



ENVIRONMENTAL PROTECTION DIVISION
ENVIRONMENTAL SUSTAINABILITY DIVISION
MINISTRY OF ENVIRONMENT

**Water Quality Assessment and Objectives
for Cowichan Lake**

OVERVIEW REPORT

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SUMMARY

This document is one in a series that presents water quality objectives for British Columbia. This overview report summarizes the findings of the technical report, which is available as a separate document. The overview report provides general information about the water quality of Cowichan Lake, which supplies drinking water to the Town of Lake Cowichan, as well as the Cowichan Valley Regional District on the east coast of Vancouver Island in British Columbia. It is intended for both technical readers and for readers who may not be familiar with the process for setting water quality objectives. Separate tables listing water quality objectives and monitoring recommendations are included. The technical report presents the details of the water quality assessment for Cowichan Lake, and forms the basis of the recommendations and objectives presented here.

The primary activities occurring within the watershed that could potentially impact water quality are timber harvesting, recreation, residential and historical mining activities.

Water quality objectives are recommended to protect source water (raw drinking water supply), recreation, irrigation, wildlife and aquatic life.

PREFACE

Purpose of Water Quality Objectives

Water quality objectives are prepared for specific bodies of fresh, estuarine and coastal marine surface waters of British Columbia as part of the Ministry of Environment's (MoE) mandate to manage water quality. Objectives are prepared only for those waterbodies and water quality characteristics that may be affected by human activity now or in the future.

Authority to set Water Quality Objectives

The MoE has the authority to set water quality objectives under Section 5(e) of the *Environmental Management Act*. In addition, Section 150 of the *Forest and Range Practices Act* (FRPA) contains provisions for the MoE to establish objectives to protect water quality in designated community watersheds. This legislation is intended to protect consumptive uses of water in designated community watersheds within working Crown forests. For this reason water quality objectives developed for community watersheds generally focus on potential impacts from timber harvesting, range activities and forestry-related road construction.

While Cowichan Lake is not a designated community watershed (under the *Forest and Range Practices Act*), the MOE uses other tools, such as water quality objectives, and legislation, such as the *Private Managed Forest Land Act* and the *Drinking Water Protection Act*, to ensure that all watersheds and /or water supplies are managed in a consistent manner and to protect water quality within these watersheds.

How Objectives Are Determined

Water quality objectives are the safe limits for the physical, chemical or biological characteristics of water, biota (plant and animal life) or sediment that protect all designated water uses in a given waterbody or a watershed. The water uses considered in this exercise are the following:

- source water for public water supply and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial (e.g., food processing) water supplies.

Objectives are established in British Columbia for waterbodies on a site-specific basis taking into consideration provincial water quality guidelines, local water quality, water uses, water movement, waste discharges and socio-economic factors. Each objective for a location may be based on the protection of a different water use, depending on the uses that are most sensitive to the physical, chemical or biological characteristics affecting that waterbody.

How Objectives Are Used

Water quality objectives are not legally enforceable unless established under the Government Actions Regulation (B.C. Reg. 582/2004). Objectives are most commonly used to guide the evaluation of the state of water quality in a watershed, the issuance of permits, licenses and legal orders, and the management of fisheries and the province's land base. Water quality objectives are

also a standard for assessing the ministry's performance in protecting water uses.

Monitoring Requirement

Monitoring of water quality objectives is undertaken to determine if the designated water uses are being protected. Monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. In the case of forestry-related impacts, these critical times may be associated with periods of peak flows when the majority of suspended and dissolved particulates and other contaminants, such as bacteria, are introduced into a waterbody. Late summer periods of low flow could also be sensitive to impacts due to human disturbances. It is assumed that if all designated water uses are protected at the critical times, then they also will be protected at other times when the threat to water quality is less.

The monitoring usually takes place during a five-week period, twice during the calendar year which allows the specialists to measure the worst, as well as the average condition in the water. For some water bodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses and the way objectives are expressed (e.g. mean value, maximum value, 95th percentile, etc.). Lakes are generally sampled on a quarterly basis.

Vancouver Island Eco-Region Approach

There are over 60 community watersheds within the Vancouver Island Region of the Ministry of Environment. Rather than develop water quality objectives for each of these watersheds on an individual basis, an ecoregion approach has been implemented, whereby Vancouver Island has been split into six ecoregions based on similar climate, geology, soils and hydrology. Representative lake and stream watersheds within each ecoregion are selected and a three year monitoring program is implemented to collect water quality and quantity data, as well as biological data. Watershed objectives will be developed for each of the representative lake and stream watersheds based on this data, and these objectives will also be applied on an interim basis to the remaining lake and stream watersheds within that ecoregion. Over time, other priority watersheds within each ecoregion will be monitored for one year to verify the validity of the objectives developed for each ecoregion and to determine whether the objectives are being met for individual watersheds.

INTRODUCTION

This report examines the existing water quality of the Cowichan Lake watershed and recommends water quality objectives for this watershed based on potential impacts of certain key water quality parameters of concern.

The Cowichan River watershed, which includes Cowichan Lake, is one of three rivers in BC designated a Canadian Heritage River based on its outstanding natural, cultural, and recreational values. Cowichan Lake is the second largest lake on Vancouver Island and supplies drinking water to the Town of Lake Cowichan and the Cowichan Valley Regional District. The Cowichan watershed supports an abundance and diversity of both anadromous and resident salmonids that is unrivalled on Vancouver Island.

Anthropogenic land uses within the watershed include timber harvesting, residential and recreation. These activities, as well as natural erosion and the presence of wildlife, all potentially affect water quality in the Cowichan Lake watershed.

The purpose of this report is to develop water quality objectives specific for Cowichan Lake to help ensure long-term sustainability of the water resource.

BASIN PROFILE

Watershed Description

The Cowichan River watershed, which contains Cowichan Lake, is relatively large, at approximately 1,227 km² in area. The Cowichan River is 50 km in length and is a fifth-order stream. Cowichan Lake has a surface area of 6,204 ha, a perimeter of 110 km, a maximum depth of 152 m and a mean depth of 50 m. The elevation of Cowichan Lake is 164 m, with elevations within the watershed ranging from slightly over 1,500 m on the northern side of the lake at Mount Landale, to sea level where it enters the Strait of Georgia at Cowichan Bay (Figure 1).

Cowichan Lake falls within the Leeward Island Mountains (LIM) ecoregion established for Vancouver Island by MOE staff.

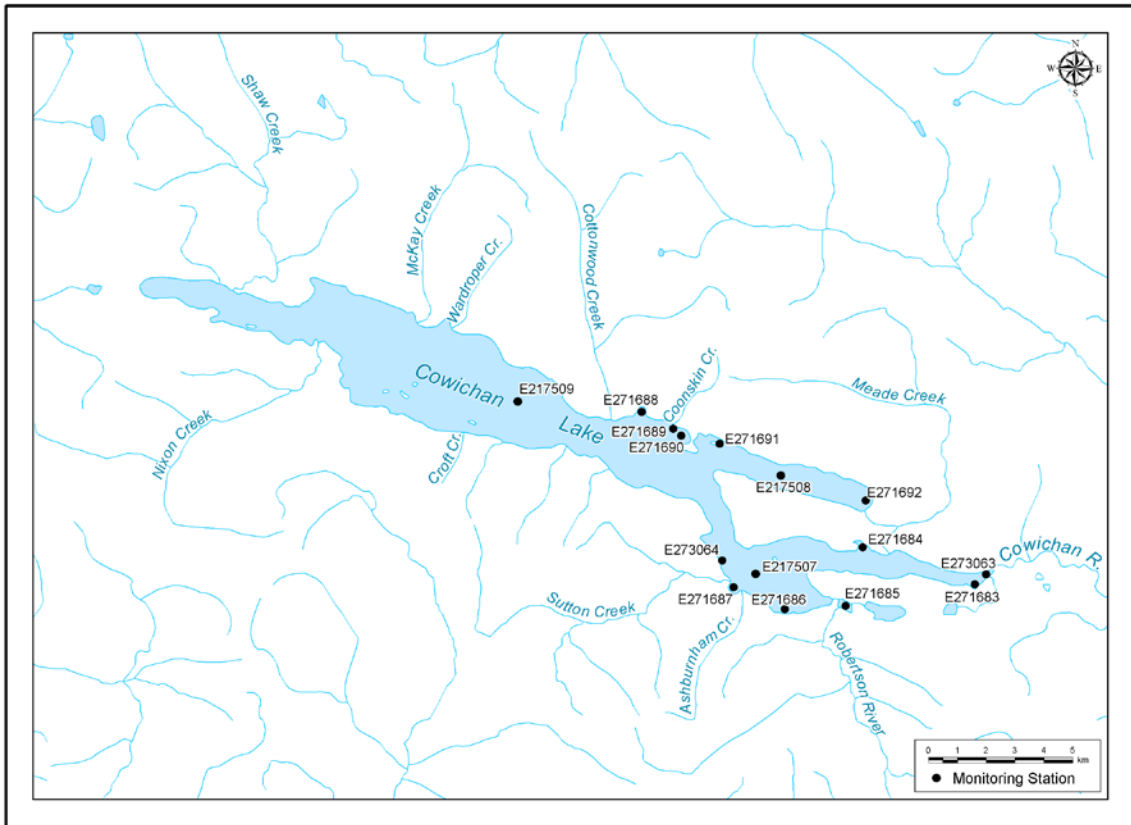


Figure 1. Overview Map of Cowichan Lake, including sampling locations.

Hydrology

Water levels in Cowichan Lake are controlled by Catalyst Paper Crofton Division's weir at the east end of the lake. These levels are guided by a "rule curve" originally developed between then-licensee Norske Canada and the MOE Water Management Branch. Currently both provincial and federal fisheries agencies are in partnership with Catalyst Paper and the BC Ministry of Forests, Lands and Natural Resource Operations to release pulses of water from the weir for low flow fisheries concerns.

Water Survey Canada (WSC) operated a hydrometric station on Cowichan Lake between 1913 and 1921 and then again between 1954 and 2007 (WSC Station 08HA009). The maximum daily water level recorded was 165.388 m above sea level (asl), while the minimum level was 161.029 m (asl).

Climate

The nearest climate station to the watershed for which climate normal data (1971-2000) are available is the Cowichan Lake Forestry station (elevation 176.8 m) (Environment Canada Climate Station 1012040). Average daily temperatures range from 2.6°C in January to 17.9°C in August. Average total annual precipitation is 2,170 mm, with only 112 mm (water equivalent) (6%) of this falling as snow. Most precipitation (1749 mm, or 81%) falls between October and March. Snowpack reaches a maximum in April and May, and snowmelt contributes to spring freshet and summer flows.

Water Uses

Water Licenses

The Town of Lake Cowichan and the Cowichan Valley Regional District (CVRD) both have water licenses to remove water from Cowichan Lake for waterworks purposes (2,408 dam³/a). There are also a number of domestic licenses allowing individuals to withdraw water for domestic use (including drinking water), and irrigation purposes. On the Cowichan River, there are a number of water licenses for domestic and irrigation purposes, as well as

for the pulp mill (Catalyst Paper) in Crofton. Storage within Cowichan Lake is licensed to Catalyst Paper. The Department of Fisheries and Oceans also holds water licenses for conservation purposes.

Recreation

Cowichan Lake is a very popular recreational area. The communities of Lake Cowichan, Youbou, and Honeymoon Bay all rely heavily on tourism to support their economies. There are also numerous cabins along the north eastern shoreline of the lake, many of which have boat slips. As well, there are a number of designated campgrounds: Gordon Bay Provincial Campground near Honeymoon Bay; the Lakeview Municipal Campground on the north shore, west of the Town of Lake Cowichan; Beaver Lake Resort on Beaver Lake; Cowichan Lake RV Resort near Youbou, Peters Pond Campground in Honeymoon Bay; four campsites maintained by Timberwest; and three campsites maintained by the BC Forestry Service. The Cowichan Lake Education Center, a full service conference and education facility, is located on the shores of Cowichan Lake west of the Town of Lake Cowichan. Swimming, fishing and boating (power boats as well as canoes and kayaks) are all very popular activities on the lake.

Fisheries

The Cowichan watershed is world famous for its fishing. Anadromous species include chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*O. kisutch*), chum salmon (*O. keta*), and populations of searun steelhead (*O. mykiss*) and cutthroat trout (*O. clarki*) trout. Resident species include brown trout (*Salmo*

trutta), Dolly Varden char (*Salvelinus malma*), rainbow and cutthroat trout, and kokanee salmon (*O. nerka*) in Cowichan Lake. Between 2005 and 2008, more than 200,000 steelhead smolts were stocked in the Cowichan River. Smallmouth bass (*Micropterus dolomieu*), brown catfish (formerly brown bullhead) (*Ameiurus nebulosus*), lake lamprey (*Lampetra macrostoma*), pacific lamprey (*L. tridentate*), prickly sculpin (*Cottus asper*), threespine stickleback (*Gasterosteus aculeatus*), and western brook lamprey (*L. richardsoni*) are also found in Cowichan Lake. The outlet of Cowichan Lake is equipped by a fishway, and passage is controlled for fisheries management.

Flora and Fauna

The Cowichan Lake watershed provides habitat to a variety of wildlife species typical of west coast Vancouver Island, including Roosevelt elk, blacktail deer, black bear, cougar, and numerous other small mammals and birds. A number of rare plant species, including red and blue-listed species, are also found within the watershed. As well, Cowichan Lake contains a red-listed vertebrate species, the Cowichan Lake Lamprey (*Lampretra macrostoma*).

Designated Uses

Based on the information presented here, the water uses to be protected should include drinking water, recreation, irrigation, wildlife and aquatic life.

Influences on Water Quality

Land Ownership

Almost all of the land surrounding Cowichan Lake is privately owned. In addition to the communities of Lake Cowichan, Youbou and Honeymoon Bay, there are numerous private residences located along the lakeshore, many with their own private boat docks.

Potential impact from residential and/or urban development to surface waters generally involve potential runoff from properties (which may contain a variety of contaminants including pesticides, fertilizers, fecal material from domestic pets, etc.), contamination from grey water or black water systems, garbage disposal, spilling of household chemicals or hydrocarbons, and inundation of homes and waste disposal facilities during extreme flooding events. Fire suppression, if any of these residences catch fire, could also be a significant source of water quality contamination.

Larger developments can also impact water quality through the proliferation of impervious surfaces and increased sediment loadings from land disturbances.

Water Licenses

Water licenses can impact aquatic habitat downstream from the withdrawal, especially during low-flow periods. However, in the case of Cowichan Lake, Catalyst Paper releases water from the weir in accordance with the 'rule curve' negotiated between then-licensee Norske Canada and the MOE Water Management Branch. To ensure there is sufficient water to allow releases for fisheries

purposes during the low-flow season, Catalyst Paper has water licenses allowing them to store water in Cowichan Lake.

Forest Harvesting and Forest Roads

Forestry activities can impact water quality both directly and indirectly in several ways. The removal of trees can decrease water retention times within the watershed and result in a more rapid response to precipitation events and earlier and higher spring freshets. The improper construction of roads can change drainage patterns, destabilize slopes and introduce high concentrations of sediment to streams.

Logging occurs throughout much of the upper Cowichan Lake watershed. As the majority of forest activity takes place on privately owned lands, it is governed by the *Private Managed Forest Land Act*. As such, the forest management objective for water quality is to protect human drinking water, both during and after harvest.

Recreation

Recreational activities can affect water quality in a number of ways. Erosion associated with 4-wheel drive and ATV vehicles, direct contamination of water from vehicle fuel, and fecal contamination from human and domestic animal wastes (*e.g.*, dogs or horses) are typical examples of potential effects.

Cowichan Lake experiences high levels of recreational activity, primarily during the summer months. Activities such as camping, swimming, fishing and boating can potentially impact water quality

in a number of ways. Microbiological contamination can be associated with campgrounds, backcountry activity, swimmers and pets. Debris left by picnickers, fuel spills and combustion by-products from ski-boats, jet-skis, and other motorized craft, could all potentially impact water quality in Cowichan Lake.

Wildlife

Warm-blooded animals can carry microorganisms such as *Giardia lamblia* and *Cryptosporidium*, which are harmful to humans, causing gastrointestinal disease.

The Cowichan Lake watershed contains valuable wildlife habitat, and provides a home for a wide variety of warm-blooded species including Roosevelt elk, blacktail deer, black bear, wolf, cougar, red squirrels, eagles, hawks, owls, grouse and numerous other species of small birds.

Mining

Mining activities can impact water quality by introducing high concentrations of metals to the watershed, depending on the location, and can also contribute to acidification of the water.

Historically, there have been five mines within the upper Cowichan Lake watershed that have produced minerals (copper, gold, silver, lead, zinc, molybdenum, manganese, and rhodonite) including two near Gordon Bay Provincial Park. There are also a relatively large number of showings all around the lake containing various minerals. However, these showings have not been developed.

WATER QUALITY ASSESSMENT AND OBJECTIVES

Water Quality Assessment

Three deep station water quality monitoring locations were established within Cowichan Lake: one in the south arm, midway between Honeymoon Bay and Goat Island (Site E217507); one in the north arm (Site E217508); and one in the main basin, approximately 4 km west of the Youbou mill (Site E217509). Physical, chemical and biological parameters were collected for the deep station lake sites. Water quality monitoring was conducted on a quarterly basis (March, June, August and November) for the three deep basin sites from May 2008 to March 2009. In addition, 12 shoreline locations were sampled for bacteriological analyses (Figure 1). The sampling frequency was weekly for five consecutive weeks during summer low-flows (August/September) and during fall peak-flows (October/November) for 2009. Monitoring sites were also established near the mouth of 11 of the larger tributaries to Cowichan Lake to determine if these are significantly impacting water quality in Cowichan Lake. The inflow sites were also sampled weekly for five consecutive weeks during fall – peak flows only and analyzed for total suspended solids and turbidity.

The monitoring results for Cowichan Lake show that water quality is excellent. The water chemistry is typical of coastal lakes with low mineral content, ample dissolved oxygen, and very clear waters, which is indicative of high quality raw drinking water. Cowichan Lake is relatively unproductive biologically and is classified as oligotrophic (low nutrient content). However, there is a diverse and normal plankton

community. These types of lakes often support many fish species, like rainbow trout, which prefer cool, well-oxygenated waters.

Turbidity values in both the lake and tributaries, and TSS concentrations in the tributaries, are generally low, however, it appears that occasional moderate values can occur. It's likely that precipitation events caused the short-term increased turbidity values.

Concentrations of microbiological indicators were primarily below detection limits (<1 CFU/100ml). The marina at the head of the south arm had the highest concentration of fecal coliforms in a single sample at 2,300 CFU/100 mL. However, the drinking water guideline for raw water receiving disinfection only was exceeded in 6 of the 60 sample sets (five samples in 30 days) for fecal coliforms and in only 1 of the sample sets for *E. coli*. The Youbou West site was the location of three of the exceedances (two for fecal coliforms and one for *E. coli*). Not all the residences in Youbou are hooked up to the community sewage system so there is potential for septic contamination from failing or aged septic fields. Seasonal campgrounds, boat and human traffic on the lake, and wildlife could all be contributing to the bacterial levels as well. These exceedances demonstrate the need to treat water for human consumption to prevent potential health risks.

Water Quality Objectives

To ensure the exceptional water quality in Cowichan Lake, water quality objectives are proposed for Secchi depth, temperature, dissolved oxygen, and chlorophyll *a* for the protection of aquatic life (Table 1). Microbiological, turbidity, total organic carbon and total suspended solids objectives have also been established for the protection of drinking water. These objectives will also protect recreation, domestic

and wildlife uses in the watershed. The water quality objectives recommended here take into account background conditions, impacts from current land use and any potential future impacts that may arise within the watershed. These objectives are required to ensure that inputs from residential, timber harvesting, and recreation activities do not impair water uses.

Table 1. Summary of proposed water quality objectives for the Cowichan Lake Watershed.

Variable	Objective Value
Water temperature	$\leq 15^{\circ}\text{C}$ summer maximum hypolimnetic temperature (>10m depth)
Dissolved oxygen	≥ 5 mg/L at any depth throughout the year
Secchi depth	≥ 6.0 m minimum, ≥ 8 m average
Turbidity- lake sites	≤ 2 NTU maximum
Turbidity – tributaries	Max of 5 NTU; average of 2 NTU with a minimum 5 weekly samples collected over a 30-day period
TSS – tributaries	Max 26 mg/L; average of 6 mg/L with a minimum 5 weekly samples collected over a 30-day period
Total organic carbon	≤ 4 mg/L maximum
<i>E. coli</i> Bacteria	≤ 10 CFU/100 mL (90 th percentile) with a minimum 5 weekly samples collected over a 30-day period
Chlorophyll <i>a</i>	≤ 2 $\mu\text{g/L}$

DESIGNATED WATER USES: DRINKING WATER, RECREATION, IRRIGATION, AQUATIC AND WILDLIFE

Monitoring Recommendations

The recommended minimum monitoring program for the Cowichan Lake watershed is summarized in Table 2. In order to capture the periods where water quality concerns are most likely to occur (i.e., freshet and summer low-flow, as well as spring overturn) we recommend quarterly sampling for a one year period. Microbiological

samples should be collected at the 12 perimeter sites once weekly for five consecutive weeks within a 30-day period both in late summer and mid-fall. Turbidity and TSS samples should be collected at the 11 inflow sites once weekly for five consecutive weeks during the fall period only. Samples collected during the fall months should coincide with rain events whenever possible. In this way, the two critical periods (minimum dilution and maximum turbidity) will be monitored.

Table 2. Proposed schedule for future monitoring in the Cowichan Lake watershed.

Frequency and timing	Characteristic to be measured
Deep station sites (3 depths per site) - quarterly sampling (March, May, August, October)	pH, specific conductivity, TSS, turbidity, colour, TOC, DOC, nitrogen species, total phosphorus, total and dissolved metals (spring overturn only), chlorophyll <i>a</i> , DO and temperature profiles, and secchi depth
Perimeter lake sites (surface grab sample) - summer and fall (weekly for five consecutive weeks in 30 day period)	<i>E. coli</i>
Tributary sites (surface grab sample) – fall (weekly for five consecutive weeks in 30 day period)	Turbidity and TSS
Deep station sites - twice per year (summer and spring overturn)	Phytoplankton and zooplankton