed
	Tributary Access	Open access to tributary habitats through barrier removal and rehabilitation of the impacted stream reach
Riparian and Stream Buffer Expansion	Riparian Habitat Enhancement	Expand and enhance the riparian buffer downstream of the FRE by planting native shrubs and trees to increase shading, bank stability, nutrient cycling, habitat complexity, and habitat value for native species
Large Wood Material Recruitment and Replacement	Riparian Habitat Enhancement	Native tree plantings for riparian habitat enhancement downstream of FRE to increase mature wood available for recruitment in the future
	Wood Placement	Enhance habitat diversity and complexity and improve ecological function using in-channel wood for aquatic habitat enhancements
	Wood Salvage and Supply	Enhance wood supply downstream of FRE with wood salvaged during construction and operation
Wildlife Habitat Conservation	Forest Conversion	Convert upland industrial forest to diverse successional old growth forests
	Wetland and Wetland Buffer Enhancement	Creation of diverse wetland and wetland buffer to support increased biodiversity
Surface Water Quality	Riparian Shade Enhancement	Expand and enhance degraded riparian habitats downstream of the FRE to increase shade and reduce potential for thermal loading to the river
	Forest Conversion	Establishment of native diverse forests and forestry roads would be decommissioned or subject to restricted use
Wetland Enhancement	Wetland Enhancement	Enhancement, restoration, or expansion of floodplain wetlands to benefit wildlife species and increase water table/exchange between rivers and wetlands

6.5 Mitigation Goals

The goal of this Revised Mitigation Plan is to identify feasible mitigation to offset potential project effects that have not been avoided or minimized. To account for uncertainty in the mitigation process some multiple of the residual project effect is proposed as mitigation. There is no set of standardized mitigation ratios for aquatic or terrestrial impacts and thus mitigation ratios will vary by impact. Bradford suggested that a multiplier of 1.5:1 or 2.5:1 is sufficient for addressing uncertainty when offsetting impacts on freshwater fish productivity (Bradford 2017). Thus, we applied a mitigation ratio of 2.5:1 for aquatic habitat mitigation. Mitigation ratios for wetlands are prescribed by regulation and vary both by impact and mitigation type (Table 6.5-1). Mitigation ratios for other impacts, including wildlife habitat, stream buffers and surface water quality, are presented in Section 8.

Table 6.5-1
Mitigation Ratios for Wetlands by Impact and Mitigation Type.

IMPACT TYPE	MITIGATION TYPE	MITIGATION RATIO
Category II Wetland	Preservation	12:1
	Enhancement	12:1
	Restoration/Creation	3:1
Category III Wetland	Preservation	8:1
	Enhancement	8:1
	Restoration/Creation	2:1
Buffer	Establish Wetland Buffer	1:1

7 MITIGATION SITE SELECTION

7.1 Mitigation Opportunities

Based on the assessment of the Proposed Action described in the SEPA DEIS, impact refinements and avoidance and minimization measures identified in Sections 5 and 6 of this report, and consideration of liming factors in the upper Chehalis River, the Applicant developed mitigation actions to offset potential effects that have a reasonable likelihood of occurrence. Mitigation Actions proposed in this proposed FRE facility Mitigation Plan are presented in this section by action category, with some categories addressing multiple impact categories and/or limiting factors. This section describes the feasibility assessments that led to the conceptual designs for site-specific mitigation actions considered the most likely to be feasible. We also present a summary of landowner engagement efforts in support of this mitigation. More detailed descriptions of site-specific mitigation plans are provided in Section 8.0 – Mitigation Plan.

7.2 Framework for Mitigation Site Selection

The Applicant completed several analyses to evaluate the feasibility of implementing mitigation actions at candidate sites and to refine mitigation concepts. Different approaches were taken depending on the type of impact and location, for example, whether the action would be implemented along the mainstem Chehalis River and its floodplain or in the vicinity of the temporary inundation pool (on-site), or in tributaries downstream of the proposed FRE facility (off-site). The general procedure was to identify mitigation project types, assess feasibility in terms of both function and constructability where appropriate, evaluate potential benefits, and then develop mitigation concepts that were determined to be feasible and beneficial. Functional feasibility included consideration of both long-term performance and persistence. For aquatic habitat enhancements, constructability was determined by site accessibility as controlled by both physical conditions and local geophysical and hydraulic conditions. Willing landowner engagement also was key to advancing sites. The resulting mitigation action type and impact category addressed by each site-selection analysis is summarized in Table 7.2-1.

While not a selection criterion, opportunities for stacking multiple mitigation actions were assessed at mitigation sites. As a result, potential locations for co-locating mitigation actions for wetlands, riparian and stream buffer, surface water quality, wildlife mitigation, and fish and aquatic habitat were identified. Co-locating mitigation actions is an ecosystem-based approach that helps to correct for limiting factors in the upper basin and increase ecological lift potential.

Table 7.2-1
Analyses Completed for Mitigation Site Selection by Action Type and Impacts the Actions Would Address.

SITE-SELECTION ANALYSIS	MITIGATION ACTION TYPE	IMPACT CATEGORY ADDRESSED
Forest conversion parcel assessment	Forest conversion	• Decreased habitat and habitat value for wildlife. • Loss of tree and stream shading and effects on water temperature and water quality. • Increased risk of erosion/landslides. • Reduced capacity to capture and filter sediment upslope from the temporary reservoir. • Increased potential for colonization by non-native/invasive species.
Geomorphic analyses	Aquatic habitat enhancements	• Loss and degradation of stream habitat for native fish and amphibians. • Decreased aquatic habitat potential within and downstream of the proposed FRE facility including habitat-forming processes. • Loss of future wood recruitment. • Reduction of stream habitat complexity within and downstream of the proposed FRE facility.
Habitat access assessment	Habitat access improvement and instream modifications	• Periodic and Temporary Conversion of stream habitat for native species spawning, incubation, rearing, and breeding.
Riparian shade analysis	Riparian enhancement and riparian planting	• Loss of riparian function. • Loss of shade resulting in increased water temperature and lower dissolved oxygen. • Localized increase in runoff. • Reduced bank stability, and increased risk of erosion. • Reduced capacity to capture and filter sediment. • Increased potential for non-native/invasive colonization. • Reduced habitat for wildlife species.

7.3 Mitigation Site Selection

7.3.1 Forest Conversion Parcel Assessment

Potential impacts of the Proposed Action upstream of the FRE facility include upland habitat disturbance to wildlife species and more specifically the potential the loss of individuals unable to move during inundation and habitat degradation. Additional potential impacts included increased risk of landslide, erosion, and siltation within and upslope of the inundation area and related water quality impacts; and increased risk of non-native/invasive species colonizing disturbed habitat, all of which could reduce habitat value. To mitigate these potential impacts, the Applicant evaluated the feasibility of transitioning existing industrial timberlands into diverse successional forests that support high-value wildlife habitat and re-establish ecological processes that would reduce risks associated with landslides, runoff and erosion, and increased water temperature.

The Applicant analyzed individual forest parcels relative to their capacity to mitigate these potential types of impact. The goal of this analysis was to prioritize areas where strategic management interventions and conversion of the commercially managed Douglas-fir forest would best mitigate impacts and provide necessary ecological lift by combining upland forest conversion with mitigation actions downslope, including the VMP and aquatic habitats enhancements. The model used for this analysis was the GIS-based Technique for Order Preference by Similarity of Ideal Solution (TOPSIS). TOPSIS provided a transparent structure for assessing which forest parcels would be best suited to meet the objective of mitigating potential proposed FRE facility impacts. Appendix I describes, in more detail, the model structure and parcel evaluation criteria used to identify priority parcels for forest conversion. A summary of the modeling approach follows.

The TOPSIS model was applied to parcels of commercial forest in the headwaters basin of the Chehalis River within a 20,688-acre area defined by the availability of geospatial data sets, the Lewis County line, distance from the mainstem river, and potential aquatic habitat mitigation actions. The resulting overall area was divided into 2,276 subunits, each with an area corresponding roughly to one sixty-fourth (1/64) of a Public Land Survey System (PLSS) section, averaging around 9.1 acres. Land transactions typically occur following PLSS sections, or fractions of sections, and this threshold area subdivision achieved a sufficiently fine resolution for this analysis. The resulting areal subdivisions of the sections were then referred to as Forest Conversion Units (FCUs).

Criteria were then identified for assessing and ranking each FCU’s suitability for forest conversion mitigation based on landscape features that influenced habitat values that might be impacted as specified in the SEPA and NEPA DEISs. Seven relevant, readily determined characteristics were defined in the analysis as follows:

1. Washington Department of Natural Resources Forest Practices Site Classification;
2. Topographic slope;
3. Proximity to proposed maximum temporary impoundment area;
4. Proximity to fish-bearing streams;
5. Proximity to anadromous salmon redds;
6. Forest stand age; and
7. Presence of terminal logging roads.

The TOPSIS model calculated the distance of each FCU from an ideal or target condition with respect to all seven characteristics to yield a relative ranking. In general, the ideal FCU would be near fish-bearing streams and anadromous salmon redds, but outside of existing protected riparian buffers. It would have a moderate slope related to intercept runoff and any sediment moving downstream, and the ability to facilitate future forest management and control of invasive species. It would be composed of a relatively young forest stand and have a moderate site class related to its growth potential, as well as the practicability of acquisition. The ideal parcel would also have a high relative proportion of terminal road segments that could potentially be decommissioned without affecting the land use of surrounding parcels or reassigned to a “mitigation maintenance only” use category.

Figure 7.3-1 depicts the ranked output of the TOPSIS model. Units closest to the ideal or target condition were those ranked in the upper 80 percent. The units targeted for potential inclusion in the Forest Conversion mitigation block were those closest to a normalized value of 1 (shaded green), while the worst-performing alternatives were those closer to 0 (shaded in red). The model resulted in classifying 456 FCUs within the top 80th percentile of all units evaluated, covering approximately 3,664 acres. After considering maintaining access to adjacent commercial forest parcels, and which units could be consolidated, a proposed Forest Conversion mitigation block was identified that spanned 1,921 acres. (Figure 7.3-2). Wildlife habitat treatments within this block are described in Appendix F.

Figure 7.3-1
Distance to Best Designation for Each Parcel in the Forest Conversion Assessment with the TOPSIS Model Based on a Combination of All Criteria. Color Indicates the Percentile Rank of the Unit, with Higher Percentiles Being Closer to the Ideal Unit for Mitigation.

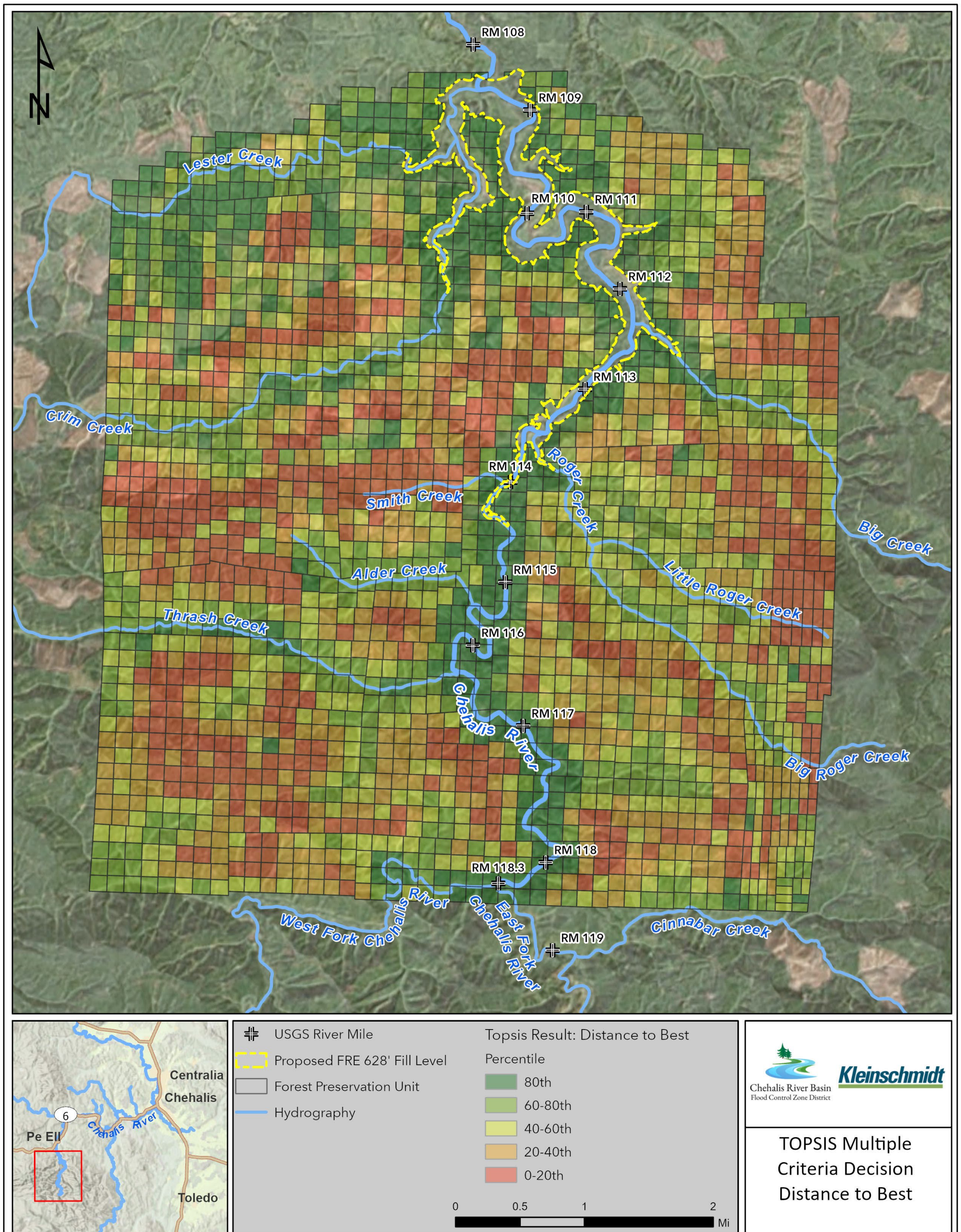
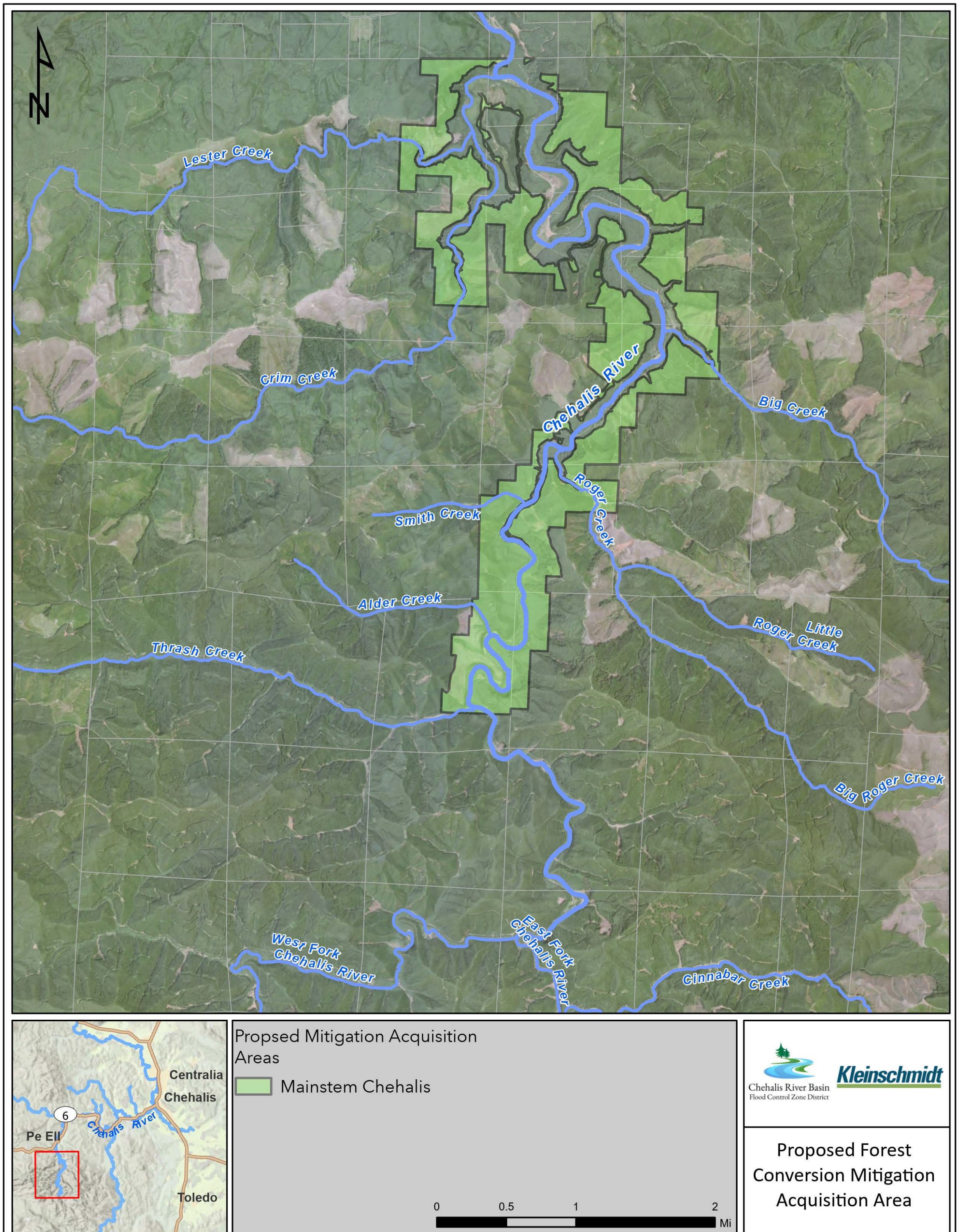


Figure 7.3-2
Proposed Block for Forest Conversion Mitigation.



7.3.2 Feasibility Assessment for Fish and Aquatic Species and Habitat Mitigation

Before developing concept designs, each opportunity for an aquatic enhancement project along the mainstem Chehalis River channel and floodplain was assessed for its likelihood of functioning as intended and persisting under prevailing reach scale flooding and sedimentation processes at the proposed general location. Projects that did not meet those conditions were considered infeasible and unlikely to be effective. The assessment involved first quantifying key flooding and geomorphic characteristics, followed by identifying how those characteristics influence the function and persistence of a specific project type. Three key reach-scale processes were evaluated in this context, including the frequency of overbank flow and long-term lateral and vertical stability of the channel, to qualify whether a particular mitigation action would be more or less likely to function as intended and persist at a given location. Other process-based indicators included whether a site was located in a reach with more vs. fewer gravel bar deposits, and if there was a larger-scale slope break in the vicinity. The rationales for concluding that a specific mitigation action would likely be compatible with characteristic reach scale processes, and corresponding mitigation sites, are summarized below.

- **Instream Modifications** using large wood and boulders to create and maintain instream habitat complexity would be expected to provide instream habitat structure and local scour and would persist longer in unconfined sub-reaches with more frequent floodplain connectivity where hydraulic forces on the structure during floods are lower. Sites should also be associated with limited lateral and vertical channel instability over the long term such that risks of scouring out, burial, or abandonment are lower. This action can be implemented at any such site that is accessible to heavy equipment in reaches where habitat complexity is considered limiting to the production and survival of fish.
- **Spawning Habitat Enhancement** sites were selected after consideration of historic patterns in mainstem spawning activity, assessments of current conditions from RM 118 (upstream of Fisk Falls) downstream to Rainbow Falls in combination with expectations of proposed FRE facility operation, and likely inundation of the temporary pool. Constraints to site selection included the availability of a sufficient, long-term gravel supply from upstream, and that gravel retention area that is not prone to scour. Site suitability for trapping spawning gravel using instream structures was determined based on predicted sediment aggradation tendency using the DEISs' hydraulic model (sites downstream of the proposed FRE facility only), whether the site already contained suitably sized spawning gravels and cobbles in reaches where Chinook spawning had been recorded previously (all sites), and assessment of the persistence of gravel patches (all sites). Candidate sites for gravel retention were identified in both the mainstem Chehalis River and Crim Creek upstream of the proposed FRE facility site. Each site and the respective prescribed design elements are presented in Table 7.3-1.

Table 7.3-1
Mitigation Actions and Benefits for Spawning Habitat Enhancement Sites.

SITE (RM)	MITIGATION ACTION	PROJECTED BENEFIT
102.2 and 102.4	Spawning gravel deposition, habitat complexity	• Rearing habitat for Chinook, coho, and steelhead juveniles, resident trout, sculpins, and native fishes (cyprinids). • Enhanced and extended spawning habitat for Chinook salmon and steelhead. • Potential off-channel habitat for amphibian spawning.
111.7	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead with the 2-mile reach below Fisk Falls.
113.2	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead with the 2-mile reach below Fisk Falls.
114.7	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead upstream of Fisk Falls and the temporary inundation area.
115.7	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead upstream of Fisk Falls and the temporary inundation area.
116.7	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead upstream of Fisk Falls and the temporary inundation area.
Crim Creek	Spawning gravel deposition	• Enhanced and expanded spawning habitat for Chinook and steelhead within the temporary inundation area in a generally gravel-poor tributary.

- **Off-channel Habitat Access Enhancements** include side channel and floodplain actions to reconnect, enhance, and expand off-channel habitat. Sites were selected based on the natural tendency to occur, the likelihood of providing suitable habitat, and the higher frequency of floodplain flow path engagement at the 2-year flood level. The likelihood for sub-reach aggradation and a greater propensity for channel migration was also considered, resulting in the selection of four mainstem sites for mitigation action (Table 7.3-2).

Table 7.3-2
Mitigation Actions and Benefits for Off-Channel Habitat Access Enhancements.

SITE (RM)	MITIGATION ACTION	PROJECTED BENEFIT
82.6	Increase off-channel habitat access	• Rearing habitat for coho juveniles and native fishes (cyprinids). • Habitat for amphibian life stages.
85.6	Maintain/enlarge split channel	• Rearing habitat for Chinook salmon and steelhead juveniles, resident trout, and native fishes (cyprinids).
87.8-89.1	Maintain/enlarge split flow side channels, improve complexity	• Rearing habitat for Chinook salmon and steelhead juveniles, resident trout, and native fishes (cyprinids). • Habitat for amphibian life stages.
104.7-104.8	Re-engage the Former main channel as a side channel	• Rearing habitat for Chinook salmon and steelhead juveniles, resident trout, and native fishes (cyprinids). • Potentially new spawning habitat for Chinook salmon and steelhead. • Habitat for amphibian life stages.

- **Floodplain Connectivity/Reforestation** can increase the frequency and duration of overbank flows onto the floodplain, thereby promoting the re-establishment and maintenance of riparian and floodplain forests which in turn function to reduce summer water temperature, provide wildlife and wetland habitat, and are a source of future large wood to the channel. Riparian plantings are included as part of the action. Site selection considered that floodplain connectivity functions better and lasts longer when overbank flows and hydraulic connectivity occur at a 2-year flood level to deliver water to riparian roots. Mitigation actions are proposed at two sites (in unconfined alluvial channel reaches) to promote the increased frequency of hydraulic connectivity of floodplain habitats, without substantially affecting larger flood stages (Table 7.3-3).

Table 7.3-3
Mitigation Actions and Benefits for Floodplain Connectivity/Reforestation.

SITE (RM)	MITIGATION ACTIONS	PROJECTED BENEFIT
84.5	Increase floodplain channel engagement	• With reforestation, a future source of LWM to improve habitat complexity for Chinook salmon and steelhead juveniles, resident trout, and native fishes (cyprinids). • Habitat for amphibian life stages.
87.6-89.3	Increase floodplain channel engagement/ Restore forest along relic channels	• With reforestation, a future source of LWM to improve habitat complexity for Chinook salmon and steelhead juveniles, resident trout, and native fishes (cyprinids). • Habitat for amphibian life stages and other wildlife.

More detailed assessments of site-specific function and persistence of project types, sites, and anticipated benefits are provided in Appendix J.

7.3.3 Off-Site Aquatic Habitat Complexity and Access Enhancements

Mitigation for increased access to aquatic habitat in tributaries includes enhancing tributary habitats at strategic locations along the mainstem river to provide off-mainstem rearing habitat for juvenile salmonids with greater habitat complexity and lower summer water temperatures and improving fish passage to increase off-site aquatic habitat access.

- **Tributary Habitat Enhancements** were evaluated in the upper Chehalis River between the proposed FRE facility site and the Newaukum River for opportunities to provide native fishes with suitable (cooler) summer habitat that is accessible from the Chehalis River mainstem. Feasibility was primarily contingent on landowner willingness, and mitigation actions were identified specific to a given parcel to address limiting habitat conditions. Three tributary habitat enhancements are proposed (Table 7.3-4).

Table 7.3-4
Mitigation Actions and Benefits for Tributary Habitat Enhancement Sites.

SITE (RM)	MITIGATION ACTION	PROJECTED BENEFIT
Mill Creek	• Enlarge Channel Connecting Mill Creek to Chehalis River	• Rearing habitat for Chinook salmon, coho salmon, and steelhead juveniles, resident trout, sculpins, and native fishes (cyprinids) • Spawning habitat for coho upstream
Bunker Creek	• Excavate Inset Floodplain • Install LWM for Complexity • Plant Native Trees • Remove Culvert[1]	• Rearing and summer thermal refuge habitat for Chinook salmon, coho salmon, and steelhead juveniles, resident trout species, and native fishes (cyprinids) • Spawning habitat for coho salmon and steelhead • Habitat for native mussels and amphibians
87.6-89.3	• Reconnect Relic Channel in Forested Floodplain • Consolidate Tributaries with Channel Excavation at the Base of Willapa Hill Trail to Connect Perennial and Ephemeral Tributaries to a Fish-accessible Confluence	• Off-channel tributary rearing and summer thermal refuge habitat for Chinook salmon, coho salmon, and steelhead juveniles, resident trout species, and native fishes (cyprinids) • Spawning, rearing, and adult habitat for native amphibians

Notes:
1. Culvert removal is further discussed below.

- **Fish Passage Enhancement** opportunities were assessed by identifying total or highly restrictive barriers to anadromous fish passage in WDFW's database, and those that partially restrict access to significant amounts of linear habitat. The Applicant then evaluated the nature of the barrier (perched, depth, or velocity limited), the estimated degree of passage blocked and associated benefit, length of upstream habitat increased, stream gradient, the number of barriers in the tributary basin, and road conditions. Landowner willingness to engage and allow access for site-specific data collection was another factor in site selection, resulting in nineteen culverts selected as candidates for mitigation (Table 7.3-5). Not all of the culverts listed are necessarily needed to meet mitigation requirements; only Priority 1 sites are proposed as mitigation to open access to 62 kilometers (km) of fish habitat (Section 8).

Table 7.3-5

List of Candidate Barrier Corrections in the Chehalis River Basin That Could Provide Substantial to Moderate Mitigation for Impacts Associated with the Construction and Operation of the Proposed FRE Facility. Culverts Are Grouped by Priority for Mitigation. Priority 2 Culverts Are Provided As Potential Backup to Replace a Priority 1 Culvert in the Event Circumstances Render Its Replacement Infeasible. Culverts in Italics Remain to Be Visited and Verified.

MITIGATION PRIORITY	STREAM	ACTION	WDFW FISH BARRIER ID	SPECIES	HABITAT UPSTREAM (KM)	REASON
1	Nicholson Creek	Replace perched culvert	125 1304W03A	coho, steelhead, Chinook	5.85	Water Surface Drop
1	Tributary to McCormick Creek	Replace perched culvert	125 1303W31A	coho, steelhead	0.85	Water Surface Drop
1	Beaver Creek	Replace undersized culvert	125 1304W35B	coho, steelhead	2.16	Water Surface Drop
1	Bunker Creek	Remove concrete split box culvert	601177	coho, steelhead	48.02	Water Surface Drop
1	Tributary to Bunker Creek	Remove perched culvert	125 1303W06A	coho, steelhead	5.3	Water Surface Drop
1	Tributary to Nicholson Creek	Remove culvert	940490	coho, steelhead	<1.2	Slope, Water Surface Drop
2	Tributary to Bunker Creek	Replace undersized culvert	601174	coho, steelhead	6.8	Slope
2	Marcuson Creek	Remove sill structure downstream, replace culvert	021(27501)(02750)	coho, steelhead	3.6	Structure/Velocity
2	Tributary to Deep Creek	Replace perched culvert	021(24024)(01701)	coho, steelhead	0.65	Water Surface Drop
2	Tributary to Chehalis River	Replace culvert	125 1305W23B	coho, steelhead	2.95	Slope
2	Curtis Hill/Penning Road Drainage	Replace culvert	125 1303W17A	coho, steelhead	2.5	Water Surface Drop
2	Tributary to Nicholson Creek	Replace culvert	940492	coho, steelhead	<0.6	Slope
2	Tributary to Stearn Creek	Replace culvert	601392	coho, steelhead	1.9	Slope
2	Tributary to Ripple Cr	Replace twin culverts	125 1302W32A	coho, steelhead	1.2	Slope
2	Nicholson Creek	Replace culvert	021(27820)(02365)	coho, steelhead	>0.3	Slope
2	Garret Creek	Replace culvert	21(27820)(02631)	coho, steelhead	>0.1	Depth
2	Tributary to Stearns Cr	Replace culvert	125 1302W30A	coho, steelhead	1.85	Slope
1	Beaver Creek	Replace perched culvert	125 1304W36C	coho, steelhead	3.24	Water Surface Drop
2	Tributary to Bunker Creek	Replace culvert	125 1303W07A	coho, steelhead	5.0	Velocity
2	Tributary to Bunker Creek	Replace Culvert	601702	coho, steelhead	4.8	Velocity
2	Van Ornum Creek	Replace culvert	125 1403W32D	coho, steelhead	2.85	Slope

7.3.4 Riparian/Stream Buffer Habitat Analysis

A reduction in riparian shade and subsequent water temperature increases were identified as potential impacts associated with the construction and operation of the proposed FRE facility. This loss of shade, and related temperature effects, can be reduced by improvements to flood-tolerant riparian forest habitats. Historic and current land use practices have resulted in degradation of riparian conditions along the Chehalis River and its tributaries downstream of the proposed FRE facility. Washington State's 2006 Forest Practices Habitat Conservation Plan (HCP) (WA DNR 2006) identified benefits of riparian habitat protections including shade, reduction of summer water temperatures, prevention of fine sediment delivery from surface erosion, and a source of large wood material. Riparian buffer zones in the mainstem and tributaries upstream of the proposed FRE facility are consistent with the HCP requirements; however, once the habitat is no longer designated for commercial forestry, additional buffers beyond current protections would be implemented with the VMP to minimize riparian-related impacts of the Proposed Action. Mitigation beyond the VMP also includes improvements to currently degraded riparian habitat in the Forest Conservation area (Section 7.3.1) and within land parcels downstream of the FRE. To identify downstream reaches of the Chehalis River with floodplain edge open areas that would benefit from riparian reforestation and buffer expansion, and quantify the mitigation potential of such parcels, the Applicant completed an analysis of existing and potential future riparian conditions and associated solar input to the river.

To develop suitable mitigation to offset shade-related temperature impacts, the Applicant conducted an analysis to understand the relationship between riparian shade and thermal load that could affect water temperature. This analysis also identified potential locations in the upper basin where riparian buffer enhancement could increase shade and reduce future thermal load. The estimates of solar inputs in average kcal/day were generated for 82-foot-long (25-meter) river reaches for the summer period of July 15 to August 31. The average kcal/day per reach was summed to an average kcal/day for each land parcel, as identified by Lewis County records.

To develop the site-specific shade mitigation needed, the Applicant looked at the results of the Shade-a-lator model and initiated landowner engagement efforts. The Shade-a-lator model identifies shade mitigation "supply" by quantifying the potential reduction in solar input possible with an intact riparian tree canopy. Locations of parcels with high to medium supply potential and interested landowners were considered for mitigation. Simultaneous review of the datasets resulted in the selection of 131 parcels along the upper Chehalis River and Bunker Creek[1] for mitigation riparian shade enhancement that would prevent 880,606,358 average kcal/day from reaching the mainstem Chehalis River. Figure 7.3-3 is a map showing the proposed riparian planting areas upstream from Anda, WA to Hope Creek, including Bunker Creek, and Figure 7.3-4 is a map showing the proposed riparian planting areas in the upstream portion of the mitigation area from Hope Creek to the proposed FRE facility. Once implemented, the parcels are predicted to provide sufficient shade to offset potential FRE facility shade-related temperature impacts by a factor of 2.45. In addition to thermal benefits, native riparian reforestation also would provide bank

[1] Results are forthcoming for analogous parcel identification along the South Fork Chehalis River.

stabilization, erosion control, wildlife habitat, and support nutrient cycling along 16.6 miles of the mainstem Chehalis River and 4.8 miles of Bunker Creek. Details about the shade and temperature models and selection of parcels for riparian shade enhancement blocks are provided in Table 7.3-6 and Appendix G.

Table 7.3-6
Thermal Supply Available for Mitigation by Area of Interest. Thermal Benefits Are Expressed As the Daily Mean Value for the Period from July 15-August 31 in Kilocalories Per Day.

SECTION/WATERWAY	TOTAL AVAILABLE SUPPLY	PROPOSED MITIGATION BENEFIT
	THERMAL INPUT REDUCTION (AVG KCAL/DAY)	THERMAL INPUT REDUCTION (AVG KCAL/DAY)
MAINSTEM CHEHALIS		
Proposed FRE facility to Elk Creek (RM 108.4 – RM 100.2)	107,983,121	76,168,718
Elk Creek to South Fork (RM 100.2 –88.1)	372,595,430	290,597,206
South Fork to Adna (RM 88.1 – 80.1)	496,323,622	404,534,434
Subtotal Mainstem	**976,902,173**	**771,300,358**
South Fork Chehalis (RM 0 – RM 17)	651,385,314	ND
Bunker Creek (RM 0 – RM 12)	197,420,691	109,306,000
Newaukum River (RM 0 – RM 10)	1,435,815,597	ND
Total	**2,284,621,602**	**880,606,358**

Figure 7.3-3
Parcels Where Riparian Shade Mitigation Is Presently Feasible Along the Upper Chehalis River and Bunker Creek Upstream of Adna, Washington, i.e., Downstream Riparian Planting Area.

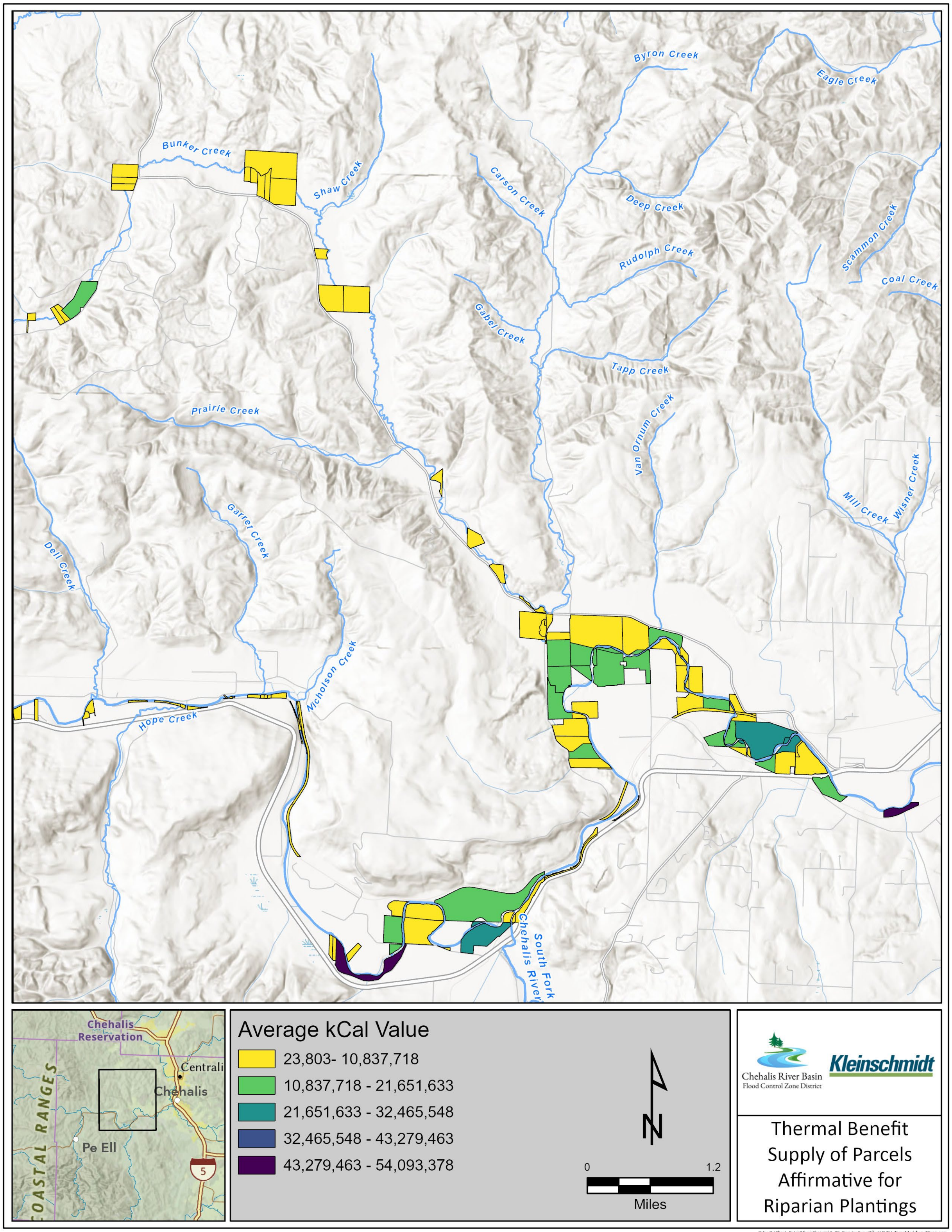
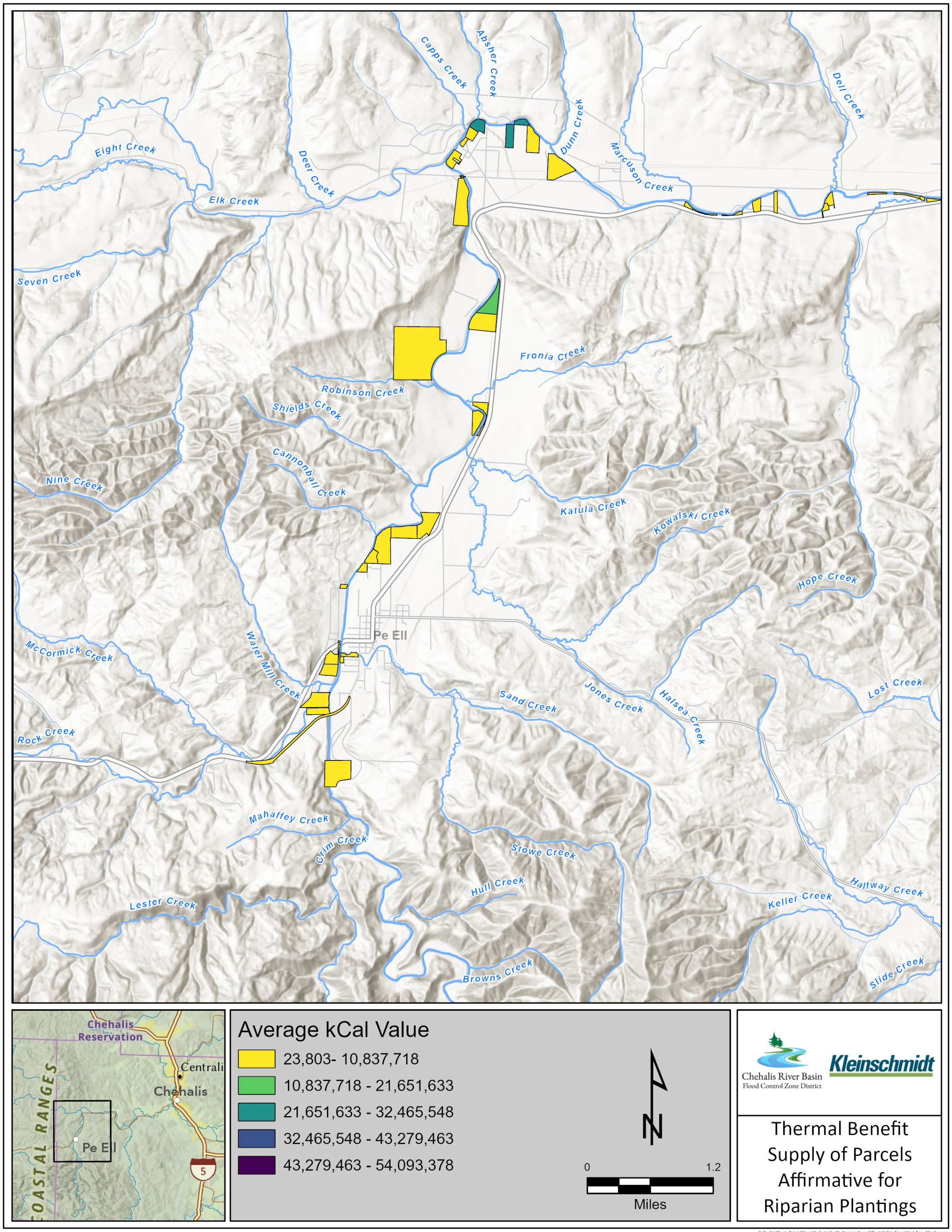


Figure 7.3-4
Parcels Where Riparian Shade Mitigation Is Presently Feasible Along the Upper Chehalis River Upstream of Hope Creek to the Proposed FRE Facility, i.e., Upstream Riparian Planting.



7.4 Wetland Enhancement Analyses and Site Selection

The Applicant explored wetland mitigation opportunities to offset unavoidable impacts to wetlands that would occur because of the construction and operation of the proposed FRE facility and the airport levee improvements. Characteristics used to identify and screen candidate mitigation sites included total wetland area, wetland categories, wetland classes, and wetland functions.

7.4.1 Geographic Considerations for Wetland Mitigation

Conventional mitigation sequencing prioritizes in-kind on-site mitigation when feasible, but off-site out-of-kind mitigation is acceptable although subject to higher mitigation ratios. On-site wetland mitigation is not feasible within the footprint of the proposed FRE facility nor within the footprint of the proposed FRE facility inundation area based on lead agency determinations that all wetlands impacted by those project elements are considered 100 percent permanent losses of wetland area and function. Project impacts to the Chehalis River and its floodplain associated with proposed FRE facility operations have been projected to extend approximately 20 miles downstream from the proposed FRE facility site to the confluence of the South Fork Chehalis River; therefore, candidate wetland sites were identified and evaluated primarily within the floodplain of the Chehalis River and its tributaries within that area.

7.4.2 Considerations for Screening and Selecting Wetland Mitigation Sites

Thirty-four (34) candidate wetland mitigation sites were first identified from remote imagery assessment (Kleinschmidt 2020b). The sites were subsequently screened based on the following considerations:

- **Location** – priority was assigned to mitigation sites located on the floodplain of the Chehalis River and its tributaries within the approximately 20-mile river segment extending downstream from the FRE facility site to the confluence with the South Fork Chehalis River.
- **Size of Available Area** – sites with larger areas available for wetland mitigation were prioritized over smaller sites. There are ecological benefits associated with larger scale and greater complexity of the mitigation areas.
- **Landscape Context** – included connectivity to existing high-value habitats, presence of geomorphic and hydrologic processes that would support desired wetland functions, history of wetlands at the site, and presence of degraded wetlands that could be reversed to produce ecological lift.
- **Landowner Engagement** – candidate sites were advanced based on the willingness of landowners to engage with mitigation planning.

7.4.3 Results of Screening and Site Selection for Wetland Mitigation

After screening, seven of the initial thirty-four candidate wetland mitigation sites (Table 7.4-1) were selected for follow-up field reconnaissance. For six of these properties, potential wetland mitigation areas were generally less than two acres. Additional areas would be required for buffers around the mitigation wetlands. In contrast, at Site 4 which was located at RM 88.4, the field reconnaissance determined that the total suitable and available area for wetland mitigation was approximately 65 acres.

The available area at RM 88.4 would be sufficient to provide about two times the estimated wetland mitigation area required to address the proposed FRE facility's unavoidable impacts on wetlands with the following considerations:

- Wetland mitigation at the site would include diverse wetland habitats and associated wetland functions.
- Wetland mitigation at the site would benefit from connectivity to existing adjacent habitats including upland forest, the active Chehalis River corridor, tributaries, and existing wetlands.
- Working at a single large mitigation site provides an economy of scale compared to working at multiple smaller sites.
- The landscape position of the site is favorable as it is located upstream of the South Fork Chehalis River confluence.

In addition, wetland mitigation at RM 88.4 will also benefit wildlife species including amphibians, birds, and mammals.

Table 7.4-1
Wetland Mitigation Sites Where Field Evaluations Were Completed, Listed from Upstream to Downstream.

SITE NUMBER	LOCATION (RM)
1	102.3
2	89.5
3	88.8
4	88.4
5	84.5
6	79.0
7	77.6

7.5 Landowner Engagement

7.5.1 Mitigation Reaches Downstream of Proposed FRE Facility

A landowner engagement strategy was developed to support the feasibility of implementing mitigation opportunities identified during the Mitigation Site Selection Process on lands and properties owned by private individuals and/or companies. This strategy was implemented in the mitigation reach downstream of the proposed FRE facility. Following the selection of priority mitigation opportunities, landowner engagement specialists began the process of contacting landowners to assess receptiveness to conceptual mitigation actions.

The Applicant visited landowners in person at their properties to discuss mitigation opportunities ranging from small-scale mitigation actions such as riparian plantings, removing/replacing culverts that represent fish passage barriers, and gravel or LWM seeding, to large-scale major actions including channel building and connectivity, aquatic habitat manipulations, substantial revegetation, and establishment of large wood and other channel forming-features.

The Applicant communicated with over 200 landowners regarding the implementation of aquatic and terrestrial habitat enhancement work on their parcels, of which over 162 landowners have responded with a willingness to engage and allow for access to their properties for the feasibility study of riparian enhancement/reforestation and/or aquatic habitat enhancement projects. A further 23 landowners were contacted about the removal or replacement of culverts, of which 19 were willing to engage and to allow for access for the feasibility study.

In addition, the Applicant had two unique opportunities to advance mitigation site confirmation. Two of the properties where the Applicant had engaged willing landowners and were in the process of assessing the feasibility of multiple mitigation actions came up for sale. For both sites, the Applicant has early assurances that their proposed mitigation can be implemented if the project is chosen to advance as part of the state’s Chehalis River Basin process. The properties include the lower Bunker Creek fish passage, tributary, and shade mitigation actions and aquatic habitat, tributary, wetland, and riparian shade mitigation between RM 89.3-87.6 of the Mainstem Chehalis River.

8 SITE-SPECIFIC MITIGATION PLANS

As described in Section 7, feasible and practicable mitigation sites were identified. This section presents the site-specific mitigation being proposed under the six mitigation plans: Fish and Aquatic Species and Habitat, Riparian and Stream Buffer Expansion, Wildlife Habitat Conservation, Large Wood Material Recruitment and Placement, Surface Water Quality, and Wetland Enhancement. For each mitigation plan below, the site-specific actions and measures are described as well as the expected species-species benefits and overall ecological lift. Table 8-1 provides an overall summary of the Applicant's proposed mitigation including benefits and mitigation quantity.

Table 8-1

Mitigation Summary Table for Compiled Mitigation Under All Mitigation Plans Included in This Proposed FRE Mitigation Plan.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
FISH AND AQUATIC SPECIES AND HABITAT PLANS				
Off-Channel Enhancement	4	Off-channel habitat enhancements including side channel and floodplain actions to reconnect, enhance, and expand off-channel habitat.	-Create habitat complexity and diversity. -Provide rearing habitat for Chinook, coho, steelhead, resident trout, cyprinid, and other native fishes such as lamprey species. -Create new spawning habitats for stream and still-water breeding amphibians, such as Columbia torrent salamander and Western toad. -Provide refugia for macroinvertebrates and small fishes from high flows. -Provide habitat for invertebrates such as dragonflies, damselflies, crane flies, arachnids, and other invertebrates. -Provides improved foraging habitat for bird species that benefit from aquatic insect larvae such as the American dipper, and from enhanced availability of small fishes, amphibians, and aquatic invertebrates such as the belted kingfisher.	-6,250 linear feet of low-flow rearing habitat. -8,300 ft^2 Chinook and steelhead spawning habitat.
Floodplain Connectivity and Reforestation	2	Measures to increase the frequency and duration of overbank flows onto the floodplain.	-Create future source of riparian and in-stream wood material. -Provide rearing habitat for Chinook, coho, steelhead, resident trout, cyprinids, sculpins, and other native fishes such as lamprey species. -Provide low-velocity refugia and overwintering habitat and still-water wetlands for native amphibian spawning, juveniles and adult. -Increases access to still-water habitat with silty bottoms, used by lamprey ammocoetes (Pacific lamprey, western river lamprey, western river lamprey) and Olympic mudminnow. -Provide foraging and stop-over habitat for migrating birds and waterfowl such as buffleheads, common goldeneye, harlequin duck, hooded merganser, wood ducks. -Provide habitat for belted kingfisher, vesper sparrow, and mammals including beaver, martin, fisher, and otter. -Provide habitat for invertebrate species including insects that utilize leafy vegetation and leaf litter, and mollusks like wood snails. -Promote channel avulsion and sediment deposition for the colonization of cottonwood.	-11,500 linear feet of enhanced floodplain flow path.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
Spawning Habitat Enhancement	6	Instream wood/rock structures designed to provide hydraulic roughness and promote accumulation and retention of salmonid spawning gravels.	-Increase rearing habitat for Chinook, coho, and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, cyprinid, and other native fishes such as adult western brook lamprey. -Enhanced spawning habitat for Chinook salmon, steelhead, Pacific lamprey, and stream-breeding amphibians such as Western toad. -Increased habitat for aquatic invertebrates such as mayflies, caddisflies, stoneflies.	-63,300 ft^2 of Chinook and/or steelhead spawning habitat. -320 ft^2 of rearing and adult-holding habitat.
Tributary Habitat Enhancement	3	Improvements to enhance the in-channel and riparian complexity of tributaries where access impediments are removed.	-Rearing habitat and thermal refuge for Chinook, coho, and steelhead juveniles, resident trout, sculpins, cyprinids, and native fishes. -Spawning habitat for coho salmon and stream-breeding and rearing amphibians such as the Pacific giant salamander and the coastal-tailed frog. -Improve riparian habitat along Bunker Creek.	-Enhance 2.3 mi with coho and resident trout-rearing habits. -Improved access to 8.4 mi of stream for coho salmon and steelhead, 4.2 mi of which contain spawning habitat. -0.9 mi of new tributary channel.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
Culvert Removal	18	Open access to tributary habitats through barrier removal and rehabilitation of the impacted stream reach.	-Provide access to rearing habitat and thermal refuge for Chinook, coho, and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, and other native fishes. -Provide access to spawning habitat for lamprey species (Pacific lamprey, western river lamprey). -Increase potential colonization of freshwater mussels associated with native migratory fishes.	-Remove barriers to 39.3 miles (63.3 km).
RIPARIAN AND STREAM BUFFER EXPANSION PLAN				
Riparian Planting Upstream of Proposed FRE Facility	1	Expand and enhance the riparian buffer upstream of the proposed FRE facility by planting native shrubs and trees to increase shading, bank stability, nutrient cycling, habitat complexity, and habitat value for native species.	-Create foraging and migratory pathways for wildlife such as bear, deer, elk, and small mammals including martin, Douglas squirrel, white spotted skunk, bats, cavity-nesting birds (i.e., wood duck and Western screech owls), marbled murrelets, songbirds, eagles and other raptors, and riparian species. -Provide habitat for amphibians including Van Dyke's and Dunn's salamander. -Provide multiple-canopy forest, and leafy vegetation cover for terrestrial insect production including coleoptera, diptera, diplopoda, lepidoptera, hymenoptera, arthropoda, arachnida, terrestrial crustacean (such as armadillidae). -Stabilize riverbanks and control erosion. -Create a future source of large wood material. -Provide stream shading to minimize thermal loading. -Improve water quality by capturing pollutants and fine sediment run-off. -Invasive species management and control.	-Riparian enhancement along 23 mile of non-fish bearing streams in the Forest Conversion area. -362.5 acres of riparian buffer created. -185.5 wetland buffer created.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
Riparian Planting-Downstream of Proposed FRE Facility	131 parcels for shade	Expand and enhance the riparian buffer downstream of the proposed FRE facility by planting native shrubs and trees to increase shading, bank stability, nutrient cycling, habitat complexity, and habitat value for native species.	-Create foraging and migratory pathways for wildlife such as bear, Columbia blacktailed deer, elk, and small mammals including American martin, American beaver, western spotted skunks, cavity-nesting birds (wood duck, Western screech owls), songbirds, eagles and other raptors, and other riparian species. -Provides improved foraging habitat for bird species that benefit from aquatic insect larvae such as the American dipper, and from enhanced availability of small fishes, amphibians, and aquatic invertebrates such as the belted kingfisher. -Stabilize riverbanks and control erosion. -Create a future source of large wood material. -Provide stream shading to minimize thermal loading. -Improve water quality by capturing pollutants and fine sediment run-off. -Provide instream and overhead vegetation cover and encourage terrestrial insect production including coleoptera, diptera, diplopoda, lepidoptera, hymenoptera, arthropoda, arachnida, terrestrial crustacean (such as armadillidae), and insect drift for native fishes. -Fallen wood debris and leaf litter provide food for aquatic insects and macroinvertebrates. -Stabilizes hydrology at a local level in small tributaries. -Enhanced holding, spawning, and rearing habitat for native fishes, and native amphibians. -Enhanced aquatic habitat for native mussels, aquatic insects, and macroinvertebrates. -Invasive species management and control.	-131 parcels and 16.6 miles along the mainstem Chehalis River between the Proposed FRE facility and Adna, WA, and 4.8 miles along Bunker Creek. -155.6 acres of riparian buffer restoration/enhancement.
Forest Conversion	1	Convert upland commercial timberlands to structurally diverse and species-rich successional old-growth forests.	-Restore habitat for eagles, hawks, owls, and other raptor species that use trees for perching, foraging, and nesting. -Create foraging and migratory pathways for wildlife such as bear, Columbia blacktailed deer, elk, and small mammals including American martin, fischer, Douglas squirrel, white spotted skunk, bats, cavity-nesting birds (wood duck), marbled murrelets, songbirds, and other upland species. -Encourage mature forest stands for use by marbled murrelet and mollusk blue-grey tail dropper butterflies.	-1,558.5 acres of Upland Forest Conversion. -362.5 acres of stream buffer. ->185.5 acres of wetland buffers.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
LARGE WOOD MATERIAL RECRUITMENT AND PLACEMENT PLAN				
Wood Relocation, Installation, Recruitment	15	Enhance habitat diversity and complexity and improve ecological function (see also Aquatic Habitat Enhancements for Floodplain and Spawning Gravel above).	-Provide instream cover for juvenile salmonids, cyprinids, and stream-breeding amphibians. -Promote gravel retention that provides spawning habitat for salmonids, lamprey, and sculpin, and other native fishes. -Provide substrate and shelter for aquatic insects such as mayflies, stoneflies, and caddisflies, and macroinvertebrates. -Long-term recruitment of wood from riparian planting.	-1,054 installed logs over 15 mitigation projects under Fish and Aquatic Species and Habitat Plans. -16.6 mi of enhanced riparian habitat in the mainstem and 4.8 mi of enhanced riparian habitat in Bunker Creek.
WILDLIFE HABITAT CONSERVATION PLAN				
Forest Conversion	1	Convert upland commercial timberlands to structurally diverse and species-rich successional old-growth forests.	-Restore habitat for eagles, hawks, owls, and other raptor species that use trees for perching, foraging, and nesting. -Provide forest habitat for large mammals such as bears, cougars, Columbia black-tailed deer, and elk. -Provide open prairie habitat for butterfly species Taylor's checkerspot and valley silver spot. -Provide habitat for upland-breeding amphibians including Van Dyke's and Dunn's salamander. -Provide multiple-canopy forest, and leafy vegetation cover for terrestrial insect production including coleoptera, diptera, diplopoda, lepidoptera, hymenoptera, arthropoda, arachnida, terrestrial crustacean (such as armadillidae). -Encourage mature forest stands used by Marbled murrelet and mollusk blue-grey tail dropper butterflies.	-1,558.5 acres of converted successional forest. -362.5 acres of stream buffer created. ->185 acres of wetland buffers created.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
Wetland and Wetland Buffer Enhancement		*See Wetland Enhancement Plan (below).*	*See Wetland Enhancement Plan (below).*	*See Wetland Enhancement Plan (below).*
SURFACE WATER QUALITY PLAN				
Forest Conversion	1	Establishment of native diverse forests and forestry roads would be decommissioned or subject to restricted use.	-Improve water quality by reducing run-off from roads and upland slopes of fine sediments and pollutants. -Stabilize local hydrology by slowing the rate of water released into the river during rain events. -Increase shading for air temperature modulation. -Increase soil stability. -Water quality improvements would benefit all aquatic species and help to control invasive species.	-1,558.5 acres of converted successional forest. -362.5 acres of mainstem and tributary stream buffer created downstream of FRE. ->185 acres of wetland buffers created upstream, of the FRE. -Decommission up to 6 miles and imposed use restrictions on up to 12 miles of forest road upstream of the FRE.

ACTION TYPE	# OF PROJECTS	DESCRIPTION	PROJECTED BENEFITS	MITIGATION QUANTITY
Riparian Shade Enhancement	131 parcels	Expand and enhance degraded riparian habitats downstream of the FRE to increase shade and reduce the potential for thermal loading to the river.	-Provide shade to reduce thermal loading and related water temperature increases. -Improve water quality by reducing run-off of fine sediments and pollutants. -Stabilize local hydrology throughout the seasons.	-131 parcels and 16.6 miles along the mainstem Chehalis River and 4.8 miles along Bunker Creek. -155.6 acres of riparian/stream buffer.
WETLAND ENHANCEMENT PLAN				
Wetland Enhancement		Creation of diverse wetland and wetland buffers to support increased biodiversity.	-Restore habitat for beaver, mink, garter snakes, and other amphibians and reptiles. -Provide access to spawning and rearing habitat for still-water amphibians. -Create foraging and stop-over habitat for birds such as waterfowl, herons, and migratory species such as American wigeon, ring-necked duck, and green-winged teal. -Provides improved foraging habitat for bird species that benefit from aquatic insect larvae such as the American dipper, and from enhanced availability of small fishes, amphibians, and aquatic invertebrates such as the belted kingfisher. -Encourage the creation of snags. -Provide habitat for amphibians including Western toad, and Van Dyke's and Dunn's salamander.	-27 Wetlands covering 3.0 acres would be conserved under the Forest Conversion Plan. -42.5 acres of depressional wetland restored/created at RM 87.6-89.3. -276.5 (185 + 91.5) acres of wetland buffer.

8.1 Fish and Aquatic Species and Habitat Plan

The Fish and Aquatic Species and Habitat Plan focuses on impacts on aquatic species and their habitats and how the existing stream condition could be enhanced to the benefit of rearing and spawning life stages of anadromous fish and aquatic amphibians. This plan works in concert with the Large Wood Material Recruitment and Placement Plan which is designed to mitigate habitat complexity losses, and the Riparian and Stream Buffer Expansion Plan, which is designed to enhance shading of aquatic habitat through revegetation of degraded riparian habitat and thereby reduce thermal loading for temperature benefits to the same suite of species. High-quality physical habitat is most valuable to aquatic species and life stages when the thermal regime is also within suitable ranges, especially for priority species such as spring-run and fall-run Chinook salmon, coho salmon, and steelhead. The plan includes measures that could be implemented in the mainstem (on-site mitigation) and in tributaries (off-site mitigation), as described below. While landowners have been engaged about the project and are cooperating at this time, most projects still require more formal agreements to be discussed and established before they could be implemented.

8.1.1 Mainstem Aquatic Habitat Enhancements

Conceptual designs were developed for on-site mitigation project locations where the type of project's function and persistence were compatible with reach-scale flooding and sediment transport processes. Instream designs are proposed to mitigate potential effects on fish habitat and productivity via the construction of instream habitat complexity and gravel retention structures; enhancing and/or providing access to off-channel habitats that provide complexity and thermal refuge. Actions were also identified that increase and enhance floodplain connectivity and thereby contribute towards riparian buffer expansion and future habitat complexity and off-channel habitat access. A quantitative accounting of the amount of aquatic habitat mitigation needed has not been developed, however, that is specific to each type of projects identified above. In view of this uncertainty, as many actions were identified as possible based on assessing physical feasibility of aquatic habitat conditions and potential for landowner buy-in. An overview is given of the specific actions below; they are described in greater detail in Appendix J. Corresponding potential benefits and estimated mitigation quantities are summarized in Table 8-1.

8.1.1.1 Instream Habitat Complexity Design Features

Loss of instream habitat complexity would be mitigated directly in the form of large wood and boulder placements in the active channel. Anchored pieces would be installed at various locations in configurations designed to provide pool and instream cover, and loose pieces would be placed downstream of the FRE facility for subsequent entrainment and natural transport/deposition as part of the Large Wood Recruitment and Placement Plan (see Section 8.4). In addition, instream habitat complexity would be provided as a secondary benefit through the construction of spawning habitat as well as off-channel habitat enhancement measures described below.

8.1.1.2 Off-Channel Habitat Enhancement Design Features

Off-channel habitat enhancements include actions to expand and/or reconnect side channels and alcoves that are connected at one or both ends sufficiently frequently so that fish can ingress and egress as needed and avoid trapping and stranding. Off-channel habitats are generally limited in existence because of the confined and entrenched nature of much of the Chehalis River. There were accordingly few opportunities to enhance these types off-channel habitats within the primary impact reaches. An emphasis was placed on enhancing side channel habitats to provide suitable edge habitat conditions for young-of-year ocean-type Chinook salmon, which are not strongly keyed in on alcove habitats (Beechie et al. 2005; Hansen et al. 2023) where predation risks can also be greater (e.g., Schoen et al. 2022; White et al. 2023). These habitats can also provide spawning opportunities under the right flow conditions.

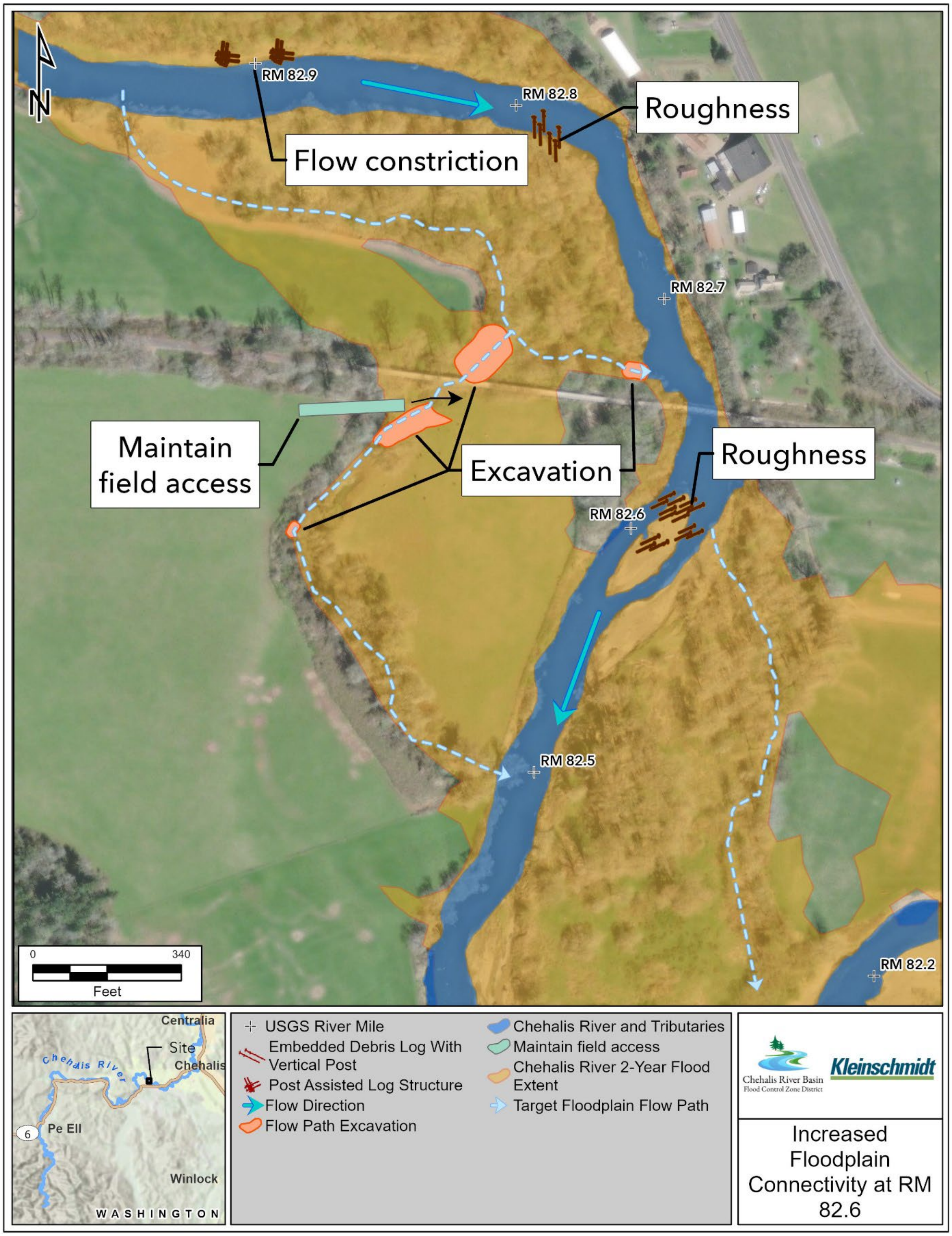
Four locations were identified where reach scale flooding and sediment transport processes are conducive to maintaining, augmenting, and/or recreating opportunities for side-channel flows. Measures are proposed below for the four sites that have the potential to promote increased frequency of hydraulic connectivity of side-channel habitats by increasing water levels at their inlets, and by presenting an in-channel ‘hard point’ that the river flows around and deposits sediment behind. This can be facilitated using two types of large wood installations, exposed debris-catching logs and post-assisted log structures (PALS) with flood fencing upstream for scour protection as needed. The purpose of the installations is to obstruct and split flow, and facilitate additional deposition of sediments on which cottonwoods and willows can become established to provide future root stability and island formation.

8.1.1.2.1 River Mile 82.6 – Increase Off-Channel Habitat Access and Develop Floodplain Channels

The proposed mitigation site at RM 82.6 is shown on Figure 8.1-1. The site provides an opportunity for floodplain forest and wetlands enhancement along two potential flow paths across lower elevation floodplain surfaces, one along the inside of a pronounced bend on river right (west side) and the other extending downstream of a mid-channel bar and along the inside of a second bend on river left. Minor excavation on the river right floodplain would be needed at two locations to increase upstream-downstream through-flow. Large wood placements would include exposed debris logs on bars below the inlets of each flow path to increase in-channel roughness and backwater upstream, thereby increasing the frequency and magnitude of hydraulic connectivity along the flow paths. Backwatering would also be increased at the river right inlet by projecting a PALS on the left bank to trap wood and constrict high flows. Access to the right bank floodplain terrace would need to be preserved and maintained for farming.

The projected benefits to species and life stages at this site include approximately 3,600 linear feet of rearing and flood refuge off-channel habitat for coho salmon juveniles and native cyprinids; and quiet water for native amphibian spawning, juveniles, and adults. The increased in-channel roughness could also facilitate increased gravel deposition in locations where fall-run Chinook salmon redds have been found in the past (WDFW electronic data for 2015-2021 received from Ecology).

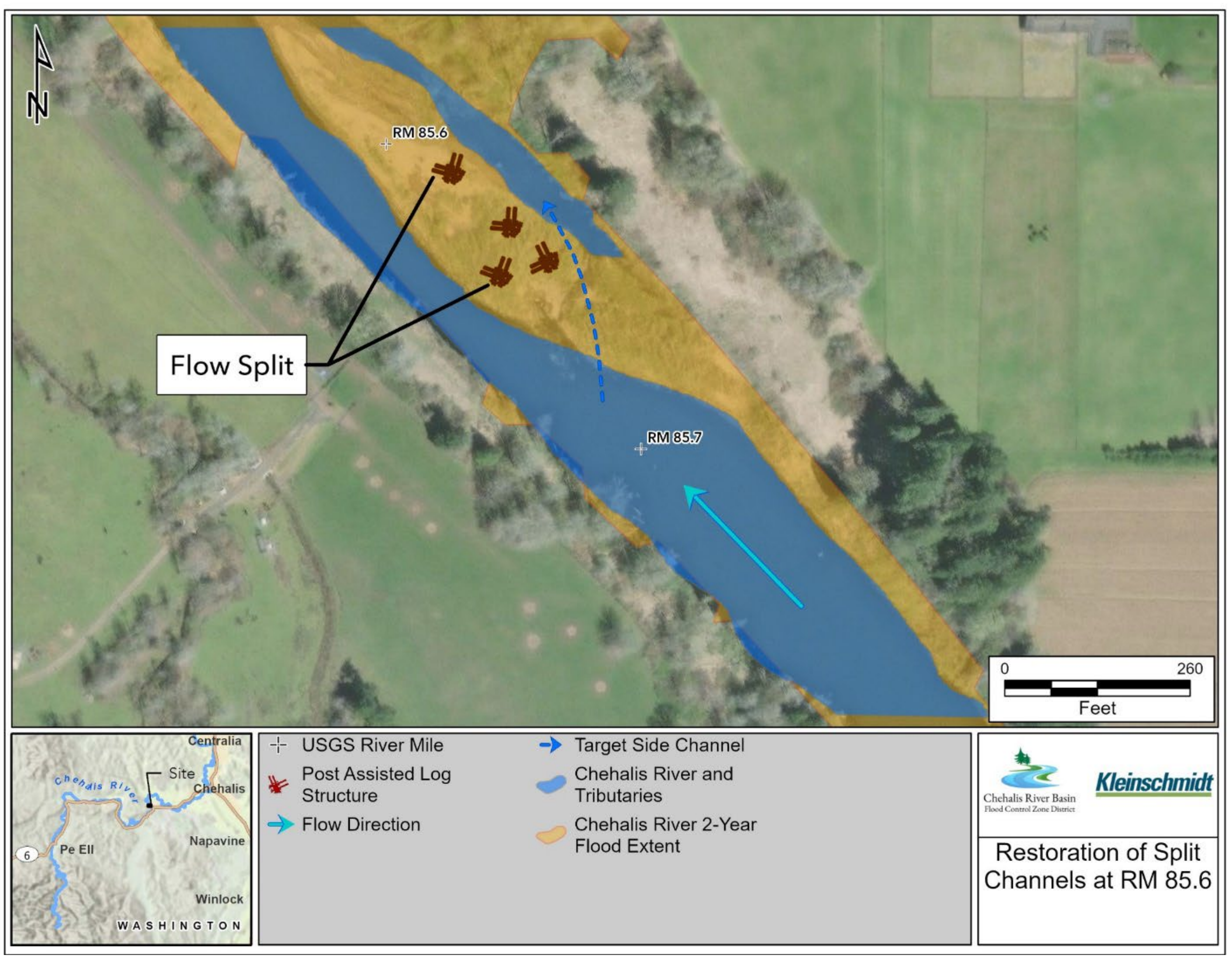
Figure 8.1-1
Conceptual Design Proposed for Creating and Enhancing Side Channel Habitat Around RM 82.6 in the Chehalis River.



8.1.1.2.2 River Mile 85.6 – Maintain/Enlarge Split Channel

The proposed site is shown on Figure 8.1-2. There is a mid-channel bar downstream of the USGS Adna gage that has persisted since its apparent formation during the 2007 flood. The channel morphology overall consists of relatively simple and uniform run/glide mesohabitat along the longer encompassing reach, where the split flow provides some habitat complexity that is otherwise missing. The right-side channel (looking downstream) is disconnected at the upstream end during lower flows. Installation of PALS and exposed debris logs across the mid-channel bar could promote longer-term persistence and the development of a vegetated island with split low flows and riffles at the upstream end of each channel.

Figure 8.1-2
Conceptual Design Proposed for Augmenting Side Channel Habitat Around RM 85.6 in the Chehalis River.



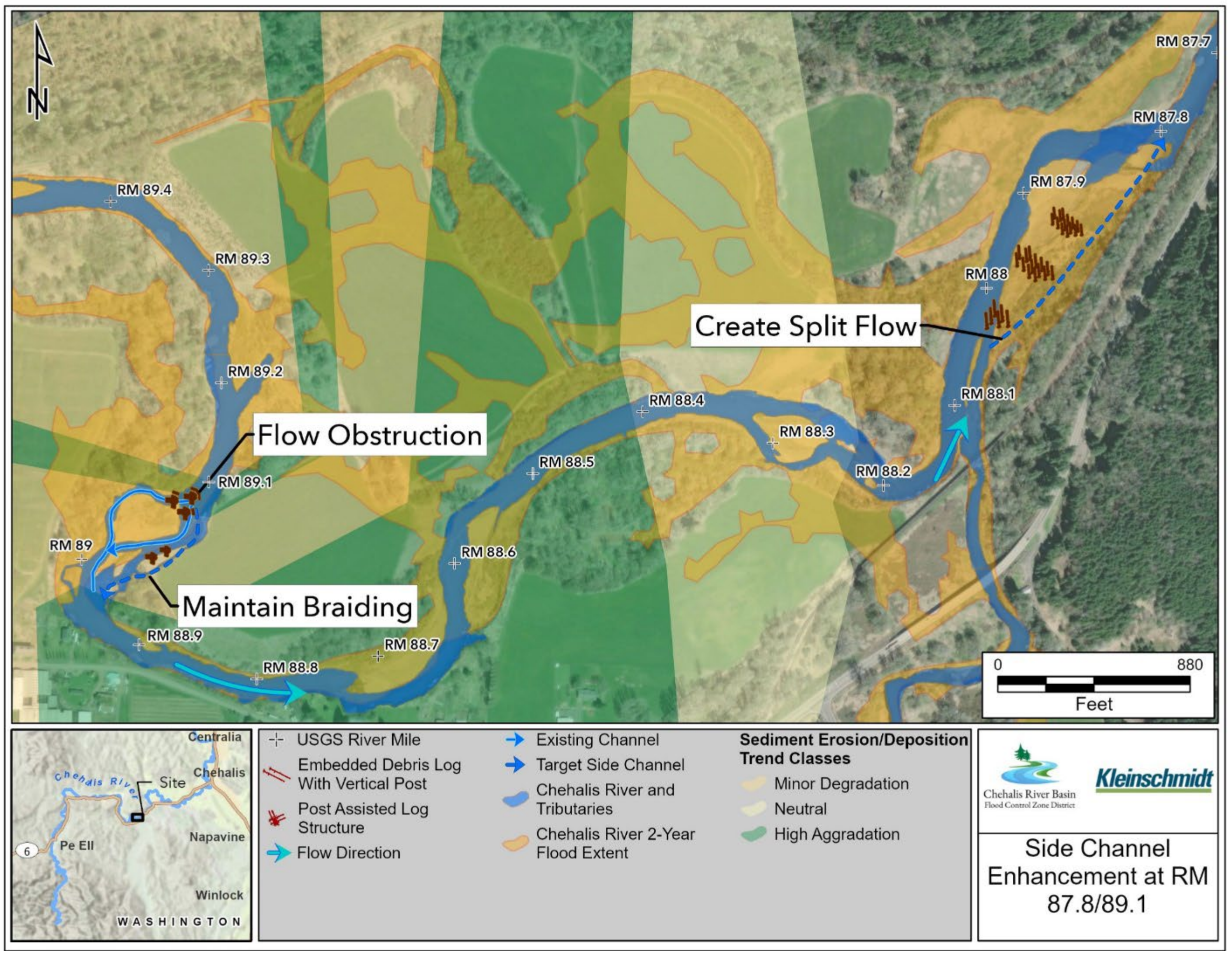
The projected benefits of this mitigation action would be to develop approximately 750 linear feet of connected side channel habitat to provide rearing habitat for Chinook salmon and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, and native cyprinids. The reach is likely too short for meaningful hyporheic flow benefits to develop below riffles at the head of the island during summer months. The site has supported fall-run and spring-run Chinook salmon redds in the past (WDFW electronic data for 2015-2021 received from Ecology), where restoration of low flow to the right side channel could provide additional area for spawning under the right flow conditions.

8.1.1.2.3 River Miles 87.8/89.1 – Maintain and Enlarge Split Flow Side Channels with Increased Habitat Complexity

The proposed site shown on Figure 8.1-3 provides an opportunity for maintaining side channels upstream and converting a high-flow split to a low-flow split downstream. The upstream flow split location is braided due to local flood flow expansion at its upstream end, and flow convergence and backwatering control downstream. The site has a strong aggradation tendency predicted at its upstream end, and a minor degradation tendency over the remainder of its length. The downstream flow split location is at the head of a large gravel bar where the channel is eroding the opposing riverbank, and where the South Fork Chehalis River appears to have flowed historically. Both locations have cottonwood and willow colonization underway and have wide gravel bars on which PALS and exposed debris logs could be constructed as island apex features that trap wood, deposit sediments, and facilitate the growth of stabilizing vegetation in their lee areas to form more persistent islands.

The Projected Benefits of this mitigation action would be to create two sites with 500 feet (upstream site) and 800 feet (downstream site) of connected low-flow side channel habitat that could provide rearing habitat for Chinook salmon and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, and native cyprinids. Reaches are likely too short for meaningful hyporheic flow benefits to develop below riffles at the head of flow splits during summer months. The upstream braided channels have supported fall-run and spring-run Chinook salmon redds in the past (WDFW electronic data for 2015-2021 received from Ecology) and the project could help maintain suitability for spawning in the future by working to maintain braiding conditions.

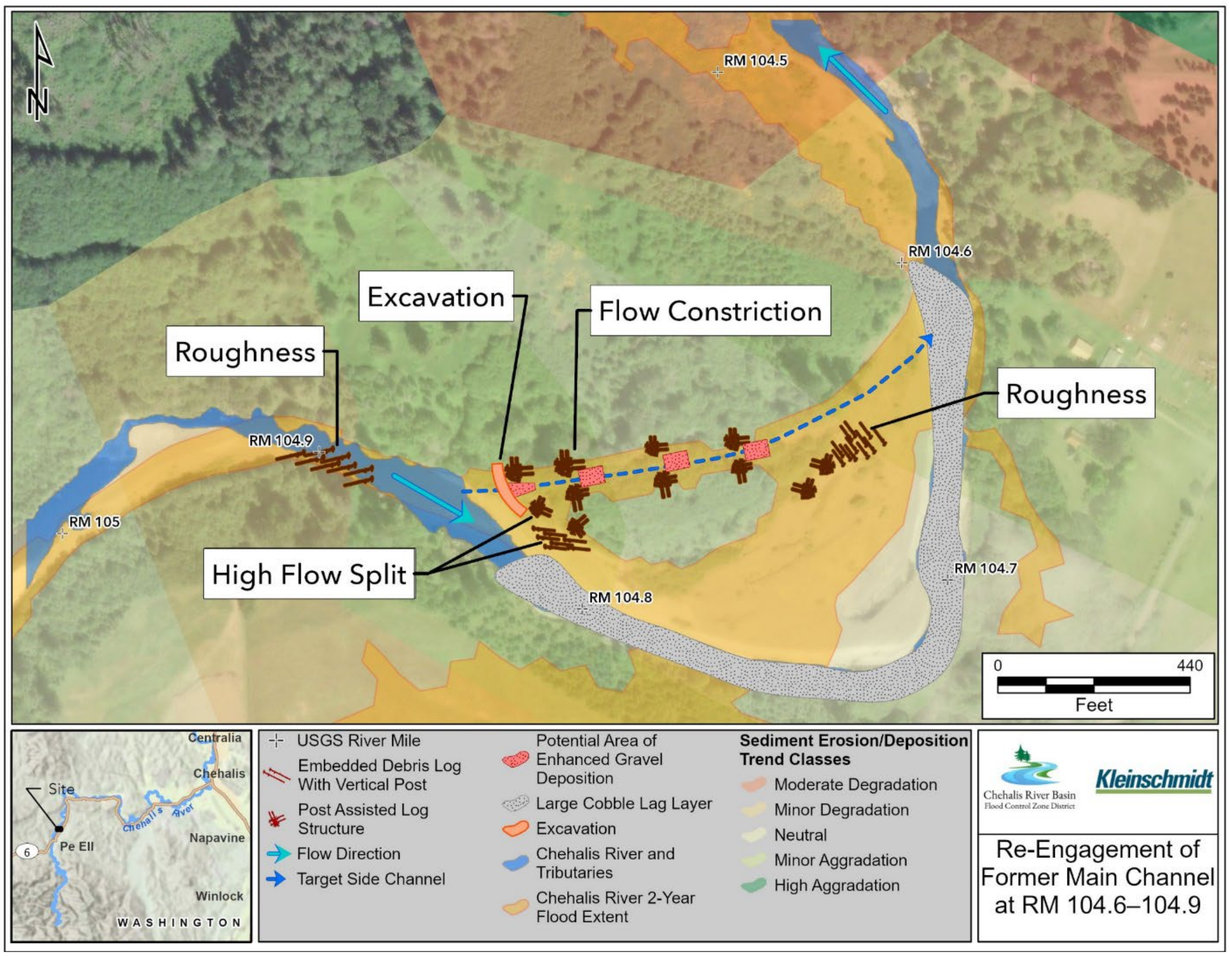
Figure 8.1-3
The Conceptual Design Proposed for Augmenting Side Channel Habitat Around RM 87.8 and RM 89.1 in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradational Tendency, the Tan Highlight at the Left Indicates a Minor Degradation Tendency, and the Pale Highlight at the Right on the Figure Upstream of the Confluence with South Fork Chehalis River Indicates Neutral Tendency. Aggradational Tendency Was Not Calculated Downstream of the South Fork Confluence.



8.1.1.2.4 *River Miles 104.6-104.9 – Re-Engage the Former Main Channel As a Side-Channel*

This site is shown on Figure 8.1-4 and has experienced significant channel migration to the east, where the former main channel location has filled in and a log jam has formed at its upstream end. The former channel location was predicted to be engaged annually during high water before the more recent meander migration. The objective would be to redirect high flow and initiate a short-cutting avulsion process to create a secondary side channel where the river used to flow. The site is predicted to have a long term aggradational tendency, which would favor avulsion back through the former channel if deposition is induced within the present main channel on the opposing bank, and downstream of the former location.

Figure 8.1-4
The Conceptual Design Proposed for Side Channel Restoration Where the Chehalis River Used to Flow Between RM 104.6-104.9. The Orange Highlight Indicates the Predicted Approximate Extent of 2-Year Flood Peak Prior to the More Recent Migration of the Channel (Indicated by Grey Dashed Polygon). The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a Minor Aggradational Tendency at the Proposed Flow Split Inlet and Outlet, the Pale Highlight Indicates a Neutral Tendency in the Main Channel In-Between, and the Tan Highlight Indicates a Minor Degradation Tendency Upstream and Downstream.



To implement a channel re-engagement, the first step would be to promote deposition in the main channel with exposed debris logs and PALS at the proposed flow split apex, and then promote deposition with debris logs on the right bank bar upstream of the proposed flow split location to trap gravel and build a bar that helps direct high flows towards the inlet as well as reduce transport of gravel downstream, and finally, to promote deposition on the expansive left bank meander bar by installing debris logs upstream of the proposed outlet of the side channel. The downstream, placement would help reduce the channel gradient around the bend and increase the gradient through the side channel. A natural levee that has formed across the inlet would also need to be excavated to form a pilot channel that can be engaged at more frequent flows. These combined measures would be expected to increase the amount of water flowing across the base of the river bend during high flows to erode a side channel over time during high flows.

The site has some potential risk of private property erosion along the right bank, although creating a side channel would likely reduce flood pressure on the outside riverbank along the bend and could lead to a larger avulsion. Both outcomes would be expected to reduce the ongoing erosion.

The projected benefits of this mitigation action would be to create approximately 650 linear feet of connected low-flow side-channel habitat in the near term, and up to approximately ¾ acres of mainstem habitat over the long term until the river avulses completely through the new channel for rearing for Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow and cutthroat trout, sculpins and native cyprinids. The pool tail, riffle crest and riffle that would likely form at the inlet and below each set of PALS could provide new spawning habitat for Chinook salmon and steelhead located centrally within the long-term Pe Ell Valley spawning reach (Appendix B), potentially around 1,700 ft^2 at the inlet, and around 2,200 ft^2 below each of the three PALS flow constrictions downstream of the inlet (up to around 8,300 ft^2, total).

8.1.1.3 Floodplain Connectivity and Reforestation Design Features

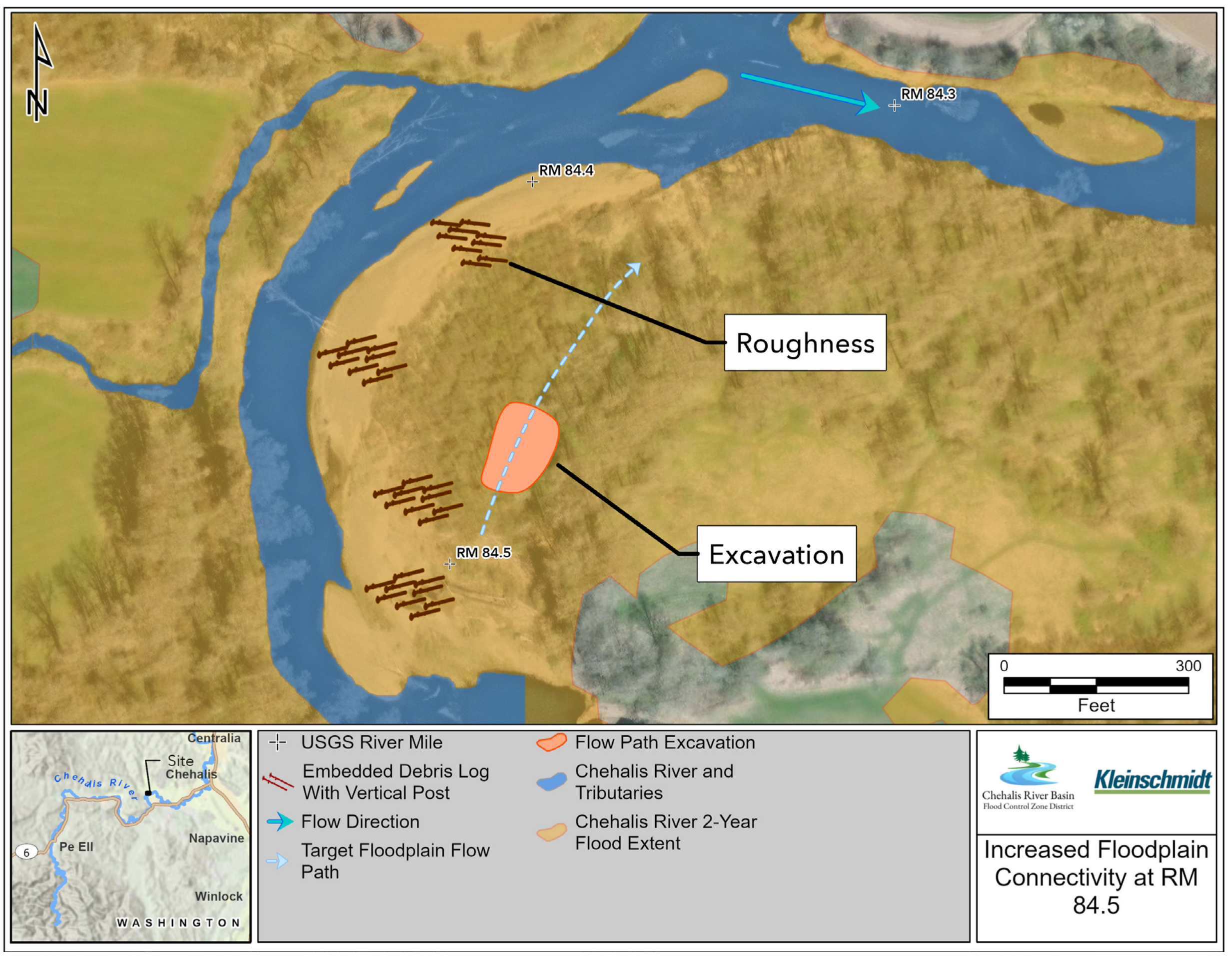
This project type involves actions that can increase the frequency and duration of overbank flows onto the floodplain, thereby promoting re-establishment and maintenance of riparian and floodplain forests which in turn function to reduce summer water temperature, provide wildlife and wetland habitat, and are a source of future large wood to the channel. Active plantings are included as part of this action. Where a floodplain or riparian forest does not currently exist, plantings would mainly consist of Douglas fir seedlings or container stock as the key species, which is generally tolerant of exposed conditions. In already-forested sites, plantings would include western red cedar and Sitka spruce as key tree species. Black Cottonwood starts would also be planted if substrate and groundwater conditions are determined to be suitable.

Two locations were identified where reach scale flooding and sedimentation processes are conducive to maintaining, augmenting, and/or re-creating opportunities for floodplain flows. Measures are proposed below for the two sites to promote increased frequency of hydraulic connectivity of floodplain habitats by increasing water levels at frequent flood levels, without substantially affecting larger flood stages. This can be accomplished using the two large wood placements (as described in Section 8.1.2 above) that present as a flow obstruction and/or promote deposition of coarse sediments in the channel but also a third type of log placement that is proposed here to increase channel roughness in sites where the depth to bedrock is shallow. The design involves groupings of logs anchored to boulders on the river bottom in deeper water sections that dissipate energy through form drag. The logs can be anchored using either chain (long-term), or hemp rope (short-term). The goal is to affect water levels sufficiently at around bankfull flows but not significantly at extreme flood levels.

8.1.1.3.1 River Mile 84.5 – Increase Floodplain Channel Engagement

The proposed site is shown on Figure 8.1-5. The site is located at an actively migrating meander bend that is situated downstream of two adjacent meander bends that are also actively migrating. There is a forested low-elevation floodplain flow path across the inside of the bend that is inundated at the 2-year flood level but is gradually becoming connected less frequently as the meander amplitude increases over time. This project would prolong the life of the floodplain flow path, thereby sustaining the floodplain forest that has developed there with more water and fine sediments. Increased connectivity would be affected by the installation of exposed debris logs along the exposed gravel bar on the inside of the bend, which would promote more rapid deposition and reduction in flow conveyance in the main channel. This in turn would increase backwatering upstream and coupled with minor excavation at the head of the floodplain flow path, increase the frequency and duration of flow through the floodplain forest. The outside bend is forested and has been generally stable. Periodic maintenance would likely be needed at this site to monitor and maintain habitat if excessive deposition occurs.

Figure 8.1-5
The Conceptual Design Proposed for Increasing Floodplain Connectivity Around RM 84.5 in the Chehalis River.



The projected benefits of this mitigation action would be the enhancement of approximately 2,300 linear feet of floodplain flow path, and with reforestation, a future source of large wood and instream habitat complexity for rearing Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow and cutthroat trout; quiet water/wetlands for native amphibian spawning, juveniles, and adults.

8.1.1.3.2 River Miles 87.6-89.3 – Increase Floodplain Channel Engagement and Restore Forest Along Relic Channel Paths

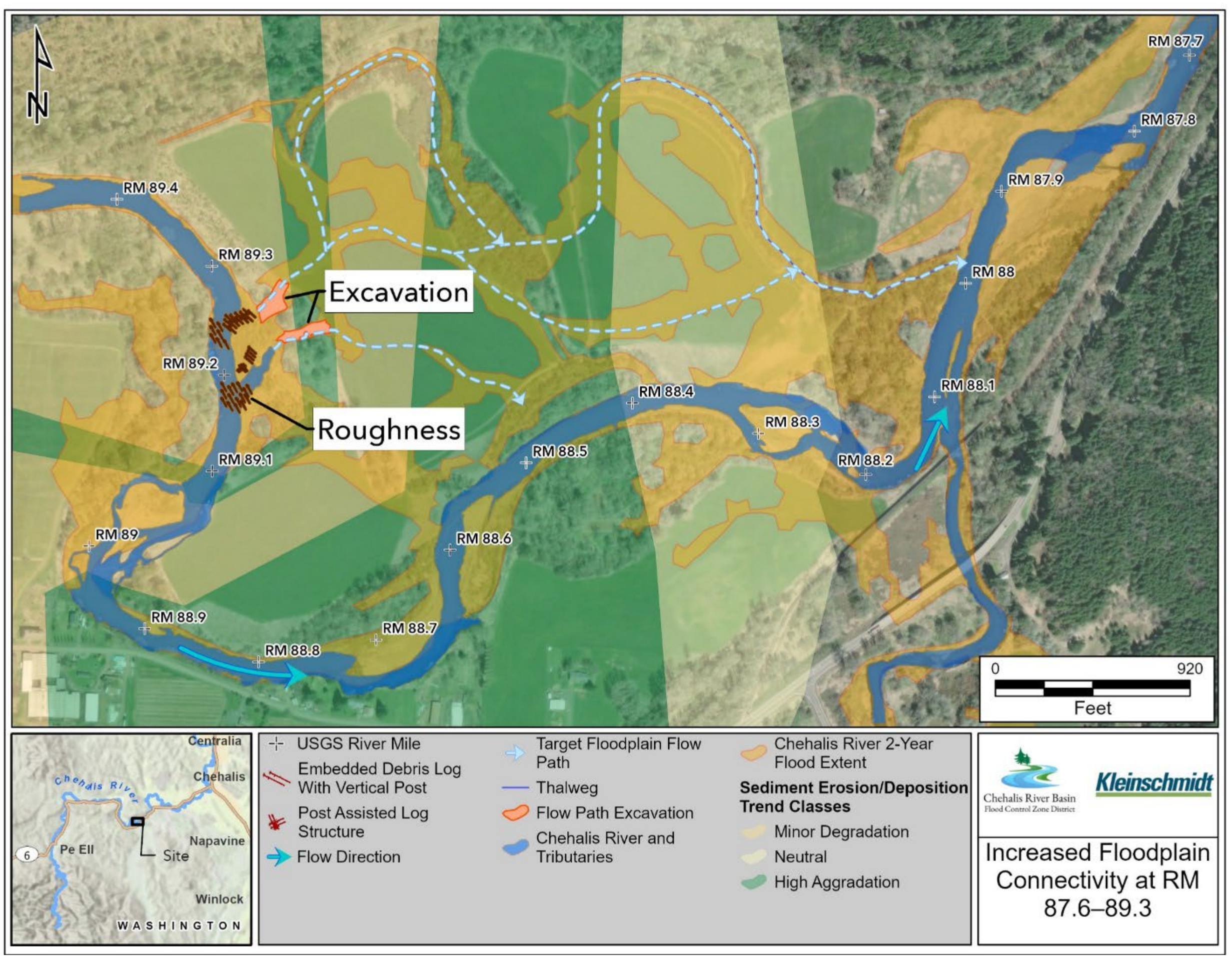
This site involves actions to increase floodplain flows between approximately RM 89.3 at the upstream end and RM 87.6 at the downstream end as depicted in Figure 8.1-6. The floodplain flow paths are situated within the first large alluvial floodplain area of the Chehalis River downstream of the proposed FRE facility. This area has more frequent overbank flow than upstream. The floodplain was formerly used for farming but was recently acquired by Washington State Parks (Parks) and the Applicant for use as a public park and conservation property. Parks' goals for the property include maintaining trails and open space for recreation, and establishment of a more complex floodplain forest and wetland mosaic for wildlife habitat. Accordingly, the site is also proposed for a wetland enhancement mitigation action (see Section 8.6, Wetlands Enhancement Plan). The reach has experienced relatively little channel migration over most of its length in the past 50 years except at the two locations proposed above as candidates for side channel enhancement. The upstream side channel enhancement actions would be placed in an aggradational setting around a hydraulic control that backwaters a relatively uniform channel reach upstream that is predicted to have a minor degradation tendency. Several relic river channel flow paths on the floodplain are hydraulically connected at around the 2-year flood. These would be planted with floodplain forest and wetland species and be connected hydraulically to the river more frequently through a combination of in-channel wood placements to raise water levels in the river at around bankfull flow events, and excavations to lower floodplain swale inlet elevations controlling inflows. A mix of PALS, exposed debris logs, and anchored bottom logs would be placed to increase roughness and reduce flow conveyance to increase water levels at the locations of the excavated inlets.

The projected benefits of this mitigation action are the enhancement of approximately 9,200 linear feet of floodplain flow path that with reforestation could be a future source of large wood and instream habitat complexity for rearing Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow and cutthroat trout; quiet water/wetlands for native amphibian spawning, juveniles, and adults.

8.1.1.4 Spawning Habitat Enhancement Design Elements

Spawning habitat enhancement mitigation would focus primarily within the documented extent of Chinook salmon spawning activity. Of all the anadromous species native to the basin, Chinook salmon are most dependent on spawning habitat potentially impacted by proposed FRE facility operations. Other anadromous SOC such as steelhead and coho salmon also have more extensive spawning habitat available in tributaries above and below the impact reaches. The majority of Chinook spawning in the upper Chehalis River basin has been recorded in the greatest concentration in a 4-mile reach in the Pe Ell Valley and the first two miles downstream of Fisk Falls, a natural upstream passage impediment on the Chehalis River above the confluence with Roger Creek (WDFW barrier site ID 23.0190 113.80, WDFW 2022; see Appendices A and B). Mitigation efforts are focused on enhancing spawning gravels in appropriate sites within each reach, and at selected appropriate locations upstream of Fisk Falls and in lower Crim Creek.

Figure 8.1-6
The Conceptual Design Proposed for Increasing Floodplain Connectivity Between RM 87.6 To RM 89.3 in the Chehalis River. The Orange Highlight Underneath the Segment Shading Depicts the Extent of the Simulated 2-Year Flood Recurrence Interval Peak Flow. The Green Segment Highlights Bounded by HEC-RAS Model Cross-Sections Indicate a High Aggradational Tendency, the Tan Highlight at Left Indicates a Minor Degradation Tendency, and the Pale Highlight at Right Above the Confluence with South Fork Chehalis River Is Neutral (Tendency Was Not Calculated Downstream of the Confluence).



Gravel retention jams and boulder arrays are proposed to mitigate fine sediment impacts on spawning habitat within the reservoir inundation zone. Large wood and boulder placements create hydraulic roughness and sheltering conditions that promote the accumulation and retention of gravel and cobble materials comprising spawning habitat. Wood structures are placed downstream of locations where additional gravel deposition is desired, in reaches with sufficient transport capacity to deliver the material. Measures are proposed below for seven gravel enhancement sites. Six of the sites are situated within or proximal to river segments where hydraulic model predictions indicated a tendency for long-term aggradation (see Appendix J), and where field observations of local gravel and cobble distributions were indicative of sites suitable for spawning with reduced risk of deep scour compared with elsewhere. The seventh site is located in lower Crim Creek, which was not modeled but where spawning gravels were observed to accumulate naturally under favorable hydraulic conditions.

8.1.1.4.1 River Miles 102.2 and RM 102.4 – Spawning Gravel Deposition

Two sites located near the downstream end of the major spawning reach in the Pe Ell Valley were documented to contain relatively large deposits of gravel that appeared suitable for Chinook salmon spawning. The sites are shown in Figure 8.1-7. Sediment transport modeling predictions indicated that the sites were suitable for gravel deposition measures to increase spawning habitat (see Appendix J). In addition, the upper site at RM 102.4 also was suitable for providing habitat complexity in the form of pools around large wood and maintaining a split flow channel. The conceptual design for RM 102.2 involves installing large wood pieces anchored with ballast boulders and large habitat boulders sitting on bedrock or the riverbed. The design for RM 102.4 involves constructing PALS and installing large wood pieces anchored with ballast boulders and various-sized habitat boulders sitting on bedrock and the gravel-cobble riverbed.

The projected benefits of this mitigation action are to enhance Chinook salmon and steelhead spawning habitat by about 3,800 ft^2 at RM 102.2 and 1,500 ft^2 at RM 102.4, and to create approximately 320 ft^2 of rearing and adult habitat at RM 102.4 for Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow (*O. mykiss*) and cutthroat (*O. clarkii*) trout, sculpins (*Cottus* sp.), and native cyprinid. This action also has the potential to provide off-channel habitat for native amphibian spawning.

8.1.1.4.2 River Mile 111.7 – Spawning Gravel Deposition

This site is shown in Figure 8.1-8 and is located upstream of the proposed FRE facility near the downstream end of the core spawning reach below Fisk Falls. The site contains the two longest riffles with potential spawning habitat mapped between the proposed FRE facility and Fisk Falls and lies within a sub-reach where predicted sediment trapping efficiencies indicate a neutral to minor aggradational tendency (see Appendix J). The strategy for the site is to increase roughness downstream of the spawning riffles and reduce the energy gradient upstream, thereby promoting continued and potentially additional deposition of spawning gravels in the riffles. This would also help reduce the risk of deep scour during floods. The conceptual design involves installing large wood pieces anchored with ballast boulders.

The projected benefits of this mitigation action would be to enhance spawning habitat for Chinook salmon and or steelhead in three locations, resulting in approximately 34,000 ft^2 of additional spawning habitat within the 2-mile-long spawning reach below Fisk Falls.

Figure 8.1-7
The Conceptual Design Proposed for the RM 102.2 and RM 102.4 Sites in Chehalis River (Red Polygons) Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradation Tendency, the Tan Highlight at Left Indicates a Minor Degradation Tendency, and the Pale Highlight Is Neutral. General Locations Where Spawning Gravel Retention Is Desired Are Indicated.

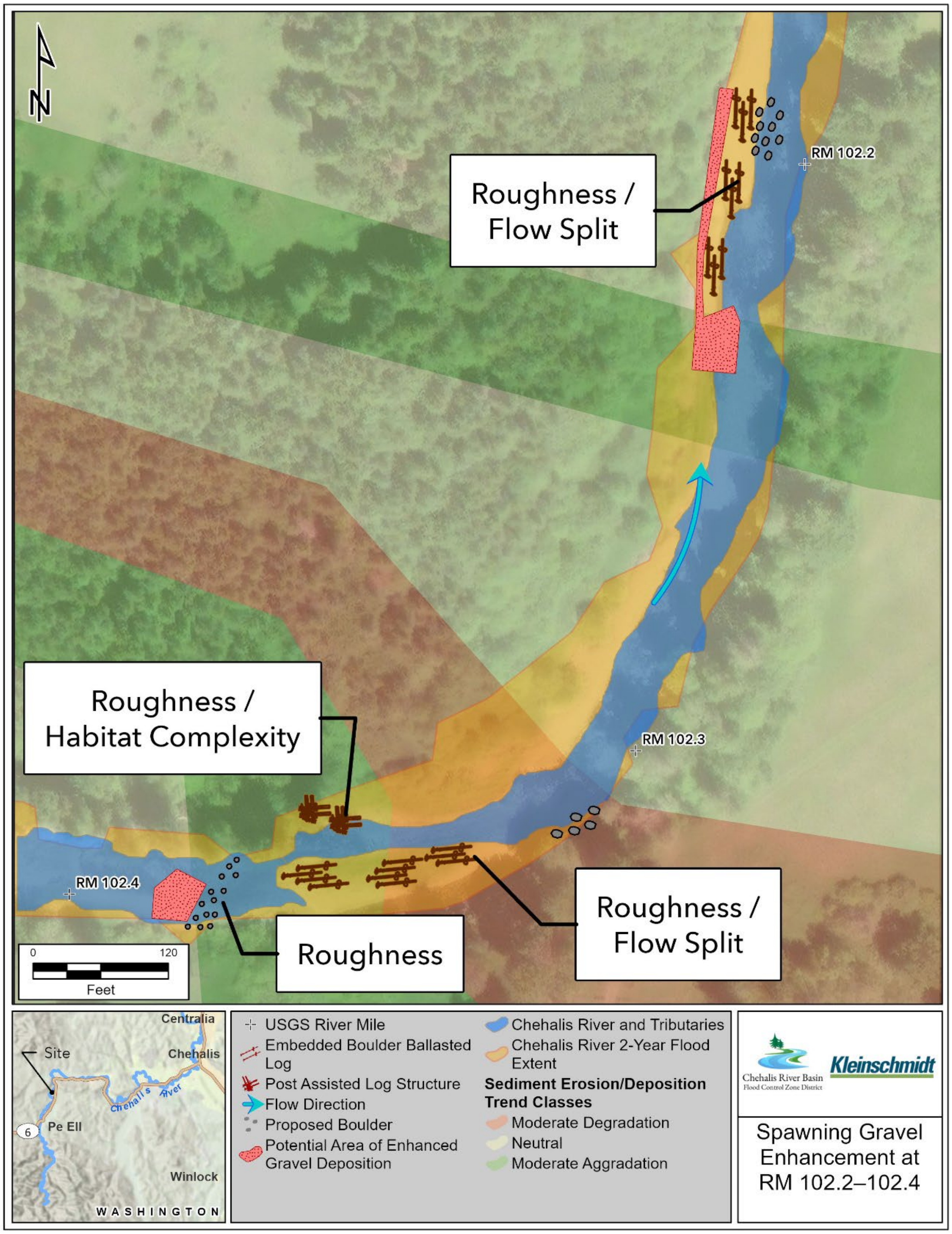
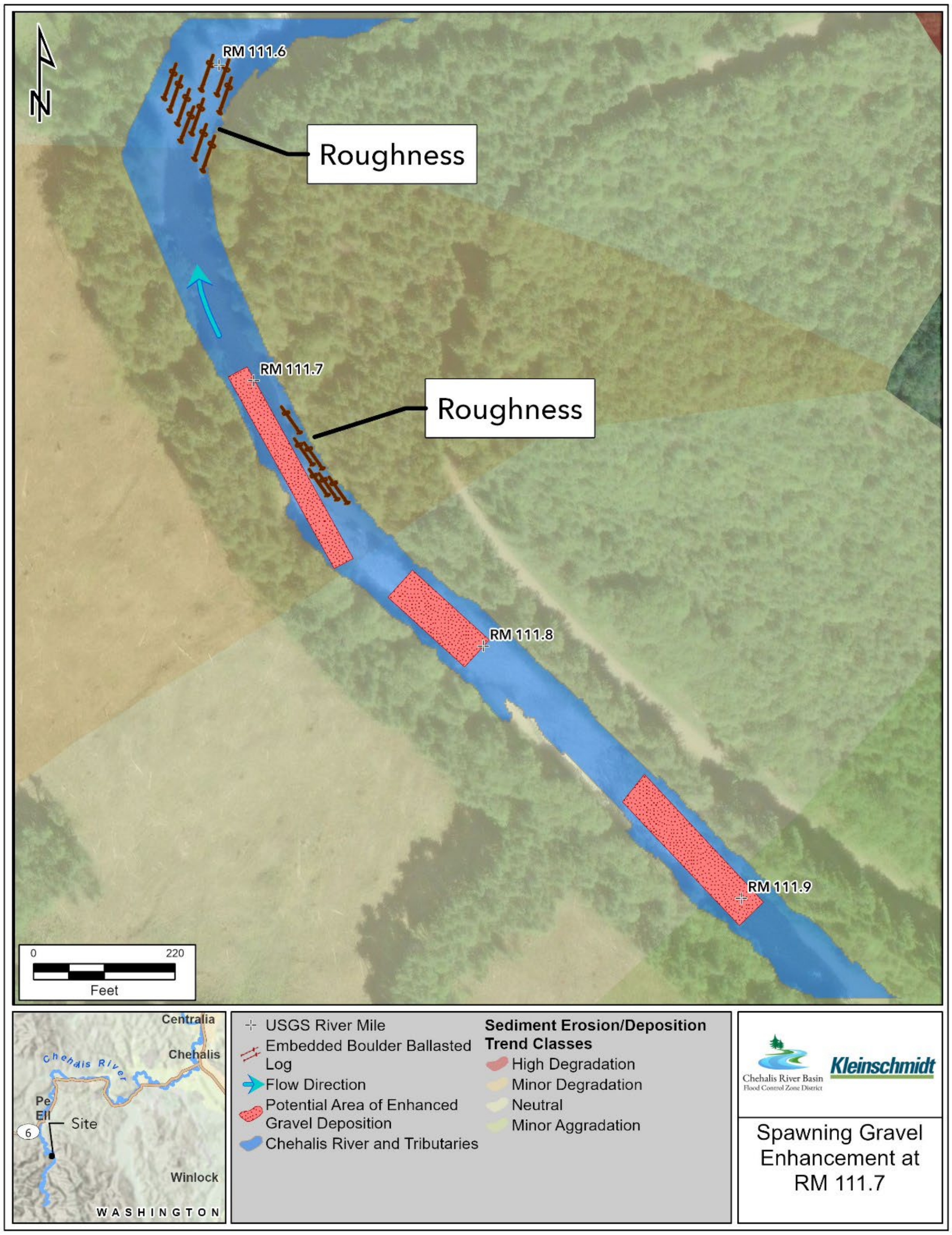


Figure 8.1-8
The Conceptual Design Proposed for RM 111.7 Site Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradational Tendency Where Spawning Gravel Deposition Would Likely Be Enhanced, the Tan Highlight in the Middle Indicates a Minor Degradation Tendency, and the Pale Highlight Is Neutral Where Existing Spawning Riffles Would Be Expected to Be Preserved. The General Location Where Spawning Gravel Retention Is Desired Is Indicated.



8.1.1.4.3 River Mile 113.2 – Spawning Gravel Deposition

This reach within the vicinity of RM 113.2 was the only mainstem site identified in previous assessments of GIS and other available data (Kleinschmidt 2020b) for the implementation of gravel retention structures downstream of Fisk Falls. The site is shown in Figure 8.1-9. The upstream portion of the site contains a mid-channel gravel-cobble bar deposit within a corresponding flood flow divergence zone that is predicted to have a long-term aggradational tendency (see Appendix J). The size of the substrate in 2023 was relatively large, but there was one patch of spawning habitat, and more patches upstream (see Appendix B). Substrates at the tail of the pool and downstream riffle crest were composed of smaller gravel than on the bars in 2022 and 2023 but may comprise a more transient deposit that erodes during rising stages and forms during falling stages of flood hydrographs. The deep pool is a desirable feature providing temporary cover for Chinook salmon spawning nearby.

To promote the deposition of smaller gravels across the site, the proposal is to: i) increase the roughness of the upstream mid-channel bar during high flows; ii) constrict flow downstream near the bedrock pool constriction to maintain the pool; and iii) place roughness mid-channel and on the bar downstream of the pool. These measures would be expected to increase backwater upstream to promote gravel deposition during high water. To accomplish this, a combination of streambed boulders and debris logs within the low-mid flow channel, and PALS opposite the bedrock outcrop to constrict high flows is proposed. The use of large wood to increase bar roughness at this site would likely require anchoring with chained ballast boulders instead of relying on deeply embedded wood pieces. In addition, large streambed boulders can be placed in arrays across the surface of the bars. The PALS would need to be anchored deep in the left bank substrate to reduce the potential for scouring out.

The projected benefits of this mitigation action are enhancement of approximately 6,400 ft^2 of spawning habitat for Chinook salmon and steelhead within the 2-mile-long spawning reach below Fisk Falls.

8.1.1.4.4 River Mile 114.7 – Spawning Gravel Deposition

This site is shown on Figure 8.1-10 and was selected based on Chinook salmon redd count data presented in the SEPA DEIS (Ecology 2020), followed by field observations of spawning gravel still present in 2023 at a pool tail/riffle crest area. The site is predicted to have a long-term degradational tendency but it sits just upstream of an aggradational reach (see Appendix J). Spawning habitat appeared to be otherwise absent downstream and upstream in the reach based on field observations. Increased roughness in the riffle would be expected to slow down velocities upstream and promote additional and/or maintain deposition in the pool tail and riffle crest of suitably sized substrates for spawning. This could be accomplished at this site by the placement of large wood pieces anchored with ballast boulders on both sides of the channel downstream of the riffle crest.

The projected benefits of this mitigation action are enhancement and extension of approximately 4,500 ft^2 of spawning habitat for Chinook salmon and steelhead upstream of Fish Falls and the temporary inundation zone.

Figure 8.1-9
The Conceptual Design Proposed for RM 113.2 Site Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradation Tendency, the Red Highlight in the Middle Indicates a High Degradation Tendency. General Locations Where Spawning Gravel Retention Is Desired Are Indicated.

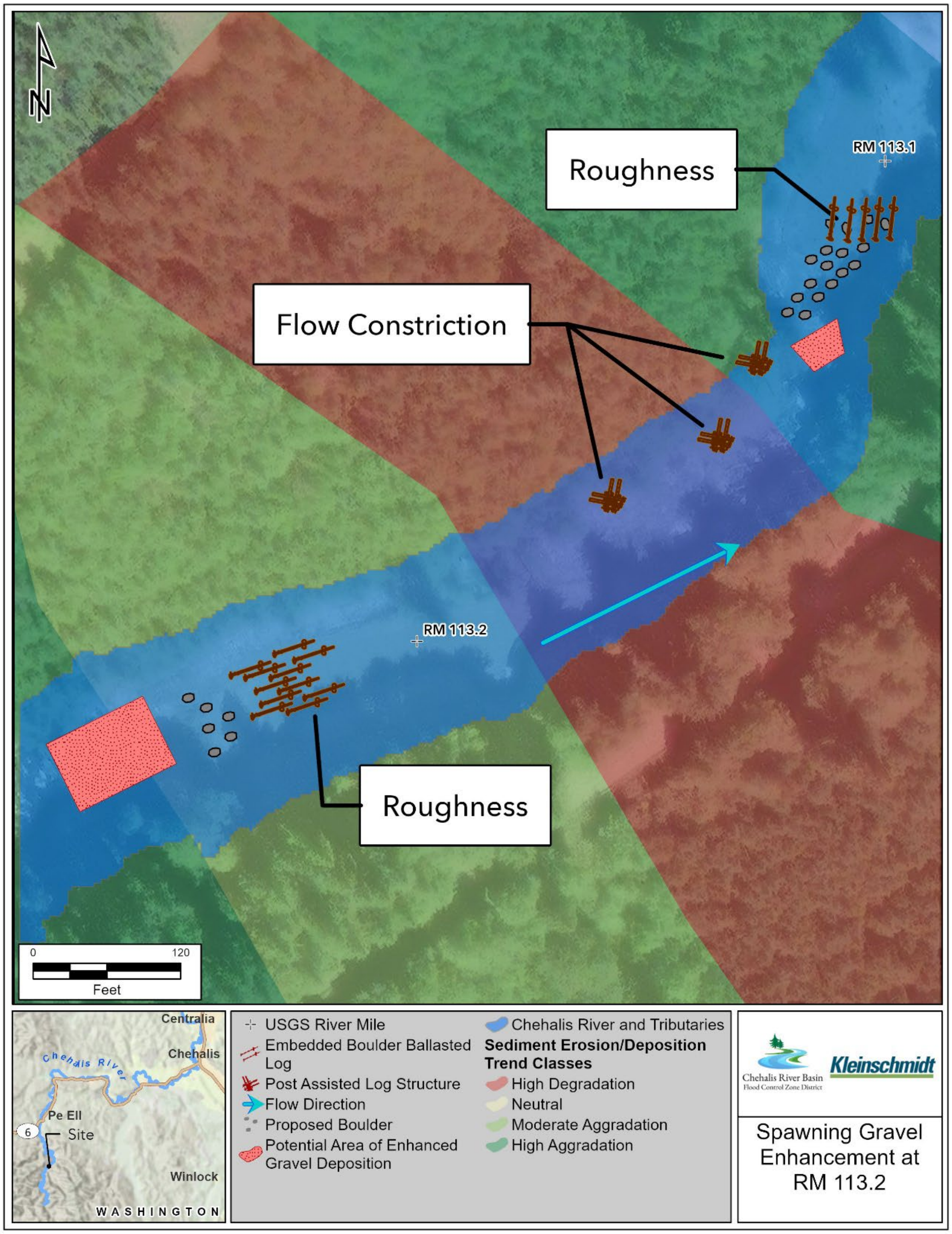
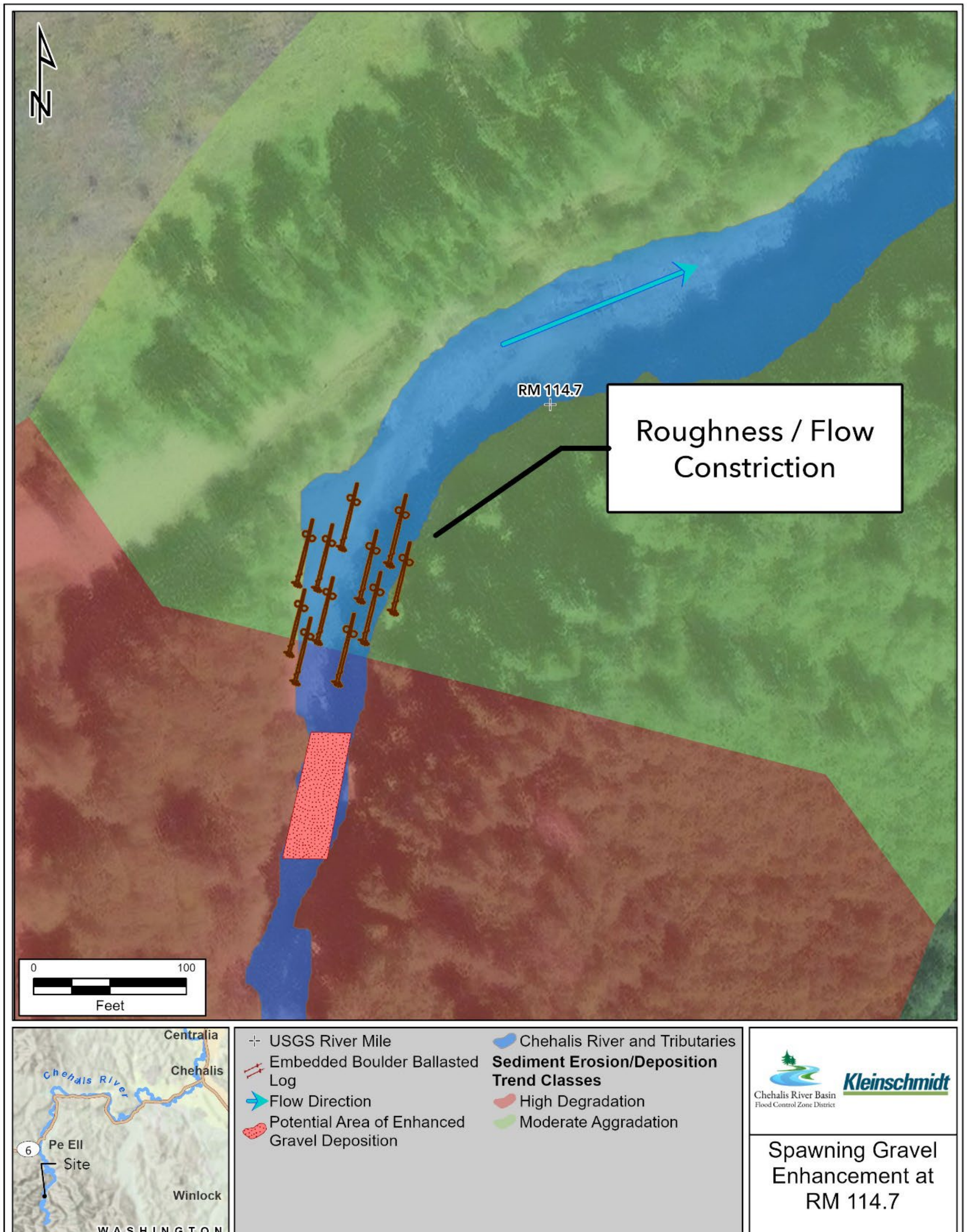


Figure 8.1-10
The Conceptual Design Proposal for RM 114.7 Site Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradation Tendency, Red Highlight Indicates a High Degradation Tendency. The General Location Where Spawning Gravel Retention Is Desired Is Indicated.



8.1.1.4.5 River Mile 115.7 – Spawning Gravel Deposition

This site is shown on Figure 8.1-11. Redd count data presented in the SEPA DEIS (Ecology 2020) identified the 300-foot-long riffle/run in the reach as a fall Chinook salmon spawning site that was also identified as a candidate for gravel retention structures in previous assessments of GIS and other available data (Kleinschmidt 2020b). The site is predicted to have a long-term aggradational tendency (see Appendix J). Additional gravel deposition would be associated with higher-quality habitat if velocities could be slowed within the site through a combination of increased roughness and flow constriction at the downstream end. The site is upstream of the potential inundation zone but is also difficult to access with heavy equipment for installing embedded large wood pieces. The conceptual design accordingly involves installing loose large wood pieces wedged into jams with boulders, and placement of large habitat boulders sitting on the riverbed.

The projected benefits of this mitigation action are enhanced and expanded spawning habitat of approximately 7,000 ft^2 for Chinook salmon and steelhead upstream of Fisk Falls and the temporary inundation zone.

8.1.1.4.6 River Mile 116.7 – Spawning Gravel Deposition

This was the most upstream site identified with spring Chinook salmon redds in the SEPA DEIS (Ecology 2020) and is shown on Figure 8.1-12. The channel is confined throughout the length of the surrounding reach but expands locally at a cobble mid-channel. The site is predicted to be strongly aggradational in its upstream half where spawning habitat is most likely to occur. The outside left channel is secondary to the main right channel and appears to have smaller substrates. Slowing down flood flows along the left side channel could promote additional deposition of suitably sized gravel and cobble for spawning, which could be accomplished primarily through increased roughness which would need to be provided by boulder placements. The conceptual design involves wedging loose large wood pieces into jams with boulders and placing large habitat boulders sitting on the riverbed for increased roughness to facilitate additional deposition of spawning-suitable substrates.

The projected benefits of this mitigation action are enhancement and expansion of spawning habitat of approximately 6,100 ft^2 for Chinook salmon and steelhead upstream of Fisk Falls and the temporary inundation zone.

Figure 8.1-11
Conceptual Design Proposal for RM 115.7 Site Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradation Tendency, the Red Highlight Indicates a High Degradation Tendency. The General Location Where Spawning Gravel Retention Is Desired Is Indicated.

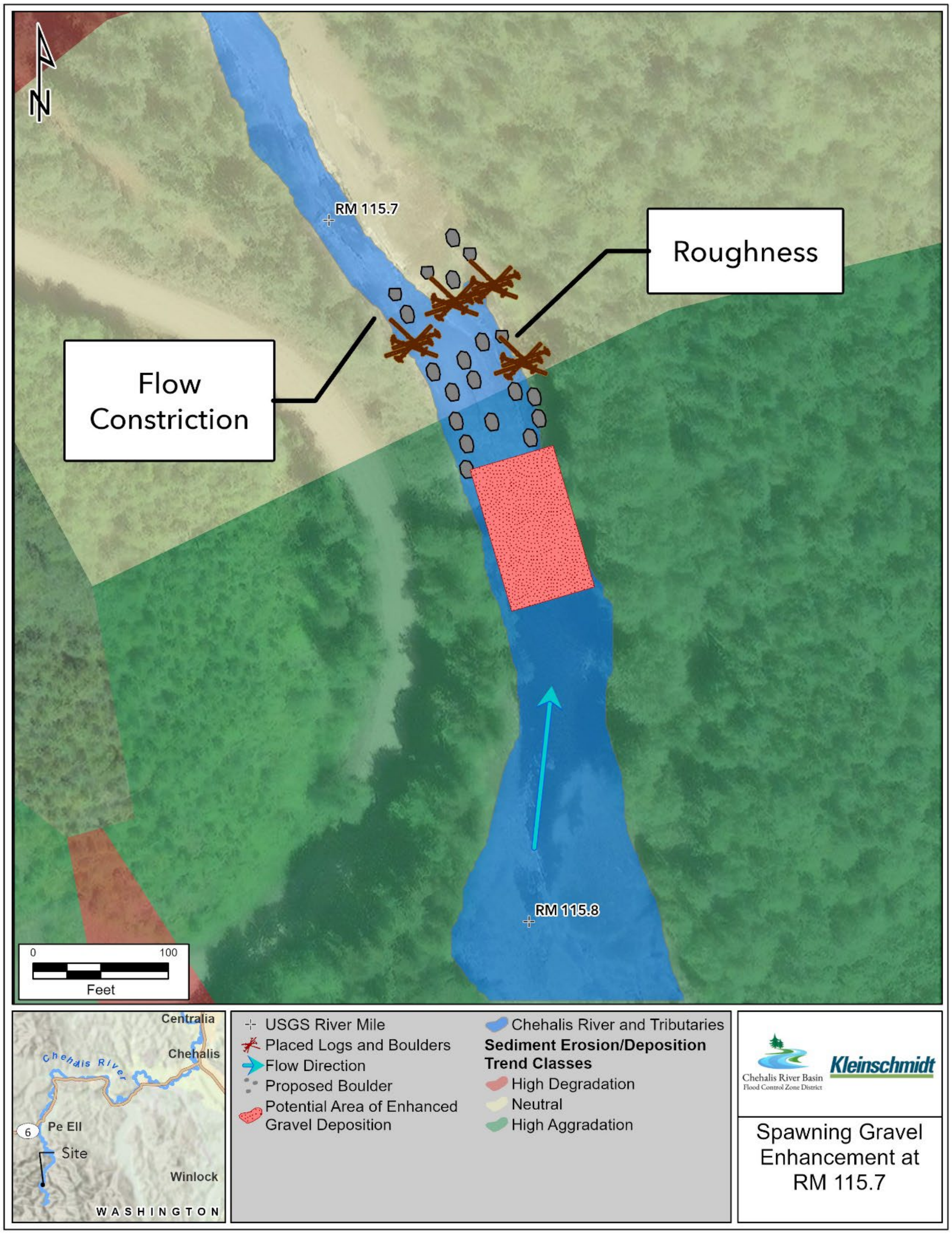
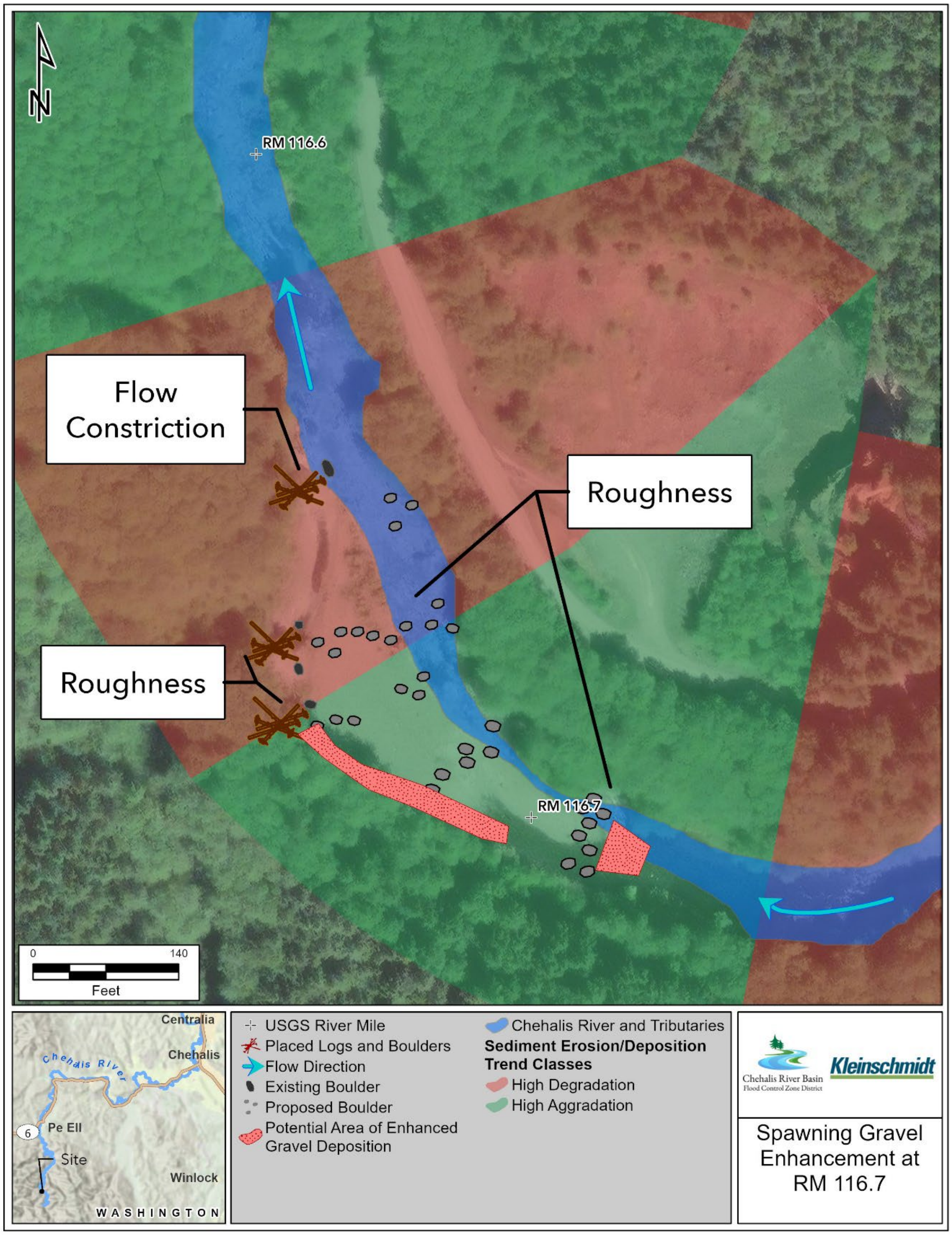


Figure 8.1-12
The Conceptual Design Proposal for The RM 116.7 Site Where Enhanced Gravel Deposition Appears Feasible Based on Reach Scale Predictions of Aggradation Tendency in the Chehalis River. The Green Segment Highlight Bounded by HEC-RAS Model Cross-Sections Indicates a High Aggradation Tendency, the Red Highlight Indicates a High Degradation Tendency. The General Locations Where Spawning Gravel Retention Is Desired Are Indicated.



8.1.1.4.7 Crim Creek – Spawning Gravel Deposition

Three locations within a strongly confined reach spanning the confluence with Lester Creek were identified during a field visit by Kleinschmidt in early 2024 to have hydraulic and geomorphic conditions associated with gravel presently settling out, as shown on Figure 8.1-13. The most downstream location is below Lester Creek and is a long pool tail and riffle crest and has the largest deposit of presently useable spawning gravel of the three. It corresponds to the approximate upstream extent of spring Chinook salmon spawning in the State DEIS (Ecology 2020). The other two locations are small deposits upstream of the confluence and correspond approximately to fall Chinook redd locations mapped in the DEIS. All three locations could be induced to settle out more gravel and cobble by roughening the streambed and slowing down flood waters. Large wood could not be placed as loose pieces because they would float away whenever the FRE would be operated and could create larger jams than desired in the confined channel. The most natural analog for the reach is to increase roughness through boulder placement.

8.1.2 Tributary Habitat Enhancements

This action type involves enhancing habitat complexity within and/or improving access to significant, smaller perennial tributaries connected to the mainstem Chehalis River. Enhancement measures involve the construction of habitat features in the perennial wetted channel to enhance, restore, induce, or create habitat-forming processes and habitat elements such as complexity, cover, hydraulic diversity, pool formation, summer thermal refugia from the mainstem, and spawning gravel retention. Example instream modifications include installing large wood material in the banks for habitat complexity, excavating new channels, constructing inset floodplains in tributary channels entrenched in the Chehalis River floodplain, and restoring degraded riparian buffers with trees and shrubs that provide bank stability and temperature regulation. Access improvements involve excavating more permanent, readily negotiated channels between the mainstem and tributaries. Three tributaries were identified where a mix of the above measures were considered to be generally feasible.

8.1.2.1 Restore Channel Connecting Upper Mill Creek with Chehalis River

Mill Creek is no longer connected to the Chehalis River east of Adna during most flows along the route drawn on USGS topographic maps and in WDFW's passage barrier database (WDFW 2019a). As shown in Figure 8.1-14, it used to flow to the east along State Route 6 in an undersized, overgrown, disconnected channel. Mill Creek presently drains south across a large wetlands complex before converging to another channel that flows under the Willapa Hills trail. The upstream channel transitions into several significantly narrower and shallower distributary channels over the wetlands area that are heavily overgrown with reed canary grass, with no clearly defined fish passage route. Upstream access by adult salmon and steelhead is accordingly difficult and likely restricted to very high flow events, with a concomitant high risk of stranding on the floodplain when flows drop. Juvenile salmonids and other native fish species are also vulnerable to stranding as floods-recede.

Figure 8.1-13
Conceptual Design Proposed for Spawning Gravel Enhancement in Lower Crim Creek.

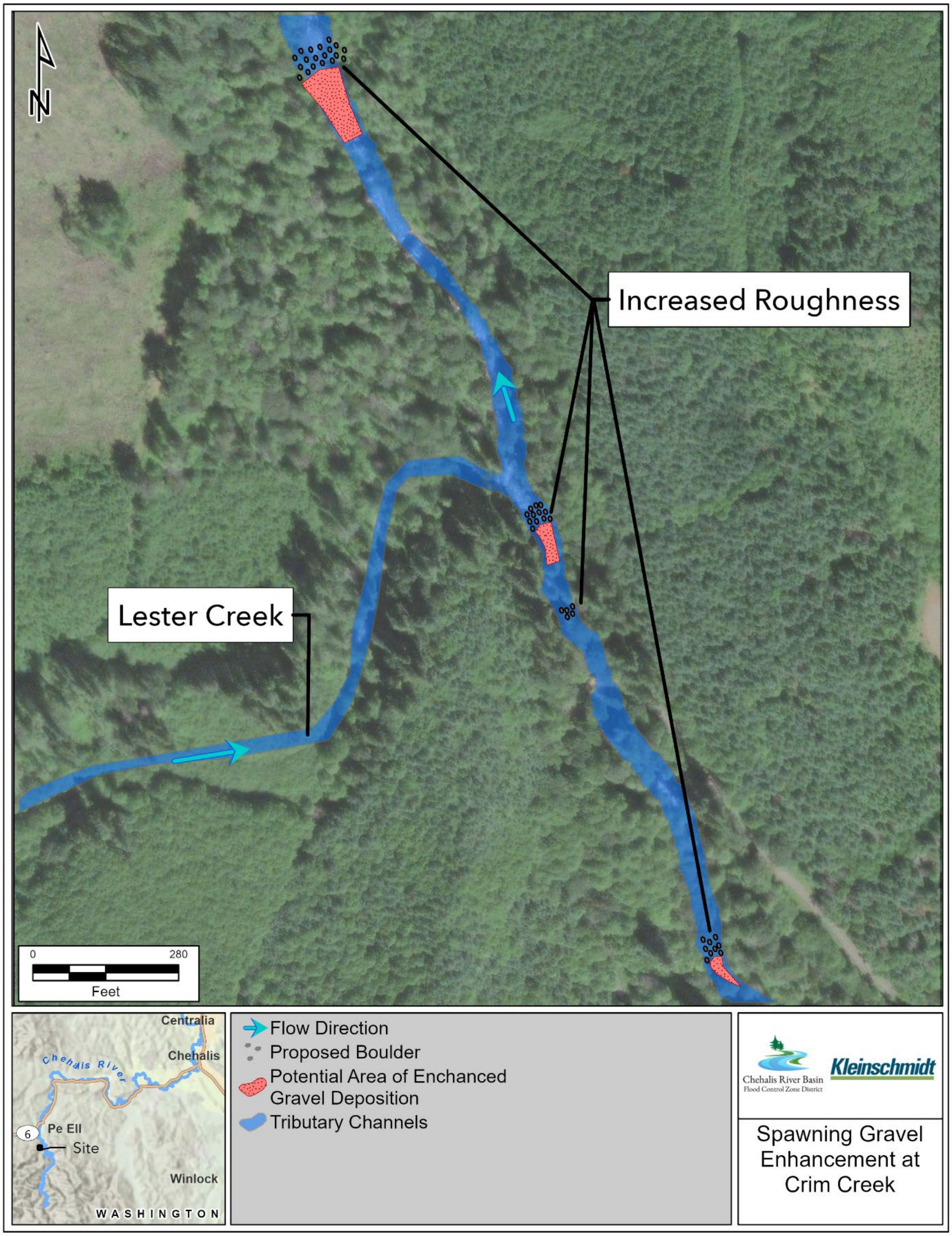
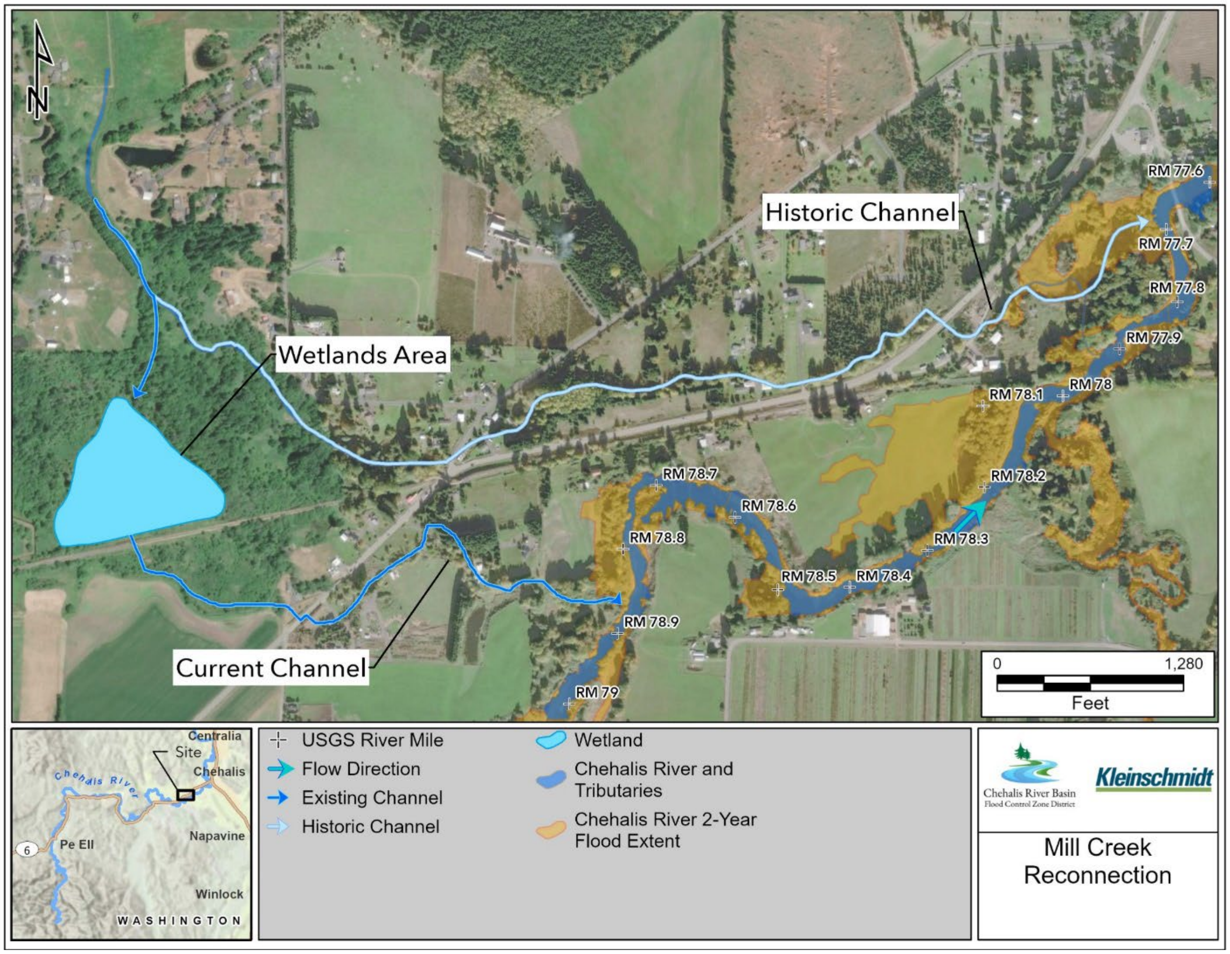


Figure 8.1-14
General Flow Paths of Mill Creek to the Chehalis River and Location of Wetlands Where a Distinct Channel Morphology Is Limited to Absent.



The primary action proposed Is to excavate a wider, deeper channel through the wetlands area that significantly improves upstream and downstream passage connectivity for fish and creates more useable juvenile salmonid rearing habitat within the wetlands complex. Large wood pieces would be embedded in the excavated streambanks to provide instream cover for rearing juveniles. The logs would also provide hydraulic roughness facilitating floodplain connectivity. The action would thereby maintain existing connectivity with low-elevation wetlands areas both within the immediate open scrub-shrub wetlands and in an adjacent low-lying forested wetlands to the east. Wetlands-tolerant riparian shrub and tree species would be planted along the constructed channel to retard encroachment of reed canary grass and provide shade to the river channel to reduce thermal loading.

The projected benefits of this mitigation action are the addition of approximately 1,400 linear feet of new stream within the wetland complex providing rearing habitat for anadromous fish species and all life stages of resident trout and native cyprinids. The new channel would open access to at least 0.29

miles of stream with potential spawning habitat for coho salmon, another approximately 1.2 miles with coho salmon and resident trout rearing habitat, and 0.2 miles more of resident trout habitat (WDFW 2022). In addition to coho salmon, the habitat upstream and locally could also potentially be used for rearing by steelhead and any Chinook salmon that remain in the system as yearlings. Other species potentially benefitting include cutthroat trout, sculpins, and native cyprinids.

8.1.2.2 Enhance Instream Habitat Complexity, Riparian Buffer, and Floodplain Connectivity in Bunker Creek

Bunker Creek is one of the largest tributaries located between the South Fork and the Newaukum River. It drains more than 32 mi^2 upstream of its first tributary, which is located approximately 1,800 feet from the confluence with the Chehalis River. Bunker Creek represents a strategic location for off-channel habitat for juvenile salmon in the middle Chehalis River, which has few large perennial tributaries that are accessible during low flow summer and fall months. The proposed reach for mitigation actions is located near the confluence with the river as shown on Figure 8.1-15. In addition, various fish passage restoration projects have been completed farther upstream in Bunker Creek and the tributary, and a culvert within the proposed enhancement reach property has been identified by WDFW as affecting passage to significant habitat upstream (WDFW barrier site ID 601174).

The channel in the mitigation project reach is entrenched within the Chehalis River floodplain. The streambed is composed of gravel at various riffle locations, some of which could potentially support salmon spawning. Streambanks are near vertical, unvegetated, and eroding at places, thereby providing a source of fine sediments and little riparian cover for shading in the channel. The absence of an intact, contiguous riparian vegetation buffer reflects the use of the surrounding Chehalis River floodplain for farming. Enhancement of the site would need to minimize effects on farming accordingly.

Several mitigation actions are proposed for enhancing fish habitat in the site and include: excavating an inset floodplain on one or both sides of Bunker Creek's ordinary high water (OHW) channel and laying back the edges of the cut at a 3H:1V slope to the surrounding Chehalis River floodplain to provide a more stable planting medium, reduce flood stage and energy during high flows in Bunker Creek, create floodplain connectivity for Bunker Creek when the Chehalis River is not flooding, and reduce sediment erosion and delivery to the channel. Grading is proposed along both banks of the channel between Ceres Hill Road and the riparian forest lining the banks of the Chehalis River, and on the west side of a section of channel upstream of the road. Large wood pieces would be installed within the OHW channel for habitat complexity. Native trees and shrubs would be planted on the laid-back bank and inset floodplain to enhance overall channel stability, and to provide shade, instream and overhead cover, insect drop, and future large wood debris (Figure 8.1-16). As part of fish passage improvements, the culvert would be removed to enhance upstream fish passage.

Figure 8.1-15
Location and Extents of Mitigation Actions Proposed for Lower Bunker Creek.

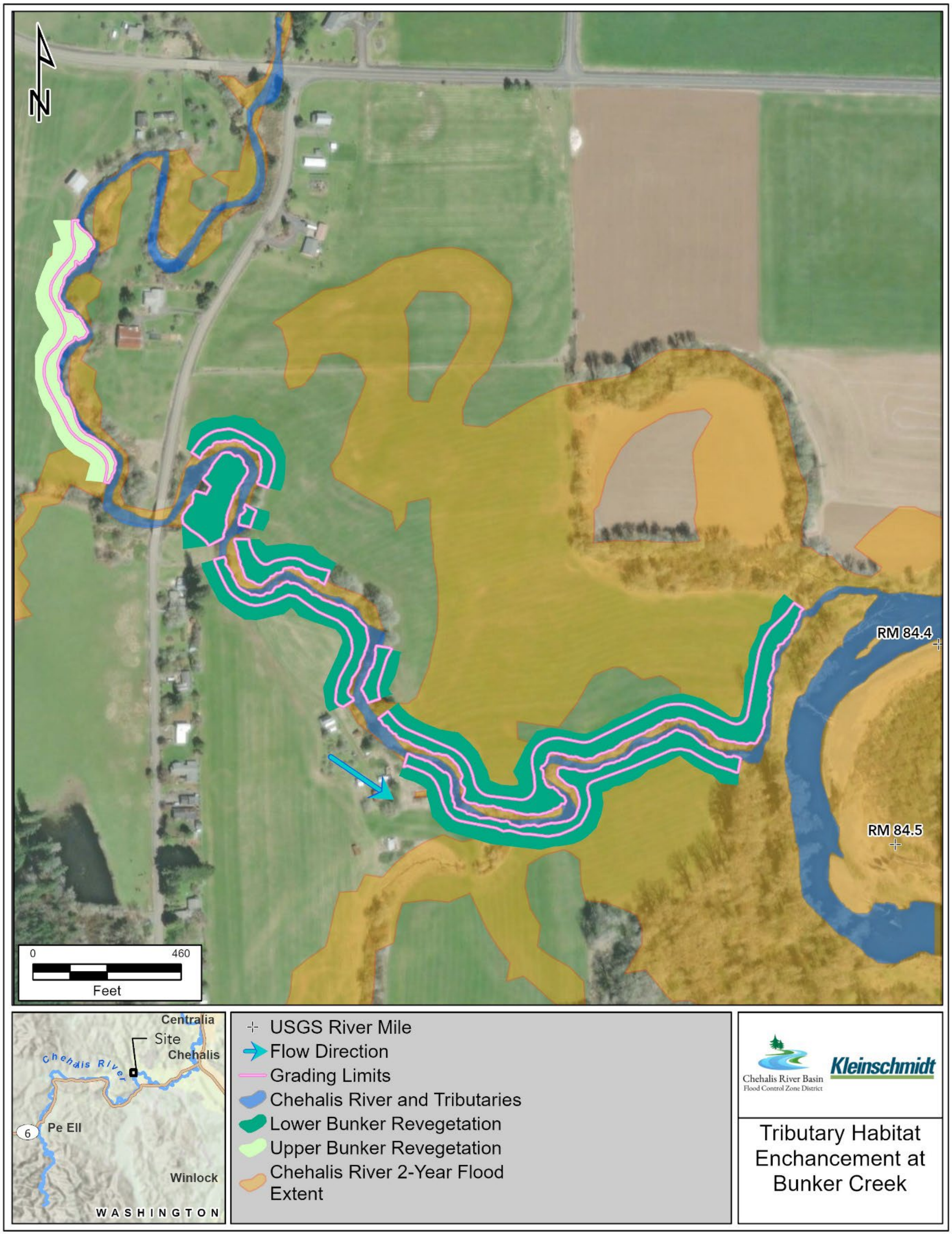
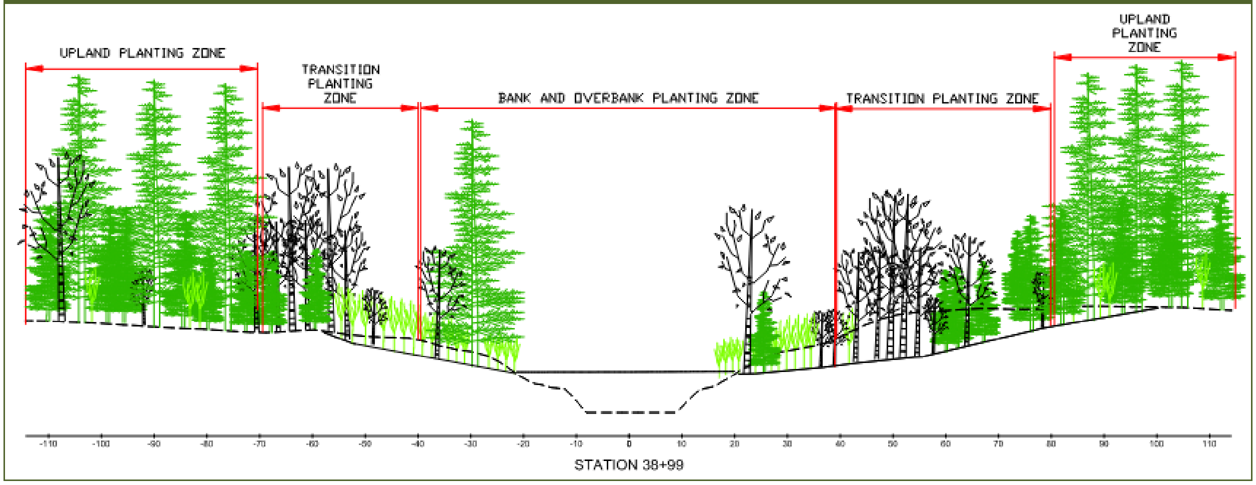


Figure 8.1-16
Example Cross-Section Profile Representing Proposed Typical Grading and Associated Generalized Planting Zones in Lower Bunker Creek. The Approximate Level of Ordinary High Water Is Depicted in the Channel.



The projected benefits of this mitigation action are approximately 0.9 miles of rearing and summer thermal refuge habitat for Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, and native cyprinids. Approximately 0.5 miles of the improved reach would also have isolated spawning riffles. Removal of the culvert (see Section 8.1.3) would improve fish access to at least 8.1 miles of stream with potential habitat for coho salmon and steelhead, of which 3.9 miles contain spawning habitat (WDFW 2022).

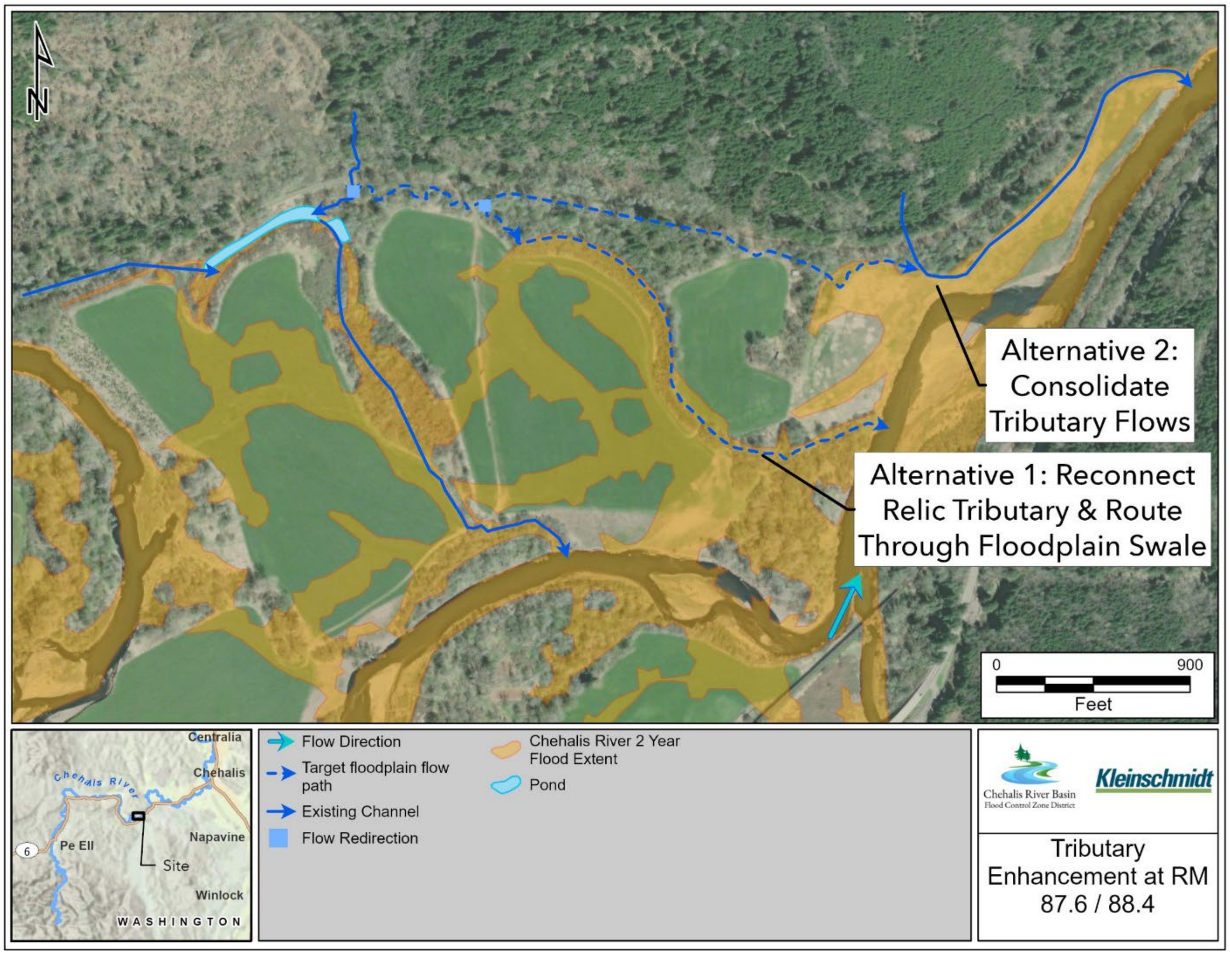
8.1.2.3 River Miles 87.6-88.4 – Extend and Consolidate Tributaries with Improved Low-Flow Access from River

A small, steep, perennial tributary drains Ceres Hill opposite the confluence of the mainstem and South Fork Chehalis River. The tributary is presently disconnected from the river at approximately RM 88.4 except during high-flow periods. The tributary loses gradient as it flows under the Willapa Hills trail through a culvert that was replaced by WDFW in 2014 (barrier site ID 125 1304W13B). The water flows into a nearby relic oxbow to the west that ponds water year-round. Anecdotal accounts of juvenile salmonids in the pond indicate connectivity exists with the river, however, the pond drains towards the river through a wetland complex with several intervening shallow beaver ponds, across a rocky ford for farm equipment, and over a steeper riverbank at the edge of the river. There is no defined, continuous channel between the pond and the ford, thus connectivity for fish passage is intermittent and restricted to higher-intensity precipitation events. This condition may contribute to an elevated risk of trapping and stranding of both juvenile and adult coho salmon and steelhead. There is also a second, smaller, ephemeral tributary that drains Ceres Hill to the east, flows under the Willapa Hills trail through an undersized culvert, and then flows through a ponded area against the base of the hillside. The tributary channel slopes gently down to its confluence with the river downstream of the South Fork at approximately RM 87.6, with an inverted elevation below typical flow levels in the river. Both tributaries north of the trail are steep (~8 percent slope) and not expected to provide significant fish habitat. The primary relevant function of the tributaries is to provide rearing habitat for juvenile salmonids and amphibian habitat.

Figure 8.1-17 shows two alternative excavation routes that were considered for extending the flow path of the perennial tributary. The selected proposed action (Alternative 2 in the figure) involves re-routing the perennial tributary towards its relic channel, excavating a connector channel with the ephemeral tributary channel that runs along the base of the hillside and Willapa Hills trail, and redirecting flow from the relic perennial channel to the excavated connector channel. This action was selected because it maximizes the overall length of new and enhanced tributary habitat (approximately 4,800 feet), consolidates flows from both tributaries and groundwater seepage from the hillslope, has a gradient that is representative of a gravel bed stream, and takes advantage of the existing connectivity with the river at the downstream end of the ephemeral tributary. In addition to providing year-round rearing habitat, the greater cumulative flows associated with this action may also provide usable thermal refuge habitat from the river over the summer months.

The projected benefit of this mitigation action is to provide approximately 0.9 linear miles of off-channel tributary rearing and summer thermal refuge habitat for Chinook salmon, coho salmon, and steelhead juveniles, resident rainbow and cutthroat trout, sculpins, and native cyprinid as well as spawning, rearing, and adult habitat for native amphibians.

Figure 8.1-17
Flow Paths of Current Drainage and Proposed Alternative Tributary Excavations to the Chehalis River in the Vicinity of the South Fork Chehalis River. Orange Highlight Depicts Extent of Simulated 2-Year Flood Recurrence Interval Peak Flow. Solid Lines = Current Tributary Flow Paths, Dashed Lines = Proposed.



8.1.3 Tributary Habitat Enhancements – Culverts

The mitigation plan has a target of improving habitat access to 2.5 times the Applicant's refined estimate of potentially impacted length of streams (Section 5), or a total of 39.3 miles (63.3 km). An assessment was performed of the feasibility and mitigation benefits of removing or replacing culverts that present as significant upstream passage barriers to get to that target. WDFW's (2022) statewide passage barrier database indicates there are more sites and stream miles where providing or enhancing access to upstream habitats would benefit coho salmon, steelhead, Pacific lamprey, and other native fish species than Chinook salmon. Hence, mitigation actions to improve upstream passage is expected to benefit primarily species other than Chinook salmon.

Opportunities for the greatest mitigation benefits appear to be associated with sites that are considered in WDFW's database to be either total barriers or highly restrictive to upstream passage by anadromous fish species, and that would open up access to significant habitats. Such sites would likely result in greater benefits should they be corrected compared with other locations. This and a variety of other criteria were considered in ranking culverts as candidates for removal or replacement as mitigation, and an initial candidate list of ~20 culverts was developed accordingly (see Appendix J). Of these, a subset was selected that were judged to provide more than sufficient mitigation needs. Table 8.1-1 lists the resulting culverts considered to have highest potential for mitigation benefits if corrected, and where access and constructability appear to be feasible based on initial assessment of landownership willingness. The table summarizes key attributes including species and life stages benefitted, the amount of habitat estimated to be upstream, and location information.

The culverts were evaluated in greater depth for feasibility and expected cost of replacement. Site characteristics reported in the WDFW database, field visit observations and topographic surveys performed by Kleinschmidt, longitudinal elevation profiles extracted from LiDAR data, and property parcel information from the Lewis County Assessor website formed the basis for identifying a likely replacement structure type, water management approach, traffic management approach, expected excavation and haul volumes, and potential constraints. Appendix J contains a more detailed summary of the existing setting, attributes affecting suitability and feasibility as a mitigation project, a conceptual design outline, and a concept screening level cost estimate to complete design, permitting, and construction for each barrier.

Table 8.1-1
List of Proposed Barrier Corrections in the Chehalis River Basin That Could Provide Mitigation for Proposed FRE Facility Impacts.

STREAM	ACTION	WDFW FISH BARRIER ID	SPECIES	HABITAT UPSTREAM MI. (KM)	REASON
Nicholson Creek	Replace perched culvert, restore channel in oxbow	125 1304W03A	coho, steelhead, Chinook	3.65 (5.85)	Water surface drop
Unnamed Tributary to McCormick Creek	Replace perched culvert	125 1303W31A	coho, steelhead	0.52 (0.85)	Water surface drop
Beaver Creek	Replace perched culvert	125 1304W35B	coho, steelhead	1.34 (2.16)	Water surface drop
Bunker Creek	Remove concrete split box culvert	601177	coho, Steelhead	29.8 (48.0)	Water surface drop
Unnamed Tributary to Bunker Creek	Remove perched culvert	125 1303W06A	coho, steelhead	3.29 (5.3)	Water surface drop
Unnamed Tributary to Nicholson Creek	Remove culvert	940490	coho, steelhead	0.74 (1.2)	Slope, water surface drop

8.2 Riparian and Stream Buffer Expansions Plan

The Riparian and Stream Buffer Expansion Plan would improve riparian habitats through 2 mitigation action types, Riparian Enhancement and Forest Conversion. Riparian Enhancement would occur along the mainstem Chehalis River and some tributary streams to mitigate residual impacts related to loss of riparian habitat and shade reduction, degraded aquatic habitat, degradation of wildlife habitat, and degraded water quality associated with the construction and operation of the FRE facility. The current condition of the riparian habitat within the mitigation area is degraded as it has been impacted by agriculture practices, tree clearing, and the establishment of invasive species for decades. Reforesting and enhancing these habitats would result in a variety of benefits to both aquatic and terrestrial species that occupy them. A primary objective of this action is shade-related reduction in summer water temperatures and associated improvements in DO. The residual impact from shade loss with implementation of the VMP is 360,048,000 average kcals/day (Section 6). The applicant is proposing sufficient riparian restoration to offset thermal load by 880,606,358 average kcals/day a bit more than 2.45 times the modeled impact.

As described in Appendix G, the Applicant has identified over 300 land parcels, between the FRE facility and the town of Chehalis including the South Fork Chehalis River, Bunker Creek, and the Newaukum Rivier, where additional shade would provide thermal buffering. Landowner outreach has resulted in 131 parcels with landowners presently amenable to riparian reforestation planning along the mainstem river and Bunker Creek, while benefits from riparian enhancement downstream of the proposed FRE facility (Section 7) are described below under surface water Quality Management Plan (Section 8.5).

Currently, peak summer water temperatures in the Chehalis River downstream of the proposed FRE facility location routinely exceeds state standards in July and August, including those required for salmon spawning and rearing. In fact, in some year fish kills of spawning Chinook salmon have occurred in the mainstem. Reducing solar input and thereby thermal load to the river to an extent even greater than the impact would provide ecological lift for this critical life stage of spring Chinook salmon that are currently limited by temperature. Because VMP planting is an early action mitigation measure, the temperature impact of the proposed FRE facility would be minimized even before the effects on shade from FRE operation are realized, offering additional benefits to native aquatic species. Finally, the planting plans include a successional approach that would allow for the transition to long-lived native riparian tree species that would provide shade benefit for many decades into the future.

Upstream of the proposed FRE facility and upslope from the temporary pool, the Applicant is proposing enhance 13.3 acres of stream buffer available in the 1,921-acre block of forested timberlands as primary mitigation for the loss of 13.3 acres of stream buffers associated construction of the proposed FRE facility that cannot be minimized by implementation of the VMP nor through restoration of quarry areas. The proposed forest block contains approximately 23 miles of non-fish bearing streams and an estimated 362.5 acres of buffer enhancement opportunity. Periodicity of flow was not available for all of these streams and the extent of required buffer is dependent upon their perennial or seasonal nature.

Consistent with Forest Practices Act (FPA) the non-fish bearing, perennial streams would have a 50-foot no-harvest zone for up to 50% of their length Outside this core zone harvest would be allowed in an additional 40-foot buffer. There are no buffers required for non-fish bearing, seasonal, or unknown streams. Thus, to quantify the potential benefit of stream buffer opportunity with the Forest Conversion block, we assumed a worst-case scenario in which the entire length of streams with unknown flow periodicity was perennial flow and would be subject to a no-cut buffer applied to 50% of the stream length. Applying this to the 23 miles of stream length, we determined that 11.5 miles would be buffered with a 50-foot core zone and 40-foot limited harvest zone where retention of 20 trees per acre is required. An additional 11.5 miles of the stream would be unbuffered and would be subjected to harvest to the stream's edge on an approximate 40-year rotation.

The entire length of streams contained within the forest conversion block would benefit from reduced tree harvest within the riparian management zone. The 11.5 miles of perennial non-fish bearing streams would have an expanded no-harvest buffer from their 40-foot outer riparian zone totaling 111.5 additional acres of buffer. This area would be enhanced with in-planting of native riparian species resulting in increased shade and localized temperature modulation, increased leaf litter, nutrient cycling, and invertebrate production, more complex and diverse habitat to support native wildlife species.

However, the biggest stream buffer benefit would be to the 11.5 non-fish-bearing streams without buffer protections under FPA. Providing similar 90-foot buffers to these streams would result in an additional 251 acres of buffer around these non-fish-bearing streams. These streams provide important habitat for forest amphibians, and invertebrates and buffer expansions would improve ecological processes within the riparian zone including bank stabilization, production of living, dead and downed wood for habitat and forage substrate, filtering storm runoff, and nutrient cycling.

8.2.1 Riparian Planting Design Elements

The majority of locations of site-specific riparian enhancement mitigation presented in Sections 8.1, 8.2, and 8.5 are along fish-bearing streams and would follow the conceptual level planting plan describe herein. However, the expansion of riparian woodland/forest within the Forest Conversion action area is expected to vary based on site-specific information collected from future field surveys as the planting design for those sites would be dependent on the nature of seasonal versus perennial flow.

- **Invasive species** including reed canary grass and Himalayan blackberry are ubiquitous and extensive across the riparian planting sites. Removal of reed canary grass is assumed to be cost-prohibitive at the scale required for some degraded sites, so successional planting is proposed to shade out these invasives as a preliminary step in establishing more shade-producing vegetation species.
- **Grading and contouring** may be required to create an appropriately engineered floodplain that would establish and provide a stable planting area.
- **Soil amendments** may be required following grading. After grading and contouring is complete, scarification of the riparian planting sites may be necessary to reduce soil compaction, aerate

the soil, improve water retention, and create microtopographic relief that allows vegetation to establish faster. Additional soil amendments to consider include fertilizer and/or pH modifiers, depending on soil and site conditions. Soils should be tested for pH, nitrogen, phosphorus, and potassium (N-P-K) to confirm existing conditions and inform which soil amendments should be applied, if any.

- **Irrigation systems** may be required to help vegetation become established. Typically, in the Pacific Northwest, early spring and late fall are the best times to plant so the trees and shrubs receive natural rainfall during their first few weeks in the ground.
- **Sediment and Erosion Control** BMPs may be developed if there are erosion concerns or stormwater management requirements at specific sites.

8.2.2 Planting Overview

Three general riparian planting zones are identified for the design consisting of bank/overbank, transition, and upland following USDA Natural Resources Conservation Service recommendations (USDA 2024). The zones would be planted with native, hardy, wetland-tolerant, elevation-appropriate tree and shrub species observed in the area (Table 8.2-1). Planting densities would be determined in subsequent design stages but would likely range between 2-5 feet for shrub species and 8-12 feet for tree species.

Table 8.2-1
General Planting Plan Proposed for Riparian Areas.

PLANTING PHASE	COMMON NAME	SCIENTIFIC NAME	HABIT	STOCK	RIPARIAN BUFFER PLANTING ZONE		
					BANK/ OVERBANK	TRANSITION	UPLAND
1	Sitka Willow	*Salix sitchensis*	Shrub/ Tree	4' Stake/ 1 Ga. Pot	✓		
1	Pacific Willow	*Salix lucida ssp. lasiandra*	Tree	4' Stake/ 1 Ga. Pot	✓		
1	Red Alder	*Alnus rubra*	Tree	1 Ga. Pot	✓	✓	✓
1	Black Cottonwood*	*Populus balsamifera* ssp.	Tree	1 Ga. Pot	✓	✓	✓
1	Pacific Ninebark	*Physocarpus capitatus*	Shrub	1 Ga. Pot	✓	✓	
1	Red osier Dogwood	*Cornus sericea ssp. sericea*	Shrub	1 Ga. Pot	✓	✓	
1	Salmonberry	*Rubus spectabilis*	Shrub	1 Ga. Pot	✓		
1	Rose (Douglas) Spirea	*Spiraea douglasii*	Shrub	Cutting/ 1 Ga. Pot	✓		
1	Black Twinberry	*Lonicera involucrata*	Shrub	1 Ga. Pot	✓	✓	
1	Nootka Rose	*Rosa nutkana*	Shrub	1 Ga. Pot		✓	✓
1	Oceanspray	*Holodiscus discolor*	Shrub	1 Ga. Pot		✓	✓

PLANTING PHASE	COMMON NAME	SCIENTIFIC NAME	HABIT	STOCK	RIPARIAN BUFFER PLANTING ZONE		
					BANK/ OVERBANK	TRANSITION	UPLAND
2	Sitka Spruce	*Picea sitchensis*	Tree	5 Ga. Pot	✓	✓	
2	Western Red Cedar	*Thuja plicata*	Tree	5 Ga. Pot		✓	✓
2	Douglas Fir	*Pseudotsuga menziesii*	Tree	5 Ga. Pot		✓	✓
2	Vine Maple	*Acer circinatum*	Tree/ Shrub	5 Ga. Pot		✓	
2	Mock Orange	*Philadelphus lewisii*	Shrub	1 Ga. Pot		✓	✓
2	Big Leaf Maple	*Acer macrophyllum*	Tree	5 Ga Pot		✓	✓

Notes:
Black cottonwood starts would be planted if substrate and groundwater conditions are determined to be suitable. While present along the mainstem river in mature stands, black cottonwood is generally absent along lower Bunker Creek and is considered less likely to become established within graded areas given the hydrogeomorphic setting (cf. Hough-Snee and Anchor QEA 2019).

8.2.3 Tree and Shrub Planting

Planting would occur in a phased approach. As shown in Table 8.2-1, the initial plantings (Phase 1) would include fast-growing tree species that can withstand prolonged inundation over the winter such as Sitka willow, Pacific willow, and red alder. These fast-growing wetland species would also help shade out encroaching invasive species such as reed canary grass and Himalayan blackberry. Shrubs that are more tolerant of sun would also be planted during Phase 1. Black cottonwood may be included in Phase 1 if the site conditions are determined to be suitable.

To strategically reduce the competitive vigor of reed canary grass, Pacific and Sitka willow plantings, along with tall red osier dogwood and Pacific ninebark, would be installed along the upper side slopes and streambank tops of the constructed channel. These plantings would be at least 4 feet tall and 1-inch in diameter, planted at 2-foot spacings (e.g., Kim et al. 2006; Hartema et al. 2015).

Trees should not be planted in rows or straight lines; they should mimic more natural curves and clusters. A unique planting diagram for each site would be developed in subsequent design stages. After the Phase 1 species have become established and provide some shade (in approximately Year 3), secondary plantings (Phase 2) would be installed. Phase 2 would include conifer species such as Western red cedar, Douglas fir, and Sitka spruce. Shrubs that are more shade-dependent would also be planted during Phase 2. If plantings from Phase 1 have become densely established, it may be necessary to thin these plantings out prior to installation of the Phase 2 species.

A layer of organic mulch should be applied to the base of planted trees and shrubs to help conserve moisture, add nutrients, and keep the soil temperature more stable. Note that mulch should not be used in areas where it would be easily washed away.

8.2.4 Planting Schedule

Planting of riparian habitats would occur over a four-year period to achieve a succession of early-shade species that would help suppress invasive species such as reed canary-grass and Himalayan blackberry and create a shaded environment for establishment of conifer species. Table 8.2-2 outlines the four-year planting plan for the primary riparian planting site at aquatic habitat mitigation sites (Section 8.1) riparian buffer planting sites along the mainstem Chehalis River (Sections 7 and 8.5).

Table 8.2-2
Treatment, Monitoring, and Reporting Schedule for Riparian Planting Plan.

YEAR	TREATMENT	MONITORING/REPORTING
Year 0	None, receive approval of Riparian Planting Plan	
Year 1	Planting Phase 1: install willow and alder plantings	Report on Planting Phase 1 activities
Year 2	Apply mulch to previous plantings, invasive plant removal as needed, assess plant survival	Progress report documenting monitoring results, recommendations
Year 3	Planting Phase 2: install conifer tree species, thin out Phase 1 plantings as needed	Progress report documenting monitoring results, Planting Phase 2 activities, recommendations
Year 4+	Apply mulch to previous plantings, invasive plant removal as needed, assess plant survival	Progress report documenting monitoring results, recommendations

8.3 Wildlife Habitat Conservation Plan

To offset the potential loss and degradation of habitat for wildlife and terrestrial species associated with FRE construction and operation, the Applicant proposes the following mitigation treatments across several mitigation sites (see Appendix F for more details):

- Purchasing private industrial forest parcels in the Forest Conversion area adjacent to and upstream of the proposed FRE temporary reservoir and setting them on a plant succession path towards diverse, old-growth forests. Forest treatments would include protecting large, older trees, selective cutting/tree thinning to promote tree and understory growth, in-planting a diversity of native trees and shrubs, and girdling trees to create snags and downed LWM.
- Improving and protecting riparian habitat along those sections of non-fish bearing streams in the Forest Conversion area that do not have protections under the FPA. In these areas, planting rapidly growing riparian trees and shrubs would increase stream shading and create wildlife habitat directly and through the production of downed LWM over time.
- At the RM 89.3-87.6 mitigation site, expansion of off-channel flow-path and perennial tributary habitat, creation of depressional palustrine wetlands in historic floodplains, converting agricultural fields to native wetland and riparian forest habitats, and increasing forest structure and plant species diversity through tree and shrub plantings.

- Protection and expansion of in-stream and riparian habitats along the Chehalis River and tributary streams downstream of the proposed FRE reservoir at the RM 89.3-87.6 and Bunker Creek sites. The proposed aquatic mitigation measures would not only benefit aquatic fish and mollusks, but terrestrial wildlife, amphibians, and insects, as well.

For this FRE Mitigation Plan, specific areas and sizes of the planned mitigation treatments (primarily native forb, shrub, and tree species plantings) within the Forest Conversion block, RM 89.3-87.6, and Bunker Creek are currently designed only at the conceptual level of vegetation structure.

To evaluate potential ecological lift in terms of improvements in wildlife habitat from the proposed mitigation treatments, the Applicant evaluated baseline and future habitat values at proposed mitigation sites for priority amphibian, bird, and mammal SOC that may occur in the Mitigation Area (see Appendix F). The wildlife habitat valuations are conducted by creating matrices of wildlife SOC and habitats and assigning a categorical habitat-value ranking to each mapped wildlife habitat type for each bird, mammal, and amphibian species. Habitats ranked as high or moderate value in combination represent the types likely to be regularly used by wildlife species. Habitats ranked as low or negligible value would see little to no use by the species in question. The mitigation goals are to set plant succession on a path towards higher-value wildlife habitats and to increase the extent of those higher-value habitats relative to baseline conditions, thus benefitting wildlife populations.

8.3.1 Forest Conversion

To qualitatively assess existing wildlife habitat value in the Forest Conversion area, we used the same 14 habitats described in-depth in the VMP summary (Section 6.1.2.4). In brief, the temporary FRE reservoir habitats are primarily composed of industrial forests and recent clear-cuts <40 years old, some mixed transitional forests, riparian mixed forests and shrublands along the Chehalis River, and scattered small slope and depressional wetlands. More details on these habitats and the baseline conditions can be found in Appendix D.

Baseline wildlife habitat evaluations were conducted for the 39 wildlife SOC and 14 habitat types expected to occur in the Forest Conversion area (Appendix F). In general, existing habitat conditions for the wildlife SOC are better for mammals and amphibians than for birds. The low complexity of vegetation structure in the managed industrial forests can explain the lower level of suitable habitats for birds. Elk and deer and spotted skunk have broader habitat preferences than many bird SOC and the upper Chehalis River, tributaries, and nearby wetlands have known populations of several amphibian SOC. Most of the birds and many of the remaining species have specific habitat needs, often requiring mature or old-growth forests. Hence, the recently logged habitats are among the least valuable habitats to the wildlife SOC. In total, of the 546 species-by-habitat combinations assessed for the 39 SOC, only 115 (21%) of habitats are considered to be of high or moderate value to any SOC (Appendix F). Overall, the wildlife habitat evaluation results indicate that within the Forest Conversion, there is abundant opportunity to create ecological lift by creating quality habitat for species that rely on mature and old-growth forests and wetland habitats.

Without implementation of the project and no mitigation actions, it is assumed that industrial forest conditions would not change substantially in 50 years, and the area would be expected to provide a similar low diversity of suitable habitats for SOC birds and a moderate diversity of suitable habitats for SOC mammals and amphibians as it does today (Appendix F).

While the TOPSIS model used to select parcels for the Forest Conversion area did not directly incorporate variables important to wildlife, several landscape processes included in the model criteria could affect terrestrial wildlife. Conserving parcels that offset impacts of erosion, landslides, and stream water temperature increases would serve to protect headwater streams and riparian habitats that some wildlife SOC depend on for portions of their life-history (Appendix F). Consideration of forest stand age and the presence of terminal logging roads prioritizes the oldest forests and those that would be easier to treat with selective tree removal and in-planting. This would directly benefit wildlife SOC that use mature and developing old-growth forests with greater forest structure than is found in even-aged industrial forest stands.

Wildlife habitat mitigation in the Forest Conversion area would focus primarily on benefiting species associated with mature or old-growth forests, as well as open-canopy, diverse conifer forests (Appendix F). Forest treatments would aim to gradually transition managed Douglas fir plantations with very low plant species and forest structure diversity to habitats with more diverse, old-growth forest characteristics. Currently, a total of 1,921 acres are planned to be treated to offset for the loss of conifer forests under the FRE construction footprint and in the proposed FRE temporary inundation zone. Mitigation treatments in the Forest Conversion area would follow forest management guidelines for black-tailed deer (Nelson et al. 2008), which is a good representative old-growth-associated wildlife species. Specifically, the following mitigation actions are recommended:

- Identify any stands in the understory initiation stage >60 years old. If the canopy is still primarily closed, selected cutting/thinning and tree girdling should be implemented to open the canopy. Tree girdling has the added benefit of creating tree snags and eventual LWM on the ground. The largest trees and any with massive and twisted limbs should be preserved as these are most likely to be used by marbled murrelets in the future. No more than 50% of the total stand basal area should be removed or girdled.
- Second-growth stands in the competitive exclusion phase 30+ years old should have Douglas fir trees selectively cut/thinned and girdled at variable spacing, treating no more than 50% of the total stand basal area. Small (<2 acres) clearcut patches should be created and a diversity of non-Douglas fir tree and shrub species should be planted in the clearings and open forest understory. Retention of >75% of the original stand is recommended to limit windthrow. Slash should be burned or chipped.
- Second-growth stands in the canopy closure stage ~10–30 years old should have Douglas fir trees thinned with variable spacing and only large trees should be girdled to create snags. In contrast to 30+ year old stands, treatments should emphasize creating open patches and

replanting with a diversity of non-Douglas fir trees and shrubs. Slash should be burned or chipped.

- Recent clearcuts <10 years old should have a large proportion of recently planted Douglas fir treated by ground-based spraying or mechanical or hand thinning and a diversity of non-Douglas fir species of trees and shrubs should be planted to initiate a more diverse forest. Plantings should be <300 seedlings/acre.

Plantings of native understory shrubs such as willows and vine maple, as well as western hemlock and western red cedar, depending on the site, and native deciduous trees (e.g., red alder, big leaf maple, black cottonwood) would be used. Snag trees would be preserved and created, and LWM of various size classes would be retained, particularly adjacent to wetlands and streams, as these structures are highly valuable for numerous wildlife species, particularly amphibians. Additionally, removal of invasive species would occur, as needed, during treatments.

Forest stands should be evaluated every ~10 years to assess canopy closure and understory vitality and determine if another round of thinning is needed. These practices would preserve the largest trees, open the canopy, promote understory development, increase growth rates of retained trees and shrubs by reducing competition for resources, create valuable snag and downed LWM structure, and reduce fuels and wildfire risk. While old-growth forests would not develop for possibly hundreds of years, in 50 years forests would be more diverse, both in terms of plant species and structure and would provide some of the ecological function of an old-growth forest. These changes could result in an increase from 21% to 39% of species-by-habitat combinations with high- or moderate-value rankings. This could directly benefit species such as marbled murrelets, numerous bird SOC, bats, and terrestrial amphibians. Marbled murrelets have been recorded near mature forests south of Big Roger Creek, indicating a potential for reestablishing use of portions of the Forest Conversion area near the Big Roger Creek drainage in the future.

Lastly, additional mitigation in the Forest Conversion area would be implemented to offset wildlife habitat that would be lost during the development of the three quarry sites required for the construction of the proposed FRE facility and associated infrastructure. This would involve the mitigation actions discussed above for industrial forest plantations and clearcut sites plus specific efforts involving mitigation for lost riparian habitats. In some clearcut sites along 50% of the length of smaller non-fish-bearing streams in the Forest Conversion area, riparian no-cut buffers are not required per Washington State Forest Practices regulations. In these areas, mitigation treatments would be focused on removing invasive species, if necessary, and planting native riparian shrubs and trees to gradually reestablish lost riparian habitats for wildlife. Species to be planted would include red alder, vine maple, red-osier dogwood, several willow species, Oregon ash, Pacific crabapple, Indian plum, and salmonberry. These species grow well in wetter soils, would shade streams and increase relative humidity, provide cover for wildlife, browse for elk and deer, and fruits and berries for numerous wildlife species, especially birds.

8.3.1.1 River Miles 87.6-89.3

This site was selected for mitigation actions for wildlife because the site is currently used primarily for agriculture, and in general, native habitats for wildlife have been heavily degraded or reduced in extent. The property is currently composed of agricultural fields, lowland mixed forests, and forested wetlands with varying tree size classes, shrublands, and ponds. There are large areas that have been taken over by invasive plant species, primarily reed canary grass, and Himalayan blackberry, along the edges of the open fields, and many of the forest stands at these sites are now restricted to narrow gallery forests along stream drainages and in areas bordering agricultural fields.

To assess existing conditions for wildlife at this site, habitat evaluations were conducted for the 39 wildlife SOC assessed for the Project and the 12 existing habitat types that occur there (Appendix F). In general, except for the negligible habitat values for marbled murrelets, results of the habitat valuations indicate that the existing conditions at the Marwood site provide a low to possibly moderate diversity of suitable habitats for the bird, mammal, and amphibian SOC assessed. Of the 468 species-by-habitat combinations assessed for the SOC, only 89 (19%) are considered to be of high or moderate value (Appendix F).

Without the implementation of the Proposed Action and without mitigation actions, in 50 years the Marwood site is expected to provide a similar low to moderate diversity of suitable habitats for wildlife SOC as it does today (Appendix F). There would be some changes in vegetation succession due to wetter winters and hotter drier summers from climate change. However, the area is expected to remain a mosaic of agricultural fields, shrublands, invasive species infestations, and narrow gallery forests if the project is not implemented.

With the implementation of the project, some ecological lift is expected for some species as agricultural fields are converted to native habitats, existing forests and shrublands are enhanced, depressional wetlands are created in the historical floodplain, tributary water is consolidated and re-routed to create off-channel habitat, and Chehalis River riparian forests are enhanced for stream shading, resulting in numerous new habitat types (Appendix F). However, most of the 39 SOC assessed rely on mature forests for part of their life history and would not see much ecological lift. These habitat improvements would largely benefit avian species and amphibians, as well as mammals that prefer riparian and wetland habitats with a dense understory. Additionally, benefits to wildlife would be gained with the creation of discrete habitat features on the landscape. For example, enhancing the availability of cavity-nesting habitat, either through the enhancement of snags or diseased trees or by erecting nest boxes would benefit cavity-nesting birds such as wood ducks and purple martins. Large snags and diseased trees are also used as roost sites for numerous bat species. Establishing terrestrial LWM, especially adjacent to wetlands and the Chehalis River, could directly benefit numerous species, especially amphibians and western spotted skunks.

Terrestrial mitigation would focus on transitioning cleared agricultural fields to habitats dominated by a mixture of tree and shrub species with multiple canopy levels that would provide diversity in vegetation structure for wildlife. This mitigation would primarily benefit avian species. An effort would also be made to reestablish depressional wetland habitats in the historical floodplain, which should be beneficial for amphibian species. Mitigation activities would also prioritize the creation of downed terrestrial LWM, which should benefit amphibians and western spotted skunks.

8.3.1.2 Bunker Creek and Similar Chehalis River Riparian Sites

The Bunker Creek (Sidorski) site was also selected for mitigation action because the site is currently used primarily for agriculture, and native habitats for wildlife have been heavily degraded or reduced in extent. Habitat evaluations were conducted for the 39 wildlife SOC assessed for the Project and the 5 existing habitat types that occur there (see Appendix F). The results of the habitat evaluation indicate that, in general, the existing conditions at the Bunker Creek site do not provide a good diversity of suitable habitats for the SOC. Of the 195 species-by-habitat combinations for the SOC evaluated, only 16 (8%) are considered to be of high or moderate value (Appendix F).

Without the implementation of the proposed FRE facility and without mitigation actions, the Bunker Creek site is likely to provide the same degraded wildlife habitats in 50 years as are present today (Appendix F). With the implementation of the project, there would be an increase from 8% to 15% of species-by-habitat combinations with high- or moderate-value habitats, indicating some ecological lift to wildlife.

Proposed habitat mitigation efforts for wildlife would include aquatic and streambank enhancements in the creek and shrub and tree plantings to expand the riparian areas bordering the creek within the buffer zone extent shown in Figure 8.1-15. There would also be riparian enhancements for shade mitigation along the Chehalis River 75 feet out from the ordinary high-water line. The aquatic enhancements, focused on increasing the value of the habitat for fish, should decrease water temperatures and create more pools and vegetated habitats. These enhancements should benefit many amphibians, including breeding and juvenile western toads. The riparian habitat expansions should also benefit birds and some mammals, by providing additional nesting and foraging riparian habitat for songbirds, hunting perches adjacent to agricultural fields and streams for eagles and other raptors, and cover habitat adjacent to agricultural fields for deer, elk, skunks, and other mammals. Discrete habitat enhancement projects, such as building cavity nest boxes or enhancing the availability of snag trees could benefit wood ducks and other cavity-nesting birds. The riparian habitat enhancements may also increase the value of this site as a travel corridor for wildlife.

8.4 Large Wood Material Recruitment and Placement Plan

The proposed FRE facility has a trashrack design that limits the size of wood likely to be transported downstream to very small pieces. This would occur in any year when a flood transports large wood downstream to the Pe Ell Valley, with and without FRE operation. Mitigation actions include relocating transient trapped wood from upstream of the proposed FRE facility downstream, and installing fixed wood pieces along the length of the river at appropriate locations that are longer lasting as part of the Fish and Aquatic Species and Habitat Plan, as described below.

A large wood recovery and relocation effort would be undertaken to mitigate the disruption of wood transport. Based on the anticipated wood load during FRE operation versus run-of-river flow periods the logs would either be stored for future habitat projects or relocated downstream of the FRE, as follows:

- When the FRE facility is operating, it is anticipated that substantial amounts of large wood material would accumulate on the trash rash. This material would be collected during drawdown and stored onsite as a “wood bank” for use in future mitigation and restoration projects downstream of the FRE facility. During operation, wood material also would be recovered from the water during drawdown, from road-accessible flood fences that are proposed to trap floating wood at different elevations as the temporary reservoir water level recedes (Figure 8.4-1), which would also reduce the time needed for in-water wood removal.
- During run-of-river flow periods any wood that accumulated on the FRE facility trash rack would be collected and relocated to a location immediately downstream of the FRE and upstream of the canyon reach so they can be transported downstream and deposit naturally to create habitat complexity. In more confined, bedrock and boulder sections of the river, it is expected that the large wood pieces would accumulate in natural jams like the example in Figure 8.4-2.

Figure 8.4-1
Proposed Layout of Flood Fences to Trap Large Wood Debris During Reservoir Drawdown.

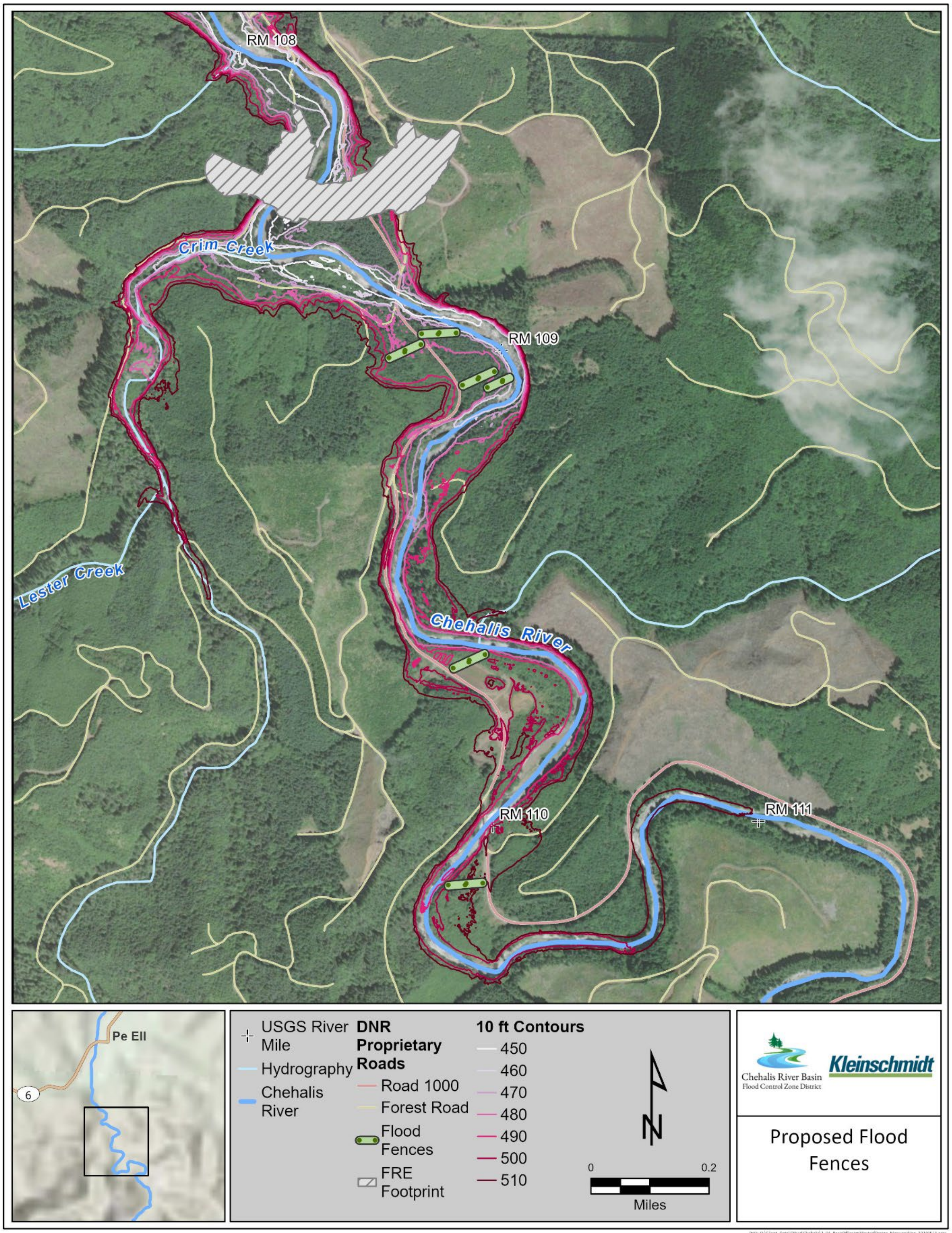


Figure 8.4-2
An Example of Large Wood and Boulders Providing Instream Habitat Complexity Within Confined Bedrock-Boulder Reaches of the Upper Chehalis River.

Intentional wood placement is also proposed as mitigation for aquatic habitat degradation (see the Fish and Aquatic Species and Habitat Plan, Section 8.1) at five (5) sites within and upstream of the inundation area and eight (8) downstream of the proposed FRE facility. Table 8.4-1 lists the numbers of logs proposed for placement as part of site-specific mitigation designs. A minimum target placement of ten (10) key pieces/mile is proposed to mitigate large-wood-associated habitat loss within the temporary inundation zone. This average loading approximates the 25th percentile criterion of Fox and Bolton (2007) for key pieces, which appears appropriate for a high-energy, confined transport channel like the upper Chehalis River. There are two sites targeted for gravel enhancement in the temporary inundation zone, at RM 111.8 and 113.2. A total of sixty-two (62) large-diameter logs with root wads are proposed for placement within the impounded reach extent, which approximates the target for the maximum inundation zone extent. An additional sixty-six (66) pieces are proposed for gravel trapping upstream of the inundation zone, more than the target. A total of 871 pieces are proposed for placement within 26 miles downstream of the FRE. Additional pieces would be installed as part of tributary enhancement in Bunker Creek and Mill Creek.

Shade mitigation along the mainstem Chehalis River and in Bunker Creek (Section 8.2 Riparian and Stream Buffer Expansion Plan) would enhance natural wood recruitment into the future. Riparian planting with native tree species would occur across the mainstem at various degraded sites. The minimum riparian width required for shade would be 60 feet; however, wherever landowners are willing, the buffer width would be expanded to provide additional large wood for future supply. The benefits of large wood enhancements are characterized in the Fish and Aquatic Species and Habitat plan, Section 8.1.1.

Table 8.4-1
Mitigation Sites Where Large Wood Material Recruitment and Placement Are Proposed, and Placement Type. Sites Are Listed in the Order in Which the Full Mitigation Proposal for Each Site Is Described in Section 8.1.

MITIGATION SITE	LWM PURPOSE	# PALS (# PIECES)	# EXPOSED DEBRIS LOGS/FLOOD FENCING	# LOOSE LOG PLACEMENTS	TOTAL # LOGS
Downstream of FRE	Loose LWM seeding for Chehalis mainstem below FRE			Total collected above FRE	Varies with flood event
82.6	Flow path control	2 (20)	93		113
85.6	Vegetated island formation	4 (40)	116		156
87.8, 89.1	Side channel enhancement	5 (50)	151		201
104.6-104.9	Side channel maintenance	11 (110)	83		193
84.5	Floodplain channel engagement		72		72
87.6-89.3	Floodplain channel engagement	1 (10)	65		96
102.2	Spawning gravel capture		9		9
102.4	Spawning gravel capture	2(20)	11		31
111.7	Spawning gravel capture		16		16
113.2	Spawning gravel capture	3 (30)	16		46
114.7	Spawning gravel capture		11		11
115.7	Spawning gravel capture			20	20
116.7	Spawning gravel capture			35	35
Mill Creek	Habitat complexity		To Be Determined (TBD)	TBD	TBD
Bunker Creek	Floodplain connectivity/habitat complexity		TBD	TBD	TBD
	Total	**28** (280)	**>643**	**>55**	**>999**

8.5 Surface Water Quality Plan

Potential water quality impacts of the Proposed Action upstream of the proposed FRE facility include increased summer water temperature within the inundation area and for approximately 20 miles downstream due to changes in vegetation and a loss of shade in the temporary pool. Summer water temperature increases could be associated with an increased risk of reduced DO because warmer water has a reduced capacity to hold dissolved gases, including oxygen. Increased turbidity during flood flow releases from the FRE facility was also identified in the DEIS.

The Applicant is proposing several mitigation actions to address water quality impacts including: i) minimizing shade reduction, and associated temperature impacts through implementation of the VMP (see Section 6); ii) riparian enhancement and reforestation along 16.6 miles of the mainstem Chehalis River and 4.8 miles of Bunker Creek for a total of 155.6 acres of stream buffer (see Section 7.3.4 and 8.2); iii) forest conversion of 1,921 acres of industrial forest to an old growth successional forest; iv) riparian buffer enhancement for 23 miles of stream under forest conversion (see Sections 7.3 and 8.2). Consistent with degraded aquatic and riparian habitat downstream of the FRE, water quality in the Chehalis River is impaired for turbidity, nutrients, fecal coliform, DO, and temperature, providing the opportunity to improve aquatic habitat and water quality conditions with mitigation.

Riparian Shade Enhancement is proposed on 131 parcels along the upper Chehalis River that would prevent approximately 880,606,358 average kcal/day of solar thermal input from reaching the water. This proposed shade mitigation accounts for more than 2 times the shade impact (349,666,000 average kcal/day) as described in Section 6.2. Restoring this amount of shade would mitigate for any shade-related summer water temperature effect to the benefit of all native aquatic species and, specifically, would reduce the risk of pre-spawning mortality for spring chinook salmon holding or spawning in this section of the Chehalis River.

Various additional parcels with opportunities for riparian enhancement are available both downstream on the Chehalis River, in Bunker Creek, and in the South Fork. Of these, several have landowners have expressed interest in supporting this mitigation action. This bank of shade supply parcels provides adaptative management opportunities as we move into an uncertain future with climate-related thermal impacts on the basin.

Riparian enhancement downstream of the FRE also would benefit water quality by capturing pollutants identified in the Chehalis River TMDLs. Fecal coliform, temperature, and DO are the main impairments in the Chehalis River basin. Riparian plantings would help capture pollutants such as fecal coliform before they enter the water. Riparian and wetland plants help to filter pollutants from the landscape via their root systems and clean water before it enters surface water or groundwater. This would be particularly beneficial especially for tributaries and to a lesser extent mainstem reaches where agricultural runoff is reaching the waterway. Decreasing nutrient loading would improve conditions for rearing salmon where 11.0 ppm is required for salmon production.

Forest Conversion includes decommissioning of 6 miles of forest roads within the inundation pool and restricting the use of non-decommissioned roads (up to 12 miles) in this block to migration access only which would reduce access to 2 or 3 times a year for plant maintenance which would reduce road-related erosion. The conversion of commercial timberlands for timber to old-growth successional forests would increase native species diversity and density. Establishing a canopy with mixed coniferous and deciduous forest trees would support a healthy understory of native species such as Indian plum, salmonberry, bramble berry, creeping Oregon grape, fern, and forest-dwelling wildflowers. This complex native habitat would increase soil stability and the interception of runoff during storm events resulting in less fine sediment input to the stream and reducing storm-related turbidity. Additionally, this mitigation would improve water retention, sediment capture, and nutrient cycling with increased riparian protection and expansion on fish and non-fish-bearing streams within the converted forest, estimated as 362.5 acres of increased riparian buffer (see Riparian and Stream Buffer Expansion).

8.6 Wetland Enhancement Plan

As described in Refined Potential Impacts (Section 5) the Applicant's analysis for the new FRE location resulted in a slight increase of wetlands and wetland buffer impact for a total of 380.2 acres. The Applicant's wetland effect analysis under new FRE facility location identified a loss of 94 wetlands covering 10.84 acres and 91.1 acres of wetland buffers. This wetland buffer area represents wetlands buffer that do not overlap with stream buffers (199.21 acres that are accounted for under Riparian and Stream Buffer Expansion, Section 8.2), and stream waterbody areas (44.63 acres that are accounted for under Aquatic Habitat [Section 8.1]). This estimate does not include the potential 6.6 acres of wetlands and 44.2 of wetland buffer impact that would be avoided by working within the existing footprint. However, our mitigation would be sufficient to cover these potential impacts if the design changes and additional mitigation is required.

1. Wetland conservation and buffer expansion with the 1,921 acres of timberlands proposed for Forest Conversion area adjacent to the temporary reservoir outside the maximum extent of the inundation zone (see Surface Water Enhancement Plan). Prior wetland delineation of approximately 760 acres of this area (Anchor QEA 2018) documented 27 wetlands with a total wetland area of 3.0 acres within this area. Of these 27 small, forested wetlands, only one has a buffer, of 25 feet. Therefore, we are assuming that we can mitigate by planting 185 acres of wetland buffer associated with these wetlands. Because previous surveys covered 46% of the Forest conversion area, we expect that additional forested wetlands are likely to exist in this area and this estimate of potential for buffer creation would increase with additional field assessment.
2. Opportunistic wetland enhancement of existing wetlands within the 21.3 miles of riparian enhancement along the Chehalis River and select tributaries downstream of the proposed FRE facility to the confluence with the South Fork Chehalis River. Note that existing wetlands within the proposed riparian corridor reforestation areas have not yet been delineated nor quantified.
3. Restoration/creation of 42.5 acres of depressional wetland and 91.5 acres of wetland buffer on the Chehalis River floodplain from RM 87.6-89.3.

All wetland mitigation would include fully vegetated buffers, and that buffer area would constitute a component of the mitigation for the wetland buffer impacts resulting from the project action. Each of these wetland and buffer mitigation components is described in more detail in Appendix J. The proposed mitigation areas and locations are summarized in Table 8.6-1.

Table 8.6-1
Proposed Mitigation for Wetland and Wetland Buffers.

MITIGATION ACTION TYPE	PROPOSED AREA (ACRES)	LOCATION
Wetland preservation within 1,921-acre forest conservation area	3.0	Upslope of the perimeter of FRE inundation area
Wetland buffer restoration/creation for 26 forested wetlands	185[1]	Upslope of the perimeter of FRE inundation area
Enhancement (reforestation) of riparian wetlands	TBD	Chehalis River shoreline, tributaries
Wetland enhancement	6.5	RM 87.6-89.3
Wetland restoration/creation	42.5	RM 87.6-89.3
Wetland buffer	91.5[1]	RM 87.6-89.3

Notes:
1. Anchor QEA surveyed approximately 46% of the Forest Conservation area and delineated 27 wetlands, 26 un-buffered due to size (Anchor QEA 2017); thus, it is assumed additional non-buffered wetlands would occur in the yet to be surveyed portion of the area.

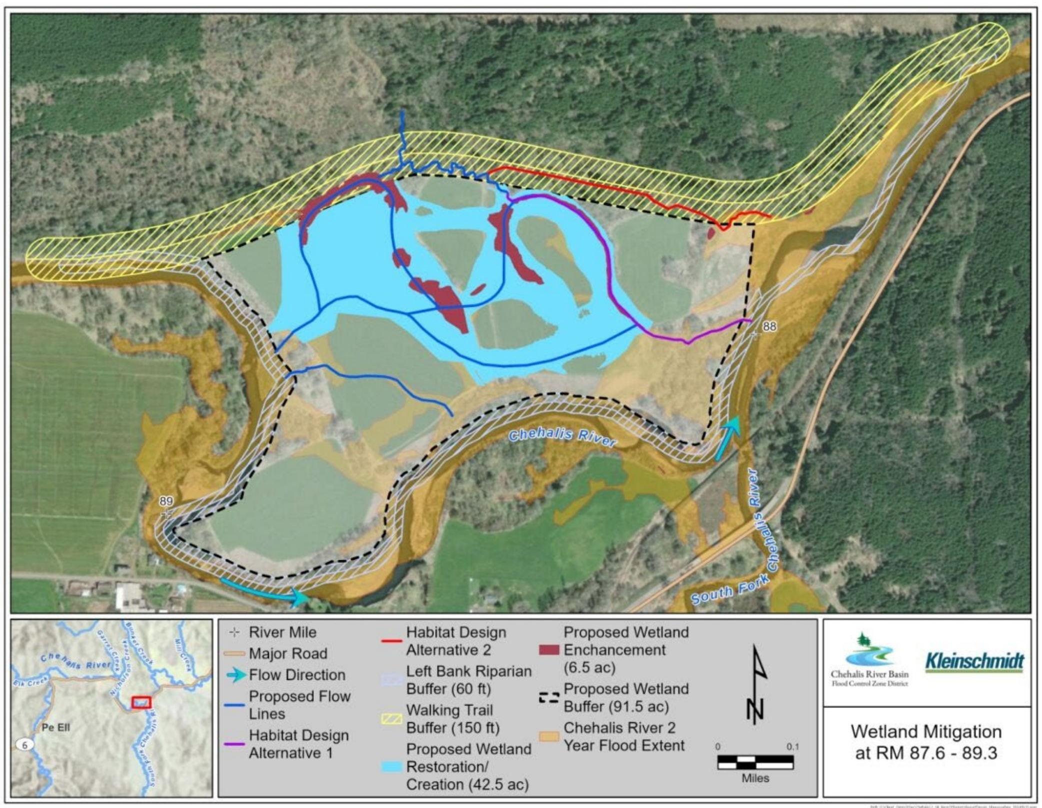
Per Table 8.6-1, a wetland mitigation conceptual design was developed for the RM 87.6-89.3 mitigation site in which other mitigation actions are also planned as described in Section 8.1.1. The design involves restoring/creating 42.5 acres of wetland, enhancing 6.5 acres of existing wetlands, and creating 91.5 acres of wetland buffer (Figure 8.6-1). There are compensatory mitigation opportunities at this site for the creation of Depressional Hydrogeomorphic class wetlands in the historic floodplain with direct connectivity to existing wetlands. The wetland creation would be achieved via grading to create a proposed wetland surface by excavating and removal of approximately 6 feet of overburden soils to increase groundwater saturation within the proposed surface and near-surface soils. There is additional potential to increase ponding on-site by installing berms or Beaver Dam Analog structures that would increase lateral inundation and standing water duration. Groundwater monitoring would be performed in the future to identify existing seasonal variations in groundwater levels and geotechnical borings would be collected to gather information on the site soils, to inform the final wetland creation design. Key assumptions incorporated in the conceptual design include:

- The design focuses on restoring the functionality of existing wetlands on the site and creating a connected complex of wetlands.
- As a part of the enhancement of riparian wetlands effort, a 60 feet wide corridor along the current edge of the Chehalis River would be planted for shading and riparian function. This area would not be available for inclusion as a wetland buffer. The proposed wetland buffer area of at least 91.5 acres provided at the mitigation site would begin in-board of the area designated as the riparian wetland's enhancement corridor.
- A setback buffer of 150 feet is assumed from the edge of the Willapa Hills Trail that bounds along the north side of the site. No wetland creation or wetland buffer is assumed within this

setback, which would establish the northern limit of wetland creation and/or buffer areas counted for mitigation purposes.

- The existing 6.5 acres of wetlands on the site would be enhanced to improve their functionality and meet the wetland enhancement mitigation goal.
- The wetland design accommodates either of the proposed potential tributary re-alignment alternatives depicted in Figure 8.1-17. Specific considerations would be addressed during the detailed design.
- The design incorporates overland flow paths needed for inundation sufficient to maintain riverine wetlands. Site groundwater monitoring would be conducted during future design development to determine the availability and feasibility of existing groundwater supporting wetland hydrology.
- The proposed area for wetland restoration/creation of 42.5 acres within the site was selected based on choosing a location with a low risk of avulsion by the Chehalis River. The proposed wetland mitigation area is likely to sustain wetland functionality even in the case of meandering and/or avulsion of the Chehalis River.

Figure 8.6-1
Wetland Mitigation at RM 87.6 – 89.3 Mitigation Site.



9 MONITORING AND ADAPTIVE MANAGEMENT PLAN

9.1 Background

As an integral part of the Mitigation Plan, the Applicant proposes to develop Monitoring and Adaptive Management Plans (M&AMPs) for all mitigation categories described in Section 8 above. The M&AMPs would address uncertainties that may affect mitigation function and the Applicant would work with applicable regulatory agencies to develop criteria that would trigger the implementation of corrective actions or implementation of contingency measures during the performance monitoring period to achieve no net habitat loss from project construction and operation. The M&AMPs would be developed during the permitting process and would be complete prior to issuance of key federal and state approvals for the project. FRE construction monitoring would be performed independently with immediate resolution measures as needed. M&AMPs activities would commence upon completion of construction and site restoration.

Ecological processes are inherently dynamic, evolving with geophysical processes that range in scale from regional climate patterns to reach-level hydrology and/or channel gradient. As such, predicting future ecological and biological conditions comes with a high level of uncertainty, especially in light of the uncertainty associated with regional climate models and their predictions for future hydrology and temperature in the basin. Additional uncertainty around mitigation implementation success is associated with unpredictable human behaviors, including landowner engagement for mitigation sites and future development and/or landscape scale changes in the upper Chehalis River Basin. The adaptive management portion of the M&AMPs provides an ongoing process by which uncertainty can be addressed to ensure successful mitigation.

For the purposes of this proposed M&AMPs, “adaptive management” refers to actions and adjustments taken to:

- Reduce or address uncertainties associated with future environmental conditions and operation of the proposed FRE facility.
- Address uncertainties associated with landowners including future landowner engagement and unanticipated activities that could result in habitat alteration.
- Identify potential problems, possible solutions, and site management adjustments to correct foreseeable challenges based on the results of monitoring efforts.
- Provide contingency plans if needed.

- Serve as a mechanism for coordination between resource monitoring and management actions to ensure appropriate adjustments to planned actions. The key questions addressed by the M&AMPs that would guide actions and adjustments to proposed mitigation measures are:
    1. Is the mitigation functioning as intended to offset actual impacts of FRE construction and operations?
    2. Are site specific uncertainties affecting performance of planned mitigation actions, and if so, how?
    3. How will the benefits of long-term mitigation be sustained in the context of climate change and associated hydrology and water temperature expectations?
    4. What can be learned from early-implementation projects to inform subsequent site-specific actions?
    5. Do any unanticipated and unmitigated impacts from construction or operation of the FRE arise requiring additional mitigation?

The M&AMPs would include a process for management input and for informing and guiding decision making. The Applicant expects that M&AMP methods and results would be reviewed and discussed in consultation with an oversight committee likely composed of Applicant/County representees, agency representatives, basin stakeholders, and regional experts appointed by the Applicant as needed.

9.2 Monitoring Plan Framework

The focus of the monitoring component of the M&AMPs would be on implementation monitoring and project effectiveness monitoring using standard monitoring protocols developed for salmon-bearing waters of the Pacific Northwest, applied at both a stream reach and site scale. Specifically:

- **Implementation Monitoring** would determine whether mitigation projects were constructed as designed. Examples include locations and number of engineered LWM structures, acres of native riparian trees and shrubs planted, and length of floodplain and side-channel reconnections achieved. Implementation monitoring would be planned for all project locations to document project activities, especially those relevant to permit compliance and required reporting. Results from implementation monitoring would be captured in as-built design plans.
- **Project Effectiveness Monitoring** determines whether the physical habitat objectives and intended ecological lift of each mitigation action have been achieved, and that the project is continuing to function as intended. The types of questions that would need to be asked would be mitigation action-type specific. Examples include whether fish have passed upstream of corrected barriers to spawn and/or rear, and whether riparian planting resulted in increased shade cover and reduced localized high summer water temperatures.

Project effectiveness monitoring would be performed at all sites or land ownership parcels where mitigation measures were implemented, and at selected locations in the mainstem Chehalis River with respect to water quality and geomorphic changes. Sites with riparian plantings or forest conversion would be sampled via a statistical areal sub-sampling scheme. Monitoring would combine direct field measurements with remote sensing using drones, LiDAR, or other applicable tools that would be useful for providing reach-level attributes. Monitoring would focus on the key habitat function or functions that the project was intended to provide as mitigation and determine if the project is (or is not) achieving those functions over a reasonable amount of time. The underlying premise for the M&AMPs is that confirmation of changes and/or function should be measurable through a small set of practical surrogate metrics that represent the most sought after (target) change(s) and conditions as simply as possible. If the key questions that the selected simple metrics represent cannot be answered affirmatively, then it is unlikely other more complicated and intensive metrics and potentially ambiguous statistical analyses would yield meaningful results either.

Standardized habitat surveys that characterize physical changes would be implemented for all habitat enhancement mitigation actions. Biological sampling would be included for specific aquatic habitat mitigation to understand aquatic species use of the newly created habitat and how habitat functions may change over time. Biological sampling of the habitat feature would include fish/aquatic species presence and macroinvertebrate sampling (specific to in-channel wood installations). To be an effective tool for adaptive management, monitoring would be completed both before construction and for the performance monitoring period specified in the environmental permits. The resulting data could be supplemented by status and trends monitoring that would continue to be implemented by the co-managers as part of their resource management objectives.

The schedule for implementation of the M&AMPs would be developed in consultation with members of the permitting agencies and Adaptive Management Committee. The following timeline captures current expectations for M&AMP components. The timespans indicated account for the continual implementation of individual mitigation actions over a 10-year period, assumed to start in Year 1.

- Organization of the M&AMP Committee: Years 1-3;
- Pre-implementation Site Monitoring: Years 3-9;
- Mitigation Implementation: Years 3-9; and
- Implementation Monitoring: Years 3-9.

9.3 Data Management

9.3.1 Data Description

The collection and recording of field data under the M&AMPs would rely upon standardized protocols established and accepted for surveys in Pacific Northwest rivers and streams. Where appropriate, protocols used would be consistent with those used for ASRP monitoring that is ongoing throughout the Chehalis River Basin. This would help inform some of the ASRP objectives related to watershed health as well as provide some watershed context to mitigation. Use of standardized metrics and procedures for data collection would increase efficiency, save money, and facilitate data compatibility.

Where possible, protocols for using remote sensing data would be followed that are compatible across similar types of monitoring (e.g., LWM counts, vegetation type, etc.). Where objectives may be specific to mitigation (e.g., measurement of canopy open angle to evaluate increased shade), the primary question(s) and corresponding data collection protocols would be discussed with permitting agencies to ensure the approach would result in mutually acceptable data for evaluating the objective.

9.3.2 Data Storage and Accessibility

Advanced database tools, data accessibility, and data security are critical for large, complex mitigation programs as multiple user groups require access to evaluate monitoring efforts and implement adaptive management. The M&AMP databases would be developed to ensure data quality, integrity, and accessibility with automated features for quality assurance, cloud-based backup, and technical support. To the extent practicable, the M&AMP databases would be made compatible with ASRP data sets.

9.4 Monitoring Period and Reporting

Effective monitoring and adaptive management would require establishing an adaptive management reporting, review, and decision framework. As noted above, an adaptive management committee would be formed consisting of the Applicant, state and tribal co-managers, and regulatory agency representatives. The results of the M&AMP monitoring would be reported directly to the committee who would review the results and discuss corresponding actions with the Applicant, as appropriate. Monitoring would be performed annually for the first 5 years after each habitat mitigation action has been implemented, and then every 5 to 10 years thereafter up to Year 50. Follow-up mitigation actions would follow a similar schedule. Report products expected to be developed under the M&AMPs include the following:

- As-built Design Reports;
- Annual Performance Monitoring Reports (first 5 years); and
- Five- and Ten-year Monitoring and Adaptive Management Reports.

As appropriate, reports would include data collected during monitoring events, show comparisons of the site from previous years, and document treatment activities. Reports would document progress toward reaching performance standards and suggest corrective actions for adaptive management consideration, as needed.

9.5 Monitoring and Adaptive Management Plan Elements

The Applicant's M&AMPs would address the mitigation categories proposed in Section 8. The plan would be developed further in consultation with the Adaptive Management Committee and additional agency representatives as appropriate during the permitting phase of the Proposed Action. The frameworks are discussed below for each of the following plan elements:

1. Aquatic Habitat Enhancement and Access;
2. Riparian Stream Buffer Expansions Downstream of the Proposed FRE facility;
3. Wildlife Habitat Conservation and Mitigation;
4. Large Wood Material Recruitment and Placement;

5. Surface Water Quality; and
6. Wetland Enhancements.

9.5.1 Aquatic Habitat Enhancement and Access

The goals of this suite of onsite and offsite mitigation actions are to enhance the ecological function of, or accessibility to, aquatic habitat. Key objectives include increasing instream, floodplain, and riparian habitat complexity; increasing floodplain connectivity; creating or enhancing access to off-channel and tributary habitats; increasing spawning habitat availability; and maintaining suitable thermal conditions for aquatic species to the extent physically possible.

Specific elements of the M&AMP for the Fish and Aquatic Species and Habitat Enhancement Mitigation Plan would be derived from the Lower Columbia Project Implementation and Long-Term Functional Performance Monitoring Protocol (Lower Columbia Fish Recovery Board 2015), which was developed under a similar framework of identifying practical simple metrics that represent the key elements of mitigation actions and their intended function over time. A pre- and post-project assessment sampling scheme is proposed, involving the following general stages:

1. Establish pre-existing (i.e., baseline) conditions within a mitigation site or parcel, and identify the impacts likely to be associated with FRE operations that are to be mitigated at the site;
2. Implementation monitoring to characterize mitigation action outcomes relative to the proposed design plan sets and mitigation targets;
3. Effectiveness (i.e., functional performance) monitoring to measure habitat responses; and
4. Reporting results and communicating with the Applicant (M&AMP committee) on any decisions or changes required in the implementation of the Fish and Aquatic Species and Habitat Enhancement Mitigation Plan to ensure that mitigation targets are being met.

The protocol is initiated with a desktop analysis of project plans and expectations and a field assessment of conditions at the project site. This approach is followed for each iteration (pre-construction, implementation, and functional performance) of monitoring to familiarize monitoring crews with characteristics affecting the site, project goals and objectives, and ensuring proper selection of metrics and measurements (Lower Columbia Fish Recovery Board 2015).

Landowner engagement is extremely important. A signed copy of a landowner acknowledgement and agreement form must be obtained prior to final design that identifies project actions and intended outcomes, and uncertainties and potential outcomes that may not be controlled or perfectly anticipated by design engineers and scientists. The landowner must fully understand and accept that habitat restoration projects can have unpredictable outcomes despite the designer executing due diligence and the highest standard of care, and that the FRE M&AMP also is being implemented to identify unanticipated outcomes as early as possible with their well-being in mind. The agreement would need to include permission and protocols for accessing project sites or areas and implementing adaptive management actions.

9.5.1.1 Aquatic Habitat Enhancements

Aquatic habitat enhancement actions that would be monitored include primarily: placing large wood and boulders for instream habitat complexity, side channel creation/maintenance, spawning gravel retention, and floodplain connectivity; excavation of pilot channels on the floodplain for floodplain connectivity; and planting of floodplain forest trees for future large wood supply and wildlife habitat.

9.5.1.1.1 Implementation Monitoring

Implementation monitoring would confirm that construction and associated planting actions reflect habitat enhancement design plans. Implementation monitoring would occur at all sites. Large wood and boulder placements would each be inspected. Plantings would be subsampled statistically to confirm density and species meet design specifications. Representative metrics are identified in Table 9.5-1.

Table 9.5-1
Representative Project Implementation Monitoring Metrics for Aquatic Habitat Enhancement Mitigation Actions.

MITIGATION ACTION	KEY IMPLEMENTATION METRIC(S)
Instream Placements (Large Wood, Boulders)	Number, Type, and Location of Structures, Boulders
	Dimension of Wood Pieces, Structures, Boulders
	Anchoring/Ballast Method
	Depth of Installation
Floodplain Connectivity Excavation	Location, Area, Volume of Cut/Fill Locations
	Longitudinal, Cross-section Profiles of Cuts
Tributary Channel Excavation	Location, Area, Volume of Cut Locations
	Longitudinal, Cross-section Profiles of Cuts
Floodplain Reforestation	Area Planted by Community Type (Map)
	Number, Species, Stock Planted (Subsample Plots)

9.5.1.1.2 Effectiveness Monitoring

Effectiveness of aquatic habitat enhancement projects would involve physical habitat and biological presence surveys to document function and persistence of design elements. A before/after sampling scheme would be followed, with baseline conditions measured at the same time as implementation monitoring. Every site would be monitored to ensure that mitigation goals continue to be met fully. The monitoring data would be evaluated over time to evaluate the trajectory of the project towards meeting its primary mitigation function(s), and anticipated longevity. The results would also be used to evaluate ecological lift. Example habitat function metrics are presented in Table 9.5-2 and would be advanced during permitting. In addition to habitat function metrics, persistence of large wood and boulder placements would also be noted with respect to structural integrity and functionality as affected by flooding and sedimentation.

Table 9.5-2
Representative Project Effectiveness Monitoring Metrics for Aquatic Habitat Enhancement Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Instream Placements (Large Wood, Boulders)	Instream Habitat Complexity	Is habitat available at summer/winter base flow?	Connectivity with summer/winter base flow channel (Y/N)
		Are scour pools around placements providing habitat?	Residual depth & volume of scour pools
		Is depth/object/overhead/turbulence cover present?	Classification of cover type(s) available
		Does placement create a velocity shear zone?	Velocity map
		Is habitat being used?	Snorkel counts
		Is loose large wood being trapped sufficiently to create new habitat?	Tagged log inventory, tracking
	Side Channel Habitat	Above what river flow does side channel habitat become suitable for juvenile Chinook and steelhead?	Minimum flow at Doty/Adna Gage at which depths and velocities become suitable on side channel thalweg
		Is side channel habitat being used, and at what river flows and seasons by which species?	Snorkel counts, Doty/Adna Gage flow
		What is rate of channel refilling/degradation/enlargement?	Longitudinal and cross-section profiles
		Are vegetated islands forming?	Area of mid-channel bars with vegetation
		Are fish trapping/stranding?	Presence/absence surveys
		Are there potential water quality limitations?	Summer temperature, dissolved oxygen
		Is predator habitat enhanced?	Predator species habitat suitability indices
	Floodplain Connectivity	Is water level being raised upstream of placements?	Stage-discharge relations near inlets and below structures
	Spawning Gravel Retention	Is gravel sorting occurring and being replenished naturally and sufficiently?	Topographic survey, pebble count
		Is loose large wood being trapped sufficiently to replace lost pieces?	Tagged log inventory, tracking
		How much habitat is usable during spawning season for target species?	Area of bed with suitable depth, velocity, substrate over general spawning flow range
		Do sedimentation/erosion influence survival to emergence?	Topographic survey, scour depth, percent embeddedness

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Floodplain Connectivity Excavation	Increase frequency, duration, and spatial extent of overbank flows across floodplain	What is frequency/duration of floodplain connectivity?	Doty/Adna gage flow time series vs. Stage-discharge relations near inlets
		Does target incipient flood level begin to engage floodplain?	Bankfull flow magnitude
		Are the inlet hydraulic control and/or flow path thalweg downstream eroding, staying the same, or aggrading?	Longitudinal and cross-section profile surveys and/or LiDAR
		How much floodplain area is inundated when?	Mapped inundation area vs. Doty/Adna gage flow
		What is likelihood of avulsion?	LiDAR survey of flow paths
		Are fish trapping/stranding?	Presence/absence surveys
Tributary Excavation	Restore connectivity with upstream habitat	Are fish moving upstream and downstream?	Redd, snorkel surveys; Passive Integrated Transponder tagging
	Restore bankfull channel width floodplain	Is channel geometry changing?	Longitudinal and cross-section profile surveys
	Reduced fine sediment inputs from banks	What length of eroding banks is restored/protected?	Length of bank with vegetative cover; Length of raw banks
	Create/enhance habitat complexity	Is habitat being used?	Snorkel counts
Floodplain Reforestation	Restore mature floodplain forest	How much of target vegetation has re-established?	% of floodplain vegetated by key species/class

9.5.1.1.3 *Adaptive Management Triggers/Actions*

If the monitoring results indicate that a particular habitat enhancement action is not reasonably progressing towards meeting functional goals or is compromised by natural processes or vandalism, the Applicant would consult with the Adaptive Management Committee to review the outcome, identify the reason, discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management include:

- Structural failure, washout, or abandonment by river;
- Changes in river morphology through erosion or sedimentation that may affect future performance or persistence;
- Slower than expected, or non-attainment of primary habitat objective listed in Table 9.5-2;
- Positive partial outcomes that may be improved on via modifications/enhancements;

- Changes in landownership or actions affecting access; and
- Vegetation growth characteristics affecting function.

Adaptive management action examples that would be adopted in consultation with the Adaptive Management Committee could include the following key prescriptive responses for aquatic habitat enhancements:

- Revision of monitoring parameters and/or frequency;
- Adjustment of site-specific actions;
- Maintenance of site-specific actions;
- Development of additional installations at same and/or additional locations;
- Landowner engagement; and
- Removal of invasive and noxious vegetation as needed.

9.5.1.2 Tributary Access

The goal of this mitigation is to increase the mileage of suitable habitat available to salmonids and other native fishes in the upper Chehalis River by removing impediments currently blocking or impeding fish passage.

9.5.1.2.1 Implementation Monitoring

Implementation monitoring would confirm that replacement structures, streambed grading, streambank stabilization, and installation of instream habitat complexity measures reflect design plans. Implementation monitoring would occur at all sites. Structures, grading, and large wood and boulder placements would each be inspected. Plantings would be subsampled statistically to confirm density and species meet design specifications. Representative metrics are identified in Table 9.5-3.

Table 9.5-3
Representative Project Implementation Monitoring Metrics for Tributary Access Mitigation Actions.

MITIGATION ACTION	KEY IMPLEMENTATION METRIC(S)
Replace fish passage structure(s)	Type, length, width, elevations of replacement structure
	Grain size distribution of placed streambed material
	Longitudinal profile upstream-downstream of crossing
Remove fish passage structure(s)	Longitudinal, cross-section profiles of cut
	Grain size distribution of placed streambed material
Bank stabilization/revegetation	Area, materials of bank treatments
	Number, species, stock planted
Instream placements (large wood, boulders)	Same as for aquatic habitat enhancements
Grade control	Structure type, cross-section profile
	Longitudinal profile upstream-downstream of control

9.5.1.2.2 *Effectiveness Monitoring*

Effectiveness of tributary access projects would involve assessing physical upstream passage conditions and biological presence surveys to document function and persistence of barrier correction measures. A before/after sampling scheme would be followed, with baseline conditions measured at the same time as implementation monitoring. Every site would be monitored to ensure that mitigation goals continue to be met fully. The monitoring data would be evaluated over time to evaluate the trajectory of the project towards meeting its primary mitigation function(s) and anticipated longevity. The results would also be used to evaluate ecological lift. Example effectiveness metrics are presented in Table 9.5-4 and would be advanced during permitting.

Table 9.5-4
Representative Project Effectiveness Monitoring Metrics for Tributary Access Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Replace fish passage structure(s)	Natural fish passage, sediment transport	Is effective upstream fish passage flow range similar or better than downstream?	Low-high passage flow range
		Are redds/juveniles found upstream?	Presence/absence
		Is streambed grade stable?	Longitudinal profile survey
Remove fish passage structure(s)	Natural fish passage, sediment transport	Are redds/juveniles found upstream?	Presence/absence
		Is streambed grade stable?	Longitudinal profile survey
Bank stabilization/revegetation	Riparian habitat restoration	How much of target vegetation has re-established?	% of floodplain vegetated by key species/class
		Are streambanks stable?	Length of unstable banks
Instream placements (large wood, boulders)	Instream habitat complexity	Same as aquatic habitat enhancements	
Grade control	Maintain upstream passage	Is streambed grade stable?	Longitudinal profile survey

9.5.1.2.3 *Adaptive Management Triggers/Actions*

If the monitoring results indicate that physical or biological changes have occurred at the mitigation site that adversely affect upstream passage, flood conveyance, sediment transport, stormwater management and pre-spawn mortality, or streambank stability in the vicinity of the action and cause the original mitigation action to not progress reasonably towards meeting the primary project goals, the Applicant would consult with the Adaptive Management Committee to review the outcome, identify the reason, discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management include observations of:

- Changes in streambed grade or head cutting/incision;
- Changes in streambed substrate composition;
- Debris racking at structure inlet;
- Excessive scour around foundation/road prism base;
- Unpermitted modifications to crossing;
- Treefall in the vicinity of inlet or outlet;
- Pre spawn mortality or poaching in the vicinity of crossing; and
- Significant beaver activity.

Adaptive management action examples that would be adopted in consultation with the Adaptive Management Committee could include the following key prescriptive responses for tributary access projects:

- More detailed fish surveys or tagging studies documenting presence/movement upstream and/or downstream;
- Correction of or protection against grade adjustments via adjustments to streambed substrate sizing and increased downstream roughness;
- Correction of or protection against unexpected incision/head cutting via downstream retrofits emulating natural channels (e.g., step-pools, roughened channel);
- Correction of streambank destabilization;
- Removal of wood debris/treefall;
- Additional coordination with WDFW and Salmon Recovery Fish Board fish passage programs; and
- Retrofits to accommodate beaver activity.

9.5.2 Riparian Stream Buffer Expansions Downstream of the Proposed FRE Facility

Riparian stream buffers would be incorporated downstream of the proposed FRE, 16.6 miles of mainstem stream miles to below Adna, Washington, and in selected tributaries including 4.8 miles of Bunker Creek. The buffers are intended to provide shade for thermal modulation of air temperatures, intercept surface runoff and reduce erosion, facilitate nutrient cycling, and enhance vegetative diversity for wildlife and amphibian habitat. Riparian stream buffer plantings would be implemented using a variety of native tree and shrub species found in the basin. Monitoring would emphasize species planted, growth rates, density, shade provided, and both short- and long-term survival.

9.5.2.1 Implementation Monitoring

Implementation monitoring would confirm that plantings were performed to specification in terms of planting technique and materials, locations, species, approved stock, and density, and that appropriate protective measures are also implemented against significant browsing and beaver damage. Implementation monitoring would occur at all parcels following a statistical sub-sampling scheme. Representative metrics are identified in Table 9.5-5.

Table 9.5-5
Representative Project Implementation Monitoring Metrics for Riparian Stream Buffer Expansions Mitigation Actions.

MITIGATION ACTION	KEY IMPLEMENTATION METRIC(S)
Plantings to restore riparian forest	Location, area planted by vegetation community type
	Average width of riparian zone planted
	Species, stock, density planted
	Use of browsing/beaver protection materials
Livestock exclusion fencing	Length and type of fencing installed

9.5.2.2 Effectiveness Monitoring

Riparian planting areas would be surveyed by a qualified riparian ecologist during the appropriate growing season (generally late spring). Planting areas would be surveyed by walking meandering transects and selecting representative plots for each area. A before/after statistical sub-sampling scheme would be followed, with baseline conditions measured at the same time as implementation monitoring. Every property parcel with riparian plantings would be subsampled to ensure that mitigation goals continue to be met fully. The monitoring data would be evaluated over time to assess vegetation conditions and progress towards performance standards. The results would also be used to evaluate ecological lift. Example effectiveness metrics are presented in Table 9.5-6 and would be advanced during permitting.

Table 9.5-6
Representative Project Effectiveness Monitoring Metrics for Riparian Stream Buffer Expansions Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Riparian buffer zone replanting	Restored riparian zone	What is planting survival rate for planted species?	Number/percent of plantings, by species, zone
	Large wood debris recruitment potential	What is density of future recruitment conifers?	Number per unit area
	Reduced fine sediment inputs from banks	What proportion/length of eroding banks is protected?	Length of bank replanted
	Shading/insulation extent	How much shading is provided on a given day?	Canopy height effective shade

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
	Prevent non-native species establishment	Are non-native species outcompeting native species?	Location, density, composition
Riparian buffer wetlands preservation	Preserve wetlands habitat	Are wetland habitats maintained?	Wetland delineation and functional assessment
	Prevent non-native species establishment	Are non-native species outcompeting native species?	Location, density, composition
Livestock exclusion fencing	Protect plantings	Is fencing intact?	Visual

Planting areas and adjacent areas would also be photo documented. Color photographs of the planting areas would be taken from fixed photo points with the same view to allow a review of the vegetation progress over time. The location, direction, and magnification of each photo point would be documented using a handheld Trimble Global Positioning System or similar device unit to ensure that the same fixed points are used during each survey.

9.5.2.3 Adaptive Management Triggers/Actions

If the monitoring results indicate that tree and shrub survival and growth rates at the mitigation site are not reasonably progressing towards meeting performance standards for achieving the target shade coverage, the Applicant would consult with the Adaptive Management Committee to review the monitoring data, identify the cause(s), discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management include observations of:

- Excessive plant mortality due to site conditions;
- Browsing mortality;
- Excessive riverbank erosion/channel migration;
- Poor growth rates;
- Encroachment by invasive species; and
- Change in land management/ownership/accessibility.

Adaptive management action examples that would be adopted in consultation with the Adaptive Management Committee could include the following key prescriptive responses for addressing deficiencies arising in riparian buffer plantings:

- Selection of additional riparian enhancement sites;
- Replanting additional plants to offset losses;
- Implementing soil amendments/treatments;
- Adjustments in species composition; and
- Revised invasive species monitoring and management strategy/frequency.

9.5.3 Wildlife Habitat Conservation and Mitigation

The goal of wildlife species and habitat mitigation is to expand and conserve sufficient wildlife habitat to offset construction related impacts as well as residual habitat degradation after implementation of the VMP. This plan includes four different action types: i) conversion of approximately 1,800 acres of industrial forest to successional old growth; ii) 111.5 acres of stream buffer creation and 361.5 acres of enhanced stream buffer habitat upslope of the FRE inundation zone; iii) aquatic, wetland, and buffer habitat enhancements from RM 89.3 to RM 87.6; and iv) riparian buffer enhancements on lower Bunker Creek and along the mainstem Chehalis River. This mitigation would protect riparian and upland forest habitat beyond compliance with forest practices, and allow for forest maturation and successional properties to be drivers of habitat complexity over the long term. This would support habitat for a broader diversity of wildlife for breeding and foraging, resting and overwintering, and specifically would benefit old growth bird SOC, marbled murrelet, and Van Dyke’s and Dunn’s salamanders.

9.5.3.1 Implementation Monitoring

Implementation monitoring would confirm which areas require canopy opening, replanting, or supplemental planting, and that plantings were performed to specification in terms of planting technique and materials, locations, species, approved stock, and density. Implementation monitoring would occur at all parcels following a statistical sub-sampling scheme. Representative metrics are identified in Table 9.5-7.

Table 9.5-7
Representative Project Implementation Monitoring Metrics for Wildlife Habitat Conservation and Mitigation Actions.

MITIGATION ACTION	KEY IMPLEMENTATION METRIC(S)
Preservation and restoration of forest habitat for wildlife	Area of forest opening and planting
	Area of stream buffer planted
	Area of wetlands and wetland buffers preserved
	Location, area, elevation by forest type, condition
	Species, stock, density planted
	Presence and removal/control of invasive and noxious species

9.5.3.2 Effectiveness Monitoring

A qualified wildlife biologist and forest ecologist would survey wildlife habitat areas. Wildlife species censuses would be performed and habitat conditions evaluated. Existing forest and replanted areas would be surveyed by walking meandering transects and selecting representative plots for each area. A before/after statistical sub-sampling scheme would be followed, with baseline conditions measured at the same time as implementation monitoring. Every property parcel purchased would be subsampled to ensure that mitigation goals continue to be met fully. The monitoring data would be evaluated over time to assess forest conditions as wildlife habitat. The results would also be used to evaluate ecological lift. Example effectiveness metrics are presented in Table 9.5-8 and would be advanced during permitting.

Table 9.5-8
Representative Project Effectiveness Monitoring Metrics or Wildlife Habitat Conservation and Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Wildlife habitat preservation, restoration	Promote high value old growth forest habitats	How much habitat is preserved now for different species?	Area by forest maturity level, target species habitat requirements
		What is the makeup and condition of forest areas available for wildlife habitat?	Stand density and diversity, stem count and basal area, forest structure (ground cover, mid- and under-story, canopy, canopy closure
		What is the quality of forest for wildlife habitat?	Wildlife richness diversity, local changes in air temperature and humidity
		Is habitat being used?	Wildlife census
	Expand and enhance forest stream buffers	What is the survival rate for planted species?	Stand density and diversity, stem count and basal area
		What is the quality of forest for wildlife habitat?	Wildlife richness diversity, reduced storm-related turbidity
		Is habitat being used?	Wildlife census
	Preserve forested wetlands	Are wetland habitats maintained?	Wetland delineation and functional assessment
	Prevent non-native species establishment	Are non-native species outcompeting native species?	Location, density, composition
	Downed wood for wildlife habitat	Is downed wood available as wildlife habitat?	Downed wood survey
		Is downed wood being used by wildlife?	Wildlife census

9.5.3.3 *Adaptive Management Triggers/Actions*

If the monitoring results indicate that tree and shrub survival and growth rates at the mitigation site are not reasonably progressing towards meeting performance standards for achieving the targeted wildlife habitat goals, the Applicant would consult with the Adaptive Management Committee to review the monitoring data, identify the cause(s), discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management include observations of:

- Excessive tree mortality;
- Poor stand diversity;

- Absence of wildlife species or sign indicative of wildlife use;
- Severely diminished growth rates of planted vegetation as compared to expectations;
- Loss of the plantings due to unanticipated actions, e.g., excessive weather/climate events, human intervention; and
- Uncontrollable encroachment of invasive/noxious species.

Adaptive management actions for riparian/stream buffer enhancements would be adopted in consultation with the Adaptive Management Committee and could include:

- Adjustments of planting plan goals for species, numbers;
- Adjustments to active stand management;
- More aggressive control measures for invasive/noxious species;
- Thinning during stem-exclusion phases; and
- Select harvest and planting to increase native species diversity.

9.5.4 Large Wood Material Recruitment and Placement

The goal of large wood mitigation is to improve the functional value of aquatic habitat by increasing quantities of in-channel LWM. This mitigation would provide hydraulic diversity, substrate diversity for macroinvertebrates, in-stream cover, pool formation, and gravel retention functions. The RMP was designed to accomplish this in three key ways that would be in effect over different timeframes: i) engineered large wood placements provide instantaneous increases in habitat complexity and diversity that are then maintained proactively as mitigation over the long term; ii) collection and relocation of loose wood pieces from above to below the FRE facility would maintain annual wood transport processes that would otherwise be interrupted; and iii) natural large wood recruitment into stream channels would be associated over a longer timeframe with riparian stream buffer expansion and forest preservation as trees grow and die. Monitoring and adaptive management actions are described for mitigation actions associated with wood placements and natural large wood recruitment in the preceding sections. This section addresses monitoring and adaptive management of mitigation efforts directly addressing the interruption of large wood transport.

9.5.4.1 Implementation Monitoring

Implementation monitoring would consist of counting location, number, size (length, diameter), configuration (with vs. without rootwad), condition (fresh vs. older vs. decomposing), and type (i.e., softwood vs. hardwood) of pieces collected and relocated downriver, by date.

9.5.4.2 Effectiveness Monitoring

Effectiveness of large wood collection and relocation would be evaluated by tagging larger softwood and hardwood logs that are collected, performing large wood surveys downriver to determine their fate, and noting if they contribute to aquatic and wildlife habitat formation along the river. The survey would extend downstream to the confluence with the South Fork Chehalis. The results would also be used to evaluate ecological lift. Example effectiveness metrics are presented in Table 9.5-9 and would be advanced during permitting.

Table 9.5-9
Representative Project Effectiveness Monitoring Metrics for Large Wood Material Recruitment and Placement Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Collecting and relocating large wood downstream	Maintain large wood transport downstream	Is relocated large wood moving and forming habitat downstream?	Density/percent of relocated wood forming habitat vs. river mile
			Type of habitat formed
			Size, type of wood forming habitat
		Is habitat formed by the relocated large wood being used by fish and aquatic invertebrates?	Seasonal presence/absence
		Is relocated large wood promoting gravel sorting and creating spawning habitat?	Area of spawning gravel vs. river mile
		Is relocated large wood increasing channel complexity?	Density/percent of relocated wood influencing channel form vs. river mile
		Is relocated large wood influencing channel migration?	Map riverbank and bar deposit locations over time

9.5.4.3 *Adaptive Management Triggers/Actions*

If the monitoring results indicate that the majority of relocated wood may not be providing effective habitat or is causing unanticipated negative effects, the Applicant would consult with the Adaptive Management Committee to review the outcome, identify the cause(s), discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management include:

- A majority of relocated large wood pieces end up high and dry in functionally ineffective positions;
- Changes in river morphology through erosion or sedimentation that affect infrastructure or accelerate erosion of private lands without landowner acceptance;
- Landownership or public removal/destruction of deposited relocated large wood pieces; and
- Short functional lifespan of relocated large wood pieces forming habitat.

Adaptive management action examples that would be adopted in consultation with the Adaptive Management Committee could include the following key prescriptive responses for aquatic habitat enhancements:

- Revision of monitoring parameters and/or frequency;
- Move to another relocation point on the river for releasing large wood pieces;
- Large wood removal where damage to property or infrastructure is occurring; and
- Reuse collected large wood pieces in engineered structures instead.

9.5.5 Surface Water Quality

The goal of the Surface Water Quality Management Plan is to evaluate and document the performance of the suite of mitigation actions intended to offset water quality and water temperature impacts throughout the Mitigation Area. Mitigation includes providing shade trees to reduce summer water temperatures and potential from related changes in DO, expanding and replanting riparian/stream buffers with native vegetation to improve interception of surface runoff, reduce erosion potential upslope, and reduce fine sediment delivery to the channel. The monitoring results may also be useful for informing other BMPs that could help reduce turbidity impacts during temporary reservoir-lowering flow releases.

9.5.5.1 Implementation Monitoring

Water quality mitigation would be accomplished through actions to enhance riparian and wetland habitat function throughout the Mitigation Area as described under the Aquatic Habitat Enhancement and Access, Riparian Stream Buffer Expansions, and Wetland Enhancement plans. As such, implementation monitoring for those actions are covered in Sections 9.5.1, 9.5.2, and 9.5.6. Compliance monitoring instead would include water quality sampling upstream and downstream of the proposed FRE location at compliance points determined during permitting.

9.5.5.2 Effectiveness Monitoring

This element of the FRE M&AMP focuses on measuring changes in water quality that can be attributed to mitigation actions. The emphasis of surface water quality monitoring would be primarily on summer water temperature and turbidity during FRE operations, and whether measured levels meet mitigation goals. Similar to effectiveness for Riparian Stream Buffer Expansions measures, water quality effectiveness would have a temporal component related to vegetative growth and restoration of the riparian process. Thus, the goals for metrics such as canopy height and effective shade would also change over time.

Performance monitoring for water temperature would include setting up continuous monitoring stations at compliance points. Sampling would be during summer months using temperature loggers that are placed in a deeper, more shaded location that is less likely to be influenced by solar radiation warming the local riverbed.

Performance monitoring for turbidity would coincide with winter storm events and would include grab sample monitoring upstream and downstream at a subset of riparian/stream buffer enhancement and forest conservation sites, and upstream and downstream of the FRE facility during operation. Example project effectiveness monitoring metrics are presented in Table 9.5-10 and would be advanced during permitting.

Table 9.5-10
Representative Project Effectiveness Monitoring Metrics for Surface Water Quality Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Riparian expansion and enhancement	Provide shade to abate thermal loading from solar inputs to the mainstem Chehalis River and specified tributary reaches	Is riparian shade protecting against high summer water temperatures?	Riparian canopy height
			Effective shade
			Water temperature at compliance points
		Are riparian conditions protecting against turbidity/fine sediment delivery?	Reduced turbidity, runoff and fine sediment input to streams after storms
		Are the modeled thermal load reductions from shade reflecting field measurements of effective shade?	Average kcal/day for planted land parcels
Best Management Practices	Shorten Elevated Turbidity Duration	Are suspended sediments settling out of channel?	Reduced turbidity, suspended sediment levels in streams after storms

9.5.5.3 Adaptive Management Triggers/Actions

If the monitoring results indicate that tree and shrub survival, canopy height, and effective shade, and fine sediment reduction at the mitigation site are not reasonably progressing towards meeting performance standards, the Applicant would consult with the Adaptive Management Committee to review the monitoring data, identify the cause(s), discuss the implications and whether/how the outcome can be addressed or if other controlling factors are in effect that are independent of FRE construction/operation, and concur on an appropriate course of action. Corresponding primary triggers for adaptive management review include:

- Canopy height and effective shade are not meeting temporal goals;
- Shade modeling indicates less than expected performance for the next time interval;
- There is no measurable reduction in summer water temperature daily maxima and range after the restored riparian canopy has matured; and
- BMPs for fine sediment input reduction do not settle out fine sediments.

Adaptive management actions related to riparian/stream buffer enhancements would be adopted in consultation with the Adaptive Management Committee and could include:

- Selection of additional riparian enhancement sites;
- Adjustments to plant composition goals; and
- Additional BMPs for out-of-channel fine sediment management.

9.5.6 Wetland Enhancement

Wetland enhancement is integrated with two other mitigation plans, Aquatic Habitat Enhancement and Access and Riparian Stream Buffer Expansions. Three mitigation actions identified for wetland enhancement include:

- Preservation and conservation of forest wetlands and wetland buffers;
- Opportunistic enhancement of existing riparian wetland buffers along the Chehalis River; and
- Restoration/creation of depressional wetland on the Chehalis River floodplain.

The first two would be monitored per Sections 9.5.2 and 9.5.3. This section describes the M&AMP for wetlands that are restored or created to mitigate wetland impacts most directly.

9.5.6.1 Implementation Monitoring

Implementation monitoring would confirm that wetland mitigation earthwork grading, plantings, and wood installations were performed to specification in terms of locations, quantities, planting technique and materials, species, approved stock, density, and that appropriate protective measures are also implemented against significant wildlife damage. Implementation monitoring would occur in all wetland areas comprising the mitigation acreage following a statistical sub-sampling scheme. Representative metrics are identified in Table 9.5-11.

Table 9.5-11
Representative Project Implementation Monitoring Metrics for Wetland Enhancement Mitigation Actions.

MITIGATION ACTION	KEY IMPLEMENTATION METRIC(S)
Grading earthwork	Location, area, volume of cut
	Elevations/gradients of excavated/planting areas
	Location, area, volume of fill within 100-year floodplain (if any)
Wetland plantings	Location, area planted by vegetation community type
	Species, stock, density planted
	Use of wildlife damage protection materials
Log installations	Location, number, size of wood pieces installed, by type

9.5.6.2 Effectiveness Monitoring

Effectiveness of wetland mitigation would be evaluated in terms of meeting specific performance standards over a performance monitoring period stipulated in environmental permits. The M&AMP for wetland mitigation typically includes the following elements for determining effectiveness:

- **Performance metrics** – metrics regarding the performance of wetland and buffer mitigation;
- **Monitoring schedule** – provides a basis for evaluating incremental progress toward ultimate target conditions for habitat and ecological function; and
- **Performance standards** – specific success criteria defined for each performance metric. Failure to meet performance standards triggers the process of diagnostic analysis and, if appropriate, contingency corrective actions.

Criteria defining performance and schedule would be defined in consultation with the Adaptive Management Committee.

Wetland mitigation areas would be surveyed by a qualified wetland ecologist during the appropriate growing season (generally late spring). Wetland areas would be delineated, and a functional assessment would be performed. A before/after statistical sub-sampling scheme for characterizing plant species composition would be followed in the case of existing wetlands, with baseline conditions measured at the same time as implementation monitoring. Every wetland area would be sampled to ensure that mitigation goals continue to be met fully. The monitoring data would be evaluated over time to assess hydrogeomorphic and vegetation conditions and progress towards performance standards. The results would also be used to evaluate ecological lift. Example effectiveness metrics are presented in Table 9.5-12 and would be advanced during permitting.

Table 9.5-12
Representative Project Effectiveness Monitoring Metrics for Wetland Enhancement Mitigation Actions.

MITIGATION ACTION	PRIMARY HABITAT OBJECTIVE	TOP LEVEL EFFECTIVENESS QUESTION(S)	METRICS
Grading earthwork	Maintain/establish wetland hydrology	Are hydric soil conditions maintained/created?	Soil saturation near surface
		What are wetland hydrology conditions?	Standing water level, timing
	Appropriate conditions for plant growth, survival	What is planting survival rate for planted species?	Number/percent of plantings, by species, zone
Wetland plantings	Wetland community diversity	Is plant community composition robust?	Number/percent of plantings, by species, zone
	Prevent non-native species establishment	Are non-native species outcompeting native species?	Location, density, composition
Placement of wood pieces	Provide floodplain wildlife habitat	Are wetland habitats maintained?	Wetland delineation and functional assessment
	Avoid/minimize avulsion risk	Is floodplain channel enlarging/eroding, or headcut forming?	Longitudinal profile survey
Wildlife damage protection	Protect plantings	Is protection intact?	Visual

9.5.6.3 Adaptive Management Triggers/Action

The monitoring data would be analyzed to document progress toward achieving performance standards and demonstrate whether sufficient progress is made, or if corrective measures may be needed to achieve performance standards. If it is determined that the proposed mitigation does not meet key performance targets, diagnostic analysis would be triggered to identify the root causes of substandard performance and select effective corrective measures. As part of this, the monitoring data would be reviewed, with potentially a follow-up site inspection to focus on confirming the monitoring results, assessing whether the observed deficiency is localized or representative of the entire wetland, and assess potential causes. The Applicant would consult with the Adaptive Management Committee to review the monitoring data, identify the cause(s), discuss the implications and whether/how the outcome can be addressed, and concur on an appropriate course of action. Primary triggers for adaptive management include:

- Evidence of local or nearby landscape changes;
- Poor plant survival/failure to meet plant establishment standards;
- Local erosion or aggradation;
- Plants showing signs of damage due to browsing, disease, desiccation, or other forms of plant stress;
- Overgrowth/out-competition by invasive species; and
- Observed portions of a site that are thriving that could offer clues on potential corrections to poorly performing areas.

Localized deficiencies may be addressed with localized corrections, whereas systemic deficiencies likely require a systemic correction. Adaptive management actions related to wetland mitigation would be adopted accordingly in consultation with the Adaptive Management Committee and could include:

- Monitoring schedule adjustments;
- Adding a temporary watering system;
- Identifying alternative or supplemental natural sources of water;
- Adding mulch or other soil amendment(s);
- Installing temporary fencing or other protective measures;
- Replacing dead and damaged plants with alternative plant species that are less favored by browsing wildlife;
- Increasing frequency and intensity of invasive species management;
- Determining shallow groundwater elevations by seasonal monitoring and grading affected portions of wetland accordingly;
- Implementing new similar mitigation to replace the reduced mitigation area; and
- Increasing the capacity of floodplain connections or lowering the inlet control elevation.

10 IMPLEMENTATION FRAMEWORK

10.1 Principles of Successful Large Project Implementation

This section provides an overview of key considerations and concepts that can be worked into the planning, permitting, contracting, and monitoring of a large-scale mitigation program for the proposed FRE facility, including examples of how various concepts have been applied successfully on past mitigation projects.

10.1.1 Performance-Based Approach

A performance-based approach to the implementation of mitigation plan actions can reduce costs, shorten schedules, reduce risk of delay, increase permit compliance, and increase potential for achieving ecological goals. An implementation contract can employ approaches suited to working over a large temporal and spatial scale, which may not be used in more typically sized mitigation projects. In this way, the implementation of the mitigation plan can be delivered more reliably and with reduced risk. For example, a mitigation plan requires wood debris piles to be maintained for 20 years. Instead of pricing in the costs of importing wood debris over 20 years, the implementation contract can include planting extra trees to grow and be cut down in future years to provide the wood debris.

10.1.2 Flexibility in the Mitigation Plan

There is inherent uncertainty in predicting future ecological conditions, thus no mitigation plan can be expected to deliver the mitigation perfectly compliant with performance requirements. In the case of mitigation projects involving large scale revegetation, for example, there would be large variations across the landscape in soil types, site conditions, hydrology, and other elements that are generally not known during the design phase of a mitigation project. Flexibility may be needed when many parcels of property are required to meet the mitigation need, as property changes hands and owners change their minds. Providing flexibility allows the implementation contractor to modify mitigation plan elements while still meeting specified goals and objectives and permit requirements in coordination with the Applicant and the Applicant's engineering consultant. For example, with the Bois D'arc Lake mitigation project in Texas, the largest permittee responsible mitigation project in the U.S., the 17,000-acre mitigation plan had to be modified numerous times after receiving agency approval to reflect site-specific soil conditions, hydrology, and other elements, and still achieve the level of mitigation needed. On the Klamath Dam Removal mitigation project, Western pond turtles were listed as candidate species during mitigation implementation requiring both additional consultation with agencies and modifications to the mitigation plan. The project team worked collaboratively with the agencies to develop appropriate protocols for this special status species.

10.1.3 Consolidated Responsibility

Whether a mitigation program follows a design/bid/build, design/build, full delivery, public-private partnership, or pay-for-performance approach, implementation contracts can combine construction with long-term maintenance and be tied to meeting the monitoring success criteria. The contract vehicle can include responding to problems that require corrective action(s). There are pros and cons to each approach, depending on the nature of mitigation actions and the environmental, social, and political setting. The Applicant would evaluate the potential alternative contracting methods available to implement this project.

10.1.4 Meeting Regulatory Project Performance Standards

Many permits are set up with performance standards and schedule, i.e., what needs to be achieved by a certain timeframe. In engineering plans, the performance measure is most often prescriptive – the plans tell the implementation contractor what to do. However, despite the best designs, a proposed mitigation plan may still not perform as expected, leaving the permittee short on meeting their mitigation credits or requirements. As an alternative, a mitigation plan can be executed making the implementation contractor responsible for the outcome of the project meeting the performance standards. The contractor is then allowed to use their experience to implement the mitigation plan in a way that they feel would meet the performance standards. Ultimately, it is the performance that is important, providing ecological offsets for the permitted impacts, not the methods or process used to accomplish it. Focusing on performance and minimizing prescriptive requirements can greatly improve the success of large mitigation projects. For example, a performance standard for a riparian buffer could state density of trees required, average height of trees, and target year (e.g., 400 trees averaging 5 feet tall by year 5). The Contractor would be free to select planting stock (e.g., bareroot, container, etc.), density, and perhaps species to achieve the required performance, considering anticipated mortality, soil differences, and growth rates.

10.2 Early Mitigation Actions

The FRE facility project and mitigation plans have focused on avoiding and minimizing impacts wherever possible. The Applicant proposes developing three specific projects ahead of other planned mitigation actions upon start of construction of the FRE facility. These early actions provide benefits to the system ahead of project related impacts and should improve resiliency of these habitats to potential FRE operational impacts. They would be evaluated following the same M&AMP protocols as other actions and may potentially inform their design depending on timing. Landowners have been engaged actively and have expressed interest in supporting mitigation on the affected properties. The three projects are described below.

10.2.1 Chehalis River Floodplain, Instream and Off-Channel Habitat Enhancement/Restoration

One complex mitigation site is located within RM 87.6-89.3. The existing conditions at this site present several different opportunities to mitigate impacts related to fish and aquatic habitat degradation, loss of wetlands and buffers, wildlife habitat degradation, and shade loss. The mitigation enhancements proposed include expanding off-channel rearing habitat for aquatic species, increasing the habitat complexity by enlarging/maintain split flow side channels, restoring wetlands and buffers, increasing floodplain channel engagement, and restoring floodplain forest along relic Chehalis River channels. In-channel feature improvement with wood debris and process-based restoration features such as post-assisted log structures should also improve habitat complexity for native fish species. Implementing multiple mitigation measures at this site would provide for synergistic benefits especially related to wildlife benefits with restoration of native wetland, riparian, forest, and stream habitats that are all within close proximity.

10.2.2 Bunker Creek Habitat, Riparian, and Fish Passage Enhancement/Restoration

The second complex mitigation site is situated along the lower reaches of Bunker Creek, a tributary to the Chehalis River. Implementing mitigation enhancement on this property represents a unique location for off-channel habitat for juvenile salmon in the middle Chehalis River. The channel is incised with unvegetated and eroding banks. Several actions are proposed to mitigate for loss of stream channel, aquatic habitat degradation, and shade-related thermal load increases. Proposed activities include culvert removal, excavation of an inset floodplain to support natural river processes, revegetation of the stream banks and buffer with native species, and installation of large wood within the ordinary high-water channel. Implementing these measures in concert would provide a synergistic effect to this tributary system and additional ecological benefits that would include improved water quality, nutrient cycling, and wildlife habitat for riparian dwelling species.

10.2.3 Pre-operations Vegetation Management

The VMP (Appendix D) concerns the maintenance of trees in riparian and upland habitats upstream of the FRE facility both during and after construction. The plan was developed to minimize the loss of trees in the temporary inundation area associated with construction and operation. Tree clearing upstream of the FRE facility would be limited to areas needed to allow routine inspection of the facilities and for salvaged large wood storage. However, much of the inundation area vegetation consists of Douglas fir monocultures, a species that is not tolerant of prolonged flooding. There are also areas that have been or would be harvested prior to construction independent of the project. The Applicant is proposing to plant native species in both areas prior to construction that are more tolerant of temporary inundation to begin the transition to a streamside and upland vegetation community that remains healthy. This would minimize potential aquatic impacts including shade loss and associated increased thermal input to rivers, loss of large wood material, increased runoff and erosion that might affect water quality, and reduction and/or degradation of habitat for a variety of terrestrial wildlife species including birds, mammals, and amphibians. The VMP would accelerate the resilience of vegetation to flooding and promote the development of pre-inundation plant communities that would benefit the aquatic environment in the Chehalis River and its tributaries, maintain wetland functions, stabilize the soil surface to reduce erosion and runoff, and provide habitat value for terrestrial wildlife.

10.3 Implementation of an Efficient Mitigation Work Plan

An efficient mitigation work plan would depend on clearly defining scopes and schedules. In some cases, there are various interconnected mitigation actions proposed by the Applicant. Some of those actions can be linked ahead of the implementation scheduling process, as described below.

10.3.1 Integrating Scopes Across Mitigation Types

Implementation of the mitigation plan would require detailed scopes of work. The Applicant would develop final engineering and design elements for contracting services and procuring materials needed for each of the mitigation actions described in Section 8. Where and when feasible, similar mitigation types may be contracted together. Many of the actions for aquatic habitat enhancements are interconnected and would be incorporated at similar locations, and thus would be implemented most cost-effectively by a contractor with commensurate experience who can combine mobilization and other direct costs. For example, a contractor with local experience in culvert installations and roadway finishing as well as aquatic habitat restoration experience could construct multiple projects in the same area involving fish passage correction and habitat enhancements, and in the same season. Having all work under a single contract for multiple sites allows for consistency and coordination benefits of reduced costs, continuous work efforts (i.e., timing), and avoidance of redundant actions. As another example, wetland mitigation designs are often paired with floodplain connectivity or other riparian projects. Reducing contracts by pairing wetland mitigation implementation to other mitigation actions would reduce coordination time and improve efficiency. Another combined effort could be to examine similarities and shared efforts in planting between the VMP, forest conversion, and riparian enhancement to reduce costs and coordination.

10.3.2 Schedule

The Applicant would develop a schedule for each mitigation action. Schedules would need to include time for contracting, plant material sourcing and development, materials procurement, equipment and labor mobilizations to and between mitigation sites, construction, planting phases, monitoring, maintenance, and close out. The mitigation schedule should also include considerations for delays due to weather, materials availability, time-of-year restrictions, growing seasons, logistics, and may also include time for development and training of a local workforce. Scheduling or planning work based on the available workforce would identify if a local training program or outside hiring is needed. Partnerships within the project area with government agencies, Tribes and/or nonprofits, and local contractors would help develop a reliable schedule and make the most of the local workforce and existing resources. For example, the Klamath River Restoration project in Oregon and California is the largest river restoration in the U.S. consisting of the restoration of four former impoundments post dam removal. The Karuk Tribe, Yurok Tribe, and the USGS were contracted to provide local staffing to operate water quality monitoring stations from upstream of J.C. Boyle reservation down to the Klamath River estuary at the Pacific Ocean, supporting flow coverage for over 240 RMs.

10.3.3 Material Procurement

Execution of the mitigation actions would require procurement of substantial plant, large wood, and boulder materials that must occur early in the process. Plant materials in particular would likely involve the longest lead time considerations. The Applicant would determine in advance whether sufficient plant material (e.g., seed and stock) would be commercially available at the times indicated in the schedule. If commercial sources are anticipated to be insufficient, then provisions would be made for local seed and cutting procurement and nursery development in time to meet the planting schedules. For example, the four former impoundments in the Klamath River Restoration project consisted of 2,200 acres needing native seeding. No commercial operation had the quantity or types of native seed needed for the project. The collection and propagation of 17 billion native seeds took approximately four years. The steps to develop the seed source began years prior to approval of the restoration plans by Federal Energy Regulatory Commission due to the known timeline for removal once approval was received.

In addition, detailed plans would be developed during the procurement stage for large wood acquisition as well as boulder procurement. These plans would utilize large wood removed from the inundation area of the FRE facility per the VMP as well as construction areas associated with the FRE facility. A storage and stockpile area would be developed to reduce the amount of handling between removal from the temporary inundation area and placement within a mitigation site. Large wood may also be needed from off-site sources. The plans would also identify the most efficient sources of boulders and soil/gravel/rock material, including that available at the mitigation sites and local quarries. Consideration would be given to the most efficient methods of materials procurement and delivery that result in minimized disturbance to the mitigation sites.

10.3.4 Construction

Each mitigation action would require development of detailed site construction plans for both permitting and construction that include descriptions of equipment access routes, staging and materials laydown areas, fuel storage and refueling areas, erosion/sedimentation controls, and water management plans. These plans may include provisions for field adjustments as developed by both the engineer and construction contractor. A project-wide safety plan would also be developed that would include specific safety action plans for each mitigation action construction site.

10.3.5 Closeout and Handoff

The Applicant would identify close-out actions to be taken by the end of the mitigation period. These actions would address any necessary continuing maintenance of the mitigation sites as well as the parties responsible for long-term stewardship. Establishing relationships with Conservancies or Native groups that would steward the land in perpetuity ahead of handoff would allow them to prepare for the eventual role and could lead to identification of required changes in legal elements for this to occur.

10.4 Coordination and Planning

A large-scale project requires significant coordination at levels beyond typical client-designer-agency contractor communication and monthly updates. Significant scheduling would be required for the known project while other elements of emergency planning and contingency planning would also be required. Detailed planning and foresight of the needs for each mitigation type and site would need to be comprehensively coordinated with a dedicated team. The timeline to begin planning has already been initiated with the development of this document. Elements laid out in this section would guide the Applicant in our work to complete the mitigation planning and designs and provide the platform for successful implementation across all the mitigation types.

11 REFERENCES

Ahmed, A., and D. Rountry, 2004. *Upper Chehalis River Fecal Coliform Bacteria Total Maximum Daily Load*. Prepared for the Washington State Department of Ecology. Publication 04-10-041. May 2004.

Anchor QEA (Anchor QEA, LLC), 2014. *Chehalis Basin Strategy Water Quality Studies Final Report.* Prepared for the Washington State Office of Financial Management. September 2014.

Anchor QEA (Anchor QEA, LLC), 2017. *Draft Operations Plan for Flood Retention Facilities*. Prepared for the Chehalis Basin Work Group. September 2016.

Anchor QEA (Anchor QEA, LLC), 2018. *Wetland, Water, and Ordinary High Water Mark Delineation Report*. Chehalis River Basin Flood Damage Reduction Project. Prepared for the Washington State Department of Ecology, Washington Department of Fish and Wildlife, and U.S. Army Corps of Engineers. December 2018.

Anchor QEA (Anchor QEA, LLC), 2019. *Chehalis - Centralia Airport Levee Wetland Delineation Report*. Chehalis River Basin Flood Damage Reduction Project. Prepared for the Washington State Department of Ecology. May 2019.

Beechie, T.J., M. Liermann, E.M. Beamer, and R. Henderson, 2005. "A classification of habitat types in a large river and their use by juvenile salmonids." *Transactions of the American Fisheries Society* 134(3):717-729.

Beechie, T., 2018. Memorandum to: Washington Department of Fish and Wildlife Staff. Regarding: Summary of Watershed Assessment Results, Chehalis River Basin. Chehalis Basin Strategy. Prepared for the Governor's Chehalis Basin Work Group. National Oceanic and Atmospheric Administration. May 14, 2018.

Beechie, T.J., C. Nicol, C. Fogel, J. Jorgensen, J. Thompson, G. Seixas, J Chamberlin, J.E. Hall, B. Timpane-Padgham, P. Kiffney, S. Kubo, and J. Keaton, 2021. *Modeling effects of habitat change and restoration alternatives on salmon in the Chehalis River basin using a salmonid life cycle model*. Phase 1 Contract Report. Prepared for the U.S. Department of Commerce. NOAA Contract Report NMFS-NWFSC-CR-2021-01. April 2021.

Beechie, T. J., A. Goodman, O. Stefankiv, B. Timpane-Padgham, and M. Lowe, 2023. *Habitat Assessment and Restoration Planning (HARP) Model for the Snohomish and Stillaguamish River Basins*. Prepared for the U.S. Department of Commerce. NOAA Contract Report NMFS-NWFSC-CR-2023-02. February 2023.

Blevins, E., S. Jepsen, and S. Selvaggio, 2020. *Petitions to list the Western Ridged Mussel (Gonidea angulata) as an Endangered Species under the W.S. Endangered Species Act.* Petition submitted by The Xerces Society for Invertebrate Conservation August 18, 2020. Accessed at: https://www.xerces.org/sites/default/files/publications/20-023.pdf.

Boughton, D., J. Nelson, and M.K. Lacy, 2022. *Integration of Steelhead Viability Monitoring, Recovery Plans, and Fisheries Management in the Southern Coastal Area*. Prepared on behalf of the State of California Natural Resources Agency and the Department of Fish and Wildlife. Fish Bulletin 182.

Boyd, M., and B. Kasper, 2003. "Analytical methods for dynamic open channel heat and mass transfer: Methodology for heat source model Version 7.0." Accessed at: https://www.oregon.gov/deq/FilterDocs/heatsourcemanual.pdf.

Bradford, M.J., 2017. "Accounting for Uncertainty and Time Lags in Equivalency Calculations for Offsetting in Aquatic Resources Management Programs." *Environmental Management* 60:588-597. Accessed at: https://doi.org/10.1007/s00267-017-0892-6.

Capelli, M., 2024. "The role of wildfires in the recovery strategy for the endangered southern California steelhead." Biogeomorphic Responses to Wildfire in Fluvial Ecosystems. *The Geological Society of America* 562. Accessed at: https://doi.org/10.1130/2024.2562(06).

CBS (Chehalis Basin Strategy), 2017. *Chehalis Basin Strategy Reducing Flood Damage and Restoring Aquatic Species Habitat*. Final Programmatic Environmental Impact Statement. Prepared for the Washington State Department of Ecology. Publication 17-06-019. June 2, 2017.

Collins, B.D., D.R. Montgomery, and A.D. Haas, 2002. "Historical changes in the distribution and functions of large wood in Puget Lowland rivers." *Canadian Journal of Fisheries and Aquatic Sciences* 59(1):66-76.

Corps (U.S. Army Corps of Engineers), 2020. *National Environmental Policy Act (NEPA) Environmental Impact Statement (EIS)*. Chehalis River Basin Flood Damage Reduction Project. Prepared for the U.S. Army Corps of Engineers, Seattle District. September 18, 2020.

Dewitz, J., 2019. National Land Cover Database (NLCD) 2016 Products (ver. 3.0, November 2023): U.S. Geological Survey data release. Available from: https://doi.org/10.5066/P96HHBIE.

Douville, K., J. Tyson, and M. Lambert, 2021. *Chehalis ASRP Western Ridged Mussel Surveys Progress Report*. Prepared for the Washington Department of Fish and Wildlife Habitat Program, Science Division, Aquatic Research Section. June 30, 2021.

Dugdale, S.J., I.A. Malcolm, K. Kantola, and D.M. Hannah, 2018. Stream temperature under contrasting riparian forest cover: Understanding thermal dynamics and heat exchange processes. *Science of the Total Environment*, 610, pp.1375-1389.

Ecology (Washington State Department of Ecology), 1992a. *Dam Safety Guidelines Part 1 - General Information and Owner Responsibilities*. Revised April 2021. Publication 92-55a. July. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255a.pdf.

Ecology (Washington State Department of Ecology), 1992b. *Dam Safety Guidelines Part 2 - Project Planning and Approval of Dam Construction and Modification*. Revised February 2008. Publication 92-55b. January 1992. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255b.pdf.

Ecology (Washington State Department of Ecology), 1992c. *Dam Safety Guidelines Part 3 - An Owner's Guidance Manual*. Revised April 2020. Publication 92-55c. July. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255c.pdf.

Ecology (Washington State Department of Ecology), 1992d. *Dam Safety Guidelines - Technical Note 1: Dam Break Inundation Analysis and Downstream Hazard Classification*. Revised December 2007. Publication 92-55e. July 1992. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255e.pdf.

Ecology (Washington State Department of Ecology), 1992e. *Dam Safety Guidelines - Technical Note 2: Selection of Design/Performance Goals for Critical Project Elements*. Publication 92-55f. July 1992. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255f.pdf.

Ecology (Washington State Department of Ecology), 1992f. *Dam Safety Guidelines - Technical Note 3: Design Storm Construction*. Revised October 2009. Publication 92-55g. July 1992. Accessed at: https://apps.ecology.wa.gov/publications/documents/9255g.pdf.

Ecology (Washington State Department of Ecology), 2001. *Upper Chehalis River Basin Temperature Total Maximum Daily Load*. Publication 99-52. July 2001. Accessed at: https://fortress.wa.gov/ecy/publications/documents/9952.pdf.

Ecology (Washington Department of Ecology), 2007. *Modeling the Effects of Riparian Buffer Width on Effective Shade and Stream Temperature*. No. 07-03-028. June 2007. Accessed at: https://fortress.wa.gov/ecy/publications/documents/0703028.pdf.

Ecology (Washington State Department of Ecology), 2020. *State Environmental Policy Act Draft Environmental Impact Statement*. Chehalis River Basin Flood Damage Reduction Project. Shorelines and Environmental Assistance Program. Publication 20-06-002. February 2020.

FCZD (Chehalis River Basin Flood Control Zone District), 2021. *Vegetation Management Plan*. Chehalis River Flood Damage Reduction Project. December 2021.

FIRP (Forest Industry Research Program), 2022. *Timber Harvest for Lewis County, WA*. Report by University of Montana under Agriculture and Food Research Initiative Competitive Grant 2011-68005-30416. Accessed at: https://www.bber.umt.edu/FIR/.

Ford, J.K.B., G.M. Ellis, P.F. Olesiuk, and K.C. Balcomb, 2010. "Linking killer whale survival and prey abundance: food limitation in the oceans' apex predator?" *Biology Letters* 6:139-142. September 15, 2009. Accessed at: https://doi.org/10.1098/rsbl.2009.0468.

Fox, M., and S. Bolton, 2007. “A regional and geomorphic reference for quantities and volumes of instream wood in unmanaged forested basins of Washington State.” *North American Journal of Fisheries Management* 27(1):342-359.

Fuller, M.R., P. Leinenbach, N.E. Detenbeck, R. Labiosa, and D.J. Isaak, 2022. Riparian vegetation shade restoration and loss effects on recent and future stream temperatures. *Restoration Ecology*, 30(7): e13626.

Gendaszek, A.S., 2011. *Hydrogeologic Framework and Groundwater/Surface-Water Interactions of the Chehalis River Basin, Southwestern Washington*. U.S. Geological Survey Scientific Investigations Report 2011-5160, 42.

GHLE (Grays Harbor County Lead Entity Habitat Work Group), 2011. *The Chehalis Basin Salmon Habitat Restoration and Preservation Strategy for WRIA 22 and 23*. Prepared with assistance by Grays Harbor County and Creative Community Solutions, Inc. June 30, 2011. Accessed at: http://www.chehalisleadentity.org/documents/.

Google, 2019. Google Earth Pro (Version 7.3.2.5776) [Software].

Hamer, T.E., and S.K. Nelson, 1995. Characteristics of marbled murrelet nest trees and nesting stands. Chapter 6. Ralph, C.J., G.L. Hunt, Jr., M.G. Raphael, J.F. Piatt, eds. *Ecology and Conservation of the Marbled Murrelet*. Gen. Tech. Rep. PSW-GTR-152. Albany, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Research Station: 69-82.

Hansen, G.S., R.W. Perry, T.J. Kock, J.S. White, P.V. Haner, J.M. Plumb, and J.R. Wallick, 2023. *Assessment of habitat use by juvenile Chinook salmon (Oncorhynchus tshawytscha) in the Willamette River Basin, 2020-21*. US Geological Survey Open-File Report 2023-1001.

Hartema, L., P. Adler, C. Toal, and J. Latterell, 2015. *Willow pole diameter affects survival and growth in wetlands dominated by reed canarygrass (Phalaris arundinacea): Year 3. King County Monitoring Memo.* Prepared for the King County Department of Natural Resources and Parks. Accessed at: https://soundnativeplants.com/wp-content/uploads/2015/10/KC-Willow-Pole-Study-in-RCG-Year-3-results_Oct-2015.pdf.

Hayes, M., J. Tyson, K. Douville, J. Layman, T. Newman, and K. Young, 2016. *2016 Chehalis Intensive Study in Off Channel Habitats 3rd (31 December 2016) Progress Report*. Prepared for the Washington Department of Fish and Wildlife, Habitat Program Science Division, Aquatic Research Section. December 31, 2016.

Hayes, M., J. Tyson, and K. Douville, 2017. *2017 Chehalis ASRP Off-Channel Extensive Surveys: 4th Progress Report for Post-Feasibility Effort. Final Report for Work Group Distribution.* Prepared for the Washington Department of Fish and Wildlife, Habitat Program Science Division, Aquatic Research Section. June 30, 2017.

Hayes, M., J. Tyson, J. Layman, and K. Douville, 2019. *Intensive Study of Chehalis Floodplain Off-Channel Habitats*. Prepared for the Washington Department of Fish and Wildlife, Habitat Program Science Division, Aquatic Research Section. March 2019.

Hayslip G.A., and L.G. Herger, 2001. *Ecological Condition of the Upper Chehalis Basin Streams*. Prepared for the U.S. Environmental Protection Agency, Region 10, Seattle, Washington. EPA Report 910-R-01-005. June 2001.

HDR (HDR, Inc.), 2018a. *Combined Dam and Fish Passage. Supplemental Design Report. FRE facility Dam Alternative*. Prepared for the Washington State Recreation and Conservation Office and the Chehalis Basin Work Group. September 2018.

HDR (HDR, Inc.), 2018b. *Fish Passage: CHTR Preliminary Design Report*. Prepared for the Washington State Recreation and Conservation Office and the Chehalis Basin Work Group. February 2018.

HDR (HDR, Inc.), 2020a. *Conceptual Vegetation Management Plan*. Chehalis River Basin Flood Damage Reduction Project. Prepared for the Chehalis River Basin Flood Control Zone District. November 2020.

HDR (HDR, Inc.), 2020b. *DRAFT Biological Assessment and Essential Fish Habitat Assessment - Flood Retention Facility, Airport Levee Improvements, and Mitigation Actions*. Chehalis River Basin Flood Damage Reduction Project. September 2020.

HDR (HDR, Inc.), 2024. *Revised Project Description: Flood Retention Expandable Structure*. Prepared for the Chehalis River Basin Flood Control Zone District. Unpublished.

Hiss, M.J., and E.E. Knudsen, 1993. *Chehalis River basin fishery resources: status, trends, and restoration*. Prepared for the United States Fish and Wildlife Service, Western Washington Fishery Resource Office, Olympia, Washington.

Hooke, J.M., 2015. "Variations in flood magnitude–effect relations and the implications for flood risk assessment and river management." *Geomorphology* 251:91-107.

Hough-Snee and Anchor QEA (Hough-Snee, N., and Anchor QEA, LLC), 2019. *Cottonwood Habitat Study*. Chehalis River Basin Flood Damage Reduction Project. Prepared for the Washington State Department of Ecology and U.S. Army Corps of Engineers. April 2019.

Hruby, T., 2014. *Washington State Wetland Rating System for Western Washington: 2014 Update*. Effective January 2015. Prepared for the Washington State Department of Ecology. Publication 14-06-029. Accessed at: https://apps.ecology.wa.gov/publications/SummaryPages/1406029.html.

Jennings, K., and P. Pickett, 2000. *Revised Upper Chehalis River Basin Dissolved Oxygen Total Maximum Daily Load Submittal Report*. Prepared for the Washington State Department of Ecology. Publication 00-10-018. March 2000. Accessed at: https://apps.ecology.wa.gov/publications/SummaryPages/0010018.html.

Jolley, J.C., G.S. Silver, J.E. Harris, E.C. Butts, and C. Cook-Tabor, 2016. *Occupancy and Distribution of Larval Pacific Lamprey and Lampetra spp. In Wadeable Streams of the Pacific Northwest*. Prepared for the U.S. Fish and Wildlife Service, Columbia River Fish and Wildlife Conservation Office, Vancouver, Washington.

Kim, K.D., K. Ewing, and D.E. Giblin, 2006. "Controlling Phalaris arundinacea (reed canarygrass) with live willow stakes: A density-dependent response." *Ecological Engineering* 27:219-227.

Kleinschmidt (Kleinschmidt Associates), 2020a. *Draft Flood Retention Expandable Facility Habitat Mitigation Plan: Aquatic Species and Habitat, Riparian and Stream Buffer, Wildlife Species and Habitat, Large Woody Material, Surface Water Quality*. Prepared for the Chehalis River Basin Flood Control Zone District. June 2022.

Kleinschmidt (Kleinschmidt Associates), 2020b. *Aquatic and Terrestrial Mitigation Opportunities Assessment Report*. Prepared for the Chehalis River Basin Flood Control Zone District. July 2020.

Larsen, E.M., 1997. *Management Recommendations for Washington's Priority Species Volume III: Amphibians and Reptiles*. Prepared for Washington Department of Fish and Wildlife, Olympia, Washington.

Lestelle L., M. Zimmerman, C. McConnaha, and J. Ferguson, 2019. *Spawning Distribution of Chehalis Spring-run Chinook Salmon and Application to Modeling*. Technical Memorandum No. 1 Final. Prepared for the Aquatic Species Restoration Plan Science and Review Team. April 8, 2019.

Lewis County, Washington (Lewis County), 2021. *Lewis County Shoreline Master Program*. Adopted by the Board of County Commissioners: September 21, 2021 by Ordinance No. 1329. Effective November 29, 2021.

Light, J., and L. Herger, 1994. *Chehalis headwaters watershed analysis fish habitat assessment*. Prepared for the Weyerhaeuser Company. Accessed at: https://fortress.wa.gov/dnr/protectionsa/ApprovedWatershedAnalyses.

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D. McEwan, R.B. MacFarlane, and C. Swanson, 2007. *Framework for assessing viability of threatened and endangered Chinook salmon and steelhead in the Sacramento–San Joaquin basin*. *San Francisco Estuary and Watershed Science* 5(1).

Litz, M., T. Seamons, L. Gilbertson, and M. Miller, 2023. *Rates of spring and fall Chinook genetic hybridization in the Chehalis*. Presentation at Washington State Recreation and Conservation Office Salmon Recovery Conference Vancouver, Washington; April 2023. Accessed at: https://chehalisbasinstrategy.com/wp-content/uploads/2022/04/Understanding-Rates-of-Spring-and-Fall-Chinook-Genetic-Hybridization.pdf.

Lower Columbia Fish Recovery Board, 2015. Project Implementation and Long-Term Function Monitoring Protocol. Longview, Washington.

Mauger, G.S., S.Y. Lee, C. Bandaragoda, Y. Serra, and J.S. Won, 2016. *Refined Estimates of Climate Change Affected Hydrology in the Chehalis Basin*. Prepared for Anchor QEA, LLC. Prepared on behalf of Climate Impacts Group, University of Washington, Seattle. Accessed at: doi.org/10.7915/CIG53F4MH.

McConnaha, W., J. Walker, K. Dickman, and M. Yelin, 2017. *Chehalis Basin Strategy Analysis of Salmonid Habitat Potential to Support the Chehalis Basin Programmatic Environmental Impact Statement*. Prepared for Anchor QEA, LLC, Seattle, Washington, 114. Prepared on behalf of ICF Portland, OR. July 2017.

Neiman, P.J., L.J. Schick, F.M. Ralph, M. Hughes, and G.A. Wick, 2011. "Flooding in Western Washington: The Connection to Atmospheric Rivers." *Journal of Hydrometeorology* 12(6):1337-1358.

Nelson, J., D. Cottam, E.W. Holman, D.J. Lancaster, S. McCorquodale, and D.K. Person, 2008. *Habitat Guidelines for Black-tailed Deer: Coastal Rainforest Ecoregion*. Prepared for the Mule Deer Working Group, Western Association of Fish and Wildlife Agencies.

Nicol, C.L., J.C. Jorgensen, C.B. Fogel, B. Timpane-Padgham, and T.J. Beechie, 2023. "Spatially overlapping salmon species have varied population response to early life history mortality from increased peak flows." *Canadian Journal of Fisheries and Aquatic Sciences* 79:1-10. Accessed at: https://doi.org/10.1139/cjfas-2021-0038.

NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service), 2000. *Guidelines for Electrofishing Waters Containing Salmonids Listed Under the Endangered Species Act*. June 2020.

NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service), 2012. *Southern California Steelhead Recovery Plan*. NOAA Fisheries, Southwest Region, Protected Resources Division, Long Beach, California. January 2012.

NOAA Fisheries (National Oceanic and Atmospheric Administration, National Marine Fisheries Service), 2023. *NOAA Fisheries West Coast Region Anadromous Salmonid Passage Design Manual*. NOAA Fisheries, West Coast Region, Portland, Oregon. Original Issue June 2022. Addendum #1 February 22, 2023.

Norman, D.K., P.J. Wampler, A.H. Throop, E.F. Schnitzer, and J.M. Roloff, 1997. *Best Management Practices for Reclaiming Surface Mines in Washington and Oregon*. Revised Edition. Washington Division of Geology and Earth Resources Open File Report 96-2. December 1997. Accessed at: https://www.dnr.wa.gov/publications/ger_ofr96-2_best_management_practices.pdf.

Olson, D.H., and C.M. Crisafulli, 2014. *Conservation Assessment for the Van Dyke's Salamander (Plethodon vandykei)*. Version 1.0. Prepared for the USDA Forest Service Region 6 and USDI Bureau of Land Management. August 2014.

Perry, G., J. Lundquist, and D. Moore, 2016. *Review of the Potential Effects of Forest Practices on Stream Flow in the Chehalis River Basin*. Prepared on behalf of the Department of Civil and Environmental Engineering, University of Washington, Seattle, Washington, USA and the Department of Geography and Department of Forest Resources Management, University of British Columbia, Vancouver, British Columbia, Canada.

Phinney, L.A., P. Bucknell, and R.W. Williams, 1975. *A catalog of Washington streams and salmon utilization. Volume 2: Coastal Regions*. Prepared for the Washington Department of Fisheries.

PSU (Portland State University), 2017. *Technical Memorandum Chehalis Water Quality and Hydrodynamic Modeling, Model Setup, Calibration and Scenario Analysis*. Prepared on behalf of the Water Quality Research Group, Department of Civil and Environmental Engineering, Maseeh College of Engineering and Computer Science, Portland State University, Portland, Oregon.

Richardson J.S., and S. Béraud, 2014. "Effects of riparian forest harvest on streams: a meta analysis." *Journal of Applied Ecology* 51:1712-1721.

Ronne L., N. VanBuskirk, and M. Litz, 2020. *Spawner Abundance and Distribution of Salmon and Steelhead in the Upper Chehalis River, 2019 and Synthesis of 2013-2019*. Prepared for the Washington Department of Fish and Wildlife, Olympia, Washington. Publication FPT 20-066.

Rubenson, E.S., and J.D. Olden, 2019. "An invader in salmonid rearing habitat: current and future distributions of smallmouth bass (*Micropterus dolomieu*) in the Columbia River Basin." *Canadian Journal of Fisheries and Aquatic Sciences* 77(2):314-325. Accessed at: https://doi.org/10.1139/cjfas-2018-0357.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott, 2006. *Independent populations of Chinook salmon in Puget Sound*. Prepared for the U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-78. July 2006.

Sarikhan, I., K. Stanton, T. Contreras, M. Polenz, J. Powell, T. Walsh, and R. Logan, 2008. *Landslide Reconnaissance Following the Storm Event of December 1-3, 2007, in Western Washington*. Prepared for the Washington Division of Geology and Earth Resources. Open File Report 2008-5. November 2008. Accessed at: https://file.dnr.wa.gov/publications/ger_ofr2008-5_dec2007_landslides.pdf.

Scharpf, M. (Washington Department of Fish and Wildlife), 2019. Personal communication with John Ferguson (Anchor QEA, LLC). Regarding: Updated WDFW spawner escapement and total return data. October 7, 2019.

Schmidt, L.J., and J.P. Potyondy, 2004. *Quantifying channel maintenance instream flows: an approach for gravel-bed streams in the Western United States*. Prepared by the U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fort Collins, Colorado. General Technical Report RMRS-GTR-128.

Schoen, E.R., K.W. Sellmer, M.S. Wipfli, J.A. López, R. Ivanoff, and B.E. Meyer, 2022. "Piscine predation on juvenile salmon in sub-arctic Alaskan rivers: Associations with season, habitat, predator size and streamflow." *Ecology of Freshwater Fish* 31(2):243-259.

Seixas G.B., T.J. Beechie, C. Fogel, and P.M. Kiffney, 2018. "Historical and future stream temperature change predicted by a Lidar-based assessment of riparian condition and channel width." *Journal of the American Water Resources Association* 54(4):974-91.

Shannon & Wilson (Shannon & Wilson, Inc.), 2015. *Landslide Reconnaissance Evaluation of the Chehalis Dam Reservoir*. Prepared for the Chehalis Basin Work Group. September 22, 2015.

Smith, C.J., and M. Wenger, 2001. *Salmon and Steelhead Habitat limiting factors, Chehalis Basin and nearby drainages WRIAs 22 and 23*. Washington State Conservation Commission Final Report.

Trimmel, H., P. Weihs, D. Leidinger, H. Formayer, G. Kalny, and A. Melcher, 2018. Can riparian vegetation shade mitigate the expected rise in stream temperatures due to climate change during heat waves in a human-impacted pre-alpine river? *Hydrology and Earth System Sciences*, 22(1), pp.437-461.

USDA (United States Department of Agriculture), 2018. Guidelines for storing and decommissioning roads. Document 1677-1804P-NTDP Transportation Management. 64p.

USDA (United States Department of Agriculture Natural Resources Conservation Service), 2024. Trees and shrubs for riparian plantings. Spokane WA. Accessed February 2024 at: https://www.nrcs.usda.gov/plantmaterials/wapmstn13160.pdf.

USFWS (United States Fish and Wildlife Service), 2011. *The Fish Files: Pacific Lamprey Redd Surveys in the Chehalis and Willapa River Basins*. Accessed at: http://the-fishfiles.blogspot.com/2011/06/pacific-lamprey-redd-surveys-in.html.

WA DNR (Washington Department of Natural Resources), 2006. *Forest Practices Habitat Conservation Plan (FPHCP)*. Accessed at: https://www.dnr.wa.gov/programs-and-services/forest-practices/forest-practices-habitat-conservation-plan.

WA DNR (Washington Department of Natural Resources), 2008. Landslide Reconnaissance Following the Storm Event of December 1-3, 2007, in Western Washington. Open File Report 2008-5. November. Available from: https://file.dnr.wa.gov/publications/ger_ofr2008-5_dec2007_landslides.pdf.

WA DNR (Washington Department of Natural Resources), 2013. *Aquatic Lands Habitat Conservation Plan - Species Spotlight; Western Toad - Bufo boreas.* Publication FS-13-011. August 20, 2013. Accessed at: https://file.dnr.wa.gov/publications/em_fs13_011.pdf.

WA DNR (Washington Department of Natural Resources), 2020a. *Digital Surface Model data: 2014-2019*. Accessed January and March 2020. Accessed at: https://www.dnr.wa.gov/lidar.

WA DNR (Washington Department of Natural Resources), 2020b. *Digital Terrain Model data: 2014-2019*. Accessed January and March 2020. Accessed at: https://www.dnr.wa.gov/lidar.

WA DNR (Washington Department of Natural Resources), 2020c. *Washington Department of Natural Resources Active Roads*. Accessed January 2020. Accessed at: http://data-wadnr.opendata.arcgis.com/datasets/wadnr-active-roads?geometry=-141.641%2C44.462%2C-99.871%2C49.693.

WA DNR (Washington Department of Natural Resources), 2024a. *Forest Practices Application and Review System (FPARS) website*. Accessed May 2024. Accessed at: https://www.dnr.wa.gov/programs-and-services/forest-practices/forest-practices-application-review-system-fpars.

WA DNR (Washington Department of Natural Resources), 2024b. *Forest Practices Application Mapping Tool (FPAMT)*. Accessed at: https://fpamt.dnr.wa.gov/.

Wainwright, T.C., M.W. Chilcote, P.W. Lawson, T.E. Nickelson, C.W. Huntington, J.S. Mills, K. Moore, G.H. Reeves, H.A. Stout, and L.A. Weitkamp, 2008. *Biological recovery criteria for the Oregon Coast coho salmon evolutionarily significant unit.* Prepared for the U.S. Department of Commerce. NOAA Technical Memorandum NMFS-NWFSC-91.

Ward, J., P. Russell, and Weyerhaeuser Company (Ward and Weyerhaeuser), 1994. *Chehalis Headwaters Watershed Analysis Mass Wasting Assessment*. Chehalis Watershed Resource Assessment Report, Appendix A.

Waterstrat, F.T., 2013. *Characteristics of Three Western Pearlshell (Margaritifera Falcata) Populations in the Chehalis River Basin, Washington State*. August 2013. Accessed at: https://archives.evergreen.edu/masterstheses/Accession86-10MES/Waterstrat_FMESthesis2013.pdf.

WDFW (Washington Department of Fish and Wildlife), 2009. *Fish Protection Screen Guidelines for Washington State*.

WDFW (Washington Department of Fish and Wildlife), 2019a. *Fish Passage Inventory, Assessment, and Prioritization Manual*. Prepared for the Washington Department of Fish and Wildlife, Olympia, Washington.

WDFW (Washington Department of Fish and Wildlife), 2019b. *Priority Habitats and Species List*. Prepared for the Washington Department of Fish and Wildlife, Olympia, Washington. Accessed at: https://wdfw.wa.gov/species-habitats/at-risk/phs/list.

WDFW (Washington Department of Fish and Wildlife), 2019c. *Priority Habitats and Species: Maps*. Accessed at: https://wdfw.wa.gov/specieshabitats/at-risk/phs/maps.

WDFW (Washington Department of Fish and Wildlife), 2020. *Thermally suitable habitat for juvenile salmonids and resident trout under current and climate change scenarios in the Chehalis River,* *WA*. Authored by John Winkowski on behalf of the Washington Department of Fish and Wildlife Fish Science Coast Ecology and Life Cycle Monitoring Unit and Dr. Mara Zimmerman on behalf of the Coast Salmon Partnership.

WDFW (Washington Department of Fish and Wildlife), 2021. *Public Comment Draft: Puget Sound Chinook Salmon*. September 2021.

WDFW (Washington Department of Fish and Wildlife), 2022. *Barrier assessment database*. Washington State Fish Passage Database. Accessed at: https://geodataservices.wdfw.wa.gov/hp/fishpassage/index.html.

WDFW (Washington Department of Fish and Wildlife), 2024a. *Priority Habitats and Species: Maps*. Accessed at: https://wdfw.wa.gov/species-habitats/at-risk/phs/maps.

WDFW (Washington Department of Fish and Wildlife), 2024b. *Washington Department of Fish and Wildlife Species & Habitats*. Accessed April 2024. Accessed at: https://wdfw.wa.gov/species-habitats/species.

WDFW (Washington Department of Fish and Wildlife), 2024c. *Salmonscape fish distribution database*. Accessed at: http://apps.wdfw.wa.gov/salmonscape/.

WDFW (Washington Department of Fish and Wildlife), 2024d. *Washington Department of Fish and Wildlife Threatened & Endangered Species*. Accessed April 2024. Accessed at: https://wdfw.wa.gov/species-habitats/at-risk/listed.

WDFW (Washington Department of Fish and Wildlife), 2024e. *Species & Habitats, Species in Washington, Western toad (Anaxyrus boreas)*. Accessed at: https://wdfw.wa.gov/species-habitats/species/anaxyrus-boreas.

WG and Anchor (Watershed GeoDynamics, and Anchor QEA, LLC), 2017. *Chehalis Basin Strategy Geomorphology, Sediment Transport, and Large Woody Debris Report - Reducing Flood Damage and Restoring Aquatic Species Habitat*. June 2017.

White, J.S., T.J. Kock, B.E. Penaluna, S. Gregory, J. Williams, and R. Wildman, 2023. "Expansion of smallmouth bass distribution and habitat overlap with juvenile Chinook salmon in the Willamette River, Oregon." *River Research and Applications* 40(2):251-263. Accessed at: https://doi.org/10.1002/rra.4228.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, E.G.R. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley, 2016. *Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest*. Prepared for the U.S. Department of Commerce. NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-564.

Winkowski, J.J., and M.S. Zimmerman, 2017. "Summer Habitat and Movements of Juvenile Salmonids in a Coastal River of Washington State." *Ecology of Freshwater Fish* 27:255-269. Accessed at: https://doi.org/10.1111/eff.12344.

Winkowski, J.J., and M.S. Zimmerman, 2018. Thermally Suitable Habitat for Juvenile Salmonid and Resident Trout Under Current and Climate Change Scenarios in the Chehalis River, WA. Document Source: Coastal Salmon Partnership. D0176-Chehalis Thermally Suitable Habitat Final Report. www.coastalsalmonpartnership.org.

Winkowski, J.J., E.J. Walther, and M.S. Zimmerman, 2018. *Summer Riverscape Patterns of Fish, Habitat, and Temperature across the Chehalis River Basin*. Prepared for the Washington Department of Fish and Wildlife, Olympia, Washington. Publication FPT 18-01.

Wolfe, J., 2019. *Standard Operating Procedure EAP121, Version 1.1: Watershed Health Monitoring: Standard Operating Procedures for Counting Large Woody Debris*. Approved 2017. Prepared for the Washington State Department of Ecology, Olympia, Washington. Publication 19-03-214. Approved 2017.

Wolman, M.G., and J.P. Miller, 1960. “Magnitude and frequency of forces in geomorphic processes.” *The Journal of Geology* 68(1):54-74.

WSDOT (Washington State Department of Transportation), 2016. *Fish Exclusion and Fish Moving Protocols and Standards*.

WSE (Watershed Science & Engineering), 2014. *Elma-Porter Flood Mitigation Project Hydraulic Modeling and Analysis Draft Memorandum*. October 16, 2014. Accessed at: https://www.ezview.wa.gov/DesktopModules/Articles2/ArticlesView2.aspx?tabID=0&alias=1779&ItemID =531&mid=65112&wversion=Staging.

WSE (Watershed Science & Engineering), 2019. Memorandum to: Robert Montgomery, Anchor QEA, LLC. Regarding: Chehalis River Basin Existing Conditions RiverFlow2D Model Development and Calibration. February 28, 2019.

Wydoski, R.S., and R.R. Whitney, 2003. *Inland fishes of Washington*. Second edition, revised and expanded. Bethesda: American Fisheries Society in association with the University of Washington Press.

Appendix A
Sediment Transport Technical Memoranda

Appendix B
Spawning Habitat Assessment Technical Memoranda

Appendix C
Mitigation Impact Crosswalk Tables

Appendix D
Vegetation Management Plan

Appendix E
Best Management Practices List

Appendix F
Wildlife Habitat Evaluation

Appendix G
Riparian Shade Analysis

Appendix H
Proposed Restoration Concepts

Appendix I
Forest Conversion Technique for Order of Preference by Similarity to Ideal Solution Model

Appendix J
Basis of Design Report