

To: Quinault Indian Nation
Attn: Karen Allston

From: Natural Systems Design and Saturna Watershed Sciences
Paul Pittman, PEG & Tim Abbe, PEG, PHG

Date: April 28, 2022

Re: Review of “Dam Safety Standards and Seismic Fault Study Review” Technical Memo by HDR dated February 23, 2022

PURPOSE AND UNDERSTANDING

An expandable flood retention facility and airport levee improvements have been proposed by the Chehalis River Basin Flood Control Zone District (FCZD) 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 by the U.S. Army Corps of Engineers (USACE) under the National Environmental Policy Act (NEPA) and by the Washington State Department of Ecology (Ecology) under the Washington State Environmental Policy Act (SEPA). The stated purpose of the FRE 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.

It is our understanding that HDR prepared the February 23, 2022 “Dam Safety Standards and Seismic Fault Study Review” technical memo (Technical Memo) to summarize federal and state dam safety standards and provide a preliminary assessment of the seismic condition at or near the site and how it would affect the proposed Flood Retention Only - Expandable (FRE) facility design. The information provided in the six-page memo supplements the information previously provided during the NEPA and SEPA environmental reviews being conducted by USACE and Ecology, respectively. NSD and Saturna Watershed Sciences have reviewed the Technical Memo to consider whether the FRE design presented as the preferred alternative in the NEPA and SEPA Draft Environmental Impact Statements (DEISs) utilized the appropriate public hazard and risk-based standards and accurately presented the potential risk of the proposed facility to decision-makers and the public as required under SEPA and NEPA environmental review standards.

For decision makers to consider the public safety risks to life and property, it is incumbent upon the FCZD as the project proponent to demonstrate that they have applied all required dam safety standards as well as current knowledge about changing hydrology resulting from the warming climate.

FINDINGS

Analysis of Risk Remains Incomplete

The Technical Memo states that “The Chehalis Basin Flood Control Zone District (District) is in the process of planning and design of a flood control facility to reduce future risks to life and property within the Chehalis River basin.” It was previously understood that the planning and level of design presented in the DEIS had been advanced to a confidently feasible level such that it would enable the public and regulatory agency decision-makers to reasonably understand the impacts to the public and Treaty-protected resources from a flood retention structure that was designed to meet required engineering standards. Because the proposed FRE

facility is “in the process of planning and design” the analysis presented to indicate compliance with dam safety standards and seismic risk paints, at best, an incomplete picture of the risk associated with the proposed FRE facility and therefore the “Dam Safety Standards and Seismic Fault Study Review” does nothing to improve the transparency or accuracy of the insufficient analysis previously prepared of potential impacts and risk posed by the proposed facility. As a result, the information provided regarding the FRE design and the impacts analysis presented in the NEPA and SEPA DEISs **may under-represent potential impacts to public safety, as well as to Treaty-protected resources.**

Construction of the proposed FRE facility creates a hazard that currently does not exist: a dam break flood. The consequences of this event would be far greater than natural floods. Risk is defined as the product of probability times consequences. Since the consequences are extremely high, even a low probability of the event occurring still poses a high risk. There are several mechanisms that could drive a dam break scenario, two of which are of particular concern given the local and regional geology and neither of which is addressed in the analysis of risk presented in the Technical Memo and DEISs. The first is landsliding within the reservoir area that could send large displacement waves over the dam. The second is a deep subduction earthquake.

Risk of Landsliding

As has been previously commented upon in detail during review of the NEPA and SEPA DEISs (Natural Systems Design and Saturna Watershed Sciences 2020a and 2020b), the reservoir area is extremely prone to landsliding due to the weak bedrock, steep slopes, and high precipitation. Reservoirs with large variation in water levels and rapid drawdowns are prone to trigger large landslides, yet the analysis evaluating these events is incomplete and did not consider or address large displacement waves that would be generated if a large landslide occurred while the reservoir was retaining water.

Risk Posed by Subduction Earthquake

The Technical Memo summarizes the updated data from WDNR regarding the larger maximum credible earthquake event (magnitude 7.3), updated fault slip rates, and increased possible fault rupture length at the Doty fault. The Technical Memo also notes that the proposed design (i.e., the design presented in the NEPA and SEPA DEISs) has not been based on seismic structural response analysis.

*“It should be noted that the proposed design for the FRE facility **has not been based on a seismic structural response analysis.** To date, the cross-sectional properties of the FRE facility have been based on HDR’s experience with other similar projects in a comparable seismic hazard location.” [emphasis added] (Section 3.0, pages 5 and 6)*

Hence, as has been previously commented upon in detail during review of the NEPA and SEPA DEISs (Natural Systems Design and Saturna Watershed Sciences 2020a and 2020b), the ability of the proposed FRE facility to withstand a deep subduction earthquake, and/or a shallow earthquake of the Doty fault, has not been incorporated into the design. It is well established that Western Washington will experience a magnitude 9 or greater Cascadia Subduction Zone event (Nelson et al. 2021, Staisch et al. 2019, Perkins et al. 2018). A magnitude 7 event releases an energy equivalent approximately equal to 500,000 tons of TNT. The energy release of a magnitude 9 event would be a thousand-fold greater, 500,000,000 tons of TNT. Yet the design implications of seismic events of that magnitude have not been adequately presented in the design and to regulatory decision makers. **Thus, the analysis of risk posed by the proposed FRE facility is incomplete and insufficient for regulatory decision makers to determine whether the proposed project is in the public interest.**

Failure to Consider All Design Standards

The Technical Memo referenced “Federal Guidelines for Dam Safety,” FEMA P-93, published by the Federal Emergency Management Agency (FEMA, 2004) as a guiding document. While including references for relevant guidelines and engineering standards is relevant information that was deficient in previous submittals, it is our opinion that there are additional guidance documents, such as “Technical Manual: Overtopping Protection for Dams” FEMA P-1015 (May 2014) and “Appurtenant Structures for Dams (Spillway and Outlet Works) Design Standards – Design Standard No. 14” by the Bureau of Reclamation and others which should guide design. The FRE design presented in the DEIS should have included these, and all relevant standards. It was not disclosed if these standards were followed, nor did the applicant demonstrate that these standards are achieved by the proposed design considered in the NEPA and SEPA DEISs.

Given the potential for overtopping of the structure by extreme precipitation events, bypass structure damage or obstructions, landslide displacement waves, or seismic seiche, and the resulting high public safety risk, more planning and design needs to be completed as part of the NEPA and SEPA EIS review processes. More planning and design development is necessary so the public and decision-makers are provided with sufficient and accurate information by which to determine the potential risk of significant impacts, including to public safety, life, and property if the proposed FRE facility were to be constructed.

According to the Association of Dam Safety Officials, most dam failures are a result of overtopping and inadequate considerations of hydrological, seismic, and/or geologic processes influencing water surface conditions (<https://damfailures.org/lessons-learned/>). Previous analyses concluded that the threat from landslides, which are expected to increase as a result of proposed drawdown rates, are woefully underrepresented and not accurately considered in the design standards process (Natural Systems Design and Saturna Watershed Sciences, 2020a and 2020b). Bureau of Reclamation design standards state that “Risks associated with plausible Potential Failure Modes (PFMs), must be tolerably below Reclamation’s public protection guidelines.” Washington State requires an Emergency Action Plan (EAP) for projects where a dam failure could pose a threat to life and dam break modeling analysis. **As presented, the information provided to public and decision-makers regarding the risk of dam overtopping and failure is not fully disclosed nor accurately depicted given that the proposed FRE facility, as presented in the DEISs and as acknowledged in the Technical Memo, has not yet been designed to meet all applicable dam safety standards.**

*“Federal dam safety standards for design of the FRE **will be based** on the most current edition of FEMA P-93 supported by technical design standards developed by the USACE. While Reclamation and USACE have independently developed design standards for roller-compacted concrete (RCC), Reclamation’s RCC standards were published in 2017, and references the USACE’s design standards published in 2000. Both standards are similar, but Because Reclamation’s technical information is based on more contemporary experience with RCC, Reclamation’s standards **will also be considered in the design**. When presented with the decision of which standard’s value or approach to use, **the decision will be made** based on industry best management practices and the design team’s judgement of the value or approach that best satisfies the design and functional objectives of the FRE facility while meeting regulatory requirements.” [emphasis on future tense added] (Section 2.0 page 2)*

As a result, the DEISs **under-represents potential impacts to public safety and to Treaty-protected resources resulting from the proposed FRE facility.**

Insufficient Hydrologic and Hydraulic Analysis

The hydrologic and hydraulic analysis for inflow design floods to support dam design parameters provided in previous technical documents was not developed to federal and state standards. According to federal

standards, this analysis should be completed prior to dam structure design. Design standard documents from both FEMA, Reclamation, and the US Army Corps of Engineer need to be used. “Selecting and Accommodating Inflow Design Floods for Dams” FEMA P-94 (August 2013) is a guide for this analysis.

Reclamation Design Standards No. 14 Appurtenant Structures for Dams (Spillways and Outlet Works) - DS-14(1)-4 states that the Probable Maximum Flood (PMF) for spillway and outlet design is the “largest flood that may reasonably be expected to occur at a given maximum runoff condition resulting from the most severe combination of meteorological and hydrologic conditions that are considered reasonably possible for the drainage basin under study”. Given the high risk of large landslides within the reservoir and fact that landslides can occur concurrently with extreme rainfall, displacement waves should be considered in PMF estimates. Given the significant increases in peak flows that will result from the warming climate, the PMF estimates should also be done to account for the worse case climate scenario (per standards for “largest flood that may reasonably occur”) over the life span of the dam. The Reclamation Design Standards describes the design process steps as: 1) Prepare initial flood routings of frequency floods up to the PMF to verify the appropriateness of the spillway type and size, and to select the Inflow Design Flood, then 2) refine spillway control (crest) structure layout and associated discharge curves based on results from previous steps. The warming climate is expected to substantially increase storm magnitudes and intensities and the peak flows from these events. These changes are expected to occur in the next several decades, well within the life span of the proposed FRE facility. A conservative estimate of the PMF including predicted changes resulting from the warming climate over the life span (>100 years) of the proposed dam is an essential part of international standards for dam safety. This has not been done.

As presented to date, the information provided to the public and decision-makers regarding the hydrologic and hydraulic (H&H) analysis and structure designs are insufficient to ensure accurate and complete information regarding the risk of the proposed FRE facility. No new H&H analyses or information was provided in the Technical Memo, and it is thus unknown the degree to which a reassessment and re-design of the proposed FRE structure will be required to meet federal and state standards. Therefore, it is conservatively assumed that **the design presented in the DEISs, having not yet been developed to meet federal and state standards, may thus under-represent potential impacts to public safety and Treaty-protected resources.**

Failure to Analyze and Design for Increased Seismic Risk

The Technical Memo identifies that new seismic data is available which increased the “maximum credible earthquake” at the Doty fault from magnitude 6.9 to magnitude 7.3. The technical memo states with respect to seismic design that “*Results from this study will be reviewed during the design phase and updated as additional data about the Doty fault is obtained. Response of the FRE facility and expected consequences over a range of return periods will be evaluated for establishing an acceptable level of risk.*” (Section 2.1.8, page 4)

While it is appropriate to use the updated seismic analysis, the resulting design analysis needs to be completed and presented to the public and decision-makers during the NEPA and SEPA environmental review process to provide the required analysis and disclosure of impacts and allow for public comment on this element of public safety. It is unclear how this new information may change the existing FRE design or influence the previous landslide hazard analyses and related characterization of potential ecosystem impacts. Alarming, the technical memo states that “*It should be noted that the proposed design for the FRE facility has not been based on a seismic structural response analysis.*” Prudent dam safety uses the maximum probable events (e.g., PMF) when public safety risk is high, as is the case with this structure. Without presenting the supporting seismic structural response analyses and a design that is compliant with applicable standards, **the public and decision-makers cannot be certain that the design adequately addresses seismic risk; therefore, it may under-represent potential impacts to public safety and Treaty resources.**

Construction of the dam introduces risks that don't currently exist, most notable of which is a dam failure. Given the catastrophic effects of a dam failure on downstream communities (e.g., Pe Ell), it is incumbent upon the FCZD to ensure the dam will meet the highest safety standards over the project's lifetime (>100 years).

Incorrect Premise Regarding Design Standards

The Technical Memo states that *“Like most states, Washington State does not specify a set of design standards for concrete dams, including roller-compacted concrete, but instead defers to federal standards”* (Section 2.0, page 2). This statement is not accurate as Washington State does have relevant regulations that apply to minimum design standards under its Dam Safety Regulations (Chapter 173-175 WAC), which includes seismic design and capacity standard for large, high hazard dams, such as the proposed FRE. Subject to RCW 43.21A.068, the Washington State Department of Ecology shall have “supervision and control over all dams and obstructions in streams and may make reasonable regulations with respect thereto concerning the flow of water which he or she deems necessary for the protection to life and property below such works from flood waters.” The authority and responsibility to regulate dams and provide for public safety in Washington are contained in the following laws:

- ▶ State Water Code (1917) - Chapter 90.03 RCW
- ▶ Flood Control Act (1935) - Chapter 86.16 RCW
- ▶ Department of Ecology (1970) - Chapter 43.21A RCW

Additionally, Washington State requires a modeled dam failure scenario mapping and an Emergency Action Plan (EAP). The map for the dam failure scenario would likely change given that the proposed FRE facility as presented in the DEISs does not meet design standards (see Comments 1 through 4 herein). This map should be disclosed to the public and decision-makers as part of the NEPA and SEPA EIS review processes to enable informed risk-based decisions and ensure that the project does not under-represent potential impacts to public safety and Treaty-protected resources.

Lack of Information Regarding FCZD Capacity to Operate and Maintain the Facility

The Chehalis Basin Flood Control Zone District (District) is the stated dam operator, or responsible party. It is the responsible party that is primarily responsible for dam maintenance and the safety of the structures as achieved through proper design, construction, operation, and maintenance of their facilities. It is unclear through the materials submitted through the SEPA and NEPA DEISs how the FCZD will not only fund construction but will fund and maintain the operations and maintenance of the facility in perpetuity. Dam maintenance is expensive and requires full-time skilled professionals. No information is provided showing that the FCZD has experience in dam operations and maintenance. Given the potential for changes to design and construction to account for the underestimated seismic, hydrologic, and hydraulic conditions, the construction costs are likely to increase, potentially significantly. The costs and associated impacts stated therefore **under-represent potential costs and impacts to public resources**.

CONCLUSIONS

We have drawn the following conclusions from the review of the supplemental “Dam Safety Standards and Seismic Fault Study Review” technical memorandum:

- ▶ Given that new information (seismic analysis) exists, Appendix H Discipline Report for Geology and Geologic Hazards (SEPA DEIS) should be updated to integrate this new information and update related

design information to address the seismic hazard and risk to the proposed structure and downstream communities.

- ▶ It is apparent that the previous technical analyses and designs presented in the DEISs did not follow all relevant design standards or use the appropriate seismic information. If design changes result from delayed integration of design standards and seismic information, the design could be different in nature, scale, function, footprint, and cost – and thus have different potential impacts than disclosed in the NEPA and SEPA DEISs. The designs should be updated to integrate all relevant standards and design requirements.
- ▶ Failing disclosure of a facility design that meets required dam safety standards, the analysis of impacts, benefits, and costs provided to the regulatory decision makers and the public are inherently flawed and inaccurate.
- ▶ Ergo a design that must change to meet dam safety requirements cannot be appropriately considered under NEPA or SEPA and thus cannot proceed to be considered for construction permits under any federal or state statute which relies on NEPA or SEPA review to determine the scale and intensity of potential impacts from issuance of said permits.

The Technical Memo does not respond to or satisfy the public comments provided under the NEPA and SEPA DEIS processes regarding risk to public safety from the proposed FRE facility. It similarly does not provide any updated analyses to the public and decision-makers to ensure that the scale, intensity, and consequence of risks to public safety and impacts from a failure of the proposed FRE facility have been sufficiently evaluated under NEPA and SEPA for informed decision-making.

For the public and decision makers to consider the public safety risks to life and property it is incumbent upon the FCZD, as the project proponent, to **demonstrate that they have applied all required dam safety standards to the design presented for regulatory agency consideration of impacts under NEPA and SEPA.** It is similarly incumbent on the FCZD to have included **current knowledge about seismic conditions, landslide hazards, and changing hydrology resulting from the warming climate in the impact analyses presented in the EISs.** The importance of a thorough risk assessment is clear given a dam failure would result in loss of life and catastrophic economic costs. **A thorough assessment has not been done.** A determination of the costs of maintenance to ensure dam safety has also not been done, nor a mechanism determined for how the funding of maintenance will be procured.

REFERENCES

- Natural Systems Design and Saturna Watershed Sciences. 2020a. *Earth Discipline Report - Geology Technical Analysis Review*. Prepared for Quinault Indian Nation for Proposed Chehalis River Basin Flood Damage Reduction Project. Draft SEPA Environmental Impact Statement review. April 23, 2020.
- Natural Systems Design and Saturna Watershed Sciences. 2020b. *Geology Discipline Report Review - Addendum*. Prepared for Quinault Indian Nation for Proposed Chehalis River Basin Flood Damage Reduction Project. Draft Environmental Impact Statement NEPA review. October 2020.
- Nelson, Alan R., Christopher B. DuRoss, Robert C. Witter, Harvey M. Kelsey, Simon E. Engelhart, Shannon A. Mahan, Harrison J. Gray, Andrea D. Hawkes, Benjamin P. Horton, Jason S. Padgett. 2021. A maximum rupture model for the central and southern Cascadia subduction zone—reassessing ages for coastal evidence of megathrust earthquakes and tsunamis. *Quaternary Science Reviews*. Volume 261. June 2021.106922. <https://doi.org/10.1016/j.quascirev.2021.106922>.

Perkins, J. P., Roering, J. J., Burns, W. J., Struble, W., Black, B. A., Schmidt, K. M., Duvall, A., and Calhoun, N. 2018. Hunting for landslides from Cascadia’s great earthquakes, *Eos*, 99, <https://doi.org/10.1029/2018EO103689>. Published on 08 August 2018.

Staisch, L., Walton, M., and Witter, R. 2019. Addressing Cascadia Subduction Zone great earthquake recurrence, *Eos*, 100, <https://doi.org/10.1029/2019EO127531>. Published on 02 July 2019.