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To: SEPA Revised Draft EIS for the Proposed Chehalis Flood Damage Reduction Project
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To Whom It May Concern:

Americans have had over a century of experience with major dams and their impacts on rivers, and on the plants, animals, and fish that live in and next to them. Even a casual review of this history reveals that these impacts have overall been large and deleterious. And yet, here we are in the year 2026, seriously contemplating yet another major dam on the only un-damned river of its size in the state of Washington. I will begin by talking about the historical, cultural, and philosophical issues that are being ignored in this deeply-flawed planning and decision making process. Following that, I will discuss technical deficiencies and oversights of the physical analysis that has been done, which point to more serious impacts than those stated.

By way of introduction, let me state that I writing to you as a private citizen. However, I am drawing on 36 years of experience as a professional fluvial geomorphologist with particular expertise in sediment transport, sediment transport modeling, and hyporheic processes. Nineteen of those 36 years were spent working in the arena of river habitat restoration, including assisting with projects proposed under the Chehalis Fisheries Restoration Program. Ironically, the vast majority of those projects had as their objective elimination of fish passage barriers. And yet, here we are, contemplating building the mother of all Chehalis River fish passage barriers! There is no evidence that the project proponents can mitigate for the effects of this barrier on the already declining salmon and steelhead stocks. There is also no evidence that they can mitigate for the loss of habitat-forming and sustaining processes which would be degraded by the dam, including flood-dependent processes like sediment transport, streambed scour-and-fill patterns and timing, large-wood recruitment, or off-channel and floodplain habitat connection and maintenance over time.

If there was one overriding lesson summarizing my experience with river restoration, it is that restoration is no substitute for protection of existing functioning habitat. We cannot continue to eliminate habitat or degrade habitat and expect to replace that function with river restoration in the guise of "mitigation." As important as restoration is for outreach and education, to connect people with river stewardship through positive action, and to jump-start recovery in locations where the habitat-forming processes are still intact, it does not make up for ongoing habitat loss and degradation. There is a whole literature supporting this statement (see, for example, Palmer, et al., 2015; Wohl, et al., 2010; dos Reis Oliveira et al., 2020).

During the heyday of dam construction in in the U.S., which began in the 1930s and continued through the 1970s, habitat and habitat-maintaining processes were often willingly sacrificed under the shortsighted notion that habitat was not needed. Either it was believed that habitat could be replaced by intensive hatchery operations, or in some egregious cases, it was thought that we already had plenty of habitat, and plenty of fish, so some could be sacrificed. This philosophy was part of an ongoing, incremental destruction of habitat that has led to the dire situation that we are now in with regard to the future of salmon and steelhead in the state of Washington. Mitigation through hatcheries has not worked. An older but still very relevant treatise on that theme is the 1999 book, Salmon Without Rivers, by Jim Lichatowich. In spite of all the money and effort spent on hatchery operations, salmon and steelhead have continued to decline. And arguably, hatcheries have become part of the problem itself, interfering with the population genetics and fitness of the remaining wild stocks and reducing the overall fitness of the species.

But the biggest philosophical failure of the age of big dams has been the reductionist approach to analyzing and trying to compensate for the effects of the dams on the river ecosystem. Each component of habitat has been analyzed separately, so that "techno fixes" could be developed for that individual component. For example, if the dam blocked sources of spawning gravel, the mitigation would be "gravel augmentation" (an unsustainable, expensive and poorly-effective practice).

There are several things wrong with this approach. First of all, it assumes that the people analyzing the effects of the dam properly identify all of the effects. Not just most of them, but all of them. This process can fail when there is a cascading chain of effects, such that one effect causes another one that was not anticipated, which in turn causes a reaction, etc. The current huge problem with predatory invasive fish species in the Columbia River system is a good example of this, and dams were the ultimate cause. The other way that this analysis process fails is in the identification of incremental or cumulative effects, and in weighing the importance of these. Many if not most of the items identified in the Revised DEIS analysis for the Chehalis River dam as "minimal" in their impact may, in the long-term, become part of a cumulative effects disaster. The dam, in fact, is adding to the greatest cumulative effects issue that we face, namely, the thousands of man-made fish passage barriers. This is such a big issue that it now gobbles up a sizeable portion of the Department of Transportation budget to replace thousands of culverts.

A much more serious failing of the reductionist, piecemeal approach that is being applied here is that it fails to treat the river as a landscape-scale, holistic, complex, interconnected system, with self-organizing and self-maintaining behavior. Because of the narrow objectives of the proposed project, and the narrow scope of engineered "solutions" to impacts, the proposed dam and its accompanying mitigation actions alter the behavior of the river corridor in unforeseen ways.

As is common to all complex systems, rivers have emergent behaviors, that is, behaviors that appear only due to the system functioning as a whole, and cannot be predicted from individual parts of that system (see, for example, Abed-Elmdoust et al., 2017; Czuba and Foufoula-Georgiou, 2015). In particular, rivers have self-organizing and self-maintaining properties that engineered solutions to individual problems do not. Each part of the long-term hydrograph, including the big floods, plays an irreplaceable role in the system behavior. Rivers undergo threshold responses to change, even gradual change, that depend on the interconnections between the channel-adjacent hillslope and headwaters, sediment source areas, the wetted channel, the floodplain, the riparian zone vegetation, the soil and streambed, and subsurface flows of water, both lateral and vertical (Bakke et al., 2020; Harris and Heathwaite, 2011). The river maintains and renews itself through the interaction of all these things. Everything from channel migration rates and patterns in alluvial reaches to the distribution and dynamics of gravel patches to the occurrence and stability of large wood pieces and logjams are part of this emergent system behavior. With the dam, whole-system function would be altered, leading the river ecosystem to evolve along unforeseen trajectories, to the detriment of the salmon and steelhead that cannot change their lifecycles or genetic predilections on human time spans.

Humans are part of this system too, as is the human economy. System trajectories that encourage yet greater resource extraction (water, large wood) or encroachment (floodplain development) are likely outcomes of the proposed dam. Human attitudes adjust in unforeseen ways that limit future mitigation or restoration options. Flood control leads to expectations for more flood control, and the political will to do this negates any promises made under the current decision process. Reservoirs create demand for stable reservoir conditions to accommodate human aesthetics, recreation or yet-unforeseen uses. It is not far-fetched to imagine this proposed dam morphing into a bigger dam, or one with a permanent reservoir that doesn't allow ANY continuity of sediment, large wood or fish migration at all. This is the proverbial camel getting its nose into the proverbial tent.

Now let us talk about salmon and salmon habitat. The most important aspect of this habitat is, of course, water; without enough water there cannot be salmon. And this water must be cool, clean, and well connected throughout the watershed, such that salmon can find and occupy complex habitat. This complex habitat consists of water velocity patterns, water discharge patterns timed correctly to match the requirements of salmon lifestyle, cover, large wood, and significantly, certain important streambed sediment characteristics. The reason that we have historically had amazing salmon populations in this part of the world is that we have had lots of clean water, following the correct seasonal flow pattern, and we have had ample streambed sediment, of the correct size mixture. Gravel-sized sediment, in a diverse streambed topography, is paramount for functional salmon habitat. Dams, this one included, reduce the availability of that habitat by altering the pattern of water flow from what it historically has been, and upsetting the availability, mobility, and type of streambed sediment.

In addition to forming complex habitat structure, and providing a substrate for the insects that salmon feed upon and lay their eggs within, the streambed forms a subsurface habitat called the hyporheic zone. This hyporheic zone is important habitat for numerous life forms, including the eggs and juveniles of salmon, and the insects they feed on. It also acts to cool, cleanse, and filter the surface water of the stream during times of the year when low water flow and high water temperatures cause extreme stress. Maintaining this hyporheic zone over time is an important ecological function of the pattern of water discharge and the scour-and-fill processes created by movement of gravel sized sediment by peak discharges. Moreover, patterns of input of sediment to the river upstream, and transport of the sediment, in the right quantities and size distribution to salmon habitat downstream is paramount to maintaining a functioning hyporheic zone, and thus to maintaining water quality, and streambed habitat quality.

When the hyporheic zone becomes exposed to a different flow and sediment transport regime or pattern, which includes reduced scour-and-fill processes due to coarsening of the streambed framework, as typically happens downstream of the dam, this important subsurface environment becomes clogged with fine sediment (sand and silt). Increases in suspended sediment from erosion occurring in the reservoir behind the dam as the water level bounces up and down exacerbates this clogging of the hyporheic zone and diminish the circulation of water into and out of the hyporheic zone. Increased suspended sediment creates embedded conditions, in which the larger grains become cemented in place by fine sand, and this embedded streambed resists vertical water movement.

These effects to the hyporheic zone are not analyzed sufficiently in the draft environmental impact statement documentation. This represents a rather serious oversight. As far as I know, nobody has figured out how to mitigate for lost hyporheic function in an effective, much less a cost-effective, manner, on the spatial scale of these impacts (Bakke et al., 2020).

The only mention of long-term impacts to the hyporheic zone that I could find in the Revised Draft EIS was to state that "The hyporheic zone of the Chehalis River at the FRE facility site and in the temporary reservoir footprint is assumed to be thin or absent due to lack of sediment along the streambed and banks." [Appendix N, page 71]. Yet, downstream from the dam there are numerous reaches of alluvial character, where hyporheic function should be protected, if not enhanced, in the name of salmon recovery. In fact, part of the intent of the forest practice rules, and the shoreline management act, both of which require forested buffer zones, are to assure that riparian forest zones will, eventually, provide large wood input for habitat function and maintenance. Hyporheic function is one of the desired physical processes driving this intent. Large wood input should, eventually, convert some currently non-alluvial bedrock reaches into forced pool-riffle morphology as streambed sediment accumulates due to greater hydraulic roughness. These reaches will have hyporheic function, and that function will be impaired by dam construction activities and ongoing dam operations as described above. Leaving this out of the discussion is unacceptable.

Dams, including this dam, disrupt the continuity of gravel sediment movement, causing long stretches of the river downstream to be gravel deficient. Dams also significantly alter the water discharge patterns downstream, altering the timing, frequency, magnitude and duration of those relatively small periods of time when gravel sized sediment is actively moving. Large short-duration discharges are replaced by longer duration medium discharges. These two situations, a natural pattern of numerous short-term large discharges versus discharges capped at an artificially set maximum, with the largest discharges replaced by longer-duration medium magnitude flows, are not equivalent either in terms of the volumes of sediment transported nor the size distribution in transport, nor, significantly, the size distribution of sediment making up the streambed as the streambed comes to equilibrium with the sediment in transport. The upshot of this is that the streambed size distribution, vertical layering pattern, and mobility changes. These changes are invariably detrimental to salmon.

There are two analytical tools that can be used to study these changes to streambed sediment size distribution and structure. The first is effective discharge analysis (Wolman and Miller, 1960). Using long-term historic water discharge data to create a statistical distribution of water discharges is the first step. Next, an appropriate sediment transport model is created to predict sediment transport rates for each discharge in the distribution. When these two entities are mathematically combined, the result is a discharge effectiveness curve, which shows graphically and mathematically how much sediment moves at each discharge over the long-term average. The peak of this effectiveness curve, the range of discharges that moves most of the sediment over the long-term, is the "effective discharge," and corresponds to the range of discharges that does most of the work mobilizing, transporting, and depositing sediment over time. This is the channel forming discharge (in its true sense; the term is conflated with "channel maintenance flows" in the Revised Draft EIS, Appendix F, Page 60). In river reaches where the streambed and banks are composed of alluvial (river-deposited) material, this discharge determines the geomorphic properties such as cross section shape and size, channel migration and planform pattern, longitudinal profile, and, significantly, the streambed composition and structure.

When effective discharge analysis is done for a natural statistical distribution of discharges and compared with an analysis done using a modified statistical distribution that is built from the modified hydrology due to the presence of a dam, this "effective discharge" changes from its natural value to the invariably larger value represented by the release of stored water from the dam during post-storm drawdown. Essentially, the distribution of energy available to transport sediment over time will be altered, which alters both the total annual volume of sediment moved and, most importantly, the grain-size distribution of that sediment. Larger discharges move disproportionately larger grain sizes than smaller discharges. Since the streambed develops an equilibrium with this dominant or channel forming discharge, that means that the streambed will coarsen, regardless of changes to the available sediment from upstream, just from this altered pattern of flow energy.

The technical documentation on which the draft environmental impact statement is based does not include an effective discharge analysis. It should. The HECRAS analysis that it does include is not equivalent to this. Moreover, that HECRAS analysis was done with an untenable sediment transport model, namely, the Ackers and White (1973) formula (Appendix F, page 69). This model was developed using flume studies with uniform-sized sediment having maximum diameter of 28 mm, rather than real rivers like the Chehalis which have mixed-grain-sized streambeds, and include much larger grains. As such, Ackers and White does not include the effect of the coarsened surface layer of the streambed in a gravel bed stream, which drastically alters the mobility of the different grain sizes of sediment (Parker and Klingeman, 1982). Using HECRAS with this obsolete model is not an acceptable way to perform this analysis. To correctly determine effects of dam-altered hydrology on streambed evolution requires a state-of-the-art model that predicts sediment transport for multiple grain sizes, not just an average or median size, and takes into account the moderating effect of the structure (layering) of the streambed, with its coarsened surface layer, on the mobility of cobble, gravel and sand particles.

The second important analytical tool for studying streambed evolution analysis is the use of a state-of-the-art multi grain sized sediment transport model to predict the changes to the streambed structure that would be required to attain equilibrium under and altered discharge regime, or an altered sediment availability from upstream. Theoretically, the gravel streambed develops a coarsened surface layer that allows it to come into equilibrium with the sediment in transport during the dominant, channel forming or effective discharges. The subsurface, that is the material beneath this coarsened layer, tends to look like the annual average bedload sediment (Parker and Toro-Escobar, 2002). Thus, the comparison of the surface and subsurface grain size compositions can be used to predict changes to the surface grain size distribution that would result from altered hydrology, or from altered total sediment volumes, or altered bedload grain size distribution, using adjustment of the salient coefficients in the transport model as a calibration exercise. Methodology for this sort of analysis has been available for decades. One example is the approach described in the classic paper by Dietrich et al. (1989). The authors of the draft EIS seem not to know how to do this.

Figure F-10 (Appendix F) indicates that surface and subsurface samples were taken, but seems to indicate that these were only used to show broad trends in downstream fining. It is not said whether the sampling included a full grain-size analysis, or only the broad "sand-gravel-cobble" categories. It is also not stated whether the surface grain sizes were determined via particle counts ("pebble counts") or sieved volumetric samples. If the former, then these samples are not useful for sediment transport analysis because they will invariably underestimate the sand component, and sand probably is a large fraction of the bedload in many if not most locations of interest. At any rate, the streambed grain size data was not used to answer key questions about the sediment load, most importantly, the bedload, and how it may change, quantitatively, with the proposed dam operations.

Also conspicuously missing are estimates of where the gravel-to-sand transition occurs in the sequence of stream reaches, and how this position may shift with the dam operations. The gravel-to-sand transition is an important feature, demarcating a significant transition in habitat type, marking limits to use by key salmon life stages, e.g. spawners, and juvenile rearing. If this transition point moves upstream, it could eliminate key habitat. Does it?

Again, the analysis done with HECRAS using the obsolete Ackers and White (1973) model does not accomplish this task, and leaves open to question the degree to which streambed sediment composition and structure will be altered. By streambed composition I do not mean just the average or median grain size, but the distribution of grain sizes, as it is this distribution which determines the quality of the habitat for key biological events such as spawning and juvenile rearing, as well as hyporheic function. The only reasonable conclusion, given this deficiency, is to assume worst-case in all alluvial portions of the channel downstream from the dam to the confluence of the mainstem, assuming that every potentially alluvial reach will have significant and unavoidable adverse environmental impacts.

Finally there is a consideration upstream of the proposed dam reservoir that deserves attention, and is poorly described in the draft environmental impact statement. The reservoir represents a new "base level," that is, a new elevation to which the channel upstream of the reservoir will adjust its longitudinal profile to equally distribute its longitudinal hydraulic energy dissipation. This adjustment is something that happens in a river over long time periods, centuries to millennia. Putting a reservoir in the middle of this river system will alter the long-term evolution of that upstream channel far beyond the limits of inundation and alluvial fan formation in the reservoir. These effects are difficult to predict. But one thing that is obvious, is that a reservoir of this type will be an unstable, constantly shifting base level. Thus, it creates a zone in the channel upstream of the reservoir that is also unstable, as the streambed is forced to adjust its slope and bed material composition without a stable endpoint. Salmon or other aquatic creatures which use the streambed will be impacted adversely by this instability, far upstream from the reservoir limits.

In closing, I would like to remind you that Washington State has shown remarkable leadership in the effort to recover some of what was lost during the era of dam building. Removal of the Elwha Dam, the Condit Dam, the Mill Pond Dam, and many other smaller dams has marked entry into a new era of learning to live sustainably with our rivers. These projects have been remarkable successes, but they are not enough. We can't "restore our way out" of past habitat destruction if we continue to add to the degradation. The era of dam building is over, and good riddance! Don't let the proposed Chehalis River dam go forward on your watch. Oppose this outmoded and destructive proposal!

Respectfully,

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