Tracey Saxby,
Executive Director,
My Sea to Sky,
PO Box 2668,
Squamish, B.C.,
V8B 0B8

June 17, 2024

Re: Henriette Dam Break Hazard to Floatel

Dear Ms. Saxby

In response to your request please find here in this letter my professional opinion based on a review of the documented hazards posed by a dam break / debris flow on WFLNG's proposed floatel.

The documents reviewed include; My Sea to Sky's (MS2S's) correspondence with BC Dam Safety Authority, MS2S's correspondence with District of Squamish (DOS), the DOS staff June18th COW memorandum "TU000076 (WLNG –Floatel)" with extracts from a 2022 NorthWest Hydraulics Consultants report, the BC OGC 2019 WFLNG permit and the BC EAO Amendment#3 "Floating worker accommodations" and the 2010 Sandwell Engineering Henriette Dam report on the structural deficiencies of the dam. I also reviewed the June 4th DOS council discussion and staff's comments to council on the hazards posed by Henriette Dam.

My professional experience as a P. Geo. includes working for 30 years for a major engineering company focused on dam construction, investigation and remediation of dam deficiencies, dam breach analysis, seismic risk and natural hazards of landslides and debris flows. I have been personally responsible for directing dam breach analysis on Extreme Consequence dams and have been involved in assessing hazards of landslides and debris flows. I have also directed modelling and assessments of impact waves in shallow water reservoirs from landslides, avalanches and debris flows.

Executive Summary

Comments have been made by DOS staff that Henriette Dam does not pose a significant hazard to the WFLNG floatel. This opinion appears to be based purely on flood inundation extents provided by NorthWest Hydraulics (NWHC). It is not clear if NWHC has properly assessed the amplitude or attenuation of impact waves in the area of the proposed floatel mooring location.

A full professional assessment by a subject matter qualified person of the NWHC report along with a review of studies of the debris flow potential of Woodfibre Creek is required to assess the potential for a significantly larger hazard of dam breach resulting from a concurrent debris flow.

A debris flow could change the routing of Woodfibre Creek during the event and result in a dam breach flood directly impacting the floatel mooring area.

The Identified Hazards

The 2010 Sandwell report draws attention to the deficient structure of the buttresses of Henriette Dam which are insufficient to withstand the design earthquake loads. The BCER (formerly BCOGC) facity permit requires these deficiencies to be addressed before operations begin at WFLNG. During operations there will only be up to 100 workers at the WFLNG site. During construction there will be well over 600 workers so clearly the exposure to risk is much higher. Due to the increased downstream activity the consequence of the dam was recently reassessed by the responsible professional from Significant to Extreme (potential for over 100 lives lost).

The nature of concrete buttress dam failure modes in the event of a loss of support from the buttresses is for a rapid full height failure of an entire panel. This means that a full height wall of water would be released almost immediately. WFLNG has commissioned a dam breach report by Northwest Hydraylics Consultants (NWHC). Although this report is not yet available to review, NWHC appears to have completed a dam breach routing analysis using the HEC-RAS software which this author is familiar with in it's uses and limitations having used it on multiple dam breach analyses. HEC-RAS computes both steady state and unsteady flows of water levels based on topographic data and dam breach parameters (failure time, breach height, width). HEC-RAS does not calculate wave propagation or model impact forces, rather it provides information primarily on extent of flooding and flow velocities resulting from the dam breach. It is not clear if NWHC actually modelled wave effects in Howe Sound or if they simply equated inundation heights with wave heights, which is not a realistic assessment of potential wave impacts on the floatel. Simple inundation analysis would predict much smaller effects than a full impact wave analysis. Review of the NWHC report by a qualified professional will be required to assess the applicability of the methodology used for wave height predictions.

The NWHC modelled dam breach flooding maps included in the DOS memorandum show flood water levels of 10 m (~33 feet) to 15 m (~50 feet) adjacent to the shoreline with velocity of up to 6 m/s. These heights and velocities correspond to a massive wall of water of three to four stories high moving at 22 km/hr. This represents an incredibly destructive occurrence, capable of pulverizing most any structure in it's path.

In the quoted text snippets from the NWHC referenced by the DOS, it does not seem credible that a 10 m to 15 m wall of water moving at 6 m/second would result in only 0.7 m to 1.0 m waves in the near shore. In the text quoted from NWHC there is no justification on how these estimates were obtained, perhaps these snippets of text were quoted without context.

To provide a full qualified professional assessment of the actual hazards posed to the floatel will require review of the NWHC by a person familiar with dam breach, debris flow and impact wave hazard assessment.

Hazards Not Identified in the DOS Memo

As a result of the lack of sediment flushing, debris flow hazards build in creeks which have been deprived of annual floods by upstream dams. Woodfibre Creek is such a creek since Henriette Dam has been in place for many years, while sediment accumulates without floods to remove it.

Debris flows greatly amplify the effects of flooding by causing the release of the additional stored mass as an accelerating flow down the creek during a flood from an event such as a dam breach.

A condition of the WFLNG EA was that debris flow hazard potential assessments were required for Woodfibre and Mill Creeks. It is suggested that a review of these reports by a qualified professional will be required to assess if the expected concurrent debris flow occurring during a dam breach substantially increases the hazard to the floatel mooring location. Concurrent debris flows during a flood often cause evulsion of the flood flow which could conceivably route the entire dam breach flow towards the floatel or anywhere on the alluvial/debris flow fan that the floatel is proposed to be moored on.

Debris flows can initiate significant impulse waves when impacting bodies of water.

While working on remediation of Britannia Mine, I observed how a small additional amount of flow diverted into a creek that had been starved of floods for years contributed to triggering a large debris flow. The resulting debris flow devastated a swath of forest over 2 km long by 40 m wide. In this debris flow, trees with butt diameter of 3 feet and 75 feet long were tossed through the air at high speed, hurled great distances and pulverized into match sticks. This small debris flow transported thousands of tonnes of sediment at high speed and obliterated roadways and other infrastructure.

Best Regards,

J. Graham Parkinson

Graham Parkinson. P. Geo.