

Pierre Friele, MSc, PGeo
PO Box 612,
Squamish, BC
V8B 0A5

June 16, 2024

By email to: council@squamish.ca

Attn: Squamish Council,

I attended the April 30, 2024 Floatel TUP Town Hall. There I heard concern expressed by the public regarding Henriette Lake dam safety and the Floatel float camp (Figure 1). I understand there is a deadline June 18, 2024 on the Floatel TUP application. As a Qualified Practitioner in the terrain sciences, required by the Professional Governance Act to speak out on matters of public safety, I offer my view of the expected scope for a risk assessment affecting the Floatel moored 200 m NE of Woodfibre Creek mouth and having a proposed carrying capacity of 650 persons.

The Hazard and Risk Scenario

The Henriette Lake dam is old (1947), 17 m tall, stores a large volume of water (10.3 M m³), and is perched 850 m above sea level. The average channel slope to the Howe Sound beach is ~10 degrees averaged over 5 km; from the dam at 850 m asl down to 500 m asl channel slopes are steep (>10 degrees), then between 550-200 m asl the channel is <10 degrees for 3.7 km; and then steep for the last 0.7 km to the beach. The channel is confined, and debris bulking of a breach-induced flood could lead to channelized debris flow. Bank scour could strip riparian forest incorporating logs and coarse wood in the debris. A dam breach would be a catastrophic, high intensity and destructive event. It is also credible, in my opinion, that an impulse wave could be generated.

The potential impact to the Floatel would depend on its anchoring location, mooring strategy, and proposed use of Woodfibre Creek as domestic water source. All or some of the following impacts are possible scenarios: direct impact to domestic water infrastructure and the ship itself, severe rocking, damage to moorings and setting adrift. Risk to life is credible.

Standard of Care

The location is within District of Squamish. In principle, the District of Squamish OCP (2040) established the need for geomorphic risk assessment, and sets individual risk thresholds at 1/10,000 for existing development and 1/100,000 per annum for proposed new development. Although the TUP is temporary, the Floatel is new residential development presenting high exposure with extreme consequence. This risk to human safety has not been addressed by Woodfibre LNG, as acknowledged in the EAO 2019 amendment. However, it has come to my attention that NHC (2022) has since prepared an extreme flood analysis (although I have not seen, nor read the document, I understand it presents results of 1000-year return period flood modelling along lower Woodfibre Creek).

The EGBC (2023) landslide assessment guidance document sets out level of effort required for risk assessment. The level of effort is geared to the consequence, with a large number of people exposed requiring a very high level of effort to define the risk.

Up to ~2023, the Henriette Dam consequence rating was considered Significant (it assumed no fatalities; design event, 1/1000 year seismic). Considering definitions of use in the Dam Safety Regulation, the exposure of 650 residents, in my opinion, would be classified as permanent: “The population at risk is ordinarily or regularly located in the dam breach inundation zone, whether to live, work or recreate.” Given the Floatel (permanent residence), with a potential for loss of life of up to 600 persons, the consequence rating would lie between High (<10 fatalities) and Extreme (>100 fatalities).

Recently, the Henriette Dam consequence rating has been updated to Extreme, and is now consistent with the proposed exposure. As such, the design event for dam safety assessment has been increased to 1/10,000 per annum, and the Sandwell (2010) report is out of date. Furthermore, the Sandwell (2010) report does not constitute a complete scope for a dam safety review. Dam management and natural hydro-geomorphic loading must also be addressed.

The dam safety regulation indicates that for Extreme consequence dams, a dam safety review must be conducted every 7-years. “A dam safety review involves a systematic review and evaluation of all aspects of the design, construction, maintenance, operation, processes, and systems affecting a dam’s safety, including the dam safety management system and natural hazard processes potentially loading the reservoir and dam.” Further, when classifications are changed, dam safety reviews need to be updated accordingly.

Considering Scope in light of Risk

It is my understanding that the Henriette Dam Failure Hazard Probability is currently rated as Moderate. A report on the stability of the dam itself (Sandwell 2010) was conducted for Western Forest Products (previous owner). At the time the dam was rated as a Significant Consequence structure. As such, the report used a 1/1000 year design seismic event. Sandwell (2010) concluded Henriette Dam was deficient to resist current earthquake loads and could possibly be breached and initiate a debris flow.

The current Henriette Dam Safety Risk estimate, resulting from combined Moderate Failure Probability and Extreme Consequence, results in Risk Management Response Category 2: Caution.

To my knowledge, the last dam safety review was completed in 2016. However, it is not clear whether this addressed only the stability of the dam, or if it met all requirements of a fulsome dam safety review. Furthermore, it is rendered out of date by the re-classification of consequence. To my knowledge, there is no quantitative risk assessment (QRI) conducted specifically considering Henriette Dam and the exposure presented by the Floatel TUP.

To properly assess the risk affecting the Floatel, catastrophic scenarios must be envisioned and evaluated. A full-scope, up to date and comprehensive Dam Safety Review, would include dam stability (1/10,000 seismic) and hydro-geomorphic hazard scenario loading. Downstream impact assessment might include some or all of the following tasks: simple dam-breach and/or meteorological/hydrogeomorphic induced breach scenarios; dam-breach flood propagation; flood bulking by scour; debris flood/flow modelling; and landslide-induced tsunami modelling. These are highly specialised tasks.

With respect to the NHC (2022) report, it is described by staff to report on 1000-year flood down Woodfibre Creek, and the size and extent of an impulse wave. The effects are deemed to have low consequence to the Floatel. In my mind several questions arise:

- 1) Why was a 1000-year event chosen? Was it considered similar to a dam-break flood? Why was the dam-break flood not modelled.

- 2) Is the reporting on a 1000-year flood consistent with the recent Dam Safety reclassification of consequence from Significant to Extreme?
- 3) Was modelling for clearwater flood only. Was debris bulking to debris flood or debris flow considered? Was there consideration of entrainment coarse wood (logs) in the debris?
- 4) Has there been consideration of more than just dam stability (i.e., external loading scenarios) in the dam safety review?

Based on my review of regulatory material available, I believe there is insufficient information to properly assess worker health and safety related to Henriette Dam and the Floatel, a proposed 650-person residential occupancy dwelling in the potential damage corridor of an identified catastrophic event. The newly updated consequence rating of Extreme and the scope outlined by practice guidance implies a fiduciary duty to require that an approval decision would be informed by a detailed Quantitative Risk Assessment (QRI).

A QRA to evaluate Henriette Dam Safety risk at the Floatel should include dam stability assessment with hydro-geomorphic loading, 1/10,000 per annum seismic loading, and process-chain numerical modelling integrating dam breach, debris flood/flow, and impulse wave components. Potential impacts to the ship, mooring lines, proposed domestic water infrastructure, and the potential for loss-of-life should be included in the risk assessment. Individual life loss estimates are required for comparison with 1/100,000 per annum threshold for new development. Group risk Assessment should also be considered.

Conclusion

As outlined above, in my opinion (notwithstanding NHC 2022), there is insufficient information to fulsomely evaluate Henriette Dam safety and the implications to Floatel worker health and safety; the existing information is out of date and incomplete. I believe the District of Squamish approving authority owes a fiduciary duty to ensure worker health and safety criteria are met; the DoS is provided with legislative tools allowing the authority to request “safe for the use intended reports” from qualified professionals. I would ask that District of Squamish execute that responsibility and authority in this case.

Sincerely,

Pierre Friele, MSc, PGeo
Squamish, BC
V8B 0A5

cc. lglenday@squamish.ca, JVelaniskis@squamish.ca

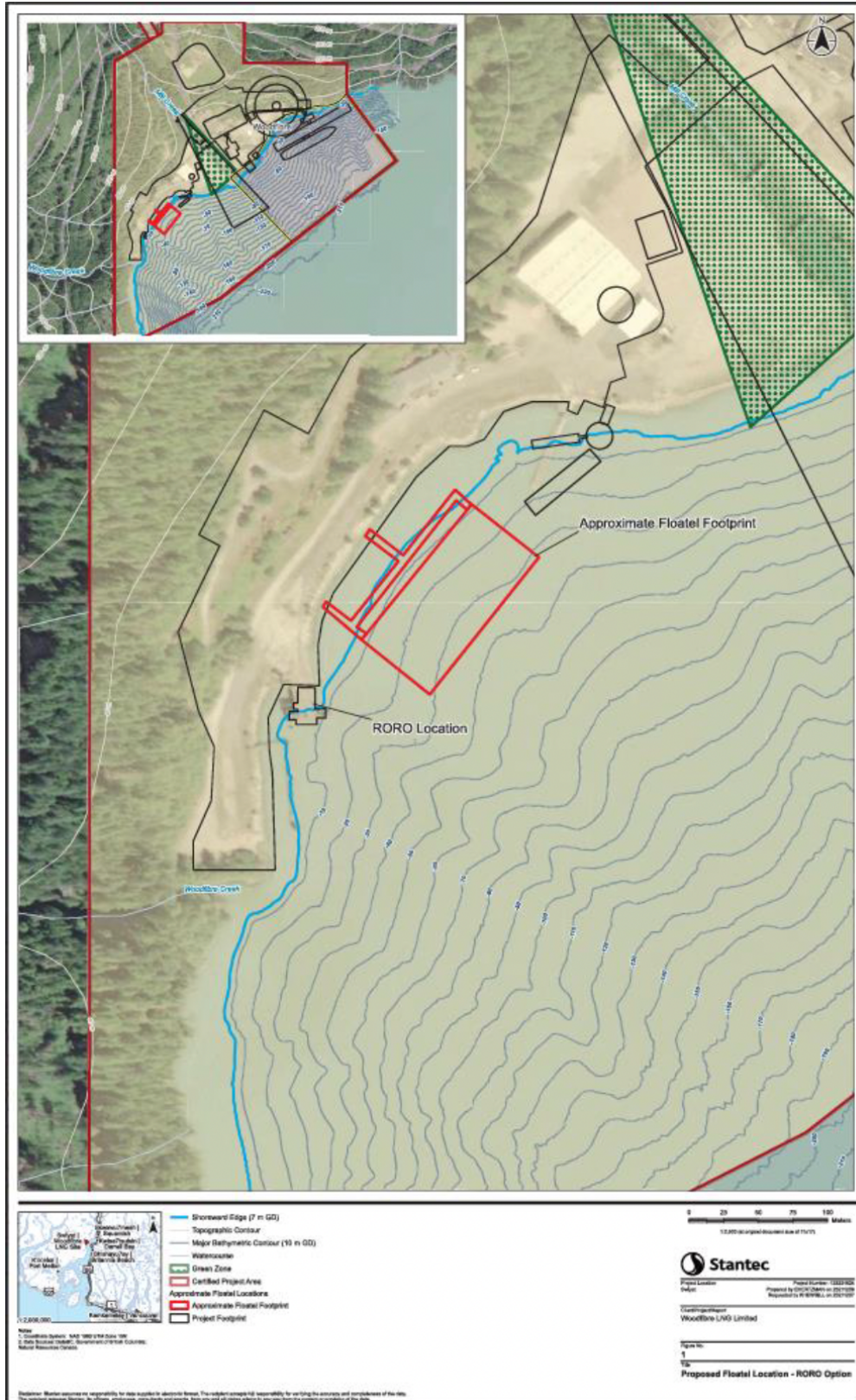


Figure 1. Location of Floatel 200 m NE of Woodfibre Creek mouth.