Pierre A. Friele, MSc, PGeo
P.O. Box 612
1021 Raven Drive
Squamish, BC
V8B-0A5
Ph. (604) 898-4770

Deb McQueen
1165 Village Green Way,
Squamish, BC V8B 0N5

September 9, 2014

Re: Flood proofing for 1038 Finch Drive, Squamish, BC.

Legal Description: Lot 30, Block 2, DL 1305, Group 1, NWD, Plan 4138.

Deb McQueen has requested that I provide flood hazard assessment for the above property located on the northeast end of Finch Drive (Fig. 1). My understanding is the report is intended to support a proposed subdivision of the property, and therefore the report is required under Section 86 of the Land Title Act. At the building permit stage, similar certification would be required under Section 56 of the Community Charter. The Acts require a qualified professional to certify "the land may be used safely for the use intended" with or without conditions to render the land "safe" for use such as, in this case, floodproofing measures to support residential use (homes). This report is intended to support both subdivision and building permits. At the subdivision stage the report will likely become attached to title.

In British Columbia, "safety" from flooding is defined as free from rainfall-induced "hydrologic" flood inundation at a frequency of 1/200-years or less (WLAP 2004).

The proposal is to subdivide the property into eight lots, bisecting the primary parcel in half east/west and into four north/south. Note that at this time there is not a detailed proposal indicating where dwellings will be located on the proposed lots. Never the less, the report sets out conservative recommendations that will be applicable to a house at any location within each of the eight proposed lots as schematically indicated in Figure 2.

Flood Hazard Affecting

Flooding from either the Mamquam or Squamish rivers could affect the subject property. The site is above the level that could be affected by sea-level flooding, even considering projected sea-level rise (Ausenco Sandwell 2011). The subject property is on a floodplain area protected by dikes. In this case, a dike along the south side of Mamquam River, which extends from the Cardinal Pit entrance west to Squamish River, then joins the Squamish River dike that extends to Howe Sound. The capacity of the dike to contain the 200-year flood has been assessed by KWL (2011). That report indicates that the level of the dike along Mamquam River is at or higher than required, while those sections of the dike along Squamish River parallel or upstream of the subject property (dike stns 9600-12000 m) have recently been raised to meet the 200 year flood level, and further riprap work is scheduled (http://www.squamishchief.com/news/local-news/dike-upgrades-on-the-way-1.1322898).

Floodproofing measures in recognized floodplain areas are normally provided on flood hazard maps prepared by the Ministry of Environment or private consultants. Although the District of Squamish has not formally adopted the report, they have traditionally supported the use of the District of Squamish Flood Hazard Management Plan (Klohn Leonoff & Graham Farstad 1994). District of Squamish is in the process of updating its Flood Hazard Management Plan, but the final update is not expected until 2016. Therefore, the District of Squamish Flood Hazard Management Plan supercedes the older floodplain mapping by the Ministry of Environment, Water Management Branch (1986), and will be referenced herein.

The subject property straddles Zones 2 & 4 of the Squamish Flood Hazard Management Plan (Fig. 1). Zone 2 is the floodplain of the Squamish/Mamquam River, while Zone 4 is the Mamquam River alluvial fan. Section 5.3 in Klohn Leonoff & Graham Farstad (1994) states flood construction levels are as shown on the floodplain maps, or the elevation of a down slope embankment plus 0.6 m, whichever is greater. In Zone 2 scour protection is required for structuiral fill supporting a building, while in Zone 4 scour protection is required for foundations and/or structural fill.

Based on the survey plan, dated July 18, 2014, by Bunbury & Associates, BC Land Surveyors (Fig. 2), existing grade on the subject property is south sloping, being 7.0 ± 0.1 m in the north and sloping to 6.4 ± 0.1 m in the south. Finch Drive is 6.3-6.5 m and does not constitute a flood barrier. No embankments were noted downstream (south) of the property that might cause ponding. Based on these observations, and the recommendations cited in the Flood Hazard Management Plan, the flood construction level for the subject property would be as interpolated from the flood hazard map.

Scour protection should be provided for structural fill supporting foundations in Lots 1, 2, 7 & 8 and for foundations and or structural fill in Lots 3, 4, 5 & 6. Conventional methods of scour proofing are provided in the Squamish Flood Hazard Management plan (Fig. 3). Other methods of scour protection may be employed. The form of scour protection depends in part on the house design, which is not avaialble at this point. Scour protection design will be required at the building permit stage.

Estimating the FCL

The FCL for each proposed lot was estimated in the following way (Fig. 2):

- The FCL was interpolated for the NE corner of each of the eight proposed lots. This provides a somewhat conservative (high) value for each lot.
- For each proposed lot, the required lift above natural ground was estimated by subtracting the spot elevation near the proposed lot centre to the estimated FCL for the proposed lot.

It was found that the estimated lifts for the proposed lots varies from 0.2 - 0.5 m (Fig. 2). For simplicity, the floodproofing lift should be standardised as 0.5 m above natural grade, or the estimated FCL for the proposed lot, whichever is greater.

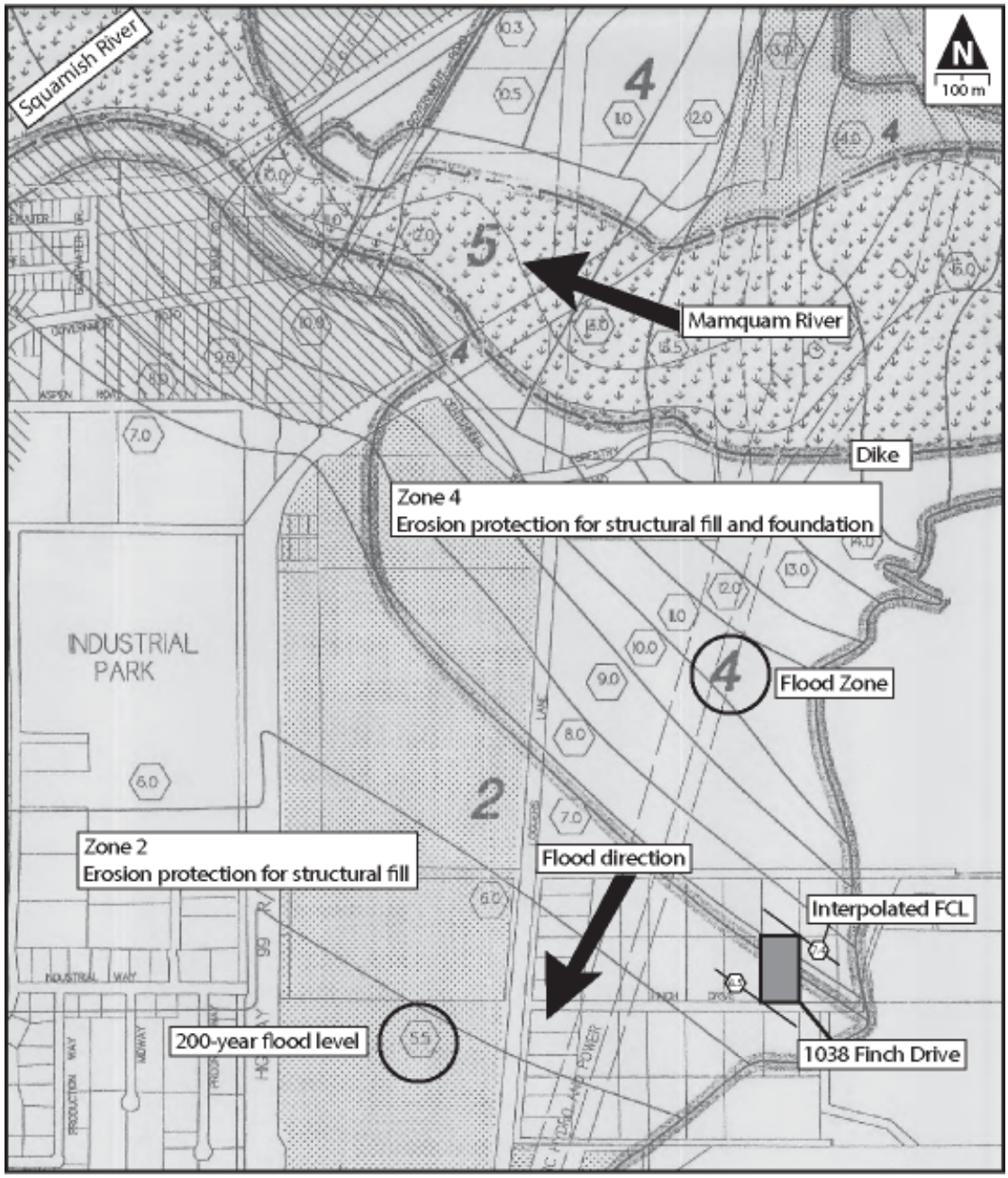
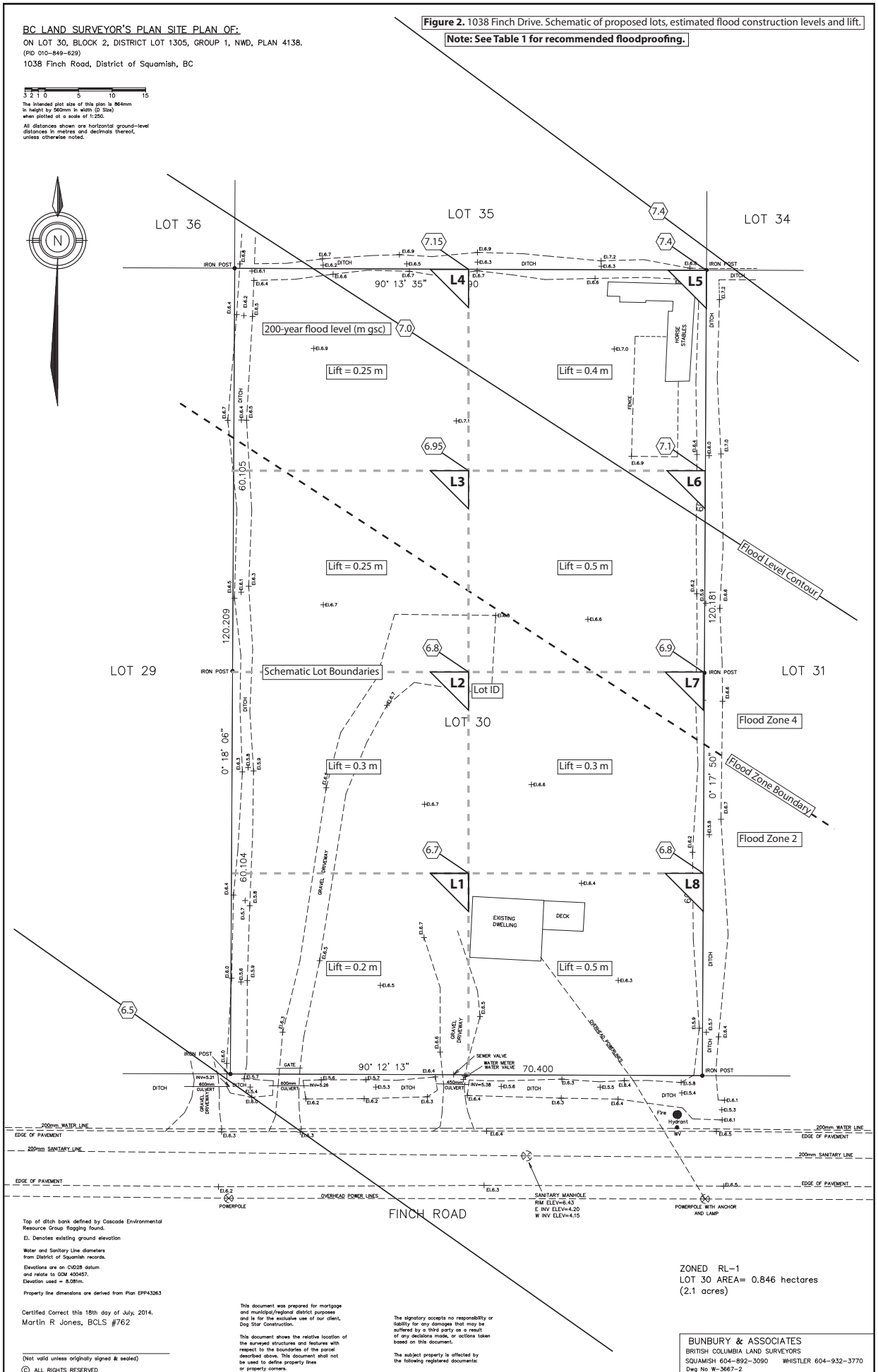


Figure 1. Squamish Flood hazard management plan map showing location of 1038 Finch Drive.

Figure 2. 1038 Finch Drive. Schematic of proposed lots, estimated flood construction levels and lift.

Note: See Table 1 for recommended floodproofing.



Top of ditch bank defined by Cascade Environmental Resource Group flagging found.

El. Denotes existing ground elevation

Water and Sanitary Line diameters from District of Squamish records.

Elevations are on CVD28 datum and relate to GCM 400457. Elevation used = 8.081m.

Property line dimensions are derived from Plan EPP43263

Certified Correct this 18th day of July, 2014.
Martin R Jones, BCLS #762

(Not valid unless originally signed & sealed)

This document was prepared for mortgage and municipal/regional district purposes and is for the exclusive use of our client, Dog Star Construction.

This document shows the relative location of the surveyed structures and features with respect to the boundaries of the parcel described above. This document shall not be used to define property lines or property corners.

The signatory accepts no responsibility or liability for any damages that may be suffered by a third party as a result of any decisions made, or actions taken based on this document.

The subject property is affected by the following registered documents:

ZONED RL-1
LOT 30 AREA= 0.846 hectares
(2.1 acres)

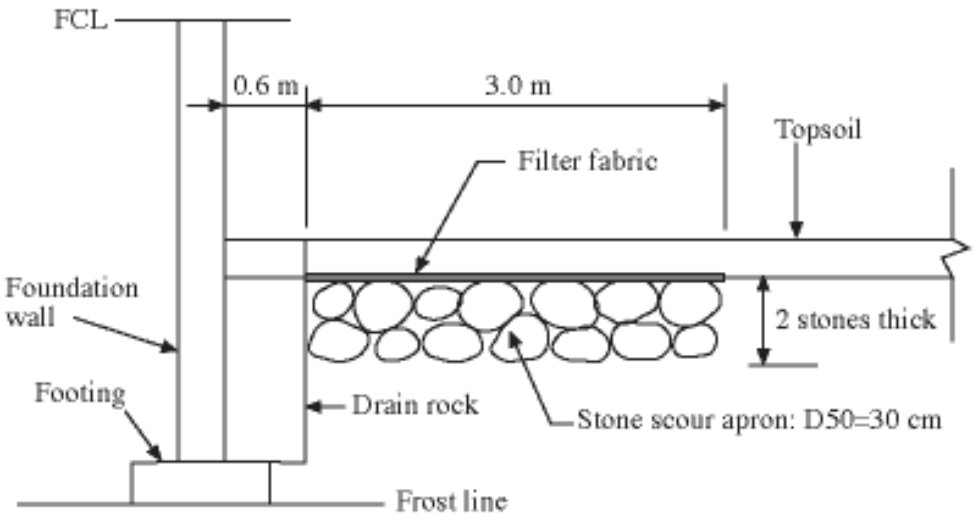
BUNBURY & ASSOCIATES
BRITISH COLUMBIA LAND SURVEYORS
SQUAMISH 604-892-3090 WHISTLER 604-932-3770
Dwg No W-3667-2
FILE No 2014-191.2 FB 2021 Pg 19-44

Conclusions & Recommendations

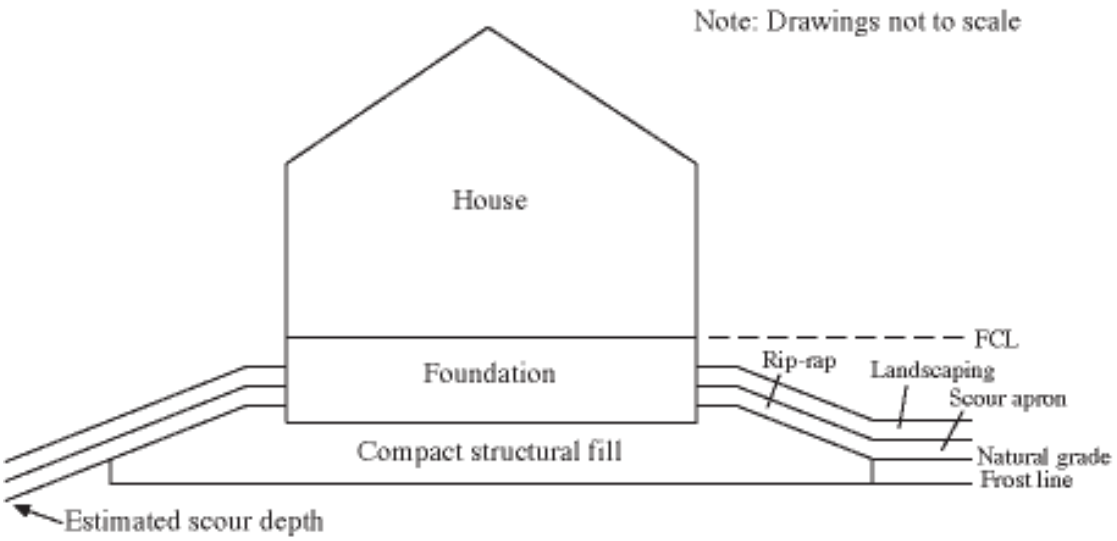
1. The District of Squamish Flood Hazard Management Plan is the reference document preferred by the District of Squamish.
2. The property is dike protected and floodproofing can be accomodated by elevation and scour protection. It is located in Zones 2 & 4 of the District of Squamish Flood Hazard Management Plan.
3. Provided the recommendations herein are adhered to, the site will be safe for the use intended. Note that "safe" does not imply complete freedom from hazard, only safe with respect to normal hydrologic floods with a return period of 200 years or less. This report does not address other geologic hazards, including floods caused by landslides, debris flows, or associated dambreak.
4. i. The residential dwellings should be designed such that the base of the joist box of the habitable floor is set at, or above, 0.5-m above grade, or no less than the recommended FCLs set out in Table 1.
   ii. Requirements for flood proofing through the use of elevation may be waived for that portion of a building or structure that is to be used as a carport, garage or entryway.
   iii. Areas below the FCL should not used for the installation of furnaces, major electrical switchgear, or other fixed equipment susceptible to damage by floodwater.
5. A standard method of erosion protection is the scour apron (Fig. 3a) using stones of about 0.3 m diameter on the medial axis layed two stones thick in an blanket 3-m wide around the perimeter of the foundation.
6. To maintain a floodway, the development plan should maintain natural grade north/south through the center of the property along that portion proposed as the communal roadway.

Table 1. Flood construction elevations and lifts for proposed lots 1038 Finch Drive. For each proposed lot, final floor elevation shall be the recommended lift or the recommended FCL, whichever is greater.

	Lot 1	Lot 2	Lot 3	Lot 4	Lot 5	Lot 6	Lot 7	Lot 8
Recommended FCL (m geodetic)	6.7	6.8	6.95	7.15	7.4	7.1	6.9	6.8
Estimated Lift (m)	0.2	0.3	0.25	0.25	0.4	0.5	0.3	0.5
Recommended Lift (m)	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5



A: Stone scour apron for foundation with footing on grade



B: Erosion Protection for foundation and pad

Figure 3. Schematic scour protection measures. Not for design or construction.

References

Ausenco Sandwell 2011. BC Ministry of Environment Climate Change Adaption Guidelines for Sea Dikes and Coastal Flood Hazard Land Use Guidelines for Management of Coastal Flood Hazard Land Use.

Klohn Leonoff and Graham Farstad and Associates, 1994. District of Squamish Flood Hazard Management Plan. Map 2.

KWL, 2011. Squamish River and Mamquam River Survey and Flood Assessment report. Report to the District of Squamish, Squamish, BC.

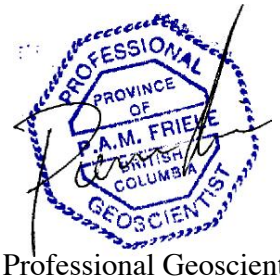
Ministry of Water, Land and Air Protection 2004. Province of British Columbia flood hazard area land use management guidelines. Victoria, BC.

Closure

This report was prepared for use by Deb McQueen, including distribution as required for purposes for which the report was commissioned. The report cannot be distributed to other third parties without prior written consent by Cordilleran Geoscience. The work has been carried out in accordance with generally accepted geoscience practice. Judgment has been applied in developing the conclusions stated herein. No other warranty is made, either expressed or implied to our clients, third parties, and any regulatory agencies affected by the conclusions.

If you have any questions please call,

Pierre A. Friele,



Professional Geoscientist