To: **Quinault Indian Nation**

From: Natural Systems Design, Inc.

Date: October 28, 2020

Re: Critical Review of Proposed Chehalis River Basin Flood Damage Reduction Project NEPA DEIS: Climate Change Impacts

EXECUTIVE SUMMARY

A qualified technical team of hydrologists and hydraulic engineers reviewed the NEPA Draft Environmental Impact Statement (DEIS), along with related documents prepared to support the proposed Flood Retention Expandable (FRE) facility and airport levee improvements project (proposed project) being reviewed by the U.S. Army Corps of Engineers under the National Environmental Policy Act (NEPA). The team was composed of Susan Dickerson-Lange, PhD, PG, Megan Nelson, MS, PE, and Leif Embertson, MS, PE.

The team reviewed the NEPA DEIS, as well as the Discipline Reports for Water Quantity and Quality (Appendix G), Geology and Geologic Hazards (Appendix H), Wetlands and Other Waters (Appendix J), and Aquatic Species and Habitats (Appendix K). Particular attention was paid to hydrologic and climate changes analyses presented in these documents, and the consequent potential impacts to hydrologic and geomorphic processes, aquatic habitat, and treaty resources.

Within the NEPA DEIS, the characterization of the types and severity of direct and indirect impacts to aquatic habitat and treaty resources due to the presence and operation of the FRE facility are directly influenced by the associated analyses of hydrology and climate change. For example, the frequency and duration of local and downstream impacts is directly tied to the frequency of peak flows that would trigger FRE operation under current and future climate conditions. The team concluded that the following critical assumptions, omissions, and errors are present in the NEPA DEIS and associated discipline reports, which result in a gross underestimation of the potential for impacts to waters and wetlands, as well as associated floodplain and instream aquatic habitat, and the amplification of impacts over time if the proposed project is approved for construction and operation:

- Flaws in the hydrologic analysis result in underestimating of the frequency and duration of operation of the FRE facility and all related impacts.
- The potential effects on groundwater, and therefore wetlands and baseflow, from the loss of over-bank groundwater recharge are underestimated in the DEIS.
- The DEIS fails to use best available science by not including quantitative analysis of climate change impacts on the frequency and duration of peak flows that would trigger FRE operation. Climate change projections are readily available for the Chehalis Basin, are based on a large body of scientific work, and are applicable to the time period of analysis for the NEPA DEIS, 2030-2080.
- The DEIS obfuscates the lack of robust analysis of climate change through its unsubstantiated and unbalanced qualitative analysis of “climate variability”, in addition to its use of the term “climate variability” to describe trends (which, by definition, are mathematically distinguishable from variability).
- Without incorporating climate change projections throughout the Chehalis Basin, it is impossible to analyze whether the FRE facility will meet its stated purpose and need related to flood damage

reduction metrics during the NEPA DEIS time period of analysis 2030 to 2080 and thus whether it is a viable alternative that should have been advanced through the Phase 1 screening criteria.

- Together, flawed hydrological analyses along with the failure to incorporate climate change projections results in severe underestimation of the frequency and duration of operation of the FRE facility during 2030 to 2080, which results in the underestimation of all local and downstream impacts related to operation of the FRE facility, including impacts to sediment delivery and transport, to instream aquatic habitat, and to floodplain wetlands.

In conclusion, many of the same technical issues, errors, and omissions identified in the review of the State Environmental Policy Act (SEPA) DEIS and supporting documents also occur in the NEPA DEIS. Therefore, we incorporate herein by reference the following SEPA Technical Memoranda which provide detailed explanations of the basis for these conclusions:

- *Cascade of FRE Facility Ecosystem Effects Technical Memo* (SEPA Cascade of Ecosystem Effects Technical Memo) (NSD 2020a)
- *Hydrology Technical Memo 1: Observed and Predicted Flows Relative to FRE Facility Operation* (SEPA Hydrology Technical Memo 1) (NSD 2020b)
- *Hydrology Technical Memo 2: Hydrology and Climate Change Technical Analyses Review* (SEPA Hydrology 2 Technical Memo) (NSD 2020c)

Additional addenda to the SEPA technical memoranda have been prepared in response to the NEPA DEIS which are incorporated herein by reference as follows:

- *Critical Review of Proposed Chehalis River Basin Flood Damage Reduction Project NEPA DEIS: Geology Discipline Report Review* (NEPA Geology Addendum) (NSD and Saturna Watershed Sciences 2020d)
- *Critical Review of Proposed Chehalis River Basin Flood Damage Reduction Project NEPA DEIS: Addendum to Cascade of FRE Ecosystems Effects Technical Memo* (NEPA Ecosystems Addendum) (NSD 2020e)

INTRODUCTION

An expandable flood retention (FRE) facility and airport levee improvements have been proposed as an alternative to accomplish flood damage reduction on the Chehalis River, Washington. Several alternative concepts were proposed, but the Flood Retention Expandable (FRE) facility has been advanced for environmental review under NEPA. The stated purpose of the facility would be to store water in the upper watershed to alleviate flood damage to developed areas of the lower floodplain near the towns of Centralia and Chehalis.

The incorporation of reasonable estimates for both the current and future frequency and duration of peak flow events is critical to a credible analysis of impacts from the proposed FRE facility. The analysis of all local and downstream effects due to operation of the FRE facility depends on the hydrology of the system, and particularly on the frequency and magnitude of flooding events that would trigger operation of the FRE facility. Our review finds there are several flaws with the hydrologic analysis that contribute to underestimation of impacts. The frequency of FRE operation, which is based on analysis of historic flood frequency, is underestimated and therefore the quantification of local and downstream impacts from operation of the FRE facility that are described in the NEPA DEIS are also underestimated. The potential effects on groundwater, and therefore wetlands, baseflow, and stream temperature from the loss of over-bank groundwater recharge are also underestimated.

Local and downstream impacts from operation of the FRE facility are further underestimated due to the exclusion of climate change projections from the analysis. Although the NEPA DEIS references "*...established, peer-reviewed and state-of-the-art climate projections*" (DEIS, Appendix G, 5.6, p. 54) related to future trends in temperature, precipitation, and flooding, the analysis of impacts tied to frequency and duration of operating the FRE facility ignores future trends. Rather, the NEPA DEIS relies on the assumption that current conditions are representative of future conditions and the assertion that future uncertainty justifies ignoring robust projections, both of which stands in contrast to a large body of scientific literature. Climate change projections are readily available for the Chehalis River Basin due to previous modeling efforts by the University of Washington Climate Impacts Group (Hamlet et al. 2013; Mauger et al. 2016). Incorporation of these, or similar, projections is critical for a robust analysis of impacts. By excluding quantitative analysis of projected increases in the frequency and magnitude of flood events, all impacts associated with the operation of the FRE facility, including the consequent "Cascade of Ecosystem Effects" and effects on geologic considerations such as landslide risk, resulting from operation of the proposed project are underestimated (see attached *NEPA Geology Addendum, SEPA Cascade of Ecosystem Effects Technical Memo, and NEPA Ecosystems Addendum*).

The NEPA DEIS further fails to analyze whether the FRE facility would meet the stated purpose "to reduce the risk of flood damage in the Chehalis/Centralia area from catastrophic flooding" into the future. Increased temperature and precipitation will result in larger peak flows in all portions of the upper Chehalis. Although the NEPA DEIS states that the proposed FRE facility would have the volumetric capacity to impound more water than is technically needed to achieve the purpose and need during a current 100-year flood, there is no analysis of how increases in peak flows from the South Fork Chehalis River, the Newaukum River, and the Skookumchuck River will affect downstream flood stage, regardless of the impoundment and storage of flood flows upstream of Doty. Without this analysis, it becomes impossible to characterize whether the FRE facility will meet the stated purpose and need during the analysis period of 2030 to 2080.

Overall, our review finds that the hydrologic analysis underestimates the frequency and duration of FRE operation and therefore underestimates the scale, intensity, and duration of all downstream impacts. The NEPA DEIS fails to incorporate best available science related to climate change and its effects on hydrology and therefore underestimates and misrepresents downstream impacts and calls into question whether the FRE facility would meet its stated purpose and need.

ANALYSIS

To understand and assess how climate change impacts on hydrology and hydrological analyses were incorporated in the DEIS analysis, the following documents were reviewed:

- NEPA DEIS
- Water Quality and Quantity Discipline Report (Appendix G)
- Geology Discipline Report (Appendix H)
- Wetlands and Other Water Discipline Report (Appendix J)
- Aquatic Species and Habitats (Appendix K)
- Supporting technical analyses referenced within Appendix G and Appendix J, specifically:
    - Water Budget of the Upper Chehalis River Basin, Southwestern Washington (Gendaszek and Welch 2018)
    - Chehalis River Basin Hydrologic Modeling (WSE 2019a)
    - Hydrology and Quality of Groundwater in the Centralia-Chehalis Area Surficial Aquifer (Pitz 2005)

- Seepage Investigation for Selected River Reaches in the Chehalis River Basin, Washington (Ely et al. 2008)
- Hydrogeologic Framework and Groundwater/Surface-Water Interactions of the Chehalis River Basin, Southwestern Washington (Gendaszek 2011)

These documents provide the basis for evaluation of design, impacts, and mitigation. Additional peer-reviewed science literature, regulations, and government agency guidelines were also referenced.

FINDINGS

Impacts are Underestimated Due to Flawed Hydrologic Analyses

There are several flaws with the hydrologic analysis that result in: (1) underestimation of the frequency and duration of the operation of the FRE facility, (2) underestimation of all impacts associated with the frequency and duration of the operation of the FRE facility, (3) underestimation of the potential effects on groundwater, and therefore wetlands and baseflow, from the loss of over-bank groundwater recharge, and (4) failure to consider the cascade of ecosystem effects that is amplified by increased frequency and duration of operation of the FRE facility. These same technical issues, errors, and omissions associated with the NEPA DEIS hydrologic analyses were identified in the review of the SEPA DEIS and therefore the details are reported in the attached technical memoranda (*SEPA Hydrology Technical Memo 1*; *SEPA Hydrology Technical Memo 2*; and *SEPA Cascade of Ecosystem Effects Technical Memo*) and briefly summarized below.

The impacts due to operation of the FRE facility are underestimated in the NEPA DEIS, as a result of analyses that:

- Underestimate the frequency of operation of the FRE facility due to underestimation of the frequency of peak flows that would trigger dam closure. The DEIS states that *"For the purposes of the impact analysis, the EIS generally assume that the flood retention facility would operate on average once every 7 years, which is the average predicted frequency of a major flood."* (DEIS, 3.6.2.4, p. 39) However, this assumption is based on analysis of the historic record of annual peaks and does not incorporate historical observations of the occurrence of multiple peak flows that would trigger operation of the FRE facility in a single year. See *SEPA Hydrology 2 Technical Memo* for discussion on why the assumption of once every 7 years is inaccurate.
- Underestimate the frequency of operation of the FRE facility due to utilizing forecasted flows to initiate closure of the FRE facility: *"The FRE facility would begin to hold back floodwaters when flood forecasts predict a major or greater flood."* (DEIS, 3.4.1.3.1, p. 31) The use of predicted flows may result in a higher frequency of FRE operation than is assumed in the NEPA DEIS, based on analysis of the relation between predicted versus observed flows at Grand Mound. See *SEPA Hydrology Technical Memo 1*.
- Therefore, underestimate all local and downstream impacts associated with operation of the FRE facility and reservoir impoundment as a result of underestimating the frequency and duration of FRE facility operation, including:
    - Underestimation of the increases in the frequency and magnitude of landslides and hillslope erosion, and therefore sediment delivery;
    - Underestimation of impacts to channel morphology, sediment transport, vegetation, and aquatic habitat within the reservoir area and downstream of the reservoir; and
    - Underestimation of the impacts to the formation and maintenance of floodplain wetlands and the recharge of groundwater.

- Underestimate the downstream impact on groundwater and wetlands by using inappropriate groundwater recharge rates and a rudimentary groundwater-surface water analysis. See *SEPA Hydrology Technical Memo 2* for details on the shortcomings of the groundwater analysis.
- Fail to account for the cascade of ecosystem effects, which is further amplified by increases in the frequency and duration of FRE facility operation. See *SEPA Cascade of Ecosystem Effects Technical Memo* for details on the incorrect assumptions and lack of analysis related to multiple direct and indirect effects on natural processes, as well as related and additional issues presented in the *NEPA Ecosystems Addendum*.

Failure to Incorporate Best Available Science on Climate Change Impacts

In addition to the shortcomings discussed above, the analysis of flood frequency, which also drives the analysis of impacts, effectively ignores climate change and therefore does not reflect best available science. **Climate change impacts on hydrology are well documented, imminent, and substantial.** In particular, peer-reviewed scientific studies in the Pacific Northwest region, as well as in the Chehalis Basin, indicate the frequency and magnitude of peak river flows will increase over the next 100 years (Hamlet et al. 2013; Mauger et al. 2016; Warner, Mass, and Salathé 2015; Hamlet and Lettenmaier 2007; Elsner et al. 2010). Climate change impacts on flooding are projected to occur in the coming decades, with increases in peak flows modeled for the 2040s (inclusive of 2030-2059; Hamlet et al. 2013), 2050s (inclusive of 2040-2069; Mauger et al. 2016), and beyond. Climate change impacts are therefore relevant to the analysis period of 2030 to 2080, for quantifying impacts that are based on the frequency and duration of operation of the FRE facility and for assessing whether the FRE facility will meet proposed project's purpose and need related to the amount and duration of potential flood reduction benefits. Furthermore, numerous studies for western Washington have indicated increases in peak flows as early as the 2020s (inclusive of 2010-2039; Elsner et al. 2010, Mantua, Tohver, and Hamlet 2010), which would affect the frequency and/or magnitude of flood events that occur during the proposed construction period of 2025-2030.

Incorporation near-term and long-term changes in the frequency and duration of peak flows is crucial to an accurate assessment of impacts because the trigger for closure of the FRE facility and consequent formation and duration of the reservoir is 'when a major or greater flood is predicted'. The NEPA DEIS uses a flood frequency analysis based on annual peak flows observed in the historic record to assert that the threshold for a major flood, defined as 38,800 cfs, would be met one time in seven years on average. However, the local climate has already changed and is continuing to change rapidly, with effects on temperature, precipitation, severe storms, and flooding (e.g., DEIS Appendix G, 5.6 p. 54). Given the body of scientific observations and projections related to climate change, relying on the assumption of stationarity, which is the assumption that the envelope of climate variability observed in the historical record is an accurate reflection of the range in future climate, is entirely inappropriate (e.g., "Stationarity is Dead", Milly et al. 2008). Relying on historical flood frequency underestimates the frequency and duration of operation of the FRE facility in 2030 through 2080 and cannot be considered 'best available science'. In fact, climate change projections specific to the Chehalis Basin were developed and utilized in the analysis presented in the SEPA DEIS (Mauger et al. 2016) but ignored in the NEPA DEIS analysis.

The NEPA DEIS describes climate change impacts that will affect peak flow generation, including warmer temperatures leading to more precipitation falling as rain rather than snow (DEIS Appendix G, 5.6.1, p. 55), more winter precipitation, increased frequency and intensity of peak flow-generating atmospheric river events (DEIS Appendix G, 5.6.2, p. 56), and therefore "***increased risk of winter and spring flooding** in the Chehalis Basin"* (DEIS Appendix G, 5.6.2, p. 56; emphasis added). Thus, the NEPA DEIS reports well-established climate trends (DEIS Appendix G, 5.6; Appendix K, 5.4), but goes on to suggest that "***because it is not possible to predict the timing or extent of future flooding,** the analysis of operational impacts generally considered two flood scenarios.... the EIS generally assumes that the flood retention facility would operate on average once every 7 years, which is the average predicted frequency of a major flood*" (DEIS Executive Summary, ES 5.2.3 p. ES-7;

emphasis added). Whereas it is certainly not possible to predict the **timing** of future flooding (I.e., when a specific event will occur in time), a robust body of scientific studies show that the **frequency and magnitude** of future flooding will increase (Hamlet et al. 2013; Mauger et al. 2016; Warner, Mass, and Salathé 2015; Hamlet and Lettenmaier 2007; Elsner et al. 2010). There is variability amongst future projections, but they point in the same direction (i.e., more winter rain and more frequent and intense atmospheric rivers), so the decision to ignore future projections due to uncertainty is a major omission in the analysis.

Not only does the NEPA DEIS ignore best available science by using the historical flood recurrence interval to represent future climate, the NEPA DEIS obscures the issue by (1) qualitatively addressing climate change impacts in an unsubstantiated and unbalanced way (see discussion below), and (2) erroneously referring to these trends as “future climate variability” (DEIS Appendix G, 5.6 p. 54). Trends are statistically distinct from variability, in that the mathematical definition of a trend involves the detection of an increasing or decreasing pattern that is larger than the variance in the data, and therefore is statistically distinguishable from data points with no trend (e.g., Helsel and Hirsch 2002). By referring to trends in future climate as “future climate variability” rather than specifically as climate change, the NEPA DEIS obfuscates the lack of climate change analysis and casts doubt on the scientific credibility of the analysis.

The NEPA DEIS further confuses the issue by using differing language related to “climate variability” in different appendices, and, more importantly, by stating that the qualitative analysis related to “climate variability” is sufficient to understand future impacts. For example, whereas Appendix G only uses “climate variability” to describe trends, which is erroneous, Appendix H claims that “...The climate variability analysis used established, peer-reviewed and state-of-the-art climate projections and historical observations to determine **potential trends** for a range of relevant climate variables... [and] how changes in those variables could affect the frequency of drought, flooding, and wildfires... The analysis considered both long-term (chronic) and short-term, extreme (acute) climate variables **to fully understand climate variability and potential impacts** in the study area.” (DEIS Appendix J, 5.5, p 44; DEIS Appendix G, 5.6, p 54; emphasis added). By choosing to exclude these acknowledged trends from any quantitative analysis of the frequency of FRE facility operation and downstream impacts, and by substituting unbalanced and unsubstantiated qualitative analysis for quantitative analysis, the claim that the aim of the analysis was to “to fully understand climate variability and potential impacts in the study area” is misleading and false. Consequently, the NEPA DEIS fails to accurately represent and disclose to regulatory decision makers the impacts to all resources analyzed in the DEIS.

All Future Impacts Related to FRE Operation are Underestimated

By not incorporating climate change in any quantitative analysis, all impacts associated with the frequency and duration of dam operation and reservoir impoundment are underestimated. The NEPA DEIS assumes that the FRE facility will be operated at a frequency of once every 7 years. In contrast, the SEPA DEIS analysis reported a frequency of once every 5 years by mid-century and once every 4 years by late-century, and our previous analysis of the SEPA DEIS estimates that the frequency would actually be once in every 1.8 and 1.4 years under mid- and late-century climate change scenarios (see *SEPA Hydrology 2 Technical Memo*).

Previous analysis of the SEPA DEIS reviews the multitude of ways that the nature, scale, and intensity of upstream and downstream impacts are underestimated when the frequency and duration of FRE operation are underestimated (see *SEPA Hydrology Technical Memo 1*, and *SEPA Cascade of Ecosystem Effects Technical Memo*, attached), including:

- Underestimation of the increases in the frequency and magnitude of landslides and hillslope erosion, and therefore sediment delivery;
- Underestimation of impacts to channel morphology, sediment transport, vegetation, and aquatic habitat within the reservoir area and downstream of the reservoir; and

- Underestimation of the impacts to the formation and maintenance of floodplain wetlands and the recharge of groundwater.

The lack of climate change analysis compounds the flawed hydrologic analyses of current conditions (discussed above), and results in more extreme underestimates of all impacts related to the frequency and duration of the operation of the FRE facility. Furthermore, the NEPA DEIS analyses fail to account for the ways in which impacts from the operation of the FRE facility, such as reduced groundwater recharge and storage, will amplify climate change projections for lower summer streamflow and higher summer stream temperatures.

Unsubstantiated and Unbalanced Qualitative Analysis of "Climate Variability"

In addition to the gross underestimation of all local and downstream impacts due to the failure to incorporate quantitative analysis related to climate change, the NEPA DEIS substitutes an unsubstantiated and unbalanced qualitative analysis of the effect of "climate variability" that gives the erroneous impression that the NEPA DEIS includes a meaningful analysis of future impacts.

Many of the <u>qualitative</u> statements use <u>quantitative</u> descriptor words that are entirely unsubstantiated by evidence. For example:

- "*These projected changes would likely result in slightly greater deterioration of water quality under Alternative 1 than outlined in the above impact analysis. For example, if the air temperature increases in the future, the water temperatures shown in the Alternative 1 modeling may be higher than those predicted under existing conditions*." (DEIS, Appendix G, 6.4.2.2.3, p. 115). There is no basis for the word "slightly" without quantitative water temperature modeling that incorporates future air temperatures.
- "*As a result, the potential impacts from floodwater impoundment on groundwater recharge, movement, connectivity, and the hyporheic zone described in the preceding sections could increase. However, such impacts would likely remain low because of the relative infrequency of FRE operation*." (DEIS, Appendix G, 5.4.3.3, p. 121) There is no basis for the conclusion of 'low' impacts made in this statement without an analysis of future frequency of FRE operation and the associated impacts.
- "*Under these conditions, it is possible that the proposed FRE facility would operate more frequently. This would result in more frequent impacts on all aquatic species in the vicinity of the FRE facility, mainly from the loss of aquatic habitat and reduced fish passage when the temporary reservoir was impounding water*." (DEIS, Appendix K, 6.4.4.4, p 130). There is no basis for the mechanism of 'loss of aquatic habitat and reduced fish passage' being the 'main' impact on aquatic species in this statement without an analysis of future frequency of FRE operation and the associated cascade and amplification of ecosystem impacts (see *SEPA Cascade of Ecosystem Effects Technical Memo*).

Furthermore, without any quantitative evidence available to compare the relative importance of different impacts, the statements included in the qualitative analysis are unbalanced. The qualitative analysis highlights components of potential future habitat improvement without providing any context of the overarching and pervasive future wetland, aquatic, and floodplain habitat degradation associated with the cascade of impacts from increased frequency and duration of impoundment at the FRE facility. For example, the NEPA DEIS states that:

- "*Including climate variability would also* ***increase the habitat benefits associated with operation of the FRE facility****. For example, with increased major or greater flooding.... impounding water behind the FRE facility* ***may result in improved conditions*** *because major or greater flooding would no longer occur and bed scour would be reduced.*" (DEIS, Appendix K, 6.4.3.6, p. 93; emphasis added) There is no basis for this statement without an analysis of future frequency of FRE operation, its effect on sediment supply and transport, and the associated cascade of ecosystem impacts.

- "*Increased instream flow during the winter and spring* ***could lead to more frequent occurrence of major and catastrophic floods that would cause both short-term negative and longer-term beneficial impacts***." (DEIS, Appendix K, section 6.3.4, p. 67; emphasis added) This statement is included in the qualitative analysis of "climate variability" impacts of the No Action Alternative but provides no additional description or substantiation of what the aforementioned "short-term negative and longer-term beneficial impacts" are or how they were determined to relate to the No Action alternative.

Lastly, the qualitative analysis of "climate variability" further describes impacts of hypothetical future projects under the No Action Alternative in comparison to the proposed projects under the FRE and FRO Alternatives:

- "*Climate variability models for the Chehalis Basin (Section 5.5) predict increased levels of winter precipitation and an increased frequency of extreme precipitation events driven by atmospheric river storms. If such changes occur, the potential for severe erosion events on construction projects that disturb soil in the study area would increase. Such increases would have a greater potential to directly and indirectly affect wetlands and other waters on or adjacent to such projects. Standard construction BMPs required by local, state, and federal agencies would likely reduce some of these potential impacts. Climate variability models also predict a potential increase in the frequency of major floods. Such conditions may require the implementation of additional flood-reduction projects in the Chehalis Basin, which could result in additional impacts on wetlands and other waters.*" (DEIS, Appendix J, 6.3, p. 52). The comparison between the potential impacts of hypothetical future projects and the proposed project gives the impression that the future impacts of the No Action Alternative are of similar scope, intensity and magnitude as the FRE and FRO Alternatives and thus that the comparison is somewhat balanced, which is unsubstantiated by analysis.

Future Achievement of Purpose and Need Cannot be Evaluated without Addressing Climate Change

By not incorporating climate change projections, the future achievement of the flood damage reduction metrics (DEIS 3.2.2, p. 23) associated with the purpose and need are called into question. Climate change projections indicate that the frequency and magnitude of peak flows will increase into the future (Hamlet et al. 2013; Mauger et al. 2016; Warner, Mass, and Salathé 2015; Hamlet and Lettenmaier 2007; Elsner et al. 2010). The NEPA DEIS suggests that the FRE facility may have sufficient capacity to impound more water and therefore to achieve its stated purpose even for floods larger than the historic 100-year: *"In such larger floods, the quantity of water held back by the proposed flood retention facility could be larger than that held back during a 100-year flood, because the flood retention facility capacity is not exhausted in the 100-year flood."* (DEIS Appendix G, 6.1.1) However, the NEPA DEIS fails to analyze at what frequency the flood retention facility capacity would be exhausted in the future, based on increases in frequency and magnitudes of future flows. Furthermore, the frequency and magnitude of peak flows is projected to increase across the Chehalis River basin (Mauger et al. 2016), but there is no analysis of how increases in peak flows in other contributing drainages will affect the ability of the FRE facility to meet the stated purpose of reducing flood stage within the 100-year floodplain of the Chehalis River from Adna to Grand Mound, which is downstream of several unregulated tributaries. For example, if peak flows from the South Fork Chehalis, Newaukum and Skooumchuck Rivers increase in the future, will the impoundment of water in the upper Chehalis River be effective for meeting the specifically stated flood reduction targets downstream? In addition, with increased frequency of atmospheric river events, what is the future probability of back-to-back storms that occur within the reservoir drawdown period, and in this scenario would the targets for downstream flood reductions be met? The lack of analysis of climate change impacts on peak flows is an omission in quantifying whether and how often the stated purpose of the FRE facility would be met, which calls into question whether the FRE and FRO alternatives meet the stated Phase 1 screening criteria for NEPA consideration as “reasonable alternatives [that] must also accomplish the underlying purpose and need” (DEIS, 3.2, p. 22).

CONCLUSIONS

Based on our understanding of the Proposed Project and the analyses presented in the DEIS, it is our conclusion that:

- The NEPA DEIS underestimates the frequency of peak flows that would trigger operation of the FRE facility under current conditions and therefore underestimates all impacts associated with frequency and duration of the operation of the FRE facility.
- The NEPA DEIS underestimates the downstream impact on groundwater and wetlands by using inappropriate groundwater recharge rates and a rudimentary groundwater-surface water analysis.
- The NEPA DEIS fails to use best available science by not including quantitative analysis of climate change impacts on the frequency and duration of peak flows that would trigger FRE operation. Climate change projections are readily available for the Chehalis Basin, are based on a large body of scientific work, and are applicable to the time period of analysis for the NEPA DEIS, 2030-2080.
- The NEPA DEIS obfuscates the lack of robust analysis of climate change through its unsubstantiated and unbalanced qualitative analysis of "climate variability", in addition to its use of the term "climate variability" to describe trends (which, by definition, are mathematically distinguishable from variability).
- Together, the flawed hydrological analyses for current conditions along with the failure to incorporate climate change projections results in an underestimation of the frequency and duration of operation of the FRE facility, which results in the underestimation of all local and downstream impacts related to operation of the FRE facility, including impacts to sediment delivery and transport, instream aquatic habitat, and floodplain wetlands.
- Without incorporating climate change projections throughout the Chehalis Basin, it is impossible to analyze whether the FRE facility will meet its stated purpose and need related to flood damage reduction metrics during 2030 to 2080.

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