



Water Quality

Ambient Water Quality Objectives For Holland Creek And Stocking Lake Watersheds

Overview Report

*Water Management Branch
Environment And Resource Division
Ministry Of Environment, Lands And Parks*

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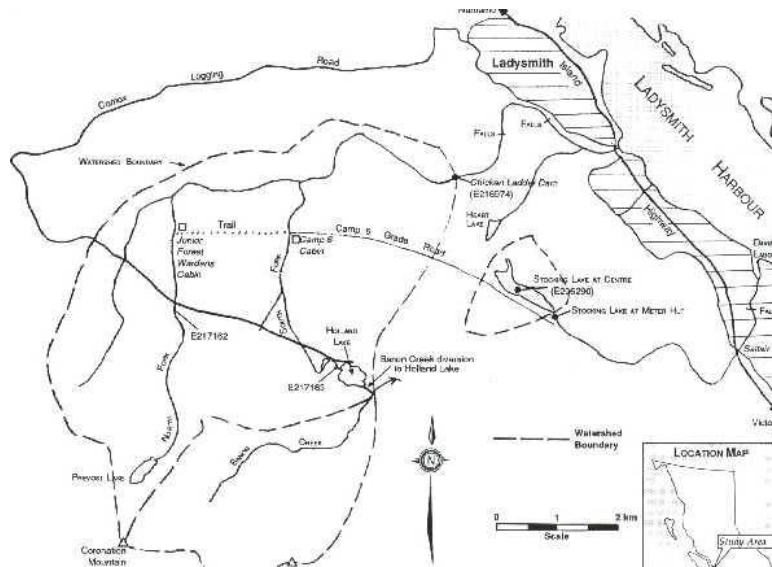
SUMMARY

This document assesses the Holland Creek and Stocking Creek watersheds located on southern Vancouver Island near Ladysmith. It is one in a series that presents water quality objectives for British Columbia. It has two parts: an overview and the report. The overview provides general information about water quality in the Holland Creek and Stocking Lake watersheds, and water quality objectives and

monitoring tables for those readers requiring this information. It is intended for both technical readers and for readers who may not be familiar with the process of setting water quality objectives. The report presents the details of the water quality assessment in the Holland Creek and Stocking Lake watersheds, and forms the basis of the recommendations and objectives presented in the overview.

In the autumn of 1991, an Integrated Watershed Management Plan was initiated for the Holland Creek and Stocking Lake watersheds in response to local concerns about logging and road building in the watersheds. The planning team is co-chaired by BC Environment and the Ministry of Forests, and includes representatives of the various stakeholders in the watershed. In early 1992, the Water Quality Branch was requested to conduct a water quality assessment and recommend water quality objectives for the watersheds. The existing information was assessed, and additional water quality monitoring began in mid-1992. This overview summarizes the results of the water quality assessment of the Holland Creek and Stocking Lake watersheds. Objectives for key drinking water characteristics (fecal coliforms, turbidity, pH, colour, and total organic carbon, plus iron, phosphorus, and chlorophyll-a in Stocking Lake) in the watersheds are proposed to protect water quality, and to guide the rehabilitation and any future development of the watersheds. All available data and current water quality criteria were used to derive the water quality objectives.

Figure 1. Holland Lake and Stocking Creek Drainage Basin Location Map



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, Lands and Parks' 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 near future.

How Objectives Are Determined

Water quality objectives are based the BC approved and working criteria as well as national water quality guidelines. Water quality criteria and guidelines are safe limits of the physical, chemical, or biological characteristics of water, biota (plant and animal life) or sediment which protect water use. Objectives are established in British Columbia for waterbodies on a site-specific basis. They are derived from the criteria by considering local water quality, water uses, water movement, waste discharges, and socio-economic factors.

Water quality objectives are set to protect the most sensitive designated water use at a specific location. A designated water use is one that is protected in a given location and is one of the following:

- raw drinking water, public water supply, and food processing
- aquatic life and wildlife
- agriculture (livestock watering and irrigation)
- recreation and aesthetics
- industrial water supplies.

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 routinely provide policy direction for resource managers for the protection of water uses in specific waterbodies. Objectives guide the evaluation of water quality, the issuing of permits, licences and orders, and the management of fisheries and the province's land base. They also provide a reference against which the state of water quality in a particular waterbody can be checked, and help to determine whether basin-wide water quality studies should be initiated.

Water quality objectives are also a standard for assessing the Ministry's performance in protecting water uses. While water quality objectives have no legal standing and are not directly enforced, these objectives become legally enforceable when included as a requirement of a permit, licence, order, or regulation, such as the Forest Practices Code Act, Water Act regulations or Waste Management Act regulations.

Objectives and Monitoring

Water quality objectives are established to protect all uses which may take place in a waterbody. Monitoring (sometimes called sampling) is undertaken to determine if all the designated water uses are being protected. The monitoring usually takes place at a critical time when a water quality specialist has determined that the water quality objectives may not be met. It is assumed that if all designated water uses are protected at the critical time, then they also will be protected at other times when the threat is less.

The monitoring usually takes place during a five week period, which allows the specialists to measure the worst, as well as the average condition in the water.

For some waterbodies, the monitoring period and frequency may vary, depending upon the nature of the problem, severity of threats to designated water uses, and the way the objectives are expressed (*i.e.*, mean value, maximum value).

INTRODUCTION

This report assesses water quality in the Holland Creek and Stocking Lake watersheds. Water quality objectives for key drinking water characteristics such as fecal coliforms, turbidity, colour, total organic carbon, pH, iron, and phosphorus are set to protect raw drinking water supplies, which is the most sensitive water use in the watersheds for these characteristics. An analysis of the available data suggested that objectives for other substances are not needed at this time.

A map of the watersheds is given in [Figure 1](#). Holland Creek originates on northern and eastern slopes of the Vancouver Island Mountains (Coronation Mountain) and flows north and east about 12 km before entering Ladysmith Harbour. Water from upper Banon Creek, which originates on Coronation Mountain and Mount Hall, is diverted into the Holland Creek watershed at Holland Lake during November to May. Stocking Creek originates in Stocking Lake on the lower slopes of the Vancouver Island Mountains, flowing east and north for about 6 km before entering Davis Lagoon and Ladysmith Harbour.

Holland Creek and Stocking Lake are licensed for domestic waterworks for the Town of Ladysmith and the Saltair area of the Cowichan Valley Regional District, supplying over 9000 people. Stocking Creek is also licensed for irrigation water supply. Holland Creek supports major runs of chum salmon and minor runs of coho salmon and cutthroat and steelhead trout in the lower 2.3 km, above which impassable falls stop upstream migration. Holland Lake supports a good recreational fishery for stocked rainbow trout. Similarly, Stocking Creek supports major chum salmon and minor coho salmon and cutthroat trout runs in the lower 0.5 km, before impassable falls stop upstream migration. Stocking Lake had a good recreational fishery for rainbow trout until fish stocking was stopped in 1986 when access to the lake was closed to protect the drinking water supply.

HOLLAND - STOCKING BASIN PROFILE

HYDROLOGY

A hydrological analysis of the Holland and Stocking watersheds was conducted to assist in the integrated watershed management planning. Holland Creek is approximately 12 km long from its origin on Coronation Mountain to the point where it enters Ladysmith Harbour ([Figure 1](#)). The drainage area of Holland Creek near its mouth at Ladysmith is 28 km², ranging in elevation from sea level to 1300 m.

The Holland Creek watershed receives an average of 2200 mm of precipitation per year, with more than 80% falling during October through March. December and January are the wettest months, while July and August are the driest. Peak streamflows occur during winter rains, while low flows occur during June through September. Flows in Holland Creek are affected by: the diversion of water from the upper 7.5 km² of Banon Creek into Holland Lake during November through May, the storage of water in Holland and Prevost Lakes in the winter and its release in the summer, and the withdrawal of water by the Town of Ladysmith at the Chicken Ladder intake. The net effect of this water regulation is to increase low flows by up to 3 to 4 times during July, August, and September.

The Stocking Lake watershed is very small, with a drainage area of only 1.65 km², ranging in elevation from 360 to 600 m. The average precipitation is 1700 mm per year, with peak runoff occurring in winter and low flows in summer. Stocking Lake is a small lake with a surface area of 0.23 km² (23 ha), a maximum depth of 19 m, and a volume of 2091 dam³ (dam³ = cubic decameter = 1000 m³). The lake is heavily used for water supply, with Ladysmith and the Cowichan Valley Regional District withdrawing about 35% of the inflow to the lake in an average year, and about 78% in a very dry year. There is no outflow from the lake during June to November when the lake is drawn down below the spillway.

WATER USES

Licenses

The only water licenses on Holland Creek are held by the Town of Ladysmith. They are authorized to withdraw up to 2728 m³/d at the Chicken Ladder intake for waterworks. This withdrawal is supported by 370 dam³ of storage in Holland and Prevost Lakes, and the Town is also licensed to divert up to 1820 dam³ from upper Banon Creek to Holland Lake during November through May. Historically, Ladysmith has withdrawn water from Holland Creek during April through October, when the water is free of turbidity. Increasing water demand will make it necessary to use Holland Creek during more of the year.

The Town of Ladysmith and the Cowichan Valley Regional District hold waterworks licenses on Stocking Lake and there are two irrigation licenses on lower Stocking Creek. The CVRD and the southern part of Ladysmith use the water year-round, while the rest of Ladysmith uses it when Holland Creek is turbid, mainly during the winter.

Recreation

Water-based recreation in the watersheds includes fishing on Holland Lake and in the lower reaches of Holland and Stocking Creeks, and hiking/camping throughout the Holland Creek watershed.

Fisheries

Holland Creek anadromous (sea-run) fisheries are limited to the lower 2.3 km by impassable falls. The major runs are chum salmon with 10-year mean and maximum escapements (returning spawners) of 3800 and 10,500, respectively. There are minor runs of coho salmon (60), steelhead (25), and cutthroat trout. Holland Lake supports a good recreational fishery of stocked rainbow trout. Little is known about fish and fish habitat between Holland Lake and lower Holland Creek.

Stocking Creek anadromous fisheries are limited to the lower 0.5 km by impassable falls. The major runs are chum salmon with 10-year mean and maximum escapements of 3700 and 8700, respectively. There are minor runs of coho salmon (75) and cutthroat trout. Stocking Lake supported a good recreational fishery for rainbow trout until fish stocking was stopped in 1986, when access to the lake was closed to protect the drinking water supply.

INFLUENCES ON WATER QUALITY

Several human activities influence water quality in the Holland Creek, Banon Creek, and Stocking Lake watersheds above the water intakes for Ladysmith and the CVRD. They are all non-point, diffuse land-use activities, including forestry, forest roads, and recreation. There are no residences or waste discharges as defined under the Waste Management Act above the water intakes. Wildlife can also influence water quality.

Forestry and Forest Roads

About 95% of the combined Holland Creek, Stocking Lake, and upper Banon Creek watershed area (37 km²) is managed for forestry by TimberWest Forest Limited, the BC Forest Service, and Pacific Forest Products Limited. The Town of Ladysmith owns the remaining 5% immediately surrounding Holland, Stocking, Prevost and Heart Lakes to protect its water supply.

About 92% of the combined watershed was logged between 1900 and the 1970's, although much of this area has been reforested and has recovered hydrologically. In the future, the forest managers would like to harvest the second growth forests as they mature. Previous logging has left some cases of erosion of forest roads, stream channels, and cutblocks in Holland and upper Banon Creeks that cause periodic episodes of turbid water during rainstorms. The Integrated Watershed Management Plan (IWMP) Committee asked the landowners to develop and implement rehabilitation plans for the watersheds. TimberWest has subsequently done remedial work on failed roads and drainage structures.

Recreation

Recreational activities in the Holland Creek watershed include fishing (Holland Lake), hiking, camping (including unsanctioned cabin use), hunting, horseback riding, cycling, motor biking, and other vehicular access. The most serious concern for recreation in a community watershed is the disposal of human and domestic animal wastes. Such wastes should be disposed of so that harmful microorganisms do not enter the water supply. The level of fecal contamination tends to increase with the level of recreation in a watershed. There were no toilets in the watershed for the safe disposal of human wastes, and a cabin adjacent to the North Fork of Holland Creek had a high potential for fecal contamination of the creek. Approved toilets should be provided in high use areas, and people should be educated to dispose of human and animal feces by burying them well away from watercourses.

Wildlife

Warm-blooded animals can carry microorganisms, such as *Giardia lamblia* and *Cryptosporidium*, which are harmful to humans, causing gastrointestinal disease. The watersheds support a wide variety of warm-blooded wildlife species, but no data are available on the occurrence of these harmful microorganisms. The prevalence of *Giardia* tends to increase with the intensity of human use in a watershed

WATER QUALITY ASSESSMENT AND OBJECTIVES

WATER QUALITY ASSESSMENT

During the assessment of the data, several observations were made regarding water quality in the Holland Creek and Stocking Lake watersheds:

Holland Creek

- Indicators of fecal contamination occasionally exceeded the guideline for raw drinking supplies, but the standard for the treated tap water was met.
- Turbidity has exceeded the drinking water guideline occasionally in the past due to rainstorms, but recent data are inadequate to indicate if this is still the case.
- Colour occasionally exceeds the aesthetic guideline for drinking water.
- Trihalomethanes (disinfection by-products) in the chlorinated tap water were well below the drinking water guideline.
- pH met the aesthetic guideline for drinking water, except during a heavy rainstorm when the pH was lowered by the naturally low pH of rainwater.
- Metals and a wide variety of other substances met drinking water guidelines.

Stocking Lake

- Indicators of fecal contamination, turbidity, and colour met the raw drinking water guidelines.
 - Trihalomethanes in chlorinated tap water met the drinking water guideline, but more monitoring is needed for confirmation.
 - pH met the aesthetic guideline for drinking water except during heavy rainstorms when the pH was lowered by the naturally low pH of rainwater.
 - Acid-buffering capacity is low, but there is no indication of acidification or other adverse trends over the last decade.
 - Metals and a wide variety of other substances met drinking water guidelines, with the exception of iron, which exceeded the aesthetic guideline on rare occasions.
 - Phosphorus and algae met drinking water guidelines, but phosphorus enrichment should be avoided to maintain water quality.
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WATER QUALITY OBJECTIVES

Water quality objectives have been set for key drinking water characteristics in the Holland Creek and Stocking Lake watersheds ([Table 1](#)). These objectives will also protect aquatic life, wildlife, water-based recreation, livestock watering, and irrigation for these characteristics. The objectives apply to the watersheds above the community water supply intakes. The proposed water quality objectives have been met with the exception of fecal coliforms and turbidity in Holland Creek.

WATER QUALITY MONITORING

The recommended minimum monitoring for Holland Creek and Stocking Lake is summarized in [Table 2](#). The monitoring is for raw water at or near the community water supply intakes, with the exception of trihalomethanes which are measured in the chlorinated tap water. The monitoring is the responsibility of the water purveyors and the Ministry of Health. It is a basic monitoring program to check the attainment of the objectives, to document water quality conditions, and to detect any trends at the intakes. Additional monitoring may be needed to evaluate conditions in the upper watersheds or specific development projects. Continuous, automatic monitoring of turbidity and flow are recommended for Holland Creek to obtain accurate records for these highly variable characteristics. A quality assurance program including field blanks and field replicates is recommended to ensure that high quality data are collected.

TABLES

Table 1. Holland Creek-Stocking Lake Basins Water Quality Objectives

Designated Water Uses: aquatic life, wildlife, drinking water, primary contact recreation, irrigation, livestock watering.

Characteristic	Holland Creek	Stocking Lake
fecal coliforms	10/100 mL, 90th percentile	10/100 mL, 90th percentile
turbidity	1 NTU maximum	1 NTU maximum
true colour	15 TCU maximum or no increase if background exceeds 15 TCU	15 TCU maximum or no increase if background exceeds 15 TCU
total organic carbon	2 mg/L as an annual mean of monthly samples	2 mg/L as an annual mean of monthly samples

pH	6.5 to 8.5 with 6.5 as the 5th percentile of at least 20 samples over 2 years	6.5 to 8.5 with 6.5 as the 5th percentile of at least 20 samples over 2 years
total iron	0.3 mg/L maximum
chlorophyll-a	2.5 micrograms/L as a summer mean
total phosphorus	10 micrograms/L mean at spring overturn

1. *These objectives apply to the Holland Creek and Stocking Lake watersheds at the community water supply intakes or at the center of Stocking Lake for chlorophyll-a and phosphorus.*
2. *For values below the detection limit, use the detection limit to calculate the statistic.*
3. *The total phosphorus value is the average of samples at 1 m, mid-depth and 1 m from the bottom.*
4. *The coliform 90th percentile applies to a minimum of 10 measurements at about equal intervals over 30 days.*
5. *The chlorophyll-a value is the grand average of monthly samples during May to August at depths of 0, 2, 4 and 6 m.*

Table 2. Recommended Water Quality Monitoring: Holland Creek-Stocking Lake Basins
Table 2a. Holland Creek

Characteristics	Frequency and Timing	Proposed Sites
flow	continuous	Chicken Ladder Intake
turbidity	continuous	Chicken Ladder Intake
fecal coliforms	weekly (daily during rainstorms)	Chicken Ladder Intake
pH	monthly	Chicken Ladder Intake

true color	monthly (quarterly)	Chicken Ladder Intake
total organic carbon	quarterly	Chicken Ladder Intake
trihalomethanes	quarterly	chlorinated tapwater
<i>Giardia lamblia</i>	initial surveillance	Chicken Ladder Intake
<i>Cryptosporidium</i>	initial surveillance	Chicken Ladder Intake

Table 2b. Stocking Lake

Characteristics	Frequency and Timing	Proposed Sites
turbidity	monthly	Meter Hut
fecal coliforms	monthly	Meter Hut
pH	monthly	Meter Hut
true colour	monthly (quarterly)	Meter Hut
total iron	monthly	Meter Hut
total organic carbon	quarterly	Meter Hut
total phosphorus	annually at spring overturn	center of lake at the deepest point
chlorophyll-a	monthly from May to August	center of lake at the deepest point
water temperature	annually at spring overturn	center of lake at the deepest point
trihalomethanes	quarterly	chlorinated tap water

- 1. In Holland Creek and Stocking Lake-for true colour, total organic carbon and trihalomethanes one needs simultaneous quarterly measurements for one year if the total organic carbon is greater than 2 mg/L.***
- 2. In Stocking Lake-for fecal coliforms there is a minimum of 10 measurements at about equal intervals over 30 days required to check attainment of the objective.***

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