

August 24, 2020

s.22

Dear <sup>s.22</sup>

**RE: Hydrological investigation and Professional Consultation for 4716 Cowichan Lake Road, Duncan, BC**

I, Luke Wagner BSc, along with Daniel Lamhonwah PhD Candidate, MES, P.Ag, of Madrone Environmental Services Ltd. ('Madrone') have prepared this letter-style report to provide a summary of our visual inspection and professional evaluation of the local hydrology and drainage infrastructure at 4716 Cowichan Lake Road, Duncan, British Columbia ('the Property'; see Figure 1 location and property boundary).

The Property owned by <sup>s.22</sup> ('the Client') is within the Cowichan Valley Regional District (CVRD). Subsequent to recent works by the Client, the Ministry of Forests, Lands, Natural Resources and Rural Developments (FLNRORD) regional operations were notified of enhanced inundation conditions on adjacent land parcels. Madrone was retained by the Client to consult on an investigation that was conducted by FLNRORD regarding a recently installed 500 mm culvert ('the culvert'). It is interpreted by FLNRORD that the reduced drainage capacity caused upstream flooding to an adjacent land parcel located at 4718 Cowichan Lake Road ('the adjacent property'). FLNRORD concluded that by limiting drainage capacity to a 500 mm culvert downstream, which is to say that outflow could not match seasonal inflow, and thus FLNRORD recommended modifications/re-install of the current drainage infrastructure on Site. FLNRORD also suggested that an 800 mm culvert be installed that is at level with surrounding culverts.

The purpose of our field inspection, conducted on July 2, 2020, was to provide a qualified professional opinion on the limitations to drainage and conveyance capacity of the Property. During our inspection, we walked the majority of the Property and focused our observations on a 500 mm culvert and downstream drainage ditch located in the northeastern quadrant of the Site.

Arriving at the field site, drainage was observed running from west to east across the Site (also identified remotely via Google Earth). Moreover, A north to south trending berm separates two bodies of water, and

When traversing the site, native surficial sediments were observed on the northern edge of the property along a cut-bank and consisted of fine-grained sandy loam. Along the retention pond, anthropogenic gravelly to very-gravelly sandy loam is interpreted to exist across developed portions of the property as observed from surface exposure and limited scratch-pits.

<sup>1</sup> Madrone was unable to verify the size of this culvert because we were not given permission to entry the property of the adjacent land parcel

- The culvert appears to be free of debris or materials that could inhibit flow;
- The intake of the culvert appears to be at a minor incline (i.e., lower than the remaining pipe). The entire culvert appears to be slightly bowed and inclined though its course;
- Thick vegetation and woody debris were also noted to occur downstream of the culvert but are not interpreted to impede flow or have been the cause of upstream flooding;
- The client's culvert was also noted to be at a higher elevation than the adjacent upstream culvert.

Given the recommendations from FLNRORD and evidence I gathered from my inspection, it is my opinion that an undersized, improperly installed 500 mm culvert has resulted in increased retention of water in the Client's pond which inundates the adjacent property beyond pre-existing conditions.

It is my suggestion that the client follows FLNRORD's advice to install an 800 mm culvert that is at level with neighboring culverts (upstream and downstream), which is approximately 10 cm lower than the existing culvert in place. I will furtherly suggest that ancillary works be conducted that includes culvert inlet armoring to protect from further erosion and entrainment of sediment to off-site sensitive receptors. Armouring can be accomplished through complete coverage with geotextile (on bottom, against native sediment) and riprap (on top) within 1m of the culvert inlet and outlet. The riprap should consist of coarse angular stones of no less than 20cm in minimum diameter.

If you have any questions about the contents of this letter, please feel free to contact the undersigned.

Sincerely,

**MADRONE ENVIRONMENTAL SERVICES LTD.**

Prepared by:

**Luke Wagner, BSc**  
Junior Geoscientist

*\*This is a digitally signed duplicate of the official manually signed and sealed document*



**Daniel Lamhonwah** PhD candidate MES P.Ag  
Hydrologist, Soil Scientist, Professional Agrologist

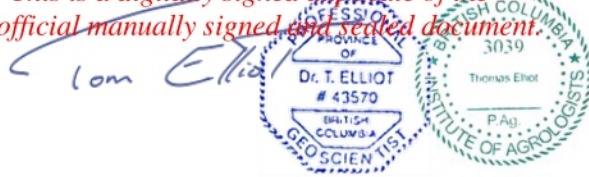


4716 COWICHAN LAKE ROAD, DUNCAN, BC

AUGUST 24, 2020

Reviewed by:

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**Thomas R Elliot PhD P.Geo P.Ag**

Hydrogeologist, Professional Geoscientist, Professional Agrologist



**PHOTO 1. RETENTION POND AND NORTH TO WEST TRENDING BERM THAT SEPERATED THE CLIENTS PROPERTY (4716 COWICHAN LAKE ROAD, DUNCAN, BRITISH COLUMBIA) FROM THE ADJACENT PROPERTY. PHOTO WAS TAKEN BY MADRONE ENVIRONMENTAL SERVICES. DATE OF PHOTO: JULY 02, 2020.**



**PHOTO 2. VIEW LOOKING DOWNSTREAM (TO THE LEFT) CULVERT INTAKE PIPE TRENDING IN AN EAST-NORTHEAST DIRECTION. PHOTO WAS TAKEN BY MADRONE ENVIRONMENTAL SERVICES. DATE OF PHOTO: JULY 02, 2020.**





**PHOTO 3. VIEW LOOKING UPSTREAM FROM OUTFLOW OF THE CULVERT. PHOTO WAS TAKEN BY MADRONE ENVIRONMENTAL SERVICES. DATE OF PHOTO: JULY 02, 2020.**