

Water Quality Objectives for Cowichan Bay and Tributary Streams



The **Water Quality Objective Series** is a collection of British Columbia (B.C.) water quality objectives reports. Water quality objectives are developed for specific waterbodies to promote the protection and stewardship of provincially significant water resources. Once approved, water quality objectives constitute Provincial policy and are considered in resource management decisions affecting water quality. For additional information visit: <https://www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-quality/water-quality-objectives>.

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EXECUTIVE SUMMARY

Water quality objectives (WQOs) were developed to promote the protection of water quality values associated with the marine waters of Cowichan Bay and its freshwater tributaries. The marine waters are to be protected for recreational and cultural uses with an additional goal of improving water quality to allow for shellfish harvesting in the future. In the freshwater tributaries, provisional WQOs are provided to ensure protection of source drinking water, aquatic life, wildlife, irrigation, and recreational and cultural uses. The WQOs are summarized in the following tables.

Water Quality Objectives for Cowichan Bay

Variable	Objective Value	Notes
Enterococci – recreational and cultural uses	≤35 CFU <u>or</u> MPN/100 mL	Geometric mean of at least 5 weekly samples collected in a 30-day period.
	≤70 CFU <u>or</u> MPN/100 mL	Single sample maximum allowable concentration.
Fecal coliforms – bivalve shellfish harvesting	≤14 MPN/100 mL	Median or geometric mean of at least 5 weekly samples collected in a 30-day period.
	≤43 MPN/100 mL	Maximum allowable 90 th percentile concentration within a sampling period with a minimum of 10 results.

Provisional Water Quality Objectives for the Freshwater Tributaries to Cowichan Bay

Variable	Objective Value	Notes
Dissolved oxygen – aquatic life	≥8 mg/L	Average of 5 weekly samples collected in a 30-day period.
	≥5 mg/L	Minimum concentration measured at any given time.
Turbidity – drinking water	<5 NTU	Maximum, October 1 – April 30.
	<2 NTU	Maximum, May 1 – September 30.
Total suspended solids	≤7 mg/L	Average of 5 weekly samples collected in a 30-day period.
	≤27 mg/L	Maximum concentration measured at any given time.
Total phosphorus – aquatic life	≤5 µg/L	Average of 5 monthly measurements, May – September. No more than 20% of results to exceed this value.
	≤10 µg/L	Maximum allowable concentration.
Total copper	≤2 µg/L	Average of 5 weekly samples collected in a 30-day period.
	≤4 µg/L	Minimum concentration measured at any given time.
Total zinc	≤7.5 µg/L	Average of 5 weekly samples collected in a 30-day period.
	≤33 µg/L	Minimum concentration measured at any given time.
<i>Escherichia coli</i>	≤10 CFU/100 mL	90 th percentile of 5 weekly samples collected in a 30-day period.

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1. INTRODUCTION

Water quality objectives (WQO) are developed as Provincial policy statements for specific waterbodies to promote the protection and stewardship of B.C.'s water resources. WQOs define conditions that represent levels of low risk to water values. They formalize expectations with respect to water quality for a given waterbody and are used to inform resource management decisions in the natural resource sector.

WQOs are established on a priority basis for waterbodies (fresh, estuarine, marine) of regional, provincial, inter-provincial, and international significance to protect, manage, and conserve B.C.'s water resources. WQOs are set with the goal of protecting water values by maintaining existing water quality, improving existing water quality, or protecting water quality for a specific use.

WQOs are based on water quality guidelines, or similar information, and water quality assessments which consider the characteristics of the waterbody. These characteristics include: the ambient water quality and its assimilative capacity; the aquatic life and wildlife, and its habitat; the hydrology; the sediments; the potential contaminant loadings from point and non-point source waste discharges; and the cultural and social values associated with a waterbody.

Once approved, WQOs are considered Provincial policy and are considered in decisions affecting water quality. This document presents WQOs for the marine waters of Cowichan Bay and its freshwater tributary streams. These WQOs are based on the document *Cowichan Bay and Tributaries: Water Quality Assessment and Recommended Objectives* (Smorong et al. 2021); readers should refer to this report for detailed water quality information on this area.

2. SITE DESCRIPTION

Cowichan Bay is located near the City of Duncan about 40 km north of Victoria (Figure 1) on Vancouver Island and lies within the traditional lands of Cowichan Tribes. It is also in Electoral Area D of the Cowichan Valley Regional District and supports a population of over 3,200. Numerous freshwater tributaries flow into the bay including the Cowichan and Koksilah rivers.

The primary concerns with respect to water quality include contamination associated with urban and rural households and agricultural activities (such as runoff, treated sewage, septic fields, fertilizers, and pesticides), commercial and industrial land use, and forestry related activities.

3. WATER USES AND VALUES

The water values to be protected in Cowichan Bay include aquatic life, wildlife, recreational and cultural uses, and shellfish harvesting. The harvest of shellfish in Cowichan Bay is currently closed due to sanitary contamination. Indigenous nations have expressed a desire to improve water quality to regain their traditional community practice of harvesting shellfish for sustenance and cultural purposes within their territory.

The freshwater tributaries in this area provide important fish and wildlife habitat, and water for domestic purposes. The water values to be protected in the freshwater tributaries to Cowichan Bay include drinking water, aquatic life, irrigation, recreational uses, and wildlife.

Given the current level of development in this area, and the potential for future development, the goal of these WQOs is to protect current water values and uses and improve water quality to allow the desired uses in the future, where appropriate (e.g., bivalve shellfish harvesting).

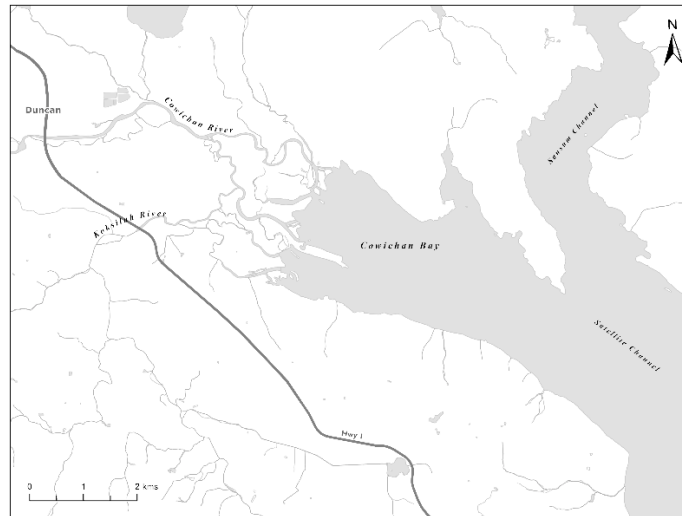


Figure 1: Map of Cowichan Bay and surrounding area.

4. WATER QUALITY OBJECTIVES

The assessment of water quality in Cowichan Bay and its freshwater tributaries (Smorong et al. 2021) found that, overall, water quality in the watershed was generally good with periodic water quality impairments associated with rainfall events. The marine portion of the study area showed occasional elevated enterococci and fecal coliforms levels, while the tributary streams showed occasional elevated turbidity, total suspended solids, total copper, total zinc, total phosphorus, and *Escherichia coli*. Therefore, the following WQOs are defined to protect the identified water values for Cowichan Bay and its tributaries.

4.1 Cowichan Bay

4.1.1 Microbiological Indicators

Fecal contamination of Cowichan Bay is a primary water quality concern. WQOs for microbiological indicators are established to ensure protection of human health in Cowichan Bay with respect to primary contact (full immersion with likelihood of swallowing water) and secondary contact (only limbs immersed with low risk of swallowing water) through recreational and cultural activities. The available data showed enterococci levels to exceed the water quality guideline (WQG) to protect recreational uses at times, particularly during the fall months, therefore a WQO is provided. Fecal coliform counts also frequently exceeded levels specified by the Canadian Shellfish Sanitation Program (CSSP). As the area is currently closed to bivalve shellfish harvest (Closure 18.1 Cowichan Bay, Genoa Bay, Boatswain Bank), a long-term WQO is provided with the goal of eventually removing this closure.

The preferred indicator organism for the protection of recreational uses in marine waters is enterococci. **The WQO for enterococci is a geometric mean of ≤ 35 CFU or MPN/100 mL, based on 5 weekly samples collected over a 30-day period. The single sample maximum allowable concentration is 70 CFU or MPN/100 mL.** The units reported, either colony-forming units (CFU) or most probable number (MPN), depends on the analytical method used (membrane filtration or multiple tube fermentation, respectively). Either method is acceptable.

To support the long-term goal of allowing bivalve shellfish harvesting in Cowichan Bay, a WQO for fecal coliforms is set based on the requirements of the CSSP (Canadian Food Inspection Agency, 2012). **The**

WQO for fecal coliforms is a median or geometric mean concentration of ≤ 14 MPN/100 mL, based on 5 weekly samples collected over a 30-day period, with a 90th percentile concentration of ≤ 43 MPN/100 mL. Note that the CSSP specifies that multiple-tube fermentation is the analytical method to be used with results reported as MPN.

4.2 Tributary Streams

Provisional WQOs are provided for the freshwater tributaries to Cowichan Bay to protect the water values of both the tributaries themselves and Cowichan Bay. These WQOs are provisional given the limited data available and may be revised in the future. The WQOs apply to all freshwater tributaries except the Cowichan River and Koksilah River as separate WQOs have been established for these streams (see Obee and Epps 2011).

4.2.1 Dissolved Oxygen

Dissolved oxygen (DO) is an important characteristic of aquatic habitats and crucial to the survival of aquatic life. The limited data available met the B.C. aquatic life WQGs and to help ensure conditions remain healthy, a provisional WQO for DO is defined. **The provisional WQO for DO is an average concentration ≥ 8 mg/L based on a minimum of 5 weekly samples collected over a 30-day period, with an instantaneous minimum of 5 mg/L DO at any given time.**

4.2.2 Turbidity

Turbidity is a concern with respect to drinking water quality and risks to human health. Turbidity can interfere with disinfection, provide a medium for microbial growth, and indicate the presence of pathogens. The freshwater tributaries to Cowichan Bay have known turbidity sources and have exceeded the Cowichan/Koksilah River WQO levels in the past.

To protect water quality entering Cowichan Bay, future data from the Cowichan Bay tributaries should be assessed relative to the objectives developed for the Cowichan and Koksilah Rivers. **The provisional WQO for turbidity is a maximum of 5 NTU from October through April, and a maximum of 2 NTU from May through September.** The need for a WQO emphasizes the importance of adequate treatment of source water to minimize risks to human health.

4.2.3 Total Suspended Solids

Total suspended solids (TSS) are typically correlated with turbidity; the TSS WQO for the Cowichan and Koksilah rivers (Obee and Epps, 2011) is an average concentration of 7 mg/L and a maximum concentration of 27 mg/l. These WQOs were based on the observation that high concentrations of TSS occur occasionally and are meant to apply to situations which may have been triggered by human activities (Obee and Epps, 2011).

The average WQO was exceeded at most locations, and it is evident that high concentrations of TSS can occur in the tributaries; given the known activities occurring in the watershed, these are likely anthropogenically sourced. For this reason, a provisional TSS WQO for the Cowichan Bay tributaries is provided. **The provisional WQO is an average TSS concentration of ≤ 7 mg/L, based on a minimum of 5 weekly samples collected in a 30-day period, and a maximum concentration of 27 mg/L at any one time.**

4.2.4 Total Phosphorus

On Vancouver Island, phosphorus concentrations are a concern during summer low flow periods when elevated levels are most likely to lead to the deterioration of aquatic habitats and the quality of source drinking water. The limited data available showed elevated total phosphorus levels in the tributaries to

Cowichan Bay which exceeded guidance developed specifically for Vancouver Island streams (British Columbia Ministry of Environment, 2014). A provisional WQO is therefore defined to protect the values of the Cowichan Bay tributary streams. **The provisional WQO is an average total phosphorus concentration of $\leq 5 \mu\text{g/L}$, based on a minimum of 5 monthly measurements from May through September, and a maximum concentration of $10 \mu\text{g/L}$ at any time.** No more than 20% of individual measurements should exceed $5 \mu\text{g/L}$.

4.2.5 Total Copper

The total copper WQO for the Cowichan and Koksilah rivers is an average concentration of $2 \mu\text{g/L}$, based on five weekly measurements collected in a 30-day period, and a maximum of $4 \mu\text{g/L}$ at any one time (Obee and Epps, 2011).

Total copper concentrations in the freshwater tributaries to Cowichan Bay were consistently above both the mean and maximum WQOs for the Cowichan and Koksilah rivers, based on samples collected during the fall months. Elevated concentrations occurred with high turbidity and a significant portion of the copper was likely associated with suspended sediments (and therefore not bioavailable). **The provisional WQO for total copper is an average concentration of $\leq 2 \mu\text{g/L}$, based on a minimum of 5 weekly measurements within a 30-day period, and a maximum concentration of $10 \mu\text{g/L}$ at any time.** It should be noted that the current B.C. approved copper WQG is based on the dissolved fraction and this WQO may be revised on the future.

4.2.6 Total Zinc

The total zinc WQO for the Cowichan and Koksilah rivers is an average concentration of $7.5 \mu\text{g/L}$, based on 5 weekly samples in 30 days, and a maximum concentration of $33 \mu\text{g/L}$ at any time (Obee and Epps, 2011).

Total zinc concentrations in the tributaries to Cowichan Bay were below the maximum WQO, but if values consistently stayed at the observed levels, the average WQO could potentially be exceeded at some sites. Because the available data were insufficient to allow an accurate assessment of the average WQO, a provisional WQO for zinc is proposed. **The provisional WQO for total zinc is an average concentration of $\leq 7.5 \mu\text{g/L}$, based on a minimum of 5 weekly measurements within a 30-day period, and a maximum concentration of $33 \mu\text{g/L}$ at any time.**

4.2.7 Microbiological Indicators

Smorong et al. (2021) identified issues with microbiological contamination in the freshwater tributaries to Cowichan Bay and concluded these streams are contributing microbiological indicators at concentrations above the shellfish harvesting guidelines to the marine waters. The available data exceeded the Cowichan and Koksilah rivers WQO for *Escherichia coli* (90th percentile $\leq 10/100 \text{ mL}$) at all sites. Recreational water users should also use caution given the extensive recreation guideline exceedances. The presence of domestic water licenses on these tributaries emphasizes the need for consideration of drinking water guidelines and the need for disinfection prior to consumption, where applicable. For these reasons, a provisional WQO for *E. coli* is recommended. **The WQO is a 90th percentile for *E. coli* of $\leq 10/100 \text{ mL}$ (MPN or CFU), based on a minimum of 5 weekly samples collected within a 30-day period.**

5. MONITORING RECOMMENDATIONS

Regular water quality monitoring is essential for assessing the attainment of WQOs. The recommended water quality monitoring program for Cowichan Bay and its tributaries is summarized in Table 1. Monitoring should occur, at a minimum, once every 5 years depending on available resources and changes to land use.

Monitoring efforts are to consist of at least 5 samples collected within a 30-day period during the summer dry period (between August and September) and the fall first-flush period (October and November) at all sites. In this way, the two critical periods (minimum dilution during low-flow and maximum turbidity during the first fall rains) will be monitored. Samples collected during the winter months should coincide with rain events whenever possible. An additional 5-in-30 monitoring period in the tributaries during spring manure spreading (March/April) may provide useful information on nutrient sources to the streams. The samples collected in the marine areas should be analyzed for microbiological parameters (enterococci and fecal coliforms) although additional analyses (e.g., metals) may be desirable if resources allow. Water samples from the tributaries should be analyzed for total and dissolved metals, water hardness, nutrients, conventional parameters, and *E. coli*.

Table 1. Recommended water quality monitoring program for Cowichan Bay and its freshwater tributaries.

Sampling area	Timing	Parameters
Cowichan Bay marine areas	5-in-30 sampling summer and fall	Enterococci, fecal coliforms
Freshwater streams	5-in-30 sampling summer and fall	Metals: Total and dissolved metals Nutrients: Total P, total N, total nitrate, total nitrite Conventional parameters: Turbidity, TSS, temperature, DO, pH, conductivity, hardness, dissolved organic carbon Microbiological: <i>E. coli</i>
Freshwater streams	Monthly (growing season only)	Total phosphorus, chlorophyll <i>a</i>

Monitoring for *E. coli* in the tributaries to Cowichan Bay should specifically target hot spots identified in Smorong et al. (2021) and sites in the upper portion of the tributaries, to provide information on contamination patterns along the streams (from the headwaters to where the stream flows into the Bay). This sampling should be done in conjunction with or following remediation activities or improved changes to land use activities (such as manure spreading and storage).

Cowichan Bay shoreline sites (see Smorong et al. 2021) should be targeted for microbiological sampling, as these sites showed a pattern of being generally higher than the open water sites. Summer monitoring for enterococci may not be required (except for the marina area) since earlier results indicate that summer concentrations are lower than those observed in the fall. However, if possible, it is recommended that summer sampling be conducted for at least one additional year to confirm this temporal pattern.

Suitable reference sites for microbiological indicators should be identified and monitored to allow comparison to sites sampled within the Bay. It is also recommended that microbial source tracking sampling be conducted (see Smorong et al. 2021) to provide additional information for identifying sources

of microbiological contaminants, and to determine if there are any changes in the sources of microbiological contaminants.

Monthly field sampling should occur during the growing season of the freshwater tributaries to measure total phosphorous and chlorophyll *a*. Chlorophyll *a* should be measured as the biomass of *naturally growing* periphytic algae to allow direct comparison to the Cowichan and Koksilah Rivers WQO.

It is recommended that marine sediment sampling be included during future attainment monitoring efforts at key sites (see Smorong et al. 2021). Sediments provide sinks for many contaminants and may serve as a source of pollutants to the water column (MacDonald and Ingersoll 2003).

Monitoring data collected by Cowichan Tribes and other parties should be included to support future water quality assessments in Cowichan Bay and its tributaries. Any group or agency planning to monitor water quality in the Cowichan Bay watershed is advised to contact ENV discuss coordination with existing initiatives.

6. REFERENCES

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