4.3 Restorative Flood Protection

4.3.1 Water Resources

4.3.1.1 Short-term Impacts

The temporary impacts described in Table 4.1-1, and their effects on water resources during construction of log and rock structures, would be relatively short in duration at each site (approximately a 4-month annual construction period), but would occur within treatment area construction sites over an approximately 10-year construction timeframe. Avoidance and minimization measures would be employed when designing, constructing and permitting each structure. Short-terms impact on water quality could also potentially occur as a result of clearing and construction associated with moving land uses out of the floodplain and relocating them in upland areas.

4.3.1.2 Long-term Impacts

The results and findings of this analysis are presented in the following study:

- *Preliminary Summary, Science and Technical Assessment of a Restorative Flood Protection Approach in the Upper Chehalis River Watershed* (Abbe et al. 2016)

Implementation of Restorative Flood Protection would have the potential to affect water resources through changes to surface water quality, surface water quantity, and groundwater. In general, floodwaters would be distributed throughout the upper Chehalis Basin watershed more evenly than at present, and during non-flood conditions surface water features would occupy more of the floodplain in treatment areas than they do at present.

Minor adverse impacts on water use and water rights are anticipated, and water right holders with groundwater rights could experience beneficial effects because of the increased groundwater recharge provided by the Restorative Flood Protection actions.

4.3.1.2.1 Surface Water Quality

No adverse impacts on surface water quality are anticipated to occur. While water quality modeling of Restorative Flood Protection actions has not been conducted for this programmatic-level analysis, the beneficial effects are expected to include cooler and less turbid stream and river flow than under current conditions. Anticipated beneficial effects are primarily related to improved stream and river corridor and riparian zone conditions from the following:

- Increased streamside vegetation to shade the stream channel and help cool the water
- Increased pools that provide places for sediment to settle rather than be transported downstream

Each of these actions would affect the water quality in the stream or river, which would in turn improve conditions for aquatic life. High summer water temperatures are a major limiting factor for fish (see Section 3.4.1). The beneficial surface water quality effects would occur at, as well as downstream of, the Restorative Flood Protection treatment areas.

Increasing streamside vegetation and associated shade along river and stream channels within the treatment areas is expected to lower water temperatures. This is the recommended approach to improving temperature conditions in Ecology's Upper Chehalis River Basin Temperature TMDL (2001), which addresses several stream reaches suitable for Restorative Flood Protection treatments. The TMDL uses streamside shade as a surrogate measure for water temperature, based on the known linkage between solar radiation reaching stream or river flow providing the energy to raise water temperature.

The extensive in-channel wood structures proposed under Restorative Flood Protection would slow streamflows, and create more channel complexity such as pools and side channels (see Section 4.3.2.2.2). These slower-water environments would result in sediments settling out of the water column, rather than being carried downstream. This would likely reduce turbidity and total suspended solid concentrations within and downstream of treatment areas.

Restorative Flood Protection actions are not expected to affect other water quality constituents, such as DO, because a decrease in water temperatures would be expected.

The potential exists for increased surface water pollution during floods from septic systems, buried fuel tanks, and stored chemicals in newly flooded areas. Restorative Flood Protection would include removal of the structures most at risk for this type of pollution, which would include decommissioning buried fuel tanks and other chemical storage. This potential water quality issue is anticipated to be addressed through implementation of this action element, in which case it would not result in an adverse impact. If not addressed, a minor adverse impact on surface water quality could occur as a result of expanded localized flooding.

Impacts on surface water quality could also occur as a result of increased development in upland areas where treatment area floodplain uses are relocated. The degree of adverse impact has not been quantitatively evaluated because specific receiving waters have not been identified. In general, long-term effects of increased sedimentation and vegetation removal from clearing, excavating, relocating transportation and utility corridors, and site development could have adverse impacts on surface water quality.

4.3.1.2.2 Surface Water Quantity

The purpose of the Restorative Flood Protection treatments is to engage floodplain storage in the watershed above Chehalis-Centralia to distribute floodwaters more evenly throughout the watershed, thereby reducing flood damage in downstream portions of the Chehalis Basin.

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

Anticipated impacts on surface water quality within Restorative Flood Protection treatment areas are related to the following:

- Installation of instream log structures to raise water levels and aggrade streambeds, and cause the stream to form multiple channels, which would occupy a wider strip throughout the river and stream valleys
- Reconnection of floodplain wetlands to the river and stream channels
- Creation of more sinuosity (curves) in the channels to lower the stream slope and slow the flow

Although not within the treatment areas, conversion of displaced floodplain land uses from within treatment areas to upland areas would likely generate higher runoff from those upland areas as a result of vegetation removal and increased developed surfaces.

Over time, it is anticipated that each of the actions within treatment areas would build upon each other and in turn create more surface water area for a larger portion of the year in the watershed upstream of the Newaukum River confluence with the Chehalis River. The larger surface water area would act as a temporary storage reservoir during flood periods, and could help feed summer low streamflows. These potential adverse impacts are considered moderate with regard to water quantity due to the predicted increase in the areal extent of flooding that would occur.

Restorative Flood Protection would increase surface water flooding in many valley bottom areas upstream of the Chehalis River confluence with the Newaukum River. Areas near the river and stream channels could flood annually where they do not now. Areas more distant from the river and stream channels could flood every 5 to 10 years where they now flood every 100 years on average. In addition, areas that currently flood could experience deeper flood levels. The duration of flooding would also increase, as floodplain areas work as temporary flood storage. The anticipated changes in area flooded during a 100-year flood for each treatment area sub-basin are shown in Table 4.3-1.

The Restorative Flood Protection treatments, by nature, are unlikely to result in higher velocity, more erosive flood flows; however, in some areas near the channel, the engineered log structures would cause turbulent flow that could be dangerous to life and property (see Section 4.3.15). Specific areas would be identified through site-level planning and design.

The additional runoff from converted upland areas is anticipated to be minor; many of these areas are currently in use as managed forestland and have been previously disturbed by vegetation removal and soil compaction. It is anticipated that stormwater runoff from converted upland areas could be addressed through site-level planning and design, including use of low-impact development stormwater management techniques. The land use and transportation impacts of increased flooding are described in Sections 4.3.10 and 4.3.13.

Table 4.3-1
Predicted Changes in Areal Extent of Flooding for Restorative Flood Protection in a 100-year Flood

RIVER	RIVER REACH LENGTH (MILES)	INUNDATED AREA (ACRES)		
		EXISTING 100-YEAR FLOODPLAIN	RESTORATIVE FLOOD PROTECTION 100-YEAR FLOODPLAIN	DIFFERENCE
AREAS WITH INCREASED FLOODING				
North and South Fork Newaukum, South Fork Chehalis, and mainstem Chehalis rivers; and Elk, Bunker, Deep, Stillman, Lake, Stearns creeks	140	16,530	21,130	4,600
AREAS WITH REDUCED FLOODING				
Chehalis and Centralia down to the Pacific Ocean	207	56,630	55,815	-815
Total	**347**	**73,160**	**76,945**	**3,785**

Note: All flood inundation acreages are rounded to the nearest 5 acres.

Existing surface water rights would not be impaired by Restorative Flood Protection actions. The locations of some water right intakes may need to be adjusted if there is a conflict with in-channel engineered log structures, or if structures and uses are displaced to converted upland areas. This would be a minor adverse impact as existing surface water rights and allocations would not be impaired. The water supply intake for Boistfort is located on a tributary of Stillman Creek. This is outside of the Restorative Flood Protection treatment area, and no impact is expected.

Water right changes would be needed to service consumptive water needs for homes, farms, public facilities, and businesses displaced because of Restorative Flood Protection actions. Restorative Flood Protection may require existing structures within a 16,000-acre area (including approximately 8,500 acres of farmland) to be relocated out of flood-prone and erosion risk areas. In addition, there would be more frequent flooding outside of the “river management” or “greenway” zone on approximately 5,200 acres, including 3,600 acres of farmland (see Section 4.3.10). Many of these affected lands hold water rights, which would be transferred to the owner’s new location if, or when, they were relocated.

Downstream of Restorative Flood Protection Treatment Areas

Beneficial surface water quantity effects created by the Restorative Flood Protection actions include reduced flooding in the Chehalis-Centralia area downstream of the Restorative Flood Protection treatment areas. The Restorative Flood Protection treatments would reduce the flood flows entering the mainstem Chehalis River as shown in Table 4.3-2 for a 100-year flood.

Table 4.3-2
Predicted Flow Reductions from Restorative Flood Protection Treatment Sub-basins for 100-year Flood

TRIBUTARY	PEAK FLOW		
	EXISTING CONDITION (cfs)	RESTORATIVE FLOOD PROTECTION (cfs)	CHANGE (%)
Elk Creek	7,245	6,450	-11%
Newaukum	13,957	12,279	-12%
Bunker Creek	2,290	2,106	-8%
South Fork Chehalis River	15,076	13,381	-11%

As shown in Table 4.3-3, the magnitude of this flood benefit would vary with different flood frequencies. A more pronounced effect could occur during higher-frequency floods, depending on location.

Table 4.3-3
Predicted Restorative Flood Protection Flood Level Reductions at Chehalis-Centralia for Various Flood Levels

FLOOD LEVEL	NEWAUKUM CONFLUENCE (FEET)	ALONG AIRPORT LEVEE (FEET)
500-year	-1.0	-0.4
100-year	-1.0	-0.4
20-year	-1.1	-0.3
10-year	-0.9	No change
2-year	-1.6	-0.4

4.3.1.2.3 Groundwater

No adverse impacts on groundwater are anticipated to occur with Restorative Flood Protection. The potential beneficial effects to groundwater would be a general raising of the water table in the Restorative Flood Protection treatment areas and adjacent floodplain. This effect would primarily result from increased surface water levels from higher water levels in the stream and river channels, and improved connections between floodplain wetlands and the stream channels.

The Restorative Flood Protection treatments would generally raise surface water levels, and increase the area of surface water present in treatment areas. Because shallow groundwater in the floodplain treatment areas is closely connected to surface water, it is expected that shallow groundwater levels would rise as the surface water elevation increases. This effect would be expected within the Restorative Flood Protection treatment areas and, to a lesser magnitude, in the adjacent areas that are connected hydraulically.

The effect of higher groundwater levels would be as follows:

- Higher groundwater levels would support stream and river base flows by feeding cool groundwater into the surface water system during late-summer, low-flow times
  - This would happen because of the close surface-groundwater connection, which would enable the groundwater to flow to the stream channels when water levels in the channel are lower than in the groundwater (gaining river reaches)
  - It is unknown whether this would cause summer low flows to be higher, as the more extensive streamside and riparian vegetation could transpire much of the additional shallow groundwater
- Expansion of wetlands would likely occur because soil moisture would increase in low areas where the water table would become shallower (see Section 4.3.3)

Landowners would see wetter conditions on farm fields and low areas that are influenced by the higher groundwater levels. This potential impact, including associated mitigation, is discussed in Sections 4.3.3 and 4.3.10. Relocating floodplain land uses to upland areas could result in an adverse impact on groundwater depending on the location, and associated magnitude of subsurface excavation and resulting impervious surface.

4.3.1.3 Mitigation

Potential mitigation measures for short-term impacts on water resources are described in Table 4.1-1. Potential avoidance and minimization, and compensatory mitigation measures for long-term impacts on water resources are described here.

4.3.1.3.1 Surface Water Quality

No long-term adverse impacts on surface water quality are anticipated, so no mitigation is proposed. New development in upland areas could be sited and designed to avoid adverse impacts on surface water quality through measures such as maintenance of functional riparian corridors.

4.3.1.3.2 Surface Water Quantity

Potential avoidance and minimization measures for adverse surface water quantity impacts could include treatment area design that avoids construction of Restorative Flood Protection treatments in areas that would not produce downstream flood benefits. At this point, Restorative Flood Protection has not been developed at a reach or site scale, so these areas have not been identified. Relocation of land uses that would be negatively affected by flooding from Restorative Flood Protection treatments is a critical component of this action element (see Section 4.3.10), and could be designed and sited to minimize impacts on surface water quantity by minimizing impervious surfaces and soil compaction.

4.3.1.3.3 Groundwater

No long-term adverse impacts on groundwater quantity or quality are anticipated, so no mitigation is proposed.

4.3.2 Geology and Geomorphology

4.3.2.1 Short-term Impacts

4.3.2.1.1 Geology

The potential short-term impacts on geology that would occur during construction are described in Table 4.1-1 and are primarily associated with necessary clearing and staging to gain construction access.

4.3.2.1.2 Geomorphology

The potential short-term impacts on geomorphology are described in Table 4.1-1, and are primarily limited to localized slope instabilities associated directly with the construction sites. Additional short-term impacts include the interruption of sediment and wood transport regimes throughout the construction work zone, and the loss of channel function for the river segment re-routed through the work zone. At each site, these impacts would be limited to an approximately 3- to 4-month-long active construction period.

4.3.2.2 Long-term Impacts

4.3.2.2.1 Geology

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The potential impacts on geology associated with Restorative Flood Protection are related to shallow, rapid, and deep-seated landslides triggered in areas where the river encroaches on valley walls.

The Restorative Flood Protection actions would encourage more active channel migration, which could cause the river to encroach on valley walls in some areas. This encroachment has the potential to undercut landslide-susceptible slopes, and trigger slope failures. This adverse impact could be moderate as a result of potential localized increases in landslides—or could be minor because it is predictable in location and severity, thus avoidable.

A preliminary examination of potential landslide hazards was conducted by overlaying known landslides mapped by DNR with the treatment areas (see Figure 4.3-1). Although there are many areas of the Chehalis Basin with landslide-susceptible slopes, the majority of known landslide hazards are in steeper tributary drainages that are upstream of, and thus not affected by, the Restorative Flood Protection treatment areas. Results of the GIS overlay show that approximately 1% of the treatment area corridors abut known landslides in the DNR database. In the few instances where there are potential landslide hazards within treatment areas, it is anticipated that future design refinements could incorporate engineered logjams and forested riparian buffers to moderate channel migration rates, and thus limit potential for undercutting landslide-susceptible slopes in these locations.

Adverse impacts on geology could occur as a result of relocating floodplain land uses to upland areas if development included disturbance of unstable or steep slopes. These impacts are anticipated to be minor because it is expected that unstable areas could be avoided during siting and design of relocated uses.

Downstream of Restorative Flood Protection Treatment Areas
No adverse impacts on geology are expected to occur downstream of Restorative Flood Protection Treatment areas.

4.3.2.2.2 Geomorphology

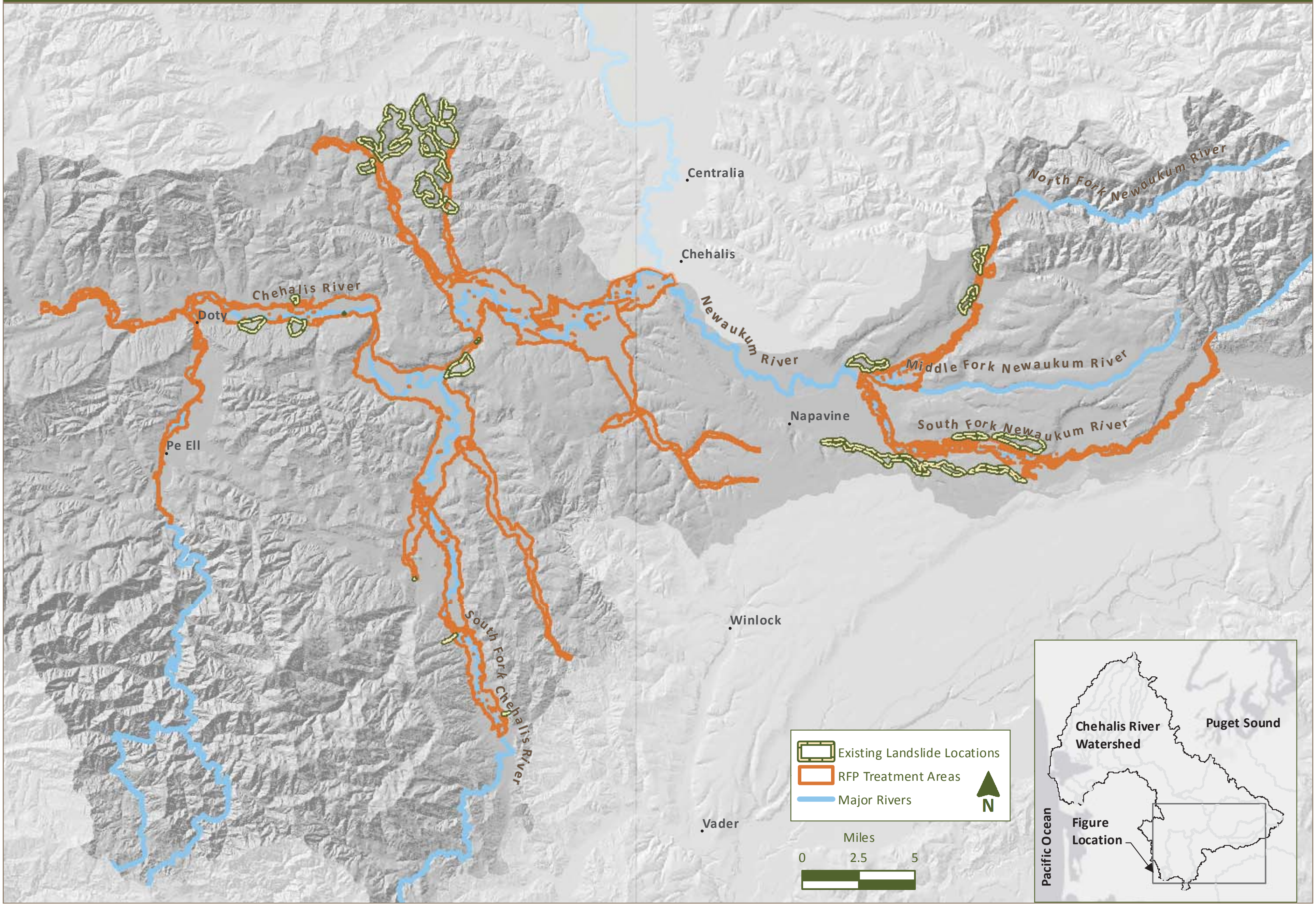
By design, the treatment actions aim to restore geomorphic processes to a condition representative of the Chehalis Basin prior to floodplain development and channel modification (pre-settlement conditions). Compared to current conditions in many of the Restorative Flood Protection treatment areas, Restorative Flood Protection treatments would result in beneficial effects on geomorphology related to the following:

- Increased channel complexity and restoration of habitat-forming processes
- Increased sediment and wood retention
- Increased floodplain connectivity (addressing effects of past channel incision)

As discussed in Section 3.2.4.1.3, channel incision has occurred over many miles of the Chehalis River mainstem, South Fork Chehalis River, and to a lesser extent in the Newaukum River. Restorative Flood Protection actions would reverse this condition, beneficially affecting geomorphology.

Figure 4.3-1

Landslides in Restorative Flood Protection Treatment Areas



Notes: Landslide data from Department of Natural Resources (2014); RFP = Restorative Flood Protection

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The Restorative Flood Protection actions would increase large wood in the channels and floodplains, which would begin a series of landscape changes. For example, the channel could become more sinuous, and additional channels would also develop. Countermeasures (such as wood) to prevent active river and stream channels from migrating are not proposed with Restorative Flood Protection actions, except when active channels have the potential to encroach on landslide-susceptible, valley-side areas (see Section 4.3.2.2.1); dynamic river processes are desirable and necessary for the re-creation and maintenance of natural geomorphic processes.

During an initial period following implementation of the treatment actions, there could be localized impacts on the sediment and wood regimes of the Chehalis Basin associated with geomorphic adjustments. Increased channel roughness and energy dissipation, driven by installation of engineered logjams, would moderate the sediment transport capacity in treatment reaches. All else remaining equal, this reduction in transport capacity would be expected to result in a net deposition of sediment and aggradation of the channel bed within treatment areas. It should be noted, however, that existing channel conditions are characterized by increased sediment transport due to past removal of logjams and impairment to wood recruitment processes associated with impacts on riparian forests and ongoing removal of wood from the channel. Further, the incoming sediment supply to Restorative Flood Protection treatment areas is elevated by forest practices that can increase channel-forming flows (see Section 3.2.4.3; Perry et al. 2016). As such, providing additional storage of alluvial sediments within the Restorative Flood Protection treatment areas could result in a net benefit for the Chehalis Basin. Aggradation of the channel bed in treatment areas would provide a positive feedback mechanism that would further engage floodplain areas affected by past channel incision.

Recent inventories reported wood loadings in the upper Chehalis River that averaged only 6% of a restoration target, representing unmanaged forest conditions (Anchor QEA 2016d). The legacy of historical splash dams to flush logs downstream and intentional wood removal to clear channels of wood jams has impaired the wood regime. Restorative Flood Protection actions would greatly increase the wood loading in treatment areas, and thus create areas that would trap incoming wood recruited from upstream reaches.

At this time, the potential for adverse impacts on geomorphology as a result of relocating floodplain development to upland areas is unknown, because specific relocation areas have not been identified. Generally, many upland areas in the Chehalis Basin are currently in use as managed forestland and have been previously disturbed. However, development that interrupts sediment or wood recruitment or transport, or disconnects streams or rivers from floodplains, has the potential to adversely affect geomorphology.

Downstream of the Restorative Flood Protection Treatment Areas

In response to Restorative Flood Protection actions, the reaches immediately downstream of the treatment areas could experience a net decrease in sediment supply relative to the baseline condition due to sediment storage within the treatment area. Such impacts on supply of bedload materials are likely to be localized in extent and diminish with downstream distance resulting in a minor adverse impact. Treatment actions would not trap 100% of incoming sediment supply, and new sources of sediment would be mobilized from creation or reactivation of secondary channels in the stream corridor. The primary source of bedload material downstream of the treatment area is locally derived streambank erosion from upstream meander bends (Glancy 1971) and this process would not be affected by Restorative Flood Protection actions.

In channel segments typical of the treatment area reaches, key wood pieces that are large enough to remain stable and affect geomorphic function are generally recruited locally and remain close to the point of recruitment. As such, the effect of Restorative Flood Protection actions on wood regime of the Chehalis Basin is not anticipated to have an adverse impact on recruitment of key pieces of wood downstream of treatment areas. Pieces of smaller, mobile wood would be trapped within engineered logjams installed as part of the treatment actions. These actions would also create additional sources of wood from riparian trees planted in treatment areas, as well as additional pathways of recruitment associated with the restoration of dynamic channel processes and the creation or re-engagement of secondary channels.

4.3.2.3 Mitigation

4.3.2.3.1 Geology

Avoidance and minimization measures for potential long-term impacts on geology resulting from triggered landslides would include identifying at-risk areas during site-specific feasibility studies, and avoiding the risks during conceptual design. This could include the installation of riverbank and floodplain barriers, such as wood revetments, to prevent channel migration from encroaching on landslide-susceptible, valley-side areas.

4.3.2.3.2 Geomorphology

No long-term adverse impacts on geomorphology are anticipated, so no mitigation is proposed. Given that the scale and extent of Restorative Flood Protection actions are greater than what has been implemented to date, it would be important to evaluate project actions through the development and implementation of a detailed monitoring program to quantify geomorphic responses—both within and outside the treatment areas.

4.3.3 Wetlands and Vegetation

4.3.3.1 Short-term Impacts

The potential short-term impacts on wetlands and vegetation from construction activities such as excavation, clearing, filling, and equipment and materials staging are described in Table 4.1-1. Short-term impacts include the temporary disturbance of vegetation in the floodplain near Restorative Flood Protection treatment areas from the construction of temporary access roads and construction equipment and material staging areas.

4.3.3.2 Long-term Impacts

Adverse impacts on wetlands and vegetation from the implementation of Restorative Flood Protection actions would primarily be associated with the conversion of vegetation communities in undeveloped upland areas and managed forests to those associated with agriculture, rural residential, public services, and commercial uses, because these land uses are relocated out of the historic floodplain. Adverse impacts on wetlands from such actions are expected to be moderate because the area is large. There would also be an opportunity to avoid wetland impacts in sites selected for relocated land use. Adverse impacts from land use conversion actions on vegetation, however, would be significant, with up to 16,000 acres of managed forestland converted to other uses that primarily support cultivated herbaceous vegetation, ornamental landscaping, and impervious areas (e.g., residential and commercial development).

Anticipated beneficial effects of Restorative Flood Protection actions on wetland and vegetation within treatment areas include the following:

- Increased extent of wetland areas in the floodplain
- Improved structure and function of riparian vegetation communities associated with off-channel and slow-water habitat
- Increased diversity and extent of riparian and floodplain vegetation communities

Over the long term, each of these outcomes could in turn affect fish, amphibians, and other wildlife currently using these areas, and change the types of available habitat through the increase in floodplain connectivity, habitat structure, and habitat-shaping processes. Potential effects on fish and wildlife are discussed further in Sections 4.3.4.2.1 and 4.3.4.2.2, respectively.

4.3.3.2.1 Wetlands

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

Restorative Flood Protection actions are designed to reconnect the river with converted bottomlands and portions of the historic floodplain that have become isolated from flood processes over time. As proposed, Restorative Flood Protection actions would generally raise surface and groundwater levels in the treatment areas as described in Section 4.3.1. Increased surface and groundwater levels would contribute to an overall increase in wetlands by allowing some floodplain areas to maintain a surface connection to the river or an elevated water table in the upper 12 to 18 inches of the soil column throughout more of the year than current conditions. The extent of this effect has not been quantified for this programmatic-level evaluation.

Adverse impacts on wetlands could occur as a result of relocating floodplain land uses to uplands; however, this impact is anticipated to be minor because it is expected that wetland impacts can be avoided and minimized when siting and designing land uses during conversion.

Downstream of Restorative Flood Protection Treatment Areas
No adverse impacts on wetlands are anticipated to occur downstream of Restorative Flood Protection treatment areas. Direct impacts would not occur because these areas are not within Restorative Flood Protection treatment areas, and indirect impacts are not anticipated because this action element is designed to hydrologically reconnect floodplain wetlands, stream channels, and groundwater (Section 4.3.1.2.3).

4.3.3.2.2 Vegetation

Within Restorative Flood Protection Treatment Areas and Upland Relocation Land Conversion Areas
Adverse impacts from land use conversion actions on vegetation would be significant, with up to 16,000 acres of managed forestland converted to other uses that primarily support cultivated herbaceous vegetation, ornamental landscaping, and impervious areas (e.g., residential and commercial development).

Within treatment areas, restorative Flood Protection would provide improved structure and function of riparian vegetation communities associated with off-channel and slow-water habitat. This would be accomplished over time by recreating the brushy riparian conditions and wetland complexes that existed in the floodplain prior to European settlement. Such conditions would allow floodwaters to spread out over a greater portion of the floodplain, slow down the speed of flood waves, and provide additional floodwater storage in floodplain wetland depressions. The return of pre-settlement flood conditions would be expected to increase the diversity and extent of native riparian and floodplain vegetation.

Establishment of these vegetation types could occur over approximately 140 river miles for the brushy riparian corridors, with up to 21,000 acres of newly created floodplain forestland. These changes in vegetation within treatment areas, over the long term, are anticipated to positively affect water quality and create habitat for fish and wildlife that rely on these areas (see Sections 4.3.1.2.1 and 4.3.4).

Vegetation in the Restorative Flood Protection Treatment Areas

Within treatment areas, anticipated riparian vegetation would include a mosaic of native willows, red osier dogwood, red alder, and black cottonwood. Adjacent floodplain forestland would likely comprise a mix of native coniferous and deciduous trees, dominated by Douglas fir and western red cedar in the higher terraces, and black cottonwood, Sitka spruce, big-leaf maple, Oregon ash, and red alder on the lower-elevation surfaces. An extensive groundcover of shade-tolerant shrubs (salal, Cascade Oregon grape, red huckleberry and Scouler's willow) and ferns (swordfern) would likely dominate the understory vegetation. All of these vegetation types are well-adapted to the moist conditions and periodic overbank sediment deposition that would accompany the Restorative Flood Protection treatment areas.

Downstream of Restorative Flood Protection Treatment Areas

No adverse impacts on vegetation downstream of the Restorative Flood Protection treatment areas are anticipated.

4.3.3.3 Mitigation

Mitigation for long-term adverse impacts on wetland and vegetation would primarily focus on avoidance and minimization measures when siting new land uses in upland conversion areas. Avoidance measures could include avoiding sites with extensive and high-quality wetlands, designing structure and disturbance areas to avoid wetland impacts and disturbance to native vegetation, and restoring vegetation in temporarily disturbed areas.

4.3.4 Fish and Wildlife

4.3.4.1 Short-term Impacts

Short-term impacts on fish and wildlife could potentially occur during construction and would be localized to the construction footprint, with conditions returning to pre-construction status and/or function following construction.

4.3.4.1.1 Fish

The potential short-term impacts on fish related to in-water construction could primarily occur from the following:

- Reduced water quality due to turbidity increases, pollutant-laden stormwater runoff, or construction-related pollutants entering the water
- Temporarily dewatering of part of the river channels, reducing habitat available to fish in the immediate vicinity of construction

- Construction noise in or near the stream channel and removal of bank vegetation, which would reduce the function of riparian habitat for fish (e.g., shading and input of terrestrial nutrients and food)

4.3.4.1.2 Wildlife

Short-term impacts on wildlife would result from construction activities that are either site-specific, such as the clearing of vegetation from construction access and staging areas or transient, like construction and equipment-generated noise. Potential short-term impacts on wildlife related to construction activities are described in Table 4.1-1. Of the listed activities, construction noise, equipment and vehicle usage, and human presence are expected to have the greatest effects on wildlife.

4.3.4.2 Long-term Impacts

4.3.4.2.1 Fish

Within and downstream of Restorative Flood Protection treatment areas, effects on salmonids are anticipated to be beneficial, while warm-water associated species could be moderately adversely affected. The treatment actions are anticipated to reduce temperatures in rivers and streams from reduced solar radiation by increasing shade, which would provide conditions that are beneficial for cool water-associated fish—both in channels and within connected floodplain habitats—and positively affect salmon abundance within the Chehalis Basin.

The magnitude of adverse impacts on other species of fish is uncertain. The agricultural and other land uses within the floodplain areas to be treated would be relocated to areas outside the affected floodplains (up to 16,000 acres). As a result, upland areas currently having some form of forested cover would likely be converted to rural development and agricultural use, resulting in some amount of increased impervious surfaces and exposed soils. Increased rates of runoff and sediment delivery to stream channels would be expected (Beechie et al. 2013). However, these effects would be expected to be largely negated by watershed processes operating within the restored riparian forest and wetland corridors within the treated floodplain areas. Large, contiguous riparian corridors are effective at ameliorating effects of land disturbance located upstream (Naiman et al. 1992; Naiman et al. 2005). The potential benefits to salmon are primarily related to the following changes in physical attributes of the environment created by Restorative Flood Protection actions:

- Restoring normative wood loads to the stream channels to re-create a diverse mix of in-channel habitat types and provide more and well-distributed, high-quality key habitats for various salmonid species and their different life stages in all seasons of the year
- In conjunction with restored floodplain riparian corridors, wood load conditions (as described previously) could help to re-create wetlands, off-channel habitats, and side-channel networks used heavily by coho salmon, and by spring-run Chinook salmon and steelhead

- More normative wood loads could reduce bed scour at spawning sites, store spawning gravel, allow fine sediment to settle in side-channel areas, and increase egg to emergent fry survival
- Gravel could be distributed through the Restorative Flood Protection treatments and new sediment sources would be created by newly formed side channels in Restorative Flood Protection treatment areas (see Section 4.3.2.2.2)
- Stream temperatures are expected to decrease compared to current conditions, and the number, quality, and distribution of thermal refugia are anticipated to be enhanced as a result of restored riparian forests and associated wetlands, channel aggradation, higher groundwater levels, and re-creation of large, deep, main channel pools
  - These conditions are anticipated to improve survival for rearing salmonids of all species during summer
  - In particular, the conditions could improve survival of adult migrant, pre-spawner, and spawning spring-run Chinook salmon
- Peak winter flows would be reduced to characteristics more similar to a normative flow regime for the upper Chehalis River and its tributaries, which is expected to improve survival of overwintering fish, specifically coho salmon and steelhead

At the Basin-wide scale, Restorative Flood Protection is modeled to have positive effects on all salmonid species, resulting in population increases, ranging from about 26% for fall-run Chinook salmon to 473% for spring-run Chinook salmon (see Table 4.3-4 and Figure 4.3-2). Restorative Flood Protection is predicted to have positive effects on coho salmon and winter-run steelhead, a small positive effect on chum salmon, and a large positive effect on spring-run Chinook salmon. The conditions created through the Restorative Flood Protection treatments are less favorable to non-native fish species. The response of non-salmonid fishes to Restorative Flood Protection has not been modeled or quantitatively evaluated at this point.

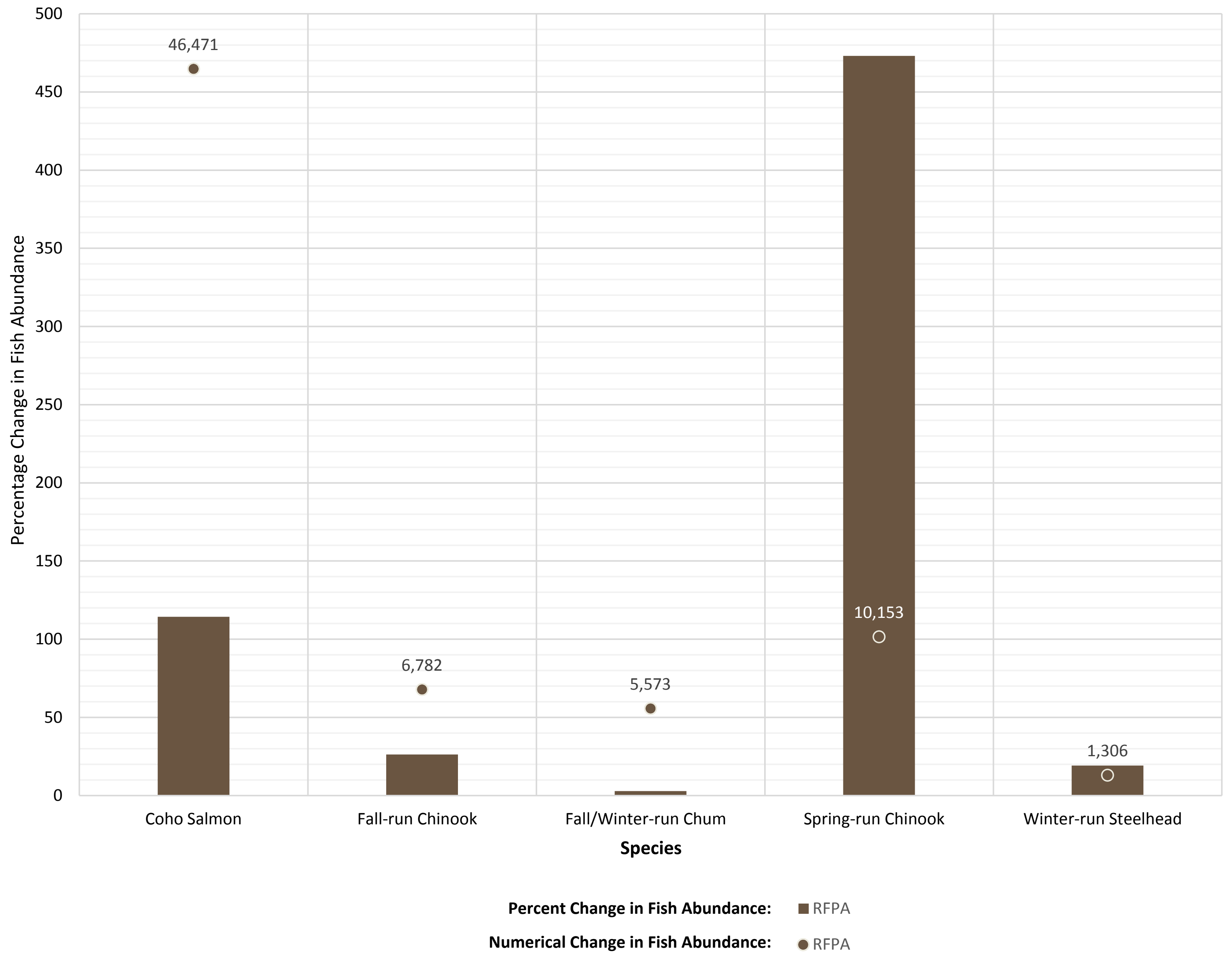
Table 4.3-4
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Restorative Flood Protection

SPECIES (CURRENT HABITAT POTENTIAL)	PRODUCTIVITY CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)
Coho salmon (40,642)	46,471 (114%)
Fall-run Chinook salmon (25,844)	6,782 (26%)
Winter/fall-run chum salmon (190,550)	5,573 (3%)
Spring-run Chinook salmon (2,146)	10,153 (473%)
Winter-run steelhead (6,800)	1,306 (19%)

Source: ICF 2016

Figure 4.3-2

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Restorative Flood Protection



Source: ICF 2016

4.3.4.2.2 Wildlife

Within Restorative Flood Protection Treatment Areas and Upland Areas Where Relocation and Land Conversion Occurs

The conversion of up to 16,000 acres of upland managed forestland to agriculture, rural residential, public services, and commercial land uses would affect wildlife by displacing and shrinking available habitat for upland-dependent species. Minor to moderate adverse impacts are anticipated because many of the wildlife species living and using these areas could also successfully occupy river greenways and Restorative Flood Protection treatment areas. However, direct impacts from construction of access to and new development sites, and habitat fragmentation within the displacement area (up to 16,000 acres) could be significant depending on site-specific characteristics, and there would be a temporal lag between when the river greenways and treatment areas would provide the same forest habitat as the converted uplands.

Beneficial effects for wildlife within Restorative Flood Protection treatment areas are anticipated to include the following:

- Improved structure and function of off-channel and slow-water habitat for species such as amphibians, providing high-quality habitat conditions for amphibians to breed and forage, and for wildlife species that rely on aquatic habitat for multiple life cycles, such as amphibians, western pond turtle, and North American beaver
- Improved connectivity to floodplain habitat could increase the quality of riparian vegetation and the diversity of wildlife species that occupy the habitats
- Improved connectivity between wildlife habitats, benefiting wildlife populations that are currently separated by human disturbances or activities and providing migration corridors that are less exposed to human disturbance (WHCWG 2010)
- Increased quality and quantity of habitat for native wildlife species of birds, amphibians, large and small mammals, and reptiles to breed, forage, rest, and overwinter
- Increased salmon abundance as described in Section 4.3.4.2.1 would benefit mammals and predators that feed on salmon and salmon carcasses, including multiple birds and mammal species in the Chehalis Basin, as well as the ESA-listed Southern Resident killer whale in the Pacific Ocean outside of Grays Harbor

Restoring connections among currently disconnected habitat could have an adverse impact by facilitating the spread of non-native invasive species, which could lower the quality of habitat functions; however, this is anticipated to be a potentially minor adverse impact considering the overall beneficial effect of improving connectivity between habitats for wildlife species. Invasive species dispersal could include non-native plants (e.g., reed canarygrass, purple loosestrife) or wildlife species (e.g., bullfrog) that prey on native wildlife.

4.3.4.3 Mitigation

No mitigation measures are proposed for fish and wildlife because long-term adverse impacts are minor to moderate, and will recover through maturation of the habitat within the river greenways.

4.3.5 Tribal Resources

The health and productivity of the entire Chehalis Basin affects the condition of treaty fisheries in the lower Chehalis River and its tributaries, and the non-treaty Chehalis Tribe fishery on the Chehalis Tribe reservation. The upper and middle Chehalis River and its tributaries contain valuable habitat for spawning and rearing salmonids.

Impacts on tribal resources could occur during or following construction, if tribal members could no longer access a resource or if the resource was diminished. The following potential impacts were considered:

- Access to treaty reserved usual and accustomed fishing areas, including Grays Harbor and the Chehalis River
- Access to treaty-reserved usual and accustomed areas for hunting and gathering on open and unclaimed lands
- Access to culturally significant areas for gathering of plant material or other related activities
- Injury and mortality of fish and wildlife and their habitats, and plants that are identified as a tribal resource; these impacts are detailed in Section 4.3.4 and are included in this Tribal Resources section by reference

Indirect impacts on tribal resources could occur as a result of the impacts on water resources, geology and geomorphology, wetlands and vegetation, and fish and wildlife detailed in Sections 4.3.1 through 4.3.4.

4.3.5.1 Short- and Long-Term Impacts

The potential impacts on tribal resources that would occur during construction of the Restorative Flood Protection treatments are related to the temporary disruption of access to tribal resources associated with a tribe's sovereignty or formal treaty rights, or reduced or limited access to plants, fish, or wildlife used for commercial, subsistence, and ceremonial purposes. These construction-related impacts could occur from activities associated with the in-channel wood structures and engineered-wood floodplain structures, or from relocation of floodplain land uses into upland conversion areas. Potential impacts could also include direct impacts during construction on, or loss of, natural resources protected by tribal treaties for fishing, hunting or gathering.

Additional input from the Quinault Indian Nation, the Chehalis Tribe, and other potentially affected tribes will help to characterize existing tribal resources and use of the area for fishing, hunting, and gathering, and confirm the nature of potential impacts from construction-related activities. Additional coordination with affected tribes to address specific impacts on tribal resources would continue during project-level environmental review and as part of continued government-to-government consultations.

The potential long-term impacts on tribal resources consider impacts following construction on fishing, hunting, gathering, and other traditional cultural activities. No long-term impacts on tribal resources have been identified for Restorative Flood Protection; however, beneficial outcomes are expected, primarily because of the significant improvement in self-sustaining fishery conditions that accompany the Restorative Flood Protection treatments.

Specific potential adverse impacts on fish and wildlife and vegetation that may directly or indirectly affect tribal resources have not been identified; however, all of the impacts described in Sections 4.3.4.2 and 4.3.3.2 could affect tribal resources. Potential long-term impacts would need to be identified prior to and during reach- and site-specific project development, with the extent of impacts pending additional coordination with tribes and continued government-to-government consultations. Potential long-term impacts could occur for tribal resources on tribal lands, within usual and accustomed fishing areas, or other areas used for hunting and gathering. As noted by the Quinault Indian Nation, adverse impacts that impede the ability to exercise treaty rights, such as impaired access to resources or actions that harm resources directly or indirectly by affecting the habitat on which they are dependent, constitutes the take of a property right that has been guaranteed to tribes (Sharp 2016a, 2016b).

4.3.5.2 Mitigation

The potential mitigation associated with impacts on tribal resources would be directly addressed with Quinault Indian Nation and Chehalis Tribe tribal leadership during project-level environmental review and continued government-to-government consultations.

Some potential long-term impacts on tribal fish resources could be addressed through avoidance and minimization measures developed in consultation with tribes. These may include the provision of fish passage around the dam during construction and operation, noise attenuation measures during construction, minimum instream flow release from the dam during operation, and release of cool water late spring to early fall during operation of the FRFA facility.

Potential compensatory mitigation measures developed in consultation with tribes could include, but are not limited to, the following:

- Coordinating with tribal leaders and managers on the timing and location of construction activities that could affect tribal access
  - Coordination could result in adjustments to the timing of construction activities to avoid periods when use is the highest or provisions to provide an access point around the construction site and proposed Flood Retention Facility

- Identifying areas with significant tribal resources and coordinating with the tribes regarding access points to these areas during and after construction

Compensatory mitigation could be required for loss of fish habitat and fish habitat function, and reduced fish population performance above and below the Flood Retention Facility. Compensatory mitigation would be developed in consultation with tribes and may include fish habitat restoration and protection, or acquisition of land that presents an opportunity for in-kind compensation for fish habitat lost. Mitigation of impacts on treaty rights is subject to consideration and agreement by the Quinault Indian Nation.

4.3.6 Air Quality

4.3.6.1 Short-term Impacts

The potential short-term impacts on air quality would occur during construction, including increased vehicle emissions from truck trips and mechanized construction equipment, and dust created by clearing and grading land and the transport and placement of excavation material, soils, and other materials. These impacts would be localized during the construction period and would not cause an overall decrease in regional air quality.

4.3.6.2 Long-term Impacts

No adverse impacts on air quality are anticipated because completed Restorative Flood Protection actions would not generate additional dust or emissions. Long-term emissions associated with land uses that are relocated to converted upland areas are not anticipated to increase over existing levels.

4.3.6.3 Mitigation

Potential mitigation measures to reduce short-term impacts on air quality are described in Table 4.1-1. No long-term adverse impacts on air quality are anticipated, so no mitigation is proposed.

4.3.7 Climate Change

4.3.7.1 Short-term Impacts

4.3.7.1.1 Effects of Restorative Flood Protection Contributing to Climate Change

The potential short-term effects that could contribute to climate change would occur during construction of Restorative Flood Protection treatments and include GHG emissions from construction equipment and vegetation removal. This effect is expected to be no more than 5,000 MT CO_2e—well below the 10,000 MT CO_2e threshold for qualitatively disclosing emissions established by Ecology over the construction period (this threshold equates to 6.2 million vehicle miles for a Class 7-8 truck).

4.3.7.1.2 Effects of Climate Change on Restorative Flood Protection

No anticipated short-term effects of climate change on Restorative Flood Protection actions are anticipated during construction.

4.3.7.2 Long-term Impacts

4.3.7.2.1 Effects of Restorative Flood Protection Contributing to Climate Change

There are no adverse impacts associated with Restorative Flood Protection actions that are anticipated to contribute to climate change. Overall, riparian and floodplain plantings, enhancement of floodplain wetlands, and shade to support cooler stream temperatures are expected to offset climate change impacts and forge a more resilient future floodplain, although this has not been modeled at this point. The conversion of upland areas from managed forestland to agriculture, rural residential, public services, and commercial land uses could mute any benefit; however, the overall effect is not expected to be adverse.

4.3.7.2.2 Effects of Climate Change on Restorative Flood Protection

The potential adverse impacts of climate change on Restorative Flood Protection would be considered and addressed during design of the treatment areas. In general, the increased frequency of extreme weather events and increased flow magnitudes expected under future climate change conditions could be incorporated into design criteria and treatment area designs to ensure that facilities withstand and perform their intended function under more extreme flow and weather conditions.

The EDT model developed for the Chehalis Basin (ICF 2016) was used to predict how fish species would respond to the effects of climate change on current habitat conditions when including implementation of Restorative Flood Protection actions. Table 4.3-5 and Figure 4.3-3 present the results for Restorative Flood Protection as a percentage increase or decrease compared to the results with climate change. Model results predict that Restorative Flood Protection would reduce the adverse effects of climate change on salmon abundance on a Basin-wide scale. Except for winter- and fall-run chum salmon, the adverse impacts on salmon from climate change are predicted to be partially buffered by Restorative Flood Protection actions. Benefits likely result from the substantial increase in channel and floodplain habitat size and quality, including cooler water temperatures and more refuge area.

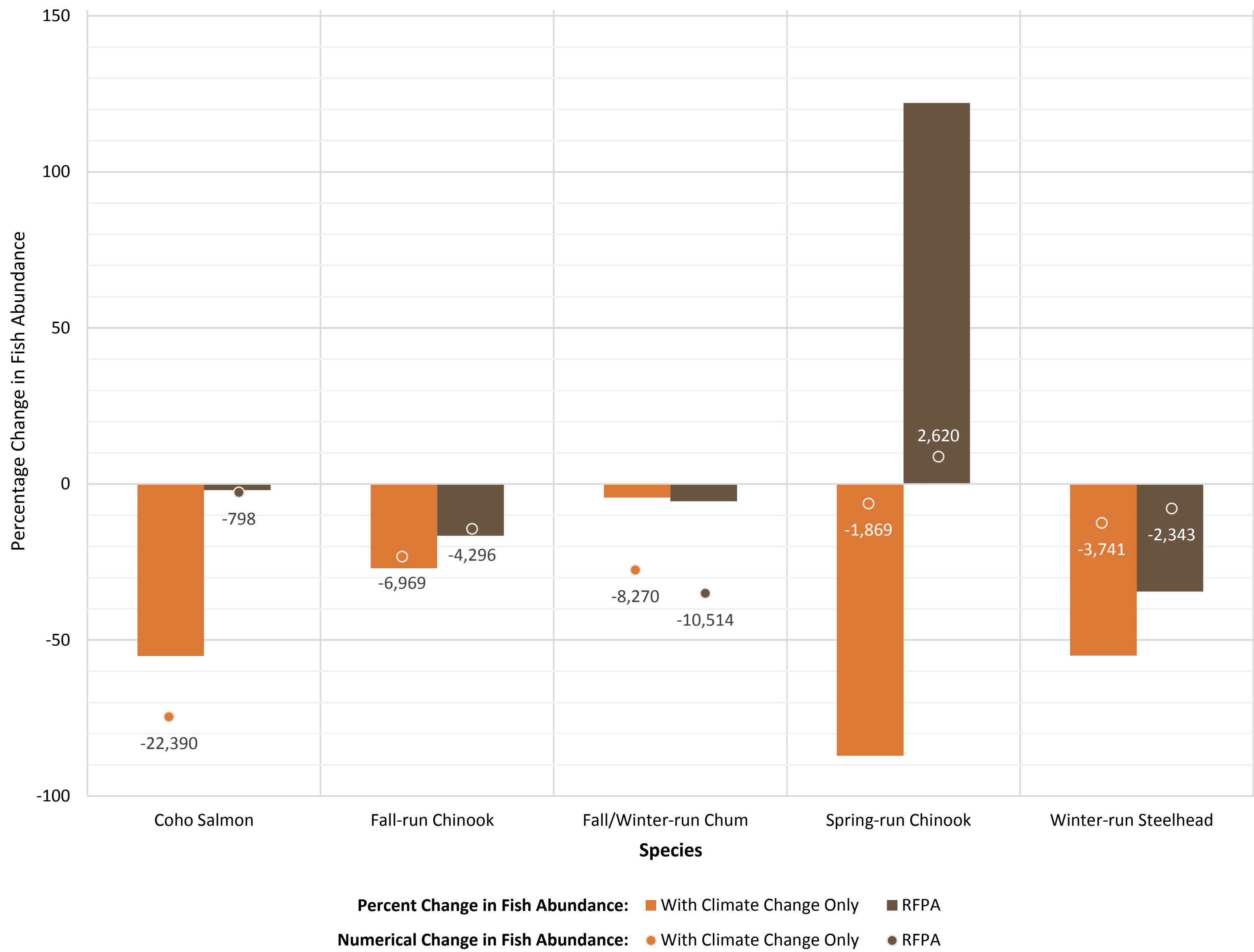
Table 4.3-5
Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Restorative Flood Protection

SPECIES (CURRENT HABITAT POTENTIAL)	CHANGE FROM CURRENT CONDITION IN NUMBER OF FISH (%)	
	WITH CLIMATE CHANGE ONLY	WITH CLIMATE CHANGE AND RESTORATIVE FLOOD PROTECTION
Coho salmon (40,642)	-22,390 (-55%)	-798 (-2%)
Fall-run Chinook salmon (25,844)	-6,969 (-27%)	-4,296 (-17%)
Winter/fall-run chum salmon (190,550)	-8,270 (-4%)	-10,514 (-6%)
Spring-run Chinook salmon (2,146)	-1,869 (-87%)	2,620 (122%)
Winter-run steelhead (6,800)	-3,741 (-55%)	-2,343 (-34%)

Source: ICF 2016

Figure 4.3-3

Potential Response in Salmonid Abundance to Habitat Change in the Chehalis Basin from Climate Change and Restorative Flood Protection



Source: ICF 2016

4.3.7.3 Mitigation

No long-term, adverse impacts contributing to climate change are anticipated, so no mitigation is proposed.

4.3.8 Visual Quality

4.3.8.1 Short-term Impacts

The potential short-term impacts on visual quality that would occur during construction are described in Table 4.1-1. In addition, construction activities would substantially alter the appearance of the areas near the Restorative Flood Protection treatment areas. Construction activities within the channel would be largely out of view; however, construction of the engineered-floodplain elements would be visible to the community.

4.3.8.2 Long-term Impacts

Potential adverse impacts on visual quality from Restorative Flood Protection are related to a long-term change or reduction in visual quality. These impacts would occur within and within viewing distance from Restorative Flood Protection treatment areas and upland land conversion areas.

Changes that would significantly contrast with the existing visual character include the following:

- Establishment of dense floodplain vegetation that would disrupt the view that currently exists across open floodplain areas
- Engineered-floodplain log structures that would be visible across large portions of the floodplain until interplanted vegetation grows tall enough to obscure the log structures
- Conversion of upland managed forestland to other land uses

Restorative Flood Protection would require construction of engineered-floodplain structures over 85% to 90% of the future 100-year floodplain, which includes up to 21,000 acres within the treatment areas. These structures would cover a large portion of the existing floodplain, much of which is currently in pasture, hay, or other cultivated crops. The vistas that are enjoyed by people would be dramatically changed. Over a 5- to 7-year period following construction of the engineered floodplain, a densely spaced matrix of constructed wood structures would be the most visible feature. Following that, shrubs and trees would be tall enough to dominate the view, and the vista would transition to that of a forest. Because of the extent of area affected by the floodplain treatments, this is considered a significant adverse impact.

Conversion of upland managed forestland to accommodate displaced land uses from the Restorative Flood Protection treatment areas would have an adverse impact on visual quality. While in managed forestland use, the view evolves over an approximately 30-year cycle from clearcuts to young forest, and then to mature forest with large conifer trees. The converted land would permanently change this view to farms, homes, and other structures—both public and private. The views are visible from the valley, and would be noticeable from a large area within each Restorative Flood Protection treatment sub-basin. This adverse impact could range from moderate to significant, depending upon the visual quality and concentration of the new land use in contrast to managed forestland.

4.3.8.3 Mitigation

In addition to those described in Table 4.1-1, short-term mitigation measures could include locating temporary construction access roads, staging areas, and stockpile sites within previously disturbed areas.

Long-term mitigation measures could include integrating view corridors that intersperse floodplain forestland with open areas within the Restorative Flood Protection floodplain treatment areas if further analysis indicates such configurations could still achieve the desired flood attenuation and storage. These measures could slightly reduce the visual quality impacts, but the impacts would still be significant.

4.3.9 Noise

4.3.9.1 Short-term Impacts

The potential short-term impacts on noise that would occur during construction are described in Table 4.1-1. Heavy equipment and construction activities associated with the Restorative Flood Protection treatments would cause short-term noise impacts.

Depending on the type of construction activity, peak noise levels from the equipment shown in Table 4.2-10 would range from 76 to 110 dBA at 50 feet from the source. Damage to hearing occurs with noise levels above 85 dBA. However, noise levels decrease with distance from the source at a rate of approximately 6 to 7.5 dBA per doubled distance. For example, noise levels from construction equipment would range from approximately 57 to 98 dBA at a distance of 200 feet; from 51 to 92 dBA at 400 feet; and from 45 to 86 dBA at 800 feet.

Construction of Restorative Flood Protection treatments would require heavy equipment and activities with high noise levels, including earth-moving equipment and pile drivers. Some of this equipment would operate at noise levels high enough to cause hearing damage at very short distances (less than 50 feet), but the noise levels would dissipate to safe levels with distance. The locations for many of the Restorative Flood Protection treatments would be proximal to private homes, businesses, and public facilities.

4.3.9.2 Long-term Impacts

Minor adverse impacts related to noise are anticipated. These impacts would be created by potential land conversion in managed forestland. New land uses in those areas would likely create noise consistent with rural residential, farming, businesses, and public services. Significant impacts would occur if projects generated noise that would conflict with local ordinances or increase noise levels by 5 dBA or greater at a sensitive land use. Restorative Flood Protection actions would not generate noise within the treatment areas where noise would likely be less than under current conditions.

4.3.9.3 Mitigation

Assuming the specifications for equipment meet the noise standards described in Table 4.1-1, no additional equipment mitigation for short-term impacts would be required. Construction workers at the site could wear hearing protectors to reduce the risk of hearing damage.

No long-term impacts on noise are anticipated, so no mitigation is required.

4.3.10 Land Use

4.3.10.1 Short-term Impacts

Potential short-term impacts on land use would occur during construction, including disruption to use of and access to land within Restorative Flood Protection and upland relocation construction areas.

4.3.10.2 Long-term Impacts

Potential adverse impacts on land use associated with the Restorative Flood Protection would result from the following:

- Conversion of floodplain land to Restorative Flood Protection treatment areas
- Increased flooding in some areas that would affect existing high and limited value structures
- Conversion of upland commercial forestland to agriculture, rural residential, and public facilities

As described in this section, the adverse impact on existing land uses within the Restorative Flood Protection treatment areas would be significant.

Within Restorative Flood Protection Treatment Areas

Restorative flood protection actions would be incompatible with many existing land uses. Many of these areas are already at-risk for flooding and loss of land from bank erosion; Restorative Flood Protection would formally recognize that risk and address it. Figure 4.3-4 illustrates the expected range of land use impacts within the floodplain treatment areas. Based on the preliminary analysis conducted, the zone within the 10-year floodplain following Restorative Flood Protection implementation would be largely unsuitable for permanent human residents. This zone, described in the Restorative Flood Protection description as the “river management zone” or “greenway,” is expected to experience active channel migration, engagement of floodplain wetlands, and frequent flooding such that structures would be at-risk to severe flood and erosion damage. There is currently approximately 16,000 acres within this zone, including 8,500 acres of active farmland.

Outside the “river management” or “greenway” zone, but still within the Restorative Flood Protection floodplain, Restorative Flood Protection treatments are likely to cover 50% to 70% of the floodplain. It is expected that flooding would be more frequent in these areas than under current conditions. An additional 5,200 acres would be more frequently flooded within this zone, including 3,600 acres of farmland.

Under Restorative Flood Protection, willing landowners would be offered a suite of compensation options, which could include measures described below under mitigation. One option could be to relocate to suitable upland areas that would not be affected by Restorative Flood Protection treatments. This option would likely convert up to 16,000 acres of land that is currently managed forestland to agriculture, rural residential, public services, and commercial (also referred to as upland conversion areas in this EIS). If all agricultural land uses in future greenways (see Figure 4.3-4) moved to upland areas, the land conversion from managed forestland to agriculture could reach 8,500 acres in size. The location, magnitude, and concentration of these potential impacts have not yet been determined. Adverse impacts on fish and wildlife, vegetation, water quantity, visual quality, and climate change associated with this land conversion (see Sections 4.3.4, 4.3.3, 4.3.1, 4.3.8, and 4.3.7) are likely. Because upland relocation would convert managed forestland to other uses, there would also be a reduction in managed forestland in the watershed.

Approximately 462 high-value structures would be affected by increased flooding within the treatment areas. Of the 462 structures, 182 structures would be inundated under current conditions during a 100-year flood. Flood depths and frequencies would increase for these 182 structures after Restorative Flood Protection treatments. The remaining 280 structures would be subject to new flooding caused by Restorative Flood Protection treatments, and may not flood currently during a 100-year flood. Because modeling was developed to be a screening-level tool, this estimate of affected structures includes all potential affected structures, and may be reduced in number with a conceptual design-level analysis.

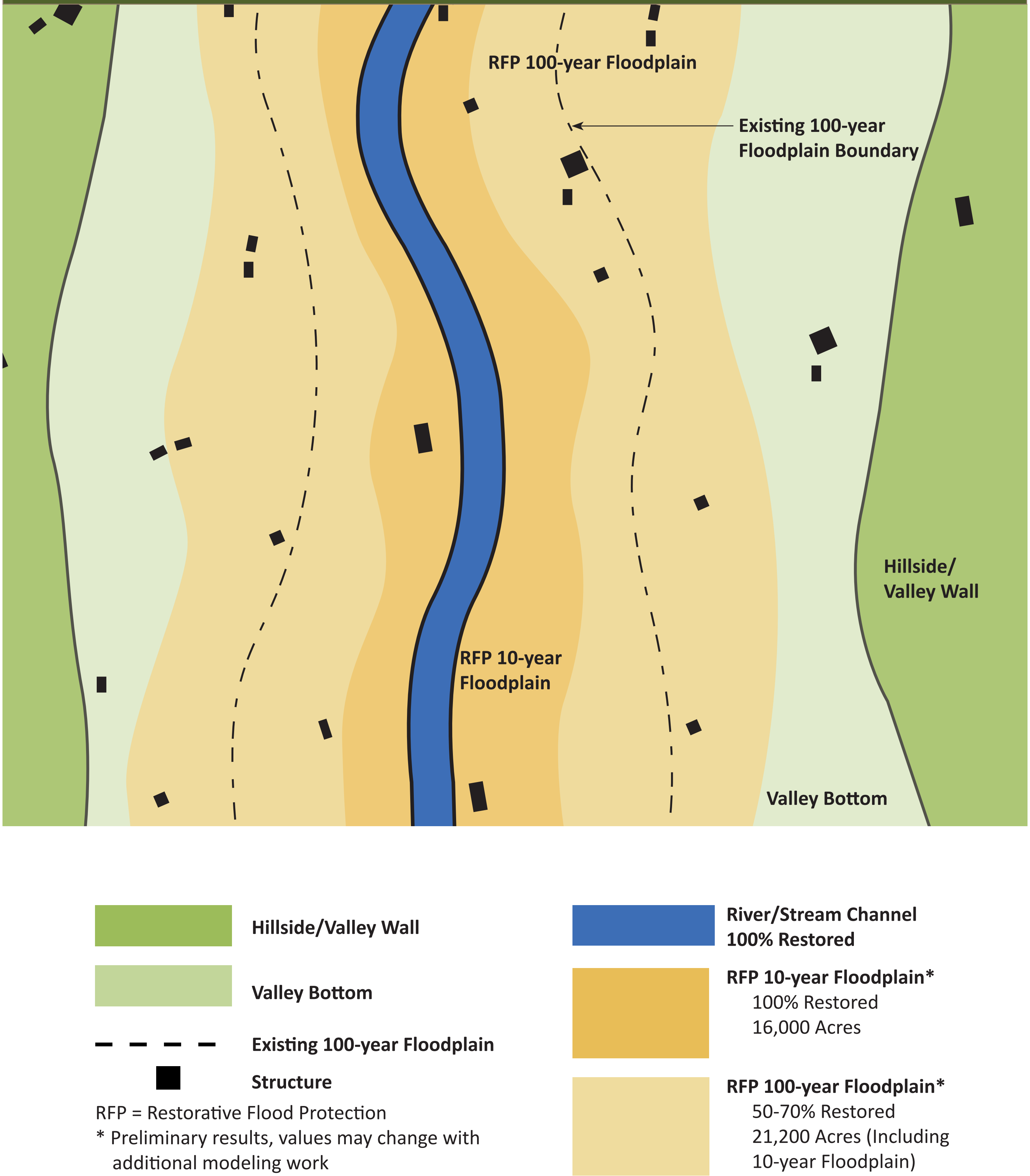
As noted above, many of the areas within Restorative Flood Protection treatment areas are already at risk from flooding and loss of land from bank erosion, and Restorative Flood Protection would formally recognize that risk and address it. If all landowners with structures that currently experience flooding, and where flooding would increase, participated, 182 fewer structures would be flooded than under current conditions. An additional 280 structures (those subject to new flooding caused by the treatments) would also be offered compensation, relocation, or adaptation assistance (see Section 4.3.10.3).

Downstream of Restorative Flood Protection Treatment Areas

Downstream of the Restorative Flood Protection treatment area, 1,197 high-value and limited-value structures are estimated to be inundated during a 100-year flood under current conditions. After implementation of Restorative Flood Protection actions, it is estimated that 1,061 structures would be inundated during a 100-year flood, for a decrease of 136 flooded structures.

Figure 4.3-4

Land Use Change Diagram



4.3.10.3 Mitigation

An integral part of this action element is to provide assistance to help ensure that willing property owners and residents can adapt. Adaptation strategies, intended to avoid and minimize the significant adverse impacts on land use associated with Restorative Flood Protection, could include the following:

- **Stay-in-place adaptation assistance –** Within treatment areas but outside of greenways, floodproofing, elevation of structures, farm pads, drainage and utility improvements, or relocation of homes and structures to more upland portions of the same parcel
- **Buy-outs –** If property owners prefer a simple buy-out option for property and structures
- **Conservation easements –** Permanent conservation easements could be used to compensate property owners for lost use of land
  - This could be combined with stay-in-place assistance or be a strategy for parcels without structures
- **Relocation support to upland areas –** A preliminary assessment of soils in the Chehalis Basin indicates that relocation of some current floodplain land uses to upland areas could be a viable option in portions of the watershed
  - The feasibility of this concept is very preliminary and unknown; the suitability of upland areas for specific land uses would have to be further explored

4.3.11 Recreation

4.3.11.1 Short-term Impacts

Construction in the Restorative Flood Protection treatment areas would restrict access to recreation sites and river recreation. The duration of this impact would be limited to the construction period at each site, likely to span approximately 3 to 4 months. Short-term impacts on recreational activities such as hunting or fishing on managed forestlands, where currently allowed by permit, could occur from site preparation and construction associated with relocation of floodplain land uses to upland areas.

4.3.11.2 Long-term Impacts

Adverse impacts on recreation resulting from implementation of Restorative Flood Protection are anticipated to be minor to moderate because of the large area over which the impacts described in this section could occur.

Restorative Flood Protection would require construction of large wood and rock structures (engineered logjams) in the mainstem and South Fork Chehalis rivers; Bunker, Elk, Stearns, Stillman, and Lake creeks; and the North and South Fork Newaukum River channel over a total length of up to 140 river miles. Logjams can create hazardous conditions for boaters of all types, and would permanently displace recreational use of some stretches of rivers and streams. If access points are not available for boaters, rafters, and floaters to access the river in safe areas, recreational use could be further affected.

Agritourism opportunities are present in the Chehalis watershed, and depending upon their specific location, Restorative Flood Protection actions could adversely affect these recreational sites. Where current agritourism facilities are located within the Restorative Flood Protection 10-year floodplain (greenways), these recreational facilities would likely be displaced.

Some recreational facilities, such as the Chehalis-Centralia Railroad, Willapa Hills Trail, and Rainbow Falls State Park could experience more frequent flooding that would likely require modifications to existing facilities, such as floodproofing, installation of new bridges, and adjustments to trail alignments. Other recreational activities would not be affected by Restorative Flood Protection, and activities like hunting, fishing, hiking, and bird-watching could benefit (increase) as a result of more floodplain habitat area and, correspondingly, more abundant fish and wildlife.

It may not be possible to relocate some types of recreational activities or facilities from the Restorative Flood Protection floodplain to upland areas. For example, features an activity may require or depend on to operate in one location may be diminished or not exist in upland areas. For example, fishing requires access to a body of water, and this opportunity would not be available in an upland area without access to a waterbody.

4.3.11.3 Mitigation

Mitigation measures for short-term impacts on recreation during construction could include providing alternative recreational opportunities or access when treatment areas are under construction. During construction, these areas would be closed to recreational use for safety purposes.

For long-term adverse impacts on in-water recreation, compensatory mitigation could consist of identification of hazards and delineation of specific river reaches where in-water recreation is encouraged and safe. Public safety communication would also be needed to inform the public about hazards within other areas along the Chehalis River and its tributaries.

Mitigation for impacts on agritourism sites could include measures associated with the overall accommodation for relocating or compensating private landowners for displacement caused by Restorative Flood Protection (see Section 4.3.10).

4.3.12 Historic and Cultural Preservation

4.3.12.1 Short- and Long-term Impacts

Potential short- and long-term impacts on historic and cultural resources include the following:

- Destruction, damage to, or alteration of a cultural resource
- Necessary removal of a cultural resource from its original location
- Changes to the use or physical features of a cultural resource

- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the significant features of a cultural resource

The potential impacts on historic and cultural resources that would occur during construction include ground disturbance associated with access routes, Restorative Flood Protection construction sites, and upland conversion areas. The engineered-floodplain elements of the Restorative Flood Protection would require some ground disturbance over a large area (up to 21,000 acres). Upland conversion areas could require ground disturbance over approximately 16,000 acres. A cultural resources assessment has not yet been conducted for potential Restorative Flood Protection treatment areas or upland conversion areas, and would be required during design and project-level environmental review. Although the degree or severity of the impact would depend on the nature of cultural resources that would be disturbed, moderate to significant adverse impacts on cultural resources could occur due to the predicted archaeological potential. Potential impacts on tribal cultural resources or graves, Indian human remains, or traditional cultural properties would be determined in coordination with tribes, and government-to-government consultations.

4.3.12.2 Mitigation

Once potential project-specific impacts of Restorative Flood Protection actions on cultural resources have been identified, avoidance and minimization measures may be considered that alter project design or construction methods to avoid or minimize these impacts. If impacts cannot be avoided, mitigation measures to address potential impacts on cultural resources would be determined during project-specific evaluations, and would include consultation with DAHP, interested and affected tribes, as well as other consulting parties (see information on addressing potential impacts on cultural resources in Section 4.2.12).

The potential compensatory mitigation measures could include data recovery (scientific excavation and analysis) of the archaeological sites; archaeological monitoring during construction to ensure that no (previously unknown) cultural resources are affected; development and implementation of an Inadvertent Discovery Plan; ethnographic studies; Historic American Building Survey/Historic American Engineering Record documentation; and cultural resources identification trainings for construction personnel.

4.3.13 Transportation

4.3.13.1 Short-term Impacts

The potential short-term impacts on transportation that would occur during construction are described in Table 4.1-1 and are related to construction traffic and temporary road closures.

4.3.13.2 Long-term Impacts

Significant adverse impacts on transportation are anticipated from implementation of Restorative Flood Protection. The potential adverse impacts on transportation include:

- Major roads that would be at risk from channel migration
- Major roads that would flood more (see Table 4.3-6)
- Roads that provide the only access route could be less accessible
- I-5, and other roads that benefit where flooding is reduced

Within Restorative Flood Protection Treatment Areas

Restorative Flood Protection would increase flooding impacts on transportation systems in the Chehalis Basin upstream of the Newaukum confluence with the Chehalis River. During a 100-year flood, Restorative Flood Protection would increase the duration of closure of SR 6 by approximately 4 days, SR 506 by approximately 1 to 2 days, and SR 508 by approximately 2 days.

Table 4.3-6
Increased Flooding Duration for Roads within the Restorative Flood Protection Treatment Areas

LOCATION	HOURS OF FLOODING DURING EXISTING 100-YEAR FLOOD	HOURS OF FLOODING DURING 100-YEAR FLOOD WITH RESTORATIVE FLOOD PROTECTION
SR 6 near Scheuber Road	43	70
SR 6 near Adna	33	71
SR 6 at Boistfort Road	15	35
SR 6 at Rainbow Falls State Park	17	18
Boisfort Road near SR 6	0	23
Boisfort Road at Boisfort	13	14
Wildwood Road Bridge	0	6
Main Avenue near South Fork Newaukum River crossing	0	20

A new transportation network and new transportation facilities would be necessary for upland conversion areas, which may affect current transportation facilities or patterns; the nature and magnitude of these impacts are currently unknown and would be evaluated through future development and design of this concept.

Downstream of the Restorative Flood Protection Treatment Areas

Restorative Flood Protection would reduce flooding impacts on transportation systems in the Chehalis Basin downstream of the Newaukum confluence with the Chehalis River. Restorative Flood Protection would not reduce the duration of closures of I-5 during a 100-year flood (up to 4 days of closure). In the Chehalis-Centralia area, Restorative Flood Protection would reduce flood depths by approximately

1 foot, and local roads within the area would experience reduced flood durations by up to 1 day. Restorative Flood Protection would protect the Chehalis-Centralia Airport during smaller floods, allowing flights to continue, but the airport would continue to flood during 100-year floods. Restorative Flood Protection would likely decrease the frequency of rail closures downstream of the Newaukum confluence.

4.3.13.3 Mitigation

Mitigation measures for short-term impacts during construction phases of Restorative Flood Protection on transportation are described in Table 4.1-1.

Potential long-term adverse impacts on transportation could be mitigated through a combination of emergency access route planning, and road relocations and modifications to increase access during flooding.

4.3.14 Public Services and Utilities

4.3.14.1 Short-term Impacts

The potential short-term impacts on public services would occur during construction due to temporary road closures that could affect public services because access to properties would be temporarily restricted. Construction could cause a temporary disturbance of on-site and nearby utilities, including overhead utility lines.

4.3.14.2 Long-term Impacts

Restorative Flood Protection includes the relocation of agricultural, residential, and commercial land uses out of the 10-year floodplain, which would require disconnection and decommissioning of existing public utilities in these areas. This would include removal or decommissioning of overhead utilities, water lines or wells, sewer or septic systems, propane tanks, and buried fuel tanks. New public services and utilities would need to be provided to the upland areas where the displaced land uses would be relocated. The Restorative Flood Protection would not directly increase demand for public services and utilities, but relocation of those services and utilities could require extension of utilities including electricity, water supplies, and sewer services. Removal and relocation of public services and utilities throughout the 10-year floodplain would be a significant adverse impact.

Restorative Flood Protection would increase flood levels in the watershed above the confluence with the Newaukum River. Public services and utilities located in the areas of increased flood levels would experience higher inundation or longer duration of flooding. The higher flood levels would close access roads for a longer period and prevent access to public services such as public health facilities and schools for longer periods than under current conditions. Higher flood levels could inundate public utilities for a longer period of time disrupting service. Public services and utilities located in these areas include the Boistfort Elementary School, post offices, power lines, electrical substations, water wells, septic tanks, as well as numerous utilities in the small communities along the Chehalis and Newaukum rivers and their tributaries. As part of Restorative Flood Protection, public services and utilities would be relocated out of the treatment areas and the 10-year floodplain, reducing the number of public services and utilities that would be affected. These adverse impacts would be moderate.

Restorative Flood Protection would decrease the level and duration of flooding in the Chehalis Basin downstream of the Newaukum River confluence. Flooding of public services and utilities would be reduced in the Chehalis and Centralia areas where flooding would be reduced by up to 1 foot.

4.3.14.3 Mitigation

Potential measures to reduce short-term construction disruptions on public services and utilities include the following:

- Providing public notification of proposed construction activities, including the timing of construction, to all local service providers within the immediate vicinity of the construction area
- Coordinating with local utility service providers to assist in utility locations, if applicable, and to identify specific mitigation measures to minimize impacts on utility purveyors
- Coordinating with local utility purveyors to identify other specific mitigation measures to minimize impacts

Mitigation planning for utilities would require coordination with involved service providers, as well as with potentially affected residents and landowners. Where local utility system connections or installations would be affected by construction activities, alternative or relocated connections and facilities could be planned and implemented prior to construction to avoid service disruptions.

Mitigation for potential long-term adverse impacts due to relocation of public services and utilities would include removal and decommissioning of utilities in the treatment areas and areas where flood levels are anticipated to increase. Wastewater treatment systems, propane tanks, and underground fuel supplies would be decommissioned according to local and state guidelines to avoid potential contamination. New services and utilities would be provided to the properties where the displaced land uses are relocated in coordination with local service providers.

Mitigation for impacts on public services and utilities in areas that would experience increased flooding could include measures to floodproof or protect the affected utilities and services or relocating them out of the flooded area.

4.3.15 Environmental Health and Safety

4.3.15.1 Short-term Impacts

The potential short-term impacts on environmental health and safety that would occur during construction are described in Table 4.1-1. In addition, construction traffic on local roadways could cause temporary delays to emergency response.

4.3.15.2 Long-term Impacts

Increased flooding could affect emergency response services in the areas upstream of the Newaukum River confluence with the Chehalis River. Higher flood levels and increased duration of flooding of SR 6 and local roadways could prevent or delay emergency service access. This would be a moderate to significant adverse impact depending on how well emergency response could be maintained. Restorative Flood Protection includes relocation of residential, agricultural, commercial, and public service land uses out of the 10-year floodplain, which would reduce the demand for emergency services during floods, but access may still be required in areas outside the 10-year floodplain. Relocation of land uses outside the 10-year floodplain would also reduce the risk of floodwater contamination by reducing the potential contaminants that could be exposed to flooding.

Restorative Flood Protection could cause a moderate to significant adverse impact on human health and safety. Higher flood levels could close roads for longer periods and prevent access for emergency response. Access to some of the rural areas within the increased flood zone is already limited, increasing the hazard of increased road closures.

4.3.15.3 Mitigation

Potential measures to reduce short-term construction disruptions to environmental health and safety could include coordinating construction with emergency services, scheduling construction to minimize impacts, and notifying the public of construction. Construction traffic control plans would be developed to reduce impacts on emergency services and response.

Potential measures to reduce long-term adverse impacts on environmental health and safety include relocating land uses out of the 10-year floodplain and providing measures to protect areas outside the 10-year floodplain that would experience increased flood levels. These measures include floodproofing structures, providing farm pads, and development plans to maintain emergency response.