Water Quality

Ambient Water Quality Objectives For Columbia Lake And Windermere Lake

Overview Report

Resource Quality Section
Water Management Branch
Ministry Of Environment

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

Original Signed By Ben Marr
Deputy Minister
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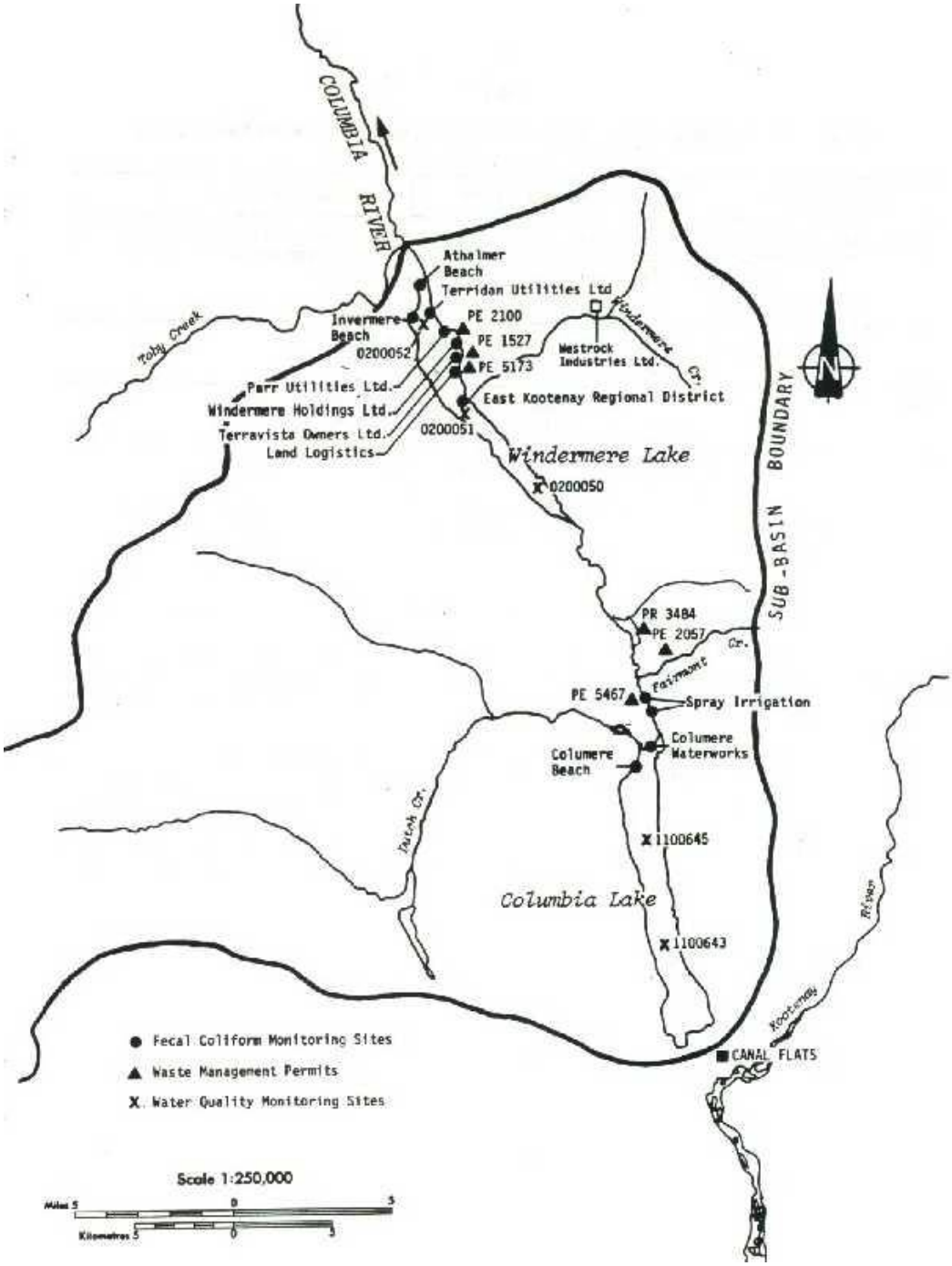
FIGURE
Figure 1. Columbia and Windermere Lakes location Map



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

The assessment of the water quality of the Columbia and Windermere Lakes sub-basin consisting of Windermere and Columbia Lakes, the Columbia River between the two lakes, the Columbia River between Windermere Lake and Toby Creek, and Windermere and Fairmont Creeks, is considered in this report. Water quality of Toby Creek and of the Columbia River to Spillamacheen is the subject of a separate report. The purpose of these reports is to develop water quality objectives where designated water uses are threatened either now or in the future.

A detailed technical appendix was prepared and forms the basis for the conclusions presented here.

HYDROLOGY

Columbia Lake, located just north of Canal Flats, is the headwaters of the Columbia River. The river then flows into Windermere Lake about 15 km further north (see Figure 1).

The flushing rates of Columbia and Windermere Lakes were estimated to be 1.0 and 8.1 times per year, respectively. The water contributioin from Dutch Creek was not considered in the flushing rate calculations for Columbia Lake because the inflow from the creek is located at the lake outlet.

The Kootenay diversion (if implemented) would divert 1,850,000 dam^3 annually into Columbia Lake from the Kootenay River at Canal Flats. The flushing rates of Columbia and Windermere Lakes would be increased to 26 and 37 times per year, respectively.

The water flow of the Columbia River at Fairmont Hotsprings between the two lakes averaged 11.6 m^3/s based on stream flow measurements from 1948-1976. Average freshet (June) values were 36.5 m^3/s and low flows in the winter months were 3.9 m^3/s. The Kootenay diversion would increase the mean annual flow by 500% to 59 m^3/s. The post-diversion freshet flows and the BC Hydro reports outlining the engineering plans designed to prevent flooding have not yet been released.

Windermere Creek flows into the east side of Windermere Lake. The mean annual discharge was 0.6 m^3/s with peak flows of 2.0 m^3/s during freshet, and low flows of 0.3 m^3/s in winter.

WATER USES

The lakes have a wide range of uses. On Windermere Lake there are 15 domestic water licences for single homes, 11 waterworks licences (4031 m^3/day. 8 irrrigation licences (18.4 dam^3/year, 4 industrial licences and one land improvement licence. Columbia Lake has one water licence for a single family residence, 3 waterworks licences (410 m^3/day and one irrigation licence (50 dam^3/year.

The lakes are important for water-based recreation. There are 16 recreational beaches on Windermere Lake and two on Columbia Lake. Fishing is the other important recreational sport. Windermere Lake has a moderate fishing pressure (5000-7000) angler days for rainbow trout, Dolly Varden char and Kokanee salmon. Columbia Lake has less fishing pressure with 3000-4000 angler days. The majority of the fishing pressure in Columbia Lake occurs for burbot during the winter near the mouth of Dutch Creek.

The Columbia River mainstem between Columbia and Windermere Lakes and between Windermere Lake and Toby Creek does not have any water licences. The most common recreational activities are hunting, canoing, fishing and boating. The extent of the recreational activities and the most important sports fish are not known.

Fairmont Creek has four water licences. The Fairmont Hotsprings Resort has two irrigation licences (93.25 dam^3/year and two industrial licences (201.4 dam^3/year. All licences are located above the discharge from the Fairmont Hotsprings Resort. Fairmont Creek has limited recreational or fisheries use due to its steep gradient and low annual flows.

Windermere Creek has 35 irrigation licences (0.37 m^3/s, 5 domestic licences and 1 industrial licence (3 dam^3/year. There are picnicking, camping and hiking opportunities in the headwaters. These recreational activities are considered to be of moderate importance. The fishing pressure is very low (100-200 angler days). Cutthroat and eastern brook trout are the main sport species.

WASTE DISCHARGES

Waste discharges under permit are shown on Figure 1. Within the study area there is only one direct discharge to surface waters. The swimming pool effluent from the Fairmont Hotsprings (Waste Management permit no. PE 2057) is discharged directly to Fairmont Creek. Calcium, magnesium and

sulphate concentrations increased significantly downstream, and occasionally exceeded drinking water standards. It has also been noted that arsenic concentrations have exceeded the drinking water standard during low stream flows. Fairmont Creek downstream from the hotsprings is not considered suitable as a source of drinking water. The poor water quality is caused by the naturally high concentrations of minerals in the discharge from the hotsprings.

There is only one industrial site that may be affecting water quality. Westrock Industries Ltd. (formerly Western Gypsum Ltd.) operates a gypsum (calcium sulphate) quarry next to Windermere Creek. No waste management permit has been issued to the company as there is no direct discharge from the quarry to the creek. There were however, elevated levels of calcium, sulphate and water hardness downstream from the mineral deposit. It was not determined whether the elevated mineral concentrations downstream from the quarry were a consequence of the mining operation, or a natural phenomenon associated with the mineral deposit.

The majority of the waste management permits are for the discharge of sewage effluent to ground. Two sewage discharges under permit (PE 1527 and PE 5173) are located on the east side of Windermere lake. A third permit in the same area (PE 2100) allows evaporation to dispose of the sewage effluent. Two other discharges of sewage effluent in the study area from the Fairmont Hotsprings Resort, are located next to the Columbia River near Fairmont Creek. One (PE 1619) was for ground disposal of sewage effluent. The permit was closed and combined with another (PE 5467) which allows spray irrigation of effluent during the summer months. The amalgamation occurred when the facilities at Fairmont Hotsprings were expanded.

The Village of Invermere has a sewage colection system with discharge to ground. The discharge is within the Toby Creek watershed. The impact on water quality is considered in the report on Toby Creek.

Of the ground discharge systems under permit, only the system under PE 1527 failed, causing minor contamination of Windermere Lake. The failure was caused by fine silts and clays which clogged the drain field. Peak summer flows eventually exceeded the reduced infiltration capacity of the field. A new tile field has been constructed farther from the lake, and has been operating adequately since 1983.

None of the other systems under permit have had similar failures, although the system under PE 5173 has had odour problems originating from its pumping station.

Pe 2100 is the third permit on the east side of Windermere Lake for sewage disposal. This permit is different from the others in that discharge to ground is not permitted. Evaporation ponds are used in both the winter and summer to dispose of the sewage effluent.

Permit PR 3484 authorizes the operation of the municipal landfill located between Columbia Lake and Fairmont Hotsprings. The potential impact of the landfill on surface and ground water is minimal because of the small volume of material deposited at the site and the low rainfall in the area.

A preliminary investigation of soil conditions around Windermere Lake was made. It showed that many areas are unsuitable for septic tank tile fields because of soil stability and erosion problems. Also, certain soils have low phosphorus retention capability which means that phosphorus from septic tank effluent can enter the lake via ground water.

The Regional District of East Kootenay has prepared a development plan for several areas around Windermere Lake. Certain of these areas could be subject to soil stability and phosphorus absorption problems. An interagency committee, of which the Regional District of East Kootenay is a member, is now investigating this matter.

WATER QUALITY

The lakes are oligotrophic and clear except during freshet when turbidity levels frequently exceed the water quality standard (5 NTU) for drinking water supplies. Coliform bacteria sampling was done from 1973 to 1982. The fecal coliform concentrations (3.3 MPN/100 mL geometric mean) for Windermere Lake never exceeded the guidelines for water contact recreation (200 MPN/100 mL geometric mean; 400 MPN/100 mL 90th percentile). Insufficient data were collected to determine if the Ministry of Health guidelines for domestic water supplies (90th percentile of less than 10 MPN/100 mL in any 30-day period) were actually met prior to disinfection. The low geometric mean (3.3 MPN/100 mL for Windermere Lake) indicates that the guidelines were probably met.

The Columbia River between the two lakes and from the outlet of Windermere Lake to Toby Creek, has water quality similar to the lakes. Its suitability for domestic water supplies can not be assessed until fecal coliform data are obtained.

Fairmont Creek downstream from Fairmont Hotsprings and Windermere Creek downstream from the gypsum quarry are questionable sources of domestic water. Fairmont Creek has high concentrations of calcium, magnesium, sulphate and possibly arsenic, while Windermere Creek has high concentrations of calcium and sulphate. Both creeks have hardness values that are considered poor to unacceptable for drinking water supplies. Frequently, sulphate levels exceed the criterion for taste (150 mg/L) and occasionally the criterion for health (500 mg/l).

At this time there are no domestic water licences on Fairmont Creek downstream from Fairmont Hotsprings. However, there are 5 domestic licences downstream from the gypsum quarry on Windermere Creek.

PROVISIONAL WATER QUALITY OBJECTIVES

A summary of the proposed provisional objectives for Columbia and Windermere Lakes is given in Table 1. The objectives are based on preliminary working criteria for water quality and on available data on ambient water quality, waste discharges, water uses and limnological characteristics. The objectives will remain provisional until receiving water monitoring programs provide adequate data, and the Ministry has established approved water quality criteria for the characteristics of concern.

The objectives can be considered as policy guidelines for resource managers to protect water uses in the specified water bodies. For example, they can be used to draw up waste management permits and

plans, regulate water use or plan fisheries management. They can also provide a reference against which the state of water quality in a particular water body can be checked.

Water quality objectives have no legal standing and their direct enforcement would not be practical. This would be due to the difficulty of accurately measuring contaminants in receiving water and attributing the contamination exceeding the objective to particular sources for legal purposes, and thus of proving violations and their causes. Hence, although water quality objectives should be used when determining effluent permit limits, they should not be incorporated as part of the conditions in a waste management permit.

Depending on the circumstances, water quality objectives may already be met in a water body, 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 water bodies and for water quality characteristics which may be affected by man's activity, now and in the foreseeable future.

The designated water uses proposed for each of the water bodies considered in this report are summarized below.

Columbia Lake
drinking and irrigation water, recreation, aquatic life
Windermere Lake
drinking and irrigation water, recreation, aquatic life
Columbia River between the lakes
wildlife, recreation, aquatic life
Columbia River between Windermere Lake and Toby Creek
wildlife, recreation, aquatic life
Fairmont Creek
drinking and irrigation water supply
Windermere Creek
drinking and irrigation water, recreation, aquatic life

Two water quality objectives are proposed for fecal coliform bacteria in Columbia and Windermere Lakes. The first objective is designed to ensure that no water treatment in addition to disinfection is required for drinking water. The second is to ensure safe recreation on the major beaches in the lakes.

The provisional water quality objective for fecal coliform bacteria near or in water intakes is: not more than 10 percent of at least 5 samples from each site in any 30-day period should have a fecal coliform density greater than 10 MPN/100 mL (*i.e.*, the 90th percentile should be less than or equal to 10 MPN/100 mL).

The provisional objective for samples taken at public beaches during the summer months is: not more than 10% of at least 5 samples from each beach in any 30-day period should have a fecal coliform density greater than 400 MPN/100mL, nor shall the running log mean for 30 days be greater than 200 MPN/100mL.

Nuisance algal growth in lakes is usually the result of excessive phosphorus in a lake. Algae can cause taste and odours in drinking water, aesthetic problems, poor water clarity and hypolimnetic oxygen depletion which result in loss of fisheries habitat and possible winter or summer kill situations

To achieve a mean summer chlorophyll-*a* of 0.002 mg/L and maintain the present oligotrophic state of the lakes, provisional objectives for total phosphorus are proposed. These cover the present situation and the future should the Kootenay Diversion proceed. The provisional objectives are 0.008 mg/L for Columbia Lake and 0.010 mg/L for Windermere Lake under present circumstances. The objectives would change to 0.013 mg/L and 0.011 mg/L, respectively, should the Kootenay Diversion proceed. The total phosphorus objectives apply at spring overturn to the average of at least three samples taken near the surface, at mid-depth and near the bottom, at mid-lake.

Turbidity can be caused by algal growth or suspended sediment resulting from erosion. Turbidity caused by algal growth wil not be a problem unless the water quality objectives for phosphorus outlined above are exceeded. Inorganic residues from natural watershed runoff or the Kootenay Diversion will be the major source of turbidity in the lakes and the Columbia River.

The provisional turbidity objective for the lakes is an average of 1 NTU and a maximum of 5 NTU. The objective is set to ensure that the water quality is suitable for domestic water supply (the most sensitive use) with no water treatment in addition to disinfection (*i.e.*, no removal of turbidity or suspended residues is required).

Because the freshet values are highly variable from year to year and frequently exceed the 5 NTU objective, no turbidity objective is proposed for domestic water supplies during freshet. The turbidity objectives should apply to any discrete sample (surface or bottom) collected anywhere during non-freshet periods.

The turbidity objectives apply only to the pre-Kootenay Diversion conditions. Should the diversion proceed, the turbidity objectives will need to be reassessed.

Cool water (less than 15 degrees Celsius) is desirable for drinking water while warm water (25 degrees Celcius) is preferable for swimming. The only development which could affect water temperature is the Kootenay Diversion which could lower temperatures at beaches. Should the diversion proceed, a record of beach water temperatures should be obtained and objectives to protect the recreational value should be considered.

Windermere Creek downstream from the gypsum deposits also has poor water quality for drinking water supplies and salt-sensitive crops, but the water is not considered a health risk. Present and potential water users should be notified of the poor water quality.

MONITORING RECOMMENDATIONS

A summary of recommended water quality monitoring is given in Table 2 and monitoring sites are shown on Figure 1.

Monitoring for fecal coliforms is recommended at eight sites on Windermere Lake (six sites at waterworks intakes and two at public beaches), two sites on Columbia Lake and two on the Columbia River between the lakes. The sampling frequency is five times in July or August at each location. The turbidity should be monitored at the fecal coliform sites at the same time.

Phosphorus and nitrogen concentrations should be monitored once a year at spring overturn in Windermere Lake and Columbia Lake.

Also required is an annual two-day survey, in both lakes, of aquatic plants. This survey, to be conducted in July or August, will insure the early detection of *Myriophyllum spicatum*, should it be introduced accidentally. Such work is needed to preserve the recreational value of the lakes.

The above mentioned monitoring would be ongoing. There are a number of other programs described below which would be one-time studies. Pesticide use is presently restricted to road and rail rights-of-way. To test for pesticides in the lake, sampling of lake sediment near the major water intakes is recommended.

Another set of programs relates to the impact of septic tanks on water quality and aquatic plants. The first program is a survey of the shoreline from Windermere to Invermere with a fluorometer designed to detect septic plumes entering the lake. The second program would use special ground water samplers to collect and quantify the volume of septic leachate entering the lake. The third program would investigate the effects of septic leachate on aquatic plants.

The recommended monitoring is based on technical considerations. Regional priorities and available funding are factors which could either limit or expand the monitoring.

TABLES

Table 1. Provisional Water Quality Objectives for Columbia and Windermere Lakes.

Water Bodies	**Columbia Lake**	**Windermere Lake**
designated water uses	**drinking water, aquatic life, recreation, irrigation**	
fecal coliforms near water intakes	**less than or equal to 10 MPN/100 mL 90th percentile**	
fecal coliforms at bathing beaches	**less than or equal to 200 MPN/100 mL geometric mean less than or equal to 400 MPN/100 mL 90th percentile**	
turbidity	**less than or equal to 1 NTU average 5 NTU maximum**	
total phosphorus under	**less than or equal to 0.008**	**less than or equal to 0.010**

current conditions	**mg/L average**	**mg/L average**
total phosphorus under Kootenay Diversion conditions	**less than or equal to 0.013 mg/L average**	**less than or equal to 0.011 mg/L average**

1. For fecal coliforms the geometric mean and the 90th percentile are calculated from at least five samples taken weekly in a period of 30 days. The recreation objectives (200-400/100 mL) apply during the recreation season and the drinking water objective (10/100 mL applies year round.
2. For turbidity the average is calculated from at least five weekly samples taken in a period of 30-days and applies to any point in the lake. The objectives do not apply either during the freshet season, or should the Kootenay Diversion proceed.
3. The average phosphorus is calculated from a set of at least 3 samples, taken at spring overturn, and including near the surface, at mid-depth and near the bottom, all 3 at mid-lake.

Table 2. Recommended Water Quality Monitoring for Columbia and Windermere Lakes and the Columbia River between the lakes.

Sites	Frequency and Timing	Characteristics
<u>Windermere Lake</u> **site #1 30 m from shore near licence 627766 [East Kootenay Regional Distict[** **.....** **site #2 30 m from shore near licence 041285 [Terravista owners]** **.....** **site #3 30 m from shore near licence c48008 [windermere Holdings Ltd.]** **.....** **site #4 30 m from shore**	**5 weekly samples over a 30-day period in July and August**	**fecal coliforms and turbidity**

near licence C47171 [Terridan Utilities Ltd.] ..... site #5 30 m from shore near licence C32369 [Parr Utilities Ltd.] ..... site #6 30 m from shore near licence C56095 [Land Logistics] ..... #7 5 m from shore at Athalmer Beach ..... site #8 5 m from shore at Invermere Beach		
<u>Windermere Lake</u> site #0200051 mid lake site #0200042 north end site #0200050 south end	annually at spring overturn (near the surface, at mid depth and near the bottom	total, ortho and total dissolved phosphorus; ammonia, nitrite, nitrate, organic and total nitrogen; turbidity
<u>Windermere Lake</u> shoreline between Windermere and Invermere	one time only in the summer	effect of septic effluent on water quality and aquatic plants
<u>Columbia and Windermere Lakes</u> shoreline and beach areas	once annually in July or August	aquatic plant survey
<u>Columbia and Windermere Lakes</u> bottom surface-sediments near water intakes	one time only in late summer or early fall	2,4-D and picloram
<u>Columbia River</u> between the lakes u/s and d/s from PE-5467, spray irrigation of effluent	4 times a year	fecal coliforms
<u>Columbia Lake</u> site #9 5 m from shore at Columere Beach	5 weekly samples over 30 days in July or August	fecal coliforms and turbidity

..... **site #10 30 m from shore near licence C53448 [Columere Waterworks]**		
<u>Columbia Lake</u> **site #1100645 at north end** **site #1100643 at south end**	**once a year at spring overturn near the surface, at mid depth and near the bottom**	**total, ortho and total dissolved phosphorus; ammonia, nitrite, nitrate, organic and total nitrogen; turbidity**

Note: Sampling may need to be increased to check objectives, depending on circumstances.

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