BRITISH COLUMBIA | Ministry of Environment

ENVIRONMENTAL PROTECTION DIVISION

ENVIRONMENTAL SUSTAINABILITY DIVISION

MINISTRY OF ENVIRONMENT

Water Quality Assessment and Objectives for the John Hart Lake Community Watershed and McIvor Lake

OVERVIEW REPORT

July 2012

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Library and Archives Canada Cataloguing in Publication

Barlak, Rosie
Water quality assessment and objectives for the John Hart Lake community watershed and McIvor Lake [electronic resource] : overview report / Rosie Barlak, Burke Phippen.

A technical report is available separately.
Includes bibliographical references.
Electronic monograph in PDF format.
ISBN 978-0-7726-6600-0

1. Water quality--British Columbia--John Hart Lake Watershed. 2. Water quality--British Columbia--McIvor Lake. 3. Water quality--British Columbia--Campbell River Region. I. Phippen, B. W II. British Columbia. Ministry of Environment III. Title.

TD227 B7 B37 2012 363.739'42097112 C2012-980142-9

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 provides general information about the water quality of John Hart Lake, a community watershed supplying drinking water to the City of Campbell River, located on the east coast of Vancouver Island in British Columbia. It also provides information about McIvor Lake, located near John Hart Lake, which, at the time of this study, was being evaluated as an alternate or additional source of drinking water for the City of Campbell River. This report 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 John Hart Lake and McIvor 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 recreational use, power generation, mining, forestry and, around McIvor Lake only, residential development. These activities, as well as natural erosion and the presence of wildlife, all potentially affect water quality in both John Hart Lake and McIvor Lake.

Water quality objectives are recommended to protect drinking water, aquatic life, irrigation, recreation and wildlife.

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.

John Hart Lake was designated as a community watershed in 2001, as defined under the *Forest Practices Code of British Columbia Act* ("the drainage area above the downstream point of diversion and which are licensed under the *Water Act* for waterworks purposes"). This designation was grandparented and continued under FRPA in 2004 and infers a level of protection. The purpose of this designation is to conserve the quality, quantity and timing of water flow or prevent cumulative hydrological effects.

As some of the John Hart Lake community watershed is on private land, the FRPA does not apply to these parts of the watershed.

However, 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 encourage management and protection of water quality within these watersheds.

How Objectives Are Determined

Water quality objectives are the safe limits for the physical, chemical, and biological characteristics of water, biota (plant and animal life), and 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, and waste discharges. 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, and 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 John Hart Lake and McIvor Lake and recommends water quality objectives for these waterbodies based on potential impacts of certain key water quality parameters of concern.

Both John Hart Lake and McIvor Lake are part of the Campbell River watershed, which includes Brewster, Lower Campbell, Upper Campbell and Buttle Lakes as well as numerous streams. This watershed has important fisheries values; John Hart Lake and McIvor Lake have known presence of rainbow trout, cutthroat trout, Dolly Varden and steelhead. John Hart Lake supplies drinking water to the City of Campbell River. Anthropogenic land uses within the watershed include recreation, power generation, mining, timber harvesting and, around McIvor Lake only, residential development. These activities, as well as natural erosion and the presence of wildlife, all potentially affect water quality in both John Hart Lake and McIvor Lake.

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

Basin Profile

Watershed Description

The Campbell River watershed, which contains both John Hart Lake and McIvor Lake, is very large, with a total area of 1,822 km^2 (Figure 1). The distance from the head of Buttle Lake to the mouth of Campbell River is over 80 km. Campbell River itself is a sixth-order stream.

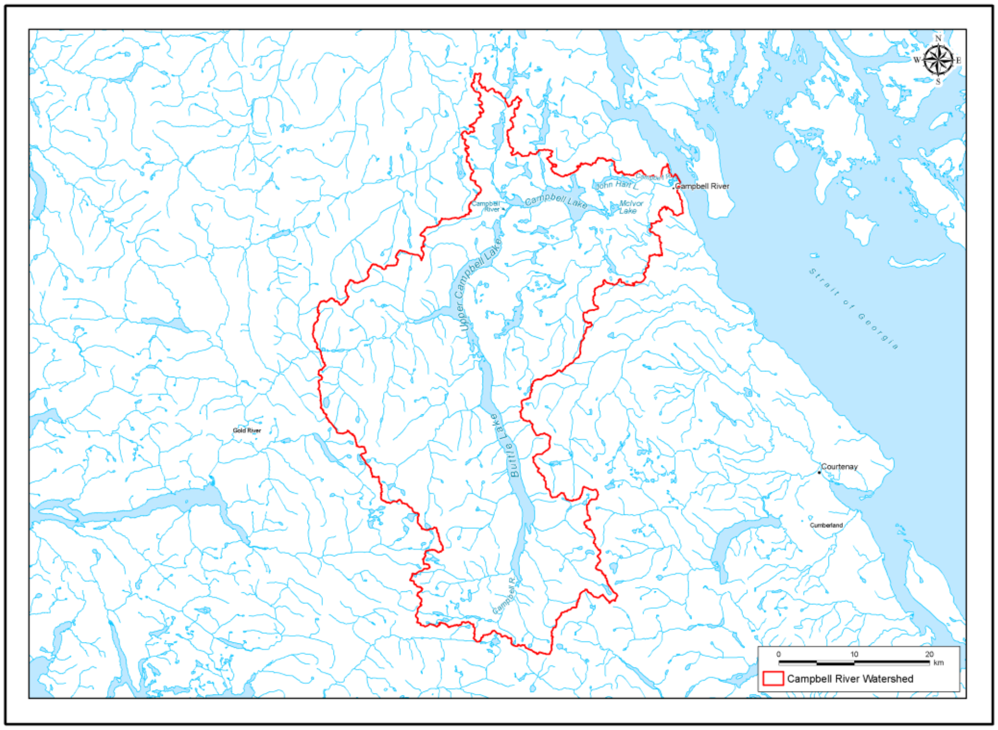

Figure 1. Map of watersheds.

The community watershed portion of the John Hart Lake watershed is approximately 2,520 ha in area. The lake has a surface area of 363 ha, a perimeter of 27.8 km, a maximum depth of 22.9 m and a mean depth of 12.2 m. The vast majority of the water (about 99%) flowing into John Hart Lake passes from Lower Campbell Lake through the Ladore Dam. Similarly, flow out of John Hart Lake is controlled by withdrawals through the BC Hydro Penstocks and over the John Hart Dam.

McIvor Lake is considerably smaller than John Hart Lake, with a surface area of 123 ha, a perimeter of 8.5 km, a maximum depth of 45.5 m and a mean depth of 16.9 m. McIvor Lake is contiguous with Lower Campbell Lake, with the boundary between the two lakes delineated by the narrow waterway surrounding the island in the south-east corner of McIvor Lake. When this monitoring program began, McIvor Lake was considered a potential option for a secondary intake based on initial evaluations of its water quality. Upon further evaluation and in consideration of watershed activities, its suitability as a drinking water intake will depend on source protection initiatives, Vancouver Island Health Authority source approval and appropriate source water treatment. Currently, a different location just upstream of McIvor Lake in Lower Campbell Lake is being considered as a secondary intake

Both John Hart Lake and McIvor Lake fall within the Coastal Western Hemlock biogeoclimatic zone (eastern very dry maritime, CWHxm1). The lakes fall within the Nanaimo Lowland (NAL) ecoregion established for Vancouver Island by MOE staff.

Hydrology

Water Survey Canada (WSC) operated a hydrometric station on Campbell River at the outlet of Lower Campbell Lake between 1910 and 1949 (prior to the construction of the Strathcona and Ladore dams). The peak flow measured between 1910 and 1949 was 858 m^3/s, while minimum flows were about 8 m^3/s. Peak flows occurred during the winter corresponding to high rainfall, with a secondary spring peak likely corresponding to snowmelt in the upper watershed. These peaks would now be mitigated by some extent due to the dams on Upper Campbell Lake and Lower Campbell Lake. Periodic discharge measurements have been made on 19 occasions on the spillway at the John Hart Lake Dam, with values ranging from 3.4 m^3/s to 11.5 m^3/s. The mean annual discharge of Campbell River near the City of Campbell River is 98.6 m^3/s.

Climate

The nearest climate station to the watershed for which climate normal data (1971 – 2000) are available is the Campbell River A station (elevation 105.5 m) (Environment Canada Climate Station 1021261). Average daily temperatures range from 1.3°C in January to 16.9°C in July and August. Average total annual precipitation is 1,452 mm, with 109 mm (water equivalent) (8%) of this falling as snow. Most precipitation (1,091 mm, or 75%) falls between October and March.

Water Uses

Water Licenses

Twenty-one water licenses from three points of diversion (PODs) have been issued for John Hart Lake, and four water licenses from four PODs have been issued for McIvor Lake. The licenses for John Hart Lake allow for the withdrawal of 10,496 dam^3/year of water for consumptive uses (drinking water, etc.) and 363,808 dam^3/year of water for non-consumptive uses (power generation). The intake for the John Hart power station is through three penstocks located within the John Hart Dam. The dam and penstocks were built by BC Hydro in 1947, and in 1949 the then Village of Campbell River utilized these penstocks as the source for their new water supply system. This system continues to feed the main City of Campbell River water system. A secondary intake (independent of the penstocks) located near the John Hart Lake pumping station provides water for the Gordon Road and Industrial Park areas. Water from the intakes on McIvor Lake provide water for domestic use to three residences on the lake, as well as for dust control.

Recreation

As a community watershed, John Hart Lake is subject to legislation that prohibits motorized access and camping in the area and limits industrial activities and recreational access. However, there are unauthorized trails and unrestricted logging roads throughout the watershed. Some off-road recreation occurs including use by “mud-boggers”, vehicles that are equipped to go through riparian and boggy areas. Garbage dumping is made easier by the presence of illegal roadways. The area is also utilized by mountain bikers, hikers, horseback riders, hunters, fishermen, as well as motorbikes and all-terrain vehicle (ATV) users.

McIvor Lake is an extremely popular recreational area for locals and tourists. Boating, fishing, swimming and various other water-based activities are very popular. There are three public-access beaches located on McIvor Lake at the north end of the lake off McIvor Lake Road: the main beach; Doggie Point Beach and Lions Beach. A boat-ramp, which allows access for motorized vessels as well as canoes and kayaks, is located between the main beach and the Doggie Point beach. There is also a pet cemetery on the waters edge at Doggie Point. The Campbell River Eagles, a water-ski club, also uses McIvor Lake as a home-base, and host a number of events on the lake each year. They have a ski-jump area located east of the main island, across from the boat launch.

Fisheries

Both John Hart Lake and McIvor Lake have recreational fisheries, with rainbow trout, cutthroat trout, Dolly Varden and steelhead reported as being present. McIvor Lake was stocked with a few steelhead in 2003.

Flora and Fauna

The Campbell River watershed provides valuable habitat to a wide variety of species including blacktail deer, black bear, cougar, and numerous other small mammals and birds. Two blue-listed plant species (the pointed rush, *Juncus oxymeris*, considered fairly secure; and the snow bramble, *Rubus nivalis*) are present in the McIvor Lake watershed. The Northern Red-legged Frog, *Rana aurora*, and the Western Screech-Owl, *Megascops kennicottii*

kennicottii, both blue-listed speces, are present in the Campbell River Watershed.

Hundreds of gulls are known to feed off solid waste in the Campbell River Landfill near McIvor Lake, then to use McIvor Lake as a resting area.

Designated Uses

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

Influences on Water Quality

Approximately 99% of water entering John Hart Lake does so through the Ladore dam, and the volume of water entering (and leaving) the lake is large relative to the volume of water contained within the lake, giving the lake a residence time of one to 14 days. McIvor Lake is contiguous with Lower Campbell Lake, which therefore dictates the water quality within McIvor Lake; however, McIvor Lake acts as a dead-end "finger" of Lower Campbell Lake, and the average annual residence times in McIvor Lake is estimated to be longer than the annual average of 40-55 days residence time identified for Lower Campbell Lake. Processes and impacts in the upper Campbell River watershed (including Buttle Lake and Upper and Lower Campbell Lakes) likely affect water quality to a significant degree in both John Hart Lake and McIvor Lake. However, continuous sources of contamination within either the John Hart Lake or McIvor Lake watersheds may also significantly impact water quality on a longer-term basis due to the fact that these impacts are not mitigated or diluted in the small tributaries before reaching the lakes. Influences on water quality throughout the Campbell River watershed will be considered, with special attention given to potential impacts near John Hart and McIvor lakes, and to the potential longer residence time in McIvor Lake.

Land Ownership

The majority (66.5%) of the Campbell River watershed falls within Provincial Parks (primarily Strathcona Provincial Park) , with Provincial Forest and TimberWest owned private lands composing another 12.1% and 11.5% of the watershed, respectively. Most of the land surrounding McIvor Lake has been developed residentially, while the perimeter of John Hart Lake is relatively pristine.

Water Licenses

Water withdrawals can affect flows downstream from the withdrawal, especially during periods of lower flows. However, in the case of John Hart Lake, BC Hydro is required to release a minimum of 3.5 m^3/s over the spillway to protect fish habitat in Campbell River downstream from the John Hart Lake Dam. BC Hydro controls the flows both into (through the Ladore Dam) and out of (through the penstocks and over the spillway) John Hart Lake. Similarly, flows into Lower Campbell Lake (and therefore McIvor Lake) are controlled through the Strathcona Dam located at the bottom of Upper Campbell Lake, and flows out of Lower Campbell Lake are controlled through the Ladore Dam. Therefore licensed water withdrawals are not likely to affect water levels in either John Hart Lake or McIvor Lake or downstream in Campbell River.

Forest Harvesting and Forest Roads

Forestry activities can impact water 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 rain on snow events. The improper construction of roads can change drainage patterns, destabilize slopes, and introduce high concentrations of sediment to streams.

Approximately 25% of the Campbell River watershed is currently under active forestry management, including lands managed as

Provincial Forest and those owned by Timber West and 0770809 BC Ltd. The majority of forestry activities occurs in the upper watershed, and are governed by the *Forest and Range Practices Act* (FRPA). On private land, the *Private Managed Forest Land Act* potentially protects for human drinking water, both during and after harvest, as well as for fish habitat through requirements to retain sufficient streamside vegetation. As such, riparian areas where impacts are most likely to affect water quality may be protected, and any impacts that occur are mitigated by the long residence times of Buttle Lake, Upper Campbell Lake and Lower Campbell Lake.

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.

Unauthorized motorized vehicle access to the John Hart Lake watershed, and especially “mud-bogging” in wet areas, is likely a source for turbidity in the lake. Access increases the potential for contamination from fecal coliforms (from unauthorized camping and pets), fuel spills and garbage dumping. It also increases the risk of forest fires within the watershed, and their associated impacts on water quality. Potential fire-related impacts include post-fire sediment fluxes, which can affect drinking water treatment processes, and an increase of nutrient loads which can increase algal productivity

McIvor Lake experiences high levels of recreational activity, primarily during the summer months. Activities include swimming and sun-bathing, as well as fishing, jet-skiing and water-skiing, and various other water-based activities. There are concerns that these activities could significantly impact water quality in a number of ways. Bacteriological contamination associated with swimmers (especially infants and toddlers) and pets, debris left by picnickers, fuel and combustion by-products from ski-boats, jet-skis and other motorized craft all could significantly impact water quality in McIvor Lake.

Wildlife

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

The Campbell River watershed contains valuable wildlife habitat, and provides a home for a wide variety of warm-blooded species. Therefore, a risk of fecal contamination from natural wildlife populations within the watershed does exist.

Gulls that have fed at the Campbell River Landfill then used McIvor Lake as a resting area have been observed to transport landfill solid waste material to McIvor Lake. Contamination from solid waste and fecal coliforms associated with the quantity of gulls using McIvor Lake could impact water quality in the lake.

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.

The primary mine operating within the Campbell River watershed is the NVI Mining Ltd's (formerly Westmin, then Boliden) Myra Falls Operations, extracting copper, zinc and some gold. From 1966 to 1983, tailings from the mine were discharged to Buttle Lake, resulting in elevated concentrations of dissolved zinc, copper, cadmium and lead throughout the system. However, remedial measures such as land-based tailings impoundments and contaminate runoff capture and treatment have resulted in decreases in metals concentrations throughout the system.

Highways and Transportation

Highways and transportation corridors can influence water quality through run-off of pollutants such as oil and gasoline, as well as alter flow patterns. Highway 28 passes close to McIvor Lake, and Brewster Lake Road runs near John Hart Lake. If a vehicle transporting potential contaminants (such as a fuel truck) were to overturn on these roads near either lake, there is the potential for contaminants to impact water quality in the lakes.

Water Quality Assessment and Objectives

Water Quality Assessment

In John Hart Lake, three water quality monitoring sites were established: Site E252669 at the inlet of the lake (near the Ladore Dam); site 1130020 at the outlet of the lake (near the BC Hydro Penstocks); and site E259337, mid-lake, at the deepest point. One water quality monitoring site was established in McIvor Lake: EMS site E207156 is near the deepest point (Figure 2). 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) from March 2003 to March 2006. In addition, the inlet and outlet sites were sampled for microbiological parameters and select chemical/physical parameters. The sampling frequency was weekly for five consecutive weeks during the summer low flow (August/September) and fall flush (October/November) periods from 2003-2005; however, due to sampling complications, only in 2004 were five consecutive weeks of sampling completed.

Water quality monitoring in John Hart Lake and McIvor Lake showed that both lakes are oligotrophic and that the overall state of the water quality is very good. All chemical, physical and biological parameters met provincial water quality guidelines with the exception of cadmium, which exceeded average aquatic life guidelines regularly in John Hart Lake; also, copper and zinc exceeded aquatic life guidelines on occasion in John Hart Lake.

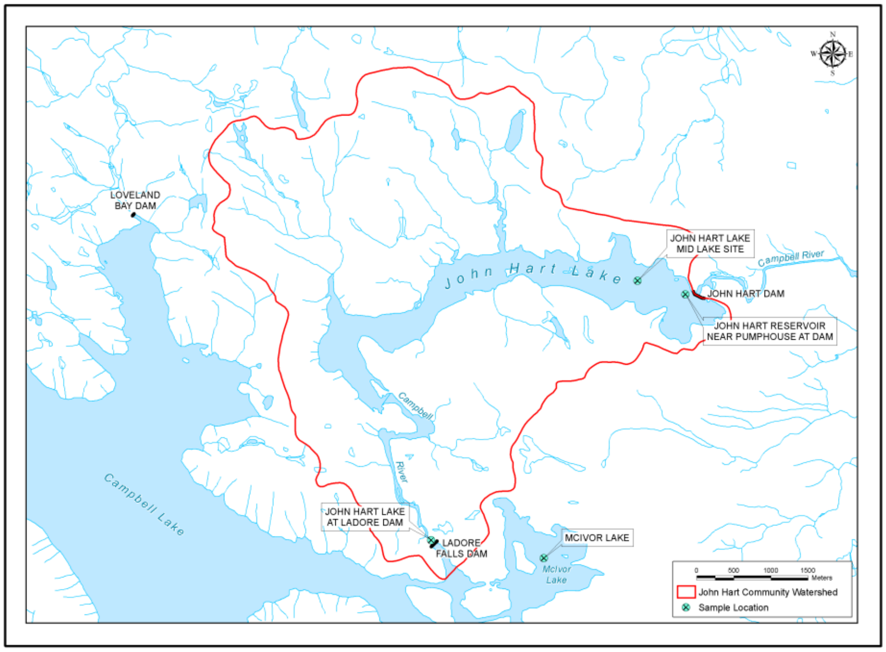

Figure 2. Map of sampling locations.

Summer surface water temperatures were relatively high in John Hart Lake and McIvor Lake, which would typically require fish to stay at or below the thermocline to avoid physiological stress associated with higher water temperatures. As summer surface temperatures exceed the aesthetic drinking water guideline, placing water intakes below 15m depth in either lake would allow this guideline to be met.

Dissolved oxygen levels were high throughout the year in both lakes, and this fact, coupled with low levels of nutrients (both nitrogen and phosphorus) suggest that the lakes have low biological productivity. An objective was established for dissolved oxygen to serve as an early warning sign for impacts from future activities.

All extinction depth (Secchi) readings were high and easily met the recreational guideline. To ensure that Secchi depths are maintained at the current level a water quality objective is proposed.

Occasional low pH appears to be a natural phenomenon in both John Hart Lake and McIvor Lake and it is not likely that anthropogenic activities will impact pH in these lakes. Colour and total organic carbon where both well below guidelines. Observed specific conductivity was typical of coastal systems. Nitrate and nitrite were both very low and well below guidelines in both lakes. No water quality objectives are recommended for these parameters.

Turbidity values were consistently low in both John Hart Lake and McIvor Lake. McIvor Lake's longer residence time makes it more susceptible to turbidity impacts should they occur. Particulate matter (especially smaller, lighter materials such as clay which are slow to settle out of the water column) introduced to the lake through runoff or slope failures are more likely to cause longer-term problems. For this reason, a water quality objective is recommended, to ensure that the exceptional water clarity of John Hart Lake and McIvor Lake is maintained.

Concentrations of total cadmium regularly exceeded, while total copper and total zinc occasionally exceeded the guidelines for the protection of aquatic life. This is likely due in part to naturally high concentrations of these metals within the watershed, coupled with the fact that both John Hart Lake and McIvor Lake have very soft water (water quality guidelines for copper and zinc are hardness-dependent, therefore, the applicable guideline is very low). Objectives are proposed for total cadmium, total copper and total zinc concentrations in John Hart Lake and McIvor Lake.

Although concentrations of phosphorus (the primary limiting nutrient in most freshwater aquatic systems) were low in both lakes, an objective is proposed to ensure that they remain pristine into the future.

Microbiological indicators were elevated on occasion in John Hart Lake but did not exceed drinking water guidelines. The source of this fecal contamination is likely endemic wildlife, but the occasional higher values measured in John Hart Lake demonstrate the need to treat water for human consumption to prevent potential health risks; thus a microbiological objective is proposed. *Escherichia coli* concentrations would likely be higher in McIvor Lake, due to the higher recreation use and high concentration of residences around the lake.

Chlorophyll *a* measured in John Hart Lake and McIvor Lake were low. To ensure that increases in productivity associated with nutrification do not occur in these lakes, a water quality objective is recommended for both John Hart and McIvor Lakes.

Water Quality Objectives

Water quality objectives have been set for key drinking water and aquatic life characteristics for John Hart Lake and McIvor Lake (Table 1). These objectives will also protect wildlife, irrigation and recreation for these characteristics. 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. The objectives are required to ensure that inputs from forestry, mining, recreation, power generation, and rural and urban development do not impair water uses. The objectives apply to the watershed above the community water supply intake.

Table 1. Summary of proposed water quality objectives for John Hart Lake and McIvor Lake.

Variable	Objective Value
Water temperature	≤ 15°C summer maximum (>15 m depth)
Secchi depth	Annual average ≥ 8 m
Dissolved oxygen	≥ 5 mg/L 1 m above substrate
***Escherichia coli* bacteria**	≤10 CFU/100 mL (90th percentile) with a minimum 5 weekly samples collected over a 30-day period
Turbidity	≤ 2.0 NTU maximum 5 m above substrate
Total phosphorus	≤5 µg/L average during epilimnetic growing season (May –Sept)
Total cadmium	≤ 0.01 µg/L average
Total copper	≤ 4 µg/L maximum, ≤ 2 µg/L average (minimum 5 weekly samples collected over a 30-day period)
Total zinc	≤ 33 µg/L maximum, ≤ 7.5 µg/L average (minimum 5 weekly samples collected over a 30-day period)
Chlorophyll *a*	≤ 1.5 µg/L chlorophyll *a* maximum, eplimnetic growing season

Monitoring Recommendations

The recommended minimum monitoring program for the John Hart Lake and McIvor Lake is summarized in Table 2. In order to capture the periods where water quality concerns are most likely to occur (i.e., winter rains and summer low-flow, as well as spring overturn) we recommend quarterly sampling for a one year period. Microbiological and metals should also be collected at the inlet and outlet sites and the future intake in Lower Campbell Lake once weekly for five consecutive weeks within a 30-day period both in late summer and mid-fall. Plankton samples should be collected twice per year, at spring overturn and in the summer. 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 water quality and benthic invertebrate monitoring in John Hart Lake and McIvor Lake.

Frequency and timing	Characteristic to be measured	Site
Quarterly sampling (once each season, including spring overturn)	Profile (every metre): temperature, pH, dissolved oxygen, specific conductivity, oxidation-reduction potential (ORP) Secchi depth Grab samples (three depths per site: surface, 10 m and 1 m from bottom): pH, specific conductivity, colour, turbidity, TOC, DOC, total phosphorous, nitrogen species, total and dissolved metals, hardness, Chlorophyll *a* (surface only)	Deep Stations: E259337, E207156
Summer and fall (once a week for five consecutive weeks)	*E. coli*, total and dissolved metals	Inlet and outlet: E252669, 1130020; future intake in Lower Campbell Lake 50°00’21.23”N, 125°24’04.91” W)
Twice per year (summer and spring overturn)	Phytoplankton and zooplankton	Deep Stations: E259337, E207156