US Army Corps of Engineers®
Seattle District

Pierce County
Public Works and Utilities
Surface Water Management

Jones Levee Flood Control Feasibility Study

Orting, Washington

Continuing Authorities Program (CAP), Section 205

DRAFT Integrated Feasibility Report / Environmental Assessment

P2# 475876

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October 2021

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Executive Summary / Abstract*

This integrated Feasibility Report and Environmental Assessment presents the results of a U.S. Army Corps of Engineers (Corps) Flood Risk Management feasibility study to identify and evaluate alternatives for managing the flood risks along Jones Levee in the city of Orting, Pierce County, Washington. Pierce County Planning and Public Works is the non-federal sponsor for this Section 205 project. The report provides documentation of the plan formulation process to evaluate a range of alternatives in the study area and tentatively select a recommended flood risk management measure along with environmental, engineering, and cost details of the recommended plan, which will allow additional design and construction to proceed following approval of this report.

The Jones Levee project is on the Puyallup River near the City of Orting and approximately 16 miles southeast of Tacoma, Washington. The study focuses on the Jones Levee extending from river mile (RM) 21.6 to RM 22.8, along the northeast side of the Puyallup River.

The sponsor submitted a letter of intent on August 14, 2018, requesting the Corps' assistance under Section 205 to address flood risk at Jones Levee. Modifications to Jones Levee to protect the city of Orting were evaluated as part of the Puyallup River General Investigation Study (GI) from 2009 to 2018 by the Corps in partnership with Pierce County. The Corps released a Draft Integrated Feasibility Report and Environmental Impact Statement (FR/EIS) for the GI in 2016, which recommended raising Jones Levee to the projected future 1% annual exceedance probability (AEP) elevation. The GI determined this action had strong economic justification. Significant public comments and concerns were put forward with the raise-in-place recommendation due to environmental impacts associated with the raise-in-place alternative. Several comments were received supporting a setback levee option. The Office of Management and Budget (OMB) canceled the Puyallup GI Study in 2018 due to increased costs and schedule delays on project completion, coupled with a total project benefit cost ratio (BCR) that was not considered budgetable. Due to the lack of support by the Administration for further work on the Puyallup GI, the Corps recommended the Sponsor pursue separable elements of the GI study. Jones Levee is the separable element with the highest BCR at OMB's preferred discount rate. Based on this recommendation, the Corps placed the Jones Levee project into the Continuing Authorities Program (CAP), Section 205, 1948 Flood Control Act, as amended.

In coordination with interested stakeholders, the Project Delivery Team (PDT) developed a series of measures for consideration. The PDT formulated an array of alternatives using the developed measures, preliminary data collection, analysis, and best professional judgment. The study team identified 15 potential measures and completed multiple rounds of screening to identify which alternatives meet the study's objectives. The PDT formulated each alternative to reduce potential flood risk to the city of Orting because existing and future conditions present a flood risk to life safety and property. Additionally, the recommendation from the GI to raise Jones Levee to the projected future 1% annual exceedance probability (AEP) elevation would be satisfied by the tentatively plan discussed in this study, which provides protection at the 0.2% annual exceedance probability in the future condition.

The PDT developed preliminary cost estimates and estimated habitat benefits for each alternative. National Economic Development (NED) analysis was the primary method used to select the recommended plan.

The Corps developed alternatives in consideration of study area problems, opportunities, study objectives, and constraints in respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability). The following are the alternatives in the final array:

Alternative 1: No Action

This alternative would maintain baseline conditions. The Corps would take no action to address flood risk to the city of Orting at the Jones Levee. All physical conditions existing at the time of this analysis would remain, and routine maintenance operations would continue to maintain the Jones Levee for flood risk reduction.

Alternative 2: Levee Raise-in-Place

A levee raise-in-place would modify the existing Jones Levee prism by raising it vertically and widening it horizontally to reduce flood risk to the city of Orting. Raising the current levee would require deconstructing and rebuilding it from the ground up in a larger footprint. The floodplain would remain disconnected, and sedimentation would continue to be an issue as it would under Alternative 1.

Alternative 3: Levee Setback with Partial Removal of Existing Levee (Locally Preferred Plan)

A levee setback would shift the alignment of the levee landward of the riverbank. The setback levee would be a newly constructed, armored earth embankment structure that ties into high ground. The riverward toe of the setback levee would be armored using 4- to 10-man rock. The sponsor prefers the larger rock in order to prevent levee degradation and breaches further. The change in rock size would reduce O&M costs and repairs in the future; however, it increases total project costs over the original set-back alternative. A setback levee provides a unique opportunity to address flood risk in the area while reconnecting the floodplain that has been cut off since at least the 1950s. Setting back the Jones Levee would also contribute to floodplain connection improvements already constructed nearby (e.g. Soldiers Home and Calistoga Levee setbacks).

Alternative 3 is the Locally Preferred Plan (LPP) and the tentatively selected plan (TSP) and consists of three major components: the setback levee, breaching of the existing levee, and engineered log jams (ELJs). The proposed setback is approximately 6,414 feet long and moves the levee alignment landward towards the historical Holocene channel migration zone. The setback levee would restore floodplain connectivity to approximately 40 to 50 acres and functionally lift the wetlands in the setback area by removing the barrier between them and the river. The existing levee would be breached in multiple locations to allow the river access to the additional riverine areas provided by the setback alignment. ELJs would be used to break up flow and reduce velocities as floodwaters from the Puyallup River enter the setback area. Setting the levee back reduces the risks associated with diminished river capacity due to sediment aggradation and reduces the risk of the riverbed becoming higher in elevation than the adjacent floodplain. The predicted decrease in water surface elevation is 1 to 3 feet lower than under the No Action Alternative. Storing sediment in the Jones levee setback area will benefit downstream areas. With a setback, water surfaces are predicted to decrease from the future without project (FWOP) condition by an average of one foot along Calistoga and High Cedars levees, reducing flood risk downstream of the project. Immediately following construction, the setback levee would provide 0.01% AEP (1 in 10,000 annual chance). With the predicted increase in development and sediment aggradation, the setback is expected to provide a 0.2% AEP (1 in 500 annual chance), or 14.5% AEP (1 in 7 annual chance) with risk and uncertainty factored in, 50 years after construction.

This alternative is also compatible with measures including adaptability of the alternative for future conditions and updates to Emergency Action Plans and Flood Hazard Management Plans based on changes to flood risks and feasibility-level design. Total design and implementation costs of $20,121,000 plus feasibility costs of $1,075,000 lead to a total project cost of $21,196,000at October 2021 prices. The Federal share comes to $10,000,000 and the non-federal share is $11,195,000.

Alternative 4: Levee Setback with Partial Removal of Existing Levee (National Economic Development Plan)

Alternative 4 is the National Economic Development (NED) Plan and consists of the same three major components as the LPP/TSP (Alternative 3). Construction of a setback levee for this alternative is almost identical to Alternative 3 in alignment, elevation profile, and slope armoring. The difference from Alternative 3 is the design of the buried toe. Toe rock for the NED alternative uses Class V riprap, which is roughly equivalent to 2- to 3-man rock, the same rock size used for slope armoring, and is designed to launch in the event of scouring. Project first cost for Alternative 4 is $16,421,000 at October 2021 prices.

Contents

The sections of this IFR/EA that are required for NEPA compliance are denoted with an asterisk (*) following the section heading.

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LIST OF ABBREVIATIONS AND ACRONYMS

AEP Annual Exceedance Probability

APE Area of Potential Effect

ATR Agency Technical Review

BA Biological Assessment

BCR Benefit Cost Ratio

BMP Best Management Practice

BO Biological Opinion

CAA Clean Air Act

CEQ Council for Environmental Quality

CERCLA Comprehensive Environmental Response, Compensation, and Liability Act

cfs Cubic feet per second

Corps U.S. Army Corps of Engineers

CZMA Coastal Zone Management Act

D&I Design and Implementation

DQC District Quality Control

EA Environmental Assessment

EAD Expected Annual Damages

Ecology Washington State Department of Ecology

EFH Essential Fish Habitat

EIS Environmental Impact Statement

ER Engineer Regulation

ESA Endangered Species Act

EP Engineering Pamphlet

EPA U.S. Environmental Protection Agency

FPPA Farmland Protection Policy Act

IFR Integrated Feasibility Report

ft/s feet per second

FWCA Fish and Wildlife Coordination Act

FWOP Future Without Project

GI General Investigation

HEC-FDA Hydrologic Engineering Center-Flood Damage Analysis Tool

HTRW Hazardous, Toxic, and Radiological Waste

IDC Interest during construction

LERRD lands, easements, rights-of-way, relocations, and disposal areas

LPP Locally Preferred Plan

LWM Large Woody Material

NED National Economic Development

NEPA National Environmental Policy Act

NFS Non-Federal Sponsor

NHPA National Historic Preservation Act

NMFS National Marine Fisheries Service

NPDES National Pollutant Discharge Elimination System

NWI National Wetlands Inventory

O&M Operations and Maintenance

OMB Office of Management and Budget

OMRR&R Operations, Maintenance, Repair, Replacement and Rehabilitation

PDT Project Delivery Team

PPA Project Partnership Agreement

RM River Mile

SHPO State Historic Preservation Officer

SWIF System Wide Improvement Framework

TSP Tentatively Selected Plan

USFWS U.S. Fish and Wildlife Service

VFZ Vegetation Free Zone

WDFW Washington State Department of Fish and Wildlife

WDOT Washington Department of Transportation

WIK Work-In-Kind

WOWA Weighted Ordered Weighted Average

WQC Water Quality Certification

1 Introduction

The U.S. Army Corps of Engineers (Corps) prepared this Integrated Feasibility Report and Environmental Assessment (IFR/EA) for the Section 205 Jones Levee Flood Risk Management feasibility study (Jones Levee Project). The study evaluates ways to reduce flood risks associated with the Puyallup River near the city of Orting, Pierce County, Washington (Figure 1-1). The Corps is formulating, evaluating, and screening potential solutions to reduce flood risk; and will seek to recommend a series of actions and solutions that have a Federal interest and a local sponsor willing to provide local cooperation. This IFR/EA documents the planning process, demonstrates consistency with Corps planning policy, and meets the regulations that implement the National Environmental Policy Act (NEPA). The following sections provide background information regarding the basis for Jones Levee Project. Sections denoted with an asterisk (*) are required for NEPA compliance.

1.1 Overview of IFR/EA

This document is an integrated IFR/EA. Engineering Regulation (ER) 1105-2-100, Planning Guidance Notebook, and the Risk-Informed Planning Manual (2017-R-03) outline the Corps planning process. A feasibility report identifies the plan that reasonably maximizes flood risk management benefits, is technically feasible, and preserves environmental and cultural values.

The EA portion of the feasibility report identifies and presents any potential environmental effects of the alternatives and incorporates environmental considerations into the decision-making process. The six steps of the Corps planning process each align with a NEPA requirement. The list of the planning steps appears below with the document chapter and NEPA element to which they relate:

Table 1-1 Overview of IFR/EA

Corps Planning Step	Analogous NEPA Requirement	IFR/EA Section
1. Specify Problems and Opportunities	Need for Action and Purpose	Chapter 2
2. Inventory and Forecast Conditions	Affected Environment	Chapter 4
3. Formulate Alternative Plans	Alternatives Including Proposed Action	Chapter 3
4. Evaluate Effects of Alternative Plans	Environmental Consequences	Chapter 4
5. Compare Alternative Plans	Alternatives Including Proposed Action	Chapter 3,4
6. Select Recommended Plan	Agency Preferred Alternative	Chapter 3, 5

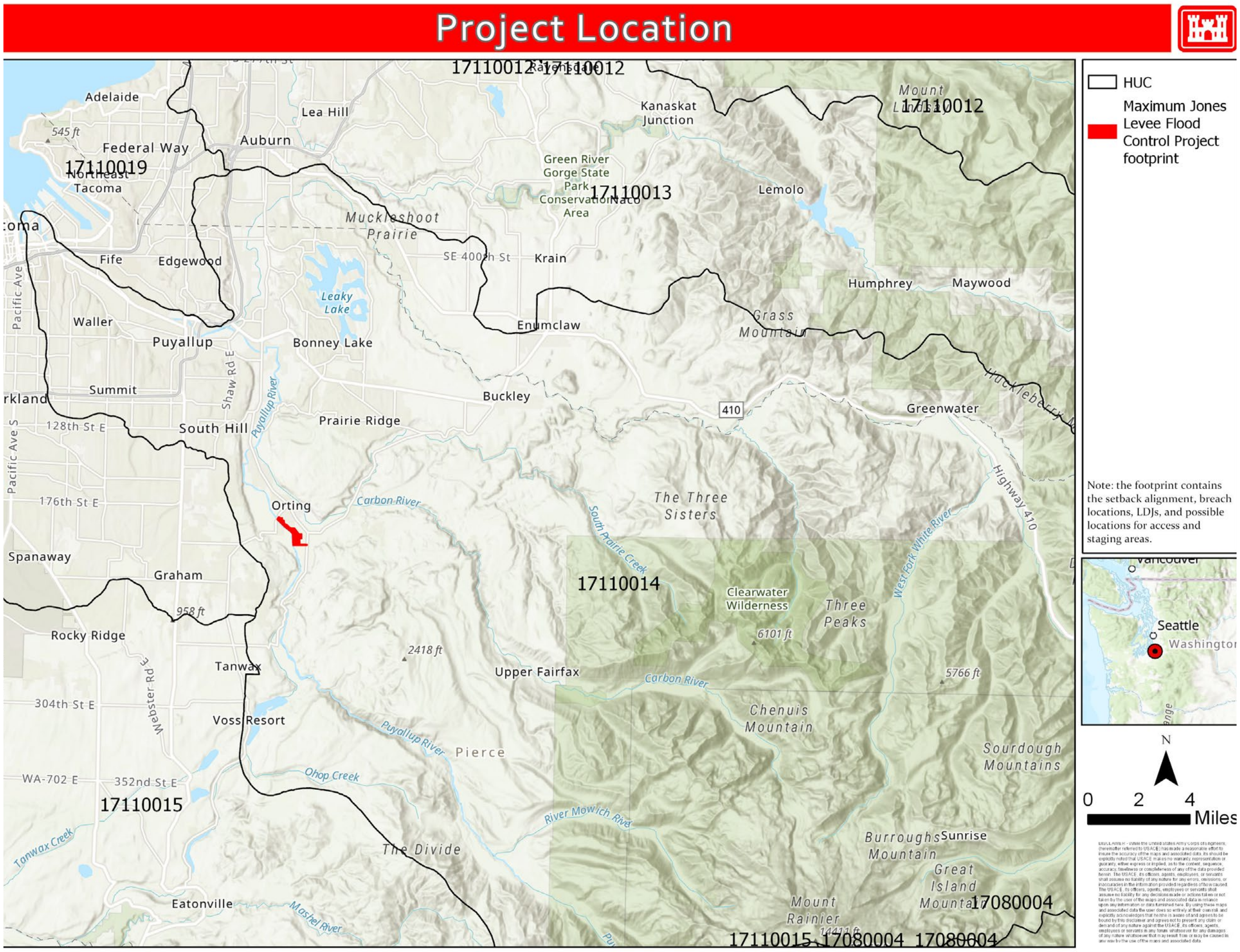

Figure 1-1 Project Location

1.2 Study Authority

The Jones Levee Project is authorized under the Corps' Continuing Authorities Program (CAP), which authorizes the Corps to plan, design, and construct small-scale projects under several program authorities from Congress. Local governments, agencies, and tribes can request the Corps investigate a water resource issue that may be approved under a particular congressional authority. The Jones Levee Project is implemented under the program authority in Section 205 of the Flood Control Act of 1948 (Public Law 80-858), as amended. Section 205 addresses flood control projects and authorizes the Corps to investigate and construct local flood control projects through construction or improvement of flood control works.

The purpose of CAP Section 205 projects is to reduce the risks of flooding, life safety and loss of life, and property damage in partnership with state and local governments or private entities. Projects may be structural (e.g., levees, floodwalls, diversion channels, bridge modifications) or nonstructural (e.g., elevation, floodproofing, relocation of structures, flood-warning systems).

1.3 Lead Federal Agency and Stakeholders*

The Corps is the lead agency for the Jones Levee Project. Pierce County is the non-federal sponsor (NFS) for this study. Pierce County submitted letters on 14 August 2018 requesting the

Corps' assistance under Section 205 to reduce flood damages associated with the Puyallup River near the city of Orting. On 22 July 2019, the Corps and Pierce County entered a Feasibility Cost Share Agreement for the Jones Levee Project. As a NFS, Pierce County contributes 50% of the total feasibility study costs. Other stakeholders involved in the project's development include the Puyallup Tribe of Indians, Muckleshoot Indian Tribe, Washington State Department of Ecology (Ecology), Washington Department of Fish and Wildlife (WDFW), the city of Orting, National Marine Fisheries Service (NMFS), and U.S. Fish and Wildlife Service (USFWS).

1.4 Study Area*

The Jones Levee is a non-Federal levee that reduces flood risk to the city of Orting, west of State Route 162 from the Puyallup River (Figure 1-2). Due to its location and topography, this area has endemic flooding from the Carbon and Puyallup Rivers. The Jones Levee extends from River Mile (RM) 21.6 to RM 22.8 and is approximately 9,400 feet long (Figure 1-2).

The Jones Levee is part of a levee system that reduces flood risk to the city of Orting from the Puyallup River. This system is comprised of Jones, the Matlock Cutoff (a part of the Jones Levee), Calistoga, Ford, and High Cedars levees (Figure 1-3). The non-federal levees in the area were constructed between the 1930s and 1960s by local entities. The exact date for the construction of the Jones Levee is unknown; however, a 1956 topographic map first labeled a levee in the area. A 1957 aerial photograph shows evidence of the levee's construction, where the river channel and floodplain are noticeably more constricted on the east bank of the Puyallup River than it was on the next earliest photograph from 1952. The historical flood of record occurred in January 2009 when heavy rainfall flooded the Snoqualmie River. Flooding occurred from Fife, WA, upstream of Orting, to Tacoma, WA downstream. There was a reported estimate of 8.8 million dollars in property value damages for this event, but no crop damage occurred. The development of this area is already very rapid and would most likely continue to expand, resulting in greater damage in future events without added levee protection. A collection of aerial imagery and topographic maps between 1941 – 2017 and 1897 – 2014, respectively, is found in Appendix D - Hazardous, Toxic, and Radiological Waste (HTRW) reports.

Jones and the upstream Ford Levee were reconstructed following extensive flood damage in 1996. The Ford Levee was reconstructed in a setback configuration, and the Matlock Cutoff was added to Jones Levee as an emergency measure to cut off flood flows into the city of Orting from levee breaches on the Ford Levee. The Matlock Cutoff hydraulically separated the upstream Ford Levee segment from the Jones, Calistoga, and High Cedars levee system. The levees along the Ford reach were devastated by a series of floods beginning with 1995, 1996 and further damaged from the 2006 and 2009 events. These levees have not been reconstructed. The Soldiers Home Levee, across the river from Jones, was setback in 2006. In 2014, the Calistoga Levee was set back. With the exception of several pinch points, at the Calistoga Street Bridge and the downstream end of the Ford Levee, the river is roughly twice the width that it was from the 1950s to the 1990s due to the setbacks.

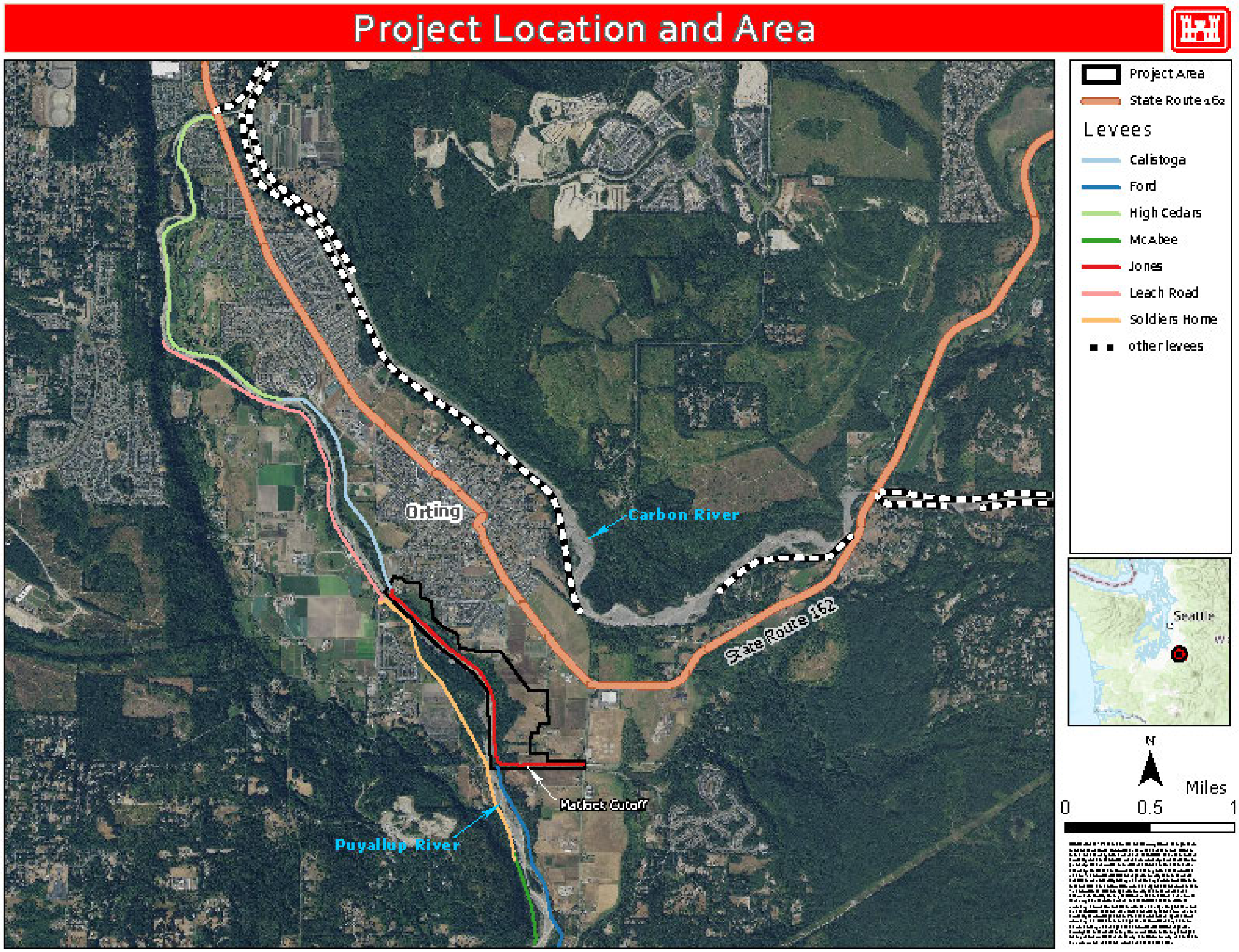

Figure 1-2. Project location and area. The current Jones levees is marked in red. Matlock Cutoff is a part of the Jones Levee and extends inland from the river

1.5 Previous Studies

Modifications to Jones Levee to protect the city of Orting were evaluated as part of the Puyallup River General Investigation Study (GI) from 2009 to 2018 by the U.S. Army Corps of Engineers Seattle District in partnership with Pierce County, the NFS. The Corps released a Draft Integrated Feasibility Report and Environmental Impact Statement (FR/EIS) for the GI in 2016, which recommended raising Jones Levee to the projected future 1% annual exceedance probability (AEP) elevation with strong economic justification. Due to environmental impacts associated with the raise-in-place, significant public comments and concerns were put forward regarding the raise-in-place alternative. Several comments were received supporting a setback levee option. The GI study was not completed, and this CAP Section 205 study was initiated to study further alternatives for Jones Levee given significant flood risk concerns and opportunities to reduce flood risk with a smaller scale flood risk management project.

The USGS has studied the geomorphic and sediment characteristics of the Puyallup Basin extensively in their 2010 and 2012 reports (USGS, 2010 and Czuba, 2012). For a summary of the information, refer to the Hydraulic Modeling of Future Conditions in Appendix A for a summary. Additionally, the Upper Puyallup system was studied for the Puyallup GI Draft FR/EIS (USACE, 2017) in support of draft measure development there. The Calistoga Levee, the reach just downstream, was studied by NHC for a levee setback project by the local sponsor in 2011 (NHC, 2011).

2 Purpose and Need*

2.1.1 Purpose*

The purpose of the Jones Levee Project is to reduce flood risks to property, critical infrastructure, and life safety in the city of Orting from diminished river capacity, sediment aggradation, and erosion-induced levee damage from the Puyallup River

2.1.2 Need*

The Jones Levee Project is needed because the Puyallup River experiences frequent flooding, resulting in damages to rural and urban areas. Three primary contributors to increased flood risks are (1) development in the floodplain, (2) sediment aggradation, and (3) significant channel migration potential. The Jones Levee provides an AEP of 17% in its existing condition, considering associated risk and uncertainty. With the predicted increase in local development and aggradation from sediment deposition, also considering associated risk and uncertainty, the Jones Levee is expected to provide a 44% AEP within 50 years.

Development in the floodplain has increased risk to life safety, property, and infrastructure. Levees confine the Puyallup and Carbon Rivers next to the city of Orting and limit channel capacity, increasing flood risk. Since 1948, major flood events in the basin occurred in 1990, 1996, 2006, 2009, 2014, 2015, 2017, and 2020. The 1996 flood caused significant damages, of approximately $40,000,000, in the Puyallup River basin. During this flood event, the Puyallup River discharge near the city of Orting was 17,500 cubic feet per second (cfs), which exceeded the designated flood stage of 10,000 cfs for this location. Besides life safety risks, there is a risk of flood damage to critical infrastructure in Orting, including two schools, a police department, and a fire department.

The Puyallup River experiences high sediment loads compared to other rivers in western Washington. The heavy sediment load contributes to long-term channel aggradation, reducing channel capacity and raising water surface levels. These effects increase the risk of channel migration and flooding, which can cause significant erosion.

Channel migration is the process of a stream or river channel moving over time. Channel migration can occur gradually, such as when a stream erodes one bank and deposits sediment along the opposite bank. On the other hand, channel migration can happen quickly, such as a flood carving a new path for a river. Ultimately, the rate of change depends on an array of factors such as gradient, geology, sediment supply, sediment transport capacity, streamflow, vegetation, and human development. While channel migration provides important habitats and natural diversity, this process can also erode the shoreline and damage or destroy homes, septic systems, roads, bridges, and other infrastructure. Repetitive flooding and high-water events often accelerate channel migration processes and burden local, state, and federal entities to repair or construct structures to prevent damage to the human environment. The Jones Levee has experienced repetitive damages from flood-related erosion. Many repairs have occurred over the last 25 years. The reliance on post-flood repair authorities and flood fighting to manage flood risk are reactive approaches, further intensifying the need for a long-term solution.

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3 Plan Formulation*

The guidance for conducting civil works planning studies (ER 1105-2-100) requires the systematic formulation of alternative plans that contribute to the Federal objective of national economic development (NED). The plan formulation process requires a systematic and repeatable approach to ensure the PDT makes sound decisions in developing alternatives and plan selection.

This chapter presents the results of the plan formulation process. The Corps developed alternatives in consideration of study area problems, opportunities, study objectives, and constraints with respect to the four evaluation criteria described in the Principles and Guidelines (completeness, effectiveness, efficiency, and acceptability). Figure 3-1 presents a summary of the plan formulation process presented throughout this chapter.

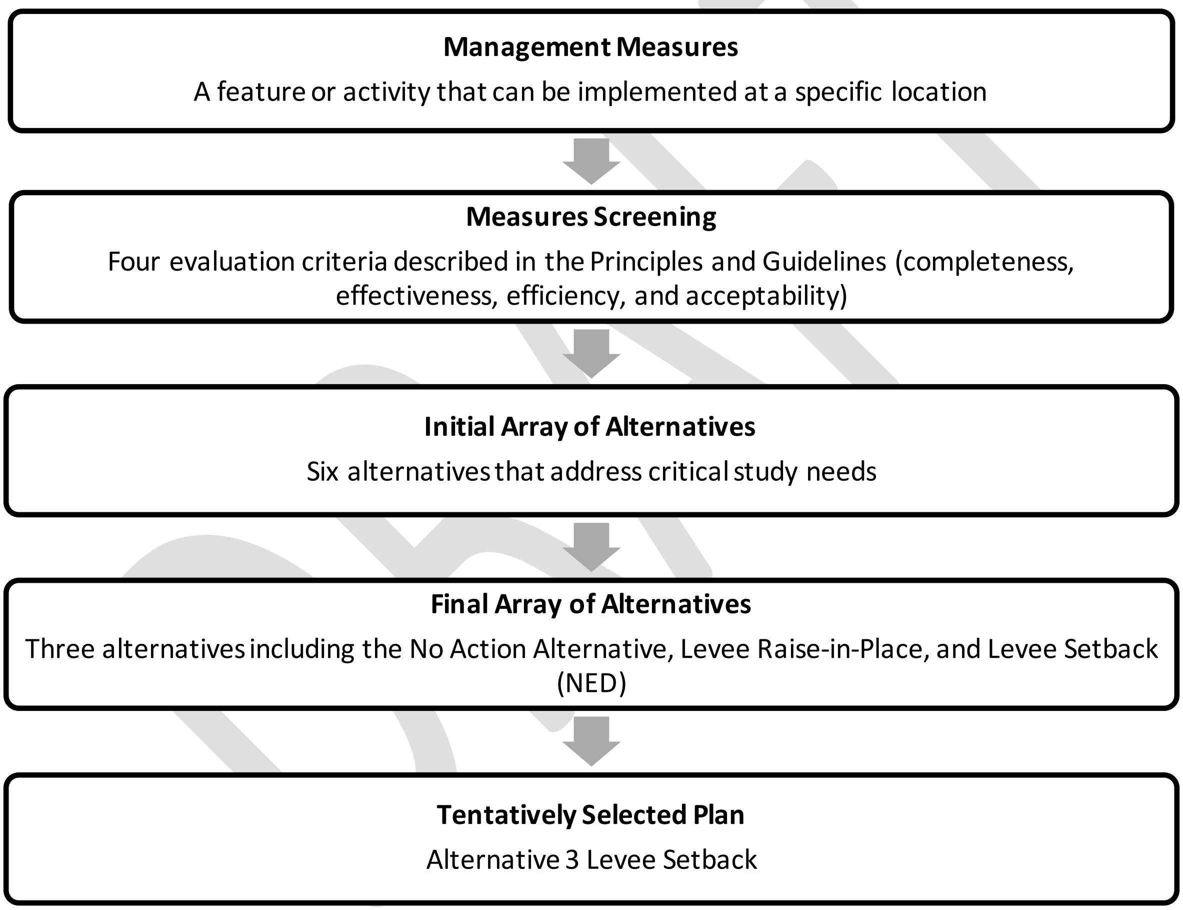


Figure 3-1. The Corps' Plan Formulation Process with details about the Jones Levee Project.

3.1 Planning Horizon

The study estimates a construction duration of 1-2 years starting in approximately 2023. The project base year (the year the proposed project is expected to be operational) is 2024. The Corps uses a 50-year planning horizon for the evaluation of economic costs and benefits for civil works projects. Therefore, this study assumes a period of analysis of 2024 to 2073 to evaluate alternative plans.

3.2 Planning Strategy

3.2.1 Corps Section 205 Authority

Continuing Authorities Program Section 205 projects are structural or non-structural flood risk management projects. Flood risks and damages must be caused by overland flooding by a stream or a major drainage way. To qualify for Section 205 program assistance, watersheds contributing to flooding problems must have a drainage area of at least one square mile and a peak flow of at least 800 cfs for a 10% AEP event. In accordance with ER 1105-2-100, a study may consider structural measures like levees, floodwalls, diversion channels, and bridge modifications; nonstructural measures like raising structures, floodproofing, relocation of structures, flood-warning systems; or a combination of both. This project meets these requirements and qualifies for the Section 205 program. Federal contributions are limited to $10 million for all study phases from feasibility through construction.

3.2.2 Consideration of the Four Planning Criteria

All Corps feasibility studies formulate alternative plans within the context of the four fundamental planning criteria: completeness, effectiveness, efficiency, and acceptability. Completeness is the extent to which an alternative provides and accounts for all necessary investments or other actions to ensure the realization of the planned effects. Ensuring completeness may require relating the plan to other public or private plans if they are crucial to realizing the contributions to the objectives. Effectiveness is how an alternative alleviates the problems specified and how it achieves the specified opportunities. Efficiency is the extent an alternative is the most cost-effective means of solving the specified problems and realizes the specified opportunities consistent with protecting the nation's environment. Finally, acceptability is the extent to which the alternative is acceptable according to applicable laws, regulations, and public policies.

3.3 Problems and Opportunities

This study focuses on the problems of existing and future flood risks associated with the Jones Levee in Orting, WA. Specific problems for this study include the following:

- Development and population growth have increased flood risk to life safety, property, and infrastructure in and around the city of Orting.
- Large portions of the Puyallup River basin are subject to man-made constrictions such as bridges and levees, which limits conveyance by shrinking the floodplain.
- Sedimentation has contributed to the decrease in channel capacity, increasing channel migration and flood risks in the Puyallup River.
- Levee systems have experienced significant and repetitive damages from flood events, increasing overall flood risks.
- Increased flows and other climate-related changes may increase the frequency and severity of flooding in the future.

Opportunities focus on desirable future conditions. This study seeks to address the problems by reducing existing and future flood risks. Specific opportunities for this study include the following:

- Minimize risks to public safety and reduce potential loss of life during flood events.
- Reduce damage to property and infrastructure.
- Reduce flood vulnerability of transportation corridors to improve evacuation and emergency services.
- Incorporate the effect of sedimentation, as it relates to the increases in flood risks, into setback levee design.
- Improve the function and reliability of the flood risk management system (including reliance on physical intervention).
- Reduce the need for emergency flood fighting and levee rehabilitation efforts.
- Re-establish floodplain connectivitiy to expand channel conveyance.

3.4 Objectives and Constraints

This section establishes the planning objectives and constraints, which are the basis for the formulation of alternative plans. The objectives outline desired outcomes of the project and how the desired outcomes are measured.

Federal Objective

The Planning Guidance Notebook in ER 1105-2-100 states that the Federal objective of water and related land resources project planning is to contribute to NED consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, treaties, and other Federal planning requirements. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units. Contributions to NED are the direct net benefits that accrue in the planning area and the rest of the Nation. Contributions to NED include increases in the net value of those goods and services marketed and those not marketed.

Planning Objectives

Objectives describe the results the study seeks to achieve by solving the problems and taking advantage of the opportunities. The objectives of this study are to identify whether there is at least one policy consistent solution within the scope appropriate for CAP to manage flood risk in the city of Orting and to determine whether further Federal interest in a feasibility study is warranted. These objectives are divided into primary and secondary planning objectives for the study over the 50-year period analysis from 2024 to 2073 and include the following:

Primary objectives:

- Reduce flood risks to property and critical infrastructure to the city of Orting from the Puyallup River; and
- Reduce flood risks to life safety to the city of Orting from the Puyallup River.

Secondary objectives:

- Optimize natural floodplain functions and sustainability, including conveyance, habitat, and storage to the extent practicable; andSeek adaptable and robust solutions beyond the period of analysis that integrate county andstate policies and guidelines.

Planning Constraints and Consideration

Formulated plans are limited by constraints including resource, legal, and policy constraints. Resource constraints are associated with limits on knowledge, expertise, experience, ability, data, information, funding, and time. Legal and policy constraints are those identited by law and USACE policy and guidance. The study team does not recognize any constraints unique to this project, though many resource legal, and policy constraints common to USACE studies apply. While there are no constraints for this study there are study-specific items needing consideration including:

- Federal Emergency Management Agency (FEMA) Hazard Mitigation Grant Program land-use restrictions.
- Alternatives should try to stay within CAP Section 205 authority and cost limits.
- Alternatives will seek to avoid, minimize, or mitigate potential negative environmental impacts.

3.5 Management Measures

As part of the planning process for the study, the Project Delivery Team (PDT), in coordination with the NFS and interested stakeholders, developed a series of measures to consider as potential elements of the project solution. A management measure is a feature or activity at a site that addresses one or more of the planning objectives and is a discrete element of a recommended project solution. The PDT identified fifteen management measures during the preliminary planning stages. Those measures include three independent measures (setback levee, setback floodwall, improve existing levee) and twelve dependent measures, to combine with independent measures and other dependent measures as shown in Table 3-1.

3.6 Screening of Measures

Screening is the process of eliminating, based on planning criteria, those measures that will not be carried forward for consideration. Criteria are derived for each specific planning study based on its planning objectives, constraints, and opportunities. Preliminary criteria used to screen measures are presented in the list below:

Independent measures must meet the primary objectives but are not required to meet the secondary objectives or all screening criteria. Table 3-1 shows the results of the measures screening. Dependent measures must be acceptable and should meet at least three of the screening criteria:

- Does it meet the primary planning objectives (reduces life safety risks and reduces flood damages? Measures dependent on other flood risk measures to meet primary planning objectives are shown as partially addressing the objectives.
- Is it technically feasible?
- Is it acceptable under the applicable laws, regulations, and public policies?

- Does it have a negligible negative or net positive impact on habitat and Endangered Species Act (ESA)-listed species?
- Is it cost-efficient and falls within the scope of CAP Section 205 cost limits?

Table 3-1 Measures Screening Matrix

Measure	Meets Planning Objectives (Y/N)	Technically Feasible (Y/N)	Acceptable (Y/N)	Negligible Negative Impact to Habitat and ESA (Y/N)	Cost Efficient (Y/N)	Carried Forward (Y/N)
Structural Measures						
Construct Setback Levee	Y	Y	Y	Y	Y	Y
Build Setback Floodwall	Y	Y	Y	Y	N	N
Improve Existing Levee (Raise-in-Place)	Y	Y	Y	N	Y	Y
Engineered Log Jams (ELJ’s)	Y (partially)	Y	Y	Y	Y	Y
Adaptive Design of Structural Measures	Y (partially)	Y	Y	Y	Y/N	Y
Sediment Trap	N	Y	N	N	N	N
Dredge River Channel	N	Y	N	N	N	N
Construct Upstream Setback Levees	N	Y	Y	Y	Y	N
Channel Groins	Y (partially)	Y	Y	Y	Y	Y
Full Removal of Existing Levee	Y (partially)	Y	Y	Y	N	Y
Partial Removal of Existing Levee	Y (partially)	Y	Y	Y	Y	Y
Non-Structural Measures						
Flood Warning System or Flood Hazard Management Plan Updates	Y	Y	Y	Y	Y	Y
Wetproof or Dryproof Structures	Y	Y	Y	Y	N	N

Relocation of Residents or Property Acquisition	Y	Y	Y	Y	N	N
Elevate Structures	Y	Y	Y	Y	N	N

Measures not carried forward:

- Construct Setback Floodwall – Too costly for CAP Section 205 with an estimated cost of $34 million. Levee setback alternatives are cheaper and allow for the reuse of existing levee material.
- Sediment Trap – Measure is not acceptable and does not address secondary planning objectives. Increased environmental and economic impacts associated with this measure would require the NFS to obtain various required permits. A sediment trap would also be difficult to implement and maintain. There would be significant and repetitive negative environmental impacts to ESA-listed species and critical habitat, including known fish spawning areas, that would violate local state law on dredging in freshwater areas (*See e.g*. WAC 220-660-170).
- Dredge River Channel – Dredging the river does not meet secondary planning objectives and is not acceptable due to local state law prohibiting dredging in freshwater areas (*See e.g.* WAC 220-660-170). It would be difficult to implement, with negative environmental impacts to ESA-listed species as mentioned above in violation of discussed state law. The NFS would not be able to maintain in the future without increased environmental and economic impacts associated with maintenance dredging including but not limited to obtaining permits.
- Construct Upstream Setback Levees – This measure does not address primary flood risk objectives to the city of Orting and is not within the scope of this study.
- Wetproof or Dryproof Structures &Elevate Structures – Structures adjacent to Jones Levee are not subject to frequent flooding or repetitive losses in the existing condition. Flood proofing would elevate the structures above the 1% AEP flood (or 1 in 100 annual flood event) elevation. However, flood proofing would have limited economic benefit for the city of Orting and would not be cost-efficient.
- Relocation of Residents or Property Acquisition – Structures adjacent to Jones Levee are not subject to frequent flooding or repetitive losses in the existing condition. Costs to relocate or buy out residences would exceed the benefits under the existing condition. While an alternative that considers a large-scale relocation of residents or property acquisition is screened from further consideration, property acquisition of structures may be considered in combination with structural measures.

3.7 Measures Carried Forward for Further Evaluation and Alternative Formulation

After completing the initial screening of measures, the PDT analyzed the remaining measures for additional considerations, including combinability, dependability, mutual exclusion, and identification of sites implementation. The PDT and NFS identified specific measures that address specific problems and opportunities. The PDT used best professional judgment to assign measures to alternatives that would best function at the site to reduce flood risk while remaining within the CAP Section 205 budget. When applying measures to sites, the PDT considered qualitative considerations of sustainability, operations and maintenance, costs, real estate, scale, risk and reliability of performance. After this final screening of measures, eight measures were carried forward to alternatives formulation:

- Construct setback levee (independent);
- Improve existing levee (Raise-In-Place) (independent);
- Engineered Log Jams (ELJ's)(dependent);
- Adaptive designs of structural measures (dependent);
- Channel groins to restrict channel width and increase flows (dependent);
- Full removal of the existing levee (dependent);
- Partial removal of the existing levee (dependent); and
- Flood warning system/levee-specific evacuation planning, including evacuation maps (dependent).

3.8 Initial Array of Alternatives

An initial array of alternatives was formulated based on preliminary data collection and best professional judgment. The study team determined combinations of measures that would address the critical needs of the study area. This exercise led to an initial array of alternatives that includes combinations of the screened management measures. The PDT combined independent measures with dependent measures to form alternatives.

An alternative is not complete, acceptable, efficient, or effective unless it includes one or more of these measures. Increments will be added to the key measures to form the initial array of alternatives. The study team put together six initial alternatives, including the No Action alternative taking no Federal action.

- No Action;
- Levee Raise-In-Place (may include ELJ's, channel groins, and adaptive designs);
- Full levee setback with partial removal of the existing levee (may include ELJ's, channel groins, or adaptive);
- Full levee setback with full removal of the existing levee (may include ELJ's, channel groins, or adaptive designs);
- Partial levee setback (may include ELJ's, channel groins, or adaptive designs); and
- Stand-alone nonstructural alternative (includes carried forward measures and screened nonstructural measures)

These alternatives were then screened based on site-specific considerations. As a result, the following alternatives were screened from consideration and not carried forward into the final array of alternatives:

- Full levee setback with full removal of the existing levee – This alternative would require the construction of additional features (ELJs, spurs, etc.) to moderate channel migration into the setback area, exceeding the CAP Section 205 cost limit. This alternative would also be less efficient than the full levee setback with partial removal of the existing levee due to increased cost.
- Partial levee setback – Alternative does not optimize flood risk benefits associated with the increase in channel capacity and still incurs the additional impacts to the wetlands,

similar to the raise-in-place alternative. The wetland impacts increase the setback cost due to incorporating mitigation costs while only realizing a portion of the possible flood risk benefits.

- Nonstructural stand-alone plan (flood proofing, elevation, buyouts) – Most nonstructural measures are not appropriate for this area given infrequent economic flood damages in the existing condition for more frequent flood events, a high proportion of structures are elevated above the existing 1% AEP elevation, and the area is not subject to repetitive flood damages. However, the nonstructural measures to update flood warnings and evacuation maps are compatible with all alternative plans.

3.9 Final Array of Alternatives

Further cost analysis and professional judgment narrowed the initial array to three alternatives. Non-structural measures not screened will be considered in the two action alternatives. A brief description of general components and assumptions for the final array is summarized below. Figure 3-2 includes levee alignments for the raise-in-place and setback alternatives.

No Action
The No Action includes those conditions described in the future without project (FWOP) condition and does not include any significant structural or non-structural activities in the future without a Federal project. See the description of No Action in Chapter 4, Affected Environment and Environmental Consequences, for each of the resources analyzed for this study.

Levee Raise-in-Place
A levee raise-in-place would modify the existing Jones Levee prism by raising it vertically and horizontally landward to reduce flood risk to Orting. Raising the levee in place would require the deconstruction and reconstruction of the entire levee. Extending the footprint landward would cause the project to encroach into the adjacent wetland complex requiring additional mitigation. Disconnected floodplain and within-channel aggradation would continue to be an issue and increase flood risks to Jones Levee and adjacent levee segments. Similar to FWOP conditions, diminished river capacity due to sediment deposition modeling predicts it will increase the frequency of levee loading, resulting in increased damage, failure, and overtopping. This design is assumed to contribute to future channel conditions where the riverbed is higher in elevation than the adjacent landward side of the levee. This alternative is also compatible with measures including adaptability of the alternative for future conditions and updates to Emergency Action Plans and Flood Hazard Management Plans based on changes to flood risks and feasibility-level design.

Full Levee Setback with Partial Removal of Existing Levee
A setback levee provides a unique opportunity to address flood risk in the area while reconnecting the floodplain that has been cut off since the 1950s. Reconnecting the floodplain would provide ancillary benefit to salmon, including ESA-listed Chinook, steelhead, and bull trout, by allowing natural floodplain processes to resume over a wider area. A setback would also limit development within the area riverward of the new levee, reducing potential future human impacts and development within the floodplain. Setting back the Jones Levee would also contribute to floodplain connection improvements already constructed nearby (e.g. Soldiers Home and Calistoga Levee setbacks).

The Levee Setback alignment consists of three major components: the setback levee, breaching of the existing levee, and engineered log jams (ELJs). The proposed setback is approximately 6,414 feet long moves the levee alignment landward towards the historical Holocene channel migration zone. Setting back the levee would restore floodplain connectivity to approximately 40 to 50 acres and functionally lift the wetlands in the setback area by removing the barrier between them and the river. The existing levee would be breached in multiple locations to allow the river access to the additional storage area provided by the setback alignment. ELJs would be used to break up the flow and reduce velocities as floodwaters and the Puyallup River enter the setback area.

Setting the levee back reduces the risks associated with diminished river capacity due to aggradation and reduces the risk of the riverbed becoming higher in elevation than the adjacent floodplain. The predicted decrease in water surface elevation is 1 to 3 feet lower than under the No Action Alternative. In addition, storing sediment in the Jones levee setback area would benefit downstream areas. With a setback, water surfaces are predicted to decrease from the FWOP condition an average of one foot along Calistoga and High Cedars levees, reducing flood risk downstream of the project. Immediately following construction, the setback levee would provide 0.01% AEP. With the predicted increase in development and sediment aggradation, the setback will provide up to a 0.2% AEP (or 14.5% with risk and uncertainty factored in) at 50 years after construction.

Part of the old Jones Levee that extends inland, known as the Matlock Cutoff, would become a separate flood control structure and remain part of the levee system protecting the city of Orting. The Matlock Cutoff redirects sheet flow back to the river at Orting and prevents the river from flowing landward, should the Ford Levee fail.

This alternative is also compatible with measures, including adaptability of the alternative for future conditions and updates to Emergency Action Plans and Flood Hazard Management Plans based on changes to flood risks and feasibility-level design.

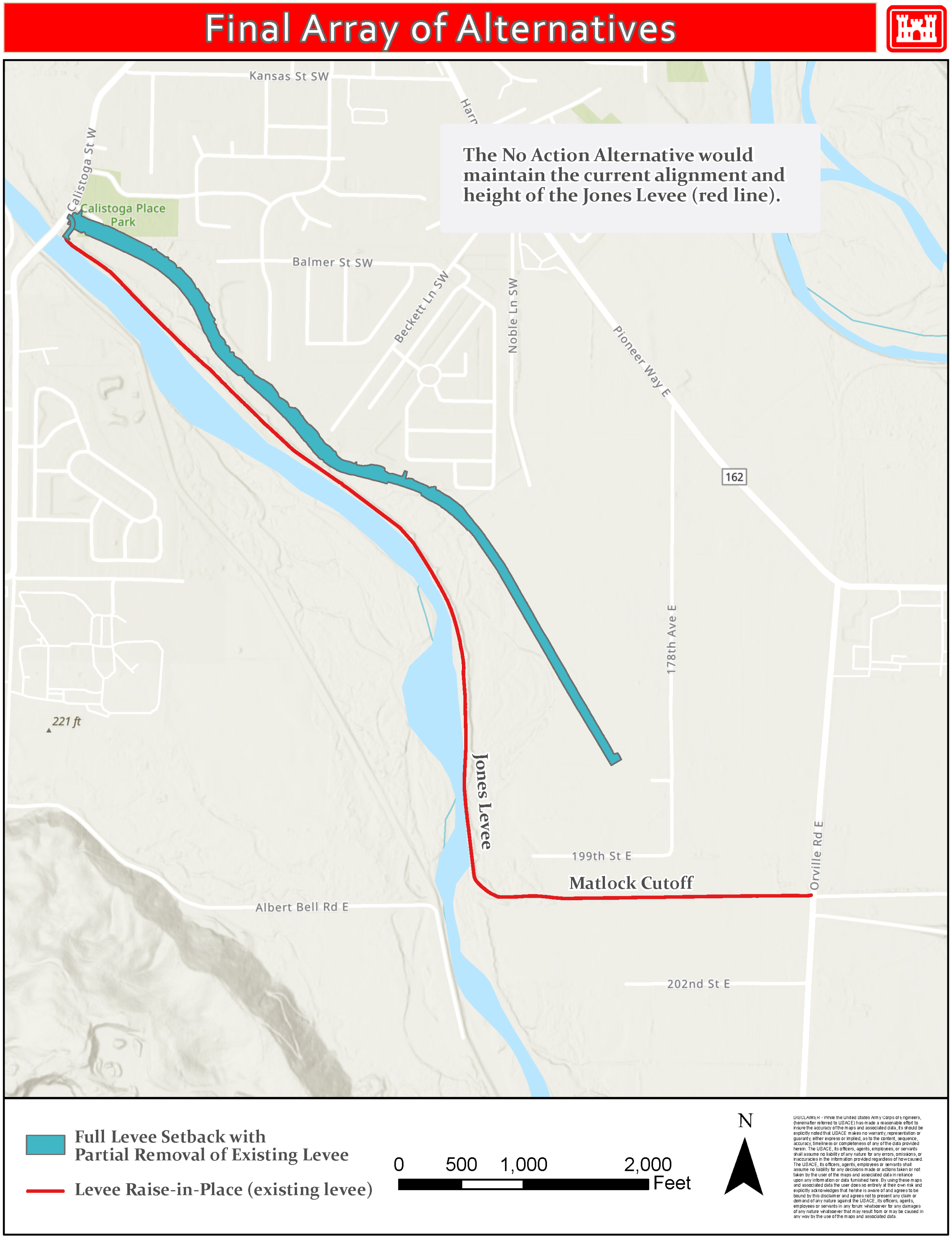


Figure 3-2 Final Array of Alternatives

3.10 Evaluation of Final Array of Alternatives

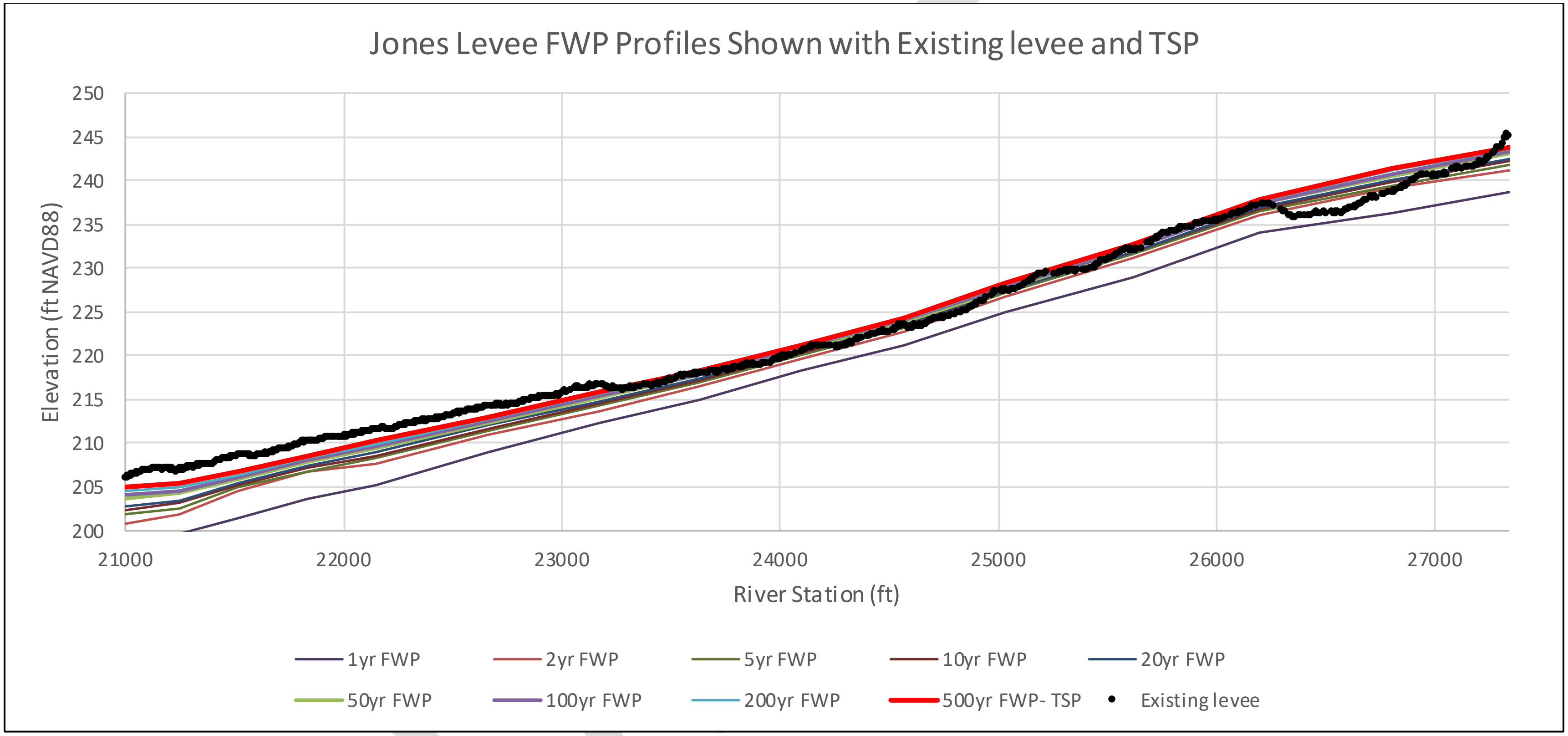
The PDT completed additional evaluation and compared the final array of alternatives to identify a Tentatively Selected Plan (TSP). The evaluation and comparison process considers contributions to NED, environmental impacts under environmental quality, and life safety as part of other social effects. Regional Economic Development (RED) considers economic impacts at a local level, including labor and income. The PDT evaluated the RED for the TSP only in Chapter 5. The Federal objective is to determine the project alternative that reasonably maximizes net NED benefits while protecting or minimizing environmental impacts.

The PDT used information from the Puyallup River GI study to the extent practicable. In addition, the PDT completed additional data collection and analyses to fill data gaps. The following sections summarize some of those key updates to data and impacts.

3.10.1 Updated Hydraulic Data

Much of the existing hydraulic modeling completed for the Puyallup River GI study was based on older data and methods. Hydraulic modeling was revised in HEC-RAS version 5.0.7 to convert floodplain areas to 2-D unsteady state from 1-D. This conversion allowed for gridded floodplain inundation data to better estimate economic consequences. New river cross-sections were collected along the Jones levee in December 2019 to supplement 2009 cross-section data. Measurements revealed sediment deposition and accumulation of approximately +0.5 to +1 feet since 2009 in the river adjacent to Jones Levee. Flow-frequency estimates were revised in March 2019 for 99.9% through 0.2% AEP events (or annual to 1 in 500 annual chance). The hydraulic model was re-calibrated with new data, including flow events at 4,500 cfs (slightly greater than an annual event (66.7% AEP) and at 12,300 cfs (10% AEP). Sediment modeling, a distinct model separate from the hydraulic model, was also revised to incorporate additional flow-load data collected in 2013 and the 2019 cross-sections along with Jones. A plot of future with-project condition water surface profiles relative to the existing levee and Figure 3-3 shows the TSP. Water surface profiles have very little variation from the 50% to 0.2% AEP events (1 in 2 to 1 in 500 annual chance), due to the flat flow-frequency curve and wide channel, with just over a 2-foot range in the existing condition and 1.5-foot range in the future condition.

Figure 3-3 Future With-project Water Surface Profiles for the TSP plotted with Existing Levee Profile for Reference



3.10.2 Environmental Impacts and Mitigation

Environmental impacts and mitigation for each alternative are significantly different. Environmental mitigation for the raise-in-place alternative was evaluated for impacts to riparian vegetation, ESA-listed species, and waters of the U.S. This evaluation estimated that at least $9 million would be necessary to mitigate for the raise-in-place alternative, not including real estate costs. In contrast, although a setback levee results in some environmental impacts related to construction, the overall environmental benefits through the restoration and reconnection of the historic floodplain would be far greater by restoring natural ecosystem function, slowing and storing floodwaters, and sustaining native fish and wildlife habitat. Therefore, no additional or separate mitigation would be required given all the beneficial effects.

Estimates show the raise-in-place alternative would affect approximately 3 acres of freshwater forested/shrub wetlands, 10 to 12 acres of riparian habitat (including forested wetland), approximately 6,500 linear feet of aquatic habitat along the riverward side of the existing levee, and a variety of aquatic species including ESA-listed Chinook, steelhead, and bull trout and their critical habitats.

These impacts from the raise-in-place alternative result from the additional levee width required to increase the height and the addition of a buried riprap toe in the river. Further impacts would result from the removal of all vegetation on the existing levee during construction and compliance with Corps vegetation standards for levees (15-foot vegetation free zones (VFZs) along either side of the levee toe) along approximately 6,500 linear feet.

This reach of the Puyallup River supports rearing and foraging for ESA-listed salmonids and salmon redds. Extending the levee could have severe consequences to spawning, redd survival, and juvenile rearing success. The aquatic habitat along the existing levee includes a mosaic of sand/gravel bars, side channels, and woody debris accumulation, features that are critical to salmon spawning and rearing success. Effects to ESA-listed fish species would be substantial with the raise-in-place alternative from permanent loss of aquatic habitat (due to increased levee width and the addition of a buried riprap toe), extensive river bottom disturbance during construction, continued floodplain isolation, and permanent loss of functionally important riparian vegetation along the river's edge. Approximately 10 to 12 acres of riparian trees (both forested wetland and upland forest along the levee slope and adjacent VFZs) would be removed due to the construction of the raise-in-place alternative. This removal would result in the reduction of organic input that fuels the food chain within the river, reduction in shading of the margins of the river for thermal refuge in the summer, reduction in woody debris, and reduction of slow water refuge along the margins of the river during high flows. All of this would negatively affect ESA-listed Chinook, steelhead, and bull trout.

Mitigation for project impacts falls under three accounts:

1. ESA;
2. Clean Water Act (CWA; i.e., Wetlands and Other Waters of the U.S.); and
3. Riparian Vegetation.

The raise-in-place alignment would not provide any habitat benefits and would require extensive off-site mitigation within the basin. The areas landward of the levee that would not be disturbed are currently forested. Thus there is no opportunity for further riparian enhancement. Creating wetlands in these areas is also not feasible, as it would require the destruction of upland riparian forest via excavation (which would result in increased loss of riparian forest in the course of compensating for forested wetland losses). Additionally, this area already contains many wetland features.

Appropriate mitigation would be located in an area that would benefit from habitat creation. Upstream of the project, the river is more natural so that mitigation efforts would be less effective and potentially harmful. Therefore, appropriate mitigation sites are located downstream in highly channelized and developed areas. Due to the increased development and channelization of the Puyallup River, mitigation would require significant investment in real estate and construction costs to create habitat. In addition, many areas that would be appropriate for mitigation along the Puyallup River are leveed and would require either increasing flood risk by removing or breaching the structure or setting it back to maintain flood risk reduction.

<u>Endangered Species Act Mitigation:</u>

Compensation for ESA impacts is for the most part separate from the compensatory mitigation for CWA (wetlands) and riparian impacts. Since no listed terrestrial species occur in the project area, the mitigation analysis focuses on impacts to listed aquatic species (Chinook, steelhead, and bull trout) and their critical habitat. The raise-in-place alternative would result in approximately 6,500 linear feet of direct impact in the river channel.

One mitigation option would be to create a similar area by removing an existing levee in another location and creating a setback area of similar function. By obtaining an off-site mitigation parcel with 6,500 feet of leveed shoreline with a 200-foot buffer, the off-site levee could be removed and a setback levee constructed as necessary to maintain flood protection. The setback would allow the river to migrate into the setback area and create a replacement habitat. The buffer area would have a width of 200-feet (standard riparian area), and it would be planted with a mix of coniferous and deciduous trees to ensure future forested conditions. In addition, large woody material (LWM) would be placed in the channel to provide additional habitat. Construction of an off-site setback for ESA mitigation of the raise-in-place alternative would require approximately 29 acres of off-site mitigation land. This off-site mitigation would also need to be located downstream for the same reasons discussed above.

Another option to compensate for the ESA impacts of the raise-in-place alternative would be to secure an off-site parcel of shoreline and create a new side channel, which is an identified limiting factor for salmonids in the Puyallup Basin. An existing levee would be breached in two spots, and a side channel would be excavated through this area to construct a new side channel. The area would also be planted with a mixture of coniferous and deciduous trees, and LWM would be placed. For this option, a new setback levee would need to be constructed to protect the area behind the mitigation site, and compensation of ESA impacts would require about 12 acres of land for the 3-acre impact based on professional judgment, training, and experience of the PDT. The area would contain the side channel plus an associated forested buffer. The side channel would need to be located downstream in the channelized portion of the Puyallup River.

Clean Water Act Mitigation:

For the raise-in-place alternative, CWA wetland mitigation would be accomplished through off-site mitigation. The amount and type of required mitigation is estimated by the quality of the wetland that would be adversely affected based on the Ecology's Credits and Debits methodology. The raise-in-place alternative, which would destroy an estimated 3 acres of high-quality forested wetlands, would require relatively more acreage of restored or created mitigation wetlands. Based on the methodology and lack of suitable area for wetland mitigation onsite, this alternative would require restoration or creation of 12 acres of wetland at an off-site location. The wetland restoration or creation would be accomplished by excavating a suitable area down or close to the seasonal water table and then planting with trees and shrubs. This mitigation could be accomplished in either side-channel area or setback area described in the ESA section above, but the wetland mitigation acreage would be additional to the ESA mitigation acreage.

With regard to a mitigation sequencing approach, preliminary analysis indicates that Section 404 of the CWA would mandate that there is another practicable alternative (the setback alignment of Jones Levee) with less environmental damage is available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes. So the raise-in-place alternative would not comply with Section 404 of the CWA, even with compensatory mitigation.

Riparian Mitigation:

Compensatory mitigation for riparian impacts and upland forested impacts could be accomplished through the planting of a similar acreage elsewhere. Based on recent levee repair mitigation practices in the area for riparian impacts (5 to 1 replacement ratio) and the estimated trees removed to construct the raise-in-place alternative (1,600 trees), approximately 8,000 trees would need to be planted to mitigate for the removal of riparian vegetation along 6,500 linear feet of the raise-in-place alternative. Understory shrubs would also need to be planted but were not estimated. For the raise-in-place alternative, 18 to 20 acres of land would need to be obtained adjacent to the Puyallup River and planted. Plantings would be placed 10 feet off-center from each other with suitable shrubs interspersed between the trees. Tree mitigation is based on acreage and estimated to cost an estimated $11,700 in 2021 dollars. The estimated 18 to 20 acres in total would cost approximately $234,000.

3.10.3 Induced Flood Impacts

The raise-in-place alternative also assumed induced flood damages with a rough cost of $1 million for real estate takings to offset the impact on the other bank or downstream of the Jones Levee, based on estimates from the Puyallup River GI and confirmed with recent hydraulic modeling. There may be some induced flood impacts associated with the setback alternative in localized areas, but the induced impacts for the raise-in-place are thought to be a minimum estimate of those impacts above and beyond a setback levee. A detailed real estate takings analysis will be conducted as part of the feasibility-level design on the recommended plan.

3.11 National Economic Development (NED) Analysis

In addition to updating hydraulic conditions, mitigation, and flood impacts, the economic structure inventory was also revised to reflect current conditions in September 2019 using Pierce County tax assessor data and windshield surveys. The structure inventory was also determined to follow FEMA regulations regarding structure standards for any structures build after 1991. Economic consequences of the final array were estimated using the Corps' flood damage analysis tool, the Hydrologic Engineering Center-Flood Damage Analysis Tool (HEC-FDA) version 1.4.2. The model combines the economic inventory along the Puyallup River at the city of Orting, hydraulic data, and geotechnical fragility for the existing Jones Levee. The analysis used October 2021 prices, a 50-year period of analysis, and the current discount rate of 2.5%. Costs include interest during construction (IDC), assuming a one to two-year construction and annualized operations, maintenance, repair, replacement, and rehabilitation (OMRR&R) costs. The levee raise-in-place alternative includes the conservative offsite mitigation estimate of $9.1 million (not including associated real estate) and $1 million for induced impacts as described above in Sections 3.10.2 and 3.10.3. OMRR&R costs are greater for the raise-in-place alternative at an approximate cost of $35,000 versus $25,000 for the setback alternatives based on actual levee repair and maintenance costs in the Puyallup River basin.

Results of the economic analysis are summarized in Table 3-2 and shown in Figure 3-4. Due to limited variation in water surface profiles and hydraulic and economic uncertainties, project performance (mean and median AEP, 1% AEP assurance) and benefits (mean vs. median) were highly sensitive to elevation. Economic justification is tied to projected future hydraulic conditions and average annual equivalent benefits; a positive net benefit where benefit-cost ratios (BCRs) exceed one was not observed for any alternative if only considering the existing condition. Therefore, project justification is predicated on the expected increased sedimentation in the future conditions, which will raise water surface elevations and increase damages in the future condition.

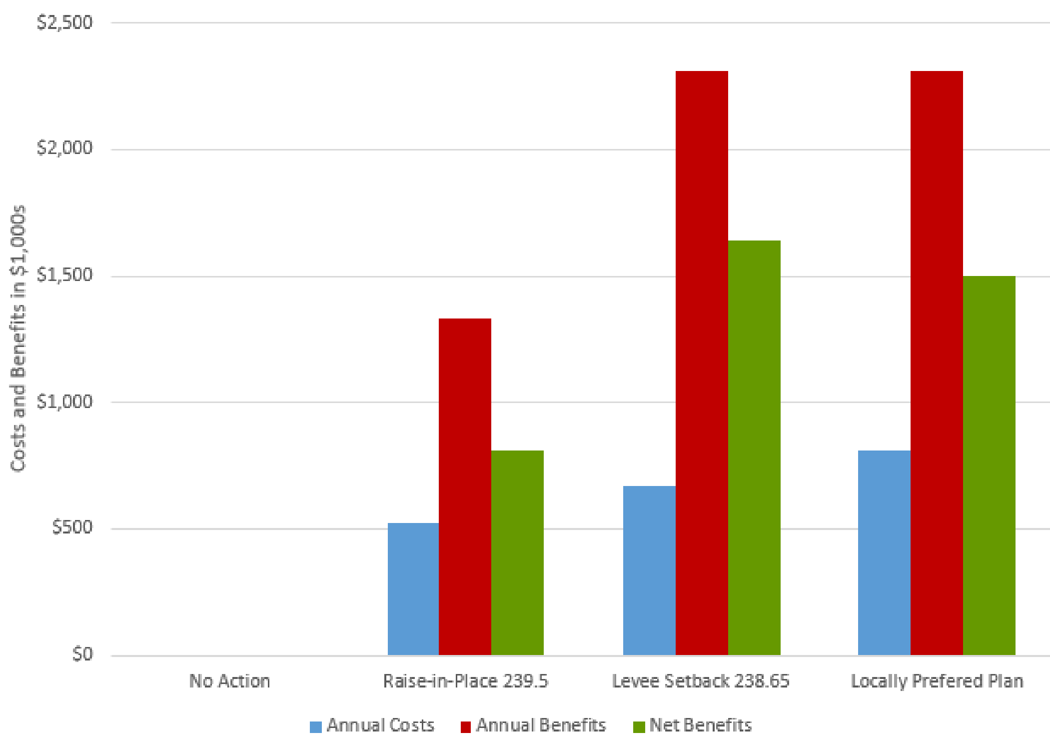
The NED plan is the plan that maximizes net benefits and is economically justified. For the Jones Levee Project, the NED plan is the setback levee alternative at a representative elevation of 238.65 feet NAVD88, at RM 22.5, with mean net benefits of $1,638,000 and a benefit-cost ratio (BCR) of 3.4 (Table 3-2). Plan refinements after the MSC Decision Milestone led to the addition of Alternative 4 (NED Plan), which includes all components of Alternative 3 but includes a different design of the buried toe. Toe rock for the NED alternative uses Class V riprap, which is roughly equivalent to 2- to 3-man rock, the same rock size used for slope armoring, and is designed to launch in the event of scouring.

The public sponsor has expressed that they have a LPP. The LPP (Alternative 3) includes adding 8- to 10-man rock as armoring on the levee set-back's riverside toe, filled with smaller 6- to 8-man rock. The sponsor prefers the larger rock to prevent levee degradation and breaches further. The change in rock size would reduce O&M costs and repairs in the future; however, it increases the cost over the original set-back alternative (Table 3-2). The LPP has mean net benefits of $1,500,000 and a BCR of 2.9.

Table 3-2 Final Array Economic Analysis ($1,000s, Oct 2020 price level, 2.5% discount rate)

Setback Alternative Scale (Elevation)	Project First Cost (Oct 2020)	Fully Funded Cost Estimate (including Feasibility)	Total Annual Cost (includes OMRR&R & IDC)	Total Annual Benefit (Mean)	Net Benefit (Mean)	BCR (mean)
Alt 1 - No Action	$0	$0	$0	$0	$0	0
Alt 2 – Raise-in-Place 239.5 ft	$13,427	$15,414	$525	$1,333	$807	2.5
Alt 3 – Setback Levee (LPP)	$20,120	$22,260	$810	$2,310	$1,500	2.9
Alt 4 - Setback Levee (NED)	$16,420	$18,350	$672	$2,310	$1,638	3.4

Figure 3-4 Final Array Economic Analysis for the No Action, Levee Setback (elevation of 238.65 feet), Raise-In-Place (elevation 239.5 feet) Alternatives, and the LPP.



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3.12 Completeness, Effectiveness, Efficiency, and Acceptability

Completeness, effectiveness, efficiency, and acceptability are the four evaluation criteria specified in the Council for Environmental Quality (CEQ) Principles and Guidelines (Paragraph1.6.2(c)) in the evaluation and screening of alternative plans. Alternatives considered in any planning study should meet minimum subjective standards of these criteria to qualify for further consideration and comparison with other plans. Table 3-3 summarizes the four criteria for the final array of alternatives.

Table 3-3 Comparison of Completeness, Effectiveness, Efficiency, and Acceptability

	Completeness	Effectiveness	Efficiency	Acceptability
Alternative 1: No Action	Y	N	N	N
Alternative 2: Raise-in-Place Levee	Y	Y	N	N
Alternative 3: Setback Levee LPP	Y	Y	Y	Y
Alternative 4: Setback Levee NED	Y	Y	Y	Y

<u>Alternative 1: No-Action Alternative</u>

The No-Action Alternative meets the completeness criterion because there are no changes to implement and no additional investments are needed. It does not meet the effectiveness criterion because it does not achieve any of the planning objectives. It is the least efficient alternative because it is not the most cost effective means of alleviating the problems and realizing the opportunities of the study area. Additionally, this alternative is considered unacceptable by other federal, Tribal, State, and local entities who maintain a policy of setting levees back when possible.

<u>Alternative 2: Raise-in-Place Levee</u>

The Raise-in-Place Levee is complete and effective at reducing flood risk, but is less efficient than the setback levee, and is unacceptable because it is not compatible with existing laws, regulations, and public policies and is generally not supported by stakeholders, the public, state, federal, tribal, and local entities.

<u>Alternative 3: Setback Levee LPP</u>

The Setback Levee best meets all four Principles and Guidelines criteria for completeness, effectiveness, efficiency, and acceptability. This plan is consistent with local stakeholder plans within the basin and is acceptable to the public, state, federal, and local entities. Furthermore, this alternative is consistent with public comments received during the Puyallup GI supporting a setback levee at this location.

<u>Alternative 4: Setback Levee NED</u>

Similar to Alternative 3, Alternative 4 meets all four Principles and Guidelines criteria for completeness, effectiveness, efficiency, and acceptability. This plan is consistent with local stakeholder plans within the basin and is acceptable to the public, state, federal, and local entities. Furthermore, this alternative is consistent with public comments received during the Puyallup GI supporting a setback levee at this location.

3.13 Tentatively Selected Plan Selection Criteria

Criteria for TSP selection were identified early in the study. They included contributions to NED, life safety improvements, environmental impacts, total project cost (CAP Section 205 limit), real estate needs, relative acceptability of the alternatives to various stakeholders (e.g., NFS, Tribes, agencies), and completeness to function with the rest of the levee system. Evaluation of these selection criteria is summarized in Table 3-4. The setback alternative best meets the TSP selection criteria. The raise-in-place alternative is not the NED plan, has significant environmental impacts, exceeds the Section 205 cost limit, and would not be implemented based on public review of the Puyallup River GI study, which faced great opposition from the public and the tribes. There are expected trade-offs to life safety with both alternatives, and impacts will be analyzed in greater detail with a levee safety risk assessment and ability of alternatives to meet Tolerable Risk Guidelines 1 and 4 as characterized by Engineering and Construction Bulletin (ECB) 2019-15 and Planning Bulletin 2019-04. An initial qualitative assessment indicates the TSP is likely to meet the societal and individual risk reference lines for current conditions but unlikely to meet individual risk tolerability at the end of the 50-year planning horizon.

Table 3-4 TSP Selection Criteria. Criteria under each alternative are rated as meeting or benefiting a criterion (+) or failing to meet or damaging a criterion (-).

Criteria	Alternative 2 Raise-in-Place	Alternative 3 Setback LPP	Alternative 4 Setback NED
Contributions to NED	+	+	+
Life Safety Improvement	+/-	+/-	+/-
Environmental Impacts	+	+	-
Total Project Cost (Section 205 limit)	-	-	-
Real Estate Needs	+	+	+
Acceptability	+	+	-
Completeness to function with levee system	+	+	+

For purposes of refining a TSP recommendation, a maximum elevation of 238.65 feet was established and thought to be appropriate for further refinement through feasibility level design and economic optimization within the CAP Section 205 cost limit. This elevation provides levee performance to the 0.2% AEP event in the future condition, where the 0.2% AEP event is associated with elevation 237.5 feet. The TSP elevation contains the 0.1% mean AEP and greater flood events in the future condition.

3.14 Tentatively Selected Plan

Based on the evaluation of the final array of alternatives, the TSP is the LPP (Alternative 3 Setback Levee at elevation 238.65 feet). The difference from the NED is the design of the buried toe. Toe rock for the NED alternative uses Class V riprap, the same rock size used for slope armoring, and is designed to launch in the event of scouring. The buried toe for the LPP uses large 8- to 10-man rock installed down to the scour depth at the levee toe, which differs in size from the Class V riprap used on the levee slope. The voids between the 8- to 10-man rock would be filled with 4- to 6-man rock. Slope armoring is Class V riprap which is on average approximately 21 inches in diameter, while the 8- to 10-man toe rock is approximately 70 inches in diameter. Class V rock is roughly equivalent to 2- to 3-man rock.

This alternative will be further refined for benefits and costs as feasibility-level designs, and economic optimization tasks are completed. The conceptual plan for the TSP is shown in Figure 3-5. Section 4.5 describes this alternative in further detail for analysis on the affected environment and environmental consequences. This description will be further refined and amended in Design and Implementation (D&I).

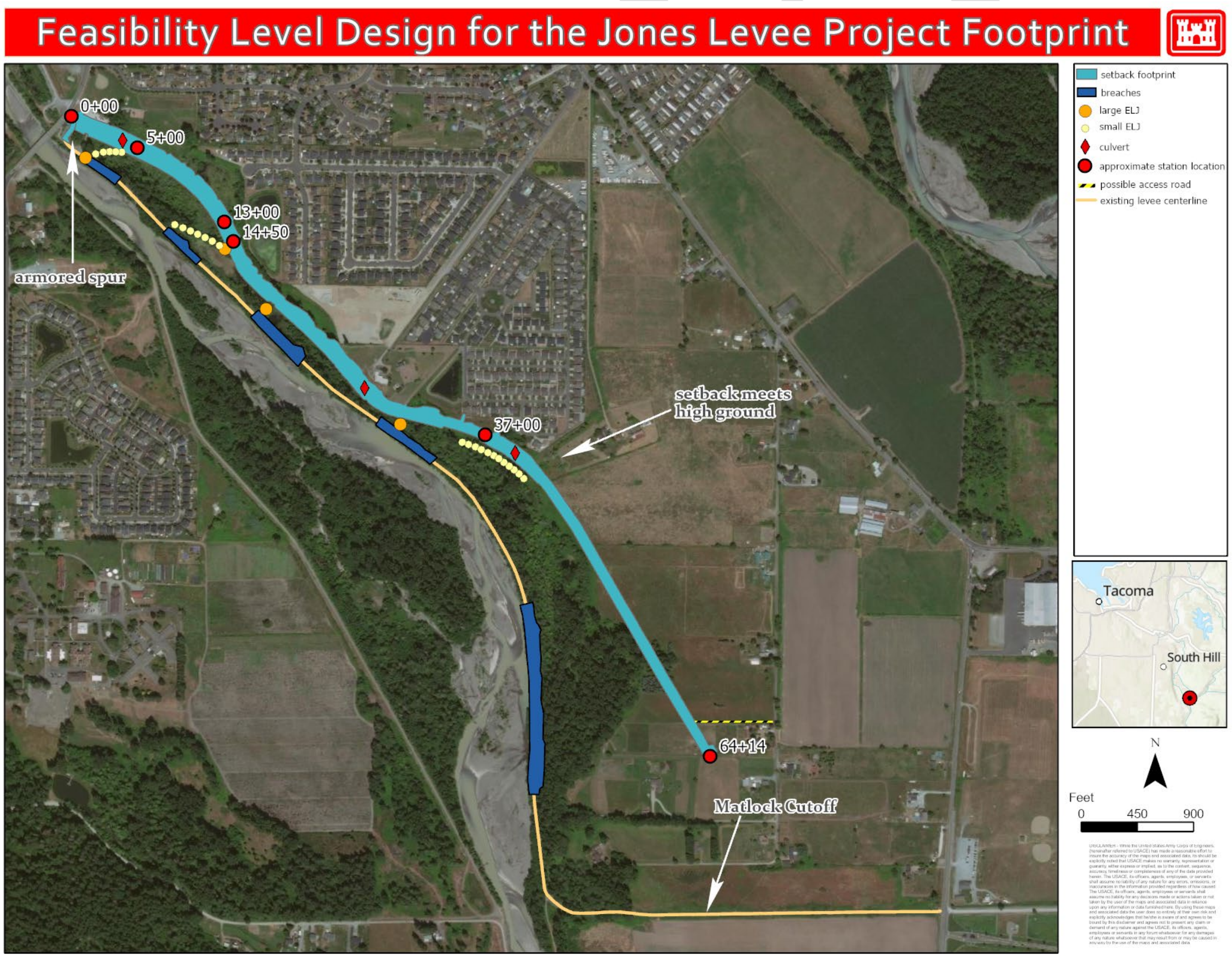

Figure 3-5. TSP Conceptual Project Footprint.

Elevation 238.65 feet corresponds with a 0.2% AEP event (1 in 500 annual chance) in the future condition and greatly exceeds existing condition events with a capacity exceeding a 0.01% AEP (1 in 10,000 annual chance) event. Costs for this elevation would allow for maximizing net benefits up to the CAP Section 205 limit of $15 million, or $10 million Federal. Net benefits range from $736,000 for the median to $1,561,000 for the mean, with BCRs from 1.9 to 2.9 (Table 3-5).

Table 3-5 TSP Economic Summary (October 2021 Price Level, 2.5% Discount Rate).

Costs and Benefits (in $1,000s, Oct 2021 price level, 2.5% discount rate)									
Project First Cost (Oct 2020)	Fully Funded Cost Estimate (with Feasibility)*	Annual OMRR&R	Total Annual Cost	Total Annual Benefit (Mean)	Net Benefit (Mean)	Total Annual Benefit (Median)	Net Benefit (Median)	BCR (Mean)	BCR (Median)
$19,905	$21,562	$25	$824	$2,385	$1,561	$1,560	$736	2.9	1.9
Performance									
AEP Expected Existing Condition (Mean)	1/x chance existing (Mean)	AEP Expected Future Condition (Mean)	1/x chance future (Mean)	AEP Future Condition (Median)	1/x chance Future Condition (Median)	Assurance 1% Existing Condition	Assurance 1% Future Condition		
0.01%	10,000	5.90%	17	0.04%	2,500	100%	75%		

4 Affected Environment and Environmental Consequences*

This chapter provides the existing conditions and regulatory setting for each of the resources that could be affected by implementing any of the final array of alternatives. Existing conditions are the physical, chemical, biological, and sociological characteristics of the project area. The assessment of environmental effects is based on a comparison of conditions with- and without implementation of the TSP and a reasonable range of alternatives; in this case, the final array of alternatives are formulated through the screening process (summarized in Section 3) and are compared to the No-Action Alternative. The analysis focuses only on significant resources that are potentially affected by the alternatives and have a material bearing on the decision-making process. The spatial scale of analysis focuses on the Jones Levee and surrounding environment. The time scale for analysis is a 50-year period beginning in 2024 and extending to 2073.

4.1 General Existing Conditions

The following summarizes the general existing conditions for the study area:

- The Puyallup River, in the vicinity of the city of Orting downstream to the Puget Sound, is heavily modified by flood risk management structures.
- Local entities likely constructed Jones Levee in the 1950s.
- Flood risk management structures require frequent erosion repairs.
- Existing levee systems have dramatically altered the natural river dynamic and perpetuate negative effects on environmental resources.
- The region has and continues to undergo rapid growth and development.
- Despite this growth and development, the Puyallup River basin still serves as a migration corridor and spawning habitat for a variety of fish species, including several ESA-listed salmon.
- Development within the floodplain is limiting restoration opportunities and increasing dependence upon structural flood management alternatives.
- The map below shows the current flood plain as determined by FEMA

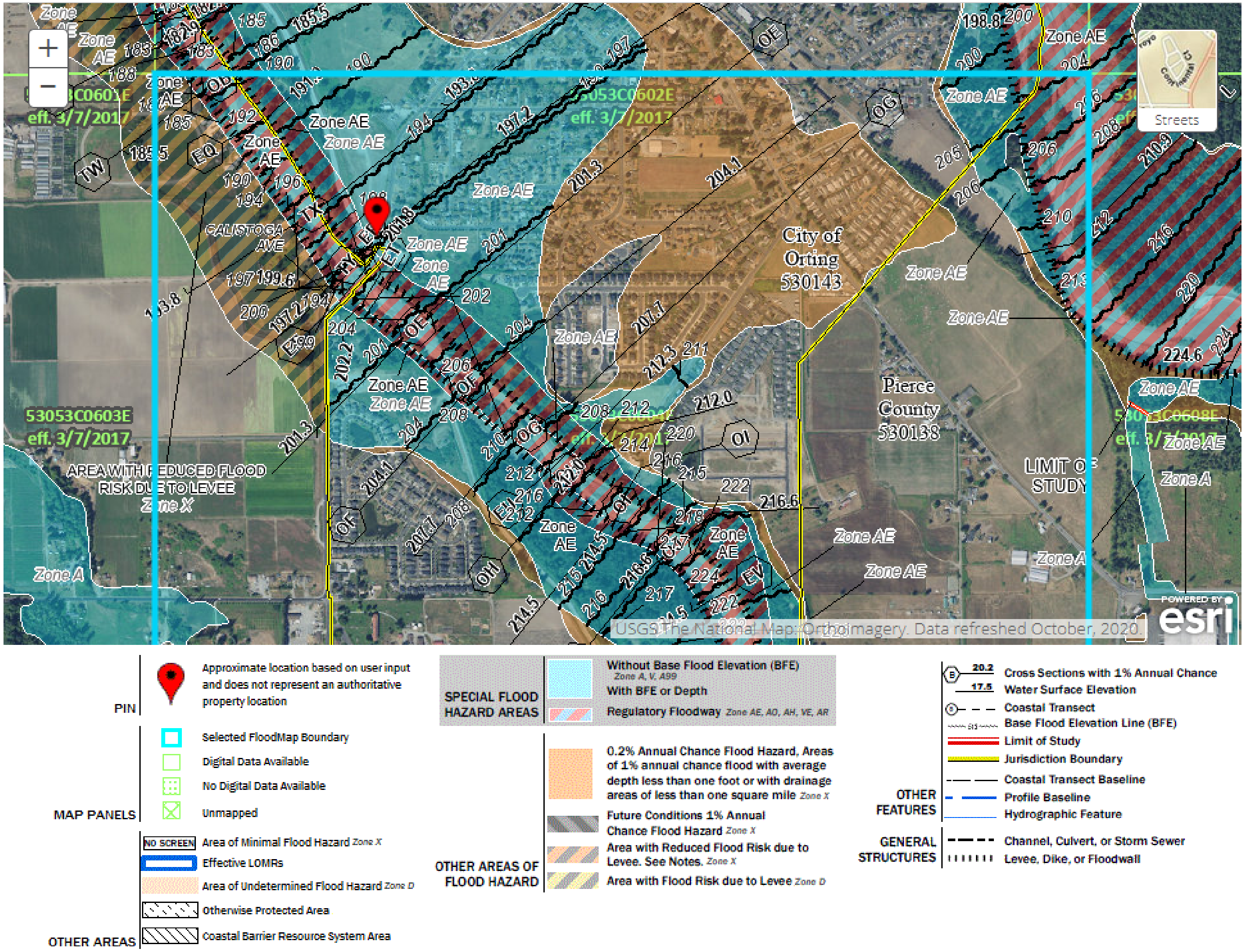

Figure 4-1 Current Flood Plain

4.2 Forecasted Future Conditions

The future forecasted conditions are an estimate of what the community will be like within the next 50 years. As expressed by other development plans, current trends and the potential for change are a basis for estimating this future condition. The following summarizes FWOP Conditions for the study area:

- Continued development and population growth in the floodplain, primarily residential and commercial uses.
- Opportunities to setback the Jones Levee will be lost or become cost-prohibitive as development continues.
- Diminished river capacity due to sediment aggradation increases the frequency of levee loading, resulting in increased damage, failure, and overtopping.
- Continued loss, impairment, or degradation of floodplain connectivity and function will cause negative impacts to water quality, habitat, and fish and wildlife.
- Continued loss, impairment, or degradation of channel structure and complexity
- Continued loss, degradation, or impairment of riparian areas and LWM recruitment

4.2.1 Future Hydrologic and Hydraulic Conditions

Future conditions within the river basin include projections of the river's conditions within the next 50 years. The two main parameters of interest for this study for future conditions are peak river flows and sediment yields from the basin. Each of these factors are expected to increase in the future, which will affect future flood risks. Much of the potential change in these factors is tied to climate change (see Section 4.11). Additional basin-wide changes to hydrologic conditions (i.e., runoff) are unlikely outside the climate change context unless land use practice changes significantly in the upper basin. The upper basin is largely heavily wooded national forest. Change to hydraulic conditions is tied to future modification of the levee system and continued sediment loading. Changes to the levee system are possible from the local sponsor. Sediment yields are affected by this, as well climate change.

4.2.2 Future Ecological and Physical Conditions

Levee systems have channelized the Puyallup River, dramatically altering natural river dynamics. The continued existence of these levee structures perpetuates negative effects on the natural environment. Natural processes that support and maintain a healthy ecosystem are no longer functioning at their full potential:

- **Loss, impairment, or degradation of floodplain connectivity and function:** results in a reduction in the watershed’s ability to store and discharge water to minimize peak flood flows and duration; prevents access to previously available habitats (seasonal wetlands, off-channel habitat, side-channels); creates a disconnected and non-functional hyporheic zone; negatively affects water quality such as temperature; and allows for further urbanization, which compounds the effects.
- **The loss, impairment, or degradation of channel structure and complexity:** results in a reduction of quantity and quality of available habitat by limiting the rivers ability to meander; diminishes a suitable distribution of riffles and functional pools, and increased gradient prevents functional amounts and sizes of LWM or other channel structures.

- **The loss, degradation, or impairment of riparian areas and LWM recruitment:** prevents the development of riparian conditions important for the production of food organisms and organic material, shading that provides cover and temperature refuge, bank stabilization from roots, nutrient and chemical mediation, control of surface erosion, and production of LWM.
- **Altered routing of stream substrate**: altered sediment transportation leads to sediment aggradation, reducing the levees' ability to reduce flood risk. It creates streambed instability, which has a negative impact on spawning and rearing conditions for aquatic organisms such as ESA-listed salmon.

These conditions will continue to worsen without significant change. Environmental laws, habitat restoration, and conservation efforts by local, state, tribal, and Federal agencies would offset or improve some impacts. Nevertheless, human presence within the floodplain is not likely to go away, and so these conditions are expected to continue to persist without changes in floodplain use.

4.2.3 Future Community and Socioeconomic Conditions

The Washington State Legislature enacted the Growth Management Act in 1990 that initiated and required developing policies to manage growth in the state. This legislation led to the Pierce County Comprehensive Plan, which adhered to 14 main objectives and was last updated in 2019. One of these objectives is the desire to encourage development in urban areas and reduce sprawl in undeveloped areas to preserve undisturbed lands. These objectives led to the creation of Designated Urban Growth Areas (UGAs). As a designated UGA, the city of Orting is projected to expand in the next twenty years (Pierce County, 2019). With the expansion of the city of Orting, business development and populations are also projected to increase. This will include the expansion of public utilities and services. While it is safe to assume that development will continue in the city of Orting, the benefit-cost ratio does not include potential future growth of the area due to uncertainty in the location of future developments within the leveed area.

4.3 Description of Alternative 1 – No Action Alternative

The No-Action Alternative is analyzed as the FWOP conditions and serves as a baseline reference for comparing the other action alternatives. Under this alternative, the Corps would take no action to address flood risk to the city of Orting at the Jones Levee. The Corps assumes that all physical conditions existing at the time of this analysis remain and that routine maintenance operations would continue to maintain the Jones Levee for flood risk reduction. The floodplain would remain disconnected, and sedimentation would continue to be an issue. Over time, sediment aggradation would increase flood risks to Jones Levee and adjacent levee segments. In addition, the Corps expects the diminished river capacity to increase the frequency of levee loading resulting in increased risk for damage, failure and overtopping. Finally, the sediment aggradation is assumed to contribute to future channel conditions where the riverbed is higher in elevation than the adjacent landward side of the levee.

4.4 Description of Alternative 2 – Levee Raise-in-Place Alternative

A levee raise-in-place would modify the existing Jones Levee prism by raising it vertically and widening it horizontally to reduce flood risk to the city of Orting. This alternative would require deconstructing the levee and rebuilding it from the ground up in a larger footprint. The expanded levee footprint would be approximately 40 feet wide with 15-foot VFZs along either side of the levee toe. Expanding the levee footprint would cause encroachment into regulated waters of the U.S. with no associated benefits, necessitating costly mitigation (see Section 3.10.2). In addition, the floodplain would remain disconnected, and loss of channel capacity would continue to be an issue as it would under Alternative 1. In addition, the affected wetlands would not experience a functional lift with floodplain reconnection and would require additional mitigation. Furthermore, off-site mitigation would be needed that would incur significant costs beyond the limit allowable under the project authority.

4.5 Description of Alternative 3 – Levee Setback and Partial Removal (LPP/TSP)

The Corps has developed a feasibility level design for the Jones Levee setback, which is supported by the NFS. The design comprises three major components: the setback levee, breaching the existing levee, and ELJs. Provided below is a summary of each component. See Section 5 for a more in-depth description of the TSP, including engineering details. The Corps will complete designs in D&I. shows the conceptual footprint of the TSP, Figure 4-1 and Figure 4-2 show the feasibility level design project cross-sections. Measurements in the below tables and figures are based on the feasibility level design; the final design and construction area may be different in D&I.D&I.

4.5.1 Description of the Locally Preferred Plan-Levee Setback with Jetty Rock (TSP)

The Corps has developed a feasibility level design for the Jones Levee setback with Jetty Rock. The design consists of all the major components from the Levee Setback and Partial Removal alternative. Three components will be included: the setback levee, breaching the existing levee, and ELJs. In addition to these components, the local sponsor has requested the riprap on the levee be upgraded to Jetty Rock size, 8-10 man stones. See Section 5 for more in-depth description of the TSP, including engineering details. The Corps will complete designs in D&I. Figure 3-5 shows the conceptual footprint of the TSP, Figure 4-1 and Figure 4-2 show the feasibility level design project cross-sections. Measurements in the below tables and figures are based on the feasibility level design; final design and construction area may be different in D&I.

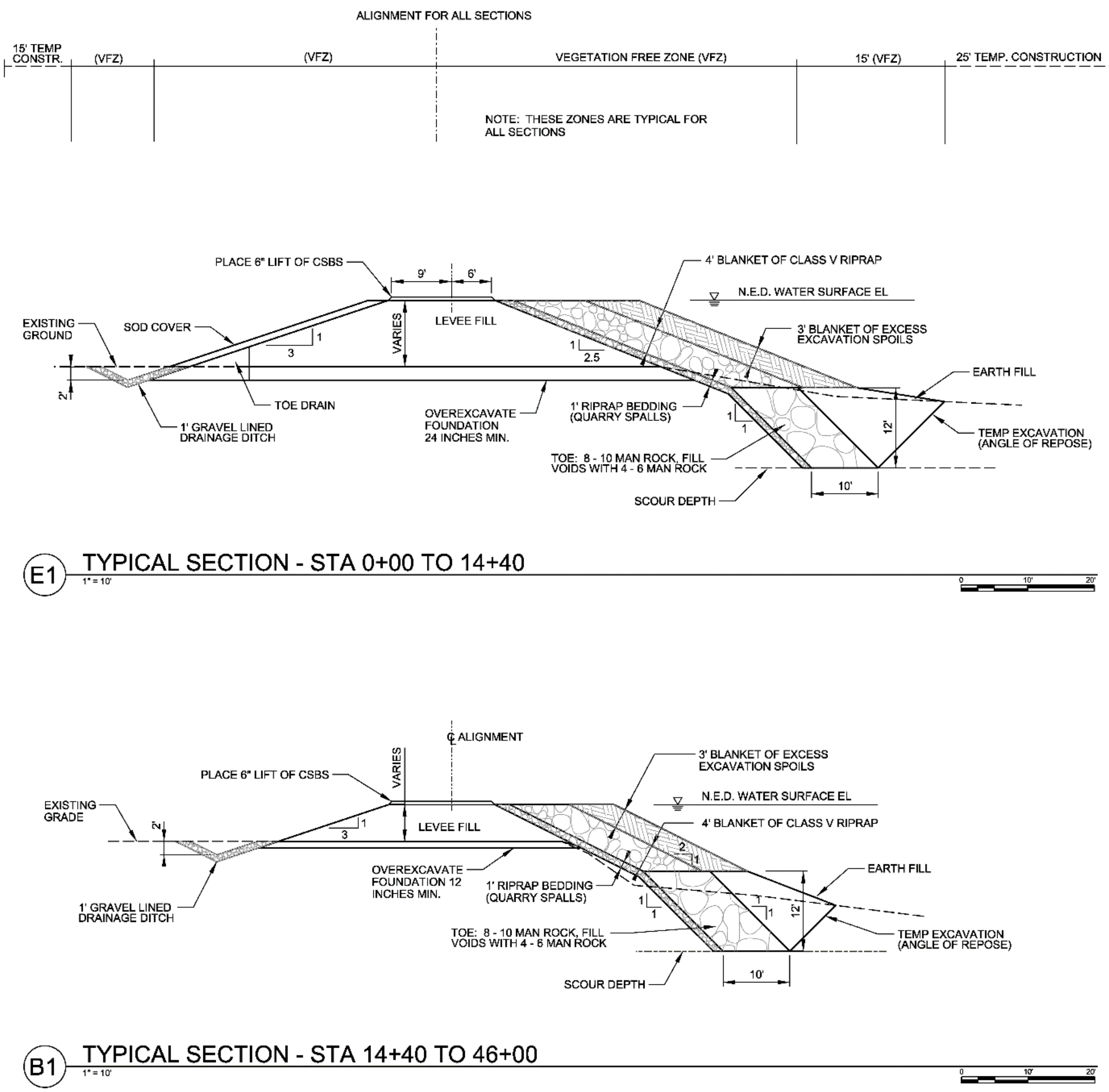

Figure 4-2 Proposed typical feasibility level design cross-sections for the TSP at the downstream end of the setback. Station locations correspond to those identified in Figure 3 5.

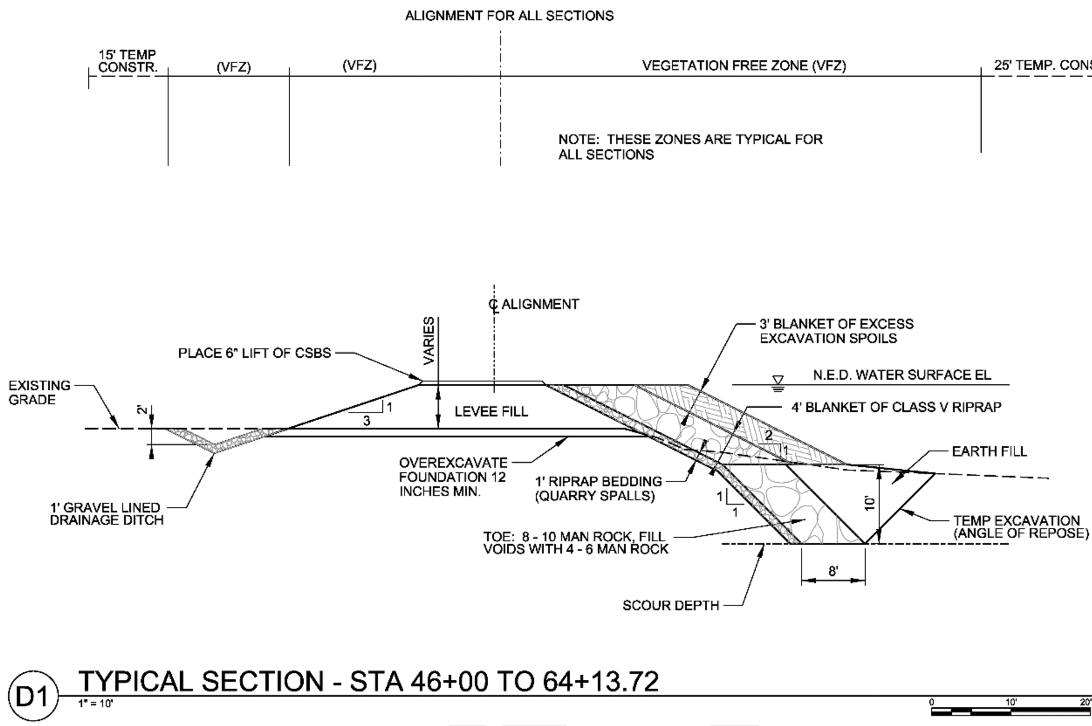

Figure 4-3 Proposed typical feasibility level design cross-sections for a majority of the setback. Station locations correspond to those identified in Figure 3-5.

4.5.1.1 Component 1 - Setback Levee

Clearing and grubbing, excavation, material placement (rock and embankment), grading, and compaction would be necessary to build the setback levee. The Jones Levee setback would tie into the Calistoga Levee at the Calistoga Bridge. Part of the levee would remain at the bridge, and the Corps would armor an existing access road to protect the Calistoga Bridge right abutment and its piers from erosion. Modifications to a gate-operated culvert under the Calistoga Bridge may be necessary, so it closes during flood events. The Corps would assess in D&I what river conditions (e.g. flow rate, flood height) would cause gate closures.

The setback levee would have side slopes between 2 horizontal to 1 vertical (2H:1V) and 3H:1V (Figure 4-1 and 4-2) with a 15-foot-wide gravel surface for vehicle access. The levee slope would be armored with Class V riprap and the toe constructed using 8- to 10-man rock installed down to the scour depth at the levee toe. The voids between the 8- to 10-man rock would be filled with 4- to 6-man rock. Slope armoring is Class V riprap which is on average approximately 21 inches in diameter, while the 8- to 10-man toe rock is approximately 70 inches in diameter. Note, the NED plan would not use 4- to 10-man rock but would instead rely on Class V armor to construct the toe. Excess substrate from excavation and salvaged from the obsolete levee would be placed on the armored slope of the setback levee to reduce offsite disposal costs. This material would be hydroseeded. Access is necessary for inspections, maintenance, and repairs. At the downstream end near Calistoga Bridge, existing roads provide access to the levee. At least one new road through agricultural land would be necessary to connect the setback levee to existing roads. During construction, the Corps would access the project by existing roads and the proposed levee footprint. The final alignment of the upstream access roads would be determined in D&I.

Both sides of the setback levee would have VFZs where only grass would be allowed to grow. These VFZs comply with the Corps' levee vegetation maintenance standards (see Engineering Pamphlet [EP] 1110-2-18). EP 1110-2-18 outlines the minimum guidelines that allow vegetation on levees without compromising the reliability of levees and other flood control structures. Upon completion, the NFS is responsible for the operation and maintenance (O&M) of the levee.

Table 4-1 lists the estimated lengths and acreage of the setback component of the project. Table 4-2 shows the estimated area of overlap of the setback component with different habitat types. These tables are based on the feasibility level design and represent the estimated footprint directly affected by the setback component.

Table 4-1. Project lengths and areas for the setback component of the Jones Levee Project TSP.

Feature	Length (linear feet)	Area (acres)
Setback	6,414	14.2
Armored spur	114	0.18
Access Roads	532	0.16[1]
[1]Based on a road width of 12 feet.		

Table 4-2. Setback component overlap with different habitat types under the Jones Levee Project TSP.

Feature	Setback (acres)	Armored Spur (acres)	Access Roads (acres)
Puyallup River	0	0	0
Freshwater Emergent Wetland[1]	1.87	0	0
Freshwater Forested/Shrub Wetland[1]	7	0	0
Freshwater Pond[1]	0.04	0	0
Upland Forest	1.95	0	0
Developed/Agricultural	3.33	0.18	0.15
[1]Based on National Wetland Inventory Data (USFWS 2020). A wetland delineation will be completed in D&I.			

4.5.1.2 Component 2 – Breaching the Existing Levee

The Corps would breach portions of the existing Jones Levee to reconnect the historical floodplain. Breaching the levee would consist of removing the structure to below the waterline, which would reconnect an estimated 40 to 50 acres of floodplain to the Puyallup River. Final breach locations and depths have yet to be determined, pending further hydraulic and hydrologic analysis. The Corps would reuse the reclaimed vegetation, embankment material, and riprap from the breach locations in the setback levee.

Outside of the breach locations, the Corps would remove armor and embankment material above the waterline for reuse in the setback levee. In addition, the Corps would avoid areas with riparian vegetation (e.g., trees and shrubs) to the greatest extent possible while retrieving materials to preserve shoreline vegetation.

The Corps would abandon the isolated parts of the old Jones Levee between breaches after construction is completed. Therefore, damage to these sections would not constitute damage to the flood control structure, and further repairs would not occur. However, part of the old Jones Levee that extends inland, known as the Matlock Cutoff, would become a separate flood control structure and remain part of the levee system protecting the city of Orting. The purpose of the Matlock Cutoff is to prevent the river from meandering landward, getting behind the Jones Levee setback, and causing sheet flows across the landscape into Orting. Therefore, future damages to the Matlock Cutoff would require repair work as it is integral to the levee system.

Table 4-3 lists the estimated lengths and acreage of this component of the project. Table 4-4 shows the estimated area of overlap of the breach component with different habitat types. These tables are based on the feasibility level design and represent the estimated footprint directly affected by the breach component.

Table 4-3. Project lengths and areas for the breach component of the Jones Levee Project TSP.

Feature	Length (linear feet)	Area (acres)
Breach	2,845[1]	5.26
Reclaimed Area[2]	2,839	Varies[3]

[1]Length of the levee to be removed and the length of in-water work in the Puyallup River.

[2]Comprises the area of the levee not breached. Does not include the Matlock Cutoff portion that would remain.

[3]Would vary due to avoidance of existing riparian vegetation.

Table 4-4. Breach component overlap with different habitat types of the Jones Levee Project TSP.

Feature	Breach	Reclaimed Area
Freshwater Forested/Shrub Wetlands[1]	0.76	N/A
Upland Forest	2.18	0[2]
Puyallup River/Freshwater Ponds	2.32 or 5.26[3]	0[4]

[1]Based on National Wetland Inventory Data (USFWS 2020). A wetland delineation would be completed in D&I.

[2]Would vary due to avoidance of existing riparian vegetation.

[3]Assuming entire breach footprint becomes inundated with waters from the Puyallup River since material would be removed below the waterline.

[4]No in-water work to reclaim material at non-breach locations.

4.5.1.3 Component 3 – Engineered Log Jams

The Corps would build multiple ELJs between the river and the setback levee. The purpose of the ELJs is to prevent the main river channel from immediately changing course to flow entirely into the setback area, which is generally lower terrain, at several key areas. ELJs will ensure the needed river alignment at the Calistoga Ave Bridge crossing, and moderate geomorphic change as the river evolves under natural processes. The ELJ's are not a long-term measure that needs maintenance beyond 20-30 years of typical service life. The levee is designed for the river to occupy the entire active width between levees. While not their primary purpose, the ELJs would also provide scour pool habitat and cover for salmonids.

The largest ELJs would be approximately 40 feet long by 80 feet wide, consisting of horizontal and vertical logs interspersed with root wads, slash, and willow stakes. Pilings for these structures would be 30 to 40-foot-long wood pilings with a bottom diameter of 27 inches, embedded at least 25 feet below the surface. The Corps would install all pilings using a vibratory hammer. The feasibility level design includes four large ELJs (Figure 3-5).

The Corps would place smaller ELJs of piled LWM along the setback levee and within the setback area in rows to roughen the bank. These smaller ELJs would not require pile driving. The feasibility level design includes three lines of smaller ELJs (Figure 3-5).

Materials for the ELJs would come from what is salvaged during clearing and grubbing activities. In addition, the Corps would assess other sources for LWM during D&I. One potential source of LWM is from Mud Mountain Dam, which collects quantities of LWM that are too large to pass through the dam. These logs would be large and may include intact root wads.

The Corps expects in-water work or work within regulated waters of the U.S. would be necessary to install the ELJs. The Corps estimates that installing the wood pilings for ELJ construction would take 12 working days. Fully breaching the levee would not be completed before the ELJs are built. The Corps would finalize the placement and design of the ELJs in D&I after further hydraulic and hydrologic analysis. Table 4-5 shows the footprint of these structures under the feasibility level design.

Table 4-5. Number and affected footprint for the ELJ component of the Jones Levee Project TSP.

Feature	ELJ Footprint
Large ELJs	0.29 acres[1]
Small ELJs	1,054 linear feet

[1]Assuming a footprint of 40 x 80 feet.

4.5.1.4 Other Construction Details

Earthwork is necessary to build the TSP. The Corps expects excavators, dump trucks, bulldozers, loaders, scrapers, graders, and compaction equipment (rollers) would be necessary. Earthwork includes the following components:

- clearing and grubbing work areas

- excavating and removing existing riprap and embankment material from the existing levee (i.e., breach locations and sections to be abandoned)
- excavating and placing material for the setback alignment
- compacting and grading the new setback alignment

The Corps has identified potential staging areas in a parking lot next to the Calistoga Bridge and in agricultural fields near the Matlock Cutoff.

The Corps anticipates the need for at least three culverts in the new setback levee to preserve stormwater connection from the city of Orting (see Figure 3-5). The Corps would assess the additional design and placement of stormwater culverts in D&I.

The Corps would restore construction areas to their previous condition. These include staging areas, the temporary construction areas next to the setback footprint, gaps and areas next to the breach locations, and areas disturbed during the construction of the ELJs. All exposed soils would be planted with native vegetation to restore the project's footprint to its previous condition and reduce soil erosion. Native vegetation may include a native hydroseed mixture, shrubs, and trees, including various willow species.

Except for invasive vegetation, organic matter generated during clearing and grubbing (e.g. soil and native vegetation including woody debris and LWM not used in ELJs) would largely be left on-site for reuse. The Corps would remove invasive vegetation offsite for composting. Woody debris and slash may be used in building the ELJs or placed within the wetland and along the old levee as habitat.

4.6 Description of Alternative 4 – Levee Setback and Partial Removal (NED)

Alternative 4 is the National Economic Development (NED) Plan and consists of the same three major components as the LPP/TSP (Alternative 3). Construction of a setback levee for this alternative is almost identical to Alternative 3 in alignment, elevation profile, and slope armoring. The difference from Alternative 3 is the design of the buried toe. Toe rock for the NED alternative uses Class V riprap, the same rock size used for slope armoring, and is designed to launch in the event of scouring. Class V rock is roughly equivalent to 2- to 3-man rock.

4.7 Resources Analyzed

The environmental analysis conducted in the NEPA process should provide the decision-maker with relevant and timely information about the environmental effects of the decision and reasonable alternatives to mitigate those impacts. Table 4-6 identifies the resources evaluated for detailed analysis and their effect on the resource in general terms. The following sections summarize existing conditions and the effects of the final array of alternatives on the resource.

Table 4-6 Summary Comparison of Environmental Effects of Alternatives, by resource

Resource	Alternative 1 – No Action Alternative	Alternative 2 – Raise-In-Place Alternative	Alternative 3 – Levee Setback and Partial Removal (LPP/TSP)	Alternative 4 – Levee Setback and Partial Removal (NED)
Hydraulics and Hydrology	Conditions are expected to change due to climate alterations, increased runoff, and sediment loads.	This alternative would increase flood carrying capacity, water surface elevation, and water velocity.	This alternative would decrease water surface elevations below that of Alternative 2, lower in-channel velocities and depth, improve hydrograph attenuation, and lower water surface elevations. Overall, there would be improvements by adding width to the river channel.	Similar to that under Alternative 3.
Geomorphology and Sediment Transport	This alternative maintains a single thread channel with continued channel aggradation.	This alternative has little or no improvement over Alternative 1. There would be continued sediment aggradation with high long-term residual risk. Perched channel conditions increase the likelihood of poor levee performance.	This alternative would widen the floodplain and provide for increased in-channel storage of sediments. It would also reduce the predicted riverbed elevations from sediment aggradation when compared to the other alternatives. This alternative also has the lowest long-term residual risk.	Similar to that under Alternative 3.
Water Quality	Overall, water quality under this alternative would remain similar to existing conditions.	Short-term negative effects to water quality would result from in-water construction	Similar effects to Alternative 2 for construction. After construction, there would be long-term	Similar to that under Alternative 3.

	As the area becomes developed, water quality would likely decline.	activities; removal of riparian vegetation and continued isolation of wetlands would contribute to degraded water quality.	benefits to water quality from reconnecting the Puyallup River floodplain to isolated riparian forest and wetlands.	
Noise and Air Quality	Future population growth is expected to increase noise and emission levels from existing sources.	Construction would cause localized, short-term increases in noise and emissions. After construction, there would be no long-term changes to noise or air quality.	Impacts under this alternative would be similar to Alternative 2.	Similar to that under Alternative 3.
Climate Change and Sea Level Change	Climate change is expected to increase the frequency of extreme rainfall events, peak river flows, and sediment loads. This alternative continues the trend of decreasing channel capacity due to aggradation.	Future climate change summarized for Alternative 1 also applies to the levee setback alternative. This alternative would increase channel capacity by raising the levee. Doing so would improve the levee's ability to contain increased peak flows from climate change.	This alternative is similar to Alternative 2 but increases channel capacity by setting the levee back. This alternative provides for greater resilience to the projected increased sediment loading from climate change.	Similar to that under Alternative 3.
Hazardous, Toxic, and Radiological Wastes (HTRW)	No HTRW or petroleum contamination concerns were identified in the project area.	There is no indication of prior commercial or industrial activities, or signs of HTRW or petroleum	There is no indication of prior commercial or industrial activities, or signs of HTRW or petroleum contamination in the project area.	Similar to that under Alternative 3.

		contamination in the project area.		
Soil Resources	Minor, localized change in soils may occur as repairs and maintenance are completed. Large-scale changes to soils are unlikely to occur.	Jones Levee would be deconstructed and rebuilt to a higher elevation. This would alter the soils within the footprint of the project. There would be no large-scale changes to soils.	Soil disturbance would occur over a larger area under the TSP than in Alternative 2. While total levee deconstruction would not occur under this alternative, soils would be removed down below the waterline at the breach locations. There would be no large-scale changes to soils.	Similar to that under Alternative 3.
Vegetation	The levee would remain in-place and continue to isolate significant portions of riparian and wetland vegetation from the floodplain. Routine maintenance and repairs would continue to degrade riparian conditions.	Long-term impacts under this alternative would be similar to Alternative 1. This alternative would also clear all vegetation from the levee during construction. Offsite mitigation would be required.	Overall, this alternative would improve vegetation function and value by removing barriers and restoring floodplain connectivity to 40 to 50 acres of riparian forest, shrub-land, and wetlands. Doing so would improve natural processes that maintain a healthy and diverse vegetation community. Levee maintenance would continue to disturb vegetation, but further inland from the river.	Similar to that under Alternative 3.
Wetlands	Wetlands landward of the Jones Levee would be	This alternative would widen the levee into wetlands	This alternative would set back the levee and reconnect	Similar to that under

	undisturbed but would remain isolated from the floodplain. This would limit wetland function and value.	and maintain their isolation from the floodplain. This would limit wetland function and value. Offsite mitigation would be necessary to mitigate for wetland impacts.	40 to 50 acres back to the floodplain. The new levee alignment would negatively affect about 8.87 acres of wetland. Wetland impacts would be offset by the functional lift provided by the setback.	Alternative 3.
Threatened and Endangered Species	Under this alternative, the Jones Levee would continue to isolate the Puyallup River from part of its floodplain, perpetuating the negative effects of an altered riverine system. Future repairs and continued vegetation maintenance would continue to affect ESA-listed species and their critical habitat.	Over the long-term, this alternative would be similar to Alternative 1. Construction related impacts could affect ESA-listed species and would negatively affect critical habitat. Off-site mitigation would be necessary to offset impacts to ESA-listed species and critical habitat.	This alternative would have short-term construction related impacts similar to those under Alternative 2. Long-term beneficial impacts would accrue after the levee is set back, restoring floodplain connectivity and natural riverine functions important for ESA-listed species and their critical habitat. The project would reconnect 40 to 50 acres back to the Puyallup River, increasing the available habitat for ESA-listed species. This alternative would be self-mitigating.	Similar to that under Alternative 3.
Fish and Wildlife	Similar to the impacts listed under Threatened and Endangered Species.	Similar to the impacts listed under Threatened and Endangered Species.	Similar to the impacts listed under Threatened and Endangered Species with additional	Similar to that under Alternative 3.

			benefits to terrestrial wildlife such as elk, from improving floodplain access.	
Cultural Resources	Any historic properties and cultural resources would remain undisturbed in the project area.	This alternative would include ground-disturbing activities that could affect historic properties if any are present in the construction footprint. Based on the literature search and consultation, the Corps determined that this alternative would have no effect to known historic properties.	Impacts under this alternative would be similar to Alternative 2.	Similar to that under Alternative 3.
Aesthetics and Recreation	Current aesthetics and recreational uses would remain unchanged.	This alternative would disrupt aesthetics and recreational uses at the project site during construction. After construction, the raised levee would be available for similar uses. However, clearing the vegetation would negatively affect aesthetics and some recreational uses.	Construction related impacts under this alternative would be similar to those under Alternative 2. After construction, recreational use would resume but along the new levee. There would still be river access at the Calistoga Bridge and at the Matlock Cutoff. Aesthetics and recreation would improve from reconnecting the river to its historical flood plain, returning it to a more natural condition.	Similar to that under Alternative 3.

Transportation, Public Services, and Utilities	Population growth would increase the need for transportation, public services, and utilities. These resources would experience more frequent flooding under future conditions.	This alternative would cause temporary traffic impacts associated with hauling of levee material. This alternative would increase flood risk reduction, reducing the risk of flood damage to these resources.	This alternative would provide better flood risk reduction than Alternative 2. Otherwise, impacts under this alternative would be similar to Alternative 2.	Similar to that under Alternative 3.
Public Health and Safety	This alternative would increase the risk to public health and safety over time.	This alternative provides a reduced risk to public health and safety from the existing condition due to an increase in the overall level of protection provided by the project	This alternative provides the greatest reduced risk to public health and safety due to an increase in the overall level of protection provided by the levee and reduced impacts of sediment aggradation.	Similar to that under Alternative 3.
Socio-Economics	The region would continue to develop and grow.	This alternative would increase the overall level of protection provided by the project, reducing flood risk that would negatively affect the region's socio-economics.	Similar to Alternative 2 but with greater flood risk reduction.	Similar to that under Alternative 3.
Land Use, Planning, and Zoning	No change to existing land use, planning, and zoning within the study area.	Temporary construction related impacts. May increase development if flood risk management lowers flood insurance costs.	Similar to Alternative 2, but the setback requires the acquisition of lands, which would prohibit those lands from future development.	Similar to that under Alternative 3.

4.8 Hydraulics and Hydrology

The Puyallup River Basin lies in Water Resource Inventory Area 10 in western Washington's Puget Sound lowland and the Cascade Range. The basin extends approximately 972 square miles from the headwaters to the mouth of the Puyallup River at Commencement Bay. Major tributaries to the Puyallup River include the White and Carbon Rivers.

Elevations within the basin range from 14,411 feet at the summit of Mt. Rainier down to as much as 11 feet below mean sea level at extreme low tide. Since it is only 43 miles from the summit of Mt. Rainier to the river’s mouth, the slopes of the rivers draining the basin are, in general, quite steep. The rivers typically exhibit a classic concave profile with steep slopes in their upper reaches and gentler slopes in the lower reaches. In addition, since much of the basin consists of two eroded plateaus, the average slope of the land surface is also quite steep except for the river’s floodplain.

Today, conditions in the Puyallup River basin result from human efforts to control and use water resources through the construction of flood control works, such as dams, levees, bank armoring, and sediment removal. Local entities built these structures intending to keep the river a predictable, static system. Non-federal levees on the Puyallup River were constructed primarily between the 1930s and the 1960s by local entities.

The upper watershed of the Puyallup River Basin is virtually undeveloped, consisting of Mount Rainier National Park and surrounding federal forest lands. In contrast, the lower basin at the city of Orting and downstream is highly developed and engineered. One dam, the Electron Hydroelectric Project, exists in the upper high gradient reach of the basin. This dam, owned by Electron Hydro LLC, operates as a hydropower dam on the Puyallup River with a diversion flume. It is a run-of-river dam, meaning that it has virtually no storage capacity.

The Upper Puyallup River Basin climate is predominantly wet and temperate (Western Regional Climate Center; WRCC, 2011). Approximately 75% of the annual precipitation occurs between October and March. Consequently, floods tend to occur between November and February. Large floods are typically the result of atmospheric rivers, also known as Pineapple Express, which transfer moist tropical air to the higher west coast latitudes. Atmospheric rivers produce seasonal heavy rainfall events in western Washington during the winter months. Flood runoff develops quickly throughout the basin, with initial river response to rainfall occurring on an hourly time scale. The average flood duration is typically one to two days, with hydrographs for major floods extending high flows for three to five days. Like many other Western Washington basins, the greater Puyallup River basin typically does not experience large floods from seasonal snowmelt runoff. Section 4.11 discusses Climate Change.

The Jones Levee is located between two adjacent levees on the right bank that have been improved significantly since the original levee system was built in the 1950s. These are the Calistoga and Ford levees. Both provide performance greater than a 0.2% AEP event. The Jones Levee is estimated to provide 1.4% AEP performance for this study, significantly less. All three levees protect the same central area of the city of Orting. Old Soldiers Home Levee on the left bank of the Puyallup River across from the Jones Levee is modified. The Old Soldiers Home Levee setback is estimated to provide 0.2% AEP performance. Improvement of the Jones Levee would seem reasonable given the large surrounding levees.

4.8.1 Alternative 1 – No Action Alternative

The upper watershed is primarily National Park, wilderness, or forest service lands. No significant changes to land use that would alter flood hydrology are expected in these areas. Logging on Forest Service lands could increase or decrease depending upon federal policy, but neither course is expected to have significant impacts on flood hydrology.

Because of sedimentation, floodplains are forecast to experience greater impacts from flooding under future conditions, increasing the risk to life safety, existing structures, critical infrastructure, and development expected to occupy the floodplain in the future. Traffic delays, school closures, railroad losses, decreased public service, and commercial and industrial business closures are also forecast to occur for events more frequent than roughly the 10% AEP flood event.

Future actions by the NFS, such as levee modifications, may result in flooding and sediment deposition changes within the basin. Areas not modified would continue to see similar or more frequent damages as depositional areas of the river system aggrade (the riverbed rises), and the levees remain static. No significant negative effects to hydraulics and hydrology are expected under the No Action Alternative.

4.8.2 Alternative 2 - Raise-In-Place Alternative

Raising the levee in place would increase the flood carrying capacity within the reach of the river adjacent to the Jones Levee through the end of the project life. Alternative 2 would improve flood risk for the city of Orting through the study period (50 years). Raising the levee would contain more floodwaters within the channel, increasing water surface elevations over the no action alternative and increasing river velocities. No significant negative effects to hydraulics and hydrology are expected under the Raise-In-Place Alternative.

4.8.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Construction of a setback levee would generally decrease water surface elevations, below what they would be if the levee were raised-in-place at events where flows access the setback area. Lower in-channel velocities and depths, more flood hydrograph attenuation, and lower water surface elevations would result from a levee setback. The expansion of the flow cross-section at a setback would also reduce flood elevations and redistribute flows within the river channel. An offset effect discussed in the next section is that a levee setback may cause greater sediment deposition than raising the levee. However, the elevation profile of a setback levee would generally be lower than the existing levee for equivalent flows. Overall, the hydraulic benefits derived by adding width to the river channel for a levee setback are greatest with this alternative. Scour protection for this alternative uses large 8- to 10-man rock installed down to the scour depth at the levee toe, which differs in size from the Class V riprap used on the levee slope. The voids between the 8- to 10-man rock would be filled with 4- to 6-man rock. Slope armoring is Class V riprap which is on average approximately 21 inches in diameter, while the 8- to 10-man toe rock is approximately 70 inches in diameter. No significant negative effects to hydraulics and hydrology are expected under the LPP/TSP.

4.8.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Construction of a setback levee for this alternative is almost identical to the LPP/TSP (Alternative 3) in alignment, elevation profile, and slope armoring. The difference from the LPP/TSP is the design of the buried toe. Toe rock for the NED alternative uses Class V riprap, the same rock size used for slope armoring, and is designed to launch in the event of scouring. There is no significant change to channel width or water surface elevations in the river channel from the LPP/TSP. No significant negative effects to hydraulics and hydrology are expected under the NED.

4.9 Geomorphology and Sediment Transport

The major rivers in the Puyallup Basin originate from glaciers on the slopes of Mount Rainier. Sediment is transported from Mount Rainier to the Puget Sound lowland through a sequence of glacial and river processes working simultaneously to deliver material downstream. Sediment sources include melting glaciers and slope failures along upper portions of the river system. Sediment loads range from fine suspended sediments to coarse gravels and boulders.

Historically, the Puyallup River basin included a mosaic of native habitats created by the influence of the Puyallup River on its floodplain. High flows scoured the river channel and altered its course through mud flow deposits within the Orting Valley. This natural process created bank erosion, shifting river channels and side-channels across the floodplain, aggradation, and scour of the riverbed. In the 1900s, the area experienced extensive population growth and development, including the creation and extension of a revetment and levee system that significantly altered the natural landscape (Kerwin, 1999). Since then, the Upper Puyallup River has largely been a single-thread channel until 1990-present, when several levees were setback, and the river channel once again become braided over setback areas. The braided river and wider floodplain resulting from the setbacks has created greater in-channel sediment storage than existed in the original channelized levee system.

<u>Geomorphology</u>

As the basin topography transitions from the Cascade Mountains to the Puget Sound lowlands, a change in riverbed slope occurs, depositing sediment at areas of greatest slope reduction. The steepest upstream river reaches are characterized by canyons, which serve as sediment transport zones. Downstream of the canyons, steep slope headwaters of each of the major tributaries transition to flatter lowlands. In the study area, coarse sediment larger than gravel is typically deposited in the Puyallup River, upstream of the Carbon River confluence. In the lower Puyallup River, below the confluence with the White River, the low slope of the river is conducive to the deposition of finer sediment. Once the slope of each river segment decreases, the river’s sediment transport capacity is reduced, resulting in deposition in the flatter lowland reaches.

The study area is divided into distinct geomorphic reaches based upon river slope and channel configuration.

The highest reaches of the upper Puyallup River within the study area are located in steep canyons upstream of heavily developed areas, with bed slopes ranging from 1% to 0.6%. The river through this reach is braided, consisting of several channels with a high-energy flow. Bed material consists of sands, gravels, cobbles, and boulders. Channel banks along some upper reaches experience significant erosion of sediments into the river.

In the city of Orting area, the valley floor widens, and the channel, although confined between levees, becomes more complex with gravel bars and LWM accumulation. Riverbed slopes become 0.5% to 0.3%. The active channel has tended to braid where it is able to adjust within levee setbacks such as at the Soldiers Home, Calistoga, and Ford levees. LWM, which consists of logs and branches, tends to concentrate at the upstream ends of gravel bars and at the entrances to side channels. These areas are characterized by significant deposition of gravel and large cobble material, and shifting gravel bars. Before the Puyallup River system was developed and actively channelized, the city of Orting area was a heavily braided river reach with a massive alluvial fan. This is apparent in recent terrain datasets, which show remnant channels between valley walls where the Puyallup and Carbon Rivers merged.

Downstream from the city of Orting, the riverbed slope transitions to 0.2% - 0.1% through the Middle Puyallup reach, where the bed is composed primarily of sand and gravel. Finally, the lower Puyallup River below the confluence with the White River is a relatively low gradient with a bed slope of 0.06% - 0.01%. This reach is essentially a straightened canal, with large historical meanders and braids visible in the terrain outside the boundaries of the current levees. Long before development, this reach was a very large alluvial fan that spread between valley walls. The present river is roughly 200 feet wide between the confluence with the White River and Commencement Bay. The channel bed is composed of sand, silt, and fine gravel.

The degree of cumulative geomorphic change is highly dependent on the magnitude and frequency of flood events that occur during the design period of analysis. Higher peak flows and more frequent high flows from climate change would be expected to increase sediment loads as more material is introduced into the river system from glacial origins.

Sedimentation

The supply of sediment from Mount Rainier and surrounding areas to the Puyallup basin is highly variable, with much of the bedload coming from sporadic rock falls at the glacial origins of its rivers. Transport of glacial sediment material into the river system is highly dependent upon the occurrence of extreme rainfall events – described earlier as atmospheric rivers (USGS, 2010). The approximate time it takes sediment to travel from its glacial origins to the basin study area can be from decades to centuries (USGS, 2010). A significant amount of sediment is also produced from within the National Park boundaries. Estimation of historical annual total sediment loads is on the scale of several hundred-thousand tons-per-year (USGS, 2012). In a typical river system with high sediment loads, deposition of material on the channel bed occurs when the available supply of sediment exceeds the transport capacity of a given section of the river. This process typically continues if there are no bedforms, adjustment of channel width, or influence of riparian vegetation, until some dynamic equilibrium state is reached. Dynamic equilibrium occurs where the river has adjusted its bed slope, channel bed configuration, and width to transport sediment through a given reach without net erosion or deposition (Leopold, 1964).

Following the last ice age, the study area consisted of braided channels and massive gravel bars that were periodically buried by catastrophic mudflow events. Returning the system to a quasi-equilibrium state, if such a state ever existed, is likely not possible given the present level of floodplain development. The result of confining rivers in this system has been a need to dredge or to raise levees higher in the most active depositional areas. Reaches where sediment has historically deposited within the channel and caused bed aggradation will continue to aggrade as the river system transports large quantities of sediment to leveed reaches.

Sediment deposition, and the associated reduction in channel capacity, is a primary driver of recent changes to flood risk in many reaches of the study area. Until the 1990s, sediment within the system had been actively managed and removed by local entities. Monitoring of bed aggradation would trigger the mechanical removal of much of the riverbed sediment on all three rivers in the Puyallup River basin. From the 1970s to the 1990s, concerns regarding salmon habitat led to agreements between tribal interests and Pierce County to reduce the overall amount of disturbance along the river, including vegetation and sediment removal. In 1998, the State of Washington approved an administrative law that prohibited dredging to lower the average channel cross-section. This effectively eliminated the practice altogether. Currently, much of the study area is experiencing long-term channel aggradation resulting in a reduction of channel capacity.

In 2010, the USGS completed an analysis of topographic and bathymetric survey data for the major tributaries in the Puyallup system along with a sediment analysis and geomorphic interpretation (USGS, 2010). This report compared surveyed river cross-sections from 1984 with information from equivalent locations in 2009. Analysis shows decreasing channel capacity at a number of locations within the Basin (Figure 4-3), with a loss of channel depth of several feet in some areas. This is most common on the Upper Puyallup, Carbon, and White Rivers. The USGS report concludes that the reduction in channel capacity is correlated to sediment transport patterns indicated by computer modeling (USGS, 2012). The reduction of channel capacity has had an adverse impact on stage-discharge relationships, resulting in an increase in river stages for a given discharge.

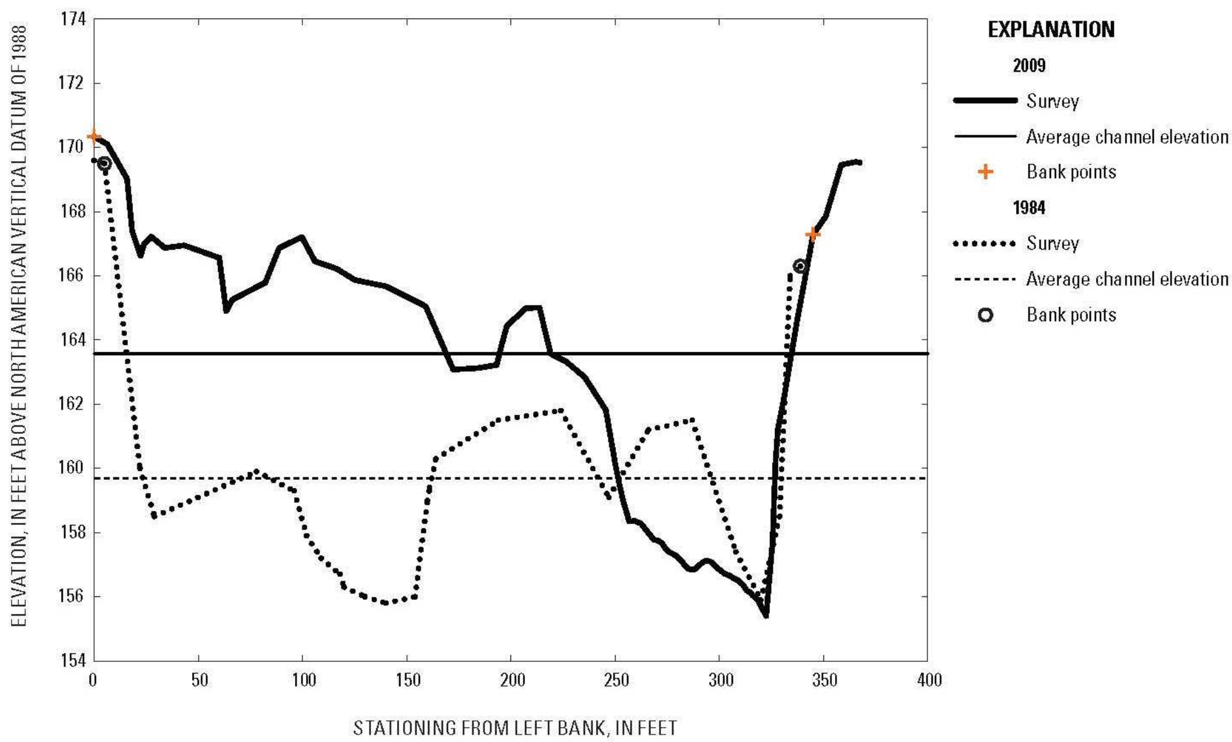

Figure 4-4 Comparison of Average Channel Elevations at Cross-Section P120 (RM 20), Upper Puyallup River (USGS, 2010)

Once sediment arrives and deposits in developed areas of the Puyallup riverine system, there are limited methods for managing it to reduce flood risk. Sediment management is further complicated by the risk of more intense precipitation in western Washington resulting from climate change. In the future, larger more frequent floods may lead to increased sediment production and delivery from Mount Rainier. As mentioned below in Section 4.11, climate change predictions are not quantitatively included in feasibility level designs.

Due to climate change trends, runoff from the upper watershed may increase. An increase in runoff in the upper basin would transport more sediment from Mount Rainier and the upper basin to leveed areas of the lower basin. This increase in sediment load would likely accelerate deposition throughout the lower basin, including areas not leveed. Projected changes to watershed hydrology and an assessment of vulnerability of the region to climate change are discussed in the Climate Change and Sea Level Change section. The historical geomorphic trend for most of the study area is one of channel aggradation. This trend would continue for all alternatives regardless of the project or action by others.

Future conditions were estimated with sediment modeling developed from historic channel data, measured sediment loads, and measured bed material gradations. Data was incorporated into a sediment model that was used to predict future conditions for the project.

4.9.1 Alternative 1 – No Action Alternative

Under this alternative, few planform changes (i.e., changes in the form of the river channel from an aerial perspective) are expected along each of the river reaches in the study area because the rivers are confined between levees. Future conditions within the project study area would likely continue to be characterized by abundant sediment supply. Areas not changed by state, federal, tribal, or local entities would remain confined as a single thread channel between levees. Sediment deposition is expected to continue into the future at rates observed over repeated cross section surveys between 2009 and 2019, along the existing Jones Levee, of roughly 1 foot per 10 years. This may continue for some time because channel geometry and bed character that could transport the incoming sediment, may be several feet above the existing levee system (USGS, 2012). An average deposition of roughly 2 feet, over existing conditions, was estimated in sediment modeling. Erosion or deposition can vary widely in a given river reach, and averages should not be construed as uniform bed change. Generally, greater deposition was predicted over the widest cross sections. As the riverbed aggrades, the risks associated with the channel bed becoming higher in elevation than the landward side of the levees increases (i.e. a perched channel). Sediment modeling for the future-without project condition has estimated the channel bed becoming perched an average of 3-5 feet over 50 years above the landward side of the Jones Levee. That is roughly 0.6-1 foot of bed deposition per 10 years, on average, and fits with observations from 2009 to 2019 collected for this study. This alternative maintains the status quo, with a single thread channel over much of the leveed reach and no improvement in the geomorphic sense. Continued aggradation could have significant negative effects to areas landward of the Jones Levee under the No Action Alternative.

4.9.2 Alternative 2 - Raise-In-Place Alternative

This alternative is in many ways similar to the No Action Alternative with regard to geomorphology and sedimentation, the difference being higher containment of flows. Raising the Jones Levee would limit changes to sedimentation patterns over the project life, from the No Action Alternative. Predictions from sediment modeling include a 6-10% increase in deposition volume on the Upper Puyallup reach adjacent to the Jones Levee. The consequence of continuing to raise levees along the Upper Puyallup is that the river channel can become perched higher and higher above the surrounding floodplain. Perched channel conditions increase the likelihood of poor levee performance resulting in elevated flood risk. This alternative may have the highest long-term residual risk, with little or no improvement in the geomorphic sense. Continued aggradation could have significant negative effects to areas landward of the Jones Levee under the Raise-In-Place Alternative.

4.9.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

This alternative follows the recent trend on the Upper Puyallup River of setting back levees and is expected to perform similarly to setbacks of the Calistoga and Ford levees. Unconfined areas of the river on the Upper Puyallup tend to occupy roughly a 1,000-foot top width through the canyon. Although the bed slope is greater there, it is an example of what the river would do. This setback would provide roughly that width through the upstream end of the setback. The river would likely become increasingly braided and increase in-channel storage of sediment. This would help the downstream reach by lessening deposition there. An average deposition of roughly 4 feet, over existing conditions, was estimated in sediment modeling. This is roughly double what was estimated for the future no action condition. With this deposition, the water surface elevation profile is increased by an average of less than 1 foot above the FWOP condition for a 1% event. Erosion or deposition can vary widely in a given river reach, and averages should not be construed as uniform bed change. Generally, greater deposition was predicted over the widest cross sections. As the riverbed aggrades, the risks associated with the channel bed becoming higher in elevation than the landward side of the levees increases (i.e. a perched channel). Sediment modeling for the FWOP condition has estimated the channel bed becoming perched an average of 2-4 feet over 50 years. A significant difference between the No Action and the LPP/TSP is that this is isolated to the downstream ~1,000 feet of the Jones setback levee for the LPP/TSP. This is due to most of the setback alignment being placed on high ground. The Old Soldiers Home levee is subject to similar conditions as the No Action condition, however more in-channel storage is provided by the setback and predicted bed elevations are reduced. The lowest long-term residual risk may be for this alternative. The greatest geomorphic change, which is beneficial from several perspectives, results from this alternative also. No significant negative effects to geomorphology and sediment transport are expected under the LPP/TSP.

4.9.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Construction of a setback levee for this alternative is almost identical to the LPP/TSP (Alternative 3) in alignment, elevation profile, and slope armoring. The difference from the LPP/TSP is the design of the buried toe. Toe rock for the NED alternative uses Class V riprap, the same rock used for slope armoring, and is designed to launch in the event of scour. The launching rock has a waste factor of 15%, recommended in EM 1110-2-1601, added to the toe rock volume to account for waste that occurs when the rock launches to fill toe scour along the levee. Contribution of sediment to the river, from this waste, is considered negligible when compared to background sediment loads. There is no significant change to channel width or water surface elevations in the river channel from what is designed for the LPP/TSP. No significant negative effects to sedimentation or geomorphology of the river are expected under the NED.

4.10 Water Quality

Ecology lists water quality in the Puyallup River next to the Jones Levee as Category 1 for pH and bacteria (Ecology 2020a). A Category 1 water meets tested standards for clean waters but does not mean that a water body is free of all pollutants. Near the city of Sumner, water quality worsens (Category 2) or is impaired (Category 4 and 5) in the Puyallup River and its tributaries as development in the basin becomes more urbanized. Water quality issues include dissolved oxygen, water temperature, bacteria, turbidity, lead, mercury, and copper. Water quality worsens in the Puyallup River estuary.

Table 602 of the Washington Administrative Code (WAC 173-201A-602) lists water body uses for the mainstem Puyallup River within the project area as core summer salmonid habitat; primary contact recreation; water supply uses like domestic, industrial, agricultural, and stock; and miscellaneous uses like wildlife habitat, harvesting, commerce/navigation, boating, and aesthetics (Ecology 2020a).

Waters whose beneficial uses (such as for drinking, recreation, aquatic habitat, and industrial use) that are impaired by pollutants are placed in the polluted water category (category 5) of the water quality assessment. The 303(d) list, so called because the process is described in Section 303(d) of the CWA, lists waters in the polluted water category. For waters on the 303(d) list, Ecology develops a Total Maximum Daily Load (TMDL) plan to reduce pollution sources throughout the surrounding watershed. After pollutant controls are in place, Ecology monitors the watershed to see if the water meets state water quality standards. The Puyallup River adjacent to the city of Orting does not have an approved TMDL or one in development. Downstream of Jones Levee, at the confluence with the Carbon River, the Puyallup River, its estuary, and a number of tributaries have TMDLs, or are in the process of developing them, for bacteria, dissolved oxygen, ammonia-N, dioxin, dissolved inorganic nitrogen, and total organic carbon (Ecology 2020a).

No Hazardous, Toxic, and Radiological Waste (HTRW) or petroleum contamination concerns were identified that would be anticipated to impact water quality. The closest active cleanup sites are 0.4 – 0.7 mile away from the study area and they contain limited groundwater and/or soil contamination, none of which would affect the water quality in the study area. See Figure 2 of Appendix D for the locations of the nearest active cleanup sites.

4.10.1 Alternative 1 – No Action Alternative

Under this alternative, continued development and industrialization would further affect water quality, especially along urban corridors and industrial areas in the lower reaches of the Puyallup River. Changes in stream flows related to climate change may increase pollutant concentrations and temperatures, especially should low summer flow rates result from a lack of snowpack. Existing water quality regulations and the future implications of TMDLs, as well as restoration measures, may work to offset potential water quality impacts throughout the Puyallup River basin. Vegetation maintenance for levee safety would diminish riparian habitat, exacerbating temperature concerns. Leaving Jones Levee in place would maintain the channelization of the river, exacerbating sedimentation concerns. Overall, future water quality is expected to remain stable or slightly decline under this alternative. No significant negative effects to water quality and quantity are expected under the No Action Alternative.

4.10.2 Alternative 2 - Raise-In-Place Alternative

Effects to water quality under this alternative would resemble those under the No Action Alternative; however, there would be temporary construction related impacts and long-term increased negative effects from widening and raising the levee.

To build a stable structure, the Corps would deconstruct the Jones Levee and rebuild it at a higher elevation, which would necessitate widening the structure at its base. In-water work during deconstruction of the Jones Levee would generate turbidity plume. A reduction in dissolved oxygen may be associated with this plume. Any water quality effects should be short-lived (hours at most) and localized (immediate vicinity). Due to the absence or minimal presence of water flow, the turbidity plumes made in the freshwater ponds behind the Jones Levee would persist longer than those in the Puyallup River, but in a much more limited area. Best management practices (BMPs) would be implemented as applicable to minimize construction related turbidity increases, such as water quality monitoring and silt curtains (see Section 5.5.1). Levee deconstruction would also remove all vegetation growing on it and widen its footprint into wetlands.

Bankside vegetation provides shade which has a positive influence on water quality, especially water temperature. Stream temperatures vary significantly between different vegetation types, with clear-cut or grassy slopes providing the least effective thermal buffer to reduce changes in water temperature while tall and wide stands of trees provided the best (Dugdale et al 2018; Cristea and Janisch 2007). Removing the stream bank vegetation would increase water temperatures, which in turn decreases the amount of dissolved oxygen. Vegetation, especially those found in wetlands, capture suspended sediments in waters, improving water clarity and quality. Plant roots and microorganisms in wetlands absorb dissolved nutrients in the river from fertilizers, manure, leaking septic tanks, and municipal sewage. Other pollutants stick to soil particles. In many cases, this filtration process removes much of the water's nutrient and pollutant load by the time it leaves a wetland. Filling in wetlands under this alternative would decrease the ability for natural processes to improve water quality. Overall, future water quality is expected to decline under this alternative. Some of the impacts to water quality would improve over time as vegetation is reestablished along the levee. This alternative is expected to have a less than significant impact to water quality.

4.10.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Setting back the Jones Levee would have short-term impacts to water quality during construction and long-term benefits after completion. Similar to Alternative 2, in-water work would cause a localized turbidity plume. However, the turbidity generated would be much less under this alternative because in-water in work in the Puyallup River is limited to specific locations (e.g., breach locations and riprap removal) and not the levee's entire length. Similar BMPs would be used as under Alternative 2 to address turbidity related impacts (See section 5.5.1).

As with Alternative 2, setting back the levee as described in Section 4.5 would clear shoreline vegetation and fill in wetlands. This would negatively affect these features as described above. However, the amount of shoreline vegetation removed next to the Puyallup River would be restricted to the breach locations, less than the amount removed under Alternative 2. The remaining shoreline vegetation would not be removed. Instead, it would be left to develop and grow naturally along the abandoned levee. Over time, the shoreline would become more vegetated than before, providing more shade and improving the thermal buffer.

The long-term benefits under this alternative comes from reconnecting between 40 to 50 acres of riparian forest and wetlands to the Puyallup River that have been isolated since the construction of the Jones Levee. This would improve natural riverine functions important for aquatic and aquatic-dependent fish and wildlife in the floodplain. It would also reconnect wetlands to the floodplain. During high flow events or floods, this setback area is expected to receive and hold water. Sediments in the water would likely remain in the reconnected floodplain and wetlands would capture and process nutrients, as described above, improving water quality in the Puyallup River.

BMPs would be implemented as applicable to minimize construction related turbidity increases, such as water quality and silt curtains. The Corps plans to seek a Water Quality Certificate (WQC) from Ecology and would comply with applicable water quality conditions and criteria issued in the permit, and the Ecology approved water quality monitoring plan. No significant negative effects to water quality are expected under the LPP/TSP.

4.10.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Water quality impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). The same long-term benefits are derived from reconnecting between 40 to 50 acres of riparian forest and wetlands to the Puyallup River. No significant negative effects to water quality are expected under the LPP/TSP.

4.11 Noise and Air Quality

Land use in the upper Puyallup River and Carbon River sub-basins is mainly rural residential and agriculture, with some commercial and industrial land uses mainly in the cities of Sumner and Orting. This area is generally rural with low-density housing, agriculture, and forestry within unincorporated areas and residential/commercial within incorporated areas. Typical sources of emissions and noise in the area include recreation and agricultural sources, boats, trucks, automobiles, industrial/commercial zones in urban areas, and other internal combustion engines.

The Clean Air Act requires the Environmental Protection Agency (EPA) to set National Ambient Air Quality Standards for pollutants considered harmful to public health and the environment. States are required to develop a plan for any areas that cannot meet these standards, called nonattainment areas, to improve air quality. After a nonattainment area consistently meets air quality standards, it is designated a maintenance area. The project area is within a maintenance area for ozone and carbon monoxide pollution (Ecology 2020b). Ozone is a component of smog that is not emitted into the air but is instead formed when nitrogen oxides (NOx) and volatile organic compounds (VOCs) react with one another in the presences of sunlight. Emissions from industrial facilities, electric utilities, motor vehicle exhaust, gasoline vapors, and chemical solvents are some of the major sources of NOx and VOCs.

No HTRW or petroleum contamination concerns were identified that would be anticipated to impact air quality. The closest active cleanup sites are 0.4 – 0.7 mile away from the study area and contain limited groundwater and/or soil contamination, none of which would affect the air quality in the study area. See Figure 2 of Appendix D for the locations of the nearest active cleanup sites. See section 4.12 for additional details on HTRW.

4.11.1 Alternative 1 – No Action Alternative

Sources of noise and emissions within the project area are expected to increase. As population growth and urban expansion continue, current land uses and their associated noise and emission generators would change. For example, ambient noise and emissions from agricultural practices may reduce as a result of conversion to residential or commercial land uses. However, ambient noise and emissions from these new uses would then increase, including increased traffic, exterior heat exchangers (ventilation, air-conditioning, etc.), and outdoor speaker systems. Future growth may also increase noise and emission levels from existing sources, such as roadways, as road use increases with population growth. No significant negative effects to noise and air quality are expected under the No Action Alternative.

4.11.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, construction activities would generate short-term emission and noise increases. Otherwise, sources of noise and emissions would grow as described above under the No Action Alternative.

Operation of construction vehicles and equipment would increase ambient noise levels in the immediate area during construction activities to raise the levee. The largest construction equipment proposed for use includes bulldozers, excavators, and dump trucks. Vehicles and equipment would only operate during daylight and typical construction hours, approximately 7:00 AM to 7:00 PM, to limit noise impacts on surrounding properties. Ambient noise levels would return to normal after construction is completed, including that generated by normal maintenance and operation of the levee. No new sources of noise would be created under this alternative. Emissions generated by gasoline and diesel exhaust fumes from vehicles and equipment during construction would also be temporary, and not extend past completion of work activities. The proposed project would not increase roadway capacity. Thus, no additional air emissions from this alternative and its construction are expected.

As needed, BMPs would minimize and control vehicle exhaust and dust in construction areas. BMPs consist of requiring proper maintenance of construction equipment, avoiding prolonged idling of vehicles, spraying water to minimize dust, and periodically sweeping paved areas as necessary. No significant negative effects to noise and air quality are expected under this alternative.

4.11.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Air quality impacts of the LPP/TSP would be essentially the same as those under Alternative 2. The LPP/TSP would have localized short-term increases in emissions and noise during construction. Noise and emissions from regular maintenance and operations of the setback are expected to closely match those completed for the existing levee. No significant negative effects to noise and air quality are expected under the LPP/TSP.

4.11.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Noise and air quality impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). No significant negative effects to noise and air quality are expected under the NED.

4.12 Climate Change and Sea Level Change

A qualitative analysis of the potential impacts of climate change to the Jones Levee CAP 205 Flood Risk Reduction Feasibility study was completed per the guidance in ECB 2018-14 (Corps, 2018) and ETL 1100-2-3 (Corps, 2017). Climate is important in the Puyallup River Basin due to its role in modulating seasonal patterns of streamflow and magnitudes of floods. The purpose of conducting this qualitative analysis is to ensure that changes in climate with the potential to significantly affect project hydrology are identified, and that their potential effects are assessed with respect to project features and performance over the project life cycle. This analysis relies on the best available science and the use of professional judgment to address the risks associated with climate change. Overall, the primary sensitivities related to climate change are higher river stages due to increased flows and increased channel sedimentation. Additional information is included in the appendices associated with this Feasibility Report, including a literature synthesis (Appendix A.5). Note that the project area is not affected directly by sea level change.

Observed Climate Trends

Regionally, a strong consensus of increasing temperature in the Pacific Northwest was found in the Corps Literature Synthesis, with an increase of up to 2°F compared to the historical (1901-1960) average. An increasing trend in temperature was observed for average, minimum, and maximum temperature alike, with the highest degree of confidence in coastal areas (Corps, 2015). The lowland areas of Puget Sound have warmed approximately 1.3°F (0.7°F – 1.9°F) between 1895 and 2014, with significant trends found in all seasons but spring (Mauger, 2015).

In the Pacific Northwest, observed changes in precipitation range from roughly -5% to +10% (NCA4 2018), with only moderate consensus due to spatial and seasonal variability (Corps, 2015). No significant trend in annual precipitation has been observed for the Puget Sound lowland region. Statistically significant increasing trends have been found in spring (March-May) however in no other months. In the Pacific Northwest, the amount of precipitation falling during the heaviest 1% of events increased by 22% from 1901-2016, and the number of 5-year, 2-day events increased by 13% from 1901-2016 (NCA4, 2018), indicating an increase in the frequency of extreme events. Studies have found modest increases in intense rainfall in Western Washington (Rosenberg et al. 2010; Mass et al, 2011). However not all trends are statistically significant and vary depending on the dates, locations, and methods of analysis.

For the latter half of the 20th century, statistically significant decreasing trends in streamflow have been observed in the Pacific Northwest for spring-summer seasonal flow, with dry years getting drier. Similarly, significant trends of decreasing snowpack, as measured by snow water equivalent, have been observed across the Pacific Northwest. This trend is primarily attributed with regional warming however is also affected by natural variability, particularly at shorter timescales. Decreasing trends in both summer streamflow and snow water equivalent are supported by strong literature consensus (Corps, 2015). The timing of snowmelt derived streamflow is shifting to earlier in the year as a product of decreased accumulation and earlier melt (Stewart et al. 2005). The streamflow gage on the Puyallup River near Orting has been in service since 1932. At this gage, eight of the top ten flood peaks occurred since 2006 (National Weather Service, 2020). The frequency of high river events may be linked to climate, however, channel sedimentation may also play a role. In a period after channel dredging activities ceased, from 1984 to 2009 the channel elevations of the Puyallup, White, and Carbon Rivers rose by several feet in some locations. A sedimentation rate of one foot per ten years was observed from 2009-2019.

Climate Assessment tools

Through the Climate Preparedness and Resilience Program, the Corps maintains a set of tools that provide information to support qualitative assessment of potential effects of climate change. These tools provide an assessment of local trends based on gage data and projections of future hydrological change simulated by hydrology models.

Hydrological analyses rely on datasets that are statistically homogeneous, or stationary, over a continuous period of record. The nonstationarity detection tool uses a set of statistical tests to detect both abrupt and smooth nonstationarities in the historical record of instantaneous peak annual flow at USGS stream gages. Identified nonstationarities are used to inform the degree at which historical statistics are stationary. The Corps nonstationarity detection tool was applied to evaluate statistical heterogeneities in the time series of annual peak flow at 3 gages near Jones Levee. For each location, 1-2 tests found single occurrences of nonstationarities. For the gage on Puyallup River near Electron and the Carbon River near Fairfax, these detections occurred in the early 1970s. However, due to the lack of detections from other statistical tests the results do not indicate the strong presence of nonstationarities in the time series.

The Climate Hydrology Assessment Tool (CHAT) was used to observe local trends in streamflow based on USGS stream gage data. The first-order statistical analysis shows a linear regression fit of annual peak instantaneous streamflow data, which is examined at the three gage locations. Time series data of annual maximum instantaneous peak flow at the three gage locations was evaluated for the presence on monotonic trends. We then applied three tests to evaluate the statistical significance of trends. The Climate Hydrology Assessment Tool was also used to examine projections of annual maximum monthly streamflow. Outputs from the CHAT qualitatively suggest that annual maximum monthly flows, and therefore annual peak flows, are expected to increase in the future relative to the current time. While the direction of change is consistent with finding in the literature, the magnitude is less. This is likely attributed to coarse spatial scale of the Puget Sound HUC as compared to basin specific analyses provided in the literature.

The Watershed Climate Vulnerability Assessment Tool (VA Tool) facilitates a screening level, comparative assessment of how vulnerable a given HUC-4 watershed is to the impacts of climate change relative to the other 202 HUC-4 watersheds within the continental United States (CONUS). The tool can be used to assess the vulnerability of specific Corps business lines to projected climate change effects. For this analysis, Flood Risk Reduction is the business line of primary interest. Assessments using this tool help to identify and characterize specific climate threats and particular sensitivities or vulnerabilities, at least in a relative sense, across regions and business lines. The tool uses the Weighted Ordered Weighted Average (WOWA) method to represent a composite index of how vulnerable a given HUC-4 watershed (Vulnerability Score) is to climate change specific to a given business line. WOWA scores range from 0-100, and the HUC-4 watersheds with the top 20% of WOWA scores are flagged as being vulnerable. With respect to Flood Risk Reduction, the Puget Sound HUC-4 watershed is not among the top 20%of the most vulnerable watersheds across CONUS. However, the Puget Sound is among the most vulnerable of the HUCs in the Seattle District. The dominant indicator contributing to increased vulnerability for Flood Risk Reduction is the Cumulative Flood Magnification Factor. This factor is derived from the relative change in runoff projected for future conditions as compared to historic norms and gave a 25% increase in vulnerability.

There is strong literature consensus that climate warming has already had an impact on seasonal snow accumulation and melt patterns. There is little evidence that extremes, both precipitation and streamflow, have changed through the historical period as noted in the literature and statistical analyses of the streamflow gage upstream of the Jones Levee.

However, there is strong consensus that extreme precipitation and runoff events will likely increase in the future. This finding is supported by projections developed by the research community documented in peer reviewed literature and from the results of the Corps CHAT and Vulnerability Assessment tools.

4.12.1 Alternative 1 – No Action Alternative

All available climate projections indicate warming in the Puget Sound region through the 21st century. On average the projections show warming of 4.2°F to 5.5°F by mid century, relative to 1970-1999. Warming is far greater later in the century and depends greatly on the amount of global emmissions considered. Warming is projected for all seasons with the largest increases projected during summer.

Seasonal projections for the Pacific Northwest region indicate an increase in precipitation for winter months, while summer precipitation is likely to decrease (NCA4, 2018). The projected changes are an amplification of the historical pattern in the region of wet winters and dry summers, a percentage increase in winter precipitation is likely to offset even large percentage decreases in summer precipitation from an annual perspective. In addition to annual and seasonal changes in precipitation, strong literature consensus exists for a trend of increasing intensity and frequency of extreme storm events (Corps, 2015), including AR's. The amount of daily precipitation associated with a 20-year return period extreme event is projected to increase by as much as +19% by the end of the century. Under a high emissions scenario, the amount of precipitation falling during the heaviest 1% of events is projected to increase by over 40% in some regions of the Northwest by the end of the 21st century.

Trends in streamflow are a manifestation of trends in precipitation and temperature. Projections of future streamflow indicate pronounced changes in the timing and magnitude of streamflow volumes in the Puyallup River Basin (Mauger et al. 2015). Historically, the mean seasonal volume of streamflow had two peaks, centered in December-January and another centered in June. The summer volume is projected to decrease substantially, with much of this volume shifting to the winter period. The projections also indicate substantial changes to annual maximum daily streamflow across a range of return intervals (Mauger et al. 2015). Most projections indicate an increase in future peak flows. Projections by Hamlet et al. (2013) predict that the 1% annual exceedance probability peak flow could increase by 37% on average, with a range of 10% - 88% among projections. Projections by Mote et al. (2015) predict that the 1% annual exceedance probability peak flow could increase by 49% under a low emissions scenario and by 80% under a high emissions scenario for the period of 2070-2100.

Increase in the frequency of extreme rainfall events, increased peak river flows, and increased sediment loads are all likely effects of climate change. The no-action alternative essentially continues present trend of decreasing channel capacity due to sedimentation, and existing levees will be further stressed by an increase in the frequency and magnitude of peak flows.

4.12.2 Alternative 2 - Raise-In-Place Alternative

Future climate change summarized for the no action alternative also applies to the levee raise-in-place alternative. The raise-in-place alternative provides greater resilience, in the form of increased channel capacity, to the climate change variable of increased peak flows. No significant change, from the present trend, for in-channel storage of increased sediment supply is provided by raising the levee.

4.12.3 Alternative 3 – Levee Setback and Partial Removal (LPP/TSP)

Future climate change summarized for the no action alternative also applies to the levee setback alternative. For the setback alternative, increased channel capacity is provided, which provides greater resilience to the climate change variable of increased peak flows. But it is accomplished by greatly increasing the top width of the river channel between levees. This alternative also provides for greater in-channel storage of sediments and is more resilient to the climate change variable of increased sediment supply. In the long term, this alternative will provide a more robust strategy to manage the effects of climate change.

4.12.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Future climate change summarized for the LPP/TSP (Alternative 3) also applies to this alternative. Construction of a setback levee for the NED alternative is almost identical to the LPP/TSP and would derive the same benefits. In the long term, this alternative, like the LPP/TSP, would provide a more robust strategy to manage the effects of climate change.

4.13 Hazardous, Toxic, and Radiological Wastes

No HTRW or petroleum contamination concerns were identified onsite. A review of environmental records indicated the presence of active cleanup sites within 0.4 – 0.7 miles of the study areas that contain groundwater or soil contamination; however, they are not anticipated to impact the study area, nor are construction activities anticipated to disturb them.

While no HTRW or petroleum concerns were identified during the field reconnaissance of Jones Levee, it is noted that reconnaissance of the eastern side of the study area was not completed as it overlaps with private properties and residences. Reconnaissance of private property and interview of property owners within the study area would be completed if necessary, prior to the acquisition of properties by the NFS during D&I of the authorized study, with a memorandum to document those additional activities.

4.13.1 Alternative 1 – No Action Alternative

Given the absence of HTRW or petroleum contamination concerns and the distance of active cleanup sites from the study area, the no action alternative is not anticipated to have any adverse outcomes for HTRW. No significant impact to HTRW is expected under the No Action Alternative.

4.13.2 Alternative 2 - Raise-In-Place Alternative

While raising the levee in place would increase surface water elevations, depths, and velocities, no HTRW or petroleum contamination concerns were identified nearby that would be affected. No significant impact to HTRW is expected under the Raise-In-Place Alternative.

4.13.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, the area of land that would be periodically flooded would increase with the construction of a setback levee. A review of aerial photographs and current databases indicate no HTRW releases have occurred, and no cleanup actions are located within the setback area. Nor was any indication observed of prior commercial or industrial activity at or within the immediate vicinity of the setback area. Since the PDT observed no private property during the site visit, nor were interviews conducted with private property owners, there is a remote possibility that HTRW releases could have occurred in the past, which are not shown on aerial photographs or included in current databases. Prior to the construction of the setback levee for this alternative, additional due diligence would be conducted as needed on those properties where no access was included in the site visit to confirm the absence of HTRW or activities and conditions that may contribute to HTRW. Therefore, no significant impact to HTRW is expected under the LPP/TSP.

4.13.4 Alternative 4 - Levee Setback and Partial Removal (NED)

HTRW impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). No significant impact to HTRW is expected under the NED.

4.14 Soil Resources

Geologic mapping of the project site consists of two main geologic units, Holocene alluvium and Electron Mudflow (Figure 4-4). The Puyallup River has eroded the Electron Mudlow unit and deposited alluvial soils. Manmade fill is also present in the project area. Geotechnical explorations indicate levee fill material consists of medium to very dense gravel with varying amounts of sand and silt.

The alluvium is typically a mixture of sand, gravel, and silt deposited by flowing water. Geotechnical explorations indicate that alluvial soils within the existing levee footprint are loose to dense sand with varying amounts of silt and gravel. Stiff to very stiff layers of sandy silt and layers of medium dense to very dense gravel were noted. Low areas immediately landward of the existing levee have wetland characteristics and soils contain higher percentages of fines. See Section 4.15 for more details on wetlands in the project area.

Electron Mudflow material is present over a wide area east and northeast of the Jones Levee. This material was deposited suddenly from debris flow (lahar) that originated on Mount Rainier. Electron Mudflow is typically a loose to a medium dense mixture of silt, clay, sand, and gravel. Boulders and intact trees are also common within the deposit. Soil density within the mudflow material can vary significantly both horizontally and vertically within the unit.

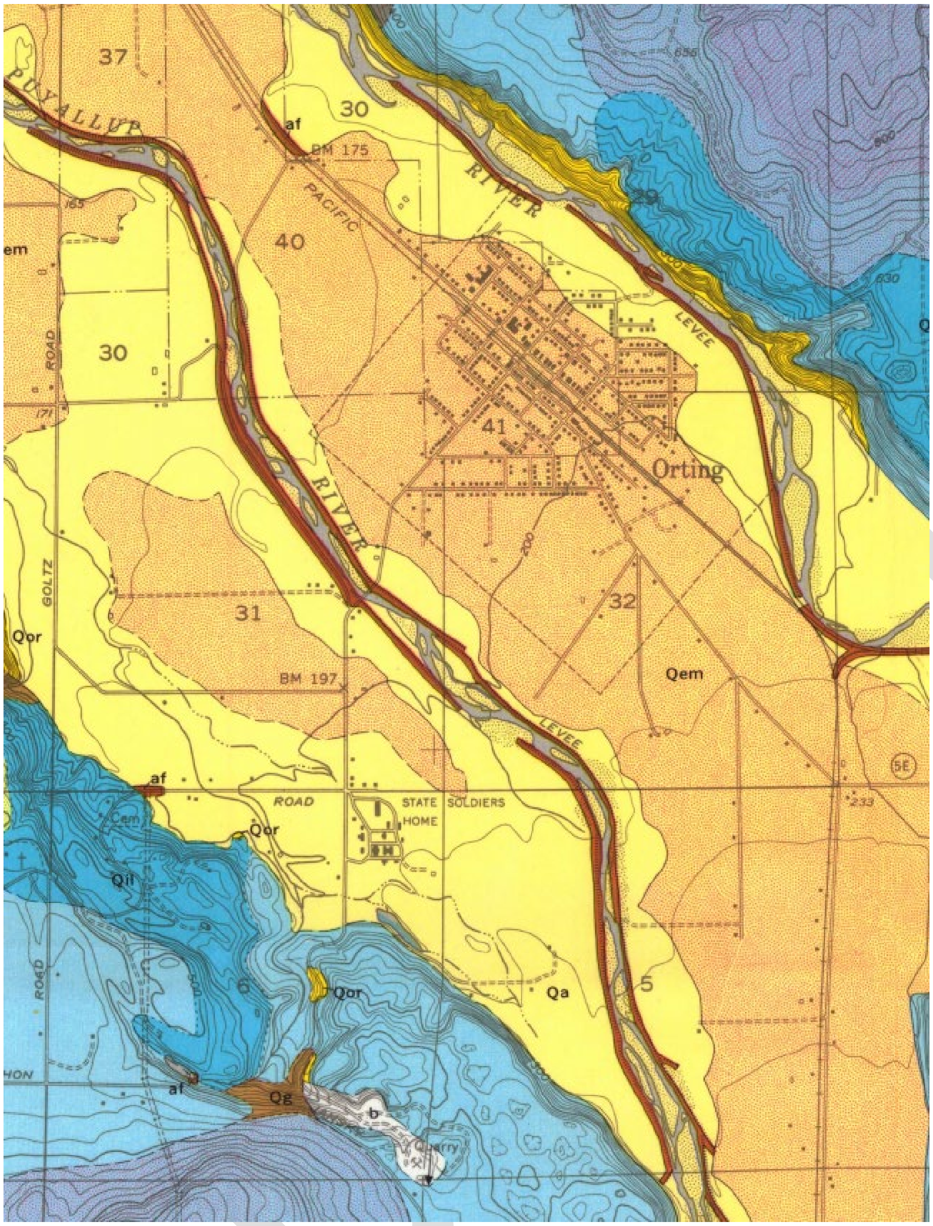

Figure 4-5 Geologic Map (Crandell, 1963). The project site includes Holocene alluvium (map symbol Qa) and Electron Mudflow (map symbol Qem).

4.14.1 Alternative 1 – No Action Alternative

Soils within the project area are expected to continually change over time from humans modification and natural processes. As population growth and urban expansion continue, the likelihood of future changes in soil composition and location increases, albeit at a small scale. Due to the location of the levee and environmental protections, soil disturbances in the immediate footprint of the levee and the wetlands behind it are unlikely to occur. Minor and localized changes in soils may occur as repairs and maintenance are completed, primarily in previously disturbed substrate. Large-scale changes to soils are unlikely unless Mount Rainier erupts, causing lahars to form. No significant impact to soil resources is expected under the No Action Alternative.

4.14.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, the Jones Levee would be deconstructed and rebuilt to a higher elevation. This would alter the soils within the footprint of the levee and the adjacent areas to accommodate a larger levee footprint. Construction activities would remove the vegetation from the soil., All exposed soils would be planted with native vegetation, such as hydroseed, to reduce soil erosion to reduce and control soil erosion (see BMPs in Section 5.5.1). Stormwater discharges would be managed under a National Pollution Discharge Elimination System (NPDES) permit. As part of the NPDES, a Stormwater Pollution Protection Plan (SWPPP) would be prepared to document the BMPs used to collect and control stormwater generated from the project construction. These BMPs would help reduce and control soil erosion until the site re-vegetates.

Soil compaction would occur from heavy machinery, such as along access roads and the levee top. Spall rock and riprap would be placed along the riverward side the levees for structural reinforcement. Soils outside of the raised levee footprint would not be affected. No significant negative effects to soils are expected under the Raise-In-Place Alternative.

4.14.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Soil disturbance would occur over a larger area under the TSP than in Alternative 2. While total levee deconstruction would not occur under this alternative, soils would be removed down below the waterline at the breach locations. Outside of the breach locations, armor and embankment material above the waterline would be removed for reuse in the setback levee. The isolated parts of the old Jones Levee, between breaches, would be abandoned after construction is completed. Damage to these sections would not constitute damage to the flood control structure, and further repairs would not occur. As a result, these parts would erode naturally over time.

Soils within the footprint of the new setback alignment would also be excavated, replaced, and compacted by the new setback levee. Any leftover soil would be reused or disposed of offsite. Completion of the setback levee and breaches would restore floodplain connectivity to approximately 40 to 50 acres of wetlands and riparian forest. Soils in these areas would receive sediment, organics, and nutrient deposits from the Puyallup River. While this is not expected to change the underlying soils, it would restore natural soil generating processes for alluvium and hydric soils. Therefore, no significant negative effects to soils are expected under the LPP/TSP.

4.14.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Soil impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). The width of the levee setback under this alternative would be slightly smaller by a few feet than the width of the LPP/TSP because the NED uses Class V riprap instead of 4- to 10-man rock for scour protection at the toe. The impact to soils would remain the same but would occur in a smaller area. No significant negative effects to water quality are expected under the NED.

4.15 Vegetation

Most of Jones Levee has large and small coniferous or deciduous trees with an understory of shrubs and herbs growing in the VFZ and on the riverward and landward slopes. The riverward slope is bare or planted with shrubs in areas recently repaired by the Corps and Pierce County. Between Jones Levee and the city of Orting is part of the Puyallup River floodplain that has been disconnected from the river since at least the 1960s. This area includes a variety of wetland types, including shrubland and forested riparian habitat. The wetland and riparian area varies in width, from approximately 150 to 750 feet wide, due to the alignment of the levee and development in and around Orting. Further inland from the project site, the vegetation community changes into agricultural fields, residential backyards, public spaces, and pasture.

Tree species present across the project area include bigleaf maple (*Acer macrophyllum*), black cottonwood (*Populus trichocarpa*), Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), red alder (*Alnus rubra*), and vine maple (*Acer circinatum*). The understory comprises native shrubs and herbs, including salmonberry (*Rubus spectabilis*), snowberry (*Symphoricarpos albus*), wild rose (*Rosa nutkana*), Pacific ninebark (*Physocarpus capitatus*), and others. Invasive plants include Himalayan blackberry (*Rubus armeniacus*) and reed canary grass (*Phalaris arundinacea*). Vegetation present in the wetland landward of the Jones Levee include black cottonwood, red alder, reed canary grass, creeping buttercup (*Ranunculus repens*), duck weed (*Lemna minor*), Douglas spirea (*Spiraea douglassii*), soft rush (*Juncus effusus*), and cattails (*Typha latifolia*). See Section 4.15 for more details on wetlands.

4.15.1 Alternative 1 – No Action Alternative

Under this alternative, the levee would continue to isolate the floodplain from the Puyallup River. Ongoing levee maintenance by Pierce County (i.e., vegetation removal and bank hardening) and floodplain development would continue, limiting riparian function. Loss of riparian vegetation in the Puyallup basin negatively affects fish and wildlife, water quality, beneficial organic and nutrient input, and LWM recruitment. Habitat restoration and conservation efforts by local, state, tribal, and federal agencies may offset some of these impacts but are increasingly limited due to floodplain development.

Pierce County is participating in the Corps System-Wide Improvement Framework (SWIF) program. The County's proposed vegetation maintenance plan targets clearing invasive vegetation and underbrush to provide avenues for inspection while maintaining larger trees for ecological benefit. Vegetation maintenance is no longer directly tied to eligibility requirements for the PL 84-99 program; therefore, it is anticipated that vegetation will be managed to preserve riparian vegetation at least to the current level, which would still prevent or reduce the development and function of the riparian zone.

Leaving Jones Levee in place would maintain the channelization of the river and isolation of the Puyallup River floodplain. Overall, future vegetation is expected to remain stable or slightly decline under this alternative. No significant negative impact to vegetation is expected under the No Action Alternative.

4.15.2 Alternative 2 - Raise-In-Place Alternative

To build a stable structure, the Corps would deconstruct the Jones Levee and rebuild it at a higher elevation, necessitating widening the structure at its base. Vegetation within the widened levee footprint and VFZs would need to be removed, increasing the extent of permanent vegetation removal adjacent to the river where it provides habitat and water quality value. Vegetation would be removed along the entire length of the Jones Levee, impacting approximately 10 to 12 acres of riparian habitat adjacent to the Puyallup River. Disturbed locations, such as staging or temporary construction areas, would be restored to their previous condition. All exposed soils would be planted with native vegetation to reduce soil erosion. Native vegetation may include a native hydroseed mixture, shrubs, and trees, including various willow species. The NFS would be responsible for O&M of the levee once construction is complete, including maintaining the VFZ in accordance with the SWIF.

The NFS would operate and maintain the raised levee per the SWIF. Depending on the level of vegetation maintenance conducted by the NFS, the levee slopes and VFZs may become revegetated with native shrubs and trees within 5 to 7 years. However, mitigation would still be necessary since removing the stream bank vegetation would negatively affect water quality as discussed previously and critical habitat features for fish and wildlife, including ESA-listed species. See Section 3.10.2 for mitigation details. With mitigation, the effect of the Raise-In-Place Alternative on vegetation would be less than significant.

4.15.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, vegetation would be cleared from parts of the existing Jones Levee and completely within the setback alignment and its VFZ. Vegetation within the ELJ footprint would also be temporarily disturbed. However, the ELJs are an organic structure that would naturally occur in the floodplain. Unlike Alternative 2, vegetation removal adjacent to the Puyallup River would be limited to the breach locations and where material (riprap and embankment) is removed for reuse in the new setback. The isolated parts of the old Jones Levee, between breaches, would experience little to no vegetation removal and would be abandoned after construction to develop naturally.

BMPs (see Section 5.5.1) would be implemented to reuse woody material generated by vegetation clearing and to revegetate the site. Disturbed sites and exposed soils at the staging areas, temporary construction areas next to the setback footprint, gaps and areas next to the breach locations, and areas disturbed during construction of the ELJs, would be replanted with native vegetation to return the project area to its pre-existing condition. Native vegetation may include a native hydroseed mixture, shrubs, and trees, including various willow species.

Overall, the project would improve vegetation function and value by removing barriers and restoring floodplain connectivity to 40 to 50 acres of riparian forest, shrub-land, and wetlands. Doing so would improve natural processes that maintain a healthy and diverse vegetation community. The Puyallup River would have access to a wider floodplain with off-channel habitat that is already forested and vegetated, increasing the amount of contiguous and available habitat for fish and wildlife, including salmonids or larger terrestrial mammals like elk. Vegetation loss from this alternative would be fully offset by the habitat restored to the flood plain. No significant negative effects to vegetation are expected under the LPP/TSP.

4.15.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Vegetation impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3), although within a smaller footprint due to the smaller size of Class V riprap used for scour protection at the toe. This alternative would have the same long-term benefits from removing barriers and restoring floodplain connectivity to 40 to 50 acres of riparian forest, shrub-land, and wetlands. The impact to vegetation would remain largely the same. No significant negative effects to vegetation are expected under the NED.

4.16 Wetlands

Wetlands are present landward of the Jones Levee. These wetlands were once contiguous with the Puyallup River channel but have since been isolated from the river after local entities constructed the Jones Levee. The National Wetland Inventory (NWI) was used to characterize and approximate wetland boundaries in the project area in feasibility. According to the NWI, freshwater emergent, freshwater forested/shrub, and freshwater pond wetlands are located landward of the Jones Levee (USFWS 2020). Ponds in the wetland are likely old borrow pits from when Jones Levee was built. The Corps will delineate wetlands and their boundaries in D&I.

Most of the water coming into these wetlands is runoff from the city of Orting and the surrounding area. A small outlet channel flows north behind the Jones Levee and under the Calistoga Bridge through several culverts, draining into the riverward side of the Calistoga Levee. This outflow channel may not fully connect to the Puyallup River. Wetlands are not present along the riverward slope of the Jones Levee. Instead, gravel bars and the Puyallup River border the shoreline.

4.16.1 Alternative 1 – No Action Alternative

Under this alternative, the Jones Levee would continue to isolate the floodplain and wetlands from the Puyallup River. Continued vegetation maintenance in the uplands along the wetland periphery could negatively affect wetland function and value over time. Continued development and industrialization are likely to increase runoff into the wetland, increasing the societal and environmental benefits the wetlands provide to water quality.

Even though the region’s population and development are expected to grow, the wetlands are likely to remain because federal, state, and local regulations protect wetlands. Habitat restoration and conservation efforts by local, state, tribal, and federal agencies may offset some of the impacts of wetland isolation. Nevertheless, without setting the levee back, the wetlands would remain impaired and function at a lower level. The potential benefits of the wetland to water quality, flood storage, and fish and wildlife habitat would not be fully realized as long as the Jones Levee isolates them from the Puyallup River.

Leaving Jones Levee in place would maintain the channelization of the river and isolation of the wetland from the Puyallup River. The wetlands would continue to provide water quality benefits but at a diminished function because of floodplain isolation. Overall, wetlands in the project area are expected to remain stable or slightly decline in the future. No significant impacts to wetlands are expected under the No Action Alternative.

4.16.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, the Jones Levee would be deconstructed and rebuilt at a higher elevation. Doing so would widen the levee, negatively affecting wetlands within the levee footprint and maintaining floodplain isolation. Expensive offsite mitigation would be required to offset wetland impacts to an estimated 3 acres of freshwater forested/shrub wetlands and 10 to 12 acres of riparian habitat that includes forested wetland.

Once construction is completed, the long-term impacts from this alternative would resemble those under the No Action Alternative. The potential wetland benefits, such as improvements to water quality or fish and wildlife, would not be fully realized. With mitigation, the effect of the Raise-In-Place Alternative on wetlands would be less than significant.

4.16.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, the Jones Levee would be strategically breached and a new levee constructed further inland. The new setback levee would reconnect 40 to 50 acres of floodplain containing wetlands that have been isolated from the river since the levee's construction. The alignment of the setback levee maximizes floodplain reconnection by roughly following the border between development in the city of Orting and the historical channel migration zone. The setback alignment balances floodplain restoration, project cost, levee safety, existing development, and other constraints. While there would be wetland excavation and fill (see tables in Section 4.5), these impacts are unavoidable and necessary to complete the proposed project.

The project would convert approximately 8.87 acres of wetland and 0.04 acres of water bodies to a new flood control structure. The increase in wetland function and value expected across 40 to 50 acres of reconnected floodplain, combined with the systemic benefits throughout the Puyallup River ecosystem from other setback projects, are expected to outweigh these impacts. The Corps anticipates that wetland impacts would be offset by the functional lift provided by the setback. The setback would improve natural riverine functions important for aquatic and aquatic-dependent fish and wildlife. It would also reconnect wetlands to the floodplain, increasing their functional value to the natural and human environment, such as water quality. There would be no net loss of ecological functions associated with the shoreline. Overall, the project would improve wetland conditions. No significant negative effects to wetlands are expected from the LPP/TSP.

4.16.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Wetland impacts from this alternative would be essentially the same as those under the LPP/TSP (Alternative 3), although within a smaller footprint due to the smaller size of Class V riprap used for scour protection at the toe. This alternative would have the same long-term benefits from removing barriers and restoring floodplain connectivity to 40 to 50 acres of riparian forest, shrub-land, and wetlands. Therefore, no significant negative effects to wetlands are expected under the NED.

4.17 Threatened and Endangered Species

In accordance with Section 7(a)(2) of the ESA, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed and proposed threatened or endangered species. The species listed in Table 4-7 are protected under the ESA and may occur in the project area. The following sections briefly summarize relevant information for the protected species; synthesizes current knowledge on the presence and utilization of the project and action areas by these species; and then evaluates how the proposed project may affect the species, concluding with a determination of effect. Pursuant to Section 7 of the ESA, the Corps submitted a Biological Assessment to the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) regarding effects to these species. See Section 6.6 for compliance details with the ESA consultation.

Table 4-7. ESA-listed species in the project area

Species	Listing Status	Critical Habitat
Coastal-Puget Sound Bull Trout *Salvelinus confluentus*	Threatened	Designated (in action area)
Puget Sound Steelhead *Oncorhynchus mykiss*	Threatened	Designated (in action area)
Puget Sound Chinook *Oncorhynchus tshawytscha*	Threatened	Designated (in action area)
Killer Whale *Orcinus orca*	Endangered	Designated (not in action area)
Eulachon *Thaleichthys pacificus*	Threatened	Designated (not in action area)
Green Sturgeon *Acipenser medirostris*	Threatened	Designated (not in action area)
Marbled Murrelet *Brachyramphus marmoratus*	Threatened	Designated (not in action area)
Streaked Horned Lark *Eremophila alpestris strigata*	Threatened	Designated (not in action area)
Yellow-Billed Cuckoo *Coccyzus americanus*	Threatened	Designated (not in action area)

The marbled murrelet is a small seabird that spends most of its time on the ocean but flies inland to nest in old-growth forests. Most marbled murrelets in Washington are found in the Puget Sound and Strait of Juan de Fuca region. Their nests are located in old-growth trees on large branches or deformities, typically 33 feet off the ground (USFWS, 2012). Most nests are in conifers over 150 years old with a diameter at breast height greater than 55 inches. Marbled murrelets are not documented to occur in the action area, nor is a suitable habitat that supports consistent, long-term breeding, rearing, and foraging. Given the project location between Puget Sound and inland nesting areas to the east, marbled murrelets may fly over the levee while traveling between their marine foraging areas and inland nesting sites. Their typical flying altitudes have been recorded at a mean height of 246 meters (807 feet) above ground level

(Stumpf et al. 2011). However, there is no designated critical habitat in the project area. The project is located near busy transportation routes, an urban center, and agricultural lands. Additional activity and noise generated from any alternative is not anticipated to have an effect on marbled murrelet because they would be acclimated to the noise and activities already present in the area. All alternatives are expected to have no effect on the marbled murrelet or its designated critical habitat. Therefore, this species will not be discussed further.

In addition, the Corps has determined that all alternatives would have "no effect" on the following species and their designated or proposed critical habitat due to physical absence in Puget Sound lowlands and Puyallup River, specialized habitat needs not found in the action area, lack of tolerance for human activity, or all. These species include green sturgeon, streaked horned lark, and yellow-billed cuckoo. These species will not be discussed further as they or their critical habitat would not be affected by any alternative.

4.17.1.1 Southern Resident Killer Whale

Southern Resident Killer Whale (SRKW) are large marine mammals requiring abundant food sources throughout the year and travel significant distances to locate sufficient prey to support their numbers (NMFS, 2006). SRKWs movement coincides with migratory salmon returning from the Pacific Ocean and therefore spend large amounts of time in the Puget Sound, Strait of Juan de Fuca, and Southern Georgia Strait (NMFS, 2006). Little is known about the winter movements and range of the SRKW (NMFS, 2005a). They may occasionally migrate as far south as Monterey Bay, California, and as far north as the northern Queen Charlotte Islands in Canada (Krahn et al., 2004). SRKWs show a strong preference for Chinook salmon, primarily Fraser River Chinook salmon, with chum salmon as the second most preferred (NMFS 2008; Ford and Ellis 2005). The survival of these whales positively correlates with Chinook salmon abundance (Ford et al. 2010). The diet of SRKW may include Puyallup River Chinook salmon.

SRKWs were listed as endangered and were designated critical habitat in 2005 (NMFS, 2005a; NMFS, 2006). Their critical habitat includes marine waters deeper than 20 feet (relative to extreme high water) throughout Puget Sound, the Strait of Juan de Fuca, and waters surrounding the San Juan Islands. The project area is not designated as critical habitat for SRKW, but the critical habitat is designated in Commencement Bay.

4.17.1.2 Pacific Eulachon

The Pacific Eulachon was listed as threatened in 2010, with critical habitat being designated in 2011 (NMFS, 2010; NMFS, 2011). Eulachon's critical habitat does not include the Puyallup River or Puget Sound. Eulachon are small, anadromous fish that typically spend 3 to 5 years in offshore marine waters and return to glacial-fed, tidal portions of rivers to spawn in late winter and early spring. Eulachon historically ranged from northern California to the Bering Sea in Alaska. Their current range extends from the Mad River in Northern California north into British Columbia. In Washington, they are present in the mainstem Columbia River up to approximately Bonneville Dam. Although established populations are not thought to exist in Puget Sound rivers, the occasional occurrence has been recorded, including in the Puyallup River around RM 10 (NMFS, 2010; Peitsch, pers. comm., 2013).

4.17.1.3 Puget Sound Chinook

Puget Sound Chinook salmon were listed as threatened in 1999 and updated in 2005 and 2014 (NMFS 2005b; NMFS 2014). Critical habitat was designated for Puget Sound Chinook in 2005 (NMFS 2005c). The Puyallup River next to the Jones Levee is designated as critical habitat for Chinook. Chinook salmon could be within the Puyallup River year-round but are most likely to be in the Puyallup River next to the Jones Levee between January and November, with a peak in the summer. Table 4-8 shows the general timing of major life stages for fall-run Chinook in the Puyallup River.

Table 4-8. Fall Chinook Life Stages (Marks et al. 2018).

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
Season	WINTER			SPRING			SUMMER			AUTUMN		
Overall Presence	YEAR ROUND (Primary Rearing in Estuary)											
Fish Window for In-Water Work												
Adult Migration												
Spawning												
Juvenile Outmigration												
Juvenile/Yearling Rearing												
Notes: The majority of ocean-type juvenile Chinook out-migrate to the estuary and Commencement Bay by June.												

Chinook are most often found in large streams or rivers, and many stocks spawn far inland. Chinook salmon are considered main channel spawners, although they do use smaller channels and streams with sufficient flow. Due to their large size, Chinook salmon are able to spawn in larger substrate than most other salmon species. The Puyallup River basin supports two populations of Chinook salmon -- the early returning spring-run White River Chinook, which spawn in the upper and lower White River, and the late returning fall-run Chinook that spawn in the Carbon River, Puyallup River, and associated tributaries. There are also late returning Chinook that spawn in the lower White River.

Puyallup River fall-run Chinook are endemic throughout the Puyallup River basin and many of the tributaries associated with the mainstem river systems. Fall-run Chinook typically enter the Lower Puyallup River in June and continue to move through the system as late as November. Most of the tributary spawning activity occurs from September through late October, except for some lower tributaries, which may have fish present into early November (Marks et al., 2007;

Marks et al., 2014). The age of adult fall-run Chinook returning to spawn can range between two-to-five years of age.

The majority of post-emergent fry spend a moderate period residing instream, typically less than one year, before migrating downstream to marine waters. A portion of spring Chinook juveniles can overwinter in the White River and migrate downstream the following spring, while fall Chinook migrate out in the spring and early summer of the year they emerge from the gravel. Chinook spend much of their time in the estuary before migrating to the ocean (Marks et al., 2014). Fall Chinook emigration out of the Puyallup begins as early as January and runs well into the last week of August, with the peak of emigration taking place at the end of May (Marks et al., 2014).

Most fall-run Chinook natural spawning occurs in South Prairie Creek up to RM 15, the Puyallup mainstem up to the Electron Dam, the lower Carbon River, Voights's Creek, Kapowsin Creek, and Niesson Creek. Some spawning is believed to occur in the upper Puyallup River since passage has been established at the Electron diversion dam (Marks et al., 2014). Pierce County (2009) mapped Chinook salmon spawning areas in the Puyallup basin and identified a fall Chinook area approximately 0.5-1.5 miles upstream of the project. Marks et al. (2018) also identified Chinook redds upstream and downstream of the Jones Levee in the Puyallup River next to the city of Orting.

NMFS (2016a), in their 5-year status review of Puget Sound Chinook salmon, indicated that the risks to the persistence of the species had not changed significantly since the final listing determination in 2005. All Puget Sound Chinook salmon populations are still well below the planning ranges for recovery escapement levels. Most populations across Puget Sound have declined in abundance since the last status review in 2011, and this decline has persisted over the past 7 to 10 years. Predominant habitat concerns include impaired water quality, lack of access to functional floodplains and marine shorelines, and impaired fish passage. An exception to impaired fish passage in the Puyallup basin is the recovery of White River spring Chinook. These Chinook have had their highest returns over the past few years after fish passage improvement projects were completed at Mud Mountain Dam and the Buckley fish trap.

The 5-year status review of Puget Sound Chinook salmon also identified specific threats to the recovery of Puget Sound populations (NMFS, 2016a). These threats include: 1) impacts to instream habitat and habitat complexity, from bank armoring, insufficient instream flows, and the increasing impervious surfaces, 2) impaired floodplain connectivity and function, resulting from roads, levees, dikes, bank armoring, bridges, and conversion of floodplains to residential and commercial development, which alters soil saturation and hyporheic recharge that is necessary to maintain stream recharge with cool, clean base flows; 3) contaminants in estuaries and the shallow marine waters near urban areas, such as the Puyallup River estuary; and 4) nearshore habitat loss from shoreline armoring, which disrupts the natural process of erosion and longshore transport. Recovery actions that provide remedies to floodplain impairments for salmon and trout are covered in the Puget Sound steelhead section.

4.17.1.4 Puget Sound Steelhead

Puget Sound steelhead were listed as threatened in 2007 and updated in 2014 (NMFS, 2007b; NMFS, 2014). Critical habitat for steelhead was designated in 2016 and included the Puyallup

River next to the Jones Levee (NMFS, 2016b). Steelhead are present in the Puyallup River year-round, rearing and spawning in areas near the project site (Pierce County, 2009). Multiple life stages could be present next to the Jones Levee between March and June. Table 4-9 shows the general timing of major life stages for winter steelhead in the Puyallup River.

Table 4-9. Winter Steelhead Life Stages (Marks et al. 2018).

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
Season	WINTER			SPRING			SUMMER			AUTUMN		
Overall Presence	YEAR ROUND											
Fish Window for In-Water Work	□□	□□	□□	□□	□□	□□	□□	□■	■■	□□	□□	□□
Adult Migration to Spawning	□□	■■	■■	■■	■■	■■	□□	□□	□□	□□	□□	□□
Adult Migration from Spawning	□□	□□	□□	□□	□□	□□	■■	■■	■■	■■	■■	■■
Spawning	□□	□□	□□	□□	■■	■■	□□	□□	□□	□□	□□	□□
Juvenile Outmigration	□□	□□	□□	■■	■■	■■	□□	□□	□□	□□	□□	□□
Juvenile/Yearling Rearing	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■	■■
Notes: Winter steelhead will be mature enough to spawn within a few months or less after entering freshwater.												

The Puyallup River basin supports two populations of Puget Sound steelhead, the Puyallup/Carbon and the White River. Both are winter-run steelhead, as are most steelhead populations in the Puget Sound. Historic population estimates for Puyallup/Carbon River steelhead ranged from 16,000 to 22,000 adult spawners. Current estimates put adult spawner abundance at 740 adults. The recovery goal for this population is 4,500 to 15,000 adult spawners (NMFS, 2019).

Steelhead enter rivers at a mature age and can spawn within a few months of entering freshwater (Pauley et al., 1986). Adult steelhead in the Puyallup River generally enter the basin in winter (January) through spring (May). Most steelhead don’t start migrating towards the upper reaches of the basin until March. The winter run continues through June, with peak migration and spawning occurring in mid-to-late April through early May. Puyallup Tribal Fisheries spawning ground data shows peak spawning takes place in the upper Puyallup and White River basins in late April to early May and in the lower White River in mid-to-late May. A majority of spawners in the Puyallup River basin are found in the upper tributaries of Kellog, Niesson, and LeDout creeks. Substantial spawning also occurs in South Prairie Creek, a tributary to the Carbon River. The mainstem below the Electron diversion dam also sustains a small number of spawners, and it is assumed that spawning occurs upstream of the Electron dam (Marks et al., 2014 and 2018). Data from Pierce County identifies steelhead spawning approximately one to two miles downstream of the project area and juvenile steelhead rearing in a side channel across from the levee (Pierce County, 2009).

Fry emerge from fertilized eggs after four to eight weeks, depending on water temperature. Juvenile steelhead rear in freshwater for one to four years before migrating to marine waters in the spring. Once in marine waters, steelhead spend another one to four years maturing. Adult steelhead return to the Puyallup River basin to spawn after reaching between three to seven years old (Marks et al., 2014). Outmigration of adults in the Puyallup River system generally occurs between April and July. Seventy percent of Puyallup steelhead stay in marine waters for approximately two years before returning to their natal streams to spawn. The other 30% return after three years (NMFS, 2016a).

The primary ecological concerns identified in the Puget Sound steelhead recovery plan are threats to 1) habitat quality, 2) food, 3) riparian condition, 4) peripheral and transitional habitats, 5) channel form and structure, 6) sediment conditions, 7) water quality and quantity, and 8) population effects (NMFS 2019). Strategies for recovery of the Puyallup River steelhead population include actions in the mainstem: 1) reducing levee impacts through setbacks and improved vegetation management, prioritized funding opportunities to setback levees and increase floodplain access, implement actions to remove hard bank protection from streams, and replace with soft approaches that improve stream functions, floodplain function, and habitat diversity; 2) increase the number and scale of floodplain connectivity projects, especially those associated with cold-water refuges, to provide refuge for steelhead during low flow and high flow events and provide hydrologic connections for flow and temperatures; and 3) develop habitat restoration projects that provide increased connectivity to groundwater and floodplain hyporheic zone.

4.17.1.5 Coastal-Puget Sound Bull Trout

Coastal/Puget Sound bull trout were listed as threatened in 1999 (USFWS, 1999a). Critical habitat was originally designated for bull trout in 2005 and revised in 2010 (USFWS, 2010). The Puyallup River next to Jones Levee is designated as critical habitat for bull trout. Bull trout are found in the Puyallup River year-round, but the presence of major life stages varies by season (Table 4-10). Adults are less likely to be in the action area during late summer when temperatures are higher and when fish are migrating upstream to spawn. Bull trout do not spawn in the project reach but use the area for forage, overwintering, and as a migration corridor. Bull trout juveniles and yearlings would be present in the upper watershed.

Table 4-10. Bull Trout Life Stages (Marks et al. 2018).[1]

Month	Dec	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov
Season	WINTER			SPRING			SUMMER			AUTUMN		
Overall Presence	Year Round											
Fish Window for In-Water Work												
Upstream migration to spawn/forage in upper watershed (adults, juveniles)												
Spawning												
Downstream Migration Post-Spawning (adults, juveniles)												
Fry Emergence and Dispersal												
Juvenile/Yearling Rearing in lateral habitat in the upper watershed along mainstem and associated tributaries												
Notes: migratory bull trout rear in freshwater before migrating to a lake, larger river, and/or estuary/nearshore area.												

Bull trout have more specific habitat requirements than most other salmonids, in that they require colder water (46 ºF or below) for spawning and egg incubation (Rieman and McIntyre 1993). Bull trout are endemic to the Puyallup, Carbon, and White River drainages in which they exhibit primarily residential and fluvial life history traits. Resident forms complete their entire life cycle in the tributary, or nearby streams, in which they spawn and rear. Fluvial fish migrate between larger, mainstem rivers and smaller tributaries in which they spawn to forage and

[1] This table is not indicative of bull trout use of the mainstem during summer months during peak water temperatures.

overwinter (Marks et al., 2018). Although diminished, the Puyallup River basin also supports the anadromous life history form of bull trout. Local opulations are found in Upper Puyallup, Mowich, Carbon, Upper White, and West Fork White Rivers (USFWS, 2015a). Puget Sound anadromous bull trout have a short period of marine residence, exiting rivers in the late winter and early spring, spending two to four months in Puget Sound or river estuaries, and then returning to freshwater between mid-May and mid-July to either spawn or rear (Goetz et al., 2004). Anadromous bull trout have been documented as residing in and using the White River and the lower mainstem Puyallup River (Goetz, 2016).

Adult bull trout are observed year-round in tributaries throughout the Puyallup River basin, foraging and overwintering. Their presence in the lower Puyallup River during summer is not well documented. During the fall, migratory bull trout journey from spawning and foraging habitats in the upper watershed to foraging and overwintering habitats located lower in the river system. From spring through early summer, bull trout commence their upstream journey to cooler spawning, rearing, and foraging habitat high in the watershed to spawn. Data gathered at the Corps fish trap on the White River shows that the peak arrival time for bull trout is June-August, although fish may be found at the fish trap most seasons of the year.

Bull trout spawn in the low gradient sections of high gradient streams with clean, loose gravel, groundwater influx, overhanging bank cover, and water temperatures of five to nine degrees Celsius (41-48 F; Goetz, 1989). Peak spawning occurs in September but can occur between the last week of August through the first week of October (Ladley et al., 2008; Marks et al., 2014). Bull trout eggs incubate until fry emerge from redds between late winter and spring (Marks et al., 2018). Upon emergence, bull trout fry disperse in search of suitable rearing habitat. This long incubation period, coupled with the fact that juveniles are strongly associated with interstitial spaces in the substrate, make bull trout particularly vulnerable to sediment deposition, bedload movement, and changes in channel morphology (Meehan and Bjornn, 1991; USFWS, 1999b). After one to three years in an upper watershed, migratory bull trout travel downstream, usually in the spring months, where they enter a larger body of water.

Threats listed in the recovery plan for bull trout in the Puyallup River are 1) instream impacts from flood control associated with residential and urban development, which results in poor structural complexity in lower river areas key to the persistence of anadromous bull trout; and 2) entrainment at electron dam, isolation of small populations, and increased isolation of populations in the upper Puyallup River[2] (USFWS, 2015b). Actions to address the primary threats are 1) reduce stream channel degradation and increase channel complexity, with removal of existing and prevent future bank armoring (bulkheads and riprap) and channel constrictions (*e.g.,* dikes and levees); 2) restore connectivity to floodplain; and recreate lost off-channel habitat, and opportunities for off-channel habitat formation through time by protecting channel migration areas; 3) avoid impacts from flood control activities (*e.g.* dredging, woody material removal, channel clearing, hardened bank stabilization, and riparian removal from dikes and levees); and 4) use alternatives that emphasize restoration of floodplain connectivity and

[2] Upstream passage was restored above the Puget Sound Energy Electron Dam in 2000.

eliminate or setback existing armored banks, dikes and levees to restore habitat-forming processes.

4.17.2 Alternative 1 – No Action Alternative

Under this alternative, the Jones Levee would continue to isolate the Puyallup River from part of its floodplain, perpetuating a static river channel and the negative effects of an altered riverine system. A static floodplain prevents or diminishes natural processes maintaining a dynamic equilibrium for which fish and wildlife, including ESA-listed species, are adapted. Future repairs and vegetation maintenance, along with human activity and development, would continue to negatively affect ESA-listed species and their critical habitat throughout the basin

Despite these negative impacts, ESA-listed species would likely persist in the Puyallup River but as a population in decline. Environmental laws, habitat restoration, and conservation efforts by local, state, tribal, and federal agencies would improve habitat conditions in the Puyallup River for ESA-listed species. However, with the Jones Levee remaining in place, the habitat behind the Jones Levee would remain inaccessible to salmon populations that need such habitat to recover.

Leaving Jones Levee in place would maintain river channelization and floodplain isolation. Channel containment structures like the Jones Levee have removed the natural sinuosity of the rivers and the aquatic spawning and rearing habitats that were once present (Kerwin, 1999). The impact of channel containment is a significant factor in limiting salmonids (Kerwin, 1999; NMFS, 2007a). Overall, ESA-listed species and their critical habitat in the project area are expected to remain stable or slightly decline in the future under this alternative. No significant impacts to threatened and endangered species are expected under the No Action Alternative.

4.17.3 Alternative 2 - Raise-In-Place Alternative

General long-term effects to ESA-listed species would resemble those under Alternative 1; however, there would be more impacts specific to the Jones Levee footprint resulting from construction-related impacts from widening and raising the levee. Construction-related impacts are discussed below under Alternative 3.

To build a stable structure, the Corps would deconstruct the Jones Levee and rebuild it at a higher elevation, which would necessitate widening the levee at its base. Deconstruction of the levee would include in-water work that would cause short-term turbidity increases. Levee deconstruction would also remove existing vegetation that provides aquatic benefits, such as shade and cover. The final structure would likely expand into the river and the landward wetland. This would negatively affect any ESA-listed species present during construction and their critical habitat, both from direct impacts and from shoreline simplification. Expensive offsite mitigation would be required to offset impacts. See Section 3.10.2 for mitigation details under this alternative. Once construction is completed, the long-term impacts from this alternative would resemble those under the No Action Alternative. This alternative would maintain river channelization and floodplain isolation that continues to negatively impact ESA-listed species and their habitat. With mitigation, the effect of the Raise-In-Place Alternative on ESA-listed species would be less than significant.

4.17.4 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Impacts to ESA-listed species and designated critical habitat under this alternative are described below. Overall, this alternative would have short-term, construction-related impacts but result in long-term beneficial effects. Construction-related impacts would be lessened using BMPs (see section 5.5.1). BMPs will be further refined during D&I. See Section 6.6 for information on Section 7 consultation under the ESA. In the aggregate, the effects on listed species and designated critical habitat from the LPP/TSP would be less than significant.

4.17.4.1 Southern Resident Killer Whale

Setting back the Jones Levee would not directly affect SRKW as they do not inhabit the project area. There is potential for indirect impacts through project affects to their prey base, including Chinook and chum salmon. Construction-related impacts to these prey species would be temporary. There would be long-term benefits resulting from floodplain improvements to the riparian habitat, which would improve freshwater food sources for juvenile salmonids in the Puyallup River. Because the percentage of Puyallup River Chinook and chum salmon that make up the SRKW diet is likely small, the Corps expects little to no discernable effect on their food base.

4.17.4.2 Eulachon

Eulachon are rare and not likely to be present in the Puyallup River near Orting. Should an individual occur in the lower Puyallup River during construction, they may be negatively affected by construction-related impacts similar to those described below for Chinook, steelhead, and bull trout. These include behavioral and physiological damage from elevated noise and turbidity. Long-term impacts associated with improvements to floodplain connectivity would likely improve river conditions for this species. There would be no effect to eulachon critical habitat.

4.17.4.3 Puget Sound Chinook

Adult and juvenile Chinook may be present during the construction of the TSP. The loss of riparian vegetation from construction could decrease organic inputs to the river and increase local water temperatures. Construction activity could cause vibrations and turbidity that could impact Chinook (adults and juveniles migrating or rearing) in the project area. After the TSP is built, approximately 40 to 50 acres of the floodplain would be reconnected to the Puyallup River. The reconnected floodplain would improve ecological functions in a landscape that has been historically degraded. Restoring this connection allows naturally turbid waters to enter the setback area and deposit sediment in the riparian and wetland area rather than in the river itself, improving turbidity conditions downstream. It would also improve off-channel habitat for rearing and prey species and off-channel refuge from high flows during flood events. The reconnected floodplain and old levee would increase shoreline complexity and provide a source of LWD in the channel when trees are taken into the river.

<u>Vegetation</u>

Vegetation in the breach footprints and the setback alignment would be removed under this alternative. Loss of riparian vegetation along the Puyallup River would decrease cover habitat and the input of nutrients, organic matter, woody material (large and small), and insects to the aquatic system. However, the loss of habitat would be fully offset by the habitat restored to the flood plain under this alternative. This restored connection would result in a functional improvement that is expected to improve over time. Overall, the project is anticipated to increase cover habitat, woody material recruitment, nutrients inputs, organic matter, and insects to the aquatic system by removing barriers and restoring floodplain connectivity. Chinook in Puyallup River would have access to more off-channel habitat that is already forested and vegetated, increasing the amount of contiguous and available habitat (e.g., vegetated cover) in the floodplain.

Water Temperature

Rising river temperatures are an issue for salmonids in Puget Sound. Therefore, preserving and increasing shade within the flood channel is important. The repairs would remove vegetation from the shoreline, which could increase water temperatures. Warmer water temperatures can increase physiological rearing costs and lower growth rates if warmer streams do not produce sufficient food resources to offset heightened metabolic demands. Additionally, the repair would place new rock. Bare rock would receive sunlight and increase local water temperatures until vegetation regrows. The amount that rock warms the water is expected to be minor and difficult to measure relative to the overall volume of water in the Puyallup River. However, most of the rock placement will occur away from the river and with limited rock placement in or next to water. Locations where new armor may be placed (or improved) would be at the existing access road for the armored spur and where the setback is next to or through the wetland. Furthermore, the new levee would be covered with soil and hydroseeded.

The river is not expected to permanently shift and remain next to the new setback levee. Instead, the river channel would meander towards and away from the setback naturally, over time. It's expected that, on average, the river would be adjacent to riprap less than it is under the existing Jones Levee alignment.

The portions of the existing levee that would be breached and abandoned would be replanted and colonized by vegetation over time. This would increase the amount of shade along the river since it would no longer be maintained by the NFS. Organic material (soil and native vegetation) cleared and grubbed during construction would be placed along the levee slope, which would further reduce the exposure of the rock to the sun. Overall, an improvement to shading and local water temperatures is expected, primarily through restoring connectivity to a forested riparian area.

Vibration and Sound

Vibration and sound would be generated from construction activities. The construction activities's greatest sound levels would be generated by removal and placement of rock below the waterline where needed, and during installation of the ELJs. These activities would occur within the in-water work window (July 15 to August 31) during both construction years. Vibration and noise generated by the repair could trigger a behavioral response in Chinook; however, the Corps does not anticipate noise levels sufficient to injure aquatic species. Fish moving past the in-water work locations at the time of construction may be temporarily delayed at the construction site due to noise. If construction does interfere with fish movement past the repairs, breaks in the work during the day or overnight would allow fish to continue past, minimizing any effect. The area affected would be limited to the portion of the channel adjacent to the levee, and the proposed actions would likely have no long-term effect on the movement or spawning of fish species. See Appendix B for additional sound and noise analysis.

<u>Rock Placement</u>

Chinook could be injured or killed if they do not leave the immediate area of construction activity, such as rock placement or removal. However, construction activities are expected to cause a startle response, causing fish and wildlife to leave the project area. For example, salmonids in the mainstem are larger and able to swim away from sources of disturbance or would not be present during the construction period. Even if no injury occurs, rock placement and removal could disturb and displace an individual in the action area.

<u>Turbidity</u>

Excavation, in-water material placement, and vibrations generated by the installation of ELJs may lead to elevated turbidity levels. Fish, including salmonids, exhibit physiological and behavioral responses to suspended sediments (Newcombe and MacDonald, 1991). Physiological effects of increased turbidity can include gill trauma (Servizi and Martens, 1987; Noggle, 1978; Redding and Schreck, 1987) and affect osmoregulation, blood chemistry (Sigler, 1988), growth, and reproduction. Behavioral responses include feeding disruption from olfactory and visual impairment (Sigler, 1988); gill flaring; and curtailment of territorial defense (LaSalle, 1988). Conversely, some protection against predation may be afforded salmonids in areas of suspended sediment (Gregory, 1988).

The Corps anticipates that turbidity generated by construction activities would be negligible. The Puyallup River is a glacially fed river system, so Chinook and other salmonids are exposed to naturally elevated suspended sediment levels (Gregory and Northcote, 1993). Construction materials would be clean, and turbidity monitoring would occur during construction. The Corps anticipates the need for a WQC from Ecology and would implement the necessary BMPs to address turbidity generation from construction activities and erosion during and between construction seasons.

4.17.4.4 Puget Sound Steelhead

Effects to steelhead under this alternative would resemble that of Chinook. However, there is a reasonable expectation that more steelhead would be present in the area than Chinook since steelhead stay in freshwater longer. Therefore, steelhead may benefit more from the reconnected floodplain than Chinook.

4.17.4.5 Coastal-Puget Sound Bull Trout

Effects to bull trout under this alternative would be similar to Chinook and steelhead. However, there is a reasonable expectation that bull trout would not be present in the river next to the project during in-water work, or present in much lower quantities. During this time, sub-adult and adult bull trout are expected to have migrated past the project area to upstream habitat areas or spawning sites (USFWS, 2009). As with Chinook and steelhead, bull trout would experience benefits from the reconnected floodplain.

4.17.5 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to ESA-listed species and designated critical habitat under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). Overall, this alternative would have short-term, construction related impacts but result in long-term beneficial effects. No significant negative effects to ESA-listed species and their critical habitat are expected under the NED.

4.18 Fish and Wildlife

The Puyallup River basin, despite increased human related pressures such as floodplain development, serves as a migration corridor and spawning habitat for a variety of aquatic species. Salmonid species found in the basin include Chinook, sockeye (*O. nerka*), coho (*O. kisutch*), pink (*O. gorbuscha*), and chum salmon, steelhead, bull trout, and coastal cutthroat trout (*O. clarki*). Other fish species include peamouth chub (*Mylocheilus caurinus)*, three-spine stickleback (*Gasterosteus aculeatus)*, largescale sucker (*Catostomus snyderi*), longnose dace (*Rhinichthys cataractae*), brook lamprey (*Lampetra richardsoni*), Pacific lamprey (*Lampetra tridentata*), and several species of sculpin (*Cottus spp*; Pierce County, 2005).

The project area provides habitat for a variety of birds. Of the more than 200 bird species recorded in the Puyallup River area, 162 species are found regularly and 36 breed within the area (Pierce County, 2005). Common birds include several species of flycatchers (family Tyrannidae) black-capped and chestnut-backed chickadees (*Poecile atricapilla, P. rufescens*), and red-breasted nuthatches (*Sitta canadensis*). Song sparrows (*Melospiza melodia*), fox sparrows (*Passerella iliaca*), spotted towhees (*Pipilo maculatus*), American robins (*Turdus migratorius*), and Swainson's thrushes (*Catharus ustulatus*) are found in the shrub layer. House sparrows (*Passer domesticus*), house finches (*Haemorhous mexicanus*), European starlings (*Sturnus vulgaris*), Brewer's blackbirds (*Euphagus cyanocephalus*), and crows (*Corvus brachyrhynchos*) are found in open urban and suburban areas. Red-tailed hawks (*Buteo jamaicensis*) and bald eagles (*Haliaeetus leucocephalus*) use tall trees for perching and foraging. No communal roosts for bald eagles or bald eagle nests are known to be in the project area. Hooded and common mergansers (*Lophodytes cucullatus* and *Mergus merganser*), mallards (*Anas platyrhynchos*), and other waterfowl are present.

Terrestrial mammals expected to use habitats within the study area include coyote (*Canis latrans)*, raccoon (*Procyon lotor)*, opossum (*Didelphis virginiana)*, skunks (family Mephitidae), black-tailed deer (*Odocoileus hemionus columbianus*), elk (*Cervus canadensis*), muskrat (*Ondatra zibethicus)*, beaver (*Castor canadensis*), river otter (*Lutra Canadensis)*, moles (family Talpidae), mice (family Muridae), eastern grey squirrel (*Sciurus carolinensis)*, and similar species, as well as dogs (*Canis lupus familiaris)* and feral cats (*Felis catus*; Pierce County, 2005). Amphibians such as the Pacific chorus frog (*Pseudacris regilla*) and ensatina salamander (*Ensatina eschscholtzii*), and reptiles like the common garter snake (*Thamnophis sirtalis)* and the northern alligator lizard (*Elgaria coerulea)* are common in the area. As Washington's human population rises and development continues to encroach further into wildlife habitat, people and animals are increasingly coming into conflict. Residential development around Orting has displaced mammals such as elk that are now making their way into the valley around Orting and conflicting with farmers (Bockstiegel, pers. comm., 2021).

4.18.1 Alternative 1 – No Action Alternative

Under this alternative, the Jones Levee would continue to isolate the Puyallup River from part of its floodplain, perpetuating the negative effects of an altered riverine system. Future repairs and continued vegetation maintenance would temporarily affect the presence of fish and wildlife near Jones Levee throughout its existence. Population growth and development would increase human activity in the area and contribute to negative impacts to fish and wildlife throughout the basin, increasing human-wildlife conflict.

Despite these negative impacts, some fish and wildlife would persist in the area, although with less diversity and resiliency than under a more natural condition. The development behind the levee could inhibit or cut-off riparian corridors, preventing wildlife, such as elk, from accessing the isolated floodplain behind the levee. Environmental laws, habitat restoration, and conservation efforts by local, state, tribal, and federal agencies would continue to improve habitat for fish and wildlife in the basin. However, without reconnecting the floodplain landward of Jones Levee, species such as salmon would not benefit from it. Other species, such as elk, would have a harder time accessing the area and may not be able to as development continues.

Leaving Jones Levee in place would maintain river channelization and floodplain isolation. Overall, fish and wildlife in the project area are expected to remain stable or slightly decline in the future under this alternative. No significant negative effects to fish and wildlife are expected under the No Action Alternative.

4.18.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, the Jones Levee would continue to isolate the Puyallup River from part the floodplain. This would perpetuate the negative effects of an altered riverine system found throughout the Puyallup River basin.

Construction would increase human activity on the levee, which would temporarily affect the presence of fish and wildlife. Construction impacts to fish under this alternative would resemble those described in Section 4.16. For terrestrial species, construction would temporarily affect wildlife from noise, vibration, human presence, and turbidity. This may cause wildlife to leave the project area during construction activities. Species landward of the levee could move further inland and into the wetlands and riparian forested area.

Fish and wildlife that use riparian vegetation, aquatic habitat and wetlands along the entire length of the levee would be negatively affected by the larger levee footprint. After construction is complete, most species are likely to return. However, habitat conditions would be degraded from their pre-project condition along the wider Jones Levee footprint, especially along the bank of the Puyallup River. Long-term effects, such as vegetation maintenance and regional development, would resemble those under the No Action Alternative. Disturbed areas would be replanted, and the levee slopes either left bare or covered in topsoil and grass. Vegetation and wetland loss would worsen water quality, decrease habitat, and reduce the input of beneficial nutrients, organic matter, woody material (large and small), and insects to the aquatic system. To offset these impacts, extensive offsite mitigation would be necessary along the Puyallup River. See Section 3.10.2 for mitigation details concerning riparian and wetland mitigation.

After construction is completed, the riparian area behind the Jones Levee would remain disconnected from the floodplain. With the completion of offsite mitigation, the effect of the Raise-In-Place Alternative on fish and wildlife would be less than significant.

4.18.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, the Jones Levee would be strategically breached and a new levee constructed further inland. The new setback levee would reconnect 40 to 50 acres of floodplain that has been isolated from the river since the levee's construction.

Construction-related effects to fish under this alternative would resemble those described in Section 4.16. BMPs would be implemented to lessen construction-related impacts to fish and wildlife (see Section 5.5.1). For terrestrial species, construction would temporarily affect wildlife from noise, vibration, human presence, and turbidity. Riparian vegetation and wetlands would be negatively affected at the breach locations and along portions of the setback alignment (see Section 4.5). The amount of in-water work and riparian vegetation removed next to the Puyallup River under this alternative would be less than under Alternative 2. Although the amount of wetlands filled or altered is expected to be more under this alternative but offset from increased function and value by reconnecting the floodplain (see Section 4.15).

After construction is complete, the Puyallup River would be reconnected to approximately 40 to 50 acres of floodplain. Restoring floodplain connection with the Puyallup River would improve conditions for fish and wildlife by removing barriers and reducing human influence. While not all species experience benefits equally, returning a floodplain to a more natural condition generally provides the greatest benefits. Natural riverine functions would create and sustain a mosaic of habitats, such as off-channel refuge for fish. The habitat would develop and alter naturally over time as the river meanders throughout its floodplain. Breaches in the old levee would limit recreational use next to the river along the old levee alignment. Any reduction in human use of an area is expected to benefit fish and wildlife, such as elk who use riparian corridors to move between different habitats.

No compensatory mitigation would be required for the LPP/TSP and there would be no net loss of ecological functions associated with the shoreline. No significant negative effects to fish and wildlife are expected from the LPP/TSP.

4.18.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to fish and wildlife under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). Overall, this alternative would have short-term, construction related impacts but result in long-term beneficial effects. No significant negative effects to fish and wildlife are expected under the NED.

4.19 Cultural Resources

The Corps has coordinated its environmental review of impacts on cultural resources for NEPA with its responsibilities to take into account effects on historic properties as required by Section 106 of the National Historic Preservation Act (NHPA). The Corps has determined and documented the area of potential effect (APE) for both direct and indirect effects, as required at 36 C.F.R § 800.4 of the regulations implementing Section 106. The APE includes the footprint of the existing levee and proposed setback alignment and all staging and access areas for all locations. The Washington State Historic Preservation Officer (SHPO) agreed with the Corps' determination of the APE on January 27, 2020.

A field investigation for archaeological and built environment resources is currently being conducted and once field work is completed the results will be documented in a cultural resources report. w

A report summarizing the findings of the field investigation, a records search and literature review of the Washington Information System Architectural and Archaeological Records Database, and Corps cultural resources records will be completed after the field investigation is completed. Based on the results of the field investigation and summarized in the report the Corps will make a determination on if the proposed project will have any effects to historic properties that may have been found during the field investigation. The Corps will provide its determination to SHPO and complete consultation as necessary.

The Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Nisqually Tribe, Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation were sent letters via email on May 10, 2021, about the project to identify properties to which they may attach religious or cultural significance or other concerns with historic properties that may be affected. The Squaxin Island Tribe responded via email on May 13, 2021, requesting a cultural resources survey in the project area. The Nisqually Tribe sent a letter via email on May 24, 2021, asking for a cultural resource assessment to be done in the project area and asked to be informed if there are any inadvertent discoveries of buried archaeological resources or human burials.

4.19.1 Alternative 1 – No Action Alternative

With the No-Action alternative, effects to historic properties and cultural resources would be the same as the existing condition. No construction activities would occur because of the No-Action Alternative. No significant impacts to cultural resources are expected under the No Action Alternative.

4.19.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, there would be ground-disturbing activities within the Jones Levee footprint and in lands immediately adjacent to it. Fieldwork started on June 21, 2021, and is ongoing. Once the results of the field investigation are finalized, the Corps will be able to make a determination on what effects (if any) Alternative 2 could have on historic places. See Section 6.10 for more details concerning the NHPA consultation process.

4.19.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, there would be ground-disturbing activities within the Jones Levee footprint and the setback alignment. Fieldwork started on June 21, 2021, and is ongoing. Once the results of the field investigation are finalized, the Corps will be able to make a determination on what effects (if any) Alternative 3 could have on historic places. See Section 6.10 for more details concerning the NHPA consultation process.

4.19.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to historic properties and cultural resources under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3).

4.20 Aesthetics and Recreation

The Jones Levee is an unofficial recreation trail providing views and access to the Puyallup River. The public is known to use the levee for horse riding, walking, and running. Other recreational opportunities like fishing, hiking, and nature watching are available throughout the region and may also occur on the levee. Near Calistoga Bridge is the Calistoga Park featuring a gravel parking area, access to the river, a baseball field, play area, and a fenced dog park.

4.20.1 Alternative 1 – No Action Alternative

Under this alternative, no impact to the aesthetics and recreational uses of the levee would occur.

4.20.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, the public would have limited access to the levee until construction is complete. Public access and use of Calistoga Park could also be affected by construction traffic and staging activities. After construction, the green space along the new levee would be lost, reducing the aesthetics of the river. Vegetation removal would also affect recreational opportunities such as bird watching and may affect nearby fishing. Overall, aesthetics and recreation is not expected to be significantly affected; however, when compared to current conditions, it would decline under this alternative.

4.20.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

The proposed work would not interfere with the public's enjoyment of the river environment or its aesthetics, except on a short-term, limited basis during construction. Public use of Calistoga Park could be temporarily affected by construction traffic and staging activities. After construction is complete, the river would return to a more natural condition that would improve aesthetic and recreational opportunities. The public would be able to use the new setback levee as an unofficial recreation trail. Additionally, part of the Matlock Cutoff would remain in its current alignment along the river after construction is completed. River and shoreline access would remain here and downstream where the setback meets the Calistoga Bridge. The Corps expects beneficial effects to recreational fishing because reconnecting the river to its historical flood plain would enhance juvenile salmon refuge and rearing habitat and increase the foraging opportunities for adult resident fish. Setting the levee back would also improve the visual quality of the river as it returns to a more natural condition. No significant negative effects to aesthetics and recreation are expected from the LPP/TSP.

4.20.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to aesthetics and recreation under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). No significant negative effects to aesthetics and recreation are expected under the NED.

4.21 Transportation, Public Services, and Utilities

Route 162 runs through Orting from southeast to northwest and has approximately 17,000 average annual daily travelers. There is moderate to significant congestion during rush hour, as the city has expanded quickly in recent years and has not been able to upgrade its infrastructure accordingly. There are two main evacuation routes in the area during flooding and lahar (a violent type of mudflow composed of a slurry of volcanic material, rocky debris, and water) events. The first of which is to the west across the Calistoga Street Bridge at the downstream end of Jones Levee, or to the southeast along Orville Road. The city of Orting provides a number of public services and utilities. No major utility corridors are present within the levee footprint.

4.21.1 Alternative 1 – No Action Alternative

As the population of Orting expands, the congestion in the area would continue to worsen until local or state governments carry out proper road expansions. Under future conditions, local roads would be flooded more frequently and result in temporary impacts to transportation and traffic until flood waters recede. There would be no significant impact to transportation, public services, and utilities under the No Action Alternative.

4.21.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, there may be temporary traffic impacts associated with hauling of levee material. Reduced flood risk may allow better access and availability of evacuation routes. No significant impacts to transportation, public services, and utilities would occur under the Raise-In-Place Alternative.

4.21.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, there may be temporary traffic impacts associated with hauling of levee material. Construction may temporarily affect public services and utilities. After construction, the Corps would restore or relocate effected public services and utilities, including stormwater connections. Reduced flood risk may allow better access and availability of evacuation routes. No significant impacts to transportation, public services, and utilities would occur under the LPP/TSP.

4.21.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to transportation, public services, and utilities under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). No significant impacts to transportation, public services, and utilities are expected under the NED.

4.22 Public Health and Safety

Pierce County and the city of Orting work together in numerous ways to protect public health and safety in relation to flood hazards. Flood education and outreach programs to property owners, including annual flood bulletins, are ongoing. Pierce County monitors National Weather Service flood information to support response activities. Emergency response activities are detailed within the County's Comprehensive Emergency Management Plan (Pierce County, 2014). All of these actions have resulted in Pierce County and the city of Orting to receive a rating of 2 and 6, respectively, within the FEMA National Flood Insurance Program Community Rating System. Pierce County, as a NFS, works with the Corps during screening level risk assessments to assess hazards and consequences related to the levee systems as well as to identify recommended actions to reduce risk to life safety.

4.22.1 Alternative 1 – No Action Alternative

This alternative would result in a continued increase in the risk to public health and safety over time. Due to the continuing sediment aggradation through this reach of the Puyallup River, the level of protection provided by the existing levee is slowly decreasing over time. This condition affects other levees around Orting. The No Action Alternative preserves the distance between the levee and the nearest residences behind the levee, acting as a buffer and increasing notice time if a levee breach or failure were to occur.

4.22.2 Alternative 2 - Raise-In-Place Alternative

This alternative provides a reduced risk to public health and safety from the existing condition due to an increase in the overall level of protection provided by the project. It preserves the distance between the levee and the nearest residences behind the levee, acting as a buffer and increasing notice time if a levee breach or failure were to occur. Due to sediment aggradation over time this alternative likely leads to a perching of the river channel and results in the levee being frequently loaded over a significant length of the project within the project life. This leads to an eventual increase in the overall risk of the project due to the potential failure of the levee leading to the river shifting into a populated area behind the levee.

4.22.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

This alternative provides a reduced risk to public health and safety over the duration of the project. The risk of flooding to the community behind the levee is reduced to an AEP of 0.2% (or 1 in 500 annual chance) from the current AEP of 1.4% (or 1 in 70 annual chance). The impacts of the sediment aggradation are generally reduced over the length of the project, resulting in only a short segment of the levee being frequently loaded at the end of the project life. By setting the levee back the facility is closer to the residences reducing the notice time given if there is a levee breach or failure. This alternative would also increase toe rock to 6- to 10-man rock. The larger rock would prevent levee degradation and breaches better than Class V riprap and reduce O&M costs and repairs in the future.

4.22.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to public health and safety under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). However, this alternative uses smaller toe rock than the LPP/TSP. The smaller rock size would increase O&M costs and repairs in the future.

4.23 Socio-Economics

The city of Orting has an estimated population of about 8,400 as of the 2018 U.S. Census estimate. Based on average population growth rates, the population in May 2020 is estimated at 8,900. The city of Orting is a rapidly expanding area and has seen extensive development over the last decade. The median household income is $80,500, with 9.3% of the population existing below the poverty line. 90.7% of the population has a high school education or higher, and the unemployment rate as of 2018 was 5.2%. While industry data for Orting, WA is unavailable, the largest employment sectors in Pierce County are in trade, transportation and utilities, followed by government. The Port of Tacoma and the necessary supporting services such as railroads and distribution centers provide many job opportunities to the surrounding communities.

4.23.1 Alternative 1 – No Action Alternative

This alternative is not expected to affect current socio-economic conditions. However, with continued development of Orting and increased flood risks in the future from both the Carbon and Puyallup Rivers, flood damages are expected to increase in the future without an action. No significant effects to socio-economics are expected under this alternative.

4.23.2 Alternative 2 - Raise-In-Place Alternative

This alternative would provide increased flood risk management to Orting in the near term, and decrease the flood damages experienced. Similar to the No Action, continued development of Orting and increased flood risks in the future from both the Carbon and Puyallup Rivers, flood damages are expected to increase in the future but less than those experienced in the No Action. At this time, no significant effects to socio-economics are expected under this alternative, but additional analysis will be conducted during the design phase.

4.23.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

This alternative would provide increased flood risk management to Orting in the near term, and decrease the flood damages experienced. Similar to the No Action, continued development of Orting and increased flood risks in the future from both the Carbon and Puyallup Rivers, flood damages are expected to increase in the future but less than those experienced in the No Action. At this time, no significant effects to socio-economics are expected under this alternative, but additional analysis will be conducted during the design phase.

4.23.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to socio-economic conditions under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). At this time, no significant effects to socio-economics are expected under this alternative, but additional analysis will be conducted during the design phase.

4.24 Land Use, Planning, and Zoning

The city of Orting, WA is a designated Urban Growth Area (UGA). This designation is intended to focus the urban growth necessary for the region to occur in areas that are already developed and prevent the expansion of development into otherwise pristine or alternative use lands. The Pierce County Comprehensive Plan dictates that UGAs will expand in the next 20 years and that expansion should continue in the years after the plan as well. Much of the surrounding areas north and west of Orting are either municipal areas or designated asUGAs. South (upstream the Puyallup River) is not designated as an UGA and should see less development in the next 20 years. If expansion degrades the ability of public services and infrastructure to keep up, then the UGA designation may be extended to currently undeveloped lands in the area.

4.24.1 Alternative 1 – No Action Alternative

Under this alternative, the current expansion of Orting and the surrounding area would not be changed or impacted. No significant impact to land use, planning, and zoning is expected under the No Action Alternative.

4.24.2 Alternative 2 - Raise-In-Place Alternative

Under this alternative, there may be temporary, minor delays to some activities related to development in the area. Ultimately this alternative would not change the future expansion of the area, and may further increase development if flood risk management lowers flood insurance costs. No significant impact to land use, planning, and zoning is expected under this alternative.

4.24.3 Alternative 3 - Levee Setback and Partial Removal (LPP/TSP)

Under this alternative, there may be temporary, minor delays to some activities related to development in the area. Ultimately this alternative would not change the future expansion of the area, and may further increase development if flood risk management lowers flood insurance costs. The setback requires the acquisition of lands which would prohibit those lands from future development. No significant impact to land use, planning, and zoning is expected under the LPP/TSP.

4.24.4 Alternative 4 - Levee Setback and Partial Removal (NED)

Impacts to land use, planning, and zoning under this alternative would be essentially the same as those under the LPP/TSP (Alternative 3). No significant impacts to land use, planning, and zoning are expected under the NED.

5 Tentatively Selected Plan / Agency Preferred Alternative*

The Corps has made a decision on a levee setback design for the Jones Levee Project TSP/LPP and has developed a 35% level design. The design comprises three major components: the setback levee, breaching the existing levee, and ELJs. The proposed design will setback the existing Jones Levee from directly on the river's edge landward towards the historical Holocene channel migration zone (i.e., the historic river channel in this area). This includes breaching section of the existing levee to allow for reconnection of the flood plain with the active river. Additionally, ELJs and woody material will be placed to help the river maintain alignment with the Calistoga Street Bridge while it adjusts into the setback area. The Corps will complete designs in D&I. See the Engineering Appendix A for the 35% design drawings.

5.1 Detailed Description of the TSP

5.1.1 Component 1 - Setback Levee

The proposed setback levee would replace the existing Jones Levee. The Setback levee is approximately 6,414 linear feet in length and provides an AEP of 0.2% (Elevation 238.65' at the index point). The setback levee shifts the levee alignment from directly adjacent to the Puyallup River to back side of the remnant river channels on the right bank. The setback distance varies from approximately 100 feet up to almost 700 feet along the alignment of the levee, shifting the levee to the landward side of a wetland complex. This levee alignment is driven by minimizing impacts to the residential development occurring on the landward side and minimizing impacts to the wetland complex on the riverward side.

At the downstream end of the project, the setback levee ties into Calistoga Ave, adjacent to the Calistoga Bridge, to form a continuous profile with the Calistoga Levee. The abutment and first bridge pier on the east side of the bridge is not currently exposed to direct river flow and is not designed for the expected erosive forces. This project expects that in the future the last span of the bridge will be opened to river flow, exposing that pier to river flow. However, the project does not propose to modify the bridge pier so a small section of the existing levee and the access road would be armored to protect the bridge pier. The sponsor is expected to rework the pier and abutment armor in the long-term, which will open up conveyance through the bridge.

The upstream end of the setback ties into high ground in a field approximately 700 feet landward of the existing levee. An access road extends from the end of the levee to 178th Ave E where access can then be made to the remaining upstream levee segments.

The setback levee will have side slopes between 2 horizontal to 1 vertical (2H:1V) and 3:1 with a 15-foot-wide gravel surface for vehicle access. The levee will be armored with a 4-foot thick blanket of Class V riprap and a buried toe of various sizes of jetty rock (4- to 10-man rock) to help mitigate scour concerns. The landward side of levee also includes a drainage swale to capture local storm drainage. Stormwater collected is conveyed through the levee via three 12-inch culverts located at low points along the levee alignment.

5.1.2 Component 2 – Breaching the Existing Levee

The existing Jones Levee will be abandoned in place with the exception of a small levee segment directly adjacent to the Calistoga Bridge and the section referred to as the Matlock Cutoff at the upstream end of the existing levee. The small segment adjacent to the Calistoga Bridge is kept to protect the existing right abutment and bridge pier. The Matlock Cutoff diverts flow back into the river if the Ford Levee were to breach and serves as an access road to the downstream end of the Ford Levee. The existing Jones Levee will be breached in five locations allowing the river to regain access to the disconnected floodplain. The levee breaches will remove enough existing levee embankment and riprap armoring to allow the river to engage the setback area at flows beginning at ordinary high water (a few times a year) to an annual event.

The breaches have been strategically placed in tandem with ELJ's to encourage the river to make a slower transition into the setback area, which is generally the lowest terrain and to avoid the river adversely impacting the Calistoga Street Bridge. Sections of the levee left in place between the breaches will be inaccessible and will not be maintained or repaired once construction is complete. Breaches should not allow the channel to permanently migrate into the setback area. As sediments deposit and the setback area evolves, it is expected that the full width of the river between levees will become a braided network of channels and pools.

Clearing riparian vegetation will be necessary when removing material from the existing levee. The cleared areas will be replanted with native vegetation (hydroseed, shrubs, and trees). A planting plan will be developed in D&I. Potential native species include black cottonwood, Douglas fir, Sitka spruce (*Picea sitchensis*), Western red cedar (*Thuja plicata*), Pacific willow

(*Salix lucida*), Sitka willow (*Salix sitchensis*), vine maple (*Acer circinatum*), snowberry, Pacific ninebark, wild rose, and salmonberry (*Rubus spectabilis*). Plantings will likely be bare rootstock and planted in February-March.

5.1.3 Component 3 – Engineered Log Jams

For the feasibility phase, two previously designed ELJ's were adopted. The Seattle district has a long history of designing and building ELJ's in similar river environments. Prior designs selected were estimated to be adequate for the feasibility phase and provide the necessary cost information to inform the design. Designs will be finalized during the Design & Implementation phase and stability refined with the most recent hydraulics and boring data. The two ELJs selected are described below. Additionally, several locations of large wood racking are provided.

Bar Apex Jam

Bar apex jams are intended to provide a robust, cost effective ELJ that can be installed efficiently in a wide range of locations where bar apex or flow deflection functions are desired. This structure is shown in Figure 5-1. Each medium bar apex jam is about 60 feet wide and 80 feet long and embedded 3 to 6 feet below the local streambed reference elevation (not including pile depth). The jam height is about 10 feet tall, slightly taller than the adjacent levee, to maintain safety factors against buoyant uplift. The dimensions of this ELJ are adequate to fit into prescribed locations. The ELJ height, inclusive of racking material in the scour pool, is 16 feet. This ELJ would be anchored with 10 untreated Douglas fir pilings (driven below maximum scour depth) and on-site streambed ballast excavated from the pre-formed scour pool, if suitable. About 25 logs, 30 to 50 feet in length (some with root wads attached), compose each structure. Unspecified racking logs (non-conifer or conifer) will be placed in front of the structure in the pre-formed scour pool. Logging slash consists of branches, treetops, roots, and small logs. Maximum depths near the structures in a 1% AEP (100-year) storm could approach 7 feet, and maximum velocities could approach 8-feet-per-second (ft/s).

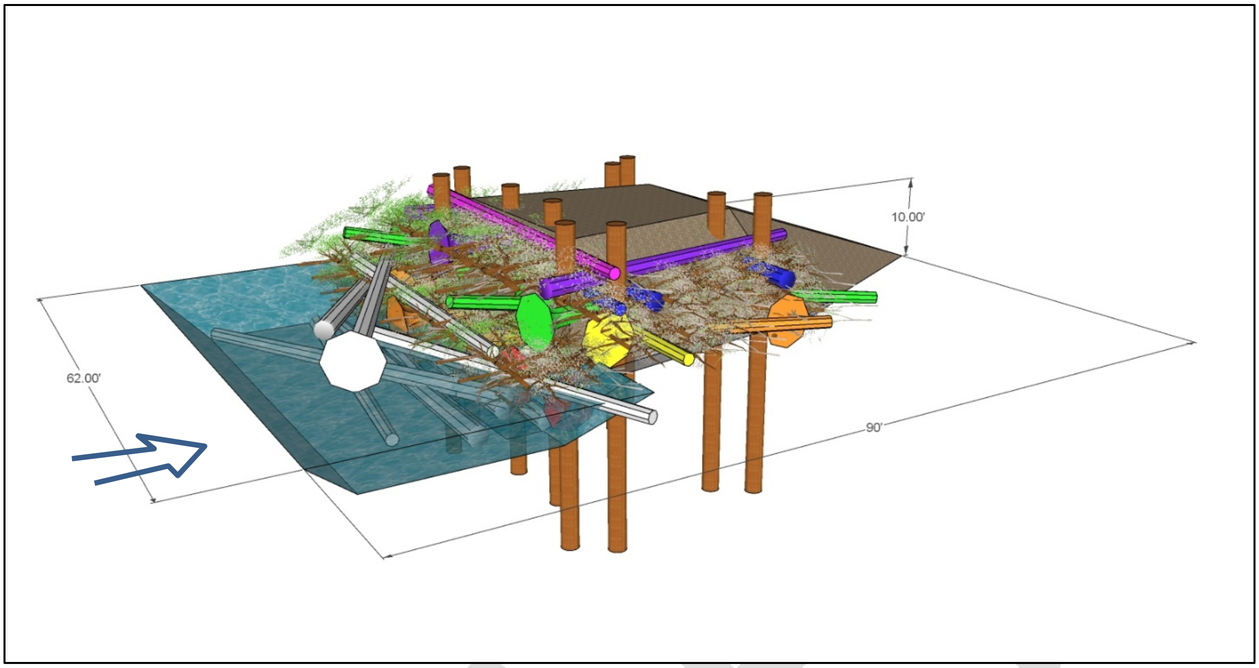

Figure 5-1: Bar Apex Jam

Three medium bar apex jams are proposed, both in the narrow mid-section of the setback area. Bar apex jams are intended to withstand the full force of flows through the setback area but have a small footprint to fit between the existing levee remnants and the new levee alignment. These ELJs will serve a flow deflection function to return significant flow that enters the setback area back into the existing main channel at several intervals along the reach. Locations are given in the table below, including at the downstream end near the bridge.

<u>Deflector Jam</u>

Bank deflector jams are intended to provide robust performance in critical locations where reliable flow deflection is required to achieve project success. Each large bank deflector jam is about 50 feet wide and 70 feet long, and embedded 3 to 7 feet below the local streambed reference elevation (not including pile support depth). The figure below shows what this ELJ would look like. The ELJ height is about 10 feet above the local reference plane, slightly higher than the adjacent levee to maintain safety factors against buoyant uplift. The total ELJ height, inclusive of racking material in the scour pool, is 17 feet. Racking logs and logging slash are incorporated to help reduce the porosity (thereby reducing internal drag forces), emulate natural logjams, and deflect flows away from the pilings and ballast. Chain lashing, diagonal bracing, and tieback logs also provide additional torsional/shear resistance. This ELJ would be anchored with 21 untreated Douglas fir pilings and on-site streambed ballast excavated from the pre-formed scour pool, if suitable. About 50 pieces of LWM in total, consisting of 30- to 60-foot logs and logs with root wads, compose each structure. Unspecified racking logs (non-conifer or conifer) will be placed in front of the structure in the pre-graded scour pool. Logging slash consists of branches, treetops, roots, and small logs. Maximum depths near the structures in a 1% AEP (100-year) storm could approach 8 feet, and maximum velocities could approach 8 ft/s.

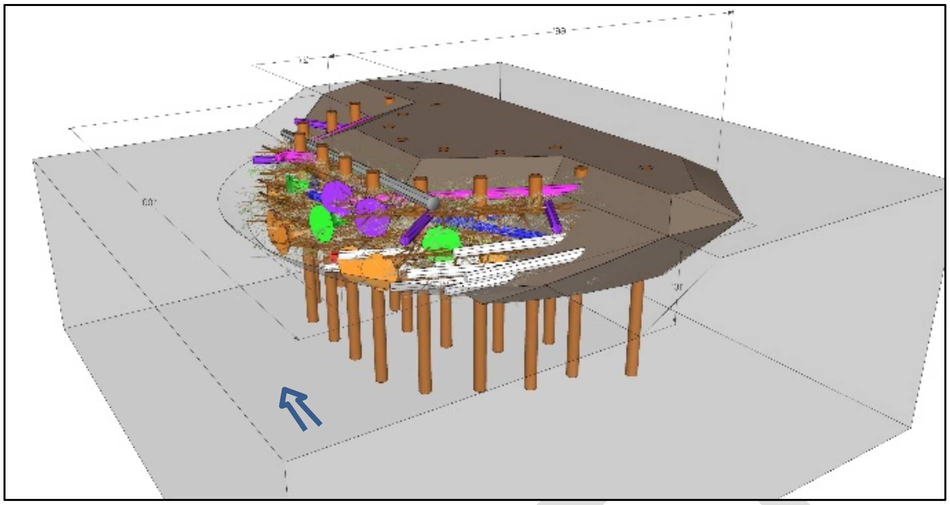

Figure 5-2: Bank deflector jam (shown in left and right configurations)

One large bank deflector jam is proposed. The bank deflector jam is intended to withstand the full force of flows in the setback area during the 1% AEP event, and have a larger footprint and hydraulic effect than the Bar Apex jam. This ELJ is located at the downstream one-third point of the setback area to provide erosion resistance at a bend in the new levee alignment to prevent the channel from entering the lowest elevation area and flow from impinging on the new levee. Locations are given in the table below.

5.2 Tentatively Selected Plan Optimization

The estimated project first cost of the TSP is $20,120,000. Estimated average annual first costs are $810,000 including IDC based on a 2.5% interest rate, a period of analysis of 50 years, construction ending in approximately 2024 (estimated 24 month construction duration), and annual operations and maintenance estimated at approximately $25,000 per year. The total average annual flood risk management benefit is estimated at $2,310,000 with net benefits of $1,500,000 and a benefit-cost ratio of 2.9 to 1 as shown in Table 5-1.

Table 5-1. Cost and Benefit Summary of the Recommended Plan

Cost and Benefit Summary of NED Plan (October 2022 price level)	
Interest Rate (Fiscal Year 2021)	2.5%
Interest Rate, Monthly	0.21%
Construction Period, Months	24
Period of Analysis, Years	50
Investment Cost	$21,180,000
Estimated Cost (Oct 2021 price level)	$20,120,000
IDC	$1,060,000
Total Annual Cost	$810,000

Average Annual Cost	$785,000
OMRR&R	$25,000
Average Annual Benefits	$2,310,000
Net Benefits	$1,500,000
Benefit-Cost Ratio (2.5%)	2.9

5.3 Cost Sharing

Feasibility costs are shared 50% Federal and 50% non-federal, D&I is cost-shared 65% Federal and 35% non-federal. The 35% non-federal costs includes credit for lands, easements, rights-of-way, relocations, and disposal areas (LERRDs), and a combination of cash and work-in-kind services. The NFS must provide at least 5% in cash contributions for flood risk management projects.

Based on October 2021 price levels, the estimated project first cost of the LPP is $20,120,000 (including preconstruction engineering and design (PED), construction costs, lands and damages, and contingencies). Costs in excess of the NED Plan (Alternative 4), $3,700,000, are 100% non-Federal expense. The value of LERRDs is $2,938,000 and is a 100% non-Federal responsibility. Costs are further adjusted to reflect the minimum 5% non-Federal cash contribution ($1,006,000). All costs in excess of the Federal CAP spending limit are 100% non-Federal responsibility. This brings the Federal share of the project first cost of the LPP to $10,000,000 and the non-Federal share to $11,195,000. The fully-funded cost estimate to the mid-point of construction is $21,186,000. See Appendix E, Cost Estimate, for more details. Table 5-2 details the cost share of the feasibility and design and implementation (D&I) phases.

Table 5-2. TSP Cost Estimate and Cost Share (October 2021 prices, $1,000s)

	Federal	Non-Federal	Total
Feasibility Costs	$538	$538	$1,075
Design and Implementation (D&I)			
Construction	$11,175	$-	$11,175
Construction - Betterment (LPP)	$-	$3,700	$3,700
LERRD	$-	$2,938	$2,938
PED	$1,731	$-	$1,731
Construction Management	$577	$-	$577
Subtotal Design and Implementation	$13,483	$6,638	$20,120
Additional Cash Constribution			
Minimum 5%	$-	$1,006	$1,006
Additional Cash Contribution*	$-	$-	$-
Additional Non-Federal Costs in Excess of Federal Participation Limit	$(4,021)	$3,014	$(1,006)
D&I Cost Share	$9,463	$10,659	$20,120
Total Cost Share (Feasibility + D&I)	$10,000	$11,195	$21,195

***Adjusted to reflect maximum Federal cost share of $10 million for total project, including feasibility phase.**

5.4 Design and Implementation (D&I) Considerations

5.4.1 Data Needs

During D&I there will be a need for new survey and geotechnical data to be collected. A Civil Site Survey of the project area should be completed to better inform design grading and any potential utility/stormwater concerns. A geotechnical investigation will need to be performed to gain a better understanding of the material used in the existing levee and what types of materials on which the new levee will be constructed. LiDAR data from 2019 will also be incorporated into the design as the most recent topography for the study area.

5.4.2 Design Considerations

- The hydraulic model should be updated with the most recent LiDAR data from 2019, and the model calibration checked. The sediment transport model should also be checked for calibration.
- Further discussion should be had with the sponsor regarding the east most bridge span. It may be a minor cost to armor the bridge pier sufficiently, there was insufficient time to fully evaluate that option during feasibility.
- There are multiple developments that are in the permitting/construction phase currently along the backside of the setback alignment. The PDT needs to work with Pierce County and the city of Orting to verify the location of any new developments and confirming the locations of the ones in construction.
- The PDT needs to coordinate with the sponsor further on the proposed rock size to ensure they are satisfied with the proposed scour protection.
- The breach locations, extends, and depths needs to be further refined and solidified during design.
- The Engineered Log Jams and racking material location and quantities need to be further defined so the designs can proceed forward.
- The PDT needs to remain aware that this project will be constructed using the rental equipment program. The plans and specification should be written accordingly. Effort should be made by the PDT to keep the design within the scope of the rental equipment programs capabilities.
- The County has a local rock quarry that is a possibility for the required armoring, this should be further explored during design because it could be a large cost savings for the project.
- Both Howard Hanson and Mud Mountain Dam have large wood material that may be used for the ELJ material and Racking material. This should be further explored during design as it could be another cost savings measure.
- The PDT also needs to further refine where all the excess material will be placed on site. Concepts were to cover all of the new riprap with a soil berm and possibly spreading over the existing levee.

5.5 Environmental Considerations

5.5.1 Best Management Practices and Mitigation*

NEPA requires that agencies identify and include in the action all relevant and reasonable measures that could reduce negative effects of the federal action. The project would not require mitigation given the significant environmental benefits anticipated, but the Corps is committed to applying conservation measures and BMPs similar to measures and practices provided in past Corps levee projects to reduce environmental impacts.

Conservation Measures

For this project, the Corps has developed a list of conservation measures and incorporated these into the levee design to reduce environmental impacts of the project to endangered and threatened listed species and designated critical habitat. This list may be further developed during D&I after feasibility:

- Project Design: The proposed action is a levee setback that would reconnect the floodplain to a wetland and riparian area separated since at least the 1960s.
- Clearing and Grubbing: Woody material would be reused onsite to the greatest extent possible. Invasive vegetation would be removed from the construction footprint. A source of other LWM to be determined in D&I. One possible source is Mud Mountain Dam operations.
- Revegetation: Disturbed soils within the project footprint would be restored with topsoil where appropriate and replanted with native species (hydroseed, shrubs, and trees). A planting plan will be developed in D&I.
- Construction Timing: All in-water work would occur during the established work window of July 15 to August 31 to reduce impacts to aquatic species.
- Construction Sequence: The Corps plans to complete most of the work before breaching the existing levee to reduce impacts to the mainstem of the Puyallup River.
- Seclusion: The Corps would determine the need for seclusion devices and structures to reduce noise and turbidity impacts during construction. Devices that may be used include bubble curtains to reduce noise impacts from ELJ construction and silt curtains to reduce turbidity during in-water work. Fish exclusion methods are not anticipated to be necessary because in-water work would occur within the approved in-water work window.
- In-water Rock Placement and Removal: All rocks would be carefully placed or removed from below the water surface individually or in small bucket loads. Dumping rocks in water would not occur. Equipment would operate slowly when in water to allow the fish time to move away.

Best Management Practices

The following BMPs would be followed during construction. Some are integrated into the project, while others are guides to the operation and care of equipment. This list may be further developed during D&I after feasibility.

- All in-water work would be scheduled within the in-water work window (July 15 to August 31).
- To avoid wetland impacts and increase floodplain reconnection benefits, the project design is being developed to increase the setback area and reduce the setback levee footprint to the greatest extent practicable.
- Erosion control practices would be implemented (e.g. silt fencing, swamp mats, covering stockpiles if rain is forecasted, coir logs, etc.).
- Clean rock would be used.
- Levee rock on the new setback would be covered with native sediments and hydroseeded.

- Material placed in the water shall be placed individually or in small bucket loads (riprap, spall rock). No in-water rock dumping is allowed.
- Wood piles would be installed using a vibratory hammer. Impact hammers would not be used.
- Water quality monitoring for turbidity would be conducted during construction. The Corps anticipates the need for a WQC from Ecology, which would be obtained during D&I. Additional BMPs related to water quality will be considered during D&I, such as silt curtains.
- Vegetation removal would be limited to the smallest extent possible.
- Disturbed soils would be revegetated native vegetation.
- Woody material generated by the action would be reused in the ELJs or placed in the river or setback area for habitat. Rootwads would remain attached to the tree to the extent feasible.
- All site access routes and staging areas would be repaired and hydroseeded as appropriate to restore the project to preconstruction conditions or better.
- Equipment maintenance and refueling would take place away from the river and other waters of the U.S. and use best practices and methods to prevent and respond to spills or leaks.
- Equipment used near the water would be cleaned before construction.
- Biodegradable hydraulic fluids would be used in machinery where appropriate.
- Construction equipment shall be regularly checked for drips or leaks. Any leak would be fixed promptly or the equipment removed from the project site.
- Fuel spill kits with absorbent pads would be onsite at all times.
- All trash and unauthorized fill resulting from construction activities would be removed from the construction and staging areas, including but not limited to concrete blocks or pieces, bricks, asphalt, metal, treated wood, glass, floating debris, and paper, and disposed of properly.

5.5.2 Unavoidable and Adverse Effects

Unavoidable adverse effects associated with the TSP are: (1) temporary and localized increases in noise, activity, and emissions which may affect fish and wildlife in the area; (2) temporary and localized disruption of local traffic by construction activity and vehicles; (3) irretrievable commitment of fuels and other materials for repairs; (4) temporary and localized increase in turbidity levels during in-water construction which may affect aquatic organisms in the area; and (5) removal of vegetation from within the construction footprint; (6) permanent loss of wetland and riparian areas due to setback construction.

NEPA requires that environmental analysis include identification of “any irreversible and irretrievable commitments of resources which would be involved in the preferred alternative should it be implemented.” This clause refers to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from using or destroying a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable period. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored because of the action (e.g., extinction of a species or the disturbance of a cultural site).

The Recommended Plan would result in an irreversible use of fossil fuels to execute the construction of the project. Machinery types were estimated during the cost estimate work for the alternatives analysis. The proposed federal action is designed to have a minimal irreversible and irretrievable commitment of resources. Most construction effects are assumed to be short-term reductions in fish and wildlife and vegetation resources, which would recover and improve their abundances under the setback design. In areas where the new levee footprint encroaches on wetlands, there will be a reduction in wetland function and value. This reduction will be offset by the project design reconnecting the floodplain, which would improve the function and value of the affected wetlands.

5.6 Summary of Economic, Environmental and Other Social Effects

Four accounts were evaluated on the optimized plan to include NED, Regional Economic Development (RED), Environmental Quality, and Other Social Effects (OSE). The summary of impacts under these four accounts is summarized in Table 5-3 or elsewhere in the report as indicated in the table.

Table 5-3. Summary of Accounts for Economic, Environmental and Other Social Effects of TSP

Evaluation Account	TSP - Levee Setback
NED Account	The NED account displays changes in the economic value of the national output of goods and services. The current design of the TSP NED Plan provides an estimated $xx in equivalent average annual benefits, with mean net benefits of $xx and a mean benefit-cost ratio of x (ranging from x to x with a 75% - 25% confidence bound, respectively) at the October 2019 price level and the FY2020 Federal discount rate of 2.75%. The figures above reflect the most recent feasibility-level analysis (NED Optimization) in Section 5.2 which maximizes net benefits within the CAP Section 205 cost limits.
RED Account	The Regional Economic Development (RED) account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output and population. The Corps certified model RECONS 2.0 was applied to the TSP and is presented in Section 7.2 of Appendix C
Environmental Quality Account	Environmental Quality information is presented in Section 4 of the main report for the TSP plan.

Evaluation Account	TSP - Levee Setback
OSE Account	The Other Social Effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts and includes impacts to life safety. The current proposed design meets Corps Tolerable Risk Guidelines 1 and 4 to the extent practicable, reducing flood risk to public infrastructure and improving overall levee reliability. A levee risk assessment was completed as part of this feasibility effort.

5.7 Division of Plan Responsibilities, Cost Sharing and Other Non-Federal Responsibilities

Upon approval of a final integrated IFR/EA for the Jones Levee CAP Section 205 project, a Project Partnership Agreement (PPA) would be executed. A PPA is a legally binding agreement between the federal government (in this case, the Corps) and a NFS (in this case, Pierce County) for the construction of a Flood Risk Reduction Project. The PPA would describe the project and the responsibilities of the Corps and the NFS in the cost sharing and execution of project work.

Following the execution of the PPA, the D&I phase is the second phase of a CAP project and is a 65% federal and 35% non-federal cost share and is completed by the Corps. Federal investment is limited to $10,000,000 per project. The Corps would complete design, issue the construction contract, and conduct contract supervision and administration. Upon completion of the project and final inspection, the Corps will finalize the O&M Manual and turn the project over to the NFS for O&M for the life of the project.

5.7.1 Federal Responsibilities

To implement the recommended plan, the Corps would provide the federal share of project cost, to equal project first cost less the total non-federal share, not including Annual O&M expenses. The federal share of the project cost is currently estimated to be $10,000,000 Cost-shared federal expenditures on any one project under Section 205 authority may not exceed a total of $10 million. The Corps would also provide the following:

- Review and certification of Real Estate provisions.
- D&I of the project.
- Contracting for project construction.
- Supervision and Administration of project construction.
- Finalize O&M Manual and turn project over to NFS for O&M for the life of the project.

5.7.2 Work-in-Kind

Work-in-Kind (WIK), or in-kind contributions, is defined as those materials or services provided by the NFS that are identified as being integral to the Project. To be integral to the Project, the material or service must be part of the work that the Government would otherwise have undertaken for the design and construction of the Project. The in-kind contributions also include any investigations performed by the NFS to identify the existence and extent of any hazardous substances that may exist in, on, or under real property interests required for the Project. In some cases, completed WIK may be credited by the Corps to the NFS, resulting in a reduction of their cash contribution on behalf of the project. At this time, no WIK has been identified. That exercise will take place as part of the PPA negotiations and execution.

5.7.3 Lands, Easements, Rights-of-Way, Relocations, and Disposal Areas (LERRD)

The Real Estate Plan is in Appendix G. The report is tentative, for planning purposes only, and for use with this integrated IFR/EA, pending any modifications to the plans during the D&I phase, following completion of the feasibility phase.

The proposed project footprint includes 83.65 publicly and privately owned acres spread over 26 parcels. Current land uses for properties required to support the proposed projects are agricultural, residential, open space/recreational, utility right of ways, and, public right of ways. The project lands include low-density agricultural and open space/recreational properties. The NFS must certify appropriate realty interest as defined by the Government in all lands required for the construction, operation, and maintenance of the project. The NFS shall also prepare or ensure the preparation of plans and specifications for, and perform or ensure the performance of, all utility, family, and business relocations the Government determines to be necessary. Real Estate interests covering known Unimproved parcels include perpetual Flood Protection Levee Easements (60.71 acres), Flowage Easements on lands that project-induced flooding may rise to the level of a legal Takings (14.36 acres), and a two year Temporary Work Area Easement (4.36 acres). Potential Land acquisitions will be confirmed during D&I.

Potential Improved lands acquisitions consist of three parcels that require further H&H Sensitivity Analysis. Further H&H will be completed during D&I.

The NFS owns five parcels/approximately 15 acres of Project land in fee and is able to certify real estate interest required to support project features that will be conducted thereon. The NFS is positioned to acquire an interest in those lands where it does not currently own real estate interest. The NFS is deemed highly Capable of acquiring real estate based upon their current funding, staffing expertise, and previous acquisition experience. The Real Estate Acquisition Capability Assessment is being updated to include this Project.

The total Estimated LERRD cost for known unimproved lands is $1.79 Mil, including a 30% contingency. There are three potential improved parcel acquisitions that depend upon the outcome of further H&H Sensitivity Analysis and the Final Takings Analysis that will be conducted during D&I. The estimated cost of the potential improved parcels would be $1.675Mil, including a 30% contingency. Valuation estimates were sourced from the District's Land Cost Estimate Report. The Valuation Effective date is 18 March 2020. The administrative cost estimate for known unimproved parcels is $218,875; administrative incidental costs covering the three potential improved parcels are $38,625. There are wetlands throughout the project footprint, and a large portion of the lands are located within the 1% AEP floodplain (i.e., the portion of the floodplain that has a one in one hundred chance of flooding any given year). Given those factors, future marketable usage is unlikely.

Suitable materials will be reintroduced to the new project; unsuitable materials (if any will be shipped to a commercial disposal facility.

5.7.4 Sponsor Views

The Sponsor has completed a considerable amount of public outreach in support of this project and has engaged with other local agencies including the City of Orting. The Sponsor . The Sponsor understands the cost share for D&I of the recommended plan is 65% federal and 35% non-federal.

5.7.5 Operation, Maintenance, Repair, Rehabilitation, and Replacement

is the NFS operates and maintains Jones Levee and other non-federal levees throughout Pierce County. After completion of construction, the NFS will assume operations and maintenance (O&M) responsibility for the entire project and is responsible for all long-term project operations, routine maintenance, repairs, replacements, and rehabilitation following completion of construction. If the project is approved, a detailed OMRR&R manual would be developed during the D&I phase and would be submitted to the NFS upon completion of construction. The current working estimate is $15,000 per year and includes the following activities:

- Mowing grass on levee at least once annually.
- Grading access road on levee crown; filling potholes.
- Removing woody vegetation from the levee embankment.
- Implementing animal control program to preclude or remove burrowing animals from the levee embankment.
- Video inspecting interior of culvert pipes no less than every 5 years; making any necessary repairs.
- Removing debris or buildup from drainage ditches in order to maintain conveyance capacity.
- Routine maintenance activities on the existing downstream culvert with closure.

The proposed setback levee is anticipated to experience less erosion than the existing levee located immediately adjacent to the river. This should reduce the frequency and severity of erosion damages requiring repair. Furthermore, the proposed setback includes buried rock slope protection, and extra volume for anticipated scour that may be experienced.

Over time, it is likely that culvert pipes through the levee may age, deteriorate, or otherwise suffer damage requiring repair, such as slip-lining or replacing.

5.8 Risk and Uncertainty

Risk and uncertainty are fundamental to all water resource planning and communication. This study incorporated risk management framework principles and risk-informed planning into its plan formulation process. Risk analysis and communication was used following ER 1105-2-101, *Risk Analysis for Flood Damage Reduction Studies*, and Engineering Manual (EM) 1110-2-1619, *Risk-Based Analysis for Flood Risk Management*. Construction cost uncertainty was captured with a contingency that was developed in accordance with ER 1110-2-1302, *Civil Works Cost Engineering*. Risks to project cost and schedule were documented in a risk register. Risks were assessed and managed throughout the study process in coordination with the Corps' Vertical Team. A summary of specific risk and uncertainty remaining is described below.

5.8.1 Cost Constraints

Under the Continuing Authorities Program (CAP), federal contribution to the project is capped at $10 Million. The total project cost is calculated based on the anticipated cost share percentage for the NFS, which is 35% for this project or $5,384,615, and is not to exceed $15 Million regardless of NFS percentage.

The project team has used a risk-based strategy in their approach to evaluating overall project costs. To that end, the biggest cost risk identified was around the acquisition strategy for the construction of the project. Typically, the Corps would seek a standalone design big build contract for this kind of project. Using commensurate projects of similar nature, the estimated costs to execute such a contract become cost-prohibitive and far exceed the CAP total project cost of $15 Million. The project team reached out to the Corps' Emergency Management group, which is responsible for all PL 84-99 actions, to see if they have alternative contract types that could be leveraged for this project. It was determined that a rental equipment contract combined with in-house oversight could reasonably produce the same level of levee quality and construction for roughly half the price. As an added measure, the team will work with construction to ensure enough QA/QC oversight is available. Rental Equipment Acquisition/Construction Strategy

The preliminary real estate requirements for the Lands, Easements, Rights-of-Ways, Relocations, and Disposal Areas (LERRD) needed to support the construction, O&M of the recommended features for the proposed TSP Alternative have been evaluated. Due to the project boundaries relative to existing parcel lines and or improvements within the project area, the acquisitions will likely result in a full take of the parcel due to damages to the remainder. The total estimated real estate land value is $2.54Million, placing projected total project costs at $16 Million. This value exceeds the CAP limit by $1 Million, and so the project team will use the design phase to further refine the levee alignment and inundation maps to reduce real estate costs.

5.8.2 Flood Risks

Following methods given in Engineering Manual (EM) 1110-2-1619, an uncertainty analysis was conducted to estimate total standard deviation in stage error, which represents the total estimate of stage variation due to the sources of uncertainty considered. Results were used to inform the economic analysis. Sources of uncertainty were screened in order to not double count and generally fell between hydrologic and hydraulic sources. Hydrologic uncertainty is considered separately in the economic analysis from hydraulic uncertainty. Several sources of uncertainty are considered in the analysis:

- Variation in river channel hydraulic roughness (i.e. Manning's roughness coefficient)
- Accuracy of high watermark and/or water surface elevation readings
- Natural variation in river conditions through the reach
- Variation due to geomorphic change and sedimentation
- Variation in elevation of flood control works (i.e. levees, grade control, etc.)

Total uncertainty in stage is then the geometric mean of individual sources and results varied by condition. Four conditions were analyzed (Existing with- and without project, future with- and without project). Results were roughly 1 foot for existing conditions (both with- and without project), and roughly 2 feet for future conditions (both with- and without project). The largest individual source of uncertainty in the analysis is sedimentation. Future efforts for the design phase will likely reduce these uncertainties considerable as new data is acquired. The consequences may be high for this uncertainty in stage, due to water surface profiles for flow frequency events being close. With a likelihood of medium or high (we know variation will be at most between 0 and 2 feet, which equates to the difference between roughly a 0.2% AEP and a 2% AEP event) the resulting risk is high.

Erosion of flood control works on the Upper Puyallup reach has long been a source of risk. Many levee repairs in this high-energy environment have occurred from the 1950s to the present. Preliminary scour estimates developed at the scoping level, as well as analysis for similar projects on the river, have shown potential scour depths of a few feet to over 20 feet. These depths are often predictions based upon empirical equations developed from a wide range of systems. Large scour depths and rock size ultimately require a significant cost. A high level of detail was desired from hydraulic modeling due to this significant cost component. Scour analysis and rock sizing were informed by 2-dimensional modeling of the with-project condition. Even with detailed modeling, safety factors of 1.3 were factored in to account for the variation of future hydraulic conditions. The largest potential scour depths, and rock size were needed at the downstream end of the levee, where both a contraction of the channel and a bend direct flows through the bridge. Estimated potential scour depths below the bed there approached 13 feet and rock size with a mean diameter (d50) of 1.8 feet (or 800 lbs). Toe rock in this area was increased one size in class for added conservatism. The remainder of the levee was given a d50 of 1.5 ft (500 lbs), and scour potential varied between 5 and 8 feet. The consequences of levee failure due to erosion can be very high, however, given detailed analysis and safety factors used for feasibility, the likelihood is low, which gives a medium risk. Future design efforts will likely improve accuracy in modeling, but with high consequences, the risk will still likely be medium. Expressed methods of protection configuration varied between the sponsor and the Corps. The sponsor has typically used very large stone for toe protection (on the order of boulder size), with typical rip rap rock gradations used above that for slope protection. The methods typically employed by the Corps for estimating revetment rock size are not able to give such sizes, because the configuration is significantly different than what equations are developed for (i.e. individual large boulders vs. graded rock). Future efforts for design phase will likely reduce uncertainties, and it is hoped that a better agreement on configuration can be reached.

The terrain LiDAR dataset used for this study was collected in 2009 and may be considered dated. While new LiDAR is expected, it will not be available to inform the feasibility phase design. As such, uncertainty exists in several areas: the river channel between levees has changed observably due to sedimentation, the levee may have settled (although this is likely minor), LiDAR technology in 2009 did not penetrate the wetland ponds behind the existing levee very well (and consequentially the levee landside toe is obscured), and the tie-in to Calistoga Ave has changed from what is depicted in the LiDAR (due to the Calistoga levee setback adding a new access ramp and gate at the downstream end of the Jones Levee). Field surveys were performed (of in-channel cross-sections and the access ramps at the bridge) to mitigate some of these sources. While these sources of uncertainty are not critical, they may affect quantities of levee fill and in-channel hydraulic modeling. Uncertainty has been accounted for in both these efforts and is expected to be reduced significantly when new LiDAR is acquired. With low consequences and high likelihood, the risk is medium.

5.8.3 Environmental Liabilities

ESA consultation with USFWS and NMFS is complete. The Corps will continue to assess impacts to ESA-listed species and their critical habitat throughout D&I and will reinitiate consultation as necessary. Consultation may be reinitiated if new species or critical habitats are listed or if design work results in new or additional impacts not evaluated during feasibility.

As pre-application coordination, the Corps submitted draft documents essential to requesting a 401 WQC and concurrence with the Coastal Zone Management Act Consistency Determination from Ecology. Further design and engineering will be completed in D&I. Any changes in footprint or design will need to be evaluated for environmental compliance. See Section 6.5 and 6.6 for more details.

6 Compliance with Applicable Environmental Laws, Regulations and Executive Orders*

This chapter describes how the recommended plan (TSP) complies with all applicable federal environmental laws, statutes, and executive orders.

6.1 American Indian Religious Freedom Act

The American Indian Religious Freedom Act of 1978 (42 U.S.C. 1996) establishes protection and preservation of Native Americans' rights of freedom of belief, expression, and exercise of traditional religions. Courts have interpreted this Act to mean that public officials must consider Native Americans' interests before undertaking actions that might impact their religious practices, including impact on sacred sites.

No alternative is expected to have any effect upon Native Americans' rights of freedom of belief, expression, and exercise of traditional religions. There are no known cultural resources, or any sacred sites, at the project location. Nor were there any identified by the Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Nisqually Tribe, Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation.

6.2 Bald and Golden Eagle Protection Act of 1940

The Bald and Golden Eagle Protection Act (16 U.S.C. 668-668d) prohibits the taking, possession or commerce of bald and golden eagles, except under certain circumstances. Amendments in 1972 added to penalties for violations of the act or related regulations. There are no known eagle nests in the project area. The TSP is not expected to harm bald or golden eagles. Potential impacts to bald and golden eagles will be evaluated again in D&I.

6.3 Clean Air Act of 1972

The Clean Air Act (42 U.S.C. § 7401, et seq.) requires states to develop plans, called State Implementation Plans, for eliminating or reducing the severity and number of violations of National Ambient Air Quality Standards while achieving expeditious attainment of the National Ambient Air Quality Standards. The Act also requires federal actions to conform to the appropriate State Implementation Plan. An action that conforms to a State Implementation Plan is an action that would not:

1. Cause or contribute to any new violation of any standard in any area;
2. Increase the frequency or severity of any existing violation of any standard in any area; or
3. Delay timely attainment of any standard or any required interim emission reductions or other milestones in any area.

Activities during the proposed project would have short-term effects to air quality. There would be a temporary increase in emissions during equipment operation; however, the effects would be minimal given the short duration of the action and type of equipment needed. The pollutant production from equipment would contribute only a small fraction to global greenhouse gas emissions. The proposed alteration is not in an area of concern. Therefore, the proposed project is in compliance with this Act.

6.4 Clean Water Act - Federal Water Pollution Control Act

The Federal Water Pollution Control Act (33 U.S.C. 1251 et seq.) is more commonly referred to as the CWA. This act is the primary legislative vehicle for federal water pollution control programs and the basic structure for regulating discharges of pollutants into waters of the United States. The CWA was established to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The CWA sets goals to eliminate discharges of pollutants into navigable waters, protect fish and wildlife, and prohibit the discharge of toxic pollutants in quantities that could adversely affect the environment. Three sections of the CWA are pertinent to this project and are further described below.

<u>Section 401</u>

Any project that involves placing dredged or fill material in waters of the United States or wetlands, or mechanized clearing of wetlands, requires a WQC from the State agency as delegated by the EPA. For the Puyallup River, the delegated authority is Ecology.

Corps policy states that during the feasibility phase, a project recommended for construction authorization must show reasonable assurance that all applicable environmental compliance has been or can be obtained. The Corps submitted draft documents to Ecology as part of the pre-application procedures for requesting a 401 WQC to Ecology on May 14, 2021. These draft documents consist of the Corps' 404(b)(1) analysis and Coastal Management Act Consistency Determination. (Appendix B).

When the site-specific construction drawings and contract are prepared in D&I, the Corps will provide final versions of these and all other necessary documentation for Ecology as part of the request for WQC. The Corps will receive the WQC prior to the construction contract award.

<u>Section 402</u>

The NPDES controls discharges into waters of the United States. A NPDES permits contain industry-specific, technology-based, and/or water-quality-based limits and establish pollutant monitoring and reporting requirements. The EPA has established a program to address stormwater discharges. These regulations require that facilities or construction sites with stormwater discharges from a site that is one acre or larger apply for an NPDES permit. Stormwater discharge permits will provide the relevant authority for discharges from restoration sites during construction. Since the proposed project will likely require more than one acre of land disturbing activities, a NPDES construction site storm water runoff permit will be obtained by the Corps prior to construction.

<u>Section 404</u>

The Corps administers regulations under Section 404(b)(1) of the CWA, which establishes a program to regulate the discharge of dredged and fill material into waters of the U.S., including wetlands. The Corps has evaluated potential project-induced effects subject to these regulations during feasibility-level design, and the draft 404(b)(1) evaluation is provided in Appendix B. The proposed action is determined to be in compliance with the Section 404(b)(1) Guidelines. The Corps will complete the 404(b)(1) evaluation in D&I.

6.5 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) of 1972, as amended (16 U.S.C. § 1451-1464) requires Federal agencies to conduct activities in a manner that are consistent to the maximum extent practicable with the enforceable policies of the approved State Coastal Zone Management Program. The CZMA gives states the primary role in managing coastal and shoreline resources. Under Washington's Coastal Zone Management Program, federal projects that would affect land use, water use, or natural resources must demonstrate consistency with the enforceable policies of four State laws:

- Washington State Water Pollution Control Act
- Washington State Clean Air Act
- Washington State Ocean Resources Management Act
- Shoreline Management Act (including local government SMPs)

The Corps prepared a Draft Coastal Zone Management Consistency Determination (Appendix B) and submitted it to Ecology for review on May 14, 2021. Ecology reviewed the draft Coastal Zone Management Consistency Determination and provided general comments back on August 16, 2021. No project specific comments or concerns were received. Ecology clarified on August 19, 2021, that the review was not project specific but template oriented for future consistency determinations and that the Corps would need to resubmit the document when ready. When the site-specific construction drawings and contract are prepared in the D&I, the Corps will provide the consistency determination and all other necessary documentation for Ecology as part of the request for WQC. The Corps will receive CZMA concurrence from Ecology with the WQC prior to the construction contract award.

6.6 Endangered Species Act of 1973

In accordance with Section 7(a)(2) of the ESA of 1973, as amended, federally funded, constructed, permitted, or licensed projects must take into consideration impacts to federally listed or proposed threatened or endangered species and designated critical habitat. Section 4.16 analyzes project impacts to ESA-listed species in the project area.

The Corps has analyzed potential effects to ESA-listed species and prepared a BA that was submitted to the USFWS and NMFS on May 6, 2020 for formal consultation. The BA concluded that building the Section 205 Jones Levee Project would have the following effect levels:

- **No Effect** to the following ESA-listed species and their designated critical habitat: Green Sturgeon, marbled murrelet, streaked horned lark, and yellow-billed cuckoo.
- May Affect, not likely to Adversely Affect: SRKW, and eulachon.
- **May Affect, likely to Adversely Affect**: Coastal-Puget Sound bull trout, Puget Sound Chinook, and Puget Sound steelhead.

The BA also concluded that the proposed action would not cause the destruction or adverse modification of designated critical habitat for any species but would have **No Effect** to eulachon critical habitat and **May Affect, Not Likely to Adversely Affect** the critical habitat of Puget Sound Chinook, steelhead, bull trout, and SRKW.

Consultation is complete. The NMFS notified the Corps on May 8, 2020, that the Project meets the requirements of the Fish Passage and Restoration III Programmatic Biological Opinion (WCRO-2014-00004), concluding consultation for the ESA (Appendix B). On June 16, 2020, the USFWS notified the Corps that the project meets all the applicable criteria in the 2008 Fish Passage and Habitat Restoration Programmatic Biological Opinion (13410-2008-FWS-F-0209) for Activity Categories (AC) 2c: Installation of Instream Structures, Placement of Engineered Log Jams; and AC 3: Levee Removal and Modification (Appendix B). The Corps will continue to assess impacts to ESA-listed species and their critical habitat throughout D&I and will reinitiate consultation as necessary.

6.7 Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. §1801 et. seq.) requires federal agencies to consult with NMFS on activities that may adversely affect Essential Fish Habitat (EFH). The objective of an EFH assessment is to determine whether the proposed action(s) “may adversely affect” designated EFH for relevant commercial, federally managed fisheries species. EFH includes those waters and substrates necessary for fish spawning, breeding, feeding, or growth to maturity.

An effects analysis for EFH was included in the BA sent to NMFS on May 6, 2020. This analysis concluded that the project would include short-term adverse impacts during construction and so may adversely affect EFH. After the project is completed, there would be long-term benefits to EFH habitat.

Consultation is complete. The NMFS notified the Corps on May 8, 2020, that the Project meets the requirements of the Fish Passage and Restoration III Programmatic Biological Opinion (WCRO-2014-00004), concluding consultation under the Magnuson-Stevens Fishery Conservation and Management Act.

6.8 Migratory Bird Treaty Act of 1918

The Migratory Bird Treaty Act (16 U.S.C. §703-712), as amended, protects over 800 bird species and their habitat and commits that the U.S. will take measures to protect identified ecosystems of special importance to migratory birds against pollution, detrimental alterations, and other environmental degradations. Executive Order 13186 directs federal agencies to evaluate the effects of their actions on migratory birds, with emphasis on species of concern, and inform the USFWS of potential negative effects to migratory birds. The proposed setback would result in long-term benefits to migratory birds by restricting development in the floodplain and increasing the amount and quality of riparian and wetland habitat through floodplain reconnection, channel creation and restoration, and restored hydrology. Migratory bird habitat would be investigated during the D&I to determine whether any negative effects would occur. The Corps would coordinate appropriate actions with USFWS.

6.9 National Environmental Policy Act

The NEPA (42 U.S.C. § 4321 et seq.) commits federal agencies to considering, documenting, and publicly disclosing the environmental effects of their actions. It requires that an EIS be included in every recommendation or report on proposals for legislation and other major federal actions significantly affecting the quality of the human environment. The EIS must provide detailed information regarding the proposed action and alternatives, the environmental effects of the alternatives, appropriate mitigation measures, and any adverse environmental effects that cannot be avoided if the proposal is implemented. Agencies are required to demonstrate that decision makers have considered these factors prior to undertaking actions. Major federal actions determined not to have a significant adverse effect on the quality of the human environment may be evaluated through an EA.

This IFR/EA describes existing environmental conditions in the study area, the proposed action and alternatives, environmental impacts of the proposed project and alternatives, and measures to minimize environmental impacts. This document is the primary vehicle to achieve NEPA compliance for the proposed project and used when soliciting public comment. This document determines if the project would create any significant environmental impacts that would warrant preparing an EIS, or whether it is appropriate to prepare a Finding of No Significant Impact. A draft Finding of No Significant Impact is included in Appendix B.

6.10 National Historic Preservation Act

Section 106 of the NHPA (54 U.S.C. 200101 et seq.) requires federal agencies evaluate the effects of proposed federal undertakings on historic properties included or eligible for the National Register of Historic Places. The implementing of regulations for Section 106 (36 C.F.R. § 800) requires federal agencies to consult with various parties, including the Advisory Council on Historic Preservation, SHPO, and Indian tribes and THPO, to identify and evaluate historic properties, and to assess and resolve effects to historic properties. If an effect cannot reasonably be avoided, measures must be taken to minimize or mitigate potential adverse effects.

To meet the Agency's responsibilities under NHPA, the Corps has taken actions to identify historic properties that may be affected by the proposed action as required by Section 106 of the NHPA. An initial letter to document the APE was sent to the Washington SHPO on January 27, 2020 (Appendix B). The SHPO agreed with the Corps' determination of the APE on January 27, 2020 (Appendix B).

A field investigation for archaeological and built environment resources will be conducted within the project APE tentatively scheduled to begin June 21, 2021. A report summarizing the findings of the field investigation, a records search and literature review of the Washington Information System Architectural and Archaeological Records Database, and Corps cultural resources records will be completed after the field investigation is completed. Based on the results of the field investigation and summarized in the report the Corps will make a determination on if the proposed project will have any effects to historic properties that may have been found during the field investigation. The Corps will provide its determination to SHPO and complete consultation as necessary.

The Corps also requested knowledge and concerns from the Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Nisqually Tribe, Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation on May 10, 2021. The Squaxin Island Tribe responded via email on May 13, 2021 requesting a cultural resources survey in the project area. The Nisqually Tribe sent a letter via email on May 24, 2021 asking for a cultural resource assessment to be done in the project area and asked to informed if there are any inadvertent discoveries of buried archaeological resources or human burials.

6.11 Farmland Protection Policy Act

Congress passed the Farmland Protection Policy Act (FPPA) because of substantial decreases in farmland acreage. The purpose of the Act is to minimize the extent to which federal actions contribute to the unnecessary and irreversible conversion of farmland to nonagricultural uses. Projects are subject to FPPA requirements if they may irreversibly convert farmland (directly or indirectly) to nonagricultural use and are completed by a federal agency or with assistance from a federal agency. The study area has no designated prime and unique farmland that would be converted to other uses.

6.12 Fish and Wildlife Coordination Act of 1934

The Fish and Wildlife Coordination Act (FWCA) of 1934, as amended (16 U.S.C. §661-667e) provides authority for the USFWS involvement in evaluating effects to fish and wildlife from proposed water resource development projects. It requires that fish and wildlife resources receive equal consideration to other project features.

The Corps requested preparation of FWCA report in a letter to USFWS on 29 August 2019. On 17 October 2019, the Corps received an email from the USFWS stating that they see no reason to require a FWCA report since the Corps has fully met the intent of the FWCA by the proposed setback levee project design (Appendix B).

6.13 Wild and Scenic Rivers Act of 1968

The Wild and Scenic Rivers Act (Public Law 90-542; 16 U.S.C. 1271 et seq.) establishes a National Wild and Scenic Rivers System to preserve, protect, and enhance the wilderness qualities, scenic beauties, and ecological regimes of rivers and streams. Any construction within 100 feet of a scenic stream requires a scenic streams permit. Washington has approximately 70,439 miles of river, of which 197 miles are designated as wild and scenic (National Wild and Scenic River Systems 2020). No portions of the Puyallup River are designated; thus, there would be no impact.

6.14 Federal Trust Responsibility

The federal trust responsibility to Native American Tribes is a protection and preservation of land and certain rights for them. Treaties with the Tribes are the supreme law of the land, superior to State laws, and equal to federal laws. The trust responsibility is derived from the special relationship between the U.S. and Native American Indian Tribes, first defined by U.S. Supreme Court Chief Justice John Marshall in Cherokee Nation v. Georgia, 30 U.S. 1 (5 Pet.) (1831). Later, in Seminole Nation v. United States, 316 U.S. §286 (1942), the Supreme Court noted that the U.S. "has charged itself with moral obligations of the highest responsibility and trust" toward Native American Indian Tribes. The scope of the federal trust responsibility is broad and incumbent upon all federal agencies. The U.S. government has an obligation to protect tribal land, assets, resources, and rights, as well as a duty to carry out the mandates of federal law with respect to Indian Tribes.

Federal agencies have a trust responsibility to preserve and rebuild fisheries in Washington State within Tribes' usual and accustomed fishing areas and to do so in consultation and coordination with the federally recognized tribes.

Coordination with the Puyallup and Muckleshoot tribes was initiated at the start of the planning process and continued throughout. The proposed setback levee is supported by these tribes, and they will continue to be coordinated and consulted with into D&I.

6.15 Executive Order 11988, Floodplain Management

Executive Order 11988 requires federal agencies to provide leadership and take action to (1) avoid development in the base 1% AEP event floodplain, unless such development is the only practicable alternative; (2) reduce the hazards and risk associated with floods; (3) minimize the effect of floods on human safety, health, and welfare; and (4) restore and preserve the natural and beneficial values of the base floodplain. To comply with Executive Order 11988, Corps policy is to formulate projects which, to the extent possible, avoid or minimize significant effects associated with the use of the without-project floodplain, and avoid inducing development in the existing floodplain unless there is no practicable alternative.

Since the TSP sets back the Jones Levee, it would provide increased flood risk management for adjacent properties and uses. Per the Pierce County Comprehensive Plan, future development within existing UGAs to include areas protected by the Jones Levee are planned in the future. Intensification of development is not expected as a result of the proposed project.

The Corps has analyzed the potential effects of the LPP/TSP plan on the overall floodplain management of the study area per the procedures outlined in ER 1165-2-26 (Implementation of Executive Order 11988 on Flood Plain Management). There are eight steps reflecting the decision making process required in this Executive Order. The eight steps and responses to them are summarized below.

<u>*Step 1.*</u> *Determine if the proposed action is in the base floodplain.*

The proposed actions are located within the base floodplain for the Puyallup River.

<u>*Step 2.*</u> *If the action is in the floodplain, identify and evaluate practicable alternatives to locating in the base floodplain.*

As the primary objective of the project is flood risk management, there are no practicable alternatives completely outside of the base floodplain for the proposed features that would achieve this objective.

As part of the flood risk management analysis conducted for LPP/TSP described in throughout Chapter 3 and in the Economics Appendix, the study team completed an analysis of residual risks. Measures also included a setback levee which both offset biological impacts and reduce flood risk mitigation for induced flooding. Compared to the acquisition of property, flowage easements, or other non-structural measures, the analysis indicates that setback levees are the preferred method to offset environmental impacts while also reducing flood risks to people and property along the Puyallup River.

<u>*Step 3.*</u> *Provide public review.*

The proposed project is subject to ongoing coordination with the public, government agencies, and interested stakeholders. This Draft IFR/EA is released for a 30-day public review period, as required by NEPA.

<u>Step 4.</u> Identify the impacts of the proposed action and any expected losses of natural and beneficial floodplain values.

Chapters 3 and 4 of this document presents an analysis of alternatives. Practicable measures and alternatives were formulated, and potential impacts and benefits were evaluated both qualitatively and quantitatively. The anticipated impacts associated with the recommended plan are summarized in Chapters 4 and 5 of this report.

<u>Step 5.</u> Minimize threats to life and property and to natural and beneficial floodplain values. Restore and preserve natural and beneficial floodplain values.

Implementing the recommended plan would have a reduction to flooding impacts on human health, safety, and welfare, to Orting while also restoring floodplain connections and natural processes within the Puyallup River. The proposed project is not anticipated to induce development in the floodplain above and beyond development that is expected to occur in the FWOP condition, as described in Chapter 4. Orting continues to experience population growth and development along the upper Puyallup right bank within a defined UGA, and is expected both without and with a project. Land use currently zoned as residential, commercial, or industrial is assumed to be developed with or without the project, whereas agricultural and recreational lands are assumed to be preserved in the future both without and with a project. It is further assumed that new development will be built above the base 1%AEP floodplain to comply with building codes of local municipalities and to maintain participation in the National Flood Insurance Program. Flood insurance is recommended for both without project and with the recommended plan as the insurance provides greater resiliency by providing financial risk management for residual risks.

<u>Step 6.</u> Reevaluate alternatives.

Chapters 3 and 4 of this document presents an analysis of alternatives and impacts. There are no practicable alternatives completely outside of the base floodplain for the features included in the recommended plan that would achieve the study objectives of reducing flood risks.

<u>Step 7.</u> Issue findings and a public explanation.

The public will be advised that no practicable alternative to locating the proposed action in the floodplain exists with a public notice and involvement under NEPA to fulfill this requirement as indicated in Item 3 above.

<u>Step 8.</u> Implement the action.

The proposed project on its own does not contribute to increased development in the floodplain and does not increase flood risk, but rather it decreases flood risk to existing development and restores natural and beneficial values in the setback by restoring natural processes. The recommended plan is consistent with the requirements of this Executive Order.

6.16 Executive Order 11990 on the Protection of Wetlands

EO 11990 encourages federal agencies to take actions to minimize the destruction, loss, or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands when undertaking federal activities and programs. To meet these objectives, the order requires federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The preferred alternative would reconnect the wetlands back to the Puyallup River and have the overall effect of enhancing wetland functions and values. The Corps as taken into consideration impacts to wetlands during feasibility and analyzed the potential effects of the alternatives on wetlands. Further analysis and consistency with the overall wetlands policy of this executive order will be achieved through CWA Section 404 compliance requirements and the Corps' preparation of the 404(b)(1) evaluation in D&I.

6.17 Executive Order 12898 Environmental Justice

Executive Order 12898 directs federal agencies to take the appropriate steps to identify and address any disproportionately high and adverse human health or environmental effects of federal programs, policies, and activities on minority and low-income populations. Minority populations are those persons who identify themselves as Black, Hispanic, Asian American, American Indian/Alaskan Native, and Pacific Islander. A minority population exists where the percentage of minorities in an affected area either exceeds 50% or is meaningfully greater than in the general population.

An analysis of demographic data was conducted to derive information on the approximate locations of low-income and minority populations in the community of concern. Since the analysis considers disproportionate impacts, three areas were defined to compare the area affected by the project and a larger regional area that serves as a basis for comparison and includes the area affected. The larger regional area is defined as the smallest political unit that includes the affected area and is called the community of comparison. For purposes of the analysis, the affected area is approximately a one-mile radius around the project area, and the city of Orting, Washington is the community of comparison. Demographic information was also compared against the State of Washington for reference. The EPA's EJScreen tool was used to obtain the study area demographics (EPA 2021).

As shown in table 6-1, the aggregate minority population is estimated at 13% in the affected area, 18% in the City, and 31% of the State. The aggregate population percentage in the affected area does not exceed 50% and is less than half the state average (Table 6.1). The EO does not provide criteria to determine if an affected area consists of a low-income population. For purposes of the assessment, the CEQ criterion for defining low-income population was adapted to identify whether the population in an affected area constitutes a low-income population. An affected geographic area is considered to consist of a low-income population (i.e., below the poverty level, for purposes of this analysis) where the percentage of low-income persons: 1) is greater than 50%, or 2) is meaningfully greater than the low-income population percentage in the general population or other appropriate unit of geographic analysis. The U.S. Census Bureau poverty assessment weighs income before taxes and excludes capital gains and non-cash benefits (such as public housing, Medicaid, and food stamps). Table 6-1 provides a summary of the income and poverty status for the study area. As shown in the table, 19% of the individuals in the affected area are considered below the low-income. This percentage in the affected area does not exceed 50%. In addition, the affected area low-income population percentage is roughly equivalent to the low-income population in the city (18%) and less than half the percentage of the State (27%). The affected area is not considered to have a high concentration of low-income population.

Table 6-1. Environmental Justice Demographic and Income Statistics (EPA 2021).

Demographic Affected	Area	City	State
Minority Population	13%	18%	31%
Low-Income Population	19%	18%	27%

The proposed action will not disproportionately affect minority or low-income populations nor have any adverse human health impacts. No interaction with other projects will result in any such disproportionate impacts. No cumulative impacts to environmental justice is expected from interaction of the proposed action with other past, present, and reasonably foreseeable projects. Further, tribal governments that are also environmental justice communities in the project area have been engaged and informed about the proposed action.

6.18 Executive Order 13175 Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 reaffirmed the federal Government's commitment to a government-to-government relationship with Indian Tribes, and directed federal agencies to establish procedures to consult and collaborate with tribal governments when new agency regulations would have tribal implications. The Corps has a government-to-government consultation policy to facilitate the interchange between decision makers to obtain mutually acceptable decisions. In accordance with this Executive Order, the NFS has engaged with the Puyallup and Muckleshoot tribes. Additionally, the Corps sent letters on July 21, 2021 to the Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Nisqually Tribe, Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation requesting comment on the proposed project. No comments have been received to date. The IFR/EA will be shared with the Muckleshoot Indian Tribe, Puyallup Tribe of Indians, Nisqually Tribe, Squaxin Island Tribe, and the Confederated Tribes and Bands of the Yakama Nation for public review. Consultation and coordination with these tribes will continue into D&I.

7 Public Involvement, Review and Consultation*

Public involvement activities and agency coordination are summarized in this chapter. Stakeholders, agencies, Tribes, and other interested parties are integral in providing input for defining problems, opportunities, objectives, constraints, and for developing strategies that support development of the range of alternatives to be analyzed for feasibility and environmental compliance.

In accordance with NEPA public involvement requirements (40 CFR 1506.6) and Corps Planning policy (ER 1105-2-100), opportunities are presented for the public to provide oral or written comments on potentially affected resources, environmental issues to be considered, and the agency's approach to the analysis.

7.1 Draft IFR/EA Public Review

Corps Planning policy and NEPA require a public comment period, during which any person or organization may comment on the draft IFR/EA. For this study, the public comment period will formally run for 30 days. The Corps will consider all comments received during the comment period. The complete list of comments regarding the draft IFR/EA and the Corps' responses will be included as an appendix to the final IFR/EA (Appendix F – to be completed in the Final IFR/EA).

7.2 Agency and Tribal Government Consultation and Coordination Process

Preliminary Resource Agency and Tribal coordination were conducted during this phase of the study. ESA consultation, CWA compliance, NHPA coordination, CZMA compliance, and NEPA documentation will be updated or finalized during the D&I phase, as necessary, and will be completed ahead of soliciting any contract action for construction of execution of the project.

Preparation of this IFR/EA is being coordinated with appropriate federal, state, and tribal interests. The following agencies and tribes were involved in coordination:

- National Marine Fisheries Service
- U.S. Fish and Wildlife Service
- Washington State Department of Ecology
- Washington Department of Fish and Wildlife
- Washington State Historic Preservation Officer
- Muckleshoot Indian Tribe
- Puyallup Indian Tribe
- Nisqually Tribe
- Squaxin Island Tribe
- Confederated Tribes and Bands of the Yakama Nation

The Corps invited federal, state, and local resource agencies to a site visit during the feasibility phase. The purpose of the meeting was to solicit preliminary input on environmental and cultural topics for the TSP. Attendees to the November 4, 2019 meeting included the Corps, Pierce County, USFWS, NMFS, WDFW, Muckleshoot Indian Tribe, Puyallup Indian Tribe, and Ecology. Refer to Appendix B for environmental and cultural resources compliance documentation.

7.3 Peer Review Process

The Corps developed the Review Plan for this feasibility study, which the Corps' Northwestern Division (NWD) approved on December 17, 2019. Peer review for this study was designed to meet all pertinent Corps policies (e.g. Engineering Circulars [EC] including EC 1165-2-217). This plan requires an internal and external technical review of the IFR/EA and appendices. This study has adhered to this guidance, and this document is undergoing District Quality Control review and will undergo Agency Technical Review.

8 Recommendation

The recommendations contained herein reflect the information available at this time and current Departmental policies governing the formulation of individual projects. They do not reflect program and budgeting priorities inherent in the formulation of a national Civil Works construction program nor the perspective of higher review levels within the Executive Branch. Consequently, the recommendations may be modified before they are transmitted to the Northwestern Division, Corps of Engineers as proposals for approval and implementation funding. However, prior to transmittal to Northwestern Division, the NFS, the state, interested federal agencies, and other parties will be advised of any modifications and will be afforded an opportunity to comment further.

I recommend that Alternative 3, Levee Setback and Partial Removal (TSP), be implemented as the recommended plan for the Section 205 Jones Levee Project as generally described in this report be approved for implementation as a federal project.

Based on October 2021 price levels, the estimated project first cost to design and implement the recommended plan is $20,120,000. The federal portion of the project first cost is 47%, or $10,000,000. The NFS's required portion of project first cost is 53%, or $11,196,000. The NFS shall, prior to implementation, agree to perform the following items of local cooperation:

Federal implementation of the project for structural flood risk management is subject to the NFS agreeing to perform, in accordance with applicable federal laws, regulations, and policies, the required items of local cooperation for the project, including but not limited to the following:

a. Provide a minimum of 35%, up to a maximum of 50%, of construction costs, as further specified below:
    1. Provide, during design, 35% of design costs in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;
    2. Pay, during construction, a contribution of funds equal to 5% of construction costs;
    3. Provide all real property interests, including placement area improvements, and perform all relocations determined by the Government to be required for the project;
    4. Provide, during construction, any additional contribution necessary to make its total contribution equal to at least 35% of construction costs;
b. Prevent obstructions or encroachments on the project (including prescribing and enforcing regulations to prevent such obstructions or encroachments) that might reduce the level of flood risk reduction the project affords, hinder operation and maintenance of the project, or interfere with the project's proper function;
c. Inform affected interests, at least yearly, of the extent of risk reduction afforded by the flood risk management features; participate in and comply with applicable federal floodplain management and flood insurance programs; prepare a floodplain management plan for the project to be implemented not later than one year after completion of construction of the project; and publicize floodplain information in the area concerned and provide this information to zoning and other regulatory agencies for their

use in adopting regulations, or taking other actions, to prevent unwise future development and to ensure compatibility with the project;

d. Operate, maintain, repair, rehabilitate, and replace the project or functional portion thereof at no cost to the Government, in a manner compatible with the project's authorized purposes and in accordance with applicable federal laws and regulations and any specific directions prescribed by the Government;
e. Give the Government a right to enter, at reasonable times and in a reasonable manner, upon property that the NFS owns or controls for access to the project to inspect the project, and, if necessary, to undertake work necessary to the proper functioning of the project for its authorized purpose;
f. Hold and save the Government free from all damages arising from design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project, except for damages due to the fault or negligence of the Government or its contractors;
g. Perform, or ensure the performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 42 U.S.C. 9601-9675, that may exist in, on, or under real property interests that the federal government determines to be necessary for construction, operation and maintenance of the project;
h. Assume, as between the Government and the NFS, complete performance and financial responsibility for all necessary cleanup and response actions and costs of any hazardous substances regulated under CERCLA that are located in, on, or under real property interests required for construction, operation, maintenance, repair, rehabilitation, or replacement of the project;
i. Agree, as between the Government and the NFS, that the NFS shall be considered the owner and operator of the project for the purpose of CERCLA liability, and to the maximum extent practicable, operate, maintain, repair, rehabilitate, and replace the project in a manner that will not cause liability to arise under CERCLA; and
j. Comply with the applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended, (42 U.S.C. 4630 and 4655) and the Uniform Regulations contained in 49 C.F.R Part 24, in acquiring real property interests necessary for construction, operation, and maintenance of the project including those necessary for relocations, and placement area improvements; and inform all affected persons of applicable benefits, policies, and procedures in connection with said act

9 References*

CEQ. 1997. Considering Cumulative Effects Under the National Environmental Policy Act. Council on Environmental Quality, Executive Office of the President, Washington, DC. January.

Crandell, D. R., 1963b, Surficial geology and geomorphology of the Lake Tapps quadrangle, Washington: U.S. Geological Survey Professional Paper 388-A, 84 p.

Cristea, N. and Janisch, J. 2007. Modeling the Effects of Riparian Buffer Width on Effective Shade and Stream Temperature. Report for the Washington Department of Ecology. Publication No. 007-03-028. Available online at: https://fortress.wa.gov/ecy/publications/publications/0703028.pdf

Corps (U.S. Army Corps of Engineers). 2015. Recent US Climate Change and Hydrology Literature Applicable to US Army Corps of Engineers Missions – Water Resources Region 17, Pacific Northwest. Civil Works Technical Report, CWTS 2015-23. September 2015.

Corps. 2017. Engineering Technical Letter (ETL) 1100-2-3, Guidance for Detection of Nonstationarities in Annual Maximum Discharges, to detect nonstationarities in maximum annual flow time series. April 2017.

Corps. 2018. Engineering and Construction Bulletin (ECB) No. 2018-14: Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects. September 2018.

Dugdale, S.J., Malcolm, I.A., Kantola, K., Hannah, D.M. 2018. Stream temperature under contrasting riparian forest cover: understanding thermal dynamics and heat exchange processes. Sci. Total Environ. 610–611, 1375–1389.

Ecology (Washington State Department of Ecology). 2020a. Washington Department of Ecology Water Quality Atlas. Accessed on 31 January 2020 at: https://fortress.wa.gov/ecy/waterqualityatlas/StartPage.aspx

Ecology. 2020b. Air Quality Maps of Maintenance Areas. Online at https://ecology.wa.gov/Regulations-Permits/Plans-policies/State-implementation-plans/Maintenance-SIPs Accessed 20 May 2020

EPA (Environmental Protection Agency). 2021. EJSCREEN: Environmental Justice Screening and Mapping Tool. Accessed 24 September 2021 at: https://www.epa.gov/ejscreen.

Ford, J.K.B., G.M. Ellis, and P.F. Olesiuk. 2005. Linking prey and population dynamics: did food limitation cause recent declines of ‘resident’ killer whales (Orcinus orca) in British Columbia. Fisheries and Oceans Canada, Canadian Science Advisory Secretariat, Report no. 2005/042. 27 p.

Ford, J. K. B., B. M. Wright, G. M. Ellis, and J. R. Candy. 2010. Chinook salmon predation by resident killer whales: seasonal and regional selectivity, stock identity of prey, and consumption rates. DFO Canadian Science Advisory Secretariat Research Document 2009/101.

Goetz, F. 1989. Biology of bull trout, Salvelinus confluentus, a literature review. U.S. Forest Service, Willamette National Forest. Eugene, OR.

Goetz, F.A., E. Jeanes and E. Beamer. 2004. Bull Trout in the Nearshore. Prepared for United States Army Corps of Engineers, Seattle Washington.

Goetz, F.A. 2016. Migration and residence patterns of salmonids in Puget Sound, Washington. Doctoral dissertation. University of Washington, Seattle, Washington.

Gregory, R.S. 1988. Effects of turbidity on benthic foraging and predation risk in juvenile Chinook salmon. Presentation in the 1988 “Effects of dredging on anadromous Pacific coast fishes” workshop, Sponsored by Wetland Ecosystem Team, Fisheries Research Institute: University of Washington, Seattle, WA.

Gregory, R.S. and T.G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile Chinook salmon (Oncorhynchus tshawytscha) in turbid laboratory conditions.

Kerwin, John. 1999. Salmon Habitat Limiting Factors Report for the Puyallup River Basin (Water Resource Inventory Area 10). Washington Conservation Commission Olympia, Washington. July 1999.

Krahn, M.M., M.J. Ford, W.F Perrin,P.R. Wade, R. P. Angliss, M.B. Hanson, B.L. Taylor, G.M. Ylitao, M.E. Dalheim, J.E. Stein, & R. S. Waples. 2004. 2004 status review of southern resident killer whales (Orcinus orca) under the Endangered Species Act. U.S. Dept. Commerce. NOAA Technical Memo. NMFS-NWFSC 62, 73pp.

Ladley, R., E. Marks, M. Parnel, A. Berger, T. Sebastian, and B. Smith. 2008. Movement and spawning distribution of adult fluvial bull trout within the White River, Washington. Puyallup Tribal Fisheries Department, Tacoma, Washington. 16 pp.

LaSalle, M.W. 1988. Physical and chemical alterations associated with dredging: an overview. Presentation in the 1988 “Effects of dredging on anadromous Pacific coast fishes” workshop, Sponsored by Wetland Ecosystem Team, Fisheries Research Institute: University of Washington, Seattle, WA.

Leopold. 1964. Fluvial Processes in Geomorphology. Leopold, Wolman, Miller. Dover Publications, New York.

Marks, E.L., R.C. Ladley, B.E. Smith, and T.G. Sebastian. 2007. 2006-2007 Annual Salmon, Steelhead, And Bull Trout Report: Puyallup/White River Watershed Water Resource Inventory Area 10. Puyallup Tribe of Indians Fisheries Division; Puyallup, Washington.

Marks, E. L., R.C. Ladley, B.E. Smith, A.G. Berger, J.A. Paul, T.G. Sebastian and K. Williamson. 2014. 2013-2014 Annual Salmon, Steelhead, and Bull Trout Report: Puyallup/White River Watershed--Water Resource Inventory Area 10. Puyallup Tribal Fisheries, Puyallup, WA.

Marks, E. L., R.C. Ladley, B.E. Smith, A.G. Berger, T.G. Sebastian and K. Williamson. 2018. 2017-2018 Annual Salmon, Steelhead And Bull Trout Report: Puyallup/White River Watershed–Water Resource Inventory Area 10. Puyallup Tribal Fisheries, Puyallup, WA.

Mass, C., A. Skalenakis, and M. Warner. 2011: Extreme precipitation over the west coast of North America: Is there a trend? J. Hydrometeor., 12, 310–318, doi:10.1175/2010JHM1341.1.

Mauger, G.S., J.H. Casola, H.A. Morgan, R.L. Strauch, B. Jones, B. Curry, T.M. Busch Isaksen, L. Whitely Binder, M.B. Krosby, and A.K. Snover. 2015. State of Knowledge: Climate Change in

Puget Sound. Report prepared for the Puget Sound Partnership and the National Oceanic and Atmospheric Administration. Climate Impacts Group, University of Washington, Seattle. doi:10.7915/CIG93777D.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. American Fisheries Society Special Publication 19:61–63.

Mote, P. W., Rupp, D.E., Abatzoglou, J.T., Hegewisch, K.C., Nijssen, B., Lettenmaier, D.P., Stumbaugh, M., Lee, S.--Y., & Bachelet, D. 2015. Integrated Scenarios for the Future Northwest Environment. USGS ScienceBase. Dataset accessed 2015-03-02 at https://www.sciencebase.gov/catalog/item/5006eb9de4b0abf7ce733f5c

National Weather Service. 2020. Historic Crests of the Puyallup River gage near Orting. https://water.weather.gov/ahps2/crests.php?wfo=sew&gage=ortw1&crest_type=historic Accessed June 1, 2020.

National Wild and Scenic River Systems. 2020. Washington. Accessed November 19, 2019 at: https://www.rivers.gov/washington.php.

Newcombe, C.P., and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11: 72-82.

NCA4. 2018. Impacts, Risks, and Adaptation in the United States: Fourth National Climate Assessment, Volume II. USGCRP. doi: 10.7930/NCA4.2018.

NMFS (National Marine Fisheries Service). 2005a. Endangered and Threatened Wildlife and Plants: Endangered Status for Southern Resident Killer Whale. 70 Federal Register 69903 – 69912.

NMFS. 2005b. Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. 70 Federal Register 37160 – 37204.

NMFS. 2005c. Critical habitat for 12 Evolutionarily Significant Units (ESUs) of salmon and steelhead (Oncorhynchus spp.) in Washington, Oregon and Idaho. 50 Federal Register 52629 – 52858.

NMFS. 2006. Endangered and Threatened Species; Designation of Critical Habitat for Southern Resident Killer Whale. 71 Federal Register 69054 – 69070.

NMFS. 2007a. Puget Sound Salmon Recovery Plan Volume 1. Developed and submitted by the Shared Strategy Development Committee.

NMFS. 2007b. Endangered and Threatened Species: Final Listing Determination for Puget Sound Steelhead; Final Rule. 72 FR 26722 – 26735.

NMFS. 2008. Recovery Plan for Southern Resident Killer Whales (Orcinus orca). National Marine Fisheries Service Northwest Regional Office. Seattle, WA. 251 pages.

NMFS. 2010. Endangered and Threatened Wildlife and Plants: Threatened Status for Southern Population Segment of Eulachon. Federal Register 75, 13012-13024.

NMFS. 2011. Endangered and Threatened Species; Designation of Critical Habitat for the Southern Distinct Population Segment of Eulachon. 76 Federal Register 65323 – 65352.

NMFS. 2014. Final Rule to Revise the Code of Federal Regulations for Species under the Jurisdiction of the National Marine Fisheries Service. 79 Federal Register 20802 – 20817.

NMFS. 2016a. 2016 5-Year Review: Summary & Evaluation of Puget Sound Chinook Salmon Hood Canal Summer-run Chum Salmon Puget Sound Steelhead. National Marine Fisheries Service. West Coast Region, Portland, OR. 88 pp.

NMFS. 2016b. Endangered and Threatened Species: Designation of Critical Habitat for Lower Columbia River Coho Salmon and Puget Sound Steelhead; Final Rule. FR 81 9252 – 9325

NMFS. 2019. Final Recovery Plan for the Puget Sound Steelhead Distinct Population Segment (Oncorhynchus mykiss). National Marine Fisheries Service. Seattle, WA. 291 pp.

Noggle, C.C. 1978. Behavioral, physiological and lethal effects of suspended sediment on juvenile salmonids. MS thesis. University of Washington, Seattle, WA.

Pauley, G.B., Bortz, B.M., and Shepard, M.F. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) -- steelhead trout. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.62). U.S. Army Corps of Engineers, TREL-82-4. 24pp.

Pierce County. 2005. Supplemental Environmental Impact Statement for the Proposed Mid-Puyallup Basin Plan. Pierce County Public Works and Utilities Water Programs Division. 9 August 2005.

Pierce County. 2009. Puyallup Basin fish habitat maps. Pierce County Public Works and Utilities and Surface Water Management.

Pierce County. 2019. Comprehensive Plan. Ordinance Number 2015-40, As amended by Ordinance Numers: 2016-34s, 2017-23, 2018-39s, 2019-15s. https://www.co.pierce.wa.us/DocumentCenter/View/38259/ADOPTED-Comprehensive-Plan-with-Community-Plans-Effective-8-1-2019?bidId=.

Redding, J.M., and C.B. Schreck. 1987. Physiological effects of coho salmon and steelhead of exposure to suspended solids. Trans Fish Soc 116:737-744.

Rieman, B.E., and J.D. McIntyre. 1993. Demographic and habitat requirements for conservation of bull trout. USDA Forest Service, Intermountain Research Station. General Technical Report INT-302.

Rosenberg, E. A. et al., 2010. Precipitation extremes and the impacts of climate change on stormwater infrastructure in Washington State. Climatic Change, 102(1-2), 319-349.

Servizi, J.A., and D.W. Martens. 1987. Some effects of suspended Fraser River sediments on sockeye salmon (Oncorhynchus nerka) Can. Spec. Publ. Fish. Aquat. Sci. 96:254-264.

Sigler, J.W. 1988. Effects of chronic turbidity on anadromous salmonids: Recent studies and assessment techniques perspective. Presentation in the 1988 "Effects of dredging on anadromous Pacific coast fishes" workshop, Sponsored by Wetland Ecosystem Team, Fisheries Research Institute: University of Washington, Seattle, WA.

Stewart, I. et al. 2005. Changes toward earlier streamflow timing across western North America. J. Climate, 18, 1136- 1155.

Stumpf, J. P., N. Denis, T. E. Hamer, G. Johnson, and J. Verschuyl. 2011. Flight Height distribution and Collision Risk of the Marbled Murrelet Brachyramphus marmoratus; Methodology and Preliminary Results. Marine Ornithology 39:123-128.

USFWS (U.S. Fish and Wildlife Service). 1999a. Endangered and Threatened Wildlife and Plans; Determination of Threatened Status for Bull Trout in the Coterminous United States; Final Rule. 64 FR 58910 – 58933.

USFWS. 1999b. Endangered and Threatened Wildlife and Plants; Determination of Threatened Status for Bull Trout in the Coterminous United States. Final rule. Federal Register 64(210):58910-58933.

USFWS. 2009. Correspondence responding to Corps of Engineers PL-09-07 Puyallup and Carbon River Rock Revetment Repairs. Dated 19 August 2009. USFWS Reference Number 13410-2009-I-0362.

USFWS. 2010. Revised Designation of Critical Habitat for Bull Trout in the Coterminous United States; Final Rule. 75 Federal Register 63897-64070.

USFWS. 2012. Guidance for Identifying Marbled Murrelet Nest Trees in Washington State. Washington Fish and Wildlife Office (WFWO) Lacey, WA.

USFWS. 2015a. Recovery plan for the coterminous United States population of bull trout (*Salvelinus confluentus*). Portland, Oregon. xii + 179 pages.

USFWS. 2015b. Coastal Recovery Unit Implementation Plan for Bull Trout.

USGS (U.S. Geological Survey). 2010. Channel-Conveyance Capacity, Channel Change, and Sediment Transport in the Lower Puyallup, White, and Carbon Rivers, Western Washington. Scientific Investigations Report 2010-5240. U.S. Geological Survey.

USGS. 2012. Geomorphic Analysis of the River Response to Sedimentation Downstream of Mount Rainier, Washington. Open File Report 2012-1242. U.S. Geological Survey.

Vano, J.A., N. Voisin, L. Cuo, A.F. Hamlet, M. McGuire Elsner, R.N. Palmer, A. Polebitski, and D.P. Lettenmaier. 2009. Climate change on water management in the Puget Sound region, Washington, USA, in: Littell, J.S., et al. (Eds), Washington Climate Change Impacts Assessment: Evaluating Washington’s Future in a Changing Climate. University of Washington Climate Impacts Group; Seattle, Washington.

WRCC (Western Regional Climate Center, website). 2011. Climate of Washington. Desert Research Institute: Western Regional Climate Center; Reno, Nevada. Accessed: August 2, 2011. Available at: http://www.wrcc.dri.edu/narratives/WASHINGTON.htm.