Water Quality

Ambient Water Quality Objectives For The Tributaries To Okanagan Lake Near Vernon

Overview Report

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

Prepared Pursuant To Section 2(E) Of The
Environment Management Act, 1981

Original Signed By J. O'riordan
Assistant Deputy Minister
Environment And Lands Hq Division
June 14, 1994.

Canadian Cataloguing in Publication Data
Swain, L. G. (Leslie Grant), 1950-
Water quality assessment and objectives for tributaries to Okanagan Lake near Vernon (Lower Vernon, Equesis and Deep Creeks) Okanagan area

Report prepared by L. G. Swain p. 12
Prepared pursuant to Section 2(e) of the Environment Management Act, 1981
Consists of two parts: An overview and a report, of which the overview is also available as a separate document. cf. P. 3.
ISBN 0-7726-2017-2

1. Water quality - British Columbia - Okanagan Valley.
I. BC Environment. Water Quality Branch. II. Title.

TD227.B7S84 1993 363.73'942'097115 C94-0960035-0

SUMMARY
This document is one in a series that presents ambient water quality objectives for British Columbia. It has two parts: an overview, which is available as a separate document, and the report. The overview provides general information about water quality in the three tributaries to Okanagan Lake: lower Vernon, Deep, and Equesis creeks. It is intended for both technical readers and for readers who may not be

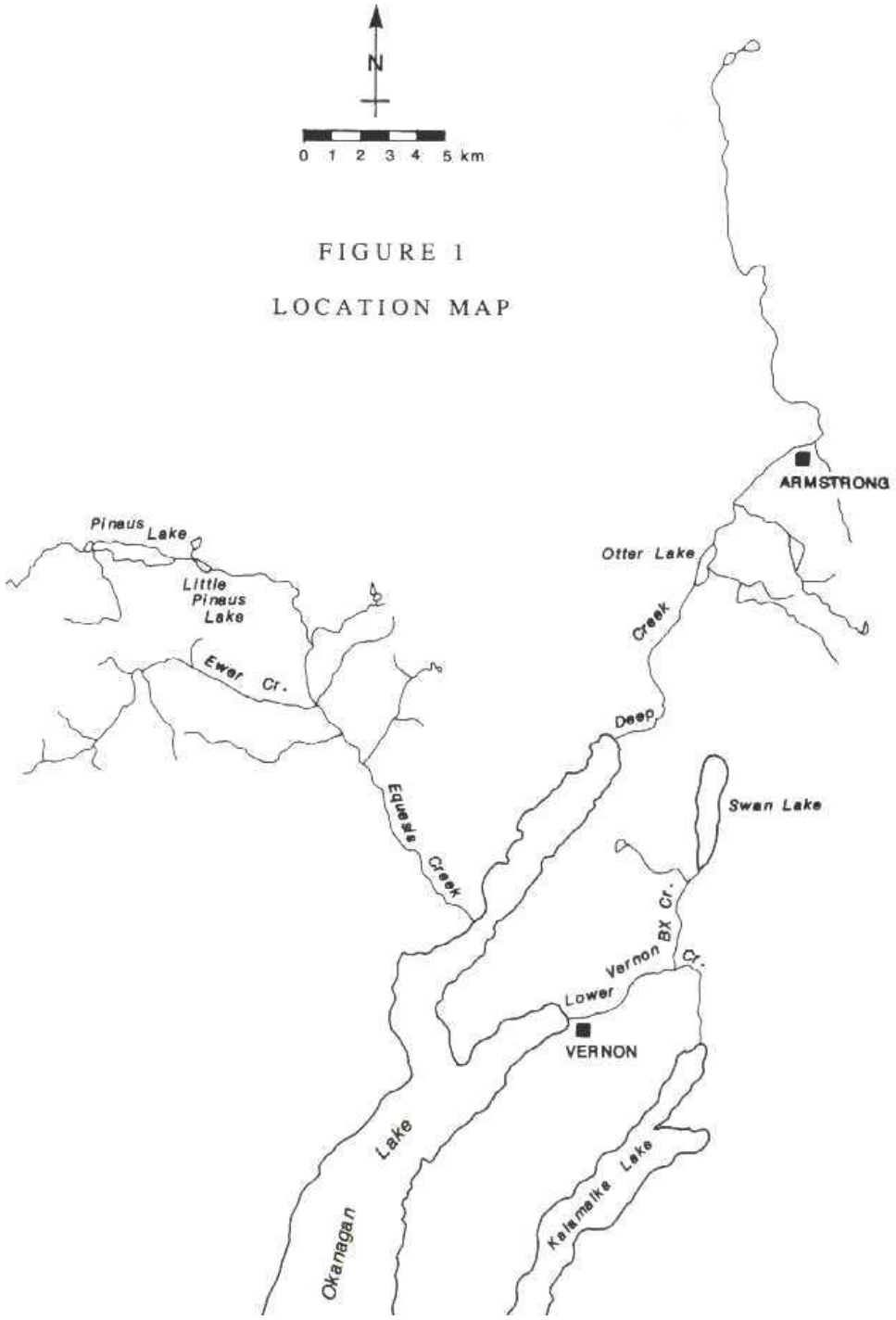
familiar with the process of setting water quality objectives. It includes tables listing water quality objectives and required monitoring. The main report presents the details of the water quality assessment for these waterbodies, and forms the basis of the recommendations and objectives presented in the overview.

Salmonid species are present in lower Vernon, Deep, and Equesis creeks, and the water quality objectives in this report are to form part of a fisheries management plan for tributaries to Okanagan Lake.

Most water contamination comes from the City of Armstrong sewage discharge into Deep Creek, non-point source discharges to Deep Creek and lower Vernon Creek, and possible ground water contamination in some areas from irrigation with treated sewage. The City of Armstrong began a program of spray irrigation of treated sewage in the Spring of 1993, so that discharges to the creek should now only take place during periods of high precipitation.

Water quality objectives are recommended to protect aquatic life, wildlife, irrigation water supplies, and drinking water supplies in Deep Creek and lower Vernon Creek. Water quality objectives were not set for Equesis Creek since there were no known anthropogenic inputs which could impact ambient water quality significantly.

Figure 1. Location Map for the Okanagan Lake tributaries near Vernon



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

Lower Vernon, Deep, and Equesis creeks are tributaries to Okanagan Lake on the east, north, and west shores, respectively, and enter the lake near the City of Vernon (see Figure 1). The purpose of this report was to determine the need for and develop water quality objectives in these waterbodies for use by Environment Managers, including the development of a fisheries management plan for tributaries to Okanagan Lake. Water quality objectives were not set for Equesis Creek.

TRIBUTARIES TO OKANAGAN LAKE NEAR VERNON-PROFILE

HYDROLOGY

The flows in Equesis and Deep creeks are regulated. In lower Vernon Creek, high flows occur during the Spring runoff, with flows decreasing so that the lowest flows are experienced during the winter months. Equesis Creek has a drainage area of 199 km^2 at the mouth of the creek, Deep Creek has a drainage area of 306 km^2, while lower Vernon Creek has a drainage area between Kalamalka and Okanagan lakes of 179 km^2.

Seven-day low flows have ranged from 0.031 to 0.356 m^3/s in the summer and from 0.034 to 0.402 m^3/s in the winter in Equesis Creek, from 0.027 to 0.261 m^3/s in Deep Creek (usually in August), and from 0.071 to 0.562 m^3/s in lower Vernon Creek. All these flows were recorded at sites in the waterbodies located near their confluence with Okanagan Lake. Return periods could not be calculated for these low flows due to incomplete data bases.

WATER USE

Water uses in all three creeks are similar. Consumptive water uses include domestic water supply withdrawals (9.1 m^3/d on Equesis Creek, 11.4 m^3/d on Deep Creek, and 48 m^3/d on lower Vernon Creek) and irrigation water supply withdrawals (3 867 dam^3/a on Equesis Creek, 1 710 dam^3/a on Deep Creek, and 1 432 dam^3/a on lower Vernon Creek). Fisheries values are considered to be moderate on Equesis Creek, low in Deep Creek, and moderate to high in lower Vernon Creek.

Equesis Creek has a large quantity of accessible habitat which would allow for habitat enhancement. Kokanee cannot access the creek beyond the first 2.6 km due to a dam. Larger rainbow trout can pass this dam, but are blocked by a second dam 3.7 km from the lake. The first 5.6 km of Equesis Creek are on reserve lands of First Nations people and complete information on fish usage in this area is not available. In Deep Creek, kokanee have not been documented as being present, and there are no real opportunities to enhance salmonid production in the lower creek. Coarse fish are plentiful in the creek below Armstrong, although there is potential to improve rainbow trout production above Armstrong.

In lower Vernon Creek, rainbow trout, kokanee, peamouth chub, carp, largescale suckers, redside shiners, squawfish, and chiselmouth are known to reside. In addition, juvenile lake trout may be using the creek as a downstream migration corridor since lake trout are beginning to be caught in Okanagan Lake (which has never been stocked with this species). The dam at the end of Kalamalka Lake prevents all species from migrating from Okanagan Lake into Kalamalka Lake. A number of enhancement projects have been undertaken by numerous groups which have improved fish access, habitat potentials, and fish populations.

WASTE WATER DISCHARGES

There are no permitted refuse sites or waste water discharges into the Equesis Creek watershed. The most significant discharge to Deep Creek until November 1992 was from the Armstrong sewage treatment plant. This discharge has been shown to increase the concentration of nutrients and decrease dissolved oxygen concentrations. The City of Armstrong completed a Waste Water Management Plan in 1988 which recommended that the treated waste water be used as a source of irrigation water in the neighbouring municipality of Spallumcheen. This began in the Spring of 1993.

Other permitted waste discharges within the Deep Creek watershed are the discharge of cooling water from a cheddar cheese manufacturing plant into Deep Creek, and a small-volume discharge from a rendering plant into a seepage pit. This latter operation also has a permitted refuse site.

In the lower Vernon Creek watershed, there are three permitted waste discharges. Two are located near a tributary to lower Vernon Creek, BX Creek, while the Vernon Sewage Treatment Plant is located adjacent to lower Vernon Creek. The treated effluent from the City of Vernon is spray-irrigated on adjacent properties, although an effluent outfall into Okanagan Lake has been built so that waste water can be discharged to the lake (with chemical phosphorus removal) in extremely wet years. It is apparent that the irrigation is causing some nutrients to increase in the ground water at some sites. The City of

Vernon Recreation complex discharges cooling water to BX Creek, while a ready-mix cement operation discharges truck wash water to an exfiltration pit.

Non-point sources are also impacting water quality, especially in Deep Creek. A two-year study conducted in 1987 and 1988 on Deep Creek showed that there was an increase of over 4 kg phosphorus per kilometre at sites upstream from Armstrong, presumably due to non-point sources. Downstream from Armstrong (and downstream from Otter Lake), the increase was 105 kg/km. Otter Lake seems to act as a reservoir for nutrients, storing them during low flow periods, and releasing them during high flows. As such, the loadings to Okanagan Lake are concentrated during the high runoff period of the year. Similar impacts likely would be apparent for nitrogen compounds and possibly bacteria concentrations if these phosphorus loadings originated from cattle wastes. It is suspected that phosphorus loadings could originate from several sources, including breakthrough from manure applications due to over-application and peat oxidation in the upper creek valley.

WATER QUALITY ASSESSMENT AND OBJECTIVES

WATER QUALITY ASSESSMENT

Equesis Creek is well-buffered to acidic inputs, while having moderate hardness. All metal concentrations in Equesis Creek were usually below the BC approved or working water quality criteria. Nitrogen compounds were usually low, although phosphorus concentrations were high enough to cause excessive algal growths if phosphorus is the limiting factor. Dissolved oxygen concentrations were usually high enough to achieve all water quality criteria, although some more restrictive criteria aimed at protecting aquatic life when embryos are present were not always achieved in July or September, periods when embryos are likely not present.

Deep Creek is well-buffered to acidic inputs, and has a moderate amount of hardness to ameliorate the toxicity of some metals. A number of metals occasionally have had concentrations which exceed BC approved or working water quality criteria to protect aquatic life. These metals included aluminum, iron, manganese, and lead. There are no known sources of metals to Deep Creek other than possibly stormwater runoff from Armstrong and alum which was used at the City of Armstrong for phosphorus removal. Maximum concentrations of ammonia, nitrite, and nitrate were all below criteria. Phosphorus concentrations were high enough to cause excessive algal growth if phosphorus is the limiting factor. Dissolved oxygen concentrations in Deep Creek were occasionally below criteria to protect aquatic life. Dissolved solids concentrations in Deep Creek can on occasion exceed water quality criteria to protect aesthetics of drinking water supplies.

Lower Vernon Creek is also considered to be well-buffered to acidic inputs, and to have moderate water hardness. Metals, which occasionally were at concentrations greater than the criteria, were aluminum, iron, and lead. The only known sources of metals to lower Vernon Creek are storm water runoff. Maximum concentrations of ammonia, nitrite, and nitrate were all below criteria. Phosphorus concentrations were high enough to cause excessive algal growths if phosphorus is the limiting factor. Dissolved oxygen concentrations infrequently were below criteria to protect aquatic life.

WATER QUALITY OBJECTIVES

Water quality objectives proposed for Deep and lower Vernon creeks are summarized in Table 1. No objectives are proposed for Equesis Creek since there are no problems in the creek which can be attributed to present or foreseen anthropogenic activities. It is believed that the water uses in Equesis Creek are protected at present. The objectives for Deep and lower Vernon creeks are based on BC approved and working criteria for water quality and on available data on ambient water quality, waste discharges, water uses, and stream flows. The objectives will be modified as necessary by new data from receiving water monitoring programs, or should the Ministry establish water quality criteria for all the characteristics of concern.

Water quality objectives have no legal standing and would not be directly enforced. The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified waterbodies. They will guide the evaluation of water quality, the issuing of permits, licenses, and orders and the management of the fisheries and of the Province's land base. They will also provide a reference against which the state of water quality in a particular waterbody can be checked, and serve to make decisions on whether to initiate basin-wide water quality studies.

Depending on the circumstances, water quality objectives may already be met in a waterbody, or may describe water quality conditions which can be met in the future. To limit the scope of the work, objectives are only being prepared for waterbodies and for water quality characteristics which may be affected by man's activity now and in the foreseeable future.

Designated water uses for all three waterbodies are for the protection of aquatic life, wildlife, irrigation, livestock watering, and drinking water supplies.

Water quality objectives which are based on approved BC water quality criteria are proposed for microbiological indicators, turbidity, suspended solids, ammonia, nitrite, nitrate, pH and periphyton chlorophyll-a (to reflect the impacts from nutrients, especially phosphorus). The objectives are required to ensure that inputs from non-point source discharges and from the Armstrong and Vernon sewage treatment plants do not impair water uses. An objective is proposed for pH as a range of values. The upper value will control the formation of toxic quantities of ammonia. Dissolved oxygen levels proposed for the waterbodies are based on the Canadian Water Quality Guidelines, but are more restrictive.

MONITORING RECOMMENDATIONS

We recommend that monitoring be carried out for at least three years to check whether the objectives are being achieved. The extent of the monitoring after that will depend on results, as well as on regional priorities and available funding. A recommended monitoring design is included as Table 5.

WATER QUALITY OBJECTIVES AND MONITORING TABLES
The following tables provide a summary of the objectives data and monitoring recommendations.

To protect water uses in a waterbody, objectives specify a range of values for characteristics (variables) that may affect these uses. These values are maximum and/or minimum values that are not to be exceeded.

Some readers may be unfamiliar with terms such as: maximum concentration, 30-day average concentration, 90th percentile, and not applicable (NA). Maximum concentration means that a value for a specific variable should not be exceeded; 30-day average concentration means that a value should not be exceeded during a period of 30 days, when five or more samples are collected at approximately equal time intervals. The term 90th percentile indicates that 9 out of 10 values should be less a particular variable. Not applicable (NA) means that water uses are not threatened for that particular variable.

Table 1. Water Quality Objectives for Deep Creek and Lower Vernon Creek

Designated Water Uses: aquatic life, wildlife, drinking water (partial treatment), irrigation, livestock watering.

Characteristic	Deep Creek	Lower Vernon Creek
pH	6.5 to 9.0	not applicable
fecal coliforms	100/cL, 90th percentile	
enterococci	25/cL, 90th percentile	
Escherichia coil	100/cL, 90th percentile	
suspended solids	10 mg/L maximum increase when upstream is less than 100 mg/L ... 10% maximum increase when upstream is greater than 100 mg/L	
turbidity	5 NTU maximum increase when upstream is less than 50 NTU ... 10% maximum increase when upstream is greater than 50 NTU	
total ammonia nitrogen	AMMONIA (Total Ammonia Nitrogen to Protect Aquatic Life)	
total nitrite nitrogen	NITRITE (Total Nitrite Nitrogen to Protect Aquatic Life)	

nitrate plus nitrite nitrogen	**10 mg/L**
periphyton chlorophyll-a	**100 mg/m^2 maximum**
dissolved oxygen	**8 mg/L minimum; 11.0 mg/L from November to April when salmonid embryoes and larvae are present**

-The objectives apply to discrete samples from all parts of lower Vernon Creek between Kalamalka Lake and Okanagan Lake, along BX Creek between Swan Lake and its confluence with lower Vernon Creek and along the entire length of Deep Creek, except from initial dilution zones of effluents. These excluded initial dilution zones are defined as extending up to 100 metres downstream from a discharge and occupying no more than 50% of the stream width around the discharge point, from the bed of the stream to the surface.
-For fecal coliforms, enterococci and Escherichia coli the mean and the 90th percentile are calculated from at least five weekly samples in a period of thirty days. For values recorded as less than the detection limit, the detection limit itself should be used in calculating the statistic. The 90th percentile can be extrapolated by graphical methods when fewer than ten samples are collected.
-For suspended solids and turbidity the increase is over levels measured at a site upstream from the discharge or series of discharges and as close to them as possible and applies to downstream values.
-The maximum chlorophyll-a is based on an average calculated from a least five randomly located samples from natural substrates at each site on any sampling date
-pH measurements may be made in situ but must be confirmed in the laboratory if the objective is not achieved.

Table 5. Recommended Water Quality Monitoring for Deep Creek and Vernon Creek

Site Number	Location	Frequency	Dates	Samples	Variables
0500020	**Deep Creek near the mouth**	**5 times weekly in 30 days**	**July to September**	**25**	**dissolved oxygen temperature**

0500258	**Deep Creek u/s Armstrong cheese**				**MF fecal coliforms MF enterococci NH_3-N NO_3-N NO_2-N chloride suspended solids**
0500768	**Deep Creek at Larkin Road**				
0500089	**Vernon Creek at the outlet of Kalamalka Lake**				
0500091	**Vernon Creek at Okanagan Lake**				
0500091	**Vernon Creek at Okanagan Lake**	**once: 6 reps**	**July to September**	**2**	**periphyton chlorophyll-a**
0500091	**Vernon Creek at Okanagan Lake**				

L. G. Swain, P.Eng.
Water Quality Branch
Environmental Protection Department
Ministry of Environment, Lands and Parks