MEMORANDUM

Date: March 31, 2020
To: Chehalis Basin Board
From: Andrea McNamara Doyle, Office of Chehalis Basin Director
Cc: Gordon White and Diane Butorac, Department of Ecology; Michael Garrity and Celina Abercrombie, Department of Fish and Wildlife; Stephen Bernath, Department of Natural Resources; Bart Gerhart, Washington State Department of Transportation
Re: Response to Chehalis Basin Board Questions on the Chehalis River Basin Flood Damage Reduction Project

Introduction

The Department of Ecology (Ecology) released the Chehalis River Basin Flood Damage Reduction Project (Project) Draft State Environmental Policy Act (SEPA) Environmental Impact Statement (EIS) on February 27, 2020. Ecology briefed the Chehalis Basin Board (the Board) on the Draft SEPA EIS at the Board's March 5, 2020 board meeting. The purpose of the briefing was to provide the Board with information about the analysis and key findings contained in the Draft SEPA EIS. It was not a formal public hearing, and no comments on the Draft SEPA EIS were received.

At the briefing, Board Members asked questions and requested additional information about some of the analysis and findings in the Draft SEPA EIS. They also asked for clarification about how the Draft SEPA EIS analysis and findings compared or related to previous information that has been presented to the Board, such as from the Programmatic EIS and the Aquatic Species Restoration Plan Phase I document. Board Members have also expressed an interest in understanding more about the Draft SEPA EIS analysis and findings, and other Project effects, as part of their evaluation process for developing the long-term strategy.

The Office of Chehalis Basin has prepared this memorandum to provide responses to clarifying questions about the Project identified by Board members as important for their consideration of the Board's long-term strategy recommendation. The memorandum responds to clarifying questions about the Draft SEPA EIS analysis and findings raised at the March 5 meeting, as well as how that information compares or relates to other analyses and findings within the Programmatic EIS and other previous studies that have been presented to the Board (or its predecessor Governor's Work Group).

The information in this memorandum uses data directly from the Draft SEPA EIS, including the Draft EIS Chapters and related technical Discipline Reports in the Appendices.[1] Where necessary to answer the Board's questions, additional information from other referenced publicly available documents is also included. This memorandum is not a supplement or addendum to the Draft SEPA EIS. It is not a public comment on the Draft SEPA EIS.

[1] The Draft SEPA EIS states: "The EIS is organized to provide information in three ways. The Summary provides quick, high-level information on key findings and significant impacts. The Draft EIS chapters provide details on the EIS technical methods, impact analysis, and findings. Each EIS chapter for a resource has a related technical discipline report in the Appendices. The Discipline Reports include detailed and technical information. The Discipline Report is the official technical documentation for this EIS and if there is conflicting information between the Summary, EIS sections, or the Discipline Report, the Discipline Report is considered to be the controlling document" (p. 4).

Board Member's questions have been summarized and are listed below in bold, followed by responses from the Office of Chehalis Basin with input from Ecology and the Washington Department of Fish and Wildlife (WDFW). Every effort was made to ensure the information in this memorandum is consistent with the data in the Draft SEPA EIS. Any inconsistencies are the responsibility of the Office of Chehalis Basin, not Ecology or WDFW.

Responses to the Board Questions

1. Board Question: Clearly explain the flood events used to inform the analysis and the rationale for using the selected flood events.

Definition of major, catastrophic, and recurrent flood events

The Draft SEPA EIS analyzes probable significant adverse environmental impacts from the Proposed Action, the Local Actions Alternative, and the No Action Alternative under the following three flooding scenarios (flow rate is measured at the Grand Mound gage):

- Major flood: Water flow rate of 38,800 cubic feet per second (cfs) or greater
- Catastrophic flood: Water flow rate of 75,100 cfs
- Recurring flood: A major flood (38,800 cfs) or greater that occurs in each of 3 consecutive years

The EIS incorporates climate change projections for precipitation, temperature, flood peak flows, and streamflows throughout the analyses as part of the future conditions for all scenarios. There is no separate climate change chapter because projected climate changes have been included in the impact analyses for all resource areas (see Section 3.3 of the Draft SEPA EIS).

Definition of mid-century and late-century

If permitted, the Chehalis River Basin Flood Control Zone District (the Applicant) expects Flood Retention Expandable (FRE) facility construction would begin in 2025 with operations beginning in 2030, and the Airport Levee Changes construction would occur over a 1-year period between 2025 and 2030. The EIS analyzes probable adverse impacts from the Proposed Action and alternatives for construction during the years 2025 to 2030 and for operations from 2030 to 2080. For purposes of analysis, the term "mid-century" applies to the operational period from approximately 2030 to 2060. The term "late-century" applies to the operational period from approximately 2060 to 2080.

Effect of climate change on flood frequency and magnitude

As described in Appendix 1 of the Draft SEPA EIS, projected future climate conditions have been included in the impact analyses for resource areas to identify potential impacts. Data and models for predicted climate change conditions used in the EIS are from the University of Washington Climate Impacts Group, Watershed Science and Engineering, National Oceanic and Atmospheric Administration, Portland State University, and Anchor QEA, LLC.

The results of the most recent climate change precipitation modeling provide forecasted streamflow rates showing mid-century (2016 to 2060) peak flows would increase 12%, and late-century (2055 to 2099) peak flows would increase 26% (Anchor QEA and WSE 2019). To avoid bias in estimating streamflow under climate change for particular locations or gages, the adjustments to streamflow were applied to historical flows from active U.S. Geological Survey (USGS) gages basin-wide. This means the mid-century major and catastrophic floods were composed of the historical condition 10-year (major) and 100-year (catastrophic) floods with all flow values increased by 12%. Similarly, the late-century major and catastrophic floods were composed of the historical condition 10-year (major) and 100-year (catastrophic) floods with all flow values increased by 26%. The increased peak flows have been incorporated into the applicable EIS analyses. Both hourly and daily flows under future climate change conditions were developed for use in models, technical studies, and discipline reports.

With respect to frequency and magnitude of future flood events, there are several ways of describing the mid- and late-century flood events developed for the EIS (see Exhibit 3-1 of the Draft SEPA EIS, provided below). The historical 10-year flood will occur more frequently in the future and will be greater in magnitude. Note that the flow at various gages includes predicted climate change, which increases flow by 12% and 26% for mid- and late-century.

Exhibit 3-1 (Draft SEPA EIS)
Flood Level Terminology

QUALITATIVE TERM USED IN THE EIS	CHANCE OF OCCURRENCE IN 1 YEAR	ASSOCIATED FLOOD-YEAR TERM	FLOW AT (CFS)	OTHER NOTES
Major flood	Current: 14% Mid-century: 20% Late-century: 25%	Current: 7-year Mid-century: 5-year Late-century: 4-year	38,800 at Grand Mound gage	• **Similar Sized Chehalis Basin Floods for Reference** – 2009 flood
Catastrophic flood	Current: 1% Mid-century: 2% Late-century: 4%	Current: 100-year Mid-century: 44-year Late-century: 27-year	75,100 at Grand Mound gage	• **Similarity to Other Flood Plan Terminology (but the flow rates within plans are different)** – Comprehensive Flood Hazard Management Plans – Base flood level used by National Flood Insurance Program – High-risk FEMA flood zones – Special Flood Hazard Area on FEMA maps – Base flood level used by Lewis County floodplain development regulations • **Similar Sized Chehalis Basin Floods for Reference** – 1996 flood

Notes:
Mid- and late-century information is based on SEPA EIS analysis that incorporates climate change projections.

Was the 2007 flood used in the Draft SEPA EIS analysis?

The December 2007 flood was not used for any of the impact analyses completed for the Draft SEPA EIS. However, it was analyzed in the Programmatic EIS (Ecology 2017).

The catastrophic flood evaluated in the EIS is based on the Applicant's purpose for the Proposed Project, which is to reduce damage from a catastrophic flood. It is not intended to retain all the water from a larger event like the 2007 flood. In the case of a flood larger than the catastrophic flood, the temporary reservoir would hold about 65,000 acre-feet of water, and any additional water would flow over the emergency spillway of the FRE structure to the Chehalis River below (see Section 3.1 of the Draft SEPA EIS). Also see page 14 of this memorandum for additional detail.

2. Board Question: Summarize the potential benefits of the Proposed Action (e.g., flood retention facility) as compared to No Action Alternative for the following.

Transportation: I-5 and SR 6

Based on hydraulic modeling, the Proposed Action would reduce flooding at key transportation locations and would decrease the duration of roadway closures at most locations but most would remain inundated under the catastrophic flood, especially during late-century.

Interstate 5. Seven locations along Interstate 5 (I-5) or on its interchanges were reviewed in the Draft SEPA EIS. Modeling found that none of these locations would flood during a major flood under the No Action Alternative or Proposed Action. Modeling indicated that six of these locations would experience flooding under the No Action Alternative during a catastrophic flood. Under the Proposed Action, flooding would be eliminated in four of these six locations under the mid-century and one location under the late-century catastrophic flood. In other locations, flood depths would be reduced but may still result in road closures. Durations of flooding would be reduced by 8 to 39 hours in mid-century, and 5 to 20 hours in late-century. One location (I-5 interchange at NW Chamber of Commerce Way) would have reduced flood duration but would still have a flood duration of 48 hours during a late-century catastrophic flood (Appendix K of the Draft SEPA EIS).

The results for the interchange at NW Chamber of Commerce Way differ from the Programmatic EIS, which predicted that no flooding would occur at this location with the Proposed Action (flood retention facility and airport levee improvements). This is primarily due to the hydraulic modeling assumptions made in the Programmatic EIS versus the Draft SEPA EIS. The flood levels in the Draft SEPA EIS are different from the Programmatic EIS for three main reasons (see Section 5.1.2.2 of the Draft SEPA EIS):

1. Climate change predictions for more rain and bigger peak flows are included in the Draft SEPA EIS.
2. For the Programmatic EIS, a one-dimensional water model was used. For the Draft SEPA EIS, a two-dimensional model was used. It included topography (shape of the land) so this model is more detailed and precise.

3. Projects that were completed after the Programmatic EIS are included in the Draft SEPA EIS, including new airport pumps and culverts.

For the Programmatic EIS, it was assumed that the area around the Chehalis-Centralia airport would be fully protected by the airport levee improvements and additional walls and levees to the east side of I-5. For the Draft SEPA EIS, the Applicant did not propose additional protection east of I-5; therefore, the levee improvements would partially protect the airport area and I-5 at Chamber Way.

State Route 6. Six locations along State Route 6 (SR 6) were reviewed within the Draft SEPA EIS. Modeling indicated that two of these locations would experience flooding under the No Action Alternative during a major flood and five of these locations would experience flooding during a catastrophic flood. Under the Proposed Action, flooding would be eliminated in most locations during a major flood. Flooding would not be eliminated during a catastrophic flood, but it would be reduced at all locations. Modeled depths of flooding indicate some of these locations that would experience reduced flooding during a catastrophic flood would still experience road closures. Durations of flooding during a catastrophic flood would be reduced by 4 to 10 hours in mid-century, and 7 to 11 hours in late-century. Two locations (SR 6 near Twin Oaks Road and SR 6 and Heden Road) would have reduced flood duration but would still have a flood duration of up to 25 and 29 hours. See Figure K-7 and Tables K-8 and K-9 excerpts from the *Transportation Discipline Report* (Appendix K of the Draft SEPA EIS) that show SR 6 locations and their modeled flood depths and durations.

Excerpt from Table K-8 (Appendix K of Draft SEPA EIS)
Maximum Simulated Flood Depth for Transportation Facilities with Proposed Action and No Action Alternative (Feet) – I-5 and SR 6 Locations

	CATASTROPHIC FLOOD					
	MID-CENTURY			LATE-CENTURY		
LOCATION	NO ACTION	PROPOSED ACTION	DIFFERENCE	NO ACTION	PROPOSED ACTION	DIFFERENCE
INTERSTATE 5						
I-5 at Labree Road Interchange	0.0	0.0	0.0	0.0	0.0	0.0
I-5 at 13th Street Interchange	0.2	**0.0**	-0.2	0.5	**0.0**	-0.5
I-5 north of SW 13th Street Interchange (Exit 76)	1.8	0.7	-1.1	2.3	1.4	-0.9
I-5 at SR 6 Interchange	0.8	**0.0**	-0.8	1.2	0.5	-0.8
I-5 Interchange at NW Chamber of Commerce Way [6]	7.0	0.4	-6.6	8.4	4.7	-3.8
I-5 at Salzer Creek	1.1	**0.0**	-1.1	2.6	0.1	-2.4
I-5 at Mile Post 81	1.9	**0.0**	-1.9	3.2	0.3	-2.9
STATE ROUTE 6						
SR 6 and River Road	0.9	**0.0**	-0.9	2.2	**0.0**	-2.2
SR 6 and Boistfort Road	5.7	0.8	-4.8	7.5	1.8	-5.7
SR 6 and Spooner Road	0.0	0.0	0.0	0.0	0.0	0.0
SR 6 near Twin Oaks Road (600 feet west of intersection)	5.5	3.8	-1.6	6.0	4.5	-1.4
SR 6 and Heden Road	2.1	1.1	-1.0	2.6	1.5	-1.0
SR 6 and Donahoe Road	0.3	**0.0**	-0.3	0.5	0.1	-0.4

Notes:

6. Maximum simulated flood depths at I-5 near NW Chamber of Commerce Way are not thought to be affected by the fact that the culverts and pump station that drain this area are not included in the main stem RiverFlow2D model.

Bold and shading indicates locations where the flood depth is reduced to zero under the Proposed Action.

Excerpt from Table K-9 (Appendix K of Draft SEPA EIS)
Estimated Flood Duration at Transportation Facilities with Proposed Action and No Action Alternative (Hours) – I-5 and SR 6 Locations

LOCATION	CATASTROPHIC FLOOD					
	MID-CENTURY			LATE-CENTURY		
	NO ACTION	PROPOSED ACTION	DIFFERENCE	NO ACTION	PROPOSED ACTION	DIFFERENCE
INTERSTATE 5						
I-5 at Labree Road Interchange	0	0	0	0	0	0
I-5 at 13th Street Interchange	0	0	0	10	**0**	-10
I-5 north of SW 13th Street Interchange (Exit 76)	20	12	-8	25	20	-5
I-5 at SR 6 Interchange	9	**0**	-9	15	6	-9
I-5 Interchange at NW Chamber of Commerce Way[6,7]	52	13	-39	59	48	-11
I-5 at Salzer Creek	10	**0**	-10	18	**0**	-18
I-5 at Mile Post 81	14	**0**	-14	22	2	-20
STATE ROUTE 6						
SR 6 and River Road	4	**0**	-4	7	**0**	-7
SR 6 and Boistfort Road	15	6	-9	17	9	-8
SR 6 and Spooner Road	0	0	0	0	0	0
SR 6 near Twin Oaks Road (600 feet west of intersection)	31	22	-9	35	25	-10
SR 6 and Heden Road	34	24	-10	40	29	-11
SR 6 and Donahoe Road	5	**0**	-5	11	0	-11

Notes:

6. Flood durations at I-5 near NW Chamber of Commerce Way are affected by ponding within the airport levee. Flood duration results for this area were estimated using a modified version of the RiverFlow2D model that includes the pumps and culverts. The analysis does not, however, include small-scale drainage features such as storm drains and ditches.
7. The flood duration for the late-century catastrophic flood with the Proposed Action at I-5 near NW Chamber of Commerce Way was simulated using a test version of the model that attempts to simulate the drawdown after the peak of the flood. The level of accuracy of this duration analysis is uncertain.

Bold and shading indicates locations where the flood depth is reduced to zero under the Proposed Action. Note that a duration of zero means water never reaches a depth of 0.25 feet (or 3 inches).

Figure K-6 (Appendix K of Draft SEPA EIS)
Locations Evaluated for Flooding at I-5 and Interchanges

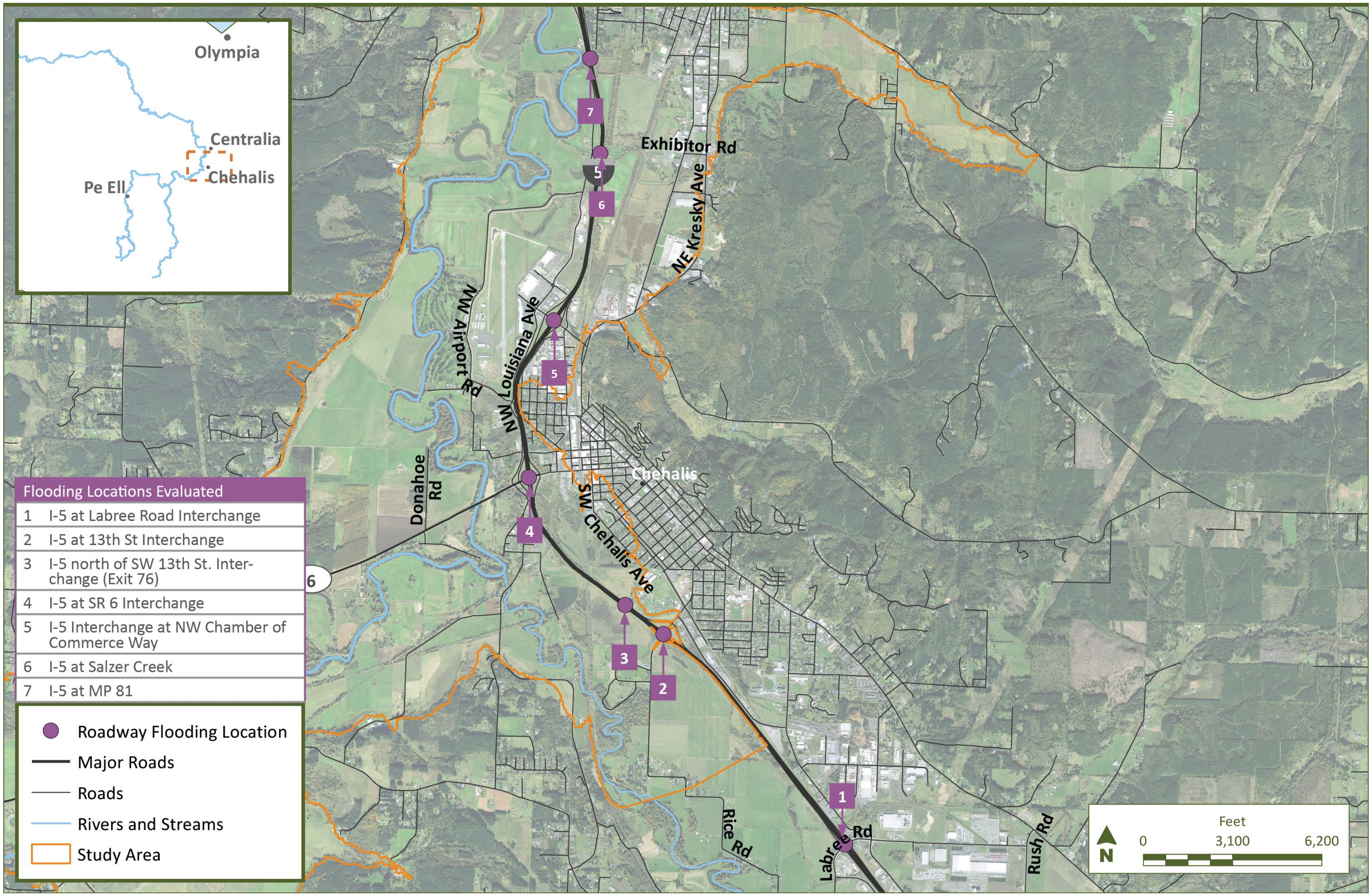
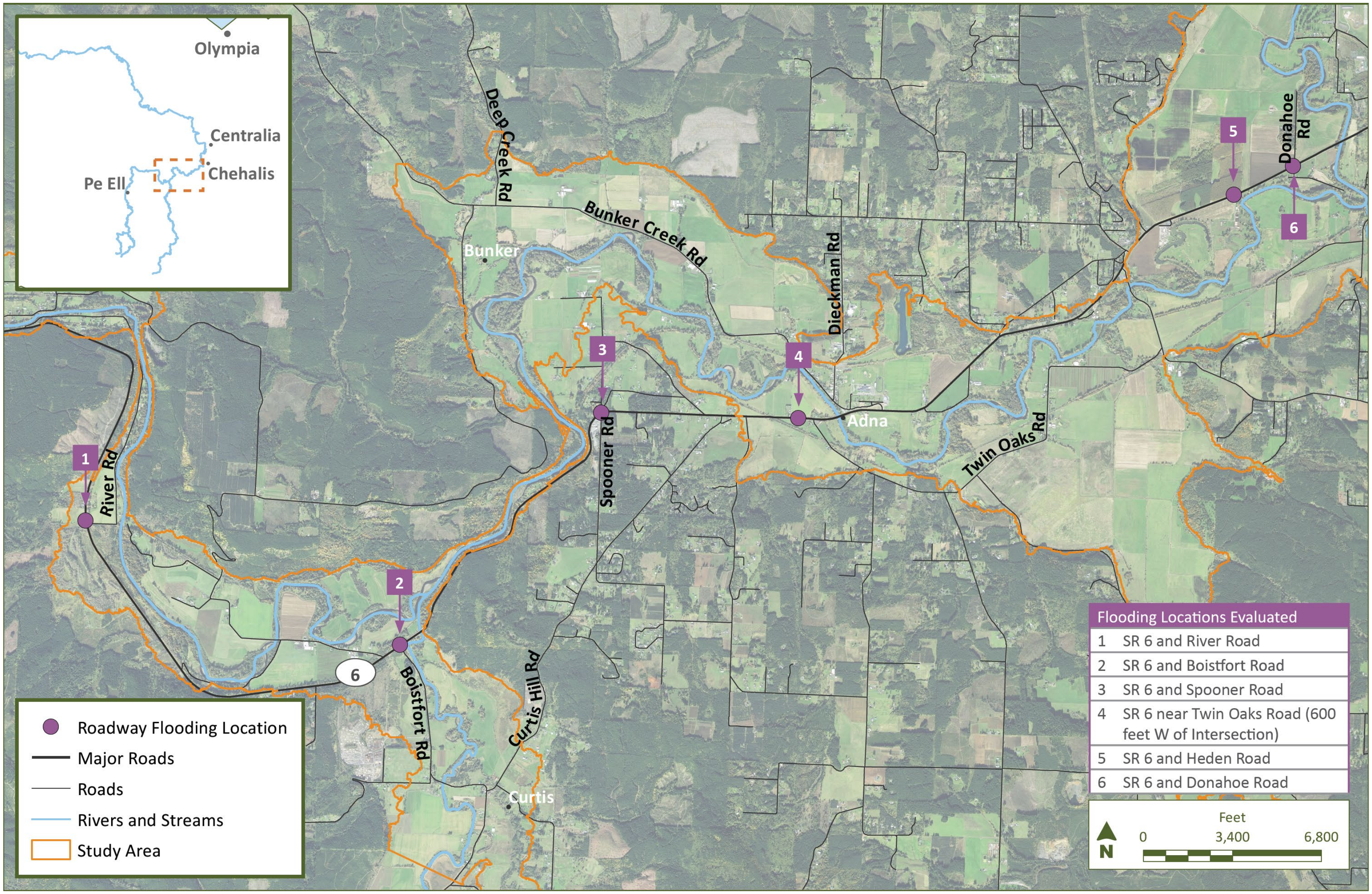


Figure K-7 (Appendix K of Draft SEPA EIS)
Locations Evaluated for Flooding at State Route 6



Flooding Locations Evaluated	
1	SR 6 and River Road
2	SR 6 and Boistfort Road
3	SR 6 and Spooner Road
4	SR 6 near Twin Oaks Road (600 feet W of Intersection)
5	SR 6 and Heden Road
6	SR 6 and Donahoe Road

Land use – structures no longer flooded

The Draft SEPA EIS found that, with the Proposed Action, 1,280 existing structures of value and approximately 3,795 acres would be protected from flooding risk during a catastrophic flood in the late-century. Approximately 13% of the acres predicted to be no longer inundated are within incorporated city limits (approximately 500 to 600 acres) and many residential areas within the City of Centralia (Appendix G of the Draft SEPA EIS). The Draft SEPA EIS also found that the Proposed Action would reduce the number of valuable structures currently exposed to flooding inundation during catastrophic floods by 50% in the mid-century and by 43% in the late-century. For information on areas that would still experience flooding with the Proposed Action, please refer to Appendix G of the Draft SEPA EIS.

Within the Draft SEPA EIS study area, changes in downstream inundation were analyzed to evaluate the effects on existing land uses with the Proposed Action. The degree of reduction in inundation would vary by flood scenario and location for both major and catastrophic flood scenarios. Under a late-century major flood, areas no longer inundated are largely near the confluence of the South Fork Chehalis River (between Bunker and Littell), in Centralia (west of Fort Borst Park), and in smaller areas downstream to Oakville (Section 5.7.2.3 of the Draft SEPA EIS). Under a late-century catastrophic flood, much of the study area from Pe Ell to just upstream of the South Fork Chehalis River would no longer be inundated. Many residential areas within the City of Centralia are predicted to be protected from flooding and many residential areas within the City of Chehalis would experience a reduction in inundation levels. The Chehalis-Centralia Airport would be protected from flooding under a mid-century catastrophic flood scenario but would not be protected from flooding under a late-century catastrophic flood scenario (Section 5.7.2.3 of the Draft SEPA EIS).

Under the No Action Alternative, 366 buildings would likely be inundated to some level in mid-century and 517 buildings would likely be inundated in late-century for major floods. For catastrophic floods, 2,245 buildings would likely be inundated to some level in mid-century and 2,955 buildings in late-century. The Programmatic EIS found that, for a catastrophic flood, 1,379 structures could be inundated.

Table 1 compares the number of structures that would no longer be inundated under the major and catastrophic flood scenarios compared to the No Action Alternatives using data from Tables G-9a, G-9b, G-10a, and G-10b in the *Land Use Discipline Report* (Appendix G of the Draft SEPA EIS). Results from the Programmatic EIS structure evaluation are also included for comparison (Ecology 2017).

Table 1
Number of Structures No Longer Inundated Under Various Flood Scenarios

STRUCTURE	MAJOR FLOOD		CATASTROPHIC FLOOD		PEIS[1] (100-YEAR FLOOD WITHOUT CLIMATE CHANGE)
	MID-CENTURY	LATE-CENTURY	MID-CENTURY	LATE-CENTURY	
Structures with Identified Finished Floor Elevations that are No Longer Inundated	35	44	836	1,036	559[2]
Structures without Identified Finished Floor Elevations that are No Longer Inundated	91	104	299	244	N/A
Total Structures that are No Longer Inundated	**126**	**148**	**1,135**	**1,280**	**559**

Notes:
1. PEIS: Programmatic Environmental Impact Statement
2. For the PEIS analysis, if structures had an identified finished floor elevation, it was used to identify inundation depths. If a finished floor elevation was not identified, the ground elevation was used to identify inundation depths.

For purposes of the Draft SEPA EIS evaluation, finished floor elevation is the elevation of the lowest finished floor of valuable structures calculated by the estimated height of the finished floor above ground level. The finished floor elevation is used to identify inundation depth under different flood scenarios. For those structures where finished floor elevation estimations were not available, inundation depth was calculated based on modeled inundation depth at ground elevation for a structure's location. If a structure with an identified finished floor elevation is no longer flooded, that means that flood levels will not rise to the level of the finished floor. It is possible that a structure could still experience flooding in this scenario, but flooding would be below the finished floor elevation. If a structure without an identified finished floor is no longer flooded, that means that flood levels will not reach the ground elevation of the structure.

Based on the information in the Draft SEPA EIS, some of the structures where finished floor elevations were not identified may benefit from the FRE facility if their finished floors are higher than the ground elevation.

What are the locations where lower income housing and/or rental structures are affected?

Based on information in the Draft SEPA EIS, the Proposed Action, in comparison to the No Action Alternative, would have a reduction in flood risk to environmental justice populations of interest in the study area from a major or catastrophic flood. The environmental justice analysis relies on data from the U.S. Census Bureau's 2013 to 2017 American Community Survey 5-year estimates to identify the locations of low-income populations. Additional information on economics characteristics from the Washington Department of Health was also considered. These sources do not indicate specific locations of lower income housing or rental structures, but those types of housing are likely also found in the block groups where these populations are indicated. Figures D-4 and D-5 from the *Environmental Justice Discipline Report* (Appendix D of the Draft SEPA EIS) show the locations of low-income populations in Census block groups that intersect the Study Area, which are also locations where lower income housing and rental structures can be assumed.

As noted in the previous sections of this memorandum, the degree of reduction in inundation would vary by flood scenario and location for both major and catastrophic flood scenarios. Areas that include environmental justice populations of interest and that would no longer be inundated under a late-century major flood are largely in Centralia (west of Fort Borst Park) and in smaller areas downstream to Oakville (see Section 5.7.2.3 of the Draft SEPA EIS). Under both late-century major and catastrophic floods, many residential areas within the City of Centralia that include environmental justice populations of interest are predicted to be protected from flooding and many residential areas within the City of Chehalis that include environmental justice populations of interest would experience a reduction in inundations. However, many structures (including residences) would continue to experience substantial flood risk, including in areas that have environmental justice populations of interest. As noted in the previous sections of this memorandum, for purposes of the Draft SEPA EIS evaluation, predictions of structures that would be protected from flooding are based on the finished floor elevation where available (i.e., if a structure with an identified finished floor elevation is no longer inundated, that means that flood levels will not rise to the level of the finished floor). Where finished floor elevations were not available, predictions of structures that would be protected from flooding indicate flood levels would not rise to the ground elevation at that structure's location.

Figure D-4 (Appendix D of Draft SEPA EIS)
Low-Income Populations in Study Area Block Groups

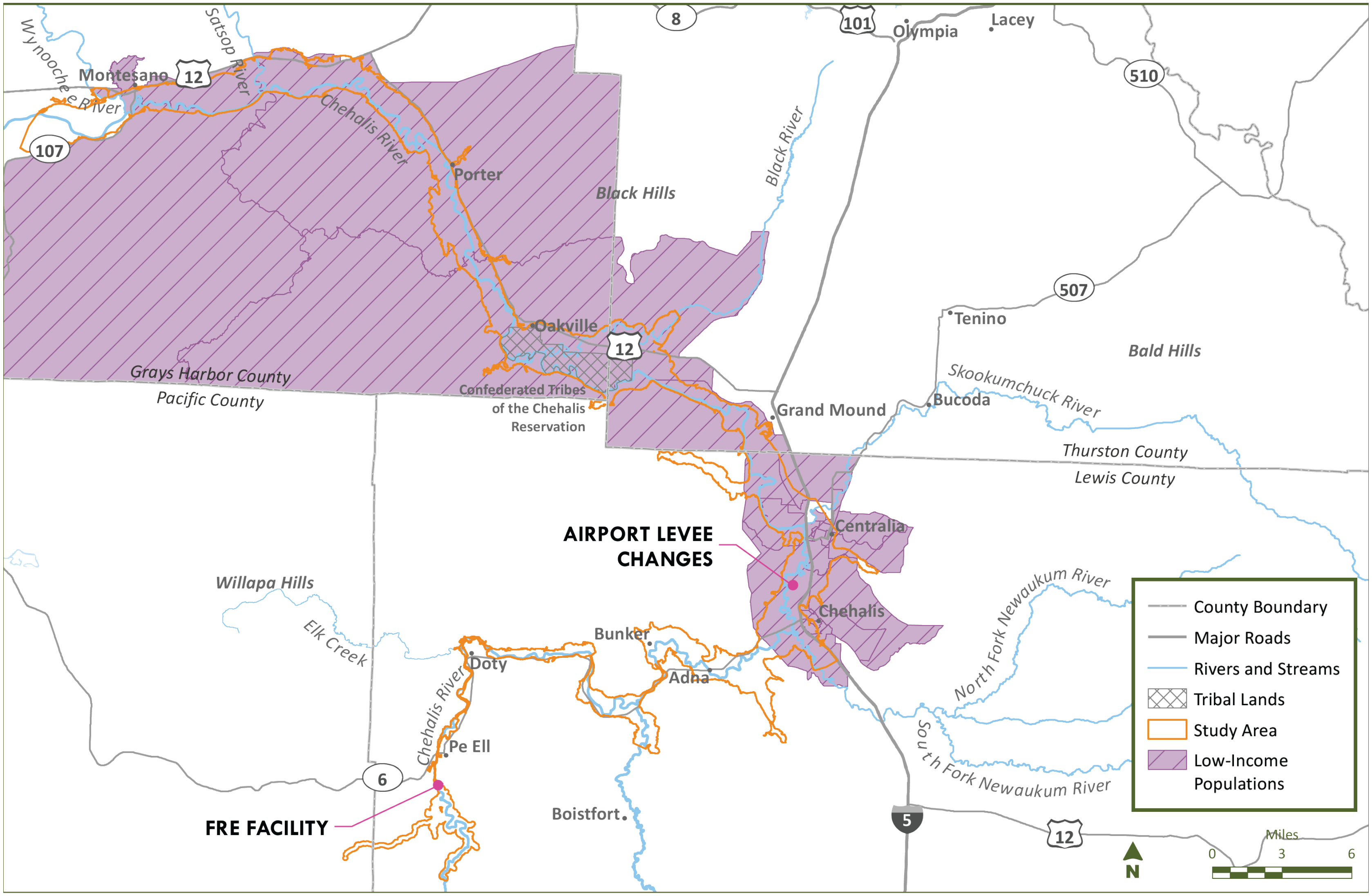
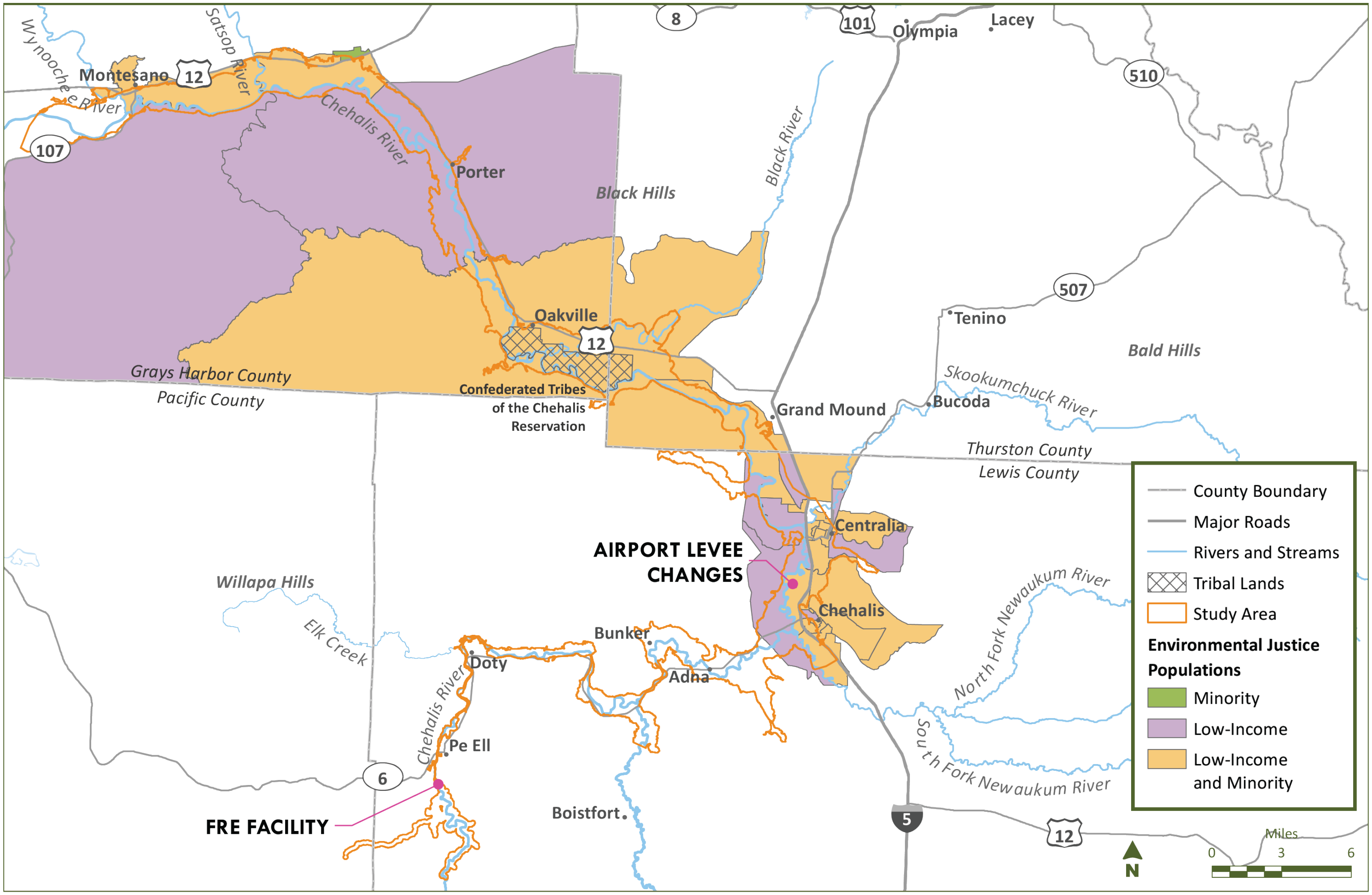


Figure D-5 (Appendix D of Draft SEPA EIS)
Environmental Justice Populations in the Study Area



Note: Although Census Tract 950400 Block Group 2 also includes minority populations, it is not shown on this figure because the small portion of the Block Group overlapping the Study Area is managed forest where people do not live.

For the dam operation, what is the dam's ability to contain floods larger than the 2007 flood, per the Operations Plan, and catastrophic flood into the future (mid-century and late-century)?

The Draft SEPA EIS does not provide specific details on the FRE function with a scenario that replicated 2007 conditions. While the flood retention facility has the capacity to retain the 2007 flood event without spilling water per the *Operations Plan for Flood Retention Facilities* (Anchor QEA 2017a), this plan did not include updated climate change predictions. As described in Section 5.1.2.2 of the Draft SEPA EIS, the temporary reservoir would be able to hold the 65,810 acre-feet of water expected for a catastrophic flood. Flows above the temporary reservoir's design capacity of 66,360 acre-feet would spill over the top of the structure using an emergency spillway.

As described in Section 3.1 of the Draft SEPA EIS, the 2007 flood event was an atmospheric river (pineapple express) event with extremely high rainfall concentrated in the Willapa Hills. This event affected the Chehalis River mainstem and South Fork, with far less rainfall to the east in the Skookumchuck River Basin. The USGS gage for Grand Mound read 79,100 cfs for the 2007 flood; however, peak flows at the Doty gage were estimated at 52,600 cfs, almost double the next highest flood in the 74-year record. This flood is approximately a 500-year flood with a 0.2% chance of occurring in a year (at the Doty gage).

For the late-century catastrophic flood scenario in the Draft SEPA EIS, rainfall and runoff projections are modeled statistically throughout the Chehalis River Basin, with peak flows distributed in all areas in the basin, and not focused on a particular area. Because rain for the 2007 flood event was focused in one area, the estimated peak flows in 2007 are higher at Doty than peak flows under the late-century catastrophic flood scenario, but lower at Grand Mound. So, while the numbers at the Grand Mound gage are similar, the 2007 flood was much larger than the catastrophic flood modeled for the EIS.

3. Board Question: Describe discrete impacts from the flood retention facility on salmonid populations separate from the No Action Alternative.

What is the incremental impact on salmonid abundance that would result from the flood retention facility (construction and operation) at mid and late century as compared to the predicted condition of salmonid abundance under the No Action Alternative (which includes the effects of climate change)? What contributes to the differences? Why is the percentage impact of the flood retention facility at mid-century greater than at late century? Are there differences between the integrated model results and EDT results? Are there differences between the integrated model results for ASRP versus SEPA EDT results on both a basin-wide and sub-basin level? If so, what is important to understand about the differences?

The analysis of impacts to salmonids for the Draft SEPA EIS did not include the effects from implementing the Aquatic Species Restoration Plan (ASRP) or from actions to mitigate the impacts identified in the Draft SEPA EIS. The relationship between the impacts of the Proposed Action, compensatory mitigation for the Proposed Action, and the ASRP will be assessed as part of the Chehalis Basin Strategy by the Chehalis Basin Board in the summer and fall of 2020. Decisions by the Board regarding the Chehalis Basin Strategy could have significantly different outcomes for salmonids depending on what actions are taken and when they are taken.

The Draft SEPA EIS evaluated the effects of the No Action Alternative and Proposed Action Alternative on salmonids by assessing the effects on spring-run and fall-run Chinook salmon, coho salmon, and steelhead within two spatial units directly related to the proposed FRE facility: Rainbow Falls to Crim Creek (below the proposed FRE facility) and Above Crim Creek (above the proposed FRE facility). Two analytical models were used. The first was the Ecosystem Diagnostics and Treatment (EDT) model, which was also used in the Programmatic EIS and is being used to estimate effects of ASRP scenarios. EDT estimates the productivity of habitat for salmonids under a specific set of modeled conditions.

A second approach was developed for the Draft SEPA EIS that incorporates salmon population dynamics and the probability of FRE flood retention events on salmonids over time. This integrated the EDT model with a salmonid life cycle model developed by the National Oceanic and Atmospheric Administration (NOAA) and simulated changes in salmonid population abundance from the current time period through late-century. This second model was termed the EDT-NOAA integrated model, or simply the integrated model. Results from both modeling approaches are reported in the Draft SEPA EIS because both models provide different types of information that were used to inform the effects of the Proposed Action. The characterization of trends in salmonid abundance through time in the Draft SEPA EIS relied primarily on integrated model results. This is because the integrated model provided both estimates of abundance and variability around the estimates by conducting multiple model runs that incorporate the probability of flood retention events occurring, and the integrated model could be used to simulate the effects of a worse-case scenario on salmonids if a major flood occurred 3 years in a row.

Four parameters were developed by NOAA Fisheries scientists to evaluate salmonid population viability: abundance, spatial structure, productivity, and diversity (McElhaney et al. 2000). Abundance is often the key parameter of interest and is discussed here in response to the Board's question. The other three parameters are discussed in the following question.

Figures 1 and 2 show estimated impacts on salmon and steelhead under the No Action Alternative and Proposed Action in mid-century and late-century, both of which included predicted climate change. These figures present the changes in abundance based on integrated model results for the two spatial units assessed and provide a visual depiction of the changes through time. These figures report the results of Exhibits 5.3-3, 5.3-4, 5.3-6, and 5.3-7 of the Draft SEPA EIS, but in a different format for comparison of the No Action Alternative to the Proposed Action. The relative changes in salmonid abundance are also presented in the Draft SEPA EIS as tables and are included after the figures.

Figure 1
Estimated Abundance Impacts Above Crim Creek from the Proposed Action and No Action Alternative

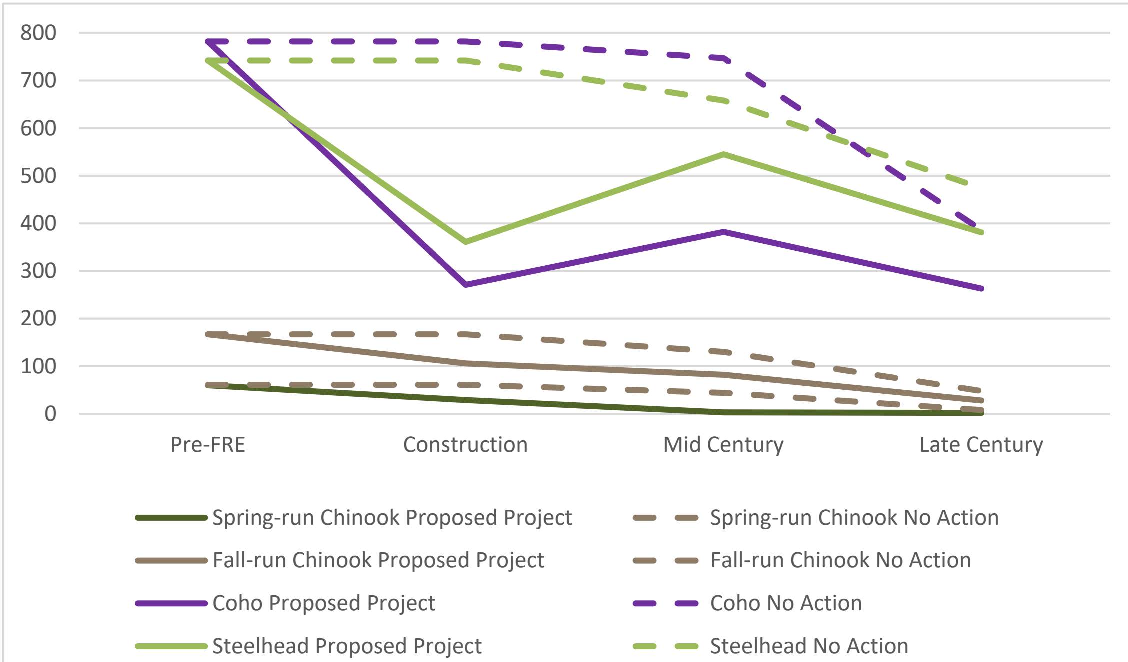
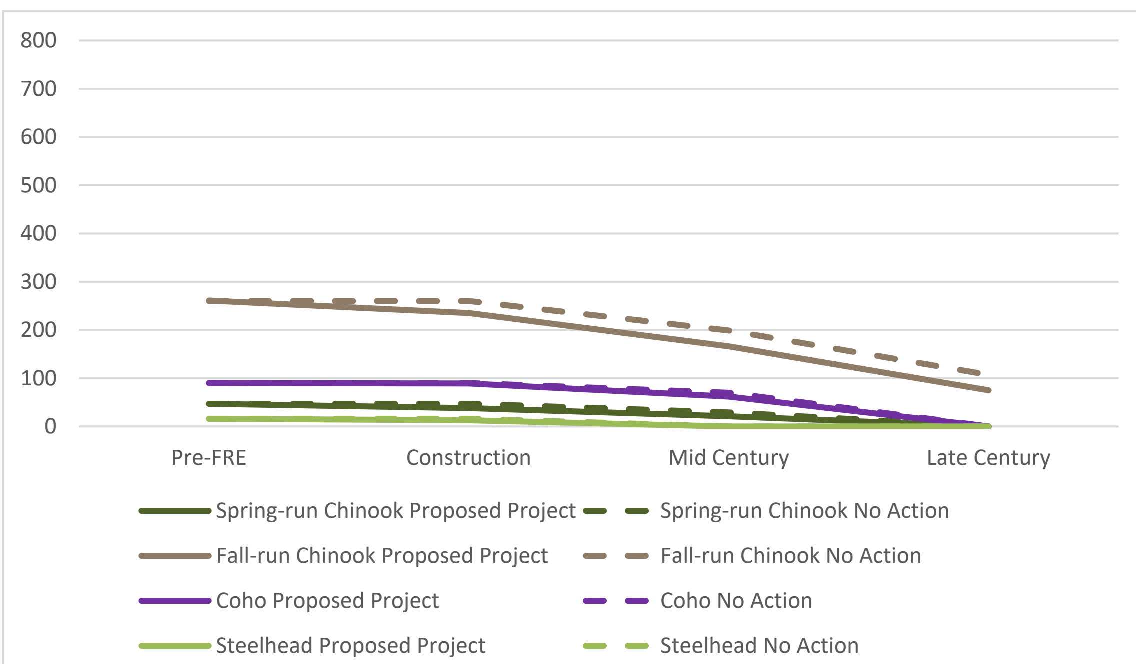


Figure 2
Estimated Abundance Impacts Crim Creek to Rainbow Falls from the Proposed Action and No Action Alternative



The effects of the Proposed Action and FRE facility alone presented in the figures above include the effects of constructing and operating the FRE facility under the typical (2-year), major (10-year), and catastrophic (100-year) flood conditions modeled. The Draft SEPA EIS discusses the effects of construction alone on salmonids because of the large effect the action had on estimated abundance. Results of the construction period from both the EDT model and integrated model were provided in Table E-10 (Appendix E of the Draft SEPA EIS). Results differ for construction between the EDT model and the integrated model because the EDT model reported abundance under the construction condition at equilibrium (which would occur at some time in the future), while the integrated model confined the effect to the 5-year construction period. Also, the integrated model allows fish born prior to construction to return as adults during construction. Both of these factors resulted in the changes in estimated abundance based on the integrated model being less than those based on the EDT model, so both sets of data were provided in Table E-10 (Appendix E of the Draft SEPA EIS).

Table E-10 (Appendix E of Draft SEPA EIS)
Change in Estimated Abundance of Salmon and Steelhead During Construction of the Proposed FRE Facility

SPECIES	ABOVE CRIM CREEK		RAINBOW FALLS TO CRIM CREEK	
	INTEGRATED MODEL	EDT	INTEGRATED MODEL	EDT
Spring-run Chinook salmon	-52%	-84%	-19%	-29%
Fall-run Chinook salmon	-37%	-45%	-10%	-13%
Coho salmon	-65%	-81%	-1%	-3%
Steelhead	-51%	-54%	-19%	-42%

The Draft SEPA EIS analysis incorporated many factors into the Proposed Action and No Action Alternatives included the effects of the FRE facility with future conditions to identify the impact analysis of the Proposed Action. To answer the Board's question, and using information presented in Tables E-11 and E-23 (Appendix E of the Draft SEPA EIS), the effect of the FRE facility alone can be approximated by subtracting the changes in abundance under the No Action Alternative from those estimated for the Proposed Action. This allows the effect of the FRE facility to be computed from model results and provides information on the effects of the FRE facility alone on salmonids in mid-century and late-century. The differences between Tables E-11 and E-23 are presented in Table 2.

Table 2
Overall Change in Estimated Abundance of Salmon and Steelhead Between the Proposed Action and the No Action Alternatives in Mid-Century and Late-Century

SPECIES	ABOVE CRIM CREEK		RAINBOW FALLS TO CRIM CREEK	
	MID-CENTURY	LATE-CENTURY	MID-CENTURY	LATE-CENTURY
Spring-run Chinook salmon	-67%	-10%	-17%	0%
Fall-run Chinook salmon	-29%	-12%	-12%	-12%
Coho salmon	-47%	-15%	-9%	0%
Steelhead	-16%	-13%	0%	0%

The information represents the computed change in salmonid abundance that occurred from the FRE facility alone when the results from the No Action Alternative are subtracted from the Proposed Action (Proposed Action - No Action). For example, for spring-run Chinook salmon in the Above Crim Creek spatial unit in late-century, there was a 97% decrease in estimated abundance under the Proposed Action (Table E-11) and a 87% decrease under the No Action Alternative (Table E-23). Thus, the effect of the FRE facility alone was an additional 10% decrease in the abundance of this species in this spatial unit in this timeframe when compared to the No Action Alternative.

Table 2 provides information on the change in projected fish abundance and how the effects vary among species and between the two time periods modeled. In the Rainbow Falls to Crim Creek spatial unit, values of 0 indicate no additional change in abundance is estimated from the FRE facility alone. This occurred when the change in estimated abundance was 100% under both alternatives, meaning the fish were eliminated from the unit under the No Action Alternative and the Proposed Action had no additional effect. The data in Table 2 indicate a general pattern where the effects of the FRE facility alone are greatest in mid-century but decrease in late-century due to the increased impacts of climate change on salmonids in late-century.

Regarding differences between the integrated model results for the ASRP versus the Draft SEPA EIS EDT model, the ASRP did not use the integrated model developed for the Draft SEPA EIS. Instead, the EDT model was used to assess the ASRP scenarios. The baseline assumptions in the ASRP and the EIS also differed. In addition, the ASRP assumed substantial restoration throughout the basin by late-century, including within the Project Area, which was not included in the EIS, while the EIS included the Proposed Project, which was not included in the ASRP.

Regarding changes in abundance at broader spatial scales such as the Chehalis Basin, these were not analyzed as part of the Draft SEPA EIS. Changes were analyzed at broader scales under the Programmatic EIS. Results of EDT modeling conducted to evaluate Alternative 1 are presented in Table 5.3-4 of the Programmatic EIS. Decreases in estimated abundance among Chinook salmon, coho salmon, and steelhead for the flood retention only alternatives evaluated (i.e., without habitat restoration) ranged from less than 1% to 4% at the Chehalis Basin scale. It is important to note that the assumptions and modeling approaches were different between the Programmatic EIS and Draft SEPA EIS.

What is the effect of the flood retention facility on VSP parameters for salmon populations both in the project impact area and basin-wide? How is this differentiated between species? For example, please clarify the following from the EIS "The modeling predicts that the Proposed Project would reduce the genetic diversity within and among salmon populations of each species across the Chehalis Basin."

In the Draft SEPA EIS, the effects of the Proposed Action and No Action Alternative were evaluated using the following Viable Salmonid Population (VSP) metrics originally developed by NOAA Fisheries (McElhany et al. 2000). These are defined as follows:

- Abundance: the number of adult fish returning to the basin in the absence of harvest
- Productivity: the density-independent survival rate from spawner to progeny (returns per spawner)
- Diversity: the breadth of potential fish performance across the modeled life-history variation
- Spatial structure: the pattern of estimated fish abundance across the Chehalis Basin

Taken together, the four parameters provide information on the number of fish returning to a basin, the ability of the habitat they depend on to support the population, and the complexity of the population. Increased complexity helps buffer the population from environmental variability and human-caused stressors. Changes in abundance for the Project Area were discussed above. Effects on spatial structure, productivity, and diversity are also addressed in detail in Appendix E, Section 3.2.3.2.2.5, of the Draft SEPA EIS. Information on these three parameters is summarized for the Board in the following sections.

The information on all four parameters was used in assessing the effects of the Proposed Action and No Action Alternatives on salmonids in the Draft SEPA EIS because they each provide important, but different, information on aspects of a population's response. The Draft SEPA EIS went into more detail on these parameters than was done in the Programmatic EIS, which focused only on changes in salmonid abundance.

Spatial Structure

The Project Area in the Above Crim Creek Subbasin represents a significant proportion of the salmon and steelhead spawning in the upper Chehalis Basin. In addition, a large fraction of salmon and steelhead spawn in the proposed FRE facility inundation area. Specifically, between 2013 and 2017, 93%, 86%, 39%, and 33% of all spring-run Chinook salmon, fall-run Chinook salmon, coho salmon, and steelhead redds, respectively, surveyed in the Chehalis River above Crim Creek were located in the reservoir inundation area (Ashcraft et al. 2017). Therefore, impacts associated with the inundation area represent significant impacts to the spatial structure of salmon and steelhead in the upper Chehalis Basin. The No Action Alternative and Proposed Action, which include climate change, would decrease the spatial structure of populations in the basin.

The decline in spatial structure for spring Chinook salmon is important because: 1) spring Chinook salmon are the least abundant anadromous salmonid in the Chehalis Basin due to habitat constraints (based on EDT model results); 2) their spatial distribution in the basin is limited; and 3) there are possible genetic issues related to fall-run Chinook salmon breeding with spring-run Chinook salmon. There are six spring-run Chinook salmon populations delineated in EDT, two of which are in the Project Area. Both populations within the Project Area were almost entirely eliminated by late-century within the EDT analysis, due to predicted climate change and the Proposed Action. The research that informed the ASRP indicated that the Willapa Hills area of the Upper Chehalis River (south of Pe Ell, including the East Fork and West Fork Chehalis rivers and other major tributaries), is no longer a stronghold for spring-run Chinook salmon. Recent observed returns of spring-run Chinook salmon to the Project Area have been very low (Ronne 2019). However, the area has supported greater abundance of spring-run Chinook salmon in the recent past under habitat conditions that are not markedly different from current conditions. Given the restricted current distribution of the species in the Chehalis Basin, habitat within the Project Area is important to the spatial structure and viability of this species (Appendix E, Section 3.2.2.1, of the Draft SEPA EIS).

Productivity

Another VSP parameter is productivity. In the EDT model, life history trajectories with a productivity that is less than 1 are considered non-sustainable. Productivity values estimated by the EDT model for the Current Condition, Proposed Action Alternative, and No Action Alternative are shown below (note that the table numbering is identical to Appendix E of the Draft SEPA EIS). The information has been reorganized to present side-by-side comparisons of changes in productivity associated with the Proposed Action compared to the No Action Alternative in late-century. The tables show reductions in the productivity of all four species in both Rainbow Falls to Crim Creek and Above Crim Creek spatial units when the Proposed Action is compared to current conditions and to the No Action Alternative in late-century.

Excerpt from Tables E-24 and E-16 (Appendix E of Draft SEPA EIS)
Estimated Spring-Run Salmon Productivity (Returns per Spawner) by Subbasin under the No Action Alternative and Proposed Action in Late-Century

FLOW SCENARIO	NO ACTION ALTERNATIVE (LATE-CENTURY)		PROPOSED ACTION (LATE-CENTURY)	
	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK
Typical seasonal flood	0.10	2.01	0.00	0.02
Major flood	0.10	2.01	0.00	0.00
Catastrophic flood	0.10	2.01	0.00	0.00

Excerpt from Tables E-24 and E-16 (Appendix E of Draft SEPA EIS)
Estimated Fall-Run Salmon Productivity (Returns per Spawner) by Subbasin under the No Action Alternative and Proposed Action in Late-Century

FLOW SCENARIO	NO ACTION ALTERNATIVE (LATE-CENTURY)		PROPOSED ACTION (LATE-CENTURY)	
	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK
Typical seasonal flood	3.39	3.18	0.09	0.04
Major flood	3.40	2.90	0.07	0.02
Catastrophic flood	3.40	2.68	0.07	0.02

Excerpt from Tables E-25 and E-17 (Appendix E of Draft SEPA EIS)
Estimated Coho Salmon Productivity (Returns per Spawner) by Subbasin under the No Action Alternative and Proposed Action in Late-Century

FLOW SCENARIO	NO ACTION ALTERNATIVE (LATE-CENTURY)		PROPOSED ACTION (LATE-CENTURY)	
	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK
Typical seasonal flood	0.12	2.67	0.00	0.08
Major flood	0.12	2.67	0.00	0.09
Catastrophic flood	0.12	2.67	0.00	0.07

Excerpt from Tables E-25 and E-17 (Appendix E of Draft SEPA EIS)
Estimated Winter Steelhead Productivity (Returns per Spawner) by Subbasin under the No Action Alternative and Proposed Action in Late-Century

FLOW SCENARIO	NO ACTION ALTERNATIVE (LATE-CENTURY)		PROPOSED ACTION (LATE-CENTURY)	
	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK	RAINBOW FALLS TO CRIM CREEK	ABOVE CRIM CREEK
Typical seasonal flood	0.03	8.00	0.00	0.28
Major flood	0.03	7.98	0.00	0.28
Catastrophic flood	0.03	7.96	0.00	0.28

The Draft SEPA EIS (Appendix E, Section 3.2.3.2.2.5) characterizes the productivity of the four species as follows:

Spring-run Chinook salmon: The low abundance of spring-run Chinook salmon basin-wide reflects low productivity compared to other species. These fish face a number of challenges that reduce survival (productivity) including the need to survive as adults during summer prior to spawning. In a warm system like the Chehalis River, this requires cool water refugia, which can be limiting. The low abundance and productivity of spring-run Chinook salmon, the need for summer holding habitat, and other issues related to genetics and interbreeding with fall-run Chinook salmon make spring-run Chinook salmon the most threatened of the four species modeled.

Fall-run Chinook salmon: Productivity of fall-run Chinook salmon is appreciably greater than that of spring-run Chinook salmon because fall-run Chinook salmon do not experience the impact on survival that occurs for spring-run Chinook salmon during the summer adult holding period. Fall-run Chinook salmon are most abundant and have the highest productivity of the four species in the Rainbow Falls to Crim Creek Subbasin below the site of the proposed FRE facility (Tables E-12 and E-13). The higher survival of fall-run Chinook salmon in this area compared to other species is because they do not have the adult summer holding stage while juveniles emigrate in their first spring and so do not experience the high summer water temperature that characterizes this section of the river.

Coho salmon: Productivity of coho salmon in the Rainbow Falls to Crim Creek Subbasin, as estimated by the EDT model, is approximately 1.6 adult returns per spawner. The low productivity of coho salmon in this subbasin means that sustained production of coho salmon may not occur in this area during years of poor ocean survival when productivity could drop below 1.0. In addition, this species is estimated to be extirpated from this subbasin by late-century due to the limited quantity and quality of habitat for coho salmon in the reach.

Steelhead: Based on EDT model results, approximately 6% of the basin-wide steelhead habitat potential was estimated to be above Rainbow Falls, and 97% of the current potential above Rainbow Falls was in the Above Crim Creek spatial unit. Steelhead potential in the Rainbow Falls to Crim Creek Subbasin is low compared to the other species as a result of steelhead life history. Winter steelhead spawn in late winter and juveniles emerge in spring and summer. The Rainbow Falls to Crim Creek Subbasin has high summer water temperature that reduced the survival of fry produced in this area in the EDT model. Based on WDFW observations of steelhead escapement across the Chehalis Basin, 15% of the steelhead produced in the basin comes from the upper Chehalis River, which represents only 4% of the total habitat. Thus, the upper Chehalis River is an important area for steelhead production.

Diversity

The Draft SEPA EIS concludes that the upper Chehalis Basin is warmer and is geographically and hydrologically distinct from other regions of the Chehalis Basin. The reduction of spring-run and fall-run Chinook salmon, coho salmon, and steelhead from the upper Chehalis Basin due to the Proposed Action represents a significant impact to the genetic, physiological, morphological, and behavioral diversity of these salmon and steelhead in the Chehalis Basin.

Diversity is calculated within the EDT model. It is defined as the proportion of sustainable life history trajectories (those with a productivity greater than 1) for a species that is used to calculate equilibrium abundance. In EDT, diversity relates to the breadth of suitable habitat within the spatial unit and variation in modeled life histories within the population being analyzed. As habitat is degraded, the proportion of trajectories with productivity greater than 1 declines, indicating that the calculated abundance relies on an increasingly narrow range of suitable habitat and life histories within the population. Populations with higher EDT diversity values are assumed to have greater resiliency to environmental perturbations compared to those with lower diversity values.

As habitat is projected to degrade in the future due to the Proposed Action, the diversity of salmonids would also decline because all of the life-history trajectories that start within the temporary reservoir area would be eliminated when the FRE outlets are closed during a flood retention event. This means the projected abundance and productivity of salmonids would be supported by a smaller array of life-history strategies.

Regarding the statement "The modeling predicts that the Proposed Project would reduce the genetic diversity within and among salmon populations of each species across the Chehalis Basin," the statement is supported by the following text in the Draft SEPA EIS (Appendix E, page E-145):

"…coho salmon and steelhead found at and upstream of the proposed FRE facility are genetically distinct from coho salmon and steelhead in lower river areas. Additionally, Chinook salmon genetic structure (both spring-run and fall-run) within the Chehalis Basin indicates that there is population structure consisting of an upstream group (South Fork and upper Chehalis River, Newaukum River, and Skookumchuck River) and a downstream group (Wynoochee, Wishkah, Satsop, Black, and Chehalis mainstem rivers; Brown et al. 2017). Any decline of Chinook salmon, coho salmon, or steelhead in the upper basin due to the Proposed Action would be a significant loss of genetic diversity from Chehalis Basin populations."

What are the major causes of the impacts to salmonids?

The major causes of impacts of the Proposed Action (specifically, the FRE facility) on all four species as estimated by the modeling approach were as follows:

1. Inundation of mainstem and lower tributary reaches above Crim Creek in years when the FRE facility was closed
2. Habitat degradation in the mainstem and lower tributaries above Crim Creek in years when the FRE facility was open caused by the removal of vegetation in the reservoir footprint and from previous flood retention events
3. Decreased adult fish passage survival during construction due to assumptions about the effectiveness of temporary trap-and-transport facilities, especially for coho salmon and steelhead

Habitat degradation within the reservoir footprint was assumed to include the loss of riparian cover due to land clearing, increased water temperature due to loss of riparian shade, increased sedimentation during reservoir filling and landslides, decreased large wood supplied to the river channel, and increased bed scour.

Additional factors that could affect salmonids, resident fish, shellfish, and aquatic macroinvertebrates during construction and operations were considered separately and were not incorporated in the model. For example, for construction this included effects of noise and vibration from blasting and equipment operation, the inability of temporary trap-and-transport facilities to pass all fish species and life stages, and potential impacts to adult steelhead (kelts) that move downstream after spawning.

What are key uncertainties in the impacts, what factors affect those uncertainties, and how are these uncertainties affected over time?

Many potential uncertainties were identified within the Draft SEPA EIS. They pertain to the state of knowledge regarding the species being modeled, how habitat will change in the future with predicted climate changes, and FRE construction and operations (including fish passage). Despite many uncertainties identified in the Draft SEPA EIS, the analysis used data and models for evaluating impacts to salmonids that was the best information available. Also, generally speaking, uncertainty increases with time and there is always greater certainty associated with what could occur in the near term compared to the long term.

The Draft SEPA EIS, Appendix E, states the following on pages E2-33 to E2-35:

"For the salmonid impacts modeling conducted for the SEPA EIS, the following limitations of the modeling approach and areas of uncertainty are acknowledged:

- The biological status of spring-run Chinook salmon in the Chehalis Basin, including current and historic distribution and pre-spawning behavior
- Uncertainties about spring-run Chinook salmon in the Chehalis Basin: Spring-run Chinook salmon are difficult to distinguish from fall-run Chinook salmon in the field during abundance surveys. There is considerable uncertainty in recent abundance estimates for the species. Recent genetics studies suggest that spring-run Chinook salmon abundance in spawner surveys has likely been overestimated, making it difficult to gauge how well the integrated model is performing relative to empirical spawner counts.
- How habitat conditions above and below the FRE facility during construction and operation will change, including:
    - How fast will habitat recover from an FRE facility closure event?
    - What will habitat above the FRE facility look like through time?
    - How will downstream conditions change?
    - Will fish recolonize habitat after an FRE facility event, and if so, how quickly?
    - Will fish self-distribute downstream from the FRE facility during a closure and spawn successfully?
- Uncertainty associated with 10- or 100-year floods occurring during FRE facility construction (rather than 2-year floods, which is what is currently modeled). A 10- or 100-year flood during this period could have impacts on fish species and habitat.
- Uncertainty associated with fish passage estimates as noted in Attachment E-3.
- The effect of climate change on conditions in Grays Harbor and the ocean. Inclusion of these factors would affect the numeric estimates of fish performance under both alternatives. Annual variation in ocean conditions and ocean survival is a significant contributor to annual variation in spawner abundance for salmon and steelhead. It is not clear how climate change will affect

salmon and steelhead survival in Grays Harbor and the ocean, although climate models suggest that ocean temperatures will likely increase in the future and increasing ocean temperatures may lead to reduced adult returns (Logerwell et al. 2003). For small or declining populations, this annual variation may result in populations going to very low numbers (or zero in some years), possibly resulting in earlier functional extirpation.

- In this analysis, effects of peak flow outside the project area were not modeled so that effects of the Proposed Action were easier to detect. This results in an underestimation of the functional extirpation of weak species, especially spring-run Chinook salmon. Inclusion of flood effects outside the project area may result in earlier functional extirpation of small populations (e.g., spring-run Chinook salmon) if that was to be modeled.
- Uncertainty in mid- and late-century conditions for peak flows, low flows, and stream temperature. There is considerable uncertainty in climate projections resulting from uncertainty in projected greenhouse gas emissions, as well as differences among climate models. While effect of this uncertainty can be evaluated in models (e.g., by using high and low estimates), this uncertainty cannot be reduced.
- Basic model uncertainties (life-stage representation, capacity estimates, survival estimates, changes in parameters due to habitat change, etc.), which are common modeling uncertainties.
- Uncertainty associated with conditions above the proposed FRE facility or in any tributary of the Chehalis River because the HEC-RAS model could not be used to evaluate these areas.
- Uncertainty in flooding impacts to flow and channel width because the EDT model is structured based on monthly (not daily) increments of time. The impacts of the flood events are diminished when daily flows are incorporated into a monthly time step in the analysis.
- Uncertainties associated with lack of variation in timing and duration of the flood events in 2-, 10-, and 100-year flood years; no variation in flow conditions at other, non-flood event, times of the year; and no variation in the life stage of the salmon and steelhead being affected by the flood event. Additionally, uncertainties due to actual differences in 2-, 10-, and 100-year flood conditions in the future have not been captured since specific water years were chosen as representative in the models.
- Uncertainty associated with the impacts of bed scour on salmon and steelhead survival in tributaries of the two modeled reaches as this was not include in the models (only impacts to the mainstem were included).
- Uncertainty associated with the fact that changes in hydrology associated with the 3 water years modeled were not modeled in the reach above the proposed FRE facility.
- Impacts due to changes in mainstem river water temperature associated with 2-, 10-, 100-year flow recurrence intervals are uncertain as these data were not available.
- Uncertainty associated with aspects of the project that were not considered in the modeling approach for areas downstream of the FRE facility:
  - Broad, long-term effects of a lack of channel-forming flows during floods

- How a lack of flooding would impact channel width, fine sediment levels, floodplain maintenance and formation, and riparian structure and function"

What is the relationship between the model predictions for current abundance and the recent redd counts? Is there other field data that are relevant to this question?

EDT estimates of salmon abundance do not line up directly with WDFW escapement estimates for two reasons. First, WDFW monitoring units do not directly align with EDT model units (geospatial unit designations). Second, WDFW reports escapement (the number of adults on the spawning grounds after harvest) while EDT reports total potential return of adults to spawning grounds in the absence of harvest (it estimates the potential of the habitat to produce salmon and steelhead). Therefore, EDT abundance should generally be appreciably higher than WDFW numbers, which represent escapement only. EDT model results are compared to WDFW escapement estimates to ensure the model is producing results that reflect trends in abundance among species across basins.

Does the No Action Alternative assume impacts to salmon populations from floods? In the past it appears large floods have had an impact that can last over several salmon life cycles. Please describe.

Floods are a natural part of the salmon landscape, and salmon evolved with floods. Floods can both impact salmon (e.g., block access, disrupt spawning, redistribute adults or juveniles, and scour redds) and benefit salmon (e.g., bank avulsions are a major source of gravel recruitment, floods move bedload and redistribute silt and cleanse spawning gravels in the process, floods water up side channels and floodplain habitats, floods displace or disrupt predators, and floods can import terrestrial nutrients into the aquatic system). Effects will vary with the timing, location and magnitude of the flood, and by species. It is difficult to relate the effect of a flood to adult returns several years later because salmon evolved to express diverse life history traits and spread their risk of not reproducing across years, and because of the variability among environments they encounter across time.

Floods were incorporated into the assessment of the Proposed Action to evaluate the effects flood retention may have on salmonids, and because data on changes in flows associated with the Proposed Action were developed specifically for this purpose and was available. The No Action Alternative was modeled in exactly the same manner as the Proposed Action (except without the proposed FRE facility). This included the effect of floods (typical flows, major floods, and catastrophic floods) under future conditions with climate change. The Draft SEPA EIS identified the continuing substantial flood risk to fish and habitat but did not make a determination of significance associated with the No Action Alternative.

4. Board Question: If the EDT model is estimating the habitat potential of the upper Chehalis Basin for spring chinook as approximately 100 adults under the No Action Alternative, what factors were used to determine that their loss under the proposed action would have a moderate adverse impact on Southern Resident killer whales? During what timeframe (current, mid, or late century)?

Provide more context for the number of Spring Chinook and other salmon species that could be impacted by the proposed action, the importance of this number of fish and orca's dependency on these populations (NOAA ranking of priority populations).

It is assumed that Southern Resident killer whales eat some Chehalis Basin salmon when residing outside Grays Harbor in fall, winter, and spring. However, they are also preying on a much more abundant and mixed group of Chinook salmon stocks from the Columbia/Snake Rivers and Central Valley California (Hanson et al. 2013, 2017).

Marine predators that prey on Chehalis Basin salmon, such as Southern Resident killer whales and fish-eating birds, would be affected by a change in salmon population sizes. The degree to which the decline of salmon and steelhead from the upper Chehalis Basin resulting from construction of the FRE facility would affect Southern Resident killer whales is uncertain. The number of fish that would likely be impacted by the Proposed Action represents a small proportion of the overall diet of the Southern Resident killer whale. However, the loss of salmon and steelhead, in particular spring-run Chinook salmon, from the Chehalis River, would present a moderate adverse impact on Southern Resident killer whales.

Justification for moderate impact on Southern Resident killer whales by loss of spring-run Chinook salmon from the upper Chehalis Basin (Appendix E, Section 3.2.3.2.5) is as follows:

The Southern Resident Distinct Population Segment killer whale population was federally listed as endangered in 2005 and updated in 2014 (70 Federal Register 69903; 79 Federal Register 20802). Grays Harbor and the coast of Washington lie outside the designated critical habitat for Southern Resident killer whales (71 Federal Register 69054); they spend the majority of spring, summer, and fall in the inland waters of Puget Sound and Strait of Juan de Fuca. In summer, salmonids make up the majority of the Southern Resident killer whale diet (more than 98%), with Chinook salmon from the Fraser River and Puget Sound composing most of their summer diet (Hanson et al. 2010; Ford et al. 2016).

The winter range and feeding habits of the Southern Resident killer whale are not as well studied; however, they have been observed frequently outside of Grays Harbor near Westport between January and June, presumably following and preying upon large runs of returning Columbia River Chinook salmon (Hanson et al. 2013). In March 2018, Governor Inslee issued an executive order directing state agencies to take immediate actions to help the struggling killer whale population and establishing the Southern Resident Orca Task Force to develop a long-term plan for recovering killer whales (Office of the Governor 2018). The task force's recommendations support overarching goals to benefit killer whales, including increasing the abundance of Chinook salmon, decreasing disturbance and other risks posed by vessel traffic and noise, reducing exposure to toxic pollutants for killer whales and their prey, and ensuring adequate funding, information, and accountability measures are in place to support effective recovery efforts moving forward.

The priority list developed by NOAA Fisheries and WDFW (NOAA Fisheries and WDFW 2018) is used as a relative and dynamic picture of which West Coast Chinook salmon populations are currently supporting the Southern Resident killer whales. The Southern Resident killer whales prefer Chinook salmon as prey, although they also feed on chum salmon, coho salmon, steelhead, and other species such as halibut and lingcod. The stocks from the Puget Sound, Columbia River, Strait of Georgia, Fraser River, and Snake River were found to be highest priority. The Washington Coast stocks include spring-run and fall-run Chinook salmon from the Chehalis River and were rated in the next category for priority.

Chinook salmon that originate from the upper Chehalis River are several subpopulations of Chinook salmon from the Chehalis River and Grays Harbor tributaries, all of which contribute to the Grays Harbor population. The Southern Resident killer whales depend on spring-run Chinook salmon as a food source. The number of these fish has been decreasing throughout the region, and several Chinook populations (outside of the Chehalis Basin) that are preyed upon by Southern Resident killer whales are designated as threatened or endangered (70 Federal Register 37160, 79 Federal Register 20802).

5. Board Question: What assumptions does the EIS use for flood-related turbidity under the No Action Alternative, and how do those turbidity conditions compare to the effects on turbidity under the proposed action (construction and operation)?

Stream turbidity levels are naturally highly variable, depending on conditions. They are typically highest in winter months during periods of heavy precipitation and low flows, and lowest in summer months when precipitation and flows are low. For example, turbidity measured on the Chehalis River at the proposed FRE facility site was 610 nephelometric turbidity units (NTUs) on February 9, 2017, during high flows, and 12.2 NTUs on March 29, 2017, during moderate flows, based on data collected by Anchor QEA in the *Summary of Upper Chehalis River and Select Tributary Water Quality Data* Technical Memorandum (Anchor QEA 2017c). Data from Ecology's long-term monitoring sites at Dryad and Porter show that summer turbidity is often in the range of 2 NTUs or less.

The Draft SEPA EIS evaluates flood-related turbidity in the context of state water quality standards to determine the significance of impacts. It is important to note that naturally elevated turbidity levels that occur during floods (e.g., the No Action Alternative) do not necessarily violate state water quality standards for turbidity. Rather, Washington's turbidity criteria are based on an activity's potential to cause stream turbidity to increase over background levels. The aquatic life turbidity criteria for Chehalis Basin streams state that an activity shall not cause turbidity to exceed 5 NTUs over background when the background is 50 NTUs or less, or a 10% increase in turbidity when the background is more than 50 NTUs. Because there is no FRE facility or temporary reservoir under the No Action Alternative, the EIS compares predicted turbidity in proposed reservoir inflows ('background') to predicted turbidity in reservoir outflows ('compliance point') to evaluate impacts relative to water quality criteria.

General Effects on Turbidity

FRE facility operations would potentially increase turbidity in the Chehalis River during certain periods and reduce turbidity during others. Turbidity impacts would be influenced by several factors relating to both surface runoff and in-water processes, as described in the *Water Discipline Report* (Appendix N of the Draft SEPA EIS) and the *Earth Discipline Report* (Appendix F of the Draft SEPA EIS) and summarized below.

Flood flows typically carry relatively high levels of suspended sediments as a result of high water velocities and associated mobilization of bed and bank material (scour). When high-velocity, high-turbidity flows enter the temporary reservoir (when the FRE facility is impounding water), velocities would slow and some suspended sediments would settle out. When the FRE facility gates are closed and the temporary reservoir is impounding water, some water would still flow through the FRE facility at a minimum of 300 cfs. However, the inflows would exceed outflows, and peak turbidity in water leaving the temporary reservoir would be lower than peak turbidity in water entering the temporary reservoir. In such conditions, FRE facility operations would not increase downstream turbidity levels.

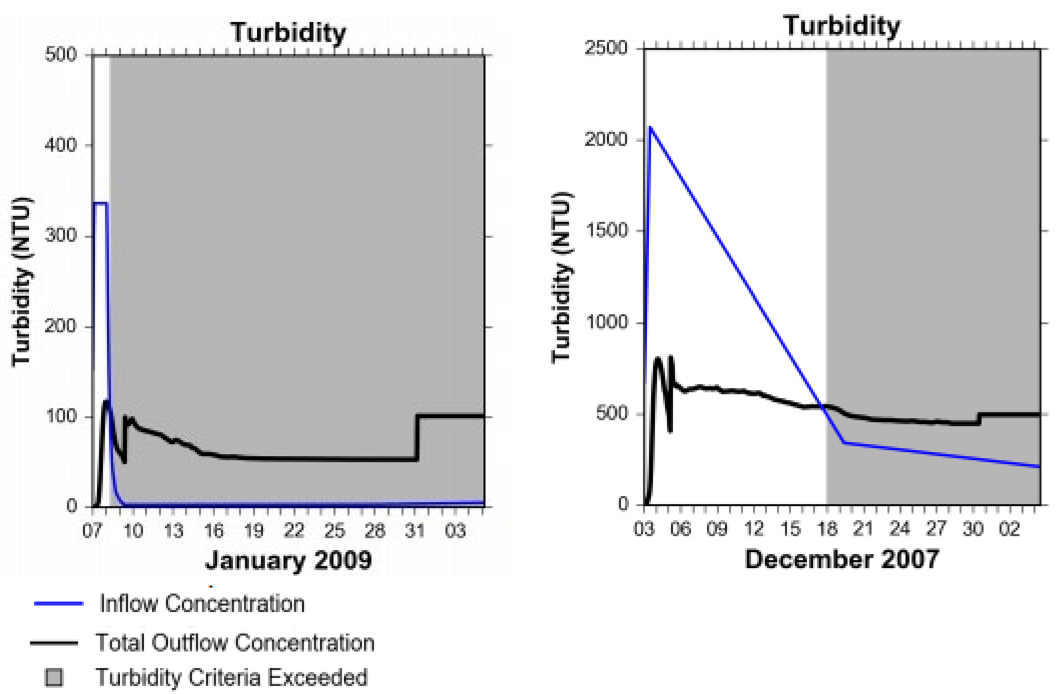
Resuspension of deposited sediments while the temporary reservoir is draining, or during subsequent storms or high flows when the temporary reservoir is not storing water, could lead to temporary increases in turbidity. Resuspension of sediments may be caused by several factors, such as erosion in the active river channel during and after impoundment, erosion on the valley walls along the shoreline due to wave action as the temporary reservoir drains, and hillslope erosion due to rainfall events after the temporary reservoir is drained. Those factors are discussed in more detail in the *Earth Discipline Report* and the *Reservoir Water Quality Report* (Anchor QEA 2017b).

Model Results Summary

The modeling described in the above-noted *Reservoir Water Quality Report* (Anchor QEA 2017b) used data from two historic floods, with the December 2007 flood for a catastrophic flood and January 2009 for a major flood.

The modeling for impoundment conditions predicted that the FRE facility would reduce *peak* outflow turbidity concentrations by more than 50% relative to reservoir inflows for both major and catastrophic floods when the FRE facility gates are closed. The modeling also showed that during major flood or larger events, the FRE facility may cause an exceedance of turbidity water quality criteria when the temporary reservoir is draining and turbidity in temporary reservoir outflows exceeds turbidity in temporary reservoir inflows. Using conservative "worst-case" assumptions during modeling based on data from past flood events, water quality criteria exceedances were predicted to occur for 18 days for a modeled catastrophic flood and 28 days for a modeled major flood. Because turbidity water quality criteria are based on increases relative to background levels, exceedances of turbidity criteria are highly dependent on the turbidity of Chehalis River flows entering the temporary reservoir following the flood. The modeling predicted more days of exceedances for the major flood than the catastrophic flood because inflowing turbidity remained elevated longer for the catastrophic flood and returned to lower levels more quickly for the major flood, so outflow turbidity remained at least 10% higher than inflow turbidity for a longer time for the major flood.

The graphs below from the *Reservoir Water Quality Report* (Anchor QEA 2017b) illustrate predicted inflow and outflow turbidity levels for the modeled January 2009 and December 2007 floods.



Modeling for non-impounding conditions showed that deposited sediments from previous inundations could later be eroded during a storm, leading to an exceedance of turbidity criteria, particularly when the background turbidity is relatively low. Increases in turbidity from rainfall-induced erosion would generally be limited to the period of the rain event. Vegetation conditions would change when water is held in the temporary reservoir because plants that are inundated for a long period would not survive. Loss of vegetation and temporary loss of root strength would reduce soil cover and is expected to increase the potential for erosion. As flood-tolerant species regrow and annual vegetation grows between periods of temporary reservoir inundation, root strength and soil cover would increase, reducing the potential for both shallow landslides and erosion. However, the frequency of major floods increases in the future so the potential for regrowth would be reduced (see Section 5.2.2.1 in the Draft SEPA EIS).

6. Board Question: What assumptions does the EIS use for water temperature under the No Action Alternative compared to the proposed action? What are the main causes of the incremental temperature impacts of the flood retention facility as compared to the No Action Alternative?

The Draft SEPA EIS evaluates water temperatures in the context of state water quality standards to determine the significance of impacts, as presented in the *Water Discipline Report* (Appendix N of the Draft SEPA EIS). The water temperature evaluation in the EIS is based largely on analyses and modeling described in the following primary studies and reports by Anchor QEA and Portland State University (PSU):

- *Reservoir Water Quality Model* (Anchor QEA 2017b)
- *Chehalis Water Quality and Hydrodynamic Modeling: Model Setup, Calibration, and Scenario Analysis* (PSU 2017)

Anchor QEA modeling analyzed water temperatures for the proposed temporary reservoir under flood storage conditions for the proposed FRE facility. PSU and Anchor QEA modeling also evaluated temperature impacts to the Chehalis River and its tributaries within the reservoir footprint under non-storage conditions, and temperature impacts to the Chehalis River downstream of the proposed FRE facility under storage and non-storage conditions.

Temperature Impacts and Main Cause

The *Water Discipline Report* (Appendix N of the Draft SEPA EIS) discusses temperature impacts of the proposed FRE facility compared to the No Action Alternative. When the FRE facility is not storing water and the Chehalis River passes through the facility outlets, daily maximum temperatures of the Chehalis River could increase by up to 2°C to 3°C in mid- to late-summer in the temporary reservoir footprint relative to the No Action Alternative, exceeding temperature water quality criteria (PSU 2017). Additionally, with the FRE facility, summer temperatures immediately downstream could be up to 2°C to 3°C warmer than with no FRE facility, exceeding temperature water quality criteria. The modeling showed the Chehalis River temperature impacts decrease moving downstream, becoming negligible below about the confluence with the South Fork Chehalis River at RM 88 (PSU 2017).

The main cause of the predicted increase in summer water temperatures as a result of the FRE facility is the associated alteration of riparian vegetation and reduced stream shading in the reservoir footprint. The construction of the FRE facility would involve removal of mature, coniferous, non-flood tolerant trees and large trees over 6 inches diameter breast height within the reservoir footprint. The Applicant's currently proposed revegetation plan would involve replanting flood-tolerant vegetation (e.g., shrubs and deciduous trees such as willow and cottonwood), but there would be a net reduction in stream shading. The water temperature modeling and predicted increase in summer temperatures for the proposed FRE facility reflect this 'partial shading' scenario.

During operations, for a catastrophic flood, the reservoir would temporarily hold water and 847 acres would be inundated. A total of 85 wetlands (9.8 acres) and wetland buffers (303 acres), and 116 streams (16.8 miles) and stream buffers (25.5 miles and 441.3 acres) would be submerged underwater for up to 35 days. Plants would not survive being submerged for this amount of time and the wetland vegetation would permanently change to smaller plants that must regrow after every flood. In addition, sediment could fill the wetlands and erosion could reduce its ability to retain water and promote the spread of non-native plants.

7. Board Question: What assumptions does the EIS use for flood-related erosion under the No Action Alternative, and how does this compare to the effects on erosion from the proposed action?

The Draft SEPA EIS evaluates three different erosion mechanisms during flood events:

- Erosion from mass wasting within the FRE footprint as a result of FRE inundation and drawdown
- Erosion from sediment that is deposited within the reservoir during flood events that is subsequently eroded during and after the reservoir is emptied
- Bank erosion downstream from the FRE facility

For each of these erosion mechanisms, the No Action Alternative assumes that existing land use, precipitation, and flood flows that contribute to erosion from these sources during flood events continues. For the Proposed Action, operation of the FRE facility during flood events that results in reservoir inundation and changes in flows downstream from the FRE facility are evaluated as described in detail in the *Earth Discipline Report* (Appendix F of the Draft SEPA EIS) and summarized below.

Mass Wasting

During flood events under the No Action Alternative, existing mass wasting (large deep-seated landslides and smaller shallow-rapid landslides) within the FRE facility is assumed to continue at similar rates as with existing timber harvest and road conditions. Although it is likely that increased mass wasting would result from climate change-induced precipitation increases, it is assumed that changes to mass wasting on forested/roaded areas resulting from differences in rainfall from climate change would be the same for the No Action Alternative and Proposed Action.

Changes to mass wasting under the Proposed Action are assumed to be the result of inundation and resulting saturation of soils within the FRE footprint that could destabilize vulnerable slopes and lead to mass wasting. Slope stability calculations were used to determine which portions of the reservoir footprint could become unstable and result in shallow-rapid landslides based on slope gradient. It was assumed that there would be no root strength within the FRE footprint as a result of harvest of timber within the FRE footprint (a maximizing assumption because there would be some tree growth in parts of the reservoir). Slope stability modeling was used to evaluate identified and confirmed large, deep-seated landslides during drawdown conditions following reservoir inundation events.

Approximately 10% of the reservoir area contains soil on slopes steep enough that they may be unstable if saturated and all root strength was removed, potentially resulting in shallow-rapid landslides. The result of the mass wasting assessment indicated that two of the potential deep-seated landslides in the proximity of the FRE could become unstable during drawdown conditions. The Applicant's project design states slope stabilization methods would be used during construction to stabilize these slides.

The soil moved during any mass wasting events that occur while the reservoir is operating (impounding water or being drawn down) would primarily be deposited within the reservoir footprint including the Chehalis River and streams.

Sediment Deposited In Reservoir and Subsequently Eroded

During times when the temporary reservoir impounds water (flood conditions), some portion of the sediment that flows into the reservoir from the Chehalis River and tributaries would be deposited in the reservoir. As the reservoir drains, this sediment could be re-eroded and suspended in outflowing water (post-flood conditions).

For the No Action Alternative, there is no deposition and re-erosion of sediment within the reservoir because the reservoir does not exist. For the Proposed Action, deposition and re-suspension was estimated based on two historic flood conditions. Estimates were based on sediment loads in the inflowing river water, deposition of this sediment within the reservoir, and subsequent re-suspension and erosion of a portion of this sediment from wave erosion and surface erosion processes.

The net effect of these erosion mechanisms during FRE facility operation would be to decrease sediment input to the mainstem Chehalis River downstream of the FRE facility during impoundment events and increase fine sediment input in the mainstem Chehalis River as the temporary reservoir drains and during one or two intense rainstorms after the temporary reservoir is drained. The turbidity effects of these erosion processes are described in the *Water Discipline Report* (Appendix N of the Draft SEPA EIS).

Bank Erosion

During flood events, bank erosion can occur along the Chehalis River as the river migrates across the floodplain in unconfined areas. Operation of the FRE facility would reduce the magnitude of some flood events and would likely change bank erosion rates. Based on the analysis of migration rates in the Chehalis River between the FRE facility (RM 108) and the Mellon Street Bridge (RM 83) from 1945 to

2013, it appears that channel migration takes place during even small peak floods in unconfined areas in response to flow against banks on the outside of meanders (Appendix F of the Draft SEPA EIS).

Bank erosion rates for the No Action Alternative were assumed to be similar to historical bank erosion rates. Bank erosion rates under the Proposed Action were assumed to be lower than under the No Action Alternative as a result of reduced large peak flows events, less large woody material, and less accumulation of coarse sediment (Appendix F of the Draft SEPA EIS).

8. Board Question: Does the air quality impact resulting from the flood retention facility assume that trucks and other heavy vehicles are idle if not used in the construction of the facility?

The commenter expressed concern that idling and operational emissions from construction equipment would occur somewhere else if the Proposed Project would not be approved.

Where and when construction equipment is deployed and operated is the responsibility of the contractor. If the contractor works on another project that is subject to SEPA, then emissions from construction-related activities would be required to be analyzed for that project. Air quality and greenhouse gas assessments relative to both SEPA and the National Environmental Policy Act have long considered construction-related exhaust emissions as part of their analysis and determinations of significant effects on the environment.

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