



ENVIRONMENTAL PROTECTION DIVISION
WATER STEWARDSHIP DIVISION
MINISTRY OF ENVIRONMENT

**Water Quality Assessment and Objectives
for the China Creek Community Watershed**

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 China Creek, a community watershed supplying drinking water to the community of Port Alberni at the head of Alberni Inlet on 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 China Creek, 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, historical mining, a hydroelectric plant, and recreation.

Water quality objectives are recommended to protect source water (raw drinking water supply), 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.

China Creek was designated as a community watershed in 1995, 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 the majority of the China Creek community watershed is on private land, the FRPA does not apply to most 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 ensure that water quality within these watersheds is protected and managed in a consistent manner.

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

In certain cases, objectives are used to address specific legislative requirements (e.g., *Water Act*, Municipal Sewage Regulation, Private Managed Forest Land Council Regulation). However, compliance with water quality objectives is often not directly 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.).

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 China Creek community watershed and recommends water quality objectives for this watershed based on potential impacts of certain key water quality parameters of concern.

China Creek provides a significant source of drinking water to the local community and has important fisheries values, with chinook, chum, coho and pink salmon, cutthroat and rainbow trout, steelhead and Dolly Varden char all present at some point during the year. Anthropogenic land uses within the watershed include timber harvesting, a hydroelectric plant, historical mining and recreation. These activities, as well as natural erosion and the presence of wildlife, all potentially affect water quality in China Creek.

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

BASIN PROFILE

Watershed Description

China Creek is a fourth-order stream 21 km in length, draining into the Alberni Inlet approximately 11 km south of the community of Port Alberni, BC. The community watershed portion of the China Creek watershed is 14 km long from its headwaters (approximately 1,575 m elevation) near Mount McQuillan to the Port Alberni intake (approximately 190 m elevation), and is 5,750 ha in area (Figure 1). The intake is located approximately 800 m downstream from the confluence of McLaughlin and China creeks. There are three named

lakes within the watershed, two (Duck Lake at 928 m elevation and Lizard Lake at 737 m elevation) are on Williams Creek and one (Bainbridge Lake at 154 m elevation) located on McFarland Creek.

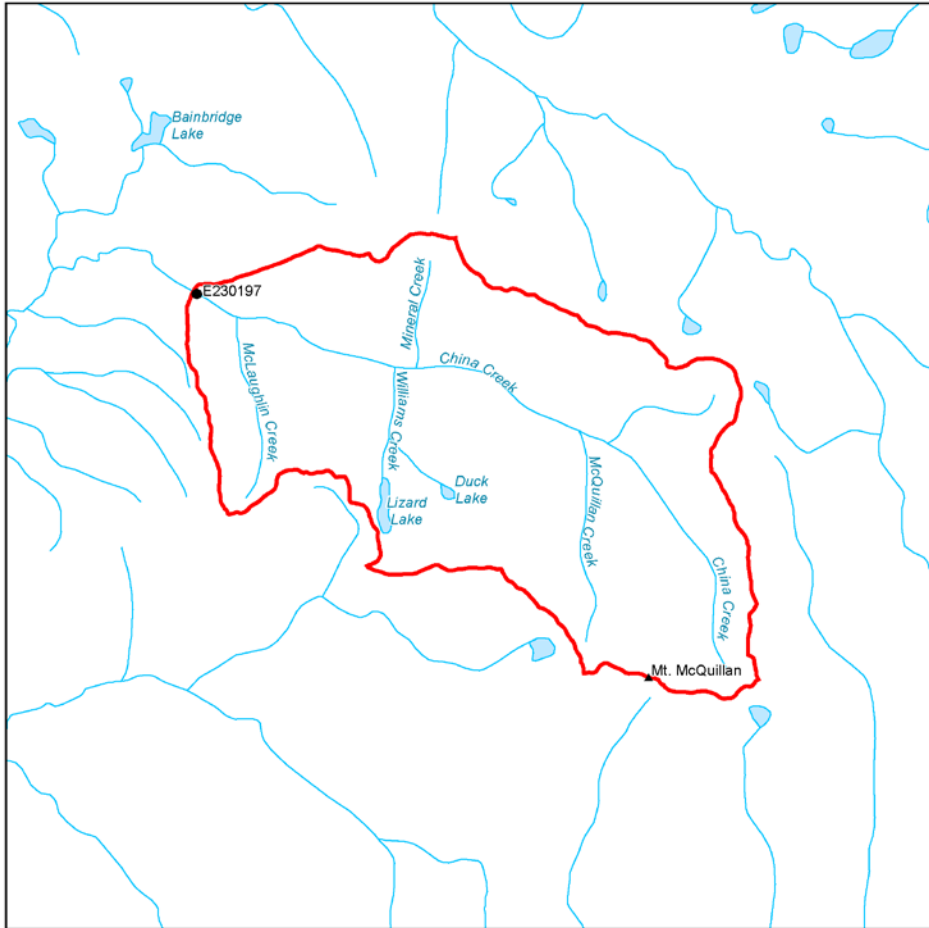


Figure 1. Map of China Creek watershed, with sampling location

The majority of the watershed falls within the Coastal Western Hemlock (montane moist maritime, CWHmm2) biogeoclimatic zone, with higher elevations (above about 800 m) falling within the Mountain Hemlock (windward moist montane, MHmm1) biogeoclimatic zone and small areas above 1,400 m composed of Alpine Tundra parkland (ATp). China Creek falls within the Leeward Island Mountains (LIM) ecoregion established for

Vancouver Island by MOE staff. The soils of this area consist of glacial deposits, limestone and volcanic rock. Water quality of the eco-section is characterized by neutral to slightly basic pH due to elevated calcium levels from limestone bedrock, with a moderate sensitivity to acidic inputs due to concentrations of calcium and alkalinity.

Hydrology

Water Survey Canada (WSC) operated a hydrometric station on China Creek between 1990 and 1995. While no hydrometric data were available for this site between late October and late March, it is expected that water levels are generally high during this period due to high rainfall at lower elevations in the watershed. This is supported by hydrometric data collected between 2003 and 2005 as part of this study, with peak water levels occurring between October and January. Peak flows measured between 1990 and 1995 were approximately $15.2 \text{ m}^3/\text{s}$, while minimum flows were approximately $0.1 \text{ m}^3/\text{s}$.

Climate

The nearest climate station to the watershed for which climate normal data are available is the Port Alberni station (elevation 2.4 m) (Environment Canada Climate Station 1036206). Average daily temperatures between 1971 and 2000 ranged from 2°C in January to 18°C in August. Average total annual precipitation between 1971 and 2000 was 1,911 mm, with only 114 mm (water equivalent) (6%) of this falling as snow. Temperatures at higher elevations in the watershed would be cooler than recorded at sea level. A larger portion of the annual total precipitation occurs as snowfall in the

higher-elevation terrain of the watershed. Most precipitation (1,542 mm, or 81%) falls between October and March.

A comparison of rainfall at the Port Alberni station with data collected from the City of Port Alberni rain gauge on China Creek showed an annual increase of between 23% and 34% from Port Alberni to China Creek between 1994 and 1996. Thus, the precipitation data from the Environment Canada Climate Station. likely underestimates the actual precipitation falling within the China Creek community watershed basin.

Water Uses

Water Licenses

Six water licenses have been issued for the China Creek mainstem, but only two of these are located within the community watershed boundaries. The City of Port Alberni has a licence to remove 8,936 dam³/year for domestic use under a “Waterworks – Local Authority” license. During winter months, they typically withdraw approximately 9 dam³/day, while in summer months they withdraw approximately 18 dam³/day. As well, a power generating company has a license to remove 16,396 dam³/year from the mainstem approximately 2.5 km upstream from the City of Port Alberni intake, for the purposes of generating power. The water is then released back into the mainstem, approximately 2.9 km downstream from the City of Port Alberni intake. The City of Port Alberni also has a license to store 645 dam³/year in Lizard Lake, which they use to relieve summer low-flows.

Recreation

There is a popular 5 km long hiking trail within the China Creek watershed, but it is in the lower portion of the watershed, below the community watershed boundaries. No specific studies have been conducted to determine the recreational use of the China Creek watershed, but the presence of logging roads throughout the upper watershed allows recreational access, and is utilized primarily by hunters and hikers, as well as all-terrain vehicle (ATV) users. There is a significant network of ATV trails located in the upper watershed that are utilized on a regular basis.

Fisheries

China Creek has high fisheries values, and is utilized by chinook (*Oncorhynchus tshawytscha*), pink (*O. gorbuscha*), coho (*O. kisutch*) and chum (*O. keta*) salmon, as well as cutthroat trout (*O. clarkii*), Dolly Varden char (*Salvelinus malma*), rainbow trout (*O. mykiss*), and steelhead (*O. mykiss*). As well, Lizard Lake is reported to contain rainbow trout, while Duck Lake and Bainbridge Lake both contain cutthroat trout.

Flora and Fauna

The China Creek watershed provides habitat to a variety of wildlife including blacktail deer (*Odocoileus hemionus columbianus*), black bear (*Ursus americanus*), cougar (*Puma concolor*), and numerous other small mammals and birds. The watershed is composed mainly of high value Douglas-fir (*Pseudotsuga menziesii*), western red cedar (*Thuja plicata*), amabilis fir (*Abies amabilis*) and western hemlock (*Tsuga heterophylla*). There is high value winter range for blacktail deer, habitat for the endangered Queen Charlotte goshawk (*Accipiter gentilis laingi*), as well as historical observations of the

endangered Vancouver Island marmot (*Marmota vancouverensis*). Other threatened species include the Vancouver Island water shrew (*Sorex palustris brooksi*), the red-legged frog (*Rana aurora*), and the *saxatilis* subspecies of white-tailed ptarmigan (*Lagopus leucura saxatilis*).

Designated Uses

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

Influences on Water Quality

Land Ownership

The community watershed portion of China Creek contains no private households located within its boundaries. Thus, potential sources of contamination associated with households (such as runoff, septic fields, fertilizers and pesticides) will not impact water quality in the upper China Creek.

Water Licenses

Water licenses can impact aquatic habitat downstream from the withdrawal, especially during low-flow periods. There are two licensed water withdrawals from the China Creek community watershed, with an overall maximum volume of 25,331 dam³/year. Assuming water was withdrawn from China Creek at a constant rate throughout the year (an unlikely scenario), the average withdrawal rate would be 0.80 m³/s. Average daily flows between 1990 and 1995 ranged from 0.24 m³/s during the mid-summer to 9.38 m³/s during spring rain on snow events, and water consumption is highest during the summer months. As a result water withdrawals

from China Creek could potentially impact summer water levels between the hydroelectric intake and the site downstream from the Port Alberni intake where the water is returned from the hydroelectric project. However, the storage capacity of Lizard Lake and the ability of the City of Port Alberni to regulate flow from this lake may mitigate these low-flow situations. As well, the hydroelectric plant is not expected to operate during August and September due to low flows, and they are required to allow a bypass flow of at least $0.51 \text{ m}^3/\text{s}$.

The construction of the water intake for the hydroelectric project has resulted in an access road being built for approximately 2 km along China Creek between the City of Port Alberni intake and the hydroelectric intake. Due to the proximity of the road to the creek, and the fact that the road is located just upstream from the City of Port Alberni intake, this road will likely be a significant source of turbidity.

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

The China Creek watershed consists primarily of private lands managed by Island Timberlands LP (5,327 ha) and TimberWest Forest Corp (401 ha), as well as Crown Land within TFL 44, managed by Western Forest Products.

Of the area managed by Island Timberlands LP, approximately 66% has been harvested, primarily in the 1930's and 1940's, and the equivalent clearcut area (ECA) was 7% to the end of 2004. This was predicted to decrease to 4% by the end of 2009 with a rate of recovery of about 47 ha/yr. By the end of 2004, the total length of roads was 123.2 km. Of this, 18.1 km was considered to have a moderate to high sediment delivery potential.

With the exception of a few short reaches, the mainstem of China Creek has been harvested to the stream bank, resulting in aging alder growing along the stream bank. A number of these will likely fall into the stream over the next decade, increasing the volume of large woody debris within the creek (which is currently quite low). This will lend some channel stability, trap sediment, and increase fish habitat, but may also result in debris jams which would divert water into the stream bank, potentially causing erosion and increased turbidity.

There have been 142 landslides within the China Creek community watershed ($2.5/\text{km}^2$), the majority (95) of which were due to natural causes. Of the remaining 47 landslides, 23 are attributed to logging activities and 24 to road construction. All of the landslides attributed to logging are now vegetated and no longer produce sediment, and only three of the 24 landslides attributed to road construction are thought to continue to produce sediment. The frequency of landslides on harvested steep terrain is $3.3/\text{km}^2$, which is considered to be moderate.

Due to the relatively high concentration of roads within the watershed and especially adjacent to the creek, runoff from these roads has the potential to impact turbidity levels in the creek, particularly during

periods of road grading or road construction. Potential impacts from these roads will decrease as roads are deactivated and reclaimed. Improvements in harvesting practices over the past 20 years, coupled with increased legislation and enforcement (for example, the *Water Act* and the *Private Managed Forest Land Act*), suggests that the potential for impacts to water quality will decrease as hydrologic recovery continues.

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. As no specific studies have been conducted on recreation within the China Creek watershed, the relative impacts of recreational activities cannot be discussed, but they are likely to be significant due to the high use of the area by ATV vehicles and other recreational users.

Wildlife

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

China Creek contains very valuable wildlife habitat, and provides a home for a wide variety of warm-blooded species. Therefore, the risk of contamination from endemic wildlife exists.

Mining and Mineral Claims

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.

There are four closed/abandoned mines, one prospect, and one developed prospect within the China Creek community watershed, as well as historical placer mining operations in the mainstem.

Metals mined included gold, silver, copper, lead, zinc, and arsenic.

WATER QUALITY ASSESSMENT AND OBJECTIVES

Water Quality Assessment

One water quality monitoring location was established within the China Creek community watershed: Site E230197 is located in China Creek at the main water intake. To represent the worst case scenario, water samples were collected at the site on a weekly basis for five consecutive weeks during the summer low flow and fall high flow periods from 2002 to 2004, and usually on a monthly basis for the remainder of the year from June 2002 to June 2005. Additional sampling was conducted at the site twice in early 1998 as part of a pre-2002 sampling program. Continuous monitoring occurred from May 2003-January 2005.

The monitoring results for China Creek show that water quality has been consistently good over the period of study. There are a few exceedances (fecal coliforms, *E. coli*, and turbidity) which have been associated with rainfall events. Parameters of importance include pH, temperature, true colour, total organic carbon, metals, microbiological indicators, turbidity, and total suspended solids (TSS).

Although pH levels are currently good within the watershed, the history of mining activities, coupled with the possibility of future mining exploration, suggest that acid rock drainage may one day be a concern. Therefore, pH should continue to be monitored.

Water temperatures were consistently below the aesthetic drinking water guideline and the aquatic life guidelines for the spawning, incubation and rearing periods for salmonids. However, it is possible that activities such as forest harvesting, the micro-hydroelectric project just upstream from the intake, and climate

change could increase water temperature to the point where this guideline is occasionally exceeded.

Turbidity levels in China Creek are generally very good throughout the year, with an average of only 0.6 NTU for the 43 samples collected throughout the monitoring program. Elevated levels generally occurred between October and April, and were usually associated with rainfall.

Total suspended solids concentrations (also referred to as non-filterable residue) were typically very low with elevated values generally occurring after rain events.

Both true color and total organic carbon (TOC) values remained below the BC drinking water and aesthetic guidelines. However there are a few elevated measurements for each parameter during rainstorm events that approach maximum acceptable values. In light of future activities in the watershed, the micro-hydroelectric project, and forest harvesting, these parameters may be subject to increases in value.

Nutrient values were generally low. MoE is working towards developing an interim phosphorous objective for Vancouver Island streams. Phosphorous data should continue to be collected, and the need for a phosphorous objective should be re-evaluated after the next attainment monitoring period.

Due to significant historical mining activities, as well as relatively recent exploration, it is possible that elevated metals concentrations due to leaching may occur in China Creek. For that reason, continued monitoring for metals is recommended to ensure that aquatic life (the most sensitive designated use for these parameters) continues to be protected.

Naturally occurring organics in the watershed can bind substantial proportions of the metals which are present, forming metal complexes which are not biologically available. To aid in the future development of metals objectives, monitoring levels of organics, as measured by dissolved organic carbon (DOC), has been recommended. As increasing water hardness can decrease the toxicity of some metals to some organisms, hardness has also been included in the China Creek monitoring program.

Concentrations of microbiological indicators were at times elevated during the low flow and high flow sampling periods. The drinking water guideline for water receiving disinfection only was exceeded in one of the three sample sets (five samples in 30 days) for *E. coli*. While the source of these coliforms is not known and may not be related to anthropogenic activities within the watershed, microbiological concentrations should continue to be monitored and assessed. These exceedances demonstrate the need to treat water for human consumption to prevent potential health risks.

Water Quality Objectives

Water quality objectives set for temperature and TSS (or non-filterable residue) are for the protection of aquatic life, while the remaining objectives are for the protection of drinking water (Table 1). These objectives will also protect wildlife and aquatic life for these characteristics. As there was little activity upstream of the China Creek Port Alberni intake during the time of this study site, these objectives were developed using the background concentration approach, whereby data collected from this site up until December 2004 reflects the natural or background conditions in the watershed. The objectives are required to ensure that inputs from forestry activities, hydroelectric power generation and

recreation do not impair water uses. The objectives apply to the watershed above the community water supply intake.

Monitoring Recommendations

The recommended minimum monitoring program for the China Creek watershed is summarized in Table 2. In order to capture the periods where water quality concerns are most likely to occur (i.e., summer low-flow and fall flush) we recommend that a minimum of five weekly samples be collected within a 30-day period between August and September, as well as between October and November. Samples collected during the winter months should coincide with rain events whenever possible. In this way, the two critical periods (minimum dilution and maximum turbidity) will be monitored. Benthic invertebrate monitoring is proposed to provide a better understanding of the overall ecosystem health.

Table 1. Summary of proposed Water Quality Objectives for the China Creek community watershed.

Variable	Objective Value
<i>Escherichia coli</i>	≤10 CFU/100 mL (90 th percentile) Dec-Sept (based on a minimum 5 weekly samples collected over a 30-day period)
Turbidity	October to April: 5 NTU maximum May to September: 2 NTU maximum
pH	6.5 – 8.5 pH units
Temperature	15°C maximum (long-term)
True Colour	15 TCU maximum
Total Organic Carbon	4.0 mg/L maximum
Non-Filterable Residue (TSS)	October to April: 28 mg/L maximum in a 24-hour period 8 mg/L average (based on a minimum of five weekly samples collected over a 30-day period) May to September: 26 mg/L maximum in a 24-hour period 6 mg/L average (based on a minimum of five weekly samples collected over a 30-day period)

Designated water uses: drinking water, aquatic life, and wildlife

Table 2. Proposed schedule for future water quality and benthic invertebrate monitoring in China Creek.

Frequency and timing	Characteristic to be measured
August – September (low-flow season): once per week for five consecutive weeks	Temperature, pH, specific conductivity, TSS, turbidity, colour, total phosphorous, DOC, TOC, and <i>E. coli</i>
October – November (high-flow season): once per week for five consecutive weeks	Temperature, pH, specific conductivity, TSS, turbidity, colour, total phosphorous, DOC, TOC, and <i>E. coli</i>
Once each during low-flow and high-flow season	Total and dissolved metals, hardness
Once every five years	Benthic invertebrate sampling