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Attn: Dr Johanna Kovarik
GPNF Supervisor
987 McClellan Road
Vancouver, WA 98661-3815

Comments on the Spirit Lake Outflow Safety Improvement Project

Dear Dr Kovarik,

My name is Colin Thorne, and I am an Emeritus Professor of Physical Geography at the University of Nottingham, England, currently residing in Vancouver, WA. I am an internationally recognized expert in river science and flood risk management, having advised governments and river authorities around the world, with my research cited more than 22,000 times¹.

I began studying the Toutle River and its tributaries draining Mount St. Helens in 1983 when I monitored the Corps' emergency pumping project, while an Associate Professor in Civil Engineering at Colorado State University. Since then, my research at MSH has focused on the river's post-eruption evolution and sediment dynamics, primarily in collaboration with the U.S. Geological Survey's Cascades Volcano Observatory. In 2009 and 2013, I was contracted by the Portland District, U.S. Army Corps of Engineers to provide guidance on sediment management in the Toutle-Cowlitz river system.

Currently, I am working with WDFW and the Lower Columbia Fish Enhancement Group to restore salmon habitat in both the North and South Forks of the Toutle. I am also collaborating with the U.S. Army Corps 'Engineer Research and Development Center' (ERDC) on a four-year, Corps-funded research project evaluating future engineering and management alternatives for the Toutle-Cowlitz system. In addition, I serve as an expert witness appointed by the Corps in two on-going cases before the U.S. Court of Federal Claims concerning management of sediment in the lower Mississippi River.

In this letter, I express my honest, expert opinion. For brevity, the detailed arguments supporting my opinion are appended in the Annex.

In my professional opinion, the USFS currently has a rare opportunity to shape a better future for Spirit Lake, the Toutle River, the Mount St. Helens National Volcanic Monument, and the people of Cowlitz County by choosing Alternative 7 -- replacing the existing tunnel with a pressure tunnel and applying Engineering with Nature (EwN®)² principles to safely create a controlled breach of the 1980 debris avalanche dam.

Alternative 7 is the clear choice because it:

¹ <https://scholar.google.com/citations?user=qShA0o0AAAAJ&hl=en>

² <https://ewn.erdcdren.mil/>

- A. Eliminates the risks to people, property, infrastructure, and ecology posed by a break-out flood.
- B. Generates multiple economic, societal, and environmental benefits that extend throughout the Toutle and lower Cowlitz valleys, are continuous, and will accrue in value for the foreseeable future.

Alternative 7 is the best option because it removes the threat of a catastrophic break-out flood by lowering Spirit Lake's elevation. It also facilitates reconnection of Spirit Lake with the North Fork Toutle River, restoring flow to six and a half miles of the headwaters and reopening passage for resident and migratory fish -- including listed salmon -- which helps revitalize Cowlitz County's eco-tourism economy.

There is an equally compelling, Policy-based case for Alternative 7, supported by three irrefutable facts:

1. Congress created the Mount St. Helens National Volcanic Monument on August 27th, 1982, in order to, *"preserve the geologic, ecologic, and cultural resources of the area, allowing geological forces and ecological succession to continue substantially unimpeded."*³
2. Spirit Lake, the Debris Avalanche, and headwaters of the NF Toutle River are located within the Monument.
3. Notwithstanding the previous two facts, the U.S. Forest Service *has* impeded geological forces and ecological succession for four decades.

There is no doubt that left unimpeded, hydro-geological forces would have naturally breached the debris avalanche dam and partially drained Spirit Lake. This is precisely what happened to previous debris dams following past eruptions⁴, and it would have happened again, soon after the 1980 event. But the impact would have been catastrophic. Thus, the emergency pumping project that stabilized the elevation of Spirit Lake between 1982 and 1985, and the decision to drill a tunnel to provide a longer-term outlet for Spirit Lake, were entirely justified.

Given that context, I do not criticize the prudent decisions that were made to protect lives, property, and key infrastructure. At that time, management alternatives were constrained by both limited knowledge of the geologic and hydrologic systems that posed the threat, and the technologies available to manage those systems. While those decisions were justified, it is regrettable that the time gained by operating the existing tunnel has not, until now, been used to develop a long-term solution—one that works *with*, rather than *against*, natural hydro-geological forces and enables rather than impedes ecological succession.

In summary, this is the singular opportunity to align management of Spirit Lake and the NF Toutle River with both the intent of Congress and the realities of Nature. Alternative 7 offers a forward-looking, science-based solution that ensures public safety while promoting natural processes, ecological succession, and economic prosperity.

Yours Sincerely,



Colin R Thorne
Professor and Emeritus Chair of Physical Geography, University of Nottingham, UK

³ <https://www.congress.gov/97/statute/STATUTE-96/STATUTE-96-Pg301.pdf>

⁴Scott, K.M. (USGS Cascades Volcano Observatory) 1988. Origin, behavior, and sedimentology of prehistoric catastrophic lahars at Mt. St. Helens, WA. *Geological Society of America Special Paper* 229.

David P. Hausback (California State Univ.) and Donald A. Swanson (USGS Cascades Volcano Observatory) 1990. Record of Prehistoric Debris Avalanches on the North Flank of Mount St. Helens Volcano, Washington. *Geoscience Canada*, vol. 17, number 3, 142-145.

Appendix

To understand why the emergency pumping project and the decision to drill a tunnel is important, it should first be noted that a natural out-break flood that scoured a breach through the debris dam would sometime during the 1980s would have substantially reduced the volume and surface elevation of Spirit Lake.

Recognizing this, it's apparent that Spirit Lake's physical evolution and ecological succession have been stymied – it's as if the lake has been in an induced coma for forty years. Also, the upper 6.4 miles of the NF Toutle River have been robbed of baseflow discharges that would otherwise have hydrated its channel and hyporheic aquifer – promoting ecological succession in the stream, its benthos, and its riparian corridor.

In 1985, the USFS had no choice but to impede hydro-geological forces and, hence, ecological succession within the Monument even though it drove a coach and horses through the Monument's Congressionally stated aim of *"allowing geological forces and ecological succession to continue substantially unimpeded."*

But it's not 1985 anymore. Today, not only do we have a far better understanding of geological, hydrological, and biological processes, but we also know how to leverage their power by using engineering techniques that work *with* Nature and finding solutions that are not only safer but also more cost-effective, sustainable, and resilient.

The advantage of Alternative 7 is that it applies our improved knowledge and technologies to replace the existing, gravity tunnel with a pressure tunnel that can be used to draw down and then modulate the surface elevation of Spirit Lake.

This is crucial because, while the existing gravity tunnel has only one function (i.e., reducing the risk of a break-out flood), a pressure tunnel is multi-functional. In addition to eliminating the risk of a break-out flood, a pressure tunnel also facilitates removal of impediments associated with the existing outfall and so generates multiple co-benefits. Consideration of these functions leads to recognition that:

First, Alternative 7 eliminates the risk of a break-out flood by gradually lowering the lake to find the 'Goldilocks' elevation': low enough to preclude a break-out flood, high enough to support an unimpaired, fully-functional lacustrine ecosystem akin to that destroyed on 18 May 1980. While the exact value of that elevation cannot be known *a priori*, it's apparent that it does exist, and the incremental control provided by a pressure tunnel means it can be found.

Second, the pressure tunnel will allow its operators to emulate seasonal variability in Spirit Lake's water surface elevation – creating and then maintaining a littoral zone: an ecotone like a bathtub ring that's characterised by a varied habitats and a rich and diverse ecology. The result will be a sapphire lake ringed by emerald wetlands.

Third, the pressure tunnel facilitates a controlled breach of the debris avalanche dam that can be performed safely and incrementally over a period of years to decades. This would create the 'habitat channel' needed to rehydrate the upper NF Toutle River, allow up and downstream volitional passage for aquatic organisms, recover lost inputs of marine nutrients from returning anadromous fish, and enable larval drift out of Spirit Lake that will enrich the food web for miles downstream. The existing tunnel has perpetuated loss of these ecosystem drivers up and downstream of the debris avalanche dam and impeded ecological succession for forty years. The good news is that those drivers can be resuscitated in a much shorter period.

The existing, gravity tunnel has also contributed to impeded recovery of wildlife and the salmon fishery in the Toutle River mainstem, downstream – to the detriment of local eco-tourism and the economy of Cowlitz County. A pressure tunnel opens the door to recovery of a fishery and eco-tourism industry that are badly missed.

Finally, and perhaps most importantly, the pressure tunnel would make time for the next generation of innovative engineers and river scientists to explore options for further developing the 'habitat channel' so that, in time, it may become the primary outlet for Spirit Lake, with the pressure tunnel transitioning towards a role as the back-up or redundant measure. Perhaps a generation after that, engineers may conclude that the pressure is no longer needed at all and could be retired.

If selection rested solely on the value of the benefits each Alternative can provide, the decision would be straightforward: the long-term, cumulative co-benefits of Alternative 7 eclipse those of the other Alternatives. However, analysis of the multiple criteria influencing the decision has identified some potential challenges that will need to be overcome if Alternative 7 is selected and implemented.

With respect to Risk;

- Measures would be required during development of the 'habitat channel' to eliminate the risk of managed erosion becoming out of control and causing a break-out flood. This risk can be eliminated by lowering Spirit Lake sufficiently to rule out such a possibility and by putting in place temporary structures that would cut off flow to the pilot channel if the rate of erosion became concerning.
- Some disturbance of the surface of the debris avalanche would be inevitable, but this would be restricted to a corridor along the selected route for the 'habitat channel' and the ground surface would recover quickly once rehydrated and naturally colonized by native vegetation.
- While sediment would be mobilized during development of the 'habitat channel', the results of my 1983 monitoring study indicate that most of the eroded sediment would likely be redeposited within the Monument. Further, a sediment budget model developed for the Portland District, USACE demonstrates that any increase in the rate of downstream sediment delivery would be undetectable (for more on this see, the Feasibility Study by Mark Havekost).

With respect to the Community Dimension;

- The highly innovative, Engineering with Nature (EwN®)⁵ approach applied in creating the 'habitat channel' will be new to the public and likely to be perceived as high risk. While this perception is inaccurate, it must be taken seriously. In my experience, such concerns can be allayed using a concerted program of deep public engagement and education.
- Creation of a 'habitat channel' could adversely impact recreation access. Such impacts can be avoided by providing suitable stream crossings, which could take the appearance of natural crossing points, such as sediment bars, riffles, and log jams.

With respect to the Environmental Dimension;

- Alternative 7 will impact long-term monitoring by research scientists, many of whom have spent decades studying post-eruption recovery. Rehydrating the upper 6.5 miles of the NF Toutle River will restore natural processes, allowing hydro-geological forcing and ecological succession to proceed, unimpeded, in ways they haven't for forty years. This is a major benefit of Alternative 7 and it offers exciting opportunities for research and education going forward. Even though the initial human impacts of the change would be distressing, this is a price worth paying to reawaken long-impaired processes and ecologies in Spirit Lake and the Toutle River and then have the opportunity to learn from them.
- Visually, the riverscape of the NF Toutle River would be transformed. Experience from dozens of projects that have rehydrated parched riparian corridors and valley floors demonstrates that biotic responses are both positive and remarkable (e.g., see Flitcroft et al. 2022⁶). Marked increases in the abundance, bio-diversity, and resilience of aquatic, amphibian, riparian, avian and floodplain species are guaranteed.

The fact is that, in 1985, we simply didn't know how to decommission dams (engineered or natural) safely and economically. Today we do, and the principles already applied to decommissioning hundreds of dams across the USA can also apply to 'decommissioning' the debris avalanche dam on the NFTR. I know this because for over a decade I advised the US Bureau of Reclamation on overcoming major sediment-related

⁵ <https://ewn.ercd.dren.mil/>

⁶ Flitcroft, R.L., Brignon, W.R., Staab, B., Bellmore, J.R., Burnett, J., Burns, P., Cluer, B., Giannico, G., Helstab, J.M., Jennings, J. and Mayes, C., 2022. Rehabilitating valley floors to a stage 0 condition: A synthesis of opening outcomes. *Frontiers in Environmental Science*, 10, p.892268.

challenges with decommissioning two dams on the Elwha River. The Glynes Canyon dam was 300 ft high and its removal in 2014 mobilized about 20 million cubic yds of sediment – a volume similar to that liberated if EwN® was used to ‘decommission’ the debris avalanche dam.

Removing the Elwha dams led to the return of salmon within months, and prompted ecological succession that has allowed the river to recover from being dammed within a decade. *In my expert opinion, this would also be the case at Mount St. Helens.* Also, challenges with managing the large volume of sediment trapped behind Glynes Canyon Dam taught us how to manage sediment safely, with minimal disruption downstream communities, and with copious benefits to river, estuary, and coastal ecosystems.

Recent experience with decommissioning four large dams on the Klamath River is also applicable to Spirit Lake. The volume of sediment stored there was about 14 million cubic yards and it too is being managed successfully and beneficially. All we need to do in implementing Alternative 7 is perform the engineering and geomorphic studies necessary to develop a detailed design and implementation plan for decommissioning the debris avalanche dam that disconnects Spirit lake from the NF Toutle River. A great start has already been made , as reported by Mark Havekost in the Feasibility Study.

Certainly, Alternative 7 would have environmental and ecological impacts. However, decades of ‘best practice’ in permitting dam decommissioning projects establishes that short-term disruption is a price well worth paying for the invaluable, long-term benefits to species, and permittees *do* recognize that.

It is recognized that Alternative 7 would disrupt long-term research in Spirit Lake and on the pumice plain. However, the historical and current trajectories of post-eruption change and, hence, the post-1985 research record, chronicle a hydro-geological and ecological recovery that has been artificially impeded. Going forward, scientists will benefit from being able to study a different, unimpeded trajectory that emulates what nature would have done 40 years ago, absent the tunnel.

The advantage of Alternative 7 is that it restores connectivity in the drainage system while keeping downstream communities, property and infrastructure safe during construction and, once construction is complete, freeing communities along the lower Cowlitz River from the risk of a break-out flood, entirely.