DRAFT

MEMORANDUM

Date: August 6, 2021
To: Chehalis River Basin Flood Control Zone District, Betsy Dillin
From: Kleinschmidt Team
Re: Commitment to No Net Loss of Aquatic Habitat Function

1.0 Introduction

The Chehalis River Basin Flood Control Zone District (CFCZD) is evaluating the merits of making a formal commitment to achieve no net loss of aquatic habitat function due to the construction and operation of the proposed Flood Retention Expandable (FRE) alternative in the upper Chehalis Basin. The formal environmental commitment statement would be offered for consideration by the U.S. Army Corps of Engineers (Corps) in the development of the final Environmental Impact Statement (FEIS) under the National Environmental Policy Act (NEPA) and by the Washington State Department of Ecology (WDOE) in the development of the FEIS under the Washington State Environmental Policy Act (SEPA). The purpose of this technical memorandum is to establish and describe this environmental commitment and explain what it means in terms of its application to mitigation development during current and future phases of environmental review. The Kleinschmidt Team anticipates the CFCZD will rely on the content of this document to prepare a formal letter of commitment directed to the Corps and WDOE.

2.0 Background

2.1 Project Description

The CFCZD is proposing construction of a new flood retention facility in the upper Chehalis watershed on the Chehalis River, near the city of Pe Ell, Washington. Figure 1 shows the project vicinity within the upper Chehalis River Basin. The proposed project includes a new flood retention facility and temporary reservoir, and levee improvements around the Chehalis Airport in Chehalis, Washington. The proposed project is intended to reduce flood damage in the Chehalis River Basin. The project will not protect communities from all flooding, nor is it designed to stop regular annual flooding from the Chehalis River. The project includes the following major project components described in preliminary design and planning documents (HDR 2017; HDR 2018; CFCZD 2019):

- FRE flood retention facility
- Temporary reservoir
- Fish passage facilities at the flood retention facility
- Construction using a temporary river bypass tunnel
- Airport levee improvements

The temporary reservoir near Pe Ell that would temporarily store floodwater during major floods and then slowly release retained floodwater when it is safe to do so and over a period of up to 35 days. Most of the time, the Chehalis River would flow through the structure's low-level outlet works at its normal rate of flow and volume—and allow fish to pass both upstream and downstream. Fish passage at the facility during construction and during post-construction operation is discussed in detail in Section 2.3.3 of the SEPA DEIS (Ecology 2020).

The fish passage facilities at the flood retention facility would allow fish to pass both upstream and downstream during construction using a river bypass tunnel. During normal flows, low-level outlets would remain open to facilitate passage during normal conditions and smaller floods. During major floods, a fish collection and transport system would be implemented to temporarily transport and release migrating fish (trap and haul) when the structure's outlets are closed.

The airport levee improvements are designed to protect the Chehalis-Centralia Airport, local businesses, and area transportation infrastructure from damage that would result from a 100-year flood. In addition to raising the existing levee around the Chehalis-Centralia Airport, 1,700 feet of Airport Road would be raised to meet the airport levee height along the southern extent of the airport.

Flood control operations at the FRE are expected to occur in response to an approximately 7-year recurrence interval flow event. For each event, the reservoir would temporarily hold water for up to 35 days. About 99 percent of the time, there would be no water storage within the FRE reservoir.

2.2 Environmental Review Process

The project is currently under environmental review between draft and FEIS documents. WDOE published a draft Environmental Impact Statement (DEIS) under SEPA in February 2020 (WDOE, 2020). The Corps published a DEIS under NEPA in September 2020 (USACE, 2020). Both documents reported that the project would have unavoidable impacts to regulated aquatic resources. Multiple stakeholders are engaged in the environmental planning process with the common goal of providing both flood control and basin-wide salmon recovery (OCB 2019).

- The NEPA and SEPA DEIS documents both identified unavoidable impacts to aquatic habitats and species and noted that mitigation would be needed to address those impacts.
- In a May 13, 2021 meeting with Ecology and Corps to discuss information needs for NEPA and SEPA FEIS development, both agencies noted that affirmative commitments may be considered differently compared to studies and communications that talk about what is possible.

2.3 Chehalis Basin Watershed

The following information has been summarized from the SEPA DEIS (WDOE 2020) and Chehalis Basin Strategy Draft Programmatic EIS (WDOE 2016) as well as appendices, and supporting technical reports listed in the reference section and available on ChehalisBasinStrategy.com.

The Chehalis River is the second largest river in Washington, with a drainage area of 2,700 acres and approximately 125 river miles from the headwaters to the sea. The basin, which drains the Willapa Hills, foothills of the Cascade Mountains, and Olympic Mountains, is predominantly rain dominated and subject to high precipitation from rain events in winter followed by very dry summer months. Landslides and mass wasting occur with storm events. In one major storm event in 2007 over 1,000 landslides were documented.

The predominant land uses in the Chehalis River basin are forestry and agricultural with some urbanization in the low-gradient valley reaches. The Chehalis River floodplain has been heavily influenced by these land uses. Historic and current land use practices have contributed to existing conditions of channel incision and loss of floodplain storage. Under current conditions, agriculture, including livestock grazing and farming, dominates land use and occurs within 41% of total floodplain by area. Timber production and recreation land uses follow closely behind agriculture occurring within 39% of the floodplain, while 11.5% is in urban development. Land use in the floodplain has resulted in a paucity of wood and vegetation, making the river's edge susceptible to erosion, and allowing the water to be warmed by more direct sunlight, both reducing aquatic habitat quality.

Aquatic habitat conditions in the basin have been affected by historic and current land uses. In the middle Chehalis River, from the confluence of the South Fork Chehalis River upstream to Rainbow Falls RM 98) channel straightening and floodplain alteration have increase the river's susceptibility to erosion, and direct thermal inputs. The result is a middle river segment with predominantly one incised channel that is disconnected from its floodplain, has more fine-grained sediment, and warmer water temperatures compared to historic conditions.

The upper Chehalis River, upstream of Rainbow Falls (RM 98), is a single thread channel confined within a narrow canyon. The riverbed in this river section, consists largely of a thin layer of alluvial substrates over bedrock. Gravel substrate can be found throughout this reach in combination with gravel/sand more common downstream of RM 110 and grave/cobble/boulder more common upstream of RM 113 dominant downstream of the confluence of the East and West Forks (RM 118). The geology, in this reach limits groundwater-surface water exchange that can occur. The dominant vegetation type in this reach is coniferous forest, a considerable proportion of which is managed for commercial timber harvest.

The Chehalis River provides habitat for multiple fish and wildlife species. Four species of Pacific Salmon inhabit the basin as well as Pacific Lamprey and other non-anadromous fishes. There are no fish species in the river listed as threatened or endangered under the federal Endangered Species Act (ESA); however recent accounts have indicated that the salmon populations have declined due to habitat degradation (WDOE, 2020; USACE 2020). The Chehalis also provides homes for an abundance of wildlife and the highest diversity of amphibians in Washington State.

The upper Chehalis River provides habitat for anadromous salmon, Pacific lamprey, native fishes and amphibians including Western Toad. Three salmon species migrate upstream of the proposed dam site to spawn, Chinook Salmon (fall- and spring-run), Coho Salmon and steelhead. Based on current conditions the habitat potential upstream as a proportion of the entire basin was estimated as less than 1% for fall Chinook and Coho salmon, 2.5 % for steelhead and 3% for Chinook Salmon. For spring Chinook Salmon 97% of their spawning distribution in the upper Chehalis River is located within 6 miles upstream of the proposed dam site. This percentage is less for steelhead, at 35%, because suitable spawning habitat extends further upstream for this species.

Consistent with degraded aquatic habitat, water quality in the middle and upper Chehalis basin has been degraded as indicated by 303d and Water of Concern listings for several parameters including turbidity, nutrients, fecal coliform, dissolved oxygen and temperature. Temperatures in the mainstems and 11 tributaries sampled may exceed state water quality standards during summer months and has been implicated as a limiting factor for spring Chinook Salmon (Winkowski et al. 2017). Low flow, high water temperature, and low dissolved oxygen were implicated in the 2009 mortality event where approximately 100 spring Chinook Salmon were killed in the mainstem Chehalis River near RM 104 and 74 and in the lower Newaukum River (Liedke et al. 2017).

Climate change models for the Puget Sound area and scaled to the Chehalis River basin predict increased precipitation and decreased summer flows (Mauger et al. 2016). These authors indicate that warner winter temperatures would mean less snow and more heavy rain events that are expected to increase risk of winter flooding along with increases in sediment transport, erosion and landslides. With less snowpack to melt and less summertime precipitation expected, lower summer stream flows and warmer water temperatures are predicted for the Chehalis Basin.

3.0 Summary of Impacts and Mitigation Needs

Major impacts to aquatic and terrestrial habitats and species (Table 1) were identified in the SEPA DEIS (WDOE 2020) and a preliminary estimate of mitigation needs (Kleinschmidt 2020) incorporating expanded information on ecological functions and values, aquatic species and life stages developed during a series of coordination meetings between the CFCZD and regulatory agencies and tribes in early 2021.

Impacts to aquatic and terrestrial species and habitats as well as estimated mitigation needs are preliminary. More rigorous impact characterization and determination of necessary mitigation types and quantities would be developed during environmental permitting should the project advance past the current phase of environmental review.

4.0 Mitigation Opportunities

The Kleinschmidt Team, on behalf of the CFCZD, identified and evaluated candidate mitigation opportunities within the upper Chehalis Basin (Kleinschmidt 2020). Figure 2 shows the geographic extent and distribution of preliminary candidate mitigation opportunity sites in the upper Chehalis Basin. Mitigation types and quantities were defined to correspond with the types and quantities of project impacts. Mitigation is intended to replace the ecological functions and values that would be lost because of habitat impacts attributable to construction and operation of the proposed project. The Kleinschmidt team developed a preliminary assessment of the types, quantities, and locations of needed mitigation. The following list of mitigation components is a preliminary illustration of one way that project impacts could be mitigated. There are many combinations of mitigation actions that could be used to replace the ecological functions lost because of project impacts. The preliminary quantities listed below and shown on Table 2 are based on an assessment of ecological functions provided by the habitats that would be impacted and best professional judgment to estimate the intensity of mitigation actions (quantity per mile) necessary to achieve ecological lift in the areas where mitigation could occur. This preliminary list of mitigation components is necessary to illustrate an approach to mitigation and form the basis for addressing the key questions of this analysis.

- Riparian reforestation along 6 miles of main channel and 11 miles of tributary channel (assumes 200 ft buffers on both sides of the channel that add up to 824 acres);
- Conservation of 824 acres including a mixture of uplands and wetlands (assumes that this would be satisfied by riparian reforestation of 824 acres);
- Conservation of 100 acres of forested upland adjacent to or near the temporary reservoir;
- Implementation of 34 cold water thermal refugia enhancements including 4 cold water retention structures (e.g., groundwater interception channels and alcoves) and 30 hyporheic enhancement structures;
- Enhancement of instream habitat in 17 miles of stream and river channel by placement of 50 wood loading structures with substrate enhancement (assume 3 structures per mile) including 30 instream wood and rock placement structures and 15 gravel retention jams;
- Implementation of 4 floodplain reconnection projects for a total of 2 miles of off-channel aquatic habitat and 100 acres of riparian buffer including a mixture of wetlands and uplands); and
- Replacement of 5 fish passage barrier culverts with fully fish-passable stream crossings.

Aquatic mitigation would be reach-scale, process-based habitat restoration enhancement that integrates multiple mitigation types appropriate in the site-specific landscape context. CZFCD intends to evaluate the sufficiency and effectiveness of mitigation on the basis of habitat function and value with a direct linage to impact analysis that has been completed. Mitigation performance would be evaluated

with a robust monitoring plan, and achievement of mitigation objectives would be bolstered by adaptive management.

5.0 Commitment to No Net Loss of Aquatic Habitat Function

The CFCZD is evaluating the merits of making a formal commitment to achieve no net loss of aquatic and terrestrial habitat function due to the construction and operation of the proposed FRE alternative in the upper Chehalis Basin. The commitment would apply to impacts attributable to the construction and operation of the proposed FRE, temporary reservoir, and levee improvements. CFCZD has conducted a preliminary assessment of impacts to aquatic and terrestrial habitat, estimated mitigation needs, and available mitigation opportunities within the upper Chehalis basin. Based on that preliminary assessment, the CFCZD believes that mitigation is technically feasible, and sufficient mitigation opportunities are available to mitigate for the anticipated project impacts to aquatic and terrestrial habitats and species. Mitigation would employ the same kinds of habitat restoration and enhancement techniques applied by the ASRP and other regional salmon recovery efforts. Mitigation would not interfere with implementation of the ASRP, and mitigation would be funded and implemented separately from the ASRP. No part of the ASRP would be construed as mitigation for project impacts.

Table 1

Summary of Estimated Mitigation Needs Compared to Impacts

IMPACT DESCRIPTION	ESTIMATED MITIGATION NEEDED
Removal of 90% of the trees within 600 acres of the temporary reservoir area	• Riparian reforestation along 6 miles of main channel and 11 miles of tributary channel (assume 200 ft forested buffer on both channel banks that ad up to 824 acres).
Episodic temporary flooding of up to 847 acres (maximum extent of temporary reservoir area at full capacity) and loss of riverine, wetland and upland fish and wildlife habitat.	• Conservation of 924 acres, including a mixture of forested uplands and wetlands • (824 acres of forested riparian buffer will be supplemented by 100 acres of upland conservation adjacent to the temporary reservoir)
Water temperature increases of up to 9 degrees F related primarily to loss of shade along 6 miles of river and 11 miles of tributary streams within the temporary reservoir. This predicted temperature increase combines project effects with temperature increased attributed to climate change. Water temperature increases of up to 5 degrees F within the 20-mile river corridor between the proposed FRE and the SF Chehalis River confluence. Model-predicted temperature increased result from the combined effects of climate change and project impacts related primarily to loss of shade along the river and tributary streams within the footprint of the temporary reservoir area This would be expected to result in an increased number of days when temperature and DO standards would be exceeded during summer months and an increased risk for salmon spawning and rearing.	• Riparian reforestation along 6 miles of main channel and 11 miles of tributary channel (assume 200 ft forested buffer on both channel banks that add up to 824 acres). • Create 34 localized thermal refugia in the middle river and tributaries below the FRE. (e.g., 30 hyporheic exchange enhancements and 4 cold-water retention structures) – assume 2 structures per mile for 17 miles
Permanent loss of approximately 11 acres of wetlands and 333 acres of wetland buffers located within the 847-acre footprint of the temporary reservoir area. This would be expected to reduce wildlife habitat, including Western Toad breeding habitat.	• Conservation of 924 acres including a mixture of forested uplands and wetlands (assume this is partially fulfilled by 824 acres of forested riparian buffer supplemented by 100 acres of upland conservation adjacent to the temporary reservoir) • 3 acres of wetland creation and enhancement targeting habitats for focal wildlife species • Wetland impacts will be comprehensively addressed in a separate wetland mitigation assessment
Permanent elimination of 17 miles of stream channel and 441 acres of stream buffers. "Permanent elimination" entails habitat degradation and loss of ecological function within approximately 6 miles of the mainstem Chehalis River channel and 11 miles of tributary stream channel within the footprint of the temporary reservoir area.	• Enhance instream habitat in 17 miles of stream and river channel by placement of 50 wood loading structures with substrate enhancement (assume 3 structures per mile for 17 miles). • 35 of the wood loading structures would each include 300 ft of large wood placement, 200 feet of wood toe, 50 ft of boulder weir, and 1 beaver dam analog.

IMPACT DESCRIPTION	ESTIMATED MITIGATION NEEDED
This includes loss of salmon, steelhead, and other native fish spawning and rearing habitat and would result in a reduction in the overall reductions is salmon and steelhead abundance, productivity, diversity, and spatial structure in the basin.	• 15 of the wood loading structures would be gravel retention jams each covering 900 linear ft of channel • Open access to blocked habitat with culvert replacements.
Permanent elimination of 0.3 acres of the Chehalis River channel at the FRE site	• Replace lost main channel habitat with 1 acre of new channel habitat created by excavating alcoves to intercept cold water from groundwater or hyporheic flow
Temporary fish passage interruption at the FRE facility during construction	• Replace 5 fish passage barrier culverts on local roads within the upper Chehalis Basin with fish passable stream crossings
Episodic increases in turbidity when water is released from the temporary reservoir after storm events. An unspecified amount of sediment deposited within the temporary reservoir area would be remobilized and flushed downstream after the water level recedes.	• Implement 4 floodplain reconnection projects for a total of 2 miles of off channel aquatic habitat and 100 acres of riparian buffer including a mixture of wetlands and uplands) • 15 gravel retention jams each covering 900 linear ft of channel
Changes in the movement of sediment, large wood, nutrients, and water resulting in unquantified effects on fish habitat. Reduced ground water recharge due to decreased area of floodplain engagement during flooding.	• Implement 4 floodplain reconnection projects for a total of 2 miles of off channel aquatic habitat and 100 acres of riparian buffer including a mixture of wetlands and uplands) • Enhance instream habitat in 17 miles of stream and river channel by placement of 50 wood loading structures with substrate enhancement (assume 3 structures per mile for 17 miles) • Create 34 localized thermal refugia in the middle river and tributaries below the FRE. (e.g., 30 hyporheic exchange enhancements and 4 cold-water retention structures) – assume 2 structures per mile for 17 miles

Notes:
1. Some of the itemized impacts are collocated within the footprint of the temporary reservoir.
2. Some of the mitigation actions would address multiple impacts at the same sites.

Table 2

Estimated Mitigation Needs and In-basin Opportunities

MITIGATION ACTION TYPES	ESTIMATED NEED (JULY 2020)	ESTIMATED AVAILABILITY (FEBRUARY 2021)	ECOLOGICAL FUNCTIONS	SPECIES/LIFESTAGE BENEFIT	HABITAT MITIGATION NOTES
Riparian Buffer Expansion	17 miles	58.6 miles	Enhanced: shade, habitat structure and complexity, water quality filtering, localized temperature buffering, erosion protection, food resources and nutrient inputs, wildlife habitat	• Migrating juvenile and adult migrating salmon and steelhead • Rearing juvenile salmon and steelhead • Spawning salmon and steelhead and incubating eggs/embryos • Migrating, spawning adult Pacific lamprey • Rearing larval and juvenile Pacific lamprey • Foraging adult and juvenile native fishes • Spawning adult native fishes • Macroinvertebrate populations • Foraging, rearing and breeding amphibians • Foraging and nesting birds • Rearing and foraging wildlife	Mainstem and tributary sites are available. May include complete reforestation, expanded forested widths, and/or management of existing full-width riparian forest in perpetuity for riparian function. Maximum theoretical extent of potential length would include all channels capable of supporting riparian vegetation in the study area that are not of optimal width, native vegetation community, and/or conservation status.
Hyporheic Exchange Enhancements	9,000 ft	31,200 ft	Enhanced localized temperature refugia, buffering, nutrient cycling	• Rearing juvenile and migrating adult salmon, steelhead	Availability is controlled by valley form.

MITIGATION ACTION TYPES	ESTIMATED NEED (JULY 2020)	ESTIMATED AVAILABILITY (FEBRUARY 2021)	ECOLOGICAL FUNCTIONS	SPECIES/LIFESTAGE BENEFIT	HABITAT MITIGATION NOTES
				• Migrating adult and juvenile Pacific lamprey Migrating and holding, native fishes • Macroinvertebrate populations • Freshwater mussels • Foraging and breeding amphibians	
Cold-water Retention Structures	1,000 ft	19,250 ft	Enhanced localized temperature refugia	• Rearing juvenile and migrating adult salmon, steelhead • Migrating adult and juvenile Pacific lamprey Migrating and holding, native fishes • Macroinvertebrate populations • Freshwater mussels • Foraging and breeding amphibians	Availability is controlled by hillslope topography and geology.
Instream Modifications	17,500 ft	112,500 ft	Enhanced: increased habitat complexity and structure, increased holding and rearing pool habitat. substrate sorting for spawning habitat, erosion protection	• Migrating juvenile and adult migrating salmon and steelhead • Rearing juvenile salmon and steelhead • Spawning salmon and steelhead and incubating eggs/embryos	Maximum theoretical extent of potential length would include all fish-bearing channels in the study area that do not conform to all preference criteria of target species.

MITIGATION ACTION TYPES	ESTIMATED NEED (JULY 2020)	ESTIMATED AVAILABILITY (FEBRUARY 2021)	ECOLOGICAL FUNCTIONS	SPECIES/LIFESTAGE BENEFIT	HABITAT MITIGATION NOTES
				• Migrating, spawning adult Pacific lamprey • Rearing larval and juvenile Pacific lamprey • Foraging adult and juvenile native fishes • Spawning adult native fishes • Foraging and breeding amphibians	
Off-channel Modifications	8,000 ft	224,000 ft	Enhanced: habitat heterogeneity, flow distribution and erosion and scour protection, low-velocity habitat, sediment deposition, nutrient flux	• Rearing and outmigrating juvenile salmon and steelhead • Incubating eggs/embryos • Rearing larval and juvenile Pacific lamprey • Out-migrating Pacific lamprey • Rearing and foraging of native fishes • Macroinvertebrate populations • Freshwater mussels • Wildlife foraging	Availability is controlled by valley form.
Gravel Retention Jams	13,500 ft	28,800 ft	Enhanced: substrate sorting, spawning habitat, redd scour protection, pool habitat, cover, velocity heterogeneity,	• Migrating juvenile and adult migrating salmon and steelhead • Rearing juvenile salmon and steelhead	Maximum theoretical extent of potential length would include all identified spawning reaches in the study area that do not conform to all preference criteria of target species.

MITIGATION ACTION TYPES	ESTIMATED NEED (JULY 2020)	ESTIMATED AVAILABILITY (FEBRUARY 2021)	ECOLOGICAL FUNCTIONS	SPECIES/LIFESTAGE BENEFIT	HABITAT MITIGATION NOTES
				• Spawning salmon and steelhead and incubating eggs/embryos • Migrating, spawning adult Pacific lamprey • Rearing larval and juvenile Pacific lamprey • Foraging adult and juvenile native fishes • Spawning adult native fishes	
Fish Passage	5 barriers	23 barriers	Enhanced/new access: to spawning, rearing, holding habitat, velocity refugia	• Migrating juvenile and adult migrating salmon and steelhead • Rearing juvenile salmon and steelhead • Spawning salmon and steelhead and incubating eggs/embryos • Migrating, spawning adult Pacific lamprey • Rearing larval and juvenile Pacific lamprey • Foraging adult and juvenile native fishes • Spawning adult native fishes • Adult amphibians • Foraging wildlife	Availability is controlled by number of existing/inventoried barriers. Some private road crossing barriers may be missing from inventories. Additional opportunities may also include funding second-tier State of WA agency-owned or other barriers.

MITIGATION ACTION TYPES	ESTIMATED NEED (JULY 2020)	ESTIMATED AVAILABILITY (FEBRUARY 2021)	ECOLOGICAL FUNCTIONS	SPECIES/LIFESTAGE BENEFIT	HABITAT MITIGATION NOTES
Wetland Enhancement	1 location (3 acres)	35 locations	Enhanced: water quality filtering, temperature buffering, fine sediment capture, invertebrate production, nutrient reduction, erosion protection, hydrologic function	• Migrating juvenile and adult migrating salmon and steelhead • Rearing juvenile salmon and steelhead • Spawning salmon and steelhead and incubating eggs/embryos • Migrating, spawning adult Pacific lamprey • Rearing larval and juvenile Pacific lamprey • Foraging adult and juvenile native fishes • Spawning adult native fishes • Macroinvertebrate populations • Foraging, rearing and breeding amphibians including Western Toad • Foraging and nesting birds • Rearing and foraging wildlife	Availability is controlled by valley form, soils, and hydrology. See Wetland Mitigation Assessment.
Upland Conservation and Enhancement	2 locations (50 acres each)	10 locations (variable size >50 acres)	Enhanced: wildlife rearing, foraging and breeding habitat, terrestrial food inputs to aquatic habitat, shade and temperature buffering	• Adult amphibians • Foraging and nesting birds • Rearing, foraging and breeding wildlife	Maximum theoretical extent of potential area would encompass nearly all non-urban lands in the study area except those already in conservation land use type.

Figure 1
Project Vicinity

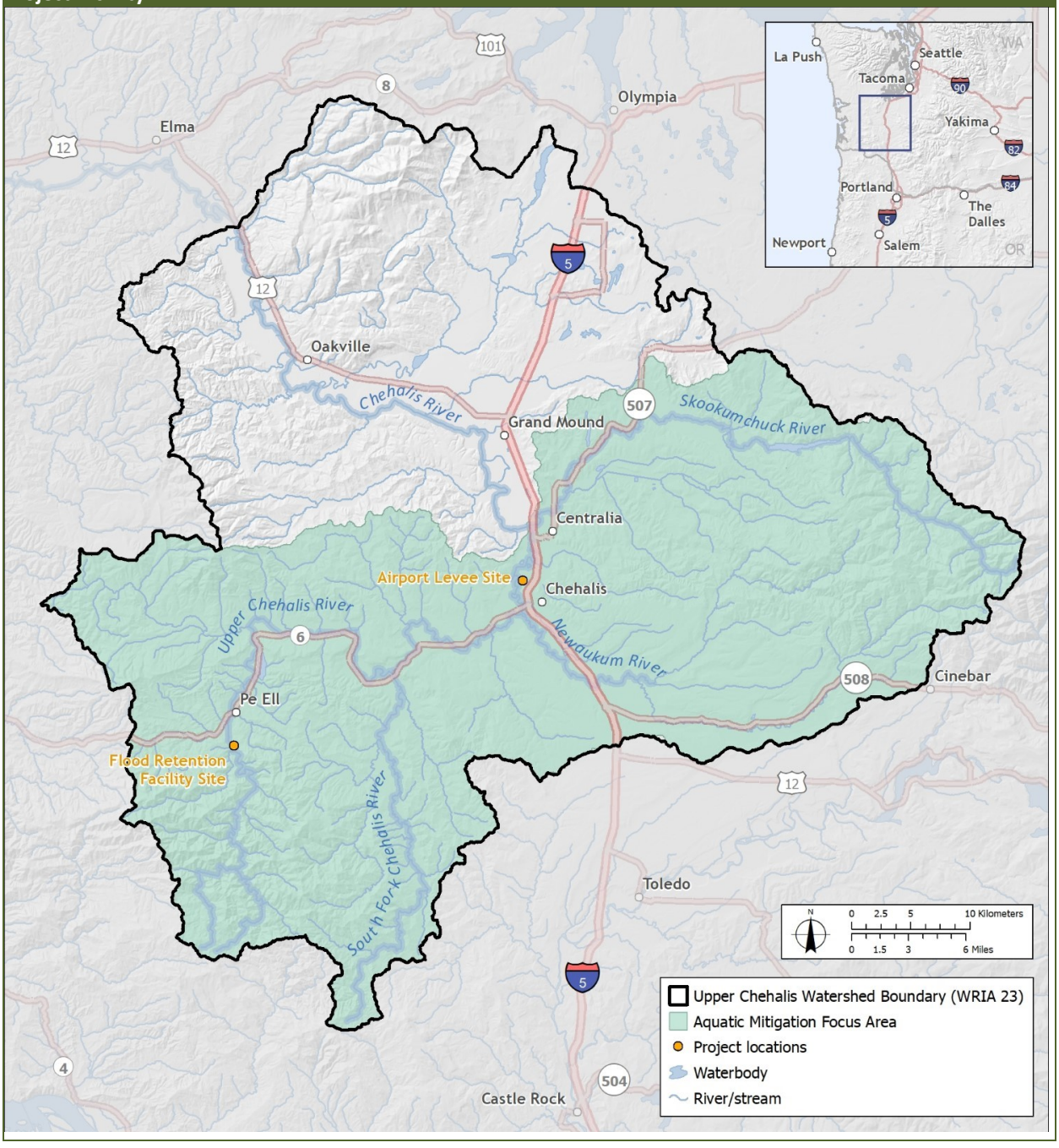
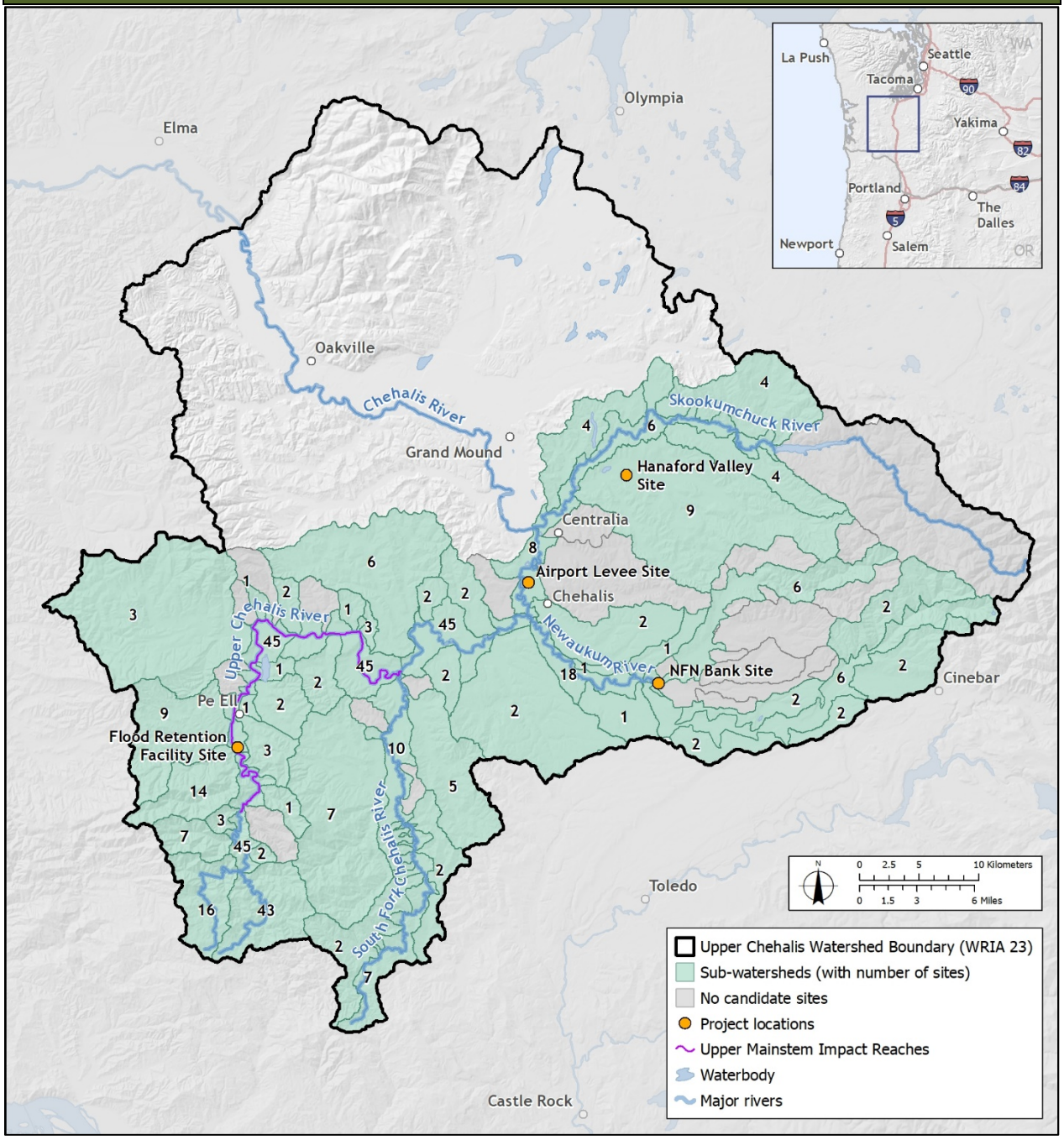


Figure 2
Geographic Extent of Mitigation Opportunities in the Upper Chehalis River Basin, Number by Subwatershed.



References

Anchor QEA, 2019. Chehalis River Basin Climate Change Flows and Flooding Results. Technical Memorandum prepared by Anchor QEA for Office of the Chehalis Basin dated 5/6/2019. Seattle, Washington. Available from: http://chehalisbasinstrategy.com/wp-content/uploads/2019/05/Climate_Change_Flows_Flooding05062019.pdf

Chehalis River Basin Flood Control Zone District (CFCZD), 2019. Chehalis River Basin Flood Damage Reduction Project – Project Description. CFCZD: Chehalis, Washington. Available from: http://chehalisbasinstrategy.com/wp-content/uploads/2018/09/FINAL-Chehalis-Dam-Airport-Levee-Descriptions_092718.pdf

HDR, 2017. Combined Dam and Fish Passage Design Conceptual Report. Prepared for the State of Washington Office of Financial Management and the Chehalis Basin Work Group. HDR: Bellevue, Washington. Available from: http://chehalisbasinstrategy.com/publications/

HDR, 2018. Chehalis River Basin Flood Control Combined Dam and Fish Passage Supplemental Design Report – FRE Dam Alternative. HDR, Inc.: Bellevue, Washington. Available from: http://chehalisbasinstrategy.com/wp-content/uploads/2018/09/FRE-Alternative-Supplemental-Report-2018-09-27-reduced.pdf

Kleinschmidt, 2020. Aquatic and Terrestrial Habitat Mitigation Opportunities Assessment Report. Report. Prepared by Kleinschmidt Associates, HydroGeoLogic, Inc., Stillwater Sciences, Biohabitats, Inc., and Ecological Engineering, LLC for the Chehalis River Basin Flood Control Zone District. July 22, 2020. 59p.

Liedtke, T.L., Hurst, W.R., Tomka, R.G., Kock, T.J., and Zimmerman, M.S., 2017, Preliminary evaluation of the behavior and movements of adult spring Chinook salmon in the Chehalis River, southwestern Washington, 2014: U.S. Geological Survey Open-File Report 2017-1004, 35 p., https://doi.org/10.3133/ofr20171004.

Mauger, G., S. Lee, C. Bandaragoda, Y. Serra, and J. Won, 2016. Effect of Climate Change on the Hydrology of the Chehalis Basin. Climate Impacts Group, University of Washington: Seattle, Washington. Available from: https://cig.uw.edu/wp-content/uploads/sites/2/2014/11/Final_Report_Chehalis_2016-07-08.compressed.pdf.

Office of the Chehalis Basin (OCB), 2019. Chehalis Basin Strategy Aquatic Species Restoration Plan – Phase 1 Draft Plan. Office of the Chehalis Basin: Olympia, Washington. Available from: http://chehalisbasinstrategy.com/asrp/asrp-phase-i-draft-plan/

U.S. Army Corps of Engineers (Corps), 2020. Chehalis River Basin Flood Damage Reduction Project, NEPA Environmental Impact Statement. Seattle, Washington. September 18, 2020. Available from: https://chehalisbasinstrategy.com/eis/nepa-process/

Washington State Department of Ecology (WDOE), 2020. State Environmental Policy Act Draft Environmental Impact Statement for Proposed Chehalis River Basin Flood Damage Reduction Project. Publication No. 20-06-002. February 27.

Washington State Department of Ecology (WDOE), 2016. Draft Programmatic Environmental Impact Statement (EIS) for Chehalis Basin Strategy. September 29.

Winkowski, J.J., E.J. Walther, and M.S. Zimmerman. 2018. Summer riverscape patterns of fish, habitat, and temperature across the Chehalis River basin. Washington Department of Fish and Wildlife. Olympia, Washington. FPT 18-01.