

Technical Memo

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KWL Project Manager

From: David C Bazett BCLS, CLS
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Date: June 2, 2021

Re: **COWICHAN LAKE SHORELINE ASSESSMENT**
2020 Present Natural Boundary at Cowichan Lake

This technical memo describes the field survey and related assessment of the present (2020) natural boundary around Cowichan Lake. This work is part of Cowichan Valley Regional District's Cowichan Lake Shoreline Assessment study led by KWL.

1. Background on "Natural Boundary"

1.1 Definition of Natural Boundary

There are conflicting definitions of the terms "natural boundary" and "high water mark". For the purposes of this work, the present natural boundary at Cowichan Lake is established based on the following definition taken from the Land Act.

"natural boundary" means the visible high water mark of any lake, river, stream or other body of water where the presence and action of the water are so common and usual, and so long continued in all ordinary years, as to mark on the soil of the bed of the body of water a character distinct from that of its banks, in vegetation, as well as in the nature of the soil itself; LAND ACT [RSBC 1996] CHAPTER 245.

The definition of high-water mark in the provincial Riparian Area Regulations (RAR) uses similar wording as the Land Act definition of natural boundary, but critically includes the phrase "...and includes the active floodplain."

From a legal survey perspective, the extreme water levels associated with flood conditions do not affect the position of the natural boundary.

The BC Water Sustainability Act refers to the Land Act definition of the natural boundary.

The term "present natural boundary" (PNB) is customarily used by land surveyors to describe the natural boundary at the time of a survey. It is important to note that there are two primary applications of the natural boundary:

- to define the *legal natural boundary* for the purpose of establishing property boundaries, and
- to establish the *physical natural boundary* for various other purposes such as establishing setbacks.

This work focuses on the physical natural boundary.

1.2 Effect of Natural Processes on Natural Boundary

Natural processes for the development of natural boundary include:

1. water level frequency,
2. slope and composition of the shoreline, and
3. wave energy and run up.

More information on this is described in Section 4.2.

The natural boundary on a lakeshore can move in response to the natural processes of erosion and accretion, but the change must be gradual and imperceptible from moment to moment. The natural boundary is not considered to move when there is a sudden change such as erosion in a storm event.

1.3 Effect of Human Activities on Natural Boundary

The natural boundary is not considered to move when human activities alter or obscure its location. This includes filling or excavating the shoreline, building retaining walls, removing native vegetation or artificially changing water levels (e.g. dams).

1.4 Role of a BC Land Surveyor in Determining Natural Boundary

The BC Land Surveyors Act gives exclusive authority for a BC Land Surveyor (BCLS) to establish property boundaries, both in general and for the specific case where a natural boundary forms part of the legal property boundary. For the Cowichan Lake shoreline assessment, the Land Act definition of the natural boundary was applied to determine the present natural boundary in its current physical location without investigation of the effects of man-made changes.

2. History of Legal Boundaries at Cowichan Lake

2.1 Original Land Grants

Lake Cowichan is a special case as it lies within the E&N Railway Belt. In 1884 the E&N Railway was granted a huge area of land on the east coast of Vancouver Island as compensation for constructing a railway. The beds of water bodies, including Cowichan Lake, were included in the original land grant from the Crown.

The E&N Railway in turn granted most of the land around Cowichan Lake to various parties at the turn of the 20th century. These subsequent land grants generally defined the lakeside property boundaries as the natural boundary at the time. The E&N Railway retained ownership of the bed of Cowichan Lake, and the lakebed is now owned by its successor company.

2.2 Survey Depiction of Legal Boundary and Natural Boundary

Many of the old surveys for the E&N land grants to other parties poorly defined the natural boundary or have errors in the depiction of the natural boundary. This occurred for two main reasons; first, the measuring technology was crude compared to today, and second, because little attention was paid by pioneer land surveyors to accurately depict the natural boundary. The latter was used because natural boundaries were considered to be a monument themselves and were defined by their position on the ground rather than by some arbitrary plan.

Modern record-keepers in the land title system have overridden the Common Law reliance on physical natural boundaries in favour of a reliance on records. This has led to the perpetuation of survey errors and inaccuracies in the depiction of natural boundaries. The fact that the bed

of Cowichan Lake is not owned by the Crown has eliminated the normal statutory remedies for correcting errors or including lawful accretion in the upland owner's title.

Due to the above factors, the titles to lakeside property boundaries at Cowichan Lake have not been treated uniformly and this has led to a complex and inconsistent situation. In many cases the depiction of the natural boundary on the original E&N land grant has been rigidly held which has resulted in modern surveys which show some lots terminating above the present natural boundary while others on the same plan extend out into the lake. On other modern surveys, the present natural boundary has been adopted and the owners of the lakebed have signed the plan to indicate acceptance. Many more properties are still defined by very old surveys. As an example, the settlement at the east end of the North Arm was surveyed in 1912. Saseenos Point was originally surveyed in 1909 and Plan 1009 shows the lots extending to the low water mark.

As noted earlier, human interference with the natural boundary does not alter its location from a legal survey perspective but can make re-establishing the original position difficult, especially when much time has passed. In the areas around the lake which were developed a century ago this is very evident. Very little natural vegetation remains and retaining walls and fill have altered the shoreline. In these areas the determination of the extent of ownership needs to be investigated on a case-by-case basis with reference to historic records and detailed site investigations.

Even in more modern developments the definition and depiction of the natural boundary on legal survey plans is the subjective opinion of the land surveyor responsible. While ownership and the extent of registered titles is generally to the present natural boundary (PNB) on waterfront properties, there are exceptions, so it is difficult to make generalized statements.

3. Field Survey Program

Our assessment and survey of the PNB of Cowichan Lake, conducted in the fall of 2020, was to establish the physical natural boundary to inform the analysis of future impacts to the shoreline by the proposed increase in the height of the weir. This was not a legal survey to define the extent of upland titles or to identify areas of human encroachment.

Following is a description of the methodology and equipment used, some observations on issues encountered, and a summary of our findings and a description of the resulting PNB location which was incorporated into the final returns.

3.1 Project Initiation

Our first task was to review the previous documentation including engineering assessments of the shoreline, the 2015 decision of the Environmental Appeal Board and other relevant documents. This was followed by discussions with CVRD staff, regulators, and stakeholders to determine the issues to be addressed and the level of detail required.

Before commencing the field survey program, a site meeting was held at Cowichan Lake with CVRD representatives Kate Miller and Leroy Van Wieren, along with KWL engineers Craig Sutherland and Eric Morris, and geomorphologist Chad Davey.

3.2 Establishing Survey Control

The field survey work began with the establishment of initial control using modern Global Navigation Satellite System (GNSS) technology. A site was chosen near the east end of the lake and a Leica VIVA receiver was used to collect satellite data over a 24-hour period. The data was post-processed using NRCanada's Precise Point Positioning (PPP) service. This service uses several worldwide stations to provide very accurate tracking of the satellite array,

which then improves the accuracy of the calculated position of the survey station. In this case our resulting precision in terms of absolute positional accuracy was 0.003 m in latitude, 0.004 m in longitude and 0.008 m in elevation. The horizontal datum used for our work was UTM NAD 83 (CSRS) 1997 and the vertical datum was CGVD2013a.

3.3 Datum

It is important to note that previous surveys have all been referred to the CGVD28 datum (adopted in 1935) and that there is a difference of about 0.2 m 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. The accepted elevation of the existing weir crest of 162.37m (CGVD28) is 162.57 (CGVD2013a).

Our GNSS system was then used in Real Time Kinematic (RTK) mode to make ties to various points around the lake. This involves setting up a Base receiver over a point with a known position and using a Rover receiver to measure to other points. The Base broadcasts differential corrections via a radio link and the Rover position is thus corrected in real time. Centimetre level accuracy or better is possible if the radio link is maintained.

In order to confirm the vertical datum, we first tied to three existing benchmarks, two in the village of Lake Cowichan and a third near Youbou. These agreed well and confirmed the shift from CGVD28 to CGVD2013a datums.

3.4 Identifying the Present Natural Boundary

Starting at the weir we then made ties to the PNB of the lake. Wherever possible the shoreline was traversed on foot by D.C. Bazett BCLS, CLS and ties were made in locations where undisturbed evidence of the natural boundary existed. As noted in the Land Act definition of the PNB this included an assessment of evidence of the action of water including the type of vegetation, the character of the soil and any changes or influences attributed to humans. Often this meant a careful analysis extending from the current water level and areas clearly below the natural boundary to upland areas above the PNB. Where the shoreline topography was steep this zone occupied a narrow band of just a few metres and the natural boundary was generally well defined. In areas of low relief, the task of assessing the evidence and determining the location of the natural boundary was much more difficult as the horizontal width of the zone to be examined was often up to 20 metres or more in width.



Photo 1: Concrete PNB



Photo 2: Natural Vegetation Removed



Photo 3: Moss line on bedrock



Photo 4: Riprap and fill

3.5 Disturbed Areas

In the developed areas of the lake, comprising about 40 kilometres of shoreline, the determination of the PNB was complicated by manmade changes. Removal of native vegetation and alteration of the contours through filling and construction of retaining walls obscured the original location of the PNB in many areas. In these areas, ties were made to places where the PNB appeared to be undisturbed, as indicated by mature trees and other vegetation. Where possible, ties were also made to retaining walls and concrete structures so that they could be identified later in the office.

3.6 Undisturbed Areas

In areas of the lake where there was no development the natural boundary was much easier to determine, and ties were made to determine the elevation as this was then used in nearby developed areas with similar substrate and exposure to trace the same contour where the natural indicator of vegetation and soil had been altered.

At each PNB tie, a photo was taken showing the tied location marked by an orange painted lath. Where the shoreline was blocked by obstructions, a boat was used to travel to the next tie point. Where overhanging trees blocked satellite signals the PNB was tied by measuring to a nearby point in the open and a measurement of the offset distance was made using a handheld laser device. The offset was recorded with the point for later processing in the office.

To verify the position and accuracy of existing datasets of LiDAR and orthophotos supplied by CVRD, ties were made to clearly identifiable features such as concrete pads and other permanent structures.

Where possible, ties were also made to cadastral survey posts to verify the positioning and accuracy of the cadastral mapping dataset obtained through Parcel Map BC. Each day a tie was made to record the lake water elevation.

3.7 Shoreline Photography

After making ties to the PNB along a section of shoreline, photos were taken from the boat using a Canon 5D Mark II digital camera. The boat travelled parallel to the shore and 20 to 30 metres out into the lake while a continuous series of overlapping photos were taken. The position of each photo was automatically recorded using the built-in GPS in the camera.

The digital shoreline photographs have been georeferenced and provided in the online GIS mapping database www.cowichanlakeweir.ca.

4. Mapping of the 2020 Present Natural Boundary

4.1 Data Processing

In the office, the data collected using the GNSS system was downloaded, checked, and integrated with the existing LiDAR, orthophoto and cadastral mapping datasets. In locations where ties were made to offset points the natural boundary points were calculated and elevations derived from the LiDAR surface.

The photo-identifiable points tied in the field, such as corners of concrete pads or permanent structures, were compared with their location in the orthophotos and all were found to agree well.

Numerous points were compared for elevation with the LiDAR data and all found to agree within the 10-15 cm tolerance generally accepted for this data.

Comparison of tied cadastral posts with the location of the existing mapping were not as consistent. Discrepancies of several metres were common and the orthophotos showed that in many areas, signs of occupation such as fences did not agree with the mapped cadastral boundaries either. In new areas where the legal plans were accurately georeferenced, the discrepancies were minor and, in these areas, the PNB we tied also agreed very well with that shown on the subdivision plan.

4.2 Determination of the 2020 Present Natural Boundary

Once all the data was processed and verified the next task was to determine the PNB between field tied points.

Generally, along each section of lake shore where the aspect, topography, substrate, and vegetation were similar, the elevation of field tied PNB points was found to be within a narrow range. An average elevation was determined for each section with similar characteristics and the PNB was drawn in as a splined line joining the tied points and points along the average elevation contour using the LiDAR surface. As the line was being drawn the orthophoto layer was used to confirm physical cues such as the edge of vegetation, the line of driftwood and the change in soil characteristics were also considered. The level of detail available in the orthophoto imagery was quite useful. For example, in bare rocky areas the line of moss and lichens was quite visible and verified by reference to the ground photos taken at the time of the survey.

Analysis of the results showed that the elevation of PNB in sheltered areas of the lake where wave action was minimized by limited fetch or the protection of structures or vegetation was lower than in areas where the action of water was greater. Similarly, the type of substrate affected the elevation of the natural boundary with the PNB being lower in areas with bedrock and higher in areas where the lakeshore consisted of gravel or sand.

The elevation of the PNB points tied ranged from a low of 162.55 m CGVD2013a datum (162.35 Old CGVD28 Datum) (essentially the same elevation as the crest of the existing weir) at a sheltered point where the edge of a lawn met the lake to a high of 165.02 m (164.82 Old CGVD28 Datum) near the northwest end of the lake where waves in SE winter storm winds with the longest fetch on the lake impacted a sloping gravel beach perpendicular to the direction of the waves.

Looking more closely at sections of shoreline with similar characteristics shows a narrower range of elevation for the tied points and a consistent “average” elevation for the PNB. For example, in the 8 km of developed area along the north shore of the South arm the elevation of the PNB ranges from 162.55 m (162.35 Old CGVD28 Datum) to 163.70 m (163.5 Old CGVD28 Datum) with an average of all 47 points equal to 162.93 m (162.73 Old CGVD28 Datum). In the 2 km of development on the south shore of the South arm the range is from 162.70 to 163.11 m and the average of 7 points equals 162.94 m (162.74 Old CGVD28 Datum).

In other locations, notably at Sandy Beach Park the elevation of the PNB changes significantly due to changes in substrate or the aspect of the shore relative to prevailing wind and waves.

As there are natural variations in the elevation of the PNB the “average” is not meaningful. The natural boundary line has been provided as a series of x,y,z points at an along-shore spacing of approximately 5 m.

4.3 Preparation of Map Showing 2020 Present Natural Boundary

A map interpretation of the PNB is shown on the online GIS map: www.cowichanlakeweir.ca. It represents a physical natural boundary based on the Land Act definition of natural boundary. This map ensures consistent horizontal and vertical datums.

As noted above, it is important to note that the mapped PNB is a physical natural boundary to reflect the physical impacts to the shoreline. In some cases, this may be consistent with the extent of upland land title, but in other cases it may be different.

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