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**COWICHAN
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WATER
SUPPLY**

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Technical Memorandum

DATE: June 1, 2022

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FROM: Craig Sutherland, M.Sc., P.Eng. Crystal Campbell, P.Eng.
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**RE: COWICHAN RIVER WATER SUPPLY PROJECT
COWICHAN LAKE SHORELINE ASSESSMENT
Mapping, Field Work, Shoreline Characterization
Our File 2212.078-300**

1. Introduction

KWL was retained by the Cowichan Valley Regional District (CVRD) to undertake a shoreline assessment for Cowichan Lake as part of the Cowichan River Water Supply Project. The Shoreline Assessment aims to better understand potential shoreline impacts of the proposed raising of the Cowichan Lake Weir to increase lake storage. A series of Technical Memoranda and Reports were prepared throughout the study, including:

- Appendix A: Project Approach and Methodology (KWL Technical Memorandum)
- **Appendix B: Mapping, Field Work, Shoreline Characterization (KWL Technical Memorandum)**
- Appendix C: Present Natural Boundary (Bazett Land Surveying Technical Memorandum)
- Appendix D: Cowichan Lake Inflow and Water Level Analysis (KWL Report)
- Appendix E: Cowichan Lake Wave Energy Assessment (KWL Report)
- Appendix F: Change in Natural Boundary (KWL Report)
- Appendix G: Property Impacts (KWL Report)

The purpose this draft Technical Memorandum is to summarize the field data collection approach and findings, and key assumptions for mapping.

2. Datum

The elevations reported in this study are presented in Canadian Geodetic Vertical Datum 2013 (CGVD2013) recently adopted in the last year. Much of the previous Cowichan Lake work references the CGVD28 datum (adopted in 1935). There is a difference of about 20 cm between these two reference datums at Cowichan Lake. The difference is not constant and ranges from 0.197 m at the east end of the lake to 0.218 m at the northwest end. CGVD2013a datum is below CGVD28 datum, or in other words, the elevation of a common point, expressed with reference to CGVD2013a is higher than if expressed with reference to CGVD28.

A topographic survey of the existing weir crest was carried out as part of the detailed design of the weir upgrades. The survey indicates that it was constructed about 0.08 m higher than the original design elevation of the weir crest at 162.37 m CGVD28. The surveyed elevation of the existing weir crest used for this study is 162.45 m (CGVD28) or 162.65 (CGVD2013a).



3. Data and Background Review

Background information listed in Table 1 was collected and reviewed; the key information which will form the foundation of the project work includes:

- 2019 GeoBC LiDAR (20 cm resolution) and orthophotos;
- Integrated Cadastral Information Society parcel layer;
- 2014 CHS bathymetry; and
- Water Survey of Canada (WSC) Daily Records for Cowichan Lake @ Lake Cowichan and Water Level and Cowichan River @ Lake Cowichan.

Key background reports include:

- Climate Projections for the Cowichan Valley Regional District (CVRD, 2017);
- Cowichan Lake Shoreline Assessment (KWL, 2013); and
- Cowichan Lake Shoreline Habitat Assessment: Foreshore Inventory and Mapping Project. Prepared for Fisheries and Oceans Canada (BC Conservation Foundation, 2012).

4. Mapping

Mapping for this study is intended to:

- provide the CVRD and a future water licence applicant with the ability to review potential shoreline and riparian right impacts with an upgraded weir with respect to potential risk/liability; and
- support the Water Licence application.

Mapping includes:

- data noted above – legal cadastral, CVRD 2019 ortho imagery, 2019 Geodata BC LiDAR;
- current natural boundary location;
- projected natural boundary location; and
- notes outlining mapping datum, projection, data sources, and limitations of natural boundary delineation.

Online mapping is hosted on the ESRI ArcGIS Online platform, searchable by property address. It allows for navigation around the map area by panning/zooming, viewing/hiding of various mapping layers and other georeferenced data such as field photographs, as well as allowing for printing of hard copy maps. Users can zoom out to the lake level and scale into the lot level. Lots can be viewed and printed at variable scales down to approximately 1:1,000 resolution to review potential impacts to riparian rights and property. The user selects the area of interest and scale prior to printing. This allows the future water licence applicant and regulators to produce specific reports for each individual property where impacts may be of concern. This approach provides for standard PDF printing and requires internet access. The online mapping holds much data, layers can be turned on and off as needed.



5. Field Data Collection

5.1 Goals

The goals of the field data collection were:

1. Ground truth key mapping assumptions including datums, control points, cadastral mapping, etc.
2. Provide a comprehensive record of existing conditions around the Cowichan Lake shoreline.
3. Record shoreline characteristics required to assess potential shoreline impacts.

5.2 Land Survey Information Ground-Truthing

Ground Truthing confirmed locations of mapping control points, datums, and cadastral mapping through a survey of property corners and benchmarks. This survey helped to identify any discrepancies with the available mapping data and to confirm consistent survey control across the entire study area.

Bazett Land Survey Inc. carried out survey using RTK GNSS technology in mid-September/early October 2020. The initial results of the ground truthing survey indicate that:

- survey control around the lake is accurate and adequate for carrying out mapping for survey purposes (+/- cm accuracy for vertical control);
- comparison of surveyed and recorded lake levels indicate accuracy to within +/- 1 cm; and
- there are inconsistencies with the ICIS cadastral mapping around the lake such that property lines shown on mapping may not always accurately reflect property boundaries at 1:5,000 mapping scale.

Results are summarized in *Appendix C: 2020 Present Natural Boundary at Cowichan Lake*.

5.3 Record of Existing Conditions

Identification of Current Natural Boundary and Photographic Record of Existing Conditions

David Bazett, BCLS of Bazett Land Survey undertook a shoreline survey around the entire lake, including islands, using RTK GPS technology in mid September/early October 2020. Field crews accessed the shoreline by boat. Information included:

1. Identification and documentation of the current natural boundary location/elevation at a lot-by-lot mapping scale.
2. Collection of a photographic record of the current natural boundary survey tie in points along the shoreline and boat-based oblique photographic record of the shoreline.
3. Collection of basic shoreline characteristics (substrate, vegetation type, evidence of erosion, evidence of human disturbance, erosion protection, vegetation removal) which can help with shoreline reach mapping (described further below).

The current natural boundary is not a consistent elevation but varies around the lake depending on exposure to wave energy and the character of the shoreline. There is about a 2 m, vertical variation in the natural boundary elevation around the lake.

The location/elevation of structures that may impact the natural boundary such as erosion protection measures, walls, etc.; and docks/piers can be determined from LiDAR.

Results are summarized in *Appendix C: 2020 Present Natural Boundary at Cowichan Lake*.

5.4 Additional Bathymetry Information

Review of existing 2014 CHS bathymetry data revealed some data gaps in seven bay areas. Additional bathymetry information for these areas was collected by Dave Bazett, Bazett Land Survey on March 24, 2021.



Figure 1: Additional Bathymetric Survey Locations

This data collection was collected by small boat using a GPS and single beam sonar system. This included a Knudsen Engineering Dual frequency single beam sounder with a 200/50 MHz transducer – linked to Leica VIVA GNSS system for 3D position and all data collected in a Panasonic ruggedized laptop. Data was processed in HyPACK software and final points were edited to provide an even distribution. The vertical and horizontal datums were Geodetic CGVD2013, UTM10 NAD83 (CSRS) 1997.

As the areas surveyed were fairly shallow the sounder provides depth readings to the centimetre. The GNSS system positions the antenna directly over the transducer and provides a 3D position that is typically accurate within a few centimetres. Once the data was processed, crossing points are checked to ensure that the bottom elevations are consistent; these were typically within 2 to 5 cm in flat areas.

This data was combined with existing 2014 CHS bathymetry (2 m resolution) and 2019 GeoBC LiDAR (20 cm resolution) into a seamless digital elevation model (DEM). See *Appendix F: Change in Natural Boundary Report*, Section 4.1, for details on the elevation datasets and DEM generation. This DEM was a critical input to many of the analyses of this project, used to define the elevations along the shoreline transects for the Inflow and Water Level Analysis, Wave Energy Analysis, and Natural Boundary Analysis.



6. Shoreline Character Mapping Refinement

6.1 Approach

Shoreline Material Character

Chad Davey, M.Sc., R.P. Bio., from KWL undertook shoreline character mapping using standard GPS technology to refine the resolution of the existing Cowichan Shoreline Assessment (KWL, 2013) mapping. The purpose of this refined shoreline character mapping is to understand how changes in total wave energy could impact the location of the natural boundary at a lot-by-lot scale. The assessment is not intended to be a detailed shoreline habitat assessment. For detailed habitat information for Cowichan Lake Shoreline, please refer to the BCCF 2012 study.

The field review was carried out using boat access on September 28 and 29, 2020. Lake level at the time of the assessment was at El. 162.27 m (or about 0.3 m below the existing weir crest level at El. 162.57 m, CGVD2013). The existing natural boundary was not yet determined.

During the field review, the shoreline band above the water line at the time of the assessment (El. 162.27 m) was visually classified and mapped into the following categories: bedrock, boulder, cobble, gravel, sand, silt, vegetated, and revetment (e.g., walls, riprap, groynes etc.) Classification of boulder, cobble, gravel, sand, and silt shorelines used a Wentworth scale to determine the appropriate shoreline material type. During the field assessment, silt shorelines were differentiated between sand shorelines by the presence of offshore aquatic vegetation (e.g., water lilies), which was typically associated with silt shorelines. The shoreline material type and associated size range (mm) is provided in Table 1. The grain size within vegetated shorelines was also visually assessed during the field review. Shoreline showing bedrock was classified as bedrock regardless of if they were vegetated or not.

Table 1: Wentworth Scale Grain Size Classes

Shoreline Material Type	Size Range ¹ (mm)
Silt	< 0.063
Sand	0.063 to 2
Gravel	2 to 64
Cobble	64 to 256
Boulder	>256

1. Size of the b-, or intermediate, grain axis.

Vegetation Classification

The vegetation types along both the shoreline (below the PNB) and riparian areas (above the PNB) were classified and mapped to better understand the vulnerability of vegetation around Cowichan Lake to changes in water level and erosion as a result of the projected changes in water level frequency due to the proposed weir.



Vegetation Classes and Subclasses

The vegetation was mapped using a class and subclass classification system as shown in Table 2, which is a modified version of the U.S. National Vegetation Classification.¹ Vegetation is first classed according to their structure (e.g., forest, shrubland, etc.) and then subdivided by vegetation composition and characteristics (e.g., grasses, hydromorphic rooted vegetation, etc.). Areas that are sparsely vegetated were also classified (Table 2). Developed areas of shoreline and riparian areas were also categorized: manicured lawn with or without trees, and areas with hard landscaping (e.g., pavement, patios, etc.). A summary table showing representative photos for each vegetation subclass is provided in Appendix B-1.

Table 2: Vegetation Classification Used for Mapping Cowichan Lake Shoreline and Riparian Areas

Class	Subclass
Forest (FO)	<ul style="list-style-type: none">Deciduous Forest (FO-DE)Mixed Evergreen – Deciduous Forest (FO-MX)
Shrubland/Herbaceous (SH)	<ul style="list-style-type: none">Perennial/Annual Graminoids (grasses) (SH-GR)Mixed Evergreen-Deciduous shrubland (SH-MX)Hydromorphic Rooted Vegetation (marshland) (SH-HY)Sedges (aquatic vegetation)
Sparse Vegetation (SV)	<ul style="list-style-type: none">Forested (SV-F)Shrubland (SV-SH)
Developed (D)	<ul style="list-style-type: none">Lawn (no trees) (D-LX)Lawn (with trees) (D-LT)Hard landscaping (pavement, patio, etc.) (D-H)
Unvegetated	<ul style="list-style-type: none">No vegetation

Shoreline Vegetation Mapping

The shoreline vegetation mapping represents the dominant vegetation class/subclass (Table 2) within the area between the existing weir crest (162.65 m) and the proposed weir crest elevation (163.35 m). This is the range of lake levels where the largest change in the occurrence is projected as a result of the proposed weir and is thus the range where vegetation will be the most vulnerable to change.

For clarity in the online mapping platform, the classified shoreline vegetation is plotted along the 162 m contour line, same as the sediment character mapping (see Section 6.2).

Riparian Vegetation Mapping

The riparian vegetation was also mapped using the same classification as shown in Table 2, and represents the dominant vegetation within the area between the current natural boundary and the average annual high-water mark (164.20 m). The classified riparian vegetation is plotted along the average annual high-water mark line. All vegetation mapping was conducted at a scale of 1:1,000.

¹ Grossman D.H., Faber-Langendoen D., Weakley A.S., Anderson M., Bergeron, P., Crawford R., Goodin K., Landaal S., Metzler K., Patterson K.D., Pyne M., Reid M., and Sneddon L. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume 1, The National Vegetation Classification System: development, status, and application. The Nature Conservancy: Arlington, VA.



6.2 Results – Shoreline Character Mapping

Shoreline Material Type

Table 3 summarizes the shoreline length and percent coverage for each shoreline class, with shoreline material type (Table 1) substituted for the vegetation class. Most of the substrate along Cowichan Lake was assessed as gravel (68%), followed by bedrock (22%). When comparing Table 2 and Table 3 most of the vegetated shoreline class has a gravel substrate.

Table 3: Summary of Shoreline Classification Results without Vegetation Class

Shoreline Class	Length (km)	% Coverage
Gravel	87.7	68.0
Bedrock	27.9	21.7
Silt	6.5	5.1
Cobble	3.7	2.9
Sand	1.8	1.4
Revetment	1.0	0.8
Boulder	0.2	0.2

The results of the shoreline classification, excluding vegetation, compares well with previous shoreline mapping conducted in 2010 (KWL).

Shoreline Vegetation Class

The results of the vegetation classification for both shoreline and riparian areas are summarized in Table 4. Outside of the unvegetated length of shoreline, the dominant vegetation class for the shoreline are Forested (FO-MX) and Shrubland (SH-MX). The dominant vegetation class for riparian areas are Forested (FO-MX), Shrubland (SH-MX) and developed areas with lawn containing trees (D-LT).

Table 4: Summary of Vegetation Classification for Both Shoreline and Riparian Areas

Vegetation Class	SubClass	Total length (km)		% Coverage	
		Shoreline	Riparian	Shoreline	Riparian
Forested	Mixed Evergreen/Deciduous	22.7	105	17.5	66.0
	Deciduous	5.7	0.0	4.4	0.0
Shrubland/ Herbaceous	Perennial/Annual Graminoids (grasses)	0.6	0.2	0.46	0.13
	Shrubland	21.5	18.3	16.6	11.5
	Hydromorphic Rooted Vegetation (marshland)	3.9	0.0	3.01	0.0
	Sedges (aquatic vegetation)	1.0	0.0	0.77	0.0
Sparse Vegetation	Forested	1.0	1.8	0.77	1.1
	Shrubland	0.0	1.7	0.0	1.1
Developed	Lawn (no trees)	0.06	6.3	0.05	4.0
	Lawn (with trees)	0.03	17.6	0.02	11.1
	Hard landscaping (pavement, patio, etc.)	0.0	2.5	0.0	1.6
Unvegetated	Exposed sediment without vegetation cover	73.1	5.7	56.4	3.6
Total		56.5	153.4	-	-



The total length of the shoreline and riparian vegetation classification assessment summarized in Table 4 differ from than Cowichan shoreline lengths posted elsewhere. The assessment followed a topographic approach to delineate the vegetation type; the elevation lines further upslope become longer in length due to topographic variation.

6.3 Additional Shoreline Assessment Ground Truthing

Following the shoreline natural boundary modelling assessment (Appendix F), additional field work was conducted to confirm aspects of the shoreline characters at several modelling transects of interest. The field work was conducted by KWL's Clayton Hiles, Coastal Engineer, on February 21, 2022. Four sites were visited:

1. Gordon Bay
2. Watts Road Beach Access
3. Lily Beach Park
4. Lakeview Park Campsite

At each site detailed photographs were taken to confirm the character of the shore, including approximate slope, sediment type, the presence of vegetation, and generally, to confirm the findings of the initial fieldwork. Sediment samples were taken from each site for gradation analysis. For more details on this site visit, please see the *Appendix F: Change in Natural Boundary*.

7. Submission

KERR WOOD LEIDAL ASSOCIATES LTD.

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Encl.: Appendix B-1: Vegetation Classification Photos



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Revision History

Revision #	Date	Status	Revision Description	Author
0	June 1, 2022	Final	Issued to Client	CS

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Appendix B-1

Vegetation Classification Photos



Appendix B-1 – Photographs



Photo 1: Forest – Deciduous



Photo 2: Forest – Mixed Evergreen/Deciduous



Appendix B-1 – Photographs



Photo 3: Forest – Sparse Vegetation



Photo 4: Shrubland – Grasses



Appendix B-1 – Photographs



Photo 5: Shrubland/Herbaceous – Shrubland



Photo 6: Shrubland – Hydromorphic



Appendix B-1 – Photographs



Photo 7: Shrubland/Herbaceous – Sedges



Photo 8: Shrubland – Sparse Vegetation



Appendix B-1 – Photographs



Photo 9: Developed – Lawn (no trees)



Photo 10: Developed – Lawn (with trees)



Appendix B-1 – Photographs



Photo 11: Developed – Hard Landscaping