

## Technical Memorandum

**DATE:** May 27, 2022

**TO:** Leroy Van Wieren, Project Manager, Cowichan Valley Regional District  
Kate Miller, Environmental Services Manager, Cowichan Valley Regional District

**CC:** **Steering Committee**

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**FROM:** Crystal Campbell, P.Eng., KWL, Project Manager  
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**RE:** **COWICHAN RIVER WATER SUPPLY PROJECT**  
**Cowichan Lake Shoreline Assessment**  
**Project Approach and Methodology**  
**Our File 2212.078-300**

## 1. Introduction

Cowichan Valley Regional District (CVRD) retained Kerr Wood Leidal Associates Ltd. (KWL) to undertake a shoreline assessment for Cowichan Lake as part of the Cowichan River Water Supply Project. The objective of the Shoreline Assessment was 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 and are included as appendices as follows:

- **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 Shoreline Assessment was kicked off at the end of July 2020. The primary focus of the study was to assess how raising the Cowichan Lake Weir and its operation (as supported in the Water Use Plan 2018) could impact property and riparian rights around the lake. The study was funded by BC Salmon Restoration and Innovation Fund and was completed by March 31, 2022.



## 2. Steering Committee Input

In the future, informed decisions regarding increased storage at Cowichan Lake will have to be made by:

- a water licence applicant who will need to understand the potential impacts and risks of proposed increase in storage at Cowichan Lake on the shoreline with respect to the rights and responsibilities of a water licence holder; and
- regulators who will need to make a series of statutory decisions around the Cowichan Lake water licence, changes to its holder, increased storage, and discharge rules.

This was informed in part by the findings and recommendations from the Cowichan Lake Shoreline Assessment. Accordingly, it was critical to have early input on the key assumptions, the proposed methodology and to have strategic check in points to respond to emerging findings and any questions which arise, as the field and assessment work proceeds. A credible, defensible, and well-documented shoreline assessment is required to support a successful water licence application and be able to potentially endure Environmental Appeal Board (EAB) scrutiny.

Having input from a Steering Committee (SC) comprised of regulators, stakeholders and rightsholders is critical to enhancing the credibility of the assessment and has helped guide the direction of the study which ensured that the analysis can support future assessment of impacts that are of concern to the SC members.

Input from the SC was needed to:

- improve the quality and utility of the technical assessment work;
- provide direction on scope, framing, and methodology;
- refine field work and methods to better support statutory decisions that will be needed in the future;
- confirm key assumptions; and
- build regulatory, stakeholder and rightholder support and buy-in to the study approach and findings.

### Milestones for Steering Committee Input

The study team met with the provincial regulators on September 3, 2020 for an early review of the study approach and field program. In addition, a minimum of three meetings with the SC were held over the course of the work, as follows.

1. After initial field work –reviewed the approach, methodology, and preliminary field work efforts (November 2020).
2. Before full technical analyses – reviewed the preliminary analyses (Early 2021).
3. At the end of project –reviewed the findings (Fall/winter of 2021).

### After Initial Field Work Input

The project approach and methodology were reviewed with your input and feedback provided during our Zoom conference call. We appreciated your involvement before preliminary analysis to ensure we had captured the right data. The primary questions we discussed were:

1. Is projecting the change in natural boundary with the proposed weir an appropriate test to assess potential impacts to property? Are there other factors (i.e., relative change in inundated area because



of proposed upgraded weir operation) that may also be useful in supporting water licence decision or other regulatory decisions?

2. What other factors may need to be considered in assessing potential property impacts?
3. What other information from the field would be useful for regulatory assessment of property impacts or other potential shoreline impacts because of the proposed weir upgrades?
4. Is there anything in the proposed field program or work program that will not yield useful results or will not be useful in the future for regulatory review?
5. Scale – what scale and resolution of assessment is useful and necessary for the province to make a decision in support of a water licence?

Further background on our current understanding of the project and our proposed approach is outlined below.

### 3. Project Objectives

The current Cowichan Lake Weir no longer meets environmental flow needs for sustaining healthy salmon populations, primarily due to climate change. The Cowichan Water Use Plan (WUP) developed through a multi-stakeholder structured decision-making process, recommended the weir be raised by 70 cm to meet current and future water needs but that further assessment be undertaken to identify potential negative impacts to the Cowichan Lake shoreline. The Shoreline Assessment objectives were to:

- assess and map Cowichan Lake shoreline current conditions, including islands;
- forecast changes to shoreline conditions based on the raised weir structure; and
- identify impacts on riparian rights.

This assessment will be used to support the water licence application and outline any responsibilities of a future licence holder to property owners where effects may be projected.

### 4. Project Approach and Methodology

The overall project approach is summarized in five phases as follows:

**Phase A: Project Initiation:** Obtained input from regulators to refine work program via technical memos and zoom calls.

**Phase B: Data Collection:** Assessed data availability versus data needs and fill gaps.

**Phase C: Lakeshore Analysis:** Assessed hydrology/climate change, wave energy, and incorporate ecological and geomorphological factors to assess lakeshore impacts.

**Phase D: Mapping:** Translated lakeshore analysis into mapping tools of existing and predicted future natural boundaries and other impacts.

**Phase E: Reporting:** Summarized project findings to support the water licence process.

Table 1 on the next page summarizes the proposed scope of work and work program.



**Table 1: Proposed Work Program**

Phase / Task	Task Description	Task	Task Description
<b>A</b>	<b>Project Initiation</b>		
A-1	CVRD Meeting #1: Project Initiation	A-4	CVRD Meeting #2: Project Methodology
A-2	Project Start-up	A-5	Steering Committee Meeting #1
A-3	Tech Memo #1: Project Methodology	A-6	Public Communication Strategy
<b>B</b>	<b>Data Collection / Ground-Truthing / Base Mapping</b>		
B-1	Collect and Review Data	B-7	Tech Memo #1: Update Project Methodology
B-2	Tech Memo #2: Draft Mapping/Data	B-8	Tech Memo #2: Updated Mapping/Data
B-3	CVRD Meeting #3: Desktop Data Review	B-9	CVRD Meeting #4: Data Update
B-4	Ground-Truthing of Data	B-10	Additional field data collection (if required)
B-5	Wind / Wave Data	B-11	Prepare Baseplan/Data Management Tool
B-6	Shoreline Review	B-12	Steering Committee Meeting #2
<b>C</b>	<b>Lake Shoreline Analysis</b>		
<b>C-1</b>	<b>Presence of Water – WL Frequency</b>		
C-1.1	Update Cowichan Lake Operation Model	C-1.4	Water Level Frequency Comparison
C-1.2	Current Weir Operation	C-1.5	Tech Memo #3: Water Level Analysis
C-1.3	Proposed Weir Operation		
<b>C-2</b>	<b>Action of Water – Wave Energy</b>		
C-2.1	Wind Time Series Development	C-2.4	Boat wake analysis
C-2.2	Wind Time Series Verification	C-2.5	Tech Memo #4: Wind Energy Assessment
C-2.3	Wind/Wave Model Hindcasting		
<b>C-3</b>	<b>Shore Character / Current NB</b>		
C-3.1	Shoreline characterization	C-3.3	Current NB at disturbed sites
C-3.2	Current NB for undisturbed sites	C-3.4	Tech Memo #5: Shoreline Character & NB
<b>C-4</b>	<b>Critical Total Wave Energy Analysis</b>		
C-4.1	WL-Wave Energy Frequency Relationship	C-4.3	Calibrate Wave Energy vs. NB Relationships
C-4.2	Undisturbed Sites Critical Wave Energy	C-4.4	Potential for Change of Natural Boundaries
<b>C-5</b>	<b>Future Changes to Natural Boundary</b>		
C-5.1	Likelihood of Shoreline Change	C-5.3	Project Future Impact to Natural Boundary
C-5.2	Seasonal Incremental WL Change	C-5.4	Tech Memo #1: Revised Methodology
<b>D</b>	<b>Results / Mapping</b>		
D-1	Map Current Natural Boundary	D-3	Identify Property Impacts
D-2	Map Projected Natural Boundary		
<b>E</b>	<b>Reporting</b>		
E-1	Draft Report/Mapping	E-3	Steering Committee Meeting #3
E-2	CVRD Meeting #5: Draft Report Review	E-4	Final Report

Notes: NB = Natural Boundary; WL = water level; blue text – CVRD meetings, purple text – SC engagement, red text - deliverables



## 12 Step Methodology to a Natural Boundary

The proposed work program focused on the components of a natural boundary and then uses advanced technical tools to assess them as follows:

1. **Methodology Review:** Reviewed approach and methodology with CVRD and Stakeholders. Based on this preliminary outline and presentation/discussion to develop an agreed upon process for formal sign off of both process and expected outputs. This Includes any potential requirements or benefits of public input/communication to the proposed technical work.
2. **Data Review:** Compiled existing data and conducted desktop review to identify any missing data or data quality issues to check in the field.
3. **Field Data Collection:** Undertook field reconnaissance/survey to ground-truth mapping/data and fill the data gaps. Assessed and documented current shoreline conditions including a georeferenced image record.
4. **Confirm Analysis Approach:** After field data collection, reconfirmed the suitability/defensibility of the analytical approach with CVRD and regulators prior to moving onto detailed analysis.
5. **Hydrologic Model:** Modeled changes in water level frequency for the current and upgraded weir operations under current and future climate conditions. This was conducted using updated climate change inputs to the same hydrological model used in the Cowichan WUP process.
6. **Wave Energy Model:** Modeled wave energy across the lake and verified using wind speeds, directions, and wave data collected on the lake January through June 2021 and combined water level frequency and wave energy frequency to establish water level-wave energy-frequency relationships for the entire shoreline of Cowichan Lake, including the islands.
7. **Ecology Classification:** Used field observations and mapping data to define relationships between existing natural boundary location and ecological characteristics and to extrapolate in GIS to map shoreline reaches with similar characteristics.
8. **Quantify the Risk of Natural Boundary Change:** Assessed the risk of change to the natural boundary as a result of increasing the amount of time the water level exceeds the natural boundary elevation, and by how much the total wave energy could change at the current natural boundary location.
9. **Quantify Future Natural Boundary Change:** For shorelines with a higher risk of potential natural boundary change, predicted changes using X-Beach shoreline erosion/sediment transport model for each shoreline transect considering the shoreline topography, the change in water level distribution, the wave energy distribution, and the shoreline ecological characteristics.
10. **Map Existing and Future Natural boundary:** Mapped the current and projected future natural boundary locations using field observations, available topographic data, aerial photography, shoreline photographic record, ecological classifications, results of the modelling of incremental change in total wave energy at the natural boundary and shoreline erosion/sediment transport modelling. Identified direct and indirect changes due to both weir and other drivers of change, where possible.
11. **Lot by Lot Impact Reports:** Used GIS and SQL database software reporting tools to develop detailed lot by lot maps to identify impacts to each property. Identify impacts related to changes by lot coverage.
12. **Report:** Reported findings and review with CVRD and stakeholders.



## 5. Project Team

The project team consists of multi-disciplinary professionals:

<b>CVRD</b>	Leroy Van Wieren, Project Manager Kate Miller, Environmental Services Manager
<b>KWL</b>	Crystal Campbell, P.Eng., Project Manager Craig Sutherland, M.Sc., P.Eng., Technical Lead Eric Morris, P.Eng., Coastal Engineering Mike Currie, M.Eng., P.Eng., FEC, Senior Technical Reviewer Chad Davey, M.Sc., R.P.Bio, Geomorphologist / Biologist Ryan Taylor, GISP, GIS
<b>Bazett Land Surveying</b>	Dave Bazett, CLS, BCLS, Land Survey Lead
<b>Compass Resource Management</b>	Michael Harstone, M.Sc., P.Eng., Communications / Facilitation
<b>Cascadia Coast Research</b>	Clayton Hiles, M.A.Sc, P.Eng., Senior Coastal Engineer

## 6. Understanding the Issues

### 6.1 Why the Natural Boundary Matters

The importance of increasing storage by raising the weir at Cowichan Lake to improve water security for the Cowichan Region has been understood for decades. Advances in modelling and GIS technologies make understanding the potential lakeshore impacts at a lot-by-lot scale more attainable.

In 2017, during the Cowichan WUP process, several concerns were identified relating to potential impacts to the Cowichan lakeshore from increased water levels due to raising the weir. These concerns included potential impacts to private property because of potential periodic higher springtime water levels in some years, which may have an affect on recreational access, infrastructure, shoreline erosion, flood risk and lakeshore habitat.

In 2013, the EAB used the location of the natural boundary as a test to assess if the proposed changes to the operating rules for the Cowichan Lake Weir could result in impacts to property. The proposed changes in operation could result in water levels being held at the weir crest earlier and longer in the spring.

EAB Decision Nos. 2013-WAT-013(b), 015(c), 016(b), 017(c), 018(c) and 019(c)

[110] [...] property rights end at the “natural boundary” of the lake, which is close to the high water mark of the lake. Below the natural boundary, the property belongs to others.”

[202] “The Panel notes that the high water mark around Cowichan Lake is above the full storage level of 162.37 metres. The Panel concludes that the high water mark, or natural boundary, of Cowichan Lake is the result of natural causes. The Panel finds that, applying the legal definition of “natural boundary” in the Land Act (as required by the Act), the present natural boundary of the lake [...] is higher than 162.37 metres.”



This EAB decision may provide precedent that changes in the location of the natural boundary could be used as a way of defining the limits of potential impacts to lakeshore properties.

Given the importance of the natural boundary on defining property impacts, the primary focus of this study was to identify the current natural boundary around the Cowichan Lake shoreline, including the islands, and predict changes with the proposed raised weir.

Therefore, knowing the current location of the natural boundary, and how it could change in the future because of raising the weir, was one of the key pieces of information required to support a water licence decision that will rest with the Comptroller of Water Rights and could likely go to the EAB.

However, changes in the natural boundary may not be the only factor to consider in impacts to property and riparian rights around the lake. The unique status of legal property boundaries around the lake, a legacy of the Esquimalt and Nanaimo Land Grant, could complicate definition of property impacts.

To successfully obtain a water licence, the applicant will need to submit a credible, defensible, and well-documented analysis of the existing natural boundary and how the location of it could change in the future as a result of raising the weir and changing climate.

The proposed work plan is therefore based around the legal definition of natural boundary and the collection, analysis, and presentation of credible and defensible results.

## 6.2 The Water Licensing Process

The primary focus of the study was to assess how the proposed upgrades and operation of the future weir could impact the natural boundary, and thus property and riparian rights around the lake. Understanding how this information will be ultimately used by the Province in making a final decision to grant a water licence for the upgraded weir and increased storage at Cowichan Lake is vitally important. In reviewing applications, the Comptroller of Water Rights needs to carefully consider several key questions including:

1. How might the water licence impact rights holders (including First Nations, other water licence holders and neighboring property owners)?
2. Is there sufficient water available to support the water licence, including environmental flows?
3. Could the works proposed for the water licence alter the water level regime in such a way as to impact the property and riparian rights either upstream or downstream of the structure?
4. Could the altered water level or flow regime impact the safe operation of private or community infrastructure such as septic fields, water intakes, treated wastewater effluent dilution, navigation, accessibility to wharfs/docks?
5. Could the altered water level or flow regime impact important aquatic or riparian habitat and what measures could be proposed to mitigate these potential impacts?

Regulator guidance can help us to successfully collect, analyze, and present the right information to answer these questions.

Understanding what is needed for an effective water licence application and appeal process will guide refinement of the proposed workplan. A reoccurring question throughout the study will be:

*"Is this information needed and how will it help support the water licence decision?"*

## 6.3 Defining a Natural Boundary

In BC, the Land Act defines the natural boundary as:

*“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 to the soil itself.”*

Due to their nature, the determination of a natural boundary is subjective and relies on the interpretation and judgement by a qualified and experienced professional, especially in situations having anthropogenic effects.

Key in determining the location of a natural boundary is careful observation of the characteristics of soil and vegetation. Since the energy of waves (the “action of water” part of the definition) varies based on the exposure of the shoreline to the prevailing wind direction, this affects the elevation of the natural boundary such that it is not necessarily constant around the lake. On steep bedrock slopes, the character of the vegetation changes quickly such that the natural boundary is demarcated by a sharp line. On relatively flat shorelines, the natural boundary can often occupy a band or zone of transition of vegetation and soil character rather than a sharp line of demarcation.

Defining the natural boundary depends on three key factors:

1. **Presence of Water:** how often water reaches a certain point on the shoreline influences what types of vegetation can grow at different elevations. Modelling water levels for Cowichan Lake will be used to define water level-frequency relationships for conditions with and without the proposed weir under current and future climate conditions.
2. **Action of Water:** the energy of waves along different shoreline exposures to prevailing winds or boat wakes influences what types of vegetation can survive at a given location. Wind-wave models will be developed to generate wave energy statistics around the lakeshore.
3. **Character of Current Shoreline:** (slope, substrate type, vegetation) not only influences the location of the current natural boundary but also plays an important role in how the natural boundary could change because of the proposed weir upgrade and operation.



The shoreline of Cowichan Lake is complex with docks, natural and manipulated shoreline vegetation, retaining walls, groins, etc.

## 6.4 Predicting the Future Natural Boundary

Once the current natural boundary is determined based on observations in the field, then changes in the water level regime will be predicted because of the proposed raised weir and how that could alter the natural boundary. Several key questions will be considered including:

- How frequently do lake water levels exceed the current natural boundary elevation and will the frequency change in the future because of the proposed weir upgrade and operation?



- How could climate change impact inflows to Cowichan Lake and the frequency of water levels exceeding the current natural boundary, both with and without the influence of the proposed weir upgrades and operation?
- How does wave energy around the lake influence the location and elevation of the natural boundary and will this change with future operation of the upgraded weir?
- How does the character of the shoreline including aspect, slope, substrate, ecology, and vegetation types influence the elevation and location of the current natural boundary and how does this change with a raised weir?
- How does the influence of human activities such as boat wakes, wharfs, docks, floating booms, retaining walls, groins, and other erosion protection or beach improvement measures impact the location of the natural boundary?

## 6.5 Natural Boundary on a Lot-by-Lot Basis

Past studies have tried to answer these questions using desktop studies carried out at a larger lake-wide or neighborhood scale. However, due to the complexity of the Cowichan Lake shoreline, the results of these studies have not been able to define potential impacts on a lot-by-lot basis. To predict lot by lot impacts, it is proposed to use a combination of desktop GIS analysis ground-truthed with limited field assessments. The field-observations of the current natural boundary location, human influences, and ecological characteristics along the shoreline will help define both the magnitude of any future changes and level of confidence in the predicted changes. The combined field-based and GIS analysis approach will provide the refinement necessary to produce mapping at an appropriate scale to better understand impacts to properties on a lot-by-lot basis.

## 7. Closing

We trust this information provides you with an overview of the proposed approach and methodology. We look forward to a fruitful discussion and receiving input to strengthen the technical assessment to better suit the water licencing process. Please contact Crystal at 604-293-3232 or Craig at 250-294-8024

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## Revision History

Revision #	Date	Status	Revision Description	Author
0	May 27, 2022	Final	Updated introduction to match other appendix materials	CC
B	November 2, 2020	DRAFT	Issued for Steering Committee Meeting #1	CS/EM
A	August 13, 2020	Draft	Issued for Regulator Meeting #1	CC/CS

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