2 ALTERNATIVES

2.1 Background and History

Although flood damage reduction in the Chehalis Basin has been examined in more than 830 studies since the 1930s, the efforts conducted to date have not resulted in appreciable reduction of damages to residents, communities, infrastructure, and natural resources. After the 2007 flood, the Chehalis River Basin Flood Authority was formed by an Interlocal Agreement among 11 jurisdictions in the Chehalis Basin (counties, cities, towns, and the Chehalis Tribe). The Flood Authority was funded by the Washington State Legislature to develop, or participate in the development of, flood damage mitigation measures throughout the Chehalis Basin. The Flood Authority published the *Chehalis River Basin Comprehensive Flood Hazard Mitigation Plan* in 2010. This plan provided a review of the characteristics in the Chehalis Basin affecting flooding, typical flood hazard mitigation solutions, and recommendations for jurisdictions to improve existing regulations within floodplains.

In 2011, the legislature (as part of the capital budget [Engrossed Substitute House Bill 2020, Section 1033]) tasked OFM with preparing a report on alternative flood damage reduction projects in the Chehalis Basin. OFM's report, prepared in coordination with local governments and state and federal agencies, contains recommendations for priority flood damage reduction projects requiring continued feasibility and design work. The purpose of the report was to provide the legislature and other decision-makers with the information needed to aid their decisions on effective solutions to reduce the adverse impacts of flooding, protect and restore fish populations and natural resources, and support the economic prosperity of communities in the Chehalis Basin.

In June 2012, a group of community leaders met to discuss the actions that had been previously taken and determine additional flood damage reduction projects that should be implemented. Both policymakers and leaders agreed that no single action would stop all flooding, and that a Basin-wide approach that "works with nature" was needed. This group recommended that the approach should include the following (Ruckelshaus Center 2012):

- Maximization of benefits from flood damage reduction projects and minimization of negative impacts
- Actions that do not result in increasing flood damage in other portions of the watershed
- A combination and sequence of projects in different locations in the Chehalis Basin that address different aspects of flooding, and which reach beyond solely protecting I-5
- Programmatic actions such as land use management, refinements to forest practices, floodproofing, elevating and buy-out of homes, farm pads, improvements to riparian buffers,

bank erosion control, and restoration of wetlands and floodplain storage and connectivity that can provide small-scale flood storage and habitat benefits

- Protection and, where possible, improvement to floodplain function, while acknowledging historical development in the floodplain

In August 2012, then-Governor Christine Gregoire appointed a Work Group of Chehalis Basin leaders and tasked them with developing recommendations for flood damage reduction actions. Up to that point, flood damage reduction and aquatic species habitat restoration efforts had been conducted piecemeal.

In November 2012, the Work Group recommended an integrated Basin-wide approach that would represent a substantial investment to reduce flood damages in the short term, restore natural floodplain function and fisheries, and put the Chehalis Basin on firm footing to make critical decisions about large-scale actions.

The 2014 Work Group's approach called for investments in the following actions, which required additional evaluation prior to implementation:

- Large-scale capital flood damage reduction projects affecting a broad geographic area, such as a water retention facility and/or improvements to protect I-5
- Small-scale capital flood damage reduction projects with more localized benefits
- Projects that enhance the overall environmental conditions and habitat for aquatic species in the Chehalis Basin, including increasing the abundance of fish
- Strategies to help people already located in the floodplain, and land use management enhancements to reduce the potential that new development would increase the risk of flood damage
- An effective flood warning and emergency response system

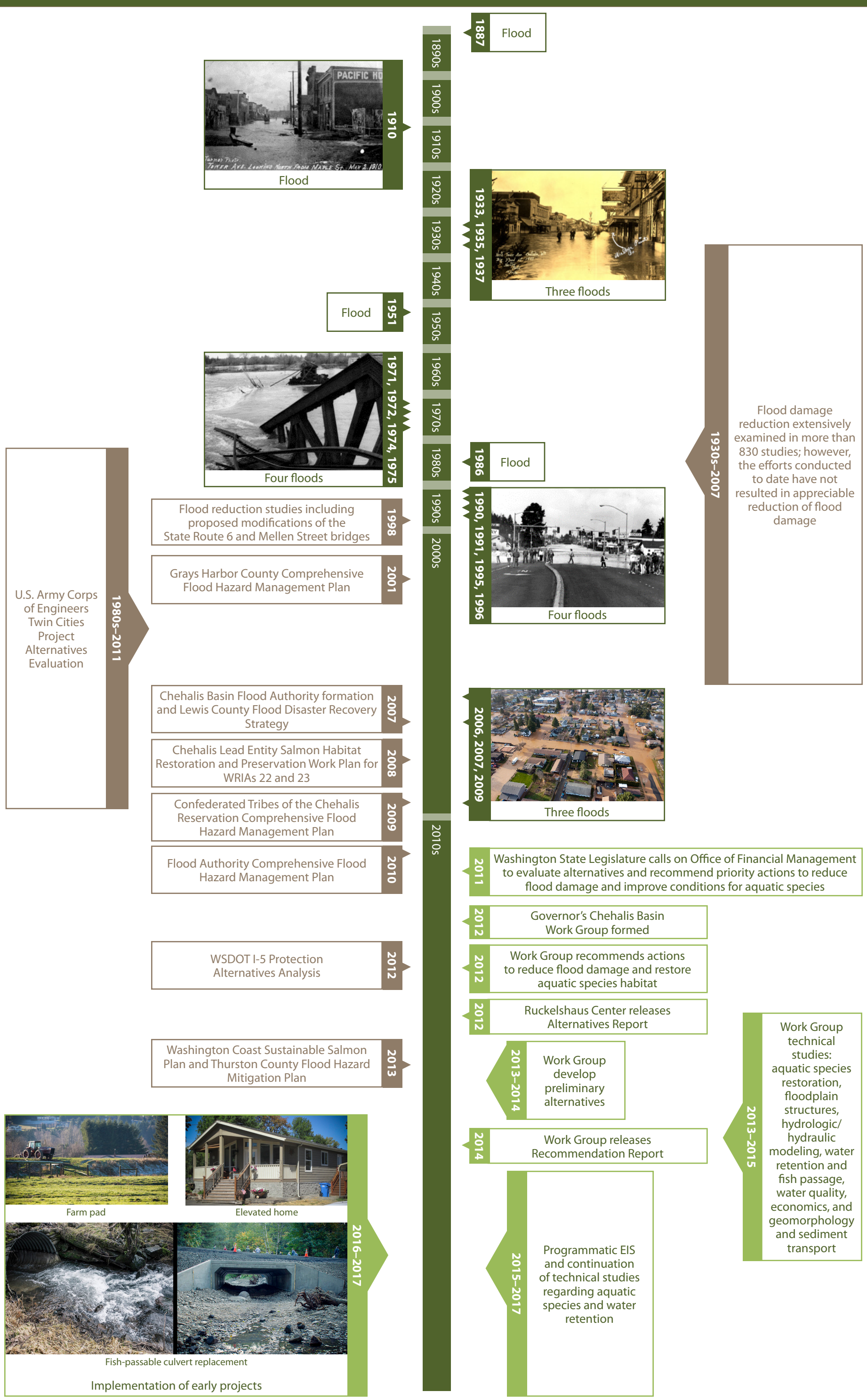
Current (2016) Chehalis Basin Work Group Members

- Rob Duff, Policy Advisor to Governor Inslee
- Vickie Raines, Grays Harbor County Commissioner and Chehalis River Basin Flood Authority Chair
- Karen Valenzuela, former Thurston County Commissioner and former Chehalis River Basin Flood Authority Vice-chair
- J. Vander Stoep, private attorney and Chehalis River Basin Flood Authority Pe Ell Alternate
- Jay Gordon, farmer in lower Chehalis Basin and Washington Dairy Federation Executive Director
- Don Secena, Chehalis Tribe Chairman
- Larry Goodell, Jr., Quinault Indian Nation Chairman of Off-reservation River and Ocean Fisheries Committees
- Steve Malloch, consultant and environmental community member

In April 2013, Governor Inslee tasked the Work Group with developing a recommendation on how to move these investments in flood damage reduction and aquatic species habitat restoration forward. From 2013 to early 2015, the Work Group oversaw a series of technical analyses to support decision-making on long-term, large-scale actions and the implementation of a number of small-scale projects. At the end of 2014, the Work Group published the 2014 Recommendation Report, outlining a program of integrated, long-term, flood damage reduction and aquatic species habitat restoration actions that would require further analysis.

A timeline of the floods, beginning in 1887, and technical studies completed since the 1930s, is shown in Figure 2.1.

Figure 2.1
Timeline of Floods and Technical Studies



Historical flood photos courtesy *The Chronicle, Centralia, Washington*

2.2 Location and Regional Setting

The Chehalis Basin, located in Southwestern Washington, is the second largest river basin within the state. The Chehalis Basin extends over eight counties, encompassing large portions of Grays Harbor, Lewis, Mason, and Thurston counties, and much smaller parts of Pacific, Cowlitz, Wahkiakum, and Jefferson counties (see Figure 2.2-1). The Chehalis Basin is bounded by the Pacific Ocean to the west, the Nisqually River Basin and the Cascade Range foothills to the east, the Olympic Mountains to the north, and the Cowlitz River Basin to the south (see Figure 2.2-2). For the purposes of water resource planning under the Washington State Watershed Planning Act of 1998, the Chehalis Basin was divided into two WRIAs: WRIA 22 and WRIA 23 (CBP 2004).

The Chehalis River flows approximately 125 miles north-northwesterly to Grays Harbor and the Pacific Ocean, and drains an area of approximately 2,700 square miles. The mainstem Chehalis River is formed by the confluence of the East Fork Chehalis River with the West Fork Chehalis River in the central Willapa Hills above Pe Ell in Lewis County (see Figure 2.2-2). Tributaries to the Chehalis River arise from diverse sources, including the Olympic Mountains, the Bald Hills, the Willapa Hills, the Black Hills, and a spur of the Cascade Mountain Range (ASEPTC 2014a).

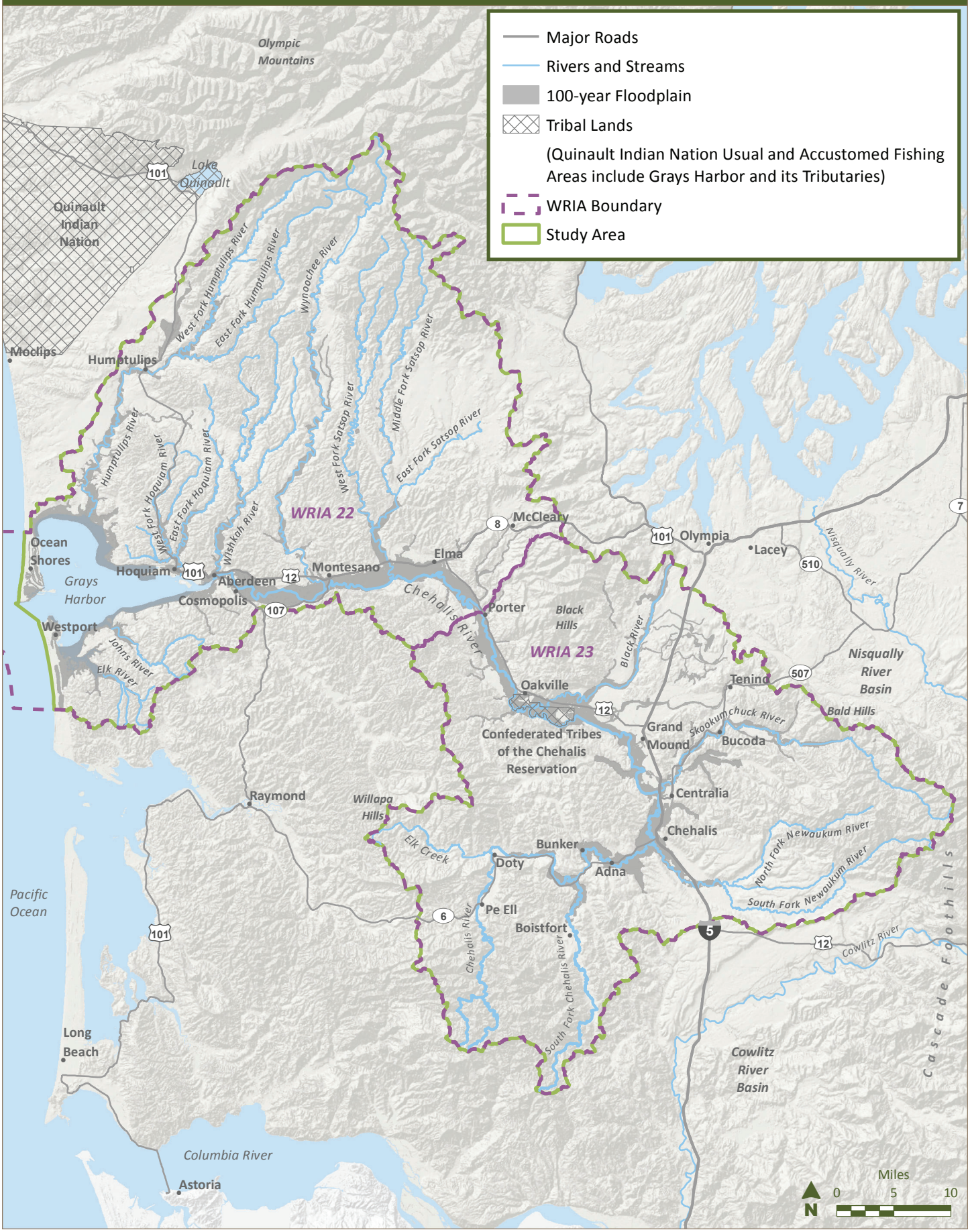
Photo credit: The Chronicle, Centralia, Washington

In the upstream (southern) portion of the Chehalis Basin, the Chehalis River valley is relatively narrow with less natural floodplain area, and land use is predominantly forestlands. The majority (approximately 80%) of the land within the Chehalis Basin is forestland (deciduous, coniferous, and mixed forest), with 54% classified as managed forests. Downstream, agriculture, industry, and residential development are concentrated in the floodplain in areas close to primary streams and rivers. Major infrastructure, including I-5 and the BNSF Railway and Union Pacific Railroad lines, cut through the middle of the Chehalis Basin within the Chehalis River floodplain. In the lower (northern) Chehalis Basin downstream of Centralia, the mainstem Chehalis River valley is much wider, less populated, and more predominantly agricultural, except for Aberdeen, Hoquiam, and Cosmopolis at the Grays Harbor estuary. Agriculture within the Chehalis Basin consists mainly of livestock grazing, crop farming, and commercial dairy operations (CBP 2004). In total, agricultural land covers approximately 41% of the area within the Chehalis River floodplain, and 5% of the entire Chehalis Basin.

The total population in the Chehalis Basin is approximately 140,000 (Ruckelshaus Center 2014), including four population centers: Chehalis (7,259) and Centralia (16,336) in the upper Chehalis Basin, and Aberdeen (16,896) and Hoquiam (8,726) at the mouth of the Chehalis River (U.S. Census Bureau 2015). The Chehalis Tribe reservation is situated on approximately 4,849 acres of land near the mouth of the Black River on the mainstem Chehalis River. The Quinault Indian Reservation is located outside of the Chehalis Basin, on the southwestern corner of the Olympic Peninsula in Grays Harbor County. The Quinualt Indian Nation's usual and accustomed fishing areas include Grays Harbor and its tributaries.

Figure 2.2-1
Cities, Counties, and Tribal Lands

Figure 2.2-2
Chehalis Basin Water Resources



2.3 Alternatives

The alternatives evaluated in this EIS represent a variety of approaches to address the dual purpose and need of reducing flood damage and restoring aquatic species habitat in the Chehalis Basin. The alternatives are characterized by different combinations of flood damage reduction and a range of aquatic species habitat restoration action elements. In addition, a No Action Alternative is included, per SEPA requirements, and for the purpose of having a basis to compare potential benefits and impacts with the proposed action alternatives.

This section includes a description of how the alternatives were developed, as well as a discussion of alternatives that were considered but eliminated from further study. Detailed descriptions of the EIS alternatives are provided, as well as a summary (see Table 2.3-1). An economic analysis is included in Appendix C, which analyzes the potential impacts of project alternatives, including costs to the environment and benefits associated with reduced flood damage and environmental improvements.

2.3.1 Alternative Development Process

The Work Group's 2014 Recommendation Report was the catalyst for this EIS. The report contemplated three types of dam structures; improvements to the levee around a portion of the Chehalis-Centralia Airport; flood protection options for I-5; combinations of aquatic species habitat restoration scenarios; local-scale projects identified by the Chehalis River Basin Flood Authority and other stakeholders in the Chehalis Basin; land use management efforts such as improved floodplain regulations; and floodproofing actions for residents and structures already located in flood-prone areas. The report also recommended the development of this EIS to evaluate a package of potential actions intended to meet flood damage reduction and aquatic species habitat restoration goals in the Chehalis Basin.

The range of potential action elements identified by the Work Group for further evaluation was refined during the EIS scoping process and assessed to determine the effectiveness in meeting the purpose and need, as well as potential environmental impacts. As further described in Chapter 6, a total of 43 public comments were received (through mail, email, and the project website) and compiled through the end of the scoping period. These comments helped to shape the development and evaluation of alternatives for the EIS, including adding the Restorative Flood Protection and Nonstructural Flood Protection alternatives, expanding the Aquatic Species Habitat Action scope, considering water rights and water supply, and evaluating effects of forest practices on streamflow and landslides.

In February 2016, the Work Group requested that Ecology consider the Aberdeen/Hoquiam North Shore Levee action element as one of its recommended Large-scale Flood Damage Reduction Actions in the EIS. The Aberdeen/Hoquiam North Shore Levee action element originated as a Local-scale Flood Damage Reduction Action because it was initially a smaller-scale levee intended to protect Aberdeen; however, the levee concept was expanded to protect Aberdeen and Hoquiam, and resulted in flood

damage reduction on a similar scale as compared to other Large-scale Flood Damage Reduction Actions evaluated in the EIS.

2.3.2 Action Elements and Proposed Alternatives

Table 2.3-1 provides a summary of the action elements evaluated in this EIS, and illustrates how the action elements are combined into the considered alternatives. Under the No Action Alternative, actions to reduce flood damage and improve aquatic habitat conditions would continue to a lesser extent than under the action alternatives (open circles demonstrate the reduced actions under this alternative).

Table 2.3-1
Action Elements and Combined Alternatives for Evaluation in the Draft EIS

ACTION ELEMENT	PROPOSED ALTERNATIVES				
	NO ACTION ALTERNATIVE	ALTERNATIVE 1: 2014 GOVERNOR'S WORK GROUP RECOMMENDATION	ALTERNATIVE 2: STRUCTURAL FLOOD PROTECTION WITHOUT FLOOD RETENTION FACILITY	ALTERNATIVE 3: NONSTRUCTURAL FLOOD PROTECTION	ALTERNATIVE 4: RESTORATIVE FLOOD PROTECTION
LARGE-SCALE FLOOD DAMAGE REDUCTION ACTIONS					
Flood Retention Facility (dam and associated reservoir)		●			
Airport Levee Improvements		●	●		
I-5 Projects			●		
Aberdeen/Hoquiam North Shore Levee		●	●		
Restorative Flood Protection					●
LOCAL-SCALE FLOOD DAMAGE REDUCTION ACTIONS					
Floodproofing		●	●	●	●
Local Projects	○	●	●	●	●
Land Use Management	○	●	●	●	●
Flood Warning System Improvements	○	●	●	●	●
AQUATIC SPECIES HABITAT ACTIONS					
Restore riparian habitat	○	●	●	●	●
Remove fish passage barriers	○	●	●	●	●
Restore off-channel habitat	○	●	●	●	●
Add wood to streams for habitat	○	●	●	●	●
Restore bank erosion to naturally occurring rates	○	●	●	●	●
Reconnect the floodplain	○	●	●	●	●
Create, restore, and enhance wetlands	○	●	●	●	●

Note: Open circles represent reduced actions under this alternative.

2.3.3 Action Elements

Action elements are described in this section in order from the largest to smallest magnitude flood damage reduction actions, followed by aquatic species habitat actions. Therefore, this section begins with a discussion of the Large-scale Flood Damage Reduction Actions, followed by Local-scale Flood Damage Reduction Actions, then Aquatic Species Habitat Actions. For the Large-scale Flood Damage Reduction Actions, those actions with the most significant impacts are described first (e.g., Flood Retention Facility and Restorative Flood Protection).

2.3.3.1 Large-scale Flood Damage Reduction Actions

Flood Retention Facility

The Flood Retention Facility (a dam and associated reservoir) would not protect communities from all flooding; however, it is intended to substantially reduce damages during a major flood. The Flood Retention Facility would operate at and above the major flood stage in order to realize the most flood damage reduction benefit, while minimizing impacts on streamflow in the Chehalis River. Flood protection provided by the Flood Retention Facility would not result in immediate changes to FEMA flood hazard mapping; however, regular FEMA mapping updates would continue to occur.

> **FEMA Flood Hazard Maps**
>
> FEMA prepares and periodically updates flood hazard maps in the Chehalis Basin and across the country. The newest maps, also known as Digital Flood Insurance Rate Maps, show flood risk at a property-by-property level based on topographic data, hyrologic/hydraulic analyses, and data for river flow and storm tides.

> **Flood Retention Facilities**
>
> The term "flood retention facility" is used in this document to collectively denote a dam and its associated reservoir. Where the discussion is focused on just the dam or the reservoir, those terms are used instead. The following two types of flood retention facilities are being considered:
>
> - A dam with a *temporary* reservoir would be designed to temporarily hold back water during major floods. This is known as a flood retention only facility. The river would flow normally during regular conditions or in smaller floods.
> - A dam with a *permanent* reservoir would continuously hold back water (instead of only during major floods). In addition to reducing flood damage during the winter, summer, and early fall, the water from the reservoir would be released to provide more water and cooler water temperatures in portions of the Chehalis River downstream of the dam. This is known as a flood retention flow augmentation facility.

The proposed Flood Retention Facility would be located on Weyerhauser property, south of State Route (SR) 6 in Lewis County, on the mainstem Chehalis River about 1 mile south of Pe Ell (see Figure 2.3-1). Ownership of the Flood Retention Facility, as well as other acquisition details, has not been determined

at this planning-level stage of the process. Property acquisition within the dam and reservoir footprint would be required, and the land would no longer be managed as commercial forestland.

Two different Flood Retention Facility types (a dam with a temporary reservoir and a dam with a permanent reservoir) are being considered (see Figure 2.3-2). The Flood Retention Only (FRO) facility consists of a dam with a temporary reservoir. The dam would temporarily retain water in the event a major flood (as previously described, flows exceeding 38,800 cubic feet per second (cfs) at the Grand Mound gage) is predicted. The flood retention flow augmentation (FRFA) facility consists of a dam with a permanent reservoir, which would include additional capacity to retain floodwaters in the event a major flood is predicted. Water stored in the permanent reservoir during winter would be released as needed (typically during late spring through early fall) to augment flows and reduce water temperatures in portions of the mainstem Chehalis River. In addition to removal of vegetation for the dam structure, tree clearing and vegetation removal would occur within the reservoir area, with the details of the tree clearing and vegetation removal approach provided in a Pre-construction Vegetation Management Plan (see Chapter 4 for more details). One of the goals of the Pre-construction Vegetation Management Plan would be to reduce the extent of tree clearing and vegetation removal in the reservoir footprint and to reduce the amount of woody material that would accumulate in the reservoir during a flood.

This action element is not assumed or intended to result in residential or community development at or around the reservoir. Creation of a reservoir is not intended to encourage development because it would be contrary to the strategy objectives of reducing flood damage to properties and threats to human safety from floods, and protection and restoration of aquatic species habitat. Temporary fish passage facilities would be used during construction of the dam, and permanent fish passage facilities would be part of the design and operation of the dam. Fish passage facility designs in this EIS are conceptual in nature and would continue to be refined during project-level SEPA analysis. Both dam types evaluated in this EIS would be constructed with roller-compacted concrete, which is more cost-effective than other types of construction methods, and would be designed to retain a flow volume similar to the 2007 flood. A new power line would be needed for the construction and operation of the dam to power pumps, gates, instruments, and other controls. The alignment would be selected to avoid and minimize impacts, including using existing local transmission lines and locating the line along areas cleared for dam construction.

Construction of the FRO or FRFA dam would include development of a quarry site, material storage, material processing, and areas for construction offices and equipment storage. Three potential quarry sites have been located; the most promising is within the reservoir inundation area approximately 2 miles from the potential dam location, mainly along Forest Road (FR) 1000. Material from the quarry site would be crushed and processed for use in the dam and other structures.

Other materials necessary for construction of the dam include large quantities of cement and fly ash, which would be transported by rail to a railhead (most likely in Chehalis) and by truck for approximately

30 miles from the railhead to the site, mainly along SR 6. Construction equipment and material processing equipment would also be transported by existing roads to the dam site. Construction would necessitate development of several miles of temporary construction roads to provide access between the materials storage and processing locations and the immediate construction area.

Figure 2.3-1

Large-scale Flood Damage Reduction Actions

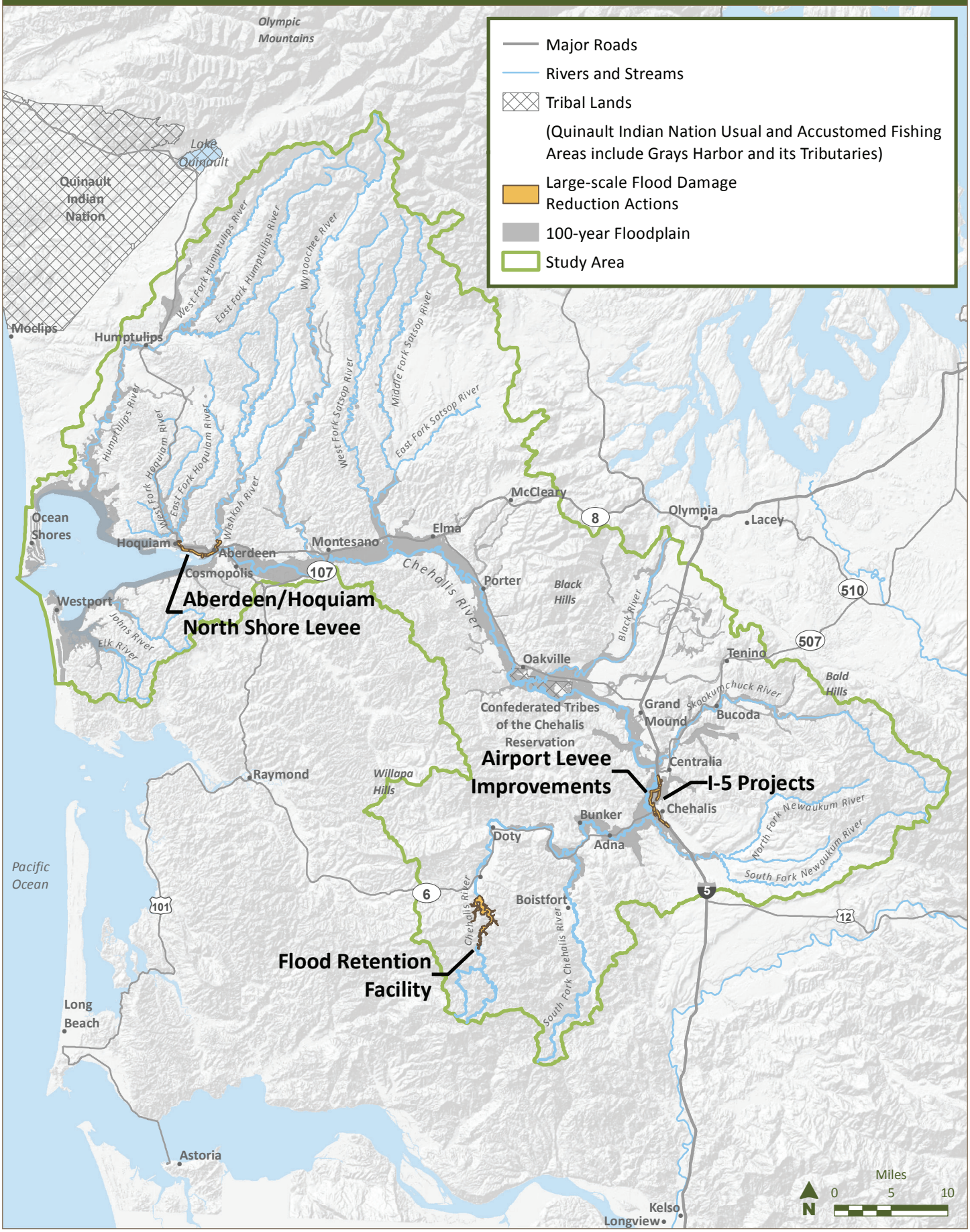
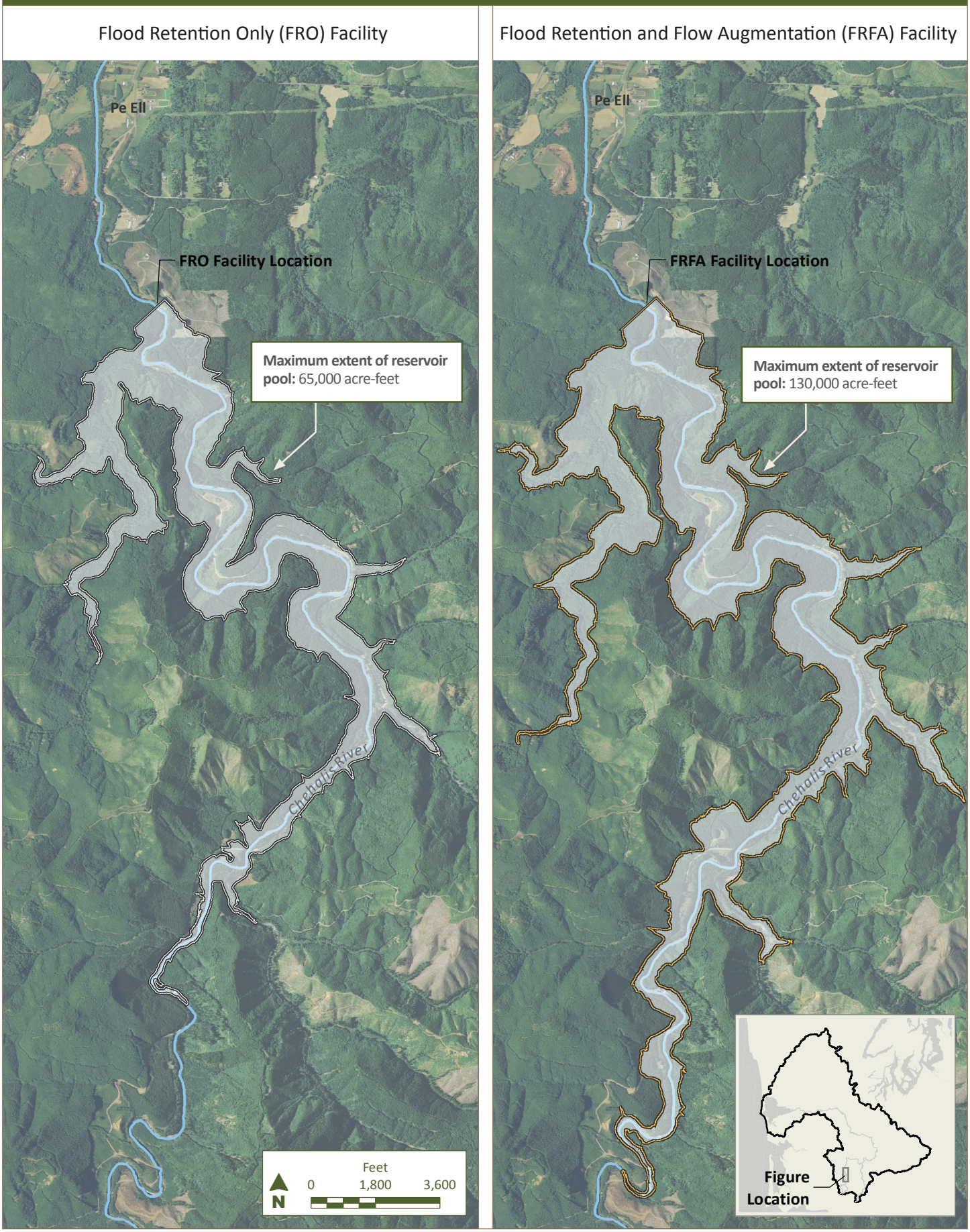


Figure 2.3-2

Reservoir Area Comparison for Flood Retention Facility Options



Flood Retention Only Facility

The FRO facility would be constructed in the upper Chehalis Basin to retain water temporarily during a major flood. The FRO dam would not impede Chehalis River flows under normal conditions or during smaller floods (e.g., less than 7-year floods). The FRO dam would transition to flood retention operations only during a major flood that could otherwise cause serious damage in downstream areas. Specific flow operations would depend on inflow and the need to hold water to relieve downstream flooding.

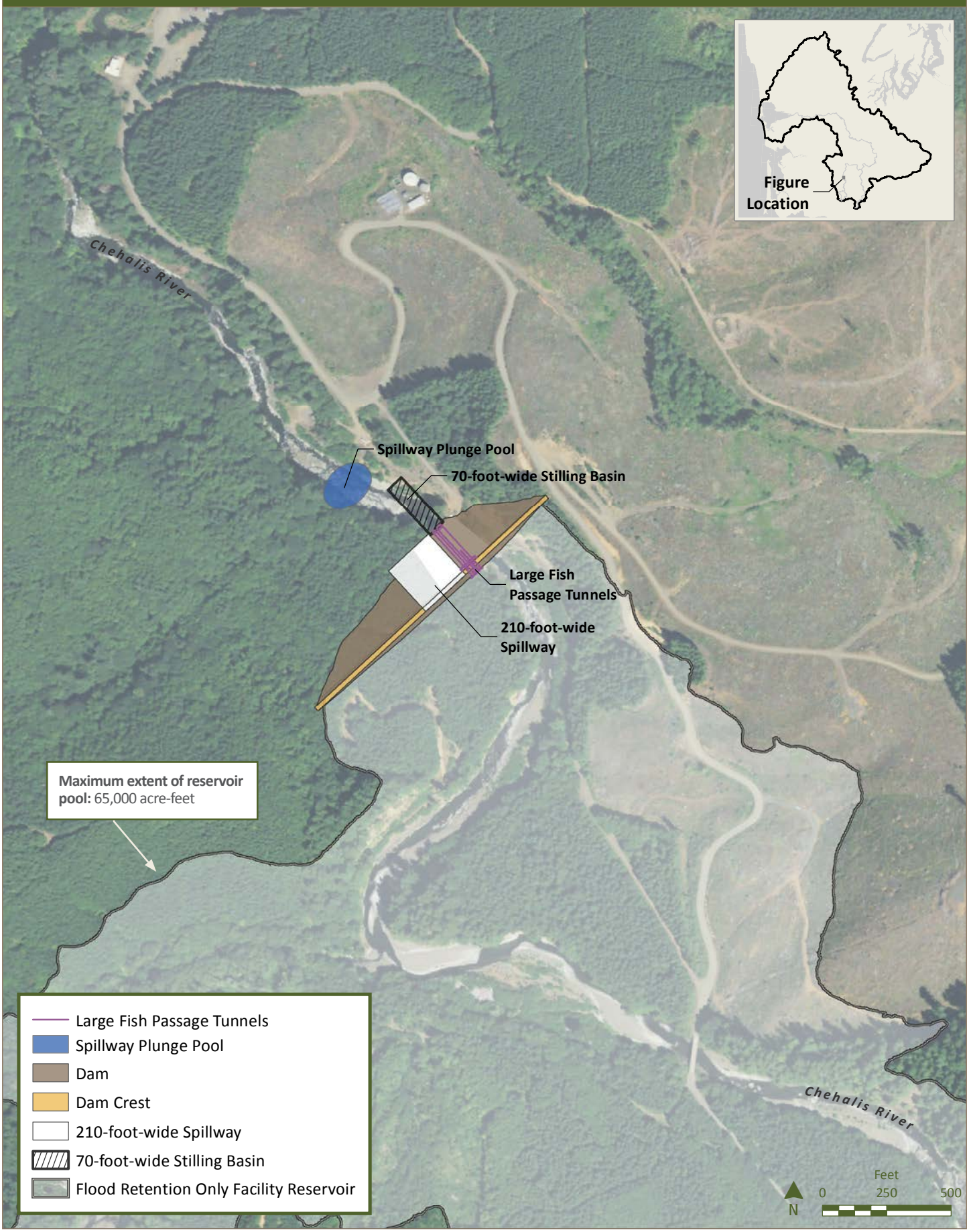
The FRO dam would be designed to provide upstream and downstream juvenile and adult fish passage (for salmonids, lamprey, and resident fish species) through three 230-foot-long open tunnels installed at river grade at the base of the dam (see Figure 2.3-3). During flood retention operations, a collection and transport system located below the dam would collect salmon, steelhead, and lamprey via a short fish ladder; hold the fish; and transport them in a truck to release points above the dam. The dam structure would also include a 210-foot-wide emergency spillway. During construction, a river bypass tunnel would be constructed for use until the tunnels are completed.

The emergency spillway would discharge into a 70-foot stilling basin, which would provide for containment and control of all flows over the emergency spillway. An anchored log boom would be placed upstream of the dam to help contain large woody material (LWM) during flood operations. A combined steel and reinforced concrete trash rack structure would protect the FRO facility entrances and prevent the entry of LWM that would not pass through the downstream control valves. Occasional maintenance of the intake to remove accumulated debris would be required.

The watershed area upstream of the FRO dam is 68.9 square miles, and the reservoir would have a capacity of up to 65,000 acre-feet. The spillway crest elevation for the FRO dam would be above the maximum estimated reservoir flood pool elevation. The top of the FRO dam structure would be 1,220 feet long, with 3 to 5 feet of freeboard as a factor of safety. The maximum structural height of the FRO dam is estimated to be up to 226 feet.

Concrete aggregate would be mined within the FRO facility site, and an on-site concrete batch plant would produce concrete. Construction activities would necessitate a detour or bypass road for FR 1000, which is a main access road for Weyerhauser forestry operations. The FR 1000 bypass or detour would also be needed during flood conditions while the dam is in operation and FR 1000 is inundated. Up to 6 miles of FR 1000 would be inundated and unavailable during flood retention, at which time, a detour could be used from FR A-line, FR F-line, and FR 2000 to rejoin FR 1000 upstream of the reservoir.

Figure 2.3-3
Flood Retention Only Facility



Flood Retention Flow Augmentation Facility

The FRFA facility would be constructed to provide flood retention similar to the FRO facility, but would also include water storage for release in late spring to early fall. Flow augmentation would be timed and designed to increase flow and decrease temperature in the upper Chehalis River downstream of the dam. The FRFA dam would retain water continuously instead of only during a major flood. Reservoir releases would be designed to attenuate floods and control water temperature, transport sediment and small debris, and maintain geomorphic processes downstream of the FRFA dam. The FRFA dam would not incorporate hydropower facilities as part of this proposal.

As shown in Figure 2.3-4, a 210-foot-wide emergency spillway would be located near the current river channel location, and would discharge into a 70-foot stilling basin. The flood control outlets would be located along the east (right-looking downstream) side of the emergency spillway. An anchored log boom would be placed to help contain LWM during flood operations. The FRFA dam would be designed to provide fish passage, and a number of fish passage options are currently being evaluated.

For upstream juvenile and adult salmon and steelhead passage, and adult lamprey passage, two alternatives are being evaluated: a fish ladder that would allow salmon and steelhead to pass volitionally over the dam; and a collection and transport system that would collect salmon, steelhead, and lamprey via a short fish ladder, hold the fish, and transport them in a truck to the release points. Both alternatives would have a normal, high-velocity entrance for adult salmonids and a low-velocity entrance for juvenile salmonids, resident fish, and adult lamprey. To pass adult lamprey, the corners of the low-velocity entrance would be rounded, bollards would be placed along the floor to provide microhabitats, and a flume entrance would be located in the pool to allow fish to exit the entrance pool, enter the flume, and migrate up the flume to a pool located at a higher elevation. Resting pools for lamprey would be located in the flume. Once in the uppermost pool, a wet wall would allow lamprey to climb the wall and drop into a hopper than could be loaded onto a truck for transportation upstream. One of these alternatives would be incorporated into the final dam design.

For downstream passage of adult (steelhead) and juvenile salmon, two systems are being evaluated: a floating surface collection system and a multi-port system. The floating surface collection system would be located in the forebay, just upstream of the dam, to collect fish. Fish would then be loaded onto transportation vehicles, taken downstream to the adult collection and transportation system (for monitoring and sorting), and released downstream. The multi-port system would be built into the dam. A total of four dewatering screen systems would be installed and operated one at a time to accommodate the approximately 40-foot fluctuation in forebay elevation. Adult and juvenile salmonids would enter and pass through the dewatering screen system, and be conveyed to a release point below the dam via specially designed transportation conduits. While it is possible that these systems may collect juvenile lamprey moving downstream through the reservoir, the expectation is that few juvenile lamprey will locate and pass through either downstream passage alternative for the FRFA.

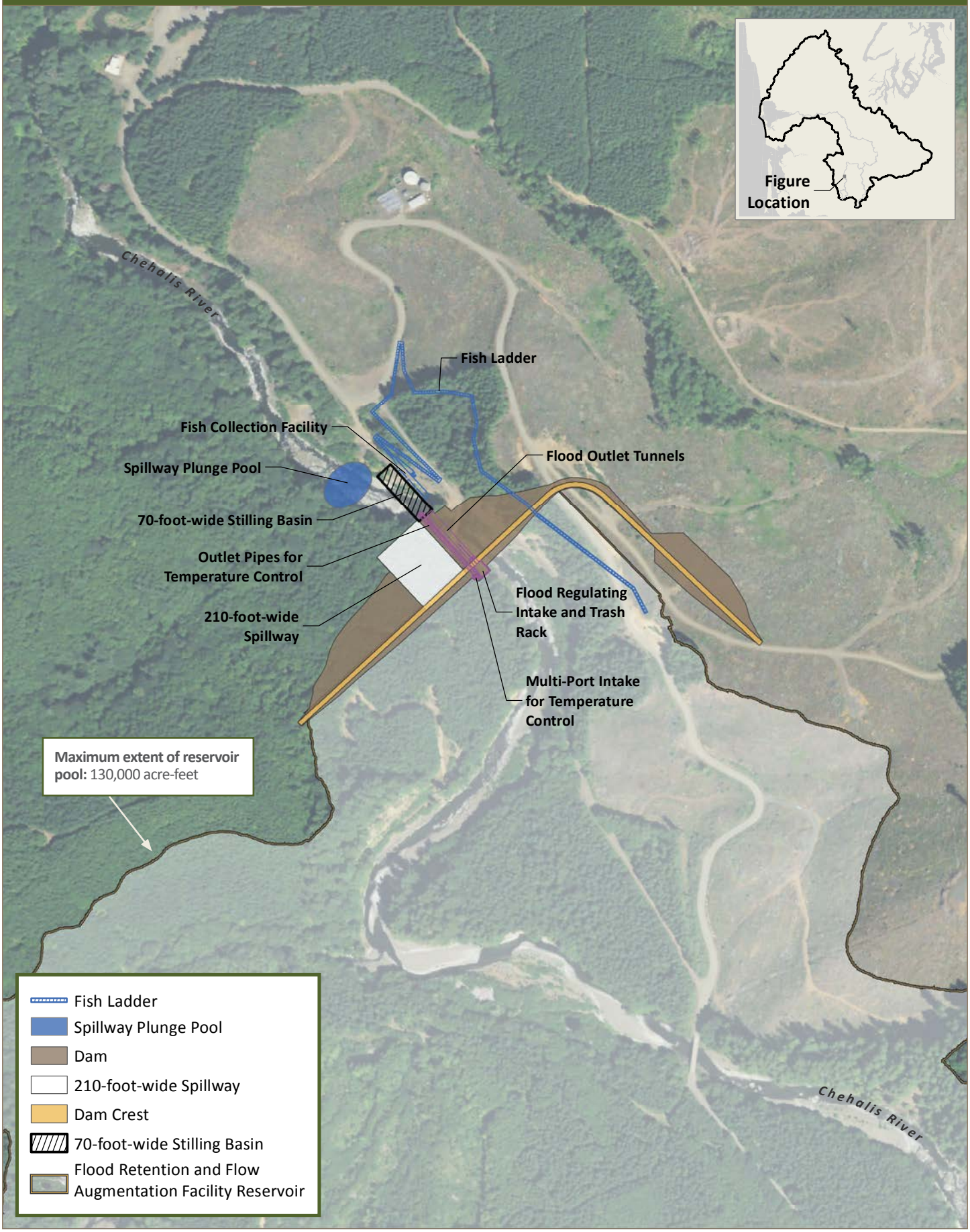
The watershed area upstream of the FRFA dam would be the same as the FRO facility (68.9 square miles), but the FRFA reservoir would have an increased capacity, up to 130,000 acre-feet. This includes 65,000 acre-feet for the conservation pool and 65,000 acre-feet for the flood storage pool. The conservation pool would be filled during winter, and accessed under low-flow conditions to augment downstream flows and reduce water temperatures. The flood storage pool would capture high flows to reduce downstream flooding during a major flood. Actual flood-flow operations would depend on inflow and the need to hold water to relieve downstream flooding.

The spillway crest elevation for the FRFA dam would also be above the maximum estimated reservoir flood pool elevation. The top of the dam would be 2,470 feet long, with an additional 3 to 5 feet of freeboard above the maximum pool as a factor of safety. The maximum structural height of the FRFA dam is estimated to be up to 285 feet.

The FRFA facility would include retirement of a section of FR 1000. The FRFA reservoir would permanently inundate approximately 5 miles of FR 1000, and up to 7 miles during flood retention. Approximately 7 miles of new road to replace FR 1000 would need to be constructed outside of the reservoir area, or a permanent detour developed using FR A-line, FR F-line, and FR 2000 to rejoin FR 1000 upstream of the reservoir.

Figure 2.3-4

Flood Retention and Flow Augmentation Facility



Restorative Flood Protection

Restorative Flood Protection is intended to rebuild the natural flood storage capacity of the Chehalis Basin by reversing landscape changes that contribute to downstream flooding and erosion. Restorative Flood Protection would increase the flood storage capacity of the Chehalis Basin by adding engineered large wood and plantings to create "roughness" (or resistance to flow) to river and stream channels and the floodplain, and by reconnecting river channels to floodplain storage. This strategy would necessitate individual actions be taken on a large scale and linked, which requires voluntary participation from many landowners within the Chehalis Basin.

Restorative Flood Protection

This approach to reducing flood damage at a large scale combines the following two types of actions:

- Constructing projects and floodplain plantings that slow and store floodwaters more evenly throughout the watershed; this is referred to as adding "roughness"
- Helping people in existing and new flood and erosion risk areas move to safe locations, or floodproof their homes and businesses

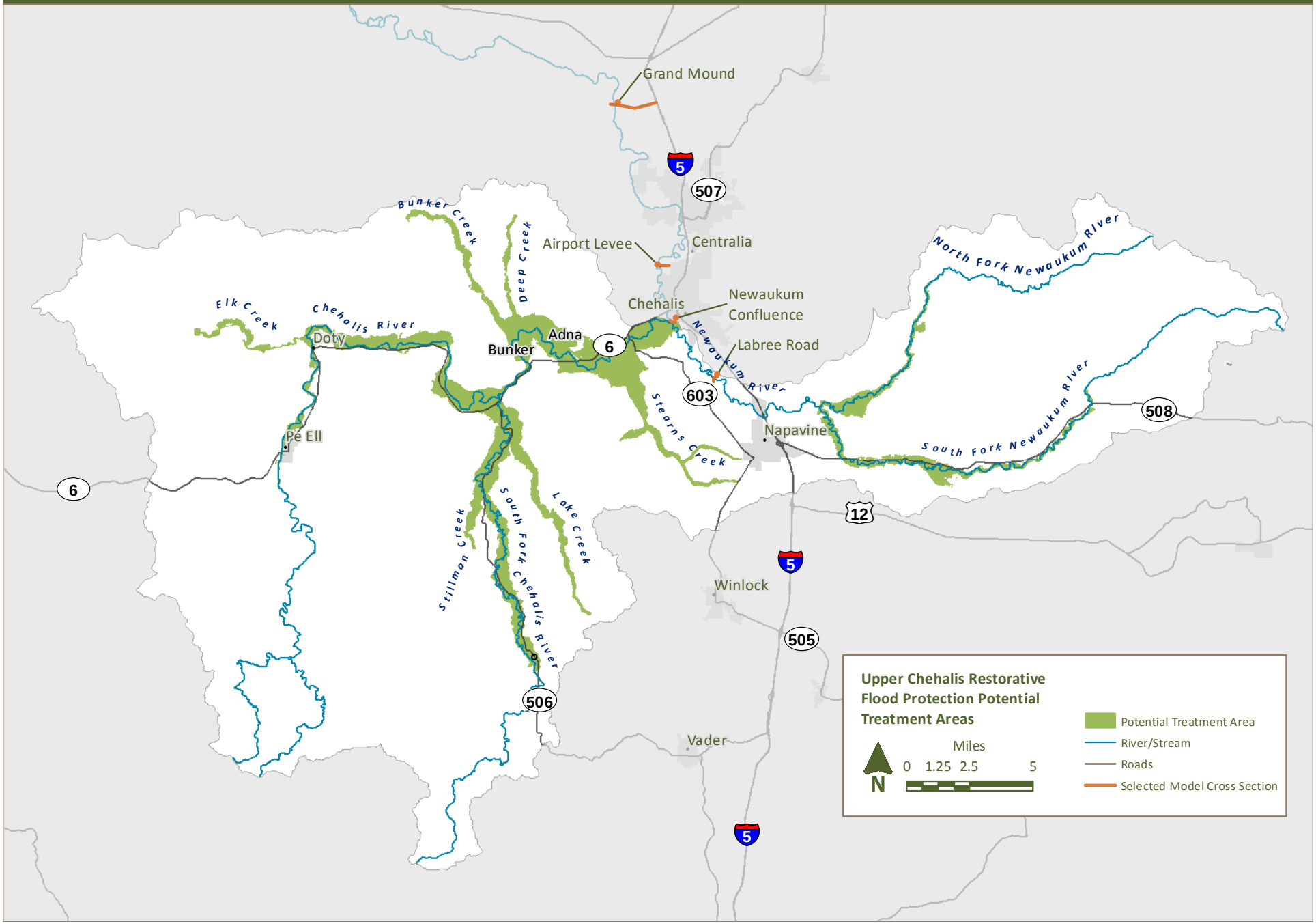
Actions that create roughness would raise water elevations in the river or stream channel and would cause water to spill overbank at lower discharges, hence more frequently. Overbank flows would spread across the floodplain, where over time natural vegetation and engineered structures would act to inhibit flow speeds, increase the time that floodwaters are stored, and discourage drainage flowing back to river channels. These actions are intended to reduce the speed at which a flood moves through the channel network, thereby reducing the magnitude of flooding downstream.

Actions to accomplish Restorative Flood Protection would include floodplain and streambank plantings, placement of engineered large wood structures in floodplains and on streambanks, and placement of engineered wood structures in channels, to mimic natural short-term and long-term ecological processes. These actions are proposed for flood protection, but would be coordinated with and complement Aquatic Species Habitat Actions. Restorative Flood Protection would reduce flood peaks on the Chehalis River downstream of the confluence with the Newaukum River, which is where the greatest flood damages have historically occurred.

Actions associated with Restorative Flood Protection, like reinstatement of native vegetation and the placement of engineered wood structures in floodplains and in channels, would occur in "treatment" areas. Most of the major river and stream floodplain areas within the mainstem Chehalis upstream of the Newaukum River confluence, South Fork Chehalis River, and Newaukum River are potential Restorative Flood Protection treatment locations (or opportunity areas). Figure 2.3-5 shows the potential treatment areas suitable for Restorative Flood Protection actions. There are about 140 river miles (RMs) within the Restorative Flood Protection treatment area, and the associated floodplain area that is engaged by these rivers during a 100-year flood is about 21,000 acres.

Figure 2.3-5

Restorative Flood Protection Opportunity Areas



Restorative Flood Protection involves substantial changes to current land use within treatment areas in the upper watershed. To attain downstream reductions in flooding, large areas of valley bottom land in upstream areas would be converted to "river management corridors" or "greenways" where flooding would occur more frequently than it currently does. An integral part of Restorative Flood Protection would be providing assistance to property owners that would be affected or displaced, and would include a suite of options for stimulating new private, agricultural, and recreational development in upland areas not at risk of flooding or erosion.

For a variety of reasons, many miles of the mainstem Chehalis River and its tributaries are isolated from their floodplains. Floodwaters in the Chehalis Basin do not spread out over floodplains, like under historical conditions, and move downstream more quickly and with more velocity than in the past. Restorative Flood Protection would rely on landowners who are willing to have their floodplain property flooded for a longer period of time or more frequently. In addition, this action element would seek landowners who are open to having their floodplain land reforested (roughened). These actions would need to be implemented over large contiguous areas within the identified treatment areas for Restorative Flood Protection to be effective.

Restorative Flood Protection Treatment Areas

The most suitable areas (shown in green in Figure 2.3-5) for Restorative Flood Protection are areas where the river channel has a slope of less than 0.5%. Computer modeling shows the greatest response to roughness actions for river sections with these low slopes (Abbe et al. 2016). Detailed analysis has shown that in steep channels, or channels with slopes greater than 1%, dense vegetation is only half as effective in reducing the average flow speed compared to channels with a mild slope (Anderson 2006). For this reason, river slope is the primary criterion for determining the technical suitability of the Restorative Flood Protection actions.

The secondary criteria for determining technical suitability of areas for Restorative Flood Protection actions are as follows:

- **Degree of channel incision –** Much of the Chehalis River channel network in the assessment area is incised, meaning that the channel is larger and deeper than under undisturbed conditions. Incised channel segments carry a larger flow volume, and at higher flow velocities, than channels under undisturbed conditions. In the incised areas, flood flows are mostly confined to the channel. Portions of the floodplain along incised channel segments would be reconnected through wood placement and elements to add roughness, which slow down flow velocity and promote small local floods, thereby reducing larger floods downstream. Channel segments incised between 3 and 6 feet can be treated with engineered wood structures to cause flood flows to reach the adjacent floodplain storage. Channel segments with incision greater than 6 feet are considered less suitable, but could be engineered.

- **Valley confinement –** Wider valleys are more suitable for Restorative Flood Protection actions than narrower valleys because they provide additional floodplain storage and, therefore, more flood attenuation.
- **Floodplain and riparian vegetation –** Areas that are not currently forested would respond more significantly to increasing roughness through floodplain reforestation and the addition of large wood on the floodplain. Floodplain roughening would attenuate overbank flows.

At this planning-level stage of the process, the completed analysis is very coarse. A more detailed, site-scale analysis would be required to determine the areal coverage over which Restorative Flood Protection actions would be necessary to achieve the most substantial downstream flood damage reduction. For purposes of this EIS, it is assumed that approximately 85% to 90% of the opportunity areas would be restored with major obstructions of timber and flanked by protective bank vegetation at frequent intervals to reconnect flows to floodplains. Figures 2.3-6 and 2.3-7 depict what Restorative Flood Protection may look like in a hypothetical river valley (note that the image is not within the Chehalis Basin).

Restorative Flood Protection would cause changes to the river and floodplain. Examples of how these changes would appear are illustrated in Figures 2.3-7 and 2.3-8. Figure 2.3-7 illustrates how the Restorative Flood Protection actions would alter a hypothetical river reach. In Figure 2.3-6, the floodplain area is primarily unvegetated and the river channel is a single, fairly straight reach with little wood. Conversely, Figure 2.3-7, the restored condition, shows the following changes:

- The active river corridor up to the 10-year floodplain (with Restorative Flood Protection) has been completely converted to floodplain forest. In some locations, a 10-year flood already overtops the riverbanks. Restorative Flood Protection actions would increase the magnitude and frequency of floodplain inundation, thereby increasing flood depth and extent in areas that currently flood, and re-engaging floodplains that have been disconnected from the river.
- The extensive addition of channel-spanning large wood to the channel has prompted the evolution of a more meandering river pattern, with some additional channels forming. This increase in channel length works to lower the overall channel gradient, slowing the water flow, and creating new off-channel wetlands for additional water storage. These off-channel wetlands and additional channels afford increased aquatic species habitat diversity and quality.

Changes to the human landscape are also shown in Figures 2.3-7 and 2.3-8. As noted above, Restorative Flood Protection would displace many types of agriculture that are currently located within the floodplain areas. Many of those affected by this displacement are currently in flood-prone areas and/or at risk to future flooding and loss of land from riverbank erosion. Figure 2.3-7 depicts new farming and rural residential land uses in upland areas, which are currently managed forestland. The community or social feasibility of implementing this relocation is currently unknown, and would require, among other things, land acquisitions/property transfer, transportation and utility improvements, and water right transfers.

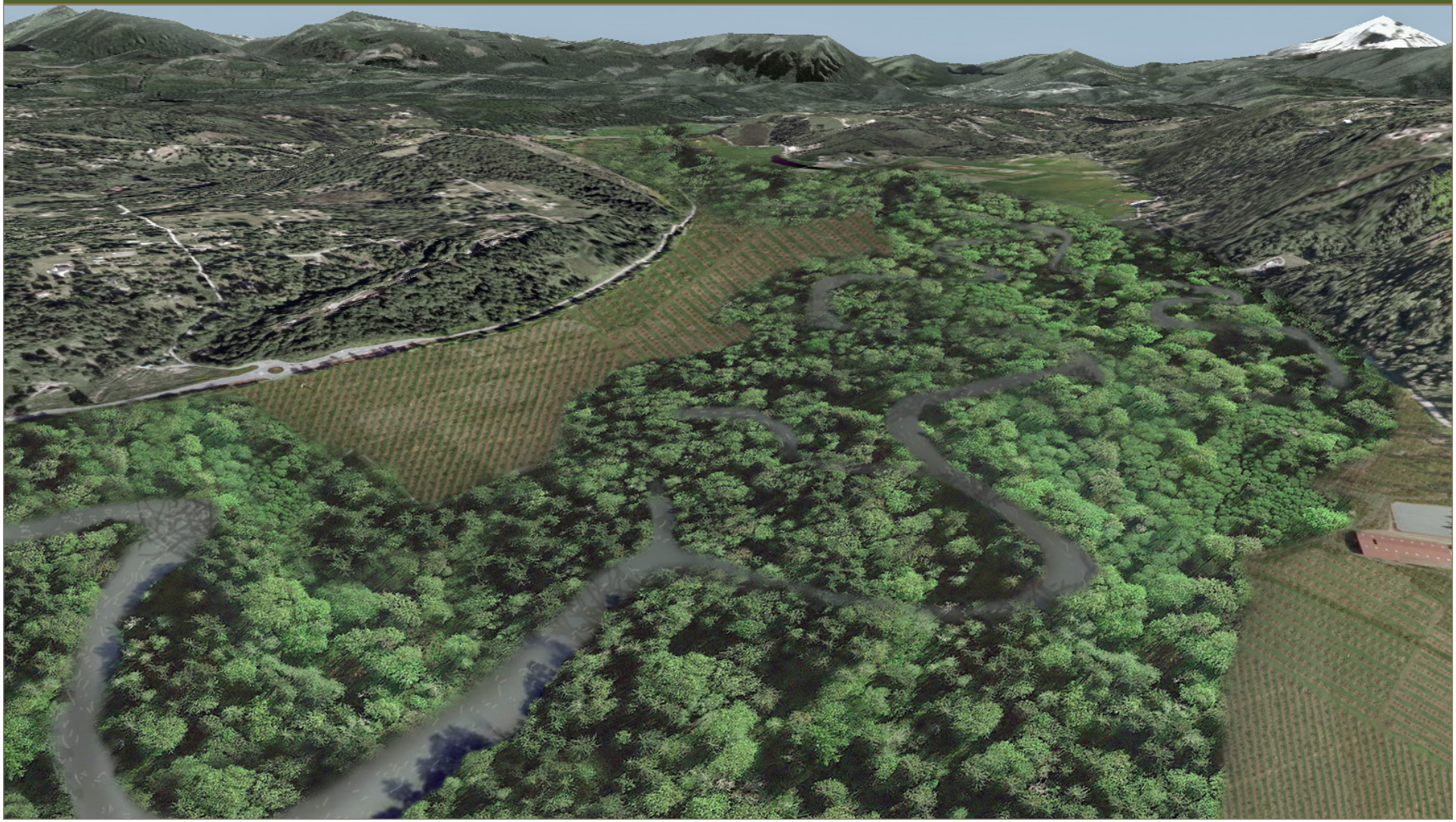
Figure 2.3-6

Example of Hypothetical Location with Typical Current Channel and Floodplain Conditions

Note: Example of a hypothetical location where the river has been somewhat straightened, in an incised condition, deforested, and disengaged from the floodplain.

Figure 2.3-7

Conceptual Drawing of Restorative Flood Protection Action Area in a Hypothetical River Valley



Note: Conceptual drawing of Restorative Flood Protection action area in a hypothetical river valley, with mature floodplain forest in the 2- to 10-year floodplain and a mixture of agriculture and restored floodplain forest in the 100-year floodplain.

Restorative Flood Protection actions are briefly described as follows, beginning with in-channel actions and extending out into the floodplain. Together, these actions would impede the flow of water downstream through river valleys and protect downstream communities from a wide range of floods, while restoring and protecting aquatic species habitat and providing other peripheral benefits.

In-channel Wood

The density of installed in-channel wood would vary by site and would not be placed evenly across and down the channel. Locations for in-channel wood installation would be chosen based on additional site assessment work that would include more detailed modeling and in-depth field verification of modeling conditions and results.

There are several examples of recent projects that utilized in-channel wood installations to re-engage incised rivers and streams with the floodplain. For example, a recently completed project (fall 2015) on the South Fork Nooksack River included channel-spanning logjams installed in four locations along a 1-mile-long reach. These jams went from riverbank to riverbank and extended up onto the floodplain to the edge of the floodplain forest. In this example, the jams were located in shallow water on the riffles of the river. In another example of a small creek, called Ellsworth Creek, wood was installed as a loose lattice across the creek channel and into the floodplain forest. The treatment length was about three times that of the channel width, or about 150 feet of wood for a 50-foot-wide creek channel. In rivers, logjams could take many forms, from piles of wood at the edge of the channel to mid-channel logjams on islands and bars, to logjams that span the entire length of the channel. In streams, it is possible that a single large tree could be enough to perform the function of slowing water and enhancing the flood frequency of the adjacent bank and floodplain. Examples of Restorative Flood Protection in-channel wood installation options are shown in Figure 2.3-8. In all cases, these wood installations are engineered to remain secure during flood conditions.

South Fork Nooksack River project
Photo credit: Gabe Zender (2015)

Ellsworth Creek in-channel wood installation
Photo credit: Mike (Rocky) Hrachovec (2010)

In the examples shown in Figure 2.3-8, the in-channel wood design options vary with desired effect. For example, the deflector logjam at the edge of a river channel works to divert flows, as well as the energy of the river, from the banks back into the middle of the channel—similar to the pins in a pinball machine. Mid-channel logjams on an island or bar promote island formation and help to maintain multi-threaded channels. More and longer channels help to slow water velocities with increased friction and relatively lower water volumes passing through the split channels. As mentioned in earlier-constructed examples, channel-spanning logjams work to push water up onto the floodplain and promote side-channel formation and/or re-engagement; channel-spanning trees in streams work to perform a similar function in smaller channels. As with all of the design options presented in Figures 2.3-8 through 2.3-10, these in-channel wood-loading options would be used in conjunction with additional design work in the riparian corridor and floodplain.

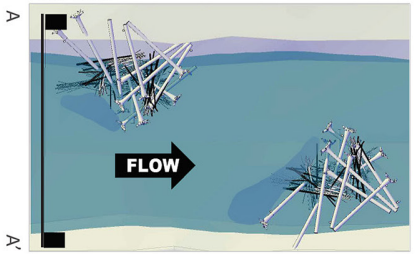
Figure 2.3-8

In-channel Restorative Flood Protection Example Design Options

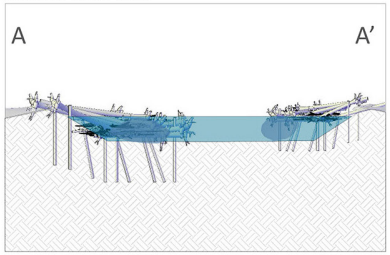
In-channel Wood Loading Options

Option 1: Deflector Log Jam at Edge of River Channel

Plan View

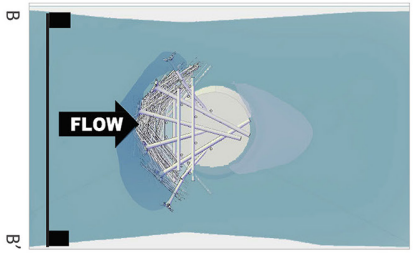


Section View A-A'

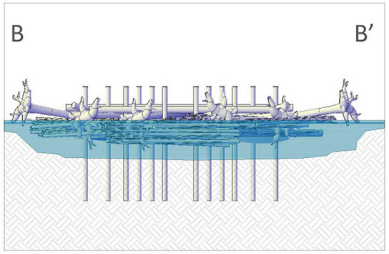


Option 2: Mid-channel Log Jam on Island or Bar

Plan View

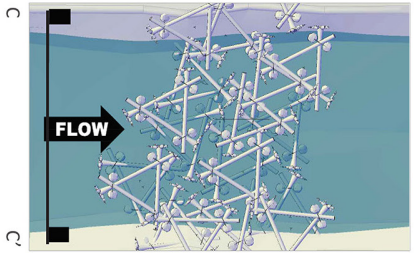


Section View B-B'

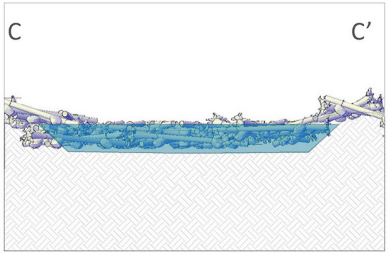


Option 3: Channel-spanning Log Jam in River

Plan View

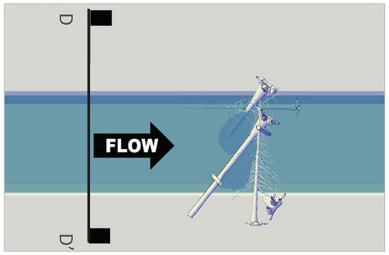


Section View C-C'

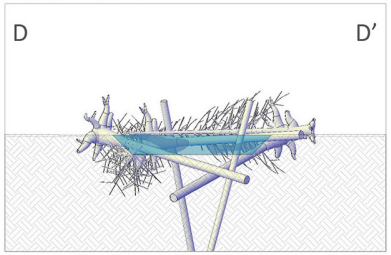


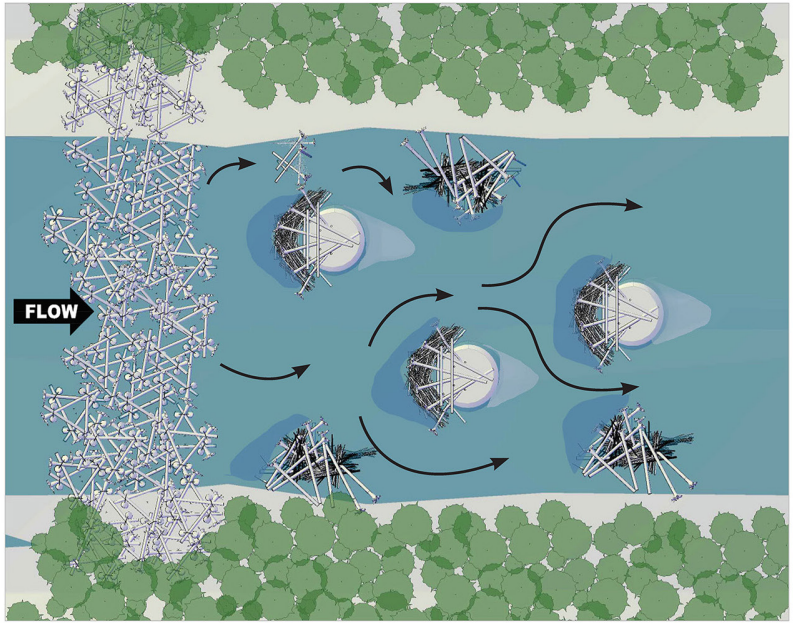
Option 4: Channel-spanning Trees in Stream

Plan View



Section View D-D'

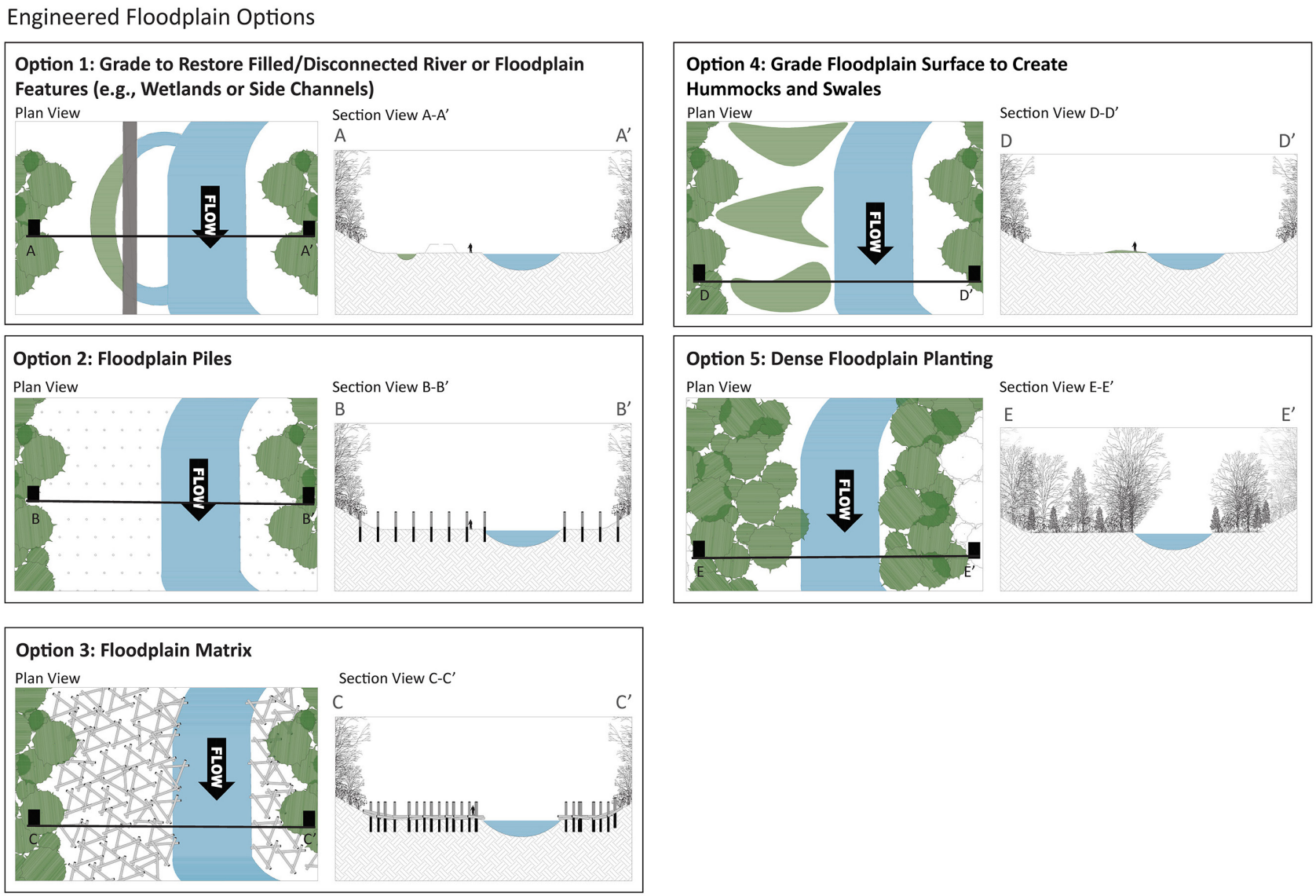




Note: Graphic examples of restorative flood protection options for increasing in-channel wood, re-engaging side channels, and other restorative actions.

Figure 2.3-9

Engineered Floodplain Restorative Flood Protection Example Design Options



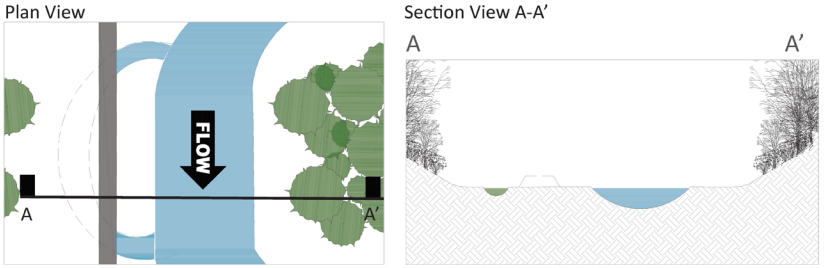
Note: Graphic examples of restorative flood protection options for engineering the floodplain to have roughness factors similar to a mature floodplain forest, as well as re-engaging or creating side channel, swale, and other changes in floodplain surface.

Figure 2.3-10

Miscellaneous Restorative Flood Protection Example Design Options

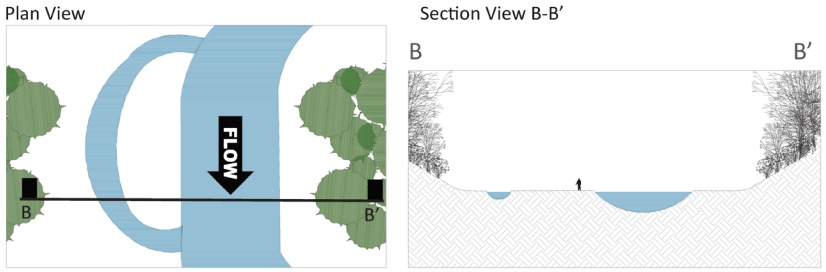
Reduce Channel Confinement

Remove Road/Railroad Grades or Other Unnatural Channel-confining Features



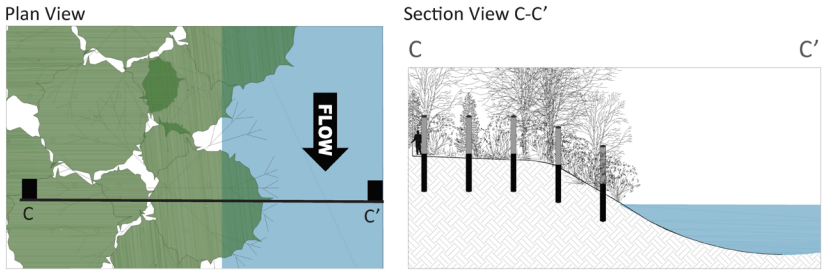
Increase Channel Length

Reconnect Oxbows, Side Channels, and Old Meanders



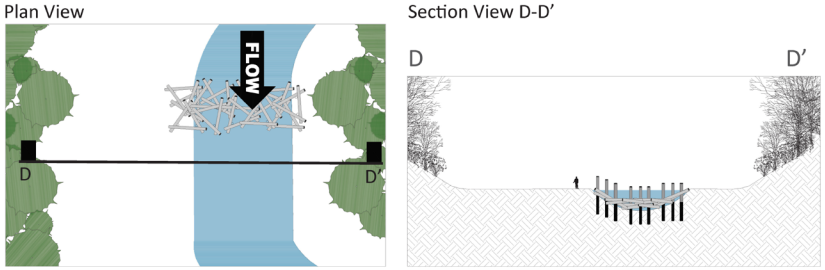
Riparian Corridor Enhancement

Dense Planting of Trees and Shrubs with Optional Piles

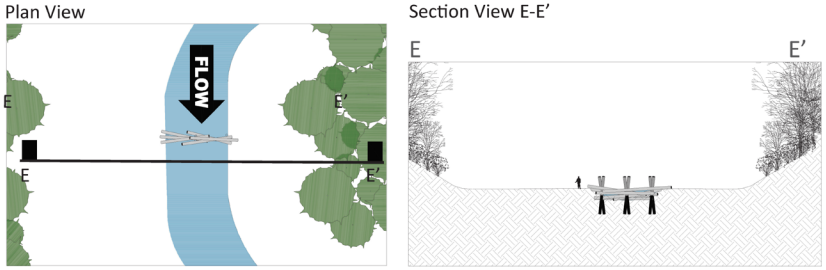


Small Impoundments

Option 1: Install Log Riffle Complexes



Option 2: Restore Beaver Habitat



Note: Graphic examples of restorative flood protection options for reducing channel confinement, increasing channel length, and storing water in and on the floodplain surface.

Brushy Riparian Corridors

Planting willows, red osier dogwood, red alder, and black cottonwood on river and streambanks would slow the water along these stream edges, creating turbulence and dissipation of energy as the water flows along the channel. This strategic type of planting would reduce floodwater velocity and add a level of flood protection within 10 years of installation, and could be applied immediately and at a broad scale. The effect and extent of this riparian planting could be further enhanced by adding floodplain matrices (described below) and in-channel wood (as previously described).

Engineered Floodplain Roughness

There are several actions that would slow water on the floodplain (see Figure 2.3-9). Floodplain wood matrices, or triangles of logs held in place by log piles or boulder ballast, would be installed in rows perpendicular to the flow of water in such a way that they work like in-channel wood to rack up smaller wood and impede the flow of water. The overall form of these matrices would be very similar to the channel-spanning logjam example shown previously. These matrices are built of dead or live trees. If posts are used to anchor the matrices to the ground, these posts would be buried half in and half out of the ground. Live posts could also be used because they may sprout brushy clumps of branches from the base of the trunks, enhancing floodplain forest development.

Floodplain wood matrices would be combined with shrubs, black cottonwood, Sitka spruce, western red cedar, and red alder plantings to create forest groves that would provide both immediate surface roughness and serve as long-term future sources of large wood to both the floodplain surface and adjacent channel.

Like the riparian edge planting and in-channel wood installation discussed previously, floodplain wood matrices work in the short term to slow floodwaters and enhance natural processes. In addition to floodplain roughness consisting of piles and log matrices, changes in floodplain topography, such as longitudinal berms and mounds, could be constructed to store and direct overbank flood flows.

Floodplain Forest

A mature floodplain forest, as has existed historically throughout much of the Chehalis Basin, would be envisioned for much of the Restorative Flood Protection treatment areas. A mature valley forest would take time to re-establish; however, active management of the actions described above could be used to hasten the establishment of a mixed conifer/hardwood floodplain forest (see Figure 2.3-9).

Airport Levee Improvements

Improvements to the Chehalis-Centralia airport levee include elevating the height of the existing levee and raising a portion of Airport Road to provide 100-year flood protection for the Chehalis-Centralia Airport, local businesses, and a portion of I-5 (see Figure 2.3-11).

Improvements to the existing airport levee would be made by increasing the height of the 9,511-foot-long levee by between 4 and 7 feet. The improvements would include either earthen materials or floodwalls atop the existing levee where the levee footprint is constricted by culverts or right-of-way. If the existing levee is raised by 7 feet, a change to the existing extent and location of the northwest corner of the levee could be necessary to avoid interference with the glide path to the active runway; otherwise, no change to the extent or location of the levee would be proposed. The new elevation of the levee would be between 181 and 182.5 feet if the levee is raised by 4 feet, depending on location, or up to 185.5 feet depending on final engineering requirements. The existing recreational trail located on top of the existing airport levee would be retained.

In addition to raising the existing levee, 1,700 feet of Airport Road would be raised to meet the raised airport levee height along the southern extent of the airport, and all utility infrastructure would be replaced, terminating at the West Street overcrossing approach. Including the raised section of Airport Road, the Airport Levee Improvements would result in up to 11,211 lineal feet of protective levee.

I-5 Projects

The I-5 Projects action element is intended to protect I-5 and the Chehalis-Centralia Airport. As shown in Figure 2.3-11, this action element includes construction of a series of earthen levees and structural floodwalls along I-5, including improvements to the existing airport levee, a new 1-mile-long Chehalis Avenue levee, and bridge replacements over Dillenbaugh and Salzer creeks. The I-5 Projects action element is located in Chehalis and Centralia along a 5-mile stretch of I-5, beginning near the 13th Street interchange (Exit 76) and extending north to the Mellen Street interchange (Exit 81; WSDOT 2012). Stormwater treatment areas would be constructed to address stormwater runoff from I-5 because rain that falls on I-5 during storm events would need to be collected, conveyed, stored, or discharged to prevent it from covering the lanes of I-5 (WSDOT 2014). Placement of levees and floodwalls at the locations identified above would be designed to maximize the cost-effective protection of I-5 while optimizing potential collateral benefits and minimizing adverse environmental impacts. Protecting I-5 and the airport may also provide protection to homes and businesses in some parts of Chehalis and Centralia (WSDOT 2012).

Figure 2.3-11

Airport Levee Improvements and I-5 Projects

Aberdeen/Hoquiam North Shore Levee

The Aberdeen/Hoquiam North Shore Levee consists of previously considered smaller projects that were combined into a comprehensive approach to protect the cities of Aberdeen and Hoquiam, which would result in a total of approximately 5.8 miles (30,000 linear feet) of levees—3.5 miles (18,400 linear feet) in Aberdeen and 2.3 miles (11,600 linear feet) in Hoquiam. The Aberdeen/Hoquiam North Shore Levee includes an earlier, smaller project known as the Northside Levee. The Northside Levee alignment, which would encircle Aberdeen's city center along the north side of the Chehalis River in Aberdeen, would be designed to provide 100-year coastal flood protection to Aberdeen (approximately 14.5 feet per the North American Vertical Datum of 1988; see Figure 2.3-12). The city center is subject to coastal floods from Grays Harbor and the lowest reaches of the Chehalis and Wishkah rivers, which are tidally influenced. The Northside Levee would run through low, flat, developed urban areas around the city center. The proposed levee system would be built using a combination of earthen levees, floodwalls, raised streets, stop-log closures, and pump stations.

The Aberdeen/Hoquiam North Shore Levee would expand protection beyond Aberdeen's city center to encompass the majority of the lowlands in Aberdeen and Hoquiam east of the Hoquiam River, north of Grays Harbor, north of the Chehalis River, and west of the Wishkah River. Conceptual design features include earthen levees, concrete T-walls, raised streets, stop-log closures, and pump stations; sheetpile walls could also be needed. The elevation of the Aberdeen/Hoquiam North Shore Levee would also be designed accommodate potential future sea level rise. The Aberdeen/Hoquiam North Shore Levee project is in the initial project planning and design phase; therefore, few details about this action element are available.

According to FEMA Hazus software, up to 2,715 structures could potentially be protected from coastal flooding after installation of this action element (Franklin 2016). The exact extent of flood protection and the number of structures protected would be determined during project-level design and environmental review.

Figure 2.3-12

Aberdeen/Hoquiam North Shore Levee

2.3.3.2 Local-scale Flood Damage Reduction Actions

Floodproofing

Floodproofing would protect existing structures in the Chehalis River floodplain by elevating structures above flood levels, building levees or floodwalls around them, demolishing or purchasing the structure, or through other floodproofing measures. Within Lewis, Thurston, and Grays Harbor counties, approximately 75% of the residential homes within the Chehalis River floodplain could feasibly be elevated or floodproofed through other means. For other buildings (commercial, industrial, government, schools), it is assumed that approximately 25% of the buildings in the Chehalis River floodplain could feasibly be raised, retrofitted, or floodproofed by constructing flood barriers or walls.

This action element is intended to reduce the cost of repetitive damage to structures in the floodplain through a strategic program of floodproofing and buy-outs. If structures cannot be floodproofed, and are instead purchased in order to be demolished, community values would be taken into consideration with regard to creating open space, protecting natural resources, and avoiding creating areas of nuisance or visual blight. Many local governments in the Chehalis Basin have conducted floodproofing and structure elevations, mainly using post-flood funding from FEMA. The EIS anticipates a substantially increased level of action with a stable funding source, oriented to making the maximum number of structures resilient to future flooding. As noted previously, no single Large-scale Flood Damage Reduction Action can protect all of the structures in floodplains in the Chehalis Basin from flooding. Programmatic efforts like Floodproofing would be necessary to address flooding in many areas. Like other actions in the EIS, Floodproofing would rely on the willingness of landowners in order for it to be a practical method of flood damage reduction.

Floodproofing also includes protecting livestock and farm investments during flooding events by constructing farm pads and creating evacuation routes. Farm pads are constructed of fill and provide an area elevated above flood levels to hold livestock and critical farm equipment during a flood. This action element would include potential farm pad projects that have been identified by local conservation

Floodproofing

Floodproofing can be defined as any combination of structural or nonstructural additions, changes, or adjustments to a building that reduces or prevents flood damage to the structure and/or its contents. Simply stated, floodproofing includes any effort a property owner may take to reduce flood damage. For purposes of this EIS, Floodproofing is a general term intended to encompass a suite of permanent measures or actions. The term floodproofing has specific meaning under the National Flood Insurance Program, the definition of which is narrower than how it is being used in this EIS.

districts, including two in Lewis County, one to two in Grays Harbor County, and possibly one in Thurston County.

Local Projects

This action element includes a program of localized, area-specific projects aimed at immediately protecting critical infrastructure, frequently flood-damaged properties, and priority areas throughout the Chehalis Basin over the next 10 years. This action element also includes projects intended to restore floodplain function. With or without Large-scale Flood Damage Reduction Actions, Local Projects would be needed to protect key infrastructure and improve the conveyance of water and drainage at key points in the Chehalis Basin (Ruckelshaus Center 2012). This action element is based on the Chehalis River Basin Flood Authority's list of projects, with the exception of farm pads and evacuation routes, which are included in the Floodproofing action element. The Local Projects action element does not include those projects from the Flood Authority's list that have already been completed or are currently ongoing, but consists of additional projects proposed for implementation, including, but not limited to, the following:

Flood Zones

Flood zones are characterized by high to moderate/minimal risk and are broken up into areas within the Special Flood Hazard Area (SFHA) and outside of SFHA (non-SFHA). SFHAs are defined as areas that have a 1% chance of being flooded in any given year, also referred to as the base flood or 100-year flood. These areas are associated with the highest level of flood risk.

Zone A includes areas within the SFHA where detailed hydraulic analyses have not been performed; therefore, no Base Flood Elevations are defined. Mandatory flood insurance purchase requirements and floodplain management standards apply to this zone.

Source: FEMA 2015

- Protection of wastewater treatment plants (WWTPs), such as the Elma WWTP outfall stabilization project and the Montesano WWTP Wynoochee River bank protection project
- Protection of roads and infrastructure, such as the Grays Harbor County Wishkah Road flood hazard reduction project, the Oakville flood relief analysis project, and the Centralia China Creek (Phase II) project
- Certification of existing levees, such as the Aberdeen Southside Dike/Levee Certification, which could include some dike improvements
- Restoration of floodplains, such as the Satsop River Floodplain Restoration (future phases)

Land Use Management

This action element involves local governments improving and revising land use regulations and practices. Improved Land Use Management would protect remaining floodplain functions and prevent future flood damage by minimizing floodplain development. Some of the recommendations would restrict the creation of developable parcels in the floodplain through open space preservation, subdivision set

asides, and low-density zoning. Other recommendations would increase the cost of future development in the floodplain, and include filling restrictions and freeboard elevation requirements.

The Land Use Management action element reflects model ordinance language for regulatory standards that are above the minimum state and National Flood Insurance Program (NFIP) requirements (French & Associates 2016). However, not every provision is appropriate for every community. For example, open space preservation and low-density zoning may only be feasible in counties. This EIS analyzes the effects of implementing the improved Land Use Management provisions in both cities and counties in the Chehalis Basin, and indicates whether, and to what extent, the revised regulations and practices minimize future floodplain development. The specific Land Use Management recommendations listed below are broken down into three categories: regulatory flood data, floodplain protection, and construction standards.

Regulatory Flood Data

These provisions would require additional flood data be utilized in floodplain regulations beyond that provided on the community's Flood Insurance Rate Map (FIRM), as follows:

- Communities would adopt flood of record data to determine the extent of the regulatory floodplain and the regulatory flood elevation where there is no Base Flood Elevation (BFE) shown on the FIRM, or where the flood of record is higher than the BFE.
- Under NFIP rules, if there are no BFEs on a FIRM (for example in Approximate A zones), new buildings do not have to be elevated above the flood level. This provision would require all permit applicants in Approximate A Zones to conduct an on-site flood study, or utilize an existing, current study, to calculate the BFE. This would **not** be required in the following scenarios:
  - In Approximate A Zones where flood of record elevations are used for regulations
  - Single-family residences: Permit applicants for single-family residences on existing lots would have the option of elevating the house 5 feet or more above grade without funding a study

Flood Insurance Rate Maps

Flood insurance rate maps generally designate Base Flood Elevations, flood zones, and the floodplain boundaries in a community. These maps allow property owners to obtain reliable information on the level of flood risk associated with their property. The level of risk is determined by the flood zone in which a property is located.

Floodplain Protection

This series of higher standards would minimize development in flood-prone locations and protect natural floodplain functions, as follows:

- **Open space preservation –** This standard would minimize construction of new buildings, filling, and destruction of natural floodplain functions. Publicly owned areas currently open space in the floodplain would be required to remain open space (i.e., no buildings, filling, storage).
- **Subdivision set asides –** This standard would require new subdivisions and other large developments to set aside all or part of their flood-prone area as open space.
- **Filling restrictions –** Filling anywhere in the floodplain would either be prohibited or compensatory storage would be required.
- **Low-density zoning –** Existing zoning districts that require minimum lot sizes of greater than 10 acres would not be amended to allow more dense development in the floodplain.

Compensatory Storage

Compensatory storage means compensation for the loss of floodplain storage caused by filling in the floodplain, which can result in raising flood elevations. Compensation could include direct replacement of storage close to the point of the lost floodplain or provision of the same volume of storage to that volume lost.

Construction Standards

The following standards would set higher or more effective protection levels for buildings constructed or substantially improved in the floodplain:

- **Freeboard –** Freeboard refers to the height above a given water level on which the lowest floor of a structure is built. In this case, the water level is the BFE as defined by regulations. This standard requires the freeboard height of new buildings to be 3 feet above BFE. This would also apply to substantial improvements of existing buildings.
- **Critical facilities –** There are two types of critical facilities: those facilities that are vital to flood response activities or critical to the health and safety of the public (e.g., hospitals, fire stations), and those that, if flooded, would make the flood problem and its impacts much worse (e.g., hazardous materials facilities). Critical facilities require a higher level of protection than normal properties. This higher standard includes two options: prohibit new critical facilities from the 500-year floodplain or protect them from damage and loss of access during a 500-year flood.
- **Non-conversion agreements –** This standard would require a permit applicant seeking to elevate or improve a building on floodwalls to sign an agreement that areas below the BFE or flood protection elevation would not be converted to a use (such as a residential living space) or be constructed with materials that are subject to water damage. For example, this means no

insulation, carpeting, and plumbing. The agreement would be required to be recorded on the property deed or title with the county auditor's office to advise future buyers of the restriction.

Flood Warning System Improvements

The existing Chehalis River Basin Flood Warning System, completed by the Chehalis River Basin Flood Authority, features publicly accessible, real-time, Web-based flood data and a monitoring and mapping site. Improvements to the existing flood warning system under this action element would include the following:

- Implementing a program to confirm the river gage rating curve/table for the Chehalis River at Centralia
  - This gage is currently located at the most populous area in the Chehalis Basin and is a key location used by the National Weather Service (NWS) to issue flood forecasts
  - The gage data used to convert river elevations to river flows has never been verified or confirmed with actual measurements of river flow
- Expanding the inundation mapping program to include the community of Bucoda
- Adding a new NWS river forecast point on the Skookumchuck River near Bucoda
- Working with the NWS River Forecast Center to implement a new hydraulic model in the lower Chehalis River that would provide the following:
  - Properly account for tides, storm surge, and sea level rise to better serve residents and businesses around Grays Harbor
  - Extend the River Forecast Center's ability to provide specific river forecasts between Porter and the mouth of the Chehalis River at Grays Harbor
- Revising inundation maps after significant floods to incorporate information obtained during the events to further verify map accuracy and reflect new changes in the floodplain
- Funding the addition of all Chehalis River inundation maps to the NWS inundation map website (currently only the maps for the Chehalis River at Centralia are available on the NWS website)

Flood Warning System

The Chehalis River Basin Flood Warning System website (www.chehalisriverflood.com) includes information on weather, rainfall, and river forecasts from the NOAA Hydrologic Prediction Service; interactive flood maps; interactive gage data maps and U.S. Geological Survey gages; and road conditions from WSDOT's travel alerts. The website also provides a link to the Chehalis River Basin Flood Authority webpage, which includes information on current projects, outreach and education, and background documents.

2.3.3.3 Aquatic Species Habitat Actions

Aquatic Species Habitat Actions would be designed to protect, improve, and create sustainable ecosystem processes and functions that support the long-term productivity of native aquatic and semi-aquatic species, and at much higher levels of abundance than current conditions support. Both a low and a high scenario are contemplated for this action. Action elements that would be implemented include the following:

- Restore riparian habitat along the lower mainstem Chehalis River and in tributaries throughout the Chehalis Basin (low and high restoration scenarios described below)
- Open up more than 295 miles of streams for migrating fish by removing partially or totally blocked fish passage barriers identified by the Washington Department of Fish and Wildlife (WDFW); this does not include the required Washington State Department of Transportation (WSDOT)-owned culvert corrections
- Restore off-channel habitat on the mainstem Chehalis River
- Add wood in the mainstem and tributaries to trap sediment and improve habitat for salmon and other species
- Restore bank erosion to naturally occurring rates
- Reconnect the floodplain, which could include the following:
  - Reconnecting oxbows in specific areas that would not exacerbate invasive predator issues
  - Removing levees and bank armoring
  - Allowing the river channel to migrate within the floodplain
- Create, restore, or enhance wetlands for use by semi-aquatic species

The low restoration scenario focuses on reaches in the middle and upper Chehalis Basin that improve habitat for spring-run Chinook salmon (104 river miles), whereas the high restoration scenario occurs across a greater geographic area with improvements to habitat focused on areas with the highest restoration potential for all salmonid species (356 river miles). Not all of these river reaches are likely to be restored under either restoration scenario, since restoration would be dependent on landowner willingness. For the purposes of this analysis, it is assumed that between 20% and 60% of these river reaches would be restored under either scenario. For the low restoration scenario, this equates to between approximately 21 and 63 river miles (1,150 to 2,900 acres). For the high scenario, this equates to between approximately 71 and 214 river miles (3,900 to 9,750 acres). While these scenarios were developed based on habitat potential for salmonid species, the restoration actions will have benefits for other fish and amphibians as well. The low and high restoration efforts evaluated in the EIS are shown in Figures 2.3-13 and 2.3-14.

Restoration of riparian and off-channel habitat would include adaptive management and monitoring to ensure these efforts are effective in meeting the goals of the restoration plan and minimizing the potential for invasive species. In addition, the long-term protection of restored riparian habitat under

the low or high scenarios through conservation easements and land acquisition would be required. As with other action elements evaluated in this EIS, some Aquatic Species Habitat Actions would rely on the willingness of landowners. This action element would be implemented as soon as possible, be completed within 15 to 20 years, and be maintained adaptively over the long term to ensure effective restoration for aquatic species in the Chehalis Basin.

As previously noted, a range of scenarios for restoring aquatic species habitat in and along river reaches within the Chehalis Basin are evaluated in this EIS. Evaluating low and high restoration scenarios is intended to bracket the potential range of measures that could ensue from implementation of the *Aquatic Species Restoration Plan* (ASRP), which is being developed by WDFW. The restoration actions identified in the final ASRP (being prepared by winter 2017) are dependent upon site conditions and landowner willingness, and would likely be within the low and high restoration scenarios.

This action element assumes the improved function of riparian areas on two types of lands within the Chehalis Basin: publicly and privately managed forestlands, most of which fall under the Washington Forest Practices Act (FPA) and Habitat Conservation Plans (HCPs); and areas outside of managed forestlands, most of which lie downstream of the publicly and privately managed forestlands. Within managed forestlands, the mechanism for achieving riparian improvements is the maturation of riparian buffers established under FPA. For areas outside managed forestlands, conditions are expected to improve due to active riparian restoration, land acquisition, or other measures.

Figure 2.3-13

Aquatic Species Habitat Actions - Low Scenario

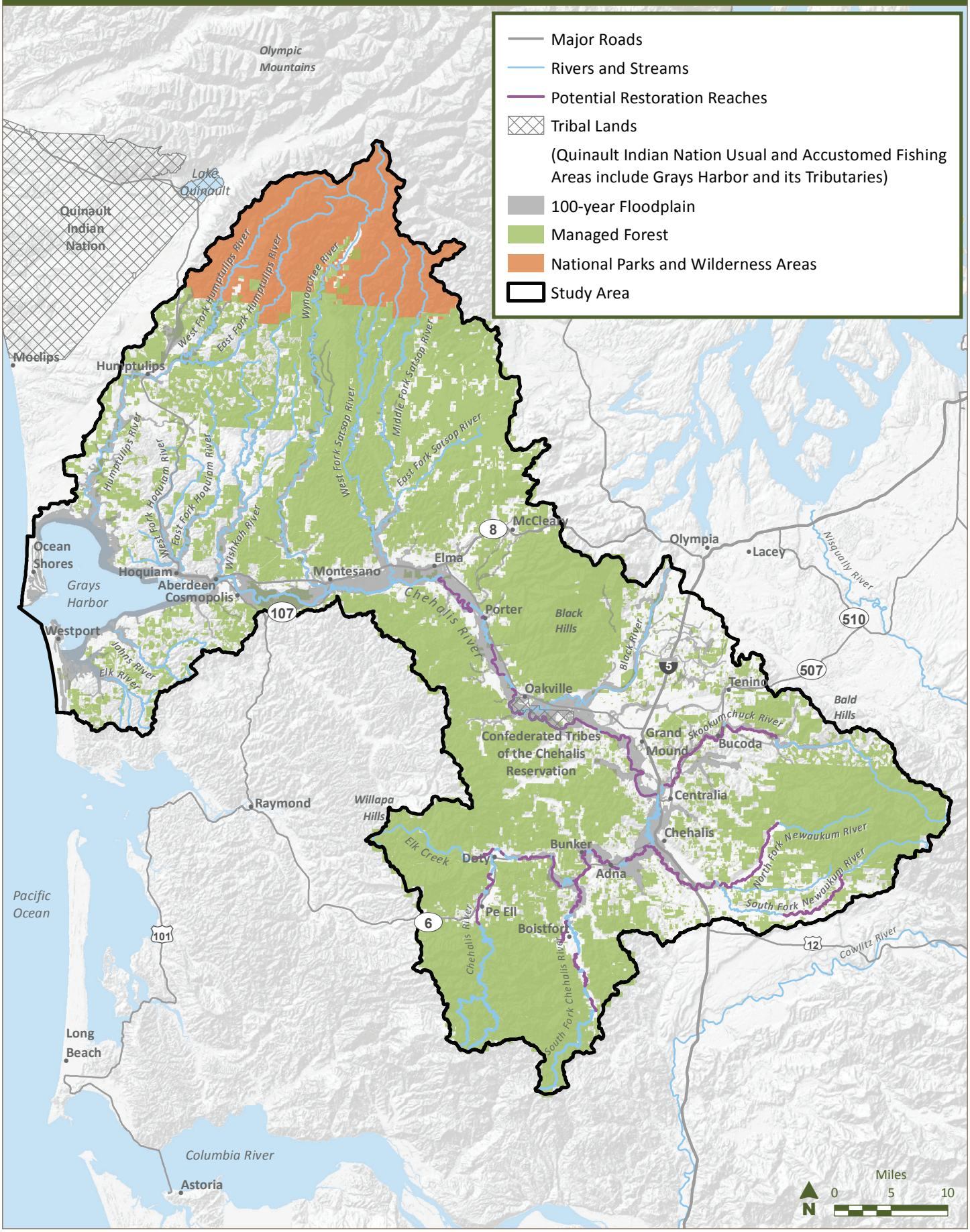
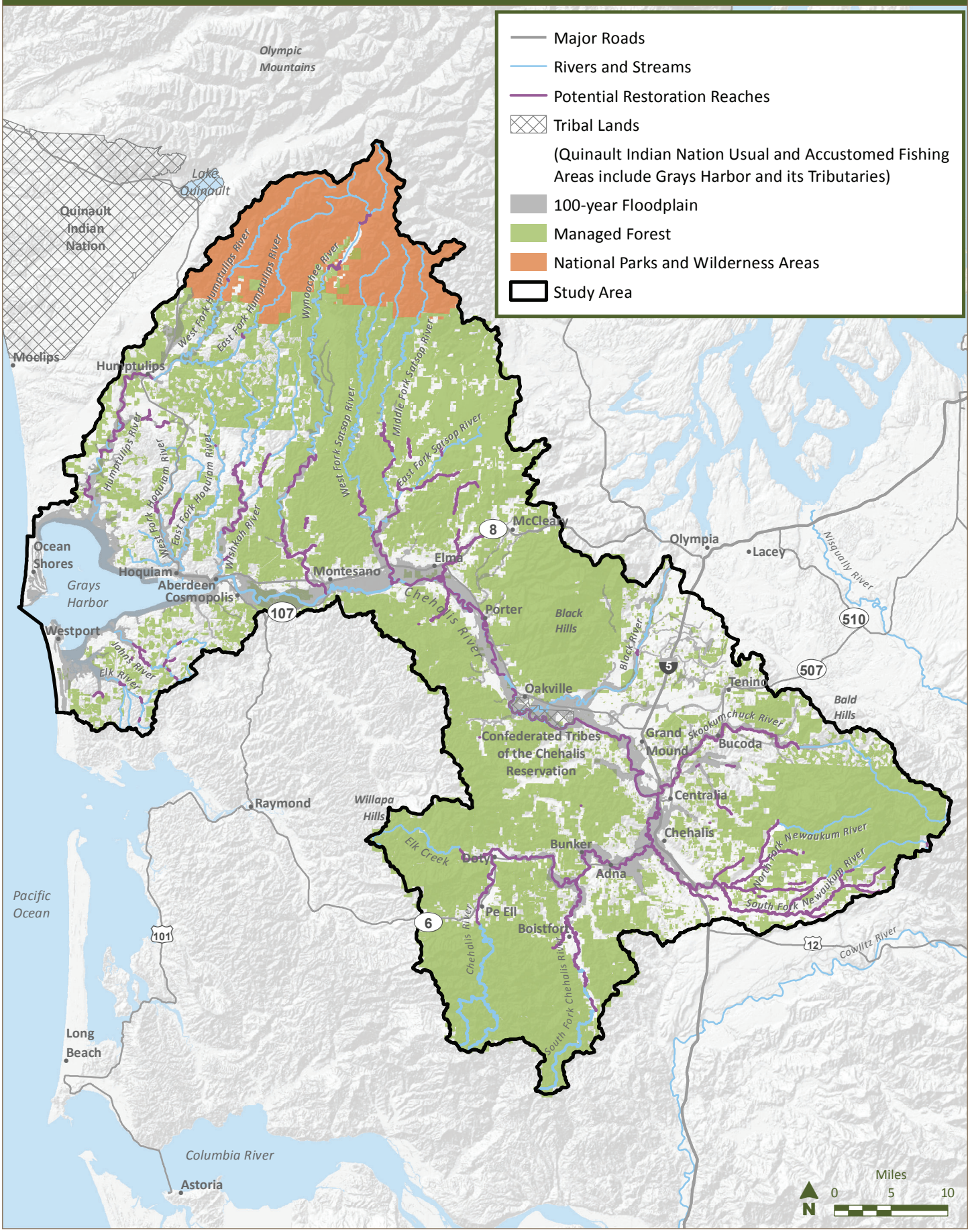


Figure 2.3-14

Aquatic Species Habitat Actions - High Scenario



2.3.4 Alternatives

2.3.4.1 No Action

The No Action Alternative is intended to represent the most likely future expected in the absence of implementing the proposed action alternative. Under the No Action Alternative, the recently increased levels of legislative funding for actions to address flood damage and aquatic species habitat degradation in the Chehalis Basin would not continue. Instead, funding for flood damage reduction and habitat improvements would be reduced to their historic levels after June 30, 2017.

For the purposes of the EIS, Ecology considers the No Action Alternative to include projects and programs that have been planned and designed to address flood damage and/or aquatic species habitat, are currently underway or being constructed, or have identified funding for implementation and are scheduled for implementation this biennium.

The No Action Alternative includes habitat restoration projects, local projects, farm pads, and evacuation route projects funded through the 2017 biennium. Long-term restoration strategies will be addressed in the ASRP. The near-term aquatic species habitat restoration projects that have been funded and will be implemented by 2017 are considered part of the No Action Alternative.

Implementation of existing state and local floodplain regulations, existing land use regulations, planned updates to Comprehensive Plans, and planned or ongoing updates to Shoreline Master Programs (SMPs) are considered part of the No Action Alternative.

Other individual actions that form the No Action Alternative include the continuation of SRFB-funded projects, as well as the continuation or implementation of Ecology's Water Quality Program, Conservation Reserve Enhancement Program (CREP), USFWS' CFRP, DNR's Forest Practices HCP and FFFPP, and WSDOT programs. The cities of Aberdeen and Hoquiam are currently developing a coordinated approach to reduce flooding, promote community development, and support salmon recovery efforts as part of the Timberworks Master Plan. The Timberworks Master Plan will proceed concurrently with the preliminary design of the Aberdeen/Hoquiam North Shore Levee action element, but would proceed even if the levee did not. Therefore, it is considered part of the No Action Alternative.

Ecology's Water Quality Program

Ecology administers the Water Quality Program, which provides funding for high-priority projects that protect and improve the health of Washington's lakes, rivers, streams, and marine water. Funding comes from a mix of state and federal funds dedicated for water quality improvement and protection. Ecology awards grants and loans to eligible public bodies under the following four main funding programs:

- Centennial Clean Water Program
- Clean Water Act (CWA) Section 319 Nonpoint Source Grant Program (Section 319)

- Washington State Water Pollution Control Revolving Fund Program (Revolving Fund)
- Stormwater Financial Assistance Program

TMDLs and other water quality improvement programs are currently being administered within the Chehalis Basin for National Pollutant Discharge Elimination System-permitted point sources, but nonpoint source pollution reduction activities are implemented on an opportunistic and voluntary basis. Water quality improvement actions are eligible for funding under the Centennial Clean Water Program, Section 319, and the Revolving Fund sources.

Habitat Restoration Programs

Conservation Reserve Enhancement Program

CREP is a joint federal- and state-funded program that restores riparian habitat and enhances wetlands along streams for salmon. Approximately 80% of the funding comes from the U.S. Department of Agriculture Farm Service Agency, with the remainder through the Washington State Conservation Commission. The landowners are paid rent for allowing their land to be used for fish and wildlife improvements and receive a monetary bonus for signing up.

Salmon Recovery Funding Board Supported Projects

Under the No Action Alternative, implementation of SRFB-funded projects in the Chehalis Basin would continue through the Chehalis Lead Entity. Funding for salmon and other aquatic species habitat restoration and preservation projects in the Chehalis Basin (WRIAs 22 and 23) would continue at historic levels. For example, from 1999 through 2014, approximately $1.6 million was granted for an average of nine aquatic species habitat restoration projects per year. This includes sponsor matching, which is approximately $500,000 per year.

Chehalis Fisheries Restoration Program

Under the No Action Alternative, the implementation of CFRP, which includes aquatic species habitat restoration and an education program, would continue in the Chehalis Basin. The primary objectives of CFRP are to restore or improve spawning and rearing habitat, improve water quality, and increase public awareness. Projects include restoring or improving spawning and rearing habitat through fish passage barrier removal, riparian planting, removing invasive plants, and incorporating large wood into other projects. CFRP funds are used to support projects funded through USFWS at investments of about $200,000 per year. The CFRP annually provides 20% of the funds allocated for the program to the Quinault Indian Nation and the Chehalis Tribe.

Forest and Timber Programs

DNR Forest Practices Habitat Conservation Plan

The DNR Forest Practices HCP would continue to be implemented within the Chehalis Basin. The plan applies to forest practice activities such as timber harvesting and forest road construction, and maintenance that can affect aquatic and riparian habitat on private and state forestlands.

DNR Family Forest Fish Passage Program

DNR administers the FFFPP, which funds fish barrier removal projects on small forest landowner properties. As a result of the FFFPP, nearly 66 landowners replaced 86 barriers to open approximately 160 miles of stream habitat within the Chehalis Basin between 2003 and 2015. There are currently 108 projects on the FFFPP waiting list within the Chehalis Basin. At an average cost of $100,000 per project, the total cost to correct these barriers is approximately $10.8 million.

WSDOT Programs

Under the No Action Alternative, no action would be taken to prevent flooding of I-5. WSDOT would continue to use its existing emergency detour routes when I-5 is closed due to flooding. One route uses SR 7 and U.S. Route (US) 12. The other detour routes trucks around I-5 through Oregon and Eastern Washington (see Section 3.13.1 for additional information).

WSDOT would also continue to implement its state-wide fish passage restoration program. Under this program, WSDOT is removing culverts that are inadequate to allow fish to migrate upstream and downstream as necessary for growth and reproduction. Fish passage restoration under this program would continue at existing levels under the No Action Alternative.

Timberworks Master Plan

Currently, Aberdeen and Hoquiam are affected by coastal, riverine, small drainage, and localized flooding, which exacerbates the economic challenges currently facing these communities. The Timberworks Master Plan will be developed to address these flooding issues in collaboration with the community. Efforts include identifying benefits such as reduced flood risk and increased public open space, as well as education regarding flood risks.

2.3.4.2 Alternative 1: 2014 Governor's Work Group Recommendation

The Work Group published its 2014 Recommendation Report, outlining a program of integrated, long-term, flood damage reduction and aquatic species habitat restoration actions for further study in the 2015 to 2017 state biennium budget. Since then, the Work Group membership has changed, and they are evaluating the alternatives in this EIS and public comments in crafting their recommendation to the Governor later in 2016. This recommendation, the 2014 Governor's Work Group Recommendation (Alternative 1), would achieve flood damage reduction through the implementation of a comprehensive package of actions to: provide Large-scale Flood Damage Reduction Actions (including the Flood Retention Facility) that target a broad geographic area, provide Local-scale Flood Damage Reduction Actions with more localized benefits, restore aquatic species habitat, and implement nonstructural actions that restore aquatic species habitat and reduce flood damage. Action elements included in Alternative 1 are as follows:

- **Large-scale Flood Damage Reduction Actions –** Flood Retention Facility (FRO or FRFA), Airport Levee Improvements, and Aberdeen/Hoquiam North Shore Levee

- **Local-scale Flood Damage Reduction Actions –** Floodproofing, Local Projects, Land Use Management, and Flood Warning System Improvements
- **Aquatic Species Habitat Actions –** Low- or high-scenario restoration actions that include restoring riparian habitat; removing fish passage barriers; restoring off-channel habitat; adding wood; restoring bank erosion to naturally occurring rates; reconnecting the floodplain; and creating, restoring, and enhancing wetlands

2.3.4.3 Alternative 2: Structural Flood Protection Without a Flood Retention Facility

Alternative 2 evaluates a scenario in which Large-scale Flood Damage Reduction Actions in the upper Chehalis Basin would be focused primarily on I-5 and the Chehalis-Centralia Airport. This alternative includes the Airport Levee Improvements, I-5 Projects, and Aberdeen/Hoquiam North Shore Levee as the Large-scale Flood Damage Reduction Actions. The rest of the action elements identified under Alternative 1 and identified in Table 2.3-1 (the Local-scale Flood Damage Reduction Actions for more localized benefit, and Aquatic Species Habitat Actions) are also included in Alternative 2.

2.3.4.4 Alternative 3: Nonstructural Flood Protection

Alternative 3 represents a "nonstructural" approach to reducing flood damage and restoring aquatic species habitat. In contrast to implementing Large-scale Flood Damage Reduction Actions, flood damage would be reduced through a programmatic effort to floodproof or remove existing structures. These structures and their contents would be protected from significant damage during floods through elevation and other measures. In limited situations where structures cannot be elevated or floodproofed, the most feasible action would be removal of structures. While flooding would continue to occur, the damage, and the cost of recovering, from such floods would be reduced. This alternative includes the implementation of all of the Local-scale Flood Damage Reduction Actions and Aquatic Species Habitat Actions identified in Table 2.3-1, without any of the Large-scale Flood Damage Reduction Actions (Flood Retention Facility, Airport Levee Improvements, I-5 Projects, Aberdeen/Hoquiam North Shore Levee, or Restorative Flood Protection).

2.3.4.5 Alternative 4: Restorative Flood Protection

The proposed actions under Alternative 4 include increasing the flood storage capacity of the Chehalis Basin watershed by adding roughness to the river and stream channels and floodplain, and by reconnecting floodplain storage to the river. This alternative focuses on reducing flood peaks downstream of the Newaukum River confluence on the mainstem Chehalis River, and would be accomplished through implementation of Restorative Flood Protection under the Large-scale Flood Damage Reduction Actions. This alternative also includes the implementation of all of the Local-scale Flood Damage Reduction Actions and Aquatic Species Habitat Actions identified in Table 2.3-1. The Restorative Flood Protection action element would be coordinated with and complement the Aquatic Species Habitat Actions within the treatment areas.

2.3.5 Elements Considered, but Not Carried Forward in the EIS Alternatives

Over the years, many flood damage reduction approaches have been studied in the Chehalis Basin—from raising bridges and removing constrictions, to reconnecting floodplains, to a series of small projects, to more and better levees, to dredging (Ruckelshaus Center 2014). These alternatives were eliminated from further detailed study for a variety of reasons, and are not carried forward in this EIS, as described in this section.

2.3.5.1 Other WSDOT I-5 Protection Alternatives

The objective of the I-5 (13th Street to Mellen Street) protection analysis, led by WSDOT, was to evaluate possible alternatives to potentially protect I-5 and the Chehalis-Centralia Airport from floodwaters, and improve access to medical and other critical facilities during floods. WSDOT also evaluated whether these alternatives would address the future need for widening this stretch of I-5 and considered those needs in the design of the alternatives. The following six primary alternatives were evaluated (WSDOT 2014):

- **I-5 Levees and Walls, Raise Airport Levee, New SW Chehalis Levee –** This alternative was a combination of earthen levees and structural walls along I-5, improvements to the existing Chehalis-Centralia airport levee, a new levee in southwest Chehalis, and bridge replacements over Dillenbaugh and Salzer creeks. Portions of this alternative were carried forward into the action elements and alternatives evaluated in this EIS.
- **I-5 Raise and Widen Only –** This alternative involved raising I-5 using fill material, widening I-5 from four to six lanes, and raising bridges, but did not include raising the Chehalis-Centralia airport levee or building a new levee in southwest Chehalis. WSDOT found this alternative would improve conditions for approximately 840 buildings, but would have a negative impact for approximately 300 buildings. Therefore, this alternative was not carried forward.
- **I-5 Express Lanes –** This alternative was the construction of new express lanes adjacent to I-5 to provide traffic the opportunity to bypass I-5 if the main interstate was closed by floods. WSDOT found there were significant uncertainties with the express lanes, including whether the City of Tacoma would sell the right-of-way along the Tacoma Rail line and the potential cost. The express lanes would also not provide local access to I-5 between 13th Street and Mellen Street, and the City of Chehalis expressed strong concerns about the potential effects of the express lanes alternative on the community. WSDOT also found this alternative would improve conditions for approximately 890 buildings, but would have a negative impact for approximately 170 buildings. The alternative did not include protection for the Chehalis-Centralia Airport. For all of these reasons, this alternative was not carried forward.
- **I-5 Temporary Bypass –** This alternative involved the construction of temporary bypass lanes adjacent to I-5, similar to the express lanes alternative. WSDOT found there were also significant uncertainties with the bypass lanes, including similar right-of-way, cost, and local

access concerns. The City of Chehalis also expressed strong concerns about the potential effects of the temporary bypass lanes alternative on the community. WSDOT found this alternative would improve conditions for approximately 900 buildings, but would have a negative impact for approximately 170 buildings. The alternative did not include protection for the Chehalis-Centralia Airport and did not address the need to widen I-5 in the future. Therefore, this alternative was not carried forward.

- **I-5 Viaduct –** This alternative evaluated constructing a viaduct by elevating I-5 on piers, widening I-5 to six lanes, and reconstructing all interchanges in the area. WSDOT determined that this was not a viable alternative due to high costs and increased flood elevations in the urban areas of Centralia.
- **I-5 Relocation –** WSDOT's final alternative was to relocate I-5 outside the flood area. The alternative included widening I-5 to six lanes and would require constructing new interchanges. WSDOT determined that this was not a viable alternative due to the high costs and impacts on the built and natural environment in and around Chehalis and Centralia.

The fill, viaduct, and relocation alternatives had cost estimates ranging from $350 million to $2 billion (Ruckelshaus Center 2012). In 2014, in consultation with WSDOT, the Work Group concluded that most of these additional efforts to protect I-5 from flooding would not be cost-effective and could increase flood damage to people and communities, particularly on the west side of I-5 near the Chehalis River, and along Dillenbaugh Creek and the Newaukum River.

Although protection of I-5 was the main focus of the 2012 WSDOT report, flood risks to SR 6 and US 12 were also recognized. The floods of 1996, 2007, and 2009 inundated SR 6 and US 12 with up to 9.5 feet of water—and even after installation of a Flood Retention Facility in the upper Chehalis Basin, the modeled 100-year flood indicated SR 6 and US 12 would continue to flood with up to 5.1 feet of water. WSDOT evaluated preliminary concepts for flood protection, which involved raising the roadway in flood-prone areas along SR 6 and US 12. WSDOT preliminarily estimated of the costs of these improvements to be $30 to $40 million even with a Flood Retention Facility in place. Additional costs for mitigation would also be incurred.

2.3.5.2 U.S. Army Corps of Engineers Twin Cities Project and Alternatives

In the 1980s, USACE began to evaluate a plan for flood damage reduction through Chehalis and Centralia, including protection of I-5. The basic plan, to build 11 miles of new levees in the floodplain, was authorized for further analysis by Congress as the USACE Centralia Flood Damage Reduction Project (aka the Twin Cities Project), but was not funded for construction. The plan included levees on the Chehalis River, the lower 2 miles of Dillenbaugh and Salzer creeks, and the lower Skookumchuck River

(Ruckelshaus Center 2012). Approaches evaluated by USACE included the following categories of elements (PIE 1998):

- **Nonstructural options** for reducing flood damages, including the following:
  - Watershed management measures such as reforestation, timber harvest control, and development control to reduce the amount of erosion and silting of streams, and to decrease the magnitude of peak runoff associated with flooding in the Chehalis Basin
  - Floodproofing residential, commercial, and industrial structures in the Chehalis-Centralia area that are currently subjected to flooding
  - Evacuating and relocating, including moving all residential, commercial, and industrial buildings in the Chehalis-Centralia area out of the floodplain

  USACE determined that evacuation and relocation would not be politically or economically feasible, and that the other nonstructural options for reducing flood damages would not reduce flooding to the extent that damages to I-5 would be reduced. However, these options could remain viable as components of a future approach. In fact, portions of these options were carried forward into the action elements and alternatives evaluated in this EIS.

- **Hydraulic capacity improvements** through excavation directly in the river channels (e.g., dredging) or the construction of levees, or a combination of the two, including the following:
  - Clearing vegetation and debris out of the main channel of the Chehalis River
  - Excavating and enlarging river sections where flow is constricted, including variations involving excavation in the mainstem Chehalis River, the Skookumchuck River, and the Newaukum River
  - Dredging 9 miles of the mainstem Chehalis River in the Centralia area and constructing levees along the banks of the Chehalis River, Skookumchuck River, and Salzer Creek
  - Building levees in Centralia and Chehalis to protect urban areas
  - Straightening and enlarging the Chehalis River, and building levees along both banks of the Chehalis and Skookumchuck rivers

  USACE determined that the removal of vegetation and debris would require annual maintenance; would affect habitat for fish, water quality, and bank erosion; would result in an insignificant increase in flow capacity compared to the flood discharges; and would not reduce I-5 flooding.

  Dredging and sediment management actions to lower the mainstem Chehalis River channel bottom by as much as 15 feet, from approximately Mellen Street in Centralia to Lincoln Creek, were evaluated at various times by USACE and consultants. Dredging of the Chehalis River would also require some dredging in the lower reaches of the Skookumchuck River

(Ruckelshaus Center 2012). According to a 1998 Pacific International Engineering *Chehalis River Basin Flood Reduction Report* (cited in Ruckelshaus Center 2012), channel dredging in this reach of the Chehalis River could result in potentially significant environmental impacts, would require long-term maintenance, would likely affect water quality during construction, and would raise issues related to permitting feasibility. The project would damage high-quality habitat near the WDFW Bob Oke Game Farm (with a potential to negatively affect Chinook salmon, coho salmon, and other species), as well as the only riparian forest in the area for miles, which also provides public access (Ruckelshaus Center 2012).

As with channel dredging, USACE determined that channel excavation and levee construction were characterized by significant concerns regarding environmental impacts and permitting feasibility, and were not economically feasible. USACE constructed some urban area levee projects and did not move forward with others, but determined that straightening and enlarging the Chehalis River with levees along both banks was not economically justified and would incur the greatest environmental impact of the previously studied flood impact reduction options.

- **Floodway and floodplain excavation options** to increase high-flow hydraulic capacity of the Chehalis, Skookumchuck, or Newaukum rivers as follows:
  - Excavating and terracing the floodplain adjacent to the river channel to provide additional flow area for higher flow events
  - Creating a secondary flood bypass channel to increase the area of flow during high-flow events

  USACE determined that both floodway and floodplain excavation options for increasing high-flow capacity would also cause an increase in peak flows downstream. Floodway excavation was also determined to have potentially significant environmental impacts. The secondary flood bypass channel options were also determined to have substantial impacts on the built environment including displacement of numerous residents and businesses, effects to agricultural lands, and the necessary relocation of medical or other public facilities.

- **Flood control dam options** to retain flood flows included the following:
  - Modifying Skookumchuck Dam
  - Constructing upstream flood control dam projects at five potential locations
  - Building several small headwater dams at 12 sites in drainages above Chehalis-Centralia
  - Constructing one or more flood storage areas in the floodplain through enclosing a large area with a dike

  Most of the modifications to the Skookumchuck Dam did not appear to be economically justified to USACE, so design work was suspended. A rubber weir option at Skookumchuck Dam was also examined; all of the Skookumchuck Dam modifications were found to have potentially significant environmental impacts including to water quality, instream flows, and habitat.

Constructing flood storage areas in the floodplain with a dike was determined to be less efficient and effective than a flood control dam or storage in the headwaters, and would have potentially substantial environmental impacts. Building several small headwater dams was determined to have a poor benefit-to-cost ratio and was not evaluated further by USACE. Several of the other flood control dam projects were determined to be economically infeasible, result in minimal downstream benefit, or result in significant impacts related to transportation and the built environment. However, Floodproofing was carried forward into the action elements and alternatives evaluated in this EIS.

Work on the USACE Twin Cities project was largely stopped in 2011 after it was determined that it would not have protected I-5 during a 100-year flood, would have increased flooding upstream and downstream of the Twin Cities, and would not pass the USACE cost-benefit test. USACE issued a draft close-out report for the project with options for how to proceed. USACE could decide to reframe the project and move forward with individual pieces, or they could re-evaluate the project and conduct additional feasibility study work to determine if a different project approach might provide better benefit-to-cost ratios. The latter would require a local sponsor, and both would require additional funding (Ruckelshaus Center 2012).

2.3.5.3 Alternate Water Retention Facility Location or Multiple Locations

The Chehalis River Basin Flood Authority built on early work by USACE and the Lewis County Public Utilities District to evaluate flood retention structures in the Chehalis Basin. A number of locations were considered in the early analysis of potential water retention facilities, including on the Newaukum River, upper Chehalis River, and South Fork Chehalis River. Based on favorable topography and maximum drainage area, a site upstream of Pe Ell on the upper Chehalis River and a site on the South Fork Chehalis River were initially carried forward (EES 2010). Based on additional studies and a technical workshop in 2012, it was determined that a single flood retention facility on the mainstem would provide the greatest reduction of flooding Basin-wide (Ruckelshaus Center 2012). The South Fork Chehalis River was not favorable from a cost-benefit analysis, including increased flood damage to commercial buildings and transportation delay or detours (EES 2010). Future study would be needed to evaluate the effects on Thurston and Grays Harbor counties, as well as impacts on fisheries.

2.3.5.4 Floodwater Bypass Routes/Structures Near Mellen Street and Scheuber Road

The bridge at Mellen Street was evaluated as a potential cause of flood impacts in the Twin Cities area. However, the HEC-RAS hydraulic modeling done to evaluate potential benefits for the *Chehalis Basin Flood Hazard Mitigation Alternatives Report* predicted that there would be little benefit from removing the bridge. This result was, in part, because even without the bridge, the natural topography at this location acts as a constriction on floodwaters (Ruckelshaus Center 2012). A different approach for reducing flood impacts in this vicinity would be to construct a high-flow bypass from the left edge of the

Chehalis River floodplain, which would bypass this constriction. Likewise, a Scheuber Bypass Alternative was explored. This approach would provide culvert or bridge connections under SR 6 to pass high flows downstream and through the bypass, with the goal of reducing peak flood levels in Chehalis.

The floodwater bypass routes/structures proposed near Mellen Street and near Scheuber Road in Centralia would provide high-flow routes for floodwater to move past existing development and constrictions. These routes could also provide an opportunity for aquatic species habitat restoration or ecological restoration (e.g., off-channel areas, wetlands). The *Chehalis Basin Flood Hazard Mitigation Alternatives Report* included potential concerns with this alternative due to predicted downstream flows and increased water levels, and WDFW staff expressed concern about the potential for the project to become a "fish sink" where fish are moved into the area during floods and then become trapped when floodwaters recede (Ruckelshaus Center 2012). Due to the potential for increased flooding to other communities and impacts on aquatic species, it was determined that these projects should not be carried forward.

2.4 Applicable Regulations, Plans, Laws, and Treaty Obligations

There are numerous regulations, plans, laws and treaty obligations that guided or influenced the development of this EIS. Implementation of the alternatives in the EIS will also require compliance with regulations and plans at federal, state, and local levels. A summary of these legal requirements and policies is provided in Sections 2.4.1 through 2.4.4.

2.4.1 Tribal Authority

Tribal Regulations

Two tribes are located in or adjacent to the Study Area: the Chehalis Tribe and the Quinault Indian Nation. As with most tribal governments in Washington, these tribes retain sovereign rights that are guaranteed under treaties and federal laws. For activities on tribal lands, tribal laws may require permits and approvals such as Tribal Environmental Policy Act determinations; critical areas approvals; clearing, grading, and building permits; and land use approvals. Implementing elements of EIS alternatives on tribal lands would need to be consistent with land use plans and comply with the applicable tribal laws.

Tribal Rights

As a signatory of the Treaty of Olympia (1856), the Quinault Indian Nation has treaty-reserved rights that reserve the rights to "taking fish, at all usual and accustomed fishing grounds and stations" and the privilege of hunting and gathering, among other rights, in exchange for ceding lands it historically roamed freely (Sharp 2016a). As a treaty tribe, the Quinault manage their fisheries and are responsible for regulating tribal fishers both on and off the reservation. The Quinault Indian Nation is a co-manager with WDFW for salmon, steelhead, white sturgeon, and Dungeness crab. Treaty resources, including fish

and plants, supported by the Pacific Ocean, the Pacific coast, Grays Harbor and its rivers and tributaries are inextricable from the Quinault people's traditional and modern ways of life. Impacts on treaty-reserved rights cannot be mitigated without consent of an affected treaty tribe. Any discussion or consideration of mitigation for impacts on treaty rights require consent by the Quinault Indian Nation.

Federal courts determined the usual and accustomed fishing areas of Quinault Indian Nation include "the waters adjacent to their territory" and "Grays Harbor and those streams which empty into Grays Harbor" (*United States vs. Washington*, 459 F.Supp. 1020, 1079 [W.D. Wash. 1978], affirmed 645 F.2d 749 [9th Cir. 1981]). In a later compilation of key Boldt Decision findings, the court concluded, "The Quinault Tribe has usual and accustomed fishing places in Grays Harbor and its watershed, including the Humptulips River" (*United States vs. Washington*, 459 F.Supp. 1020, 1038 [W.D. Wash. 1978] affirmed, 645 F.2d 749 [9th Cir. 1981]). The Chehalis River and all of its tributaries empty into Grays Harbor and are, thus, within the Quinault Indian Nation's usual and accustomed fishing areas (Sharp 2016a).

The Chehalis Tribe is a federally recognized tribe in the Chehalis Basin, and the 4,849-acre (7.6-square mile) Chehalis Tribe reservation is located on the Chehalis River at the mouth of the Black River near Oakville, northwest of Centralia. Because the Chehalis Tribe is a non-treaty tribe, their fisheries are limited to the portion of the rivers on the reservation, and their harvest is a portion of the non-treaty allowable harvest. The Chehalis Tribe's portion of the non-treaty harvest is based on a sharing formula between Washington State and the Chehalis Tribe. Access to fishing and hunting on off-reservation lands are also available to members of the Chehalis Tribe. Recreational fishing on reservation lands is permitted with a tribal fishing license. Tribal members who fish off-reservation must have a valid Washington State fishing license and follow Washington State regulations.

2.4.2 Federal Regulations

National Environmental Policy Act

Enacted in 1969, the National Environmental Policy Act (NEPA) is the federal mandate to evaluate environmental consequences of proposals before decisions are made by federal agencies. Implementing elements of the EIS alternatives may require NEPA review if federal agency approval or federal funding are required.

Endangered Species Act

Enacted in 1973, ESA is designed to protect fish and wildlife species from extinction. This EIS identifies those species and critical habitats within the Chehalis Basin that are currently listed under ESA by USFWS and the National Marine Fisheries Service (NMFS). Implementing elements of the EIS alternatives may require ESA review if federal agency approval or federal funding is required.

Magnuson-Stevens Fishery Conservation and Management Act

Implementing elements of the EIS alternatives that could affect Essential Fish Habitat (EFH) of commercial fisheries would require review by NMFS for federal- or state-sponsored projects.

Clean Water Act

Enacted in 1972, CWA was developed to protect water quality in surface water and groundwater. As water resources are a substantial component of the EIS alternatives, CWA requirements are a key part of the impact analyses documented in this EIS. Implementing elements of the EIS alternatives that could affect water resources would require compliance with CWA, which includes both federal- and state-level permits. Detailed information on CWA requirements can be found in Appendix D.

Rivers and Harbors Act

Construction of elements of the EIS alternatives that include work in, over, or under navigable waters of the United States would require a Rivers and Harbors Act Section 10 permit from USACE.

Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) is a federal program that allows states to develop a Coastal Zone Management Plan to define allowable land and water uses within the state coastal zone. Implementation of elements of the EIS alternatives that are within Thurston, Mason, Grays Harbor and/or Pacific counties would involve review by Ecology to ensure the activities are consistent with CZMA requirements.

Fish and Wildlife Coordination Act

Consultation with USFWS is required during implementation of the water resource development (e.g., flood control, water storage) portions of the program. This consultation is typically conducted concurrently with other regulatory review or permitting processes under NEPA, ESA, and CWA compliance.

National Forest Management Act

The National Forest Management Act calls for the development of land and resource management plans within national forests. Implementation of elements within the EIS alternatives that are within national forestlands, such as the Olympic National Forest, would be evaluated by the U.S. Forest Service (USFS) for their consistency with the applicable forest plan.

National Historic Preservation Act

Enacted in 1966, the National Historic Preservation Act establishes a comprehensive program to preserve historic and cultural sites. Formal consultation with the State Historic Preservation Office, tribes, and other interested parties to address potential effects to historic properties would occur during implementation of elements of the EIS alternatives if federal agency approval or federal funding are required.

Executive Order 11988: Floodplain Management

Executive Order 11988 requires federal agencies to avoid, to the extent possible, direct and indirect impacts of development in the floodplain and short- and long-term impacts related to modification or occupation within floodplains. Federal agencies responsible for funding and/or permitting elements of the EIS alternatives would need to comply with Executive Order 11988.

2.4.3 State and Local Regulations

State Environmental Policy Act

As described in Section 1.5, SEPA helps ensure that potential environmental impacts are considered during decision-making on projects and nonproject actions, such as adopting regulations, policies, or plans. Following this EIS review process, additional SEPA review would likely be necessary for implementing project-specific action elements of the EIS alternatives.

Washington State Hydraulic Code

The Washington State Hydraulic Code serves to protect fish, shellfish, and their habitats. Implementing elements of the EIS alternatives that use, divert, obstruct, or change the natural flow or bed of salt or fresh state waters would require a Hydraulic Project Approval from WDFW.

Shoreline Management Act

All local jurisdictions within the Study Area with Shorelines of the State have adopted SMPs consistent with the Shoreline Management Act, which emphasizes appropriate shoreline land use, protection of shoreline environmental resources, and protection of the public's right to access and use state shorelines. Implementing elements of the EIS alternatives that are within state shoreline areas would require a shoreline permit from the local jurisdiction to ensure the project is consistent with the SMPs.

Executive Order 05-05

Under this order, implementing elements of the EIS alternatives using state capital improvement funds would need to be reviewed by the Washington State Department of Archaeology and Historic Preservation (DAHP), in consultation with the Governor's Office of Indian Affairs and concerned tribes, in order to address potential effects to historic properties.

Washington Forest Practices Act

Enacted in 1974, FPA regulates forest practices on all non-federal and non-tribal land in Washington. In response to the federal listing of certain fish species, the Washington State Forest Practices HCP was created and approved to ensure forest practice operations protect habitat, support healthy forests, and support economically viable harvests. Implementing elements of the EIS alternatives that include forest management practices would need to comply with the FPA.

Floodplain Management

Cities and counties are responsible for managing development in floodplains in accordance with their locally adopted floodplain management ordinances. In order to maintain membership in the NFIP, which is implemented nationally by FEMA, jurisdictions are required to adopt minimum floodplain management regulations. FEMA reviews jurisdiction's floodplain development permits during regularly scheduled community assistance visits. In Washington, Ecology is the lead agency responsible for overseeing floodplain management.

Water Resources

The Washington State Water Code is made up of a series of laws that govern the use, access, ownership, and management of surface water and groundwater in the state. Ecology is responsible for overseeing the implementation of many elements of the State Water Code, including working with WDFW to establish minimum flow levels in streams to protect fish, wildlife, and water quality.

Dam Safety

Construction of a dam would require compliance with a series of dam safety permits from Ecology. These regulations establish requirements for operation and maintenance plans, owner inspections, and emergency actions.

Local Regulations

In addition to the shoreline management and floodplain management regulations described here, implementing elements of the EIS alternatives would also likely include compliance with local critical areas codes, zoning ordinances, and other land use requirements.

2.4.4 Relevant Plans

This section provides information on regional management plans that are in effect within the Chehalis Basin, which could influence the implementation of elements of the EIS alternatives.

2.4.4.1 Total Maximum Daily Load Implementation Plans

The following TMDLs are in place in WRIAs 23 and 23:

- Grays Harbor/Chehalis Fecal Coliform Bacteria TMDL (Rountry and Pelletier 2002)
- Upper Chehalis DO TMDL (Jennings and Pickett 2000)
- Upper Chehalis Temperature TMDL (Ecology 2001)
- Upper Chehalis Fecal Coliform TMDL (Ahmed and Rountry 2004)
- Upper Chehalis River Dry Season TMDL (Pickett 1994a)
- Black River Wet Season Nonpoint Source TMDL (Coots 1994)
- Black River DO and Phosphorus TMDL (Pickett 1994b)
- Upper Humptulips River Water Temperature TMDL (Graber and Stoddard 2003)

2.4.4.2 Flood Hazard Management Plans

Flood hazard management has been ongoing in the Chehalis Basin for many years, as evidenced by the plans listed here, which contain recommendations on how to mitigate flood hazards within each jurisdiction. Each of the plans recommends both structural and nonstructural elements to flood damage reduction. Many elements from the following plans have been incorporated into the EIS alternatives:

- *Grays Harbor County Comprehensive Flood Hazard Management Plan* (CH2M HILL 2001)

- *Lewis County 2007 Flood Disaster Recovery Strategy* (Cowlitz-Wahkiakum Council Governments 2009)
- *Comprehensive Flood Hazard Management Plan for Confederated Tribes of the Chehalis Reservation* (GeoEngineers and Herrera 2009)
- *Chehalis River Basin Comprehensive Flood Hazard Management Plan* (CRBFA 2010)
- *Thurston County Flood Hazard Mitigation Plan* (Tetra Tech 2013)

2.4.4.3 Watershed Management Plan

Following the enactment of the Watershed Planning Act in 1998, the two WRIAs (22 and 23) in the Chehalis Basin were created. The Chehalis Basin Watershed Management Plan was approved by Grays Harbor, Lewis, Mason, and Thurston counties in May 2004, and is currently in place for these two WRIAs. The plan provides recommended strategies for setting instream flows, improving water quality, and protecting or enhancing fish habitat.

2.4.4.4 Habitat and Salmon Recovery Plans

In response to a federal mandate under ESA, seven regional organizations in Washington formed to develop salmon recovery plans and coordinate implementation. The regional organizations are made up of local, state, and federal agencies; tribes; citizens; and others interested in salmon recovery. The Washington Coast Sustainable Salmon Partnership is the regional organization coordinating these efforts relative to the EIS Study Area. The Washington Coast Sustainable Salmon Partnership has produced the *Washington Coast Sustainable Salmon Plan* to address recovery of salmon populations in this region, in collaboration with the Grays Harbor and Chehalis Basin Lead Entity.