# Water Quality

## Ambient Water Quality Objectives For The Coquitlam-Pitt River Area Tributaries To The Lower Fraser River Along The North Shore

### 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 R. Dalon
Deputy Minister
Ministry Of Environment
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## SUMMARY

This report assesses the water quality of four tributaries to the Fraser River in the lower Mainland area: Kanaka Creek and the Brunette, Coquitlam, and Pitt rivers. Provisional water quality objectives are set to protect aquatic life and wildlife in all the tributaries. In addition, livestock, irrigation, and recreation will be protected in all tributaries except the Brunette River, and drinking water in Kanaka Creek and the Pitt River.

Considerable efforts are being made to reestablish a salmon fishery in the Brunette River system. Several salmonid species are present in Kanaka Creek, the Coquitlam River, and the Pitt River systems

Most water contamination comes directly from the precipitation which falls on the tributary watersheds or from stormwater runoff entering the water bodies. As a result, pH depression occurs, metal concentrations increase to levels which exceed criteria to protect aquatic life, suspended solids concentrations are raised, and bacteriological levels increase so that recreation is not always possible or the water must be completely treated before domestic use.

Provisional water quality objectives have been set for bacteriological indicators, suspended solids, nutrients, metals, pH, dissolved oxygen, and chlorophenols. Attainment of these objectives will protect aquatic life and will allow other uses of these waters. Modifications to the stormwater collection systems discharging to the Brunette River will be necessary if these objectives are to be achieved consistently.


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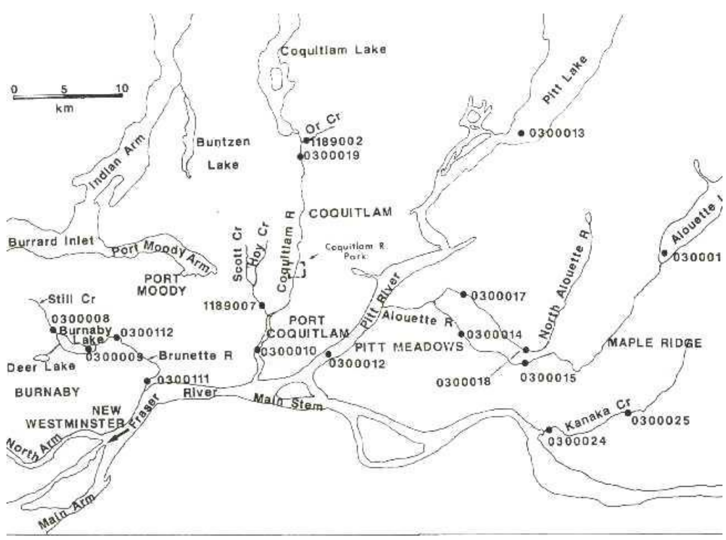
## FIGURES

**Figure 1. Coquitlam and Pitt Rivers: Tributaries to the Fraser River along the North Shore**



TRIBUTARIES TO THE FRASER RIVER ALONG THE NORTH SHORE

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**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 socioeconomic 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).

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**INTRODUCTION**

The Brunette River, Coquitlam River, Pitt River, and Kanaka Creek are tributaries from the north to the Fraser River in the Lower Mainland (see Figure 1). This report develops water quality objectives in these watersheds for use by Water Managers, including the Greater Vancouver Regional District (GVRD), in the preparation and monitoring of a liquid waste management plan.

A detailed Technical Appendix was prepared and forms the basis for the conclusions presented in this report.

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**HYDROLOGY**

The four streams have similar flow patterns, influenced by precipitation. High flows occur during the winter and low flows in the summer. The Pitt River is also influenced by snowmelt as well as backwater effects from tides.

In Kanaka Creek, seven-day low flows have been 0.148 $m^3$/s for a 10-year return period. Peak daily flows have averaged 5.91 $m^3$/s.

Seven-day low flows in the Pitt River have been 8.47 $m^3$/s for a two-year return period and 5.48 $m^3$/s for a ten-year return period. In the North Alouette and Alouette Rivers, tributaries to the Pitt, seven-day low flows were 0.199 $m^3$/s and 0.558 $m^3$/s, respectively, for a two-year return period and 0.105 $m^3$/s and 0.269 $m^3$/s, respectively, for a ten-year return period. Average peak flows were 5.02 $m^3$/s in the North Alouette, 16.1 $m^3$/s in the Alouette, and 115 $m^3$/s in the Pitt River. Flows in the Alouette River are regulated by a dam at the outlet from Alouette Lake.

In the Coquitlam River, where flows are controlled by a dam at the outlet from Coquitlam Lake, seven-day low flows were 0.67 $m^3$/s for a two-year return period and 0.363 $m^3$/s for a ten-year return period.

The average peak flow was 8.87 $m^3/s$. One tributary to the Coquitlam River, Or Creek, had a seven-day low flow of 0.186 $m^3/s$ for a two-year return period.

Flows in the Brunette River are regulated by a dam at the outlet from Burnaby Lake. The seven-day low flow was 0.122 $m^3/s$ for a two-year return period. In Still Creek, a tributary to Burnaby Lake, seven-day low flows were 0.040 $m^3/s$ for a two-year return period and 0.028 $m^3/s$ for a ten-year return period. Burnaby Lake has a retention period of about 30 days.

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**WATER USE**

Kanaka Creek is used for swimming, boating, canoeing and rafting. It contains runs of coho and chum salmon and a minor run of pink salmon. It is stocked with steelhead and cutthroat trout. A physical barrier (water falls) six kilometers from the mouth prevents upstream migration past this point. Consumptive water uses are 6.8 $m^3/d$ for drinking water and 12.6 $dam^3$/year for irrigation.

In the lower reaches of the Pitt River, and in Pitt Lake, boating, canoeing, rafting and some swimming takes place. Downstream from Pitt Lake are large populations of coho salmon, steelhead, and cutthroat trout and some chum salmon. Upstream from Pitt Lake, pink and sockeye salmon form a minor component of fisheries stocks, which include wild stocks of steelhead, cutthroat trout, chum, coho, and sockeye salmon, and Dolly Varden char. There are no consumptive water uses in the Pitt River.

The Alouette River is the most important Pitt River tributary in terms of the recreational fishery and hatchery production. It has natural populations of coho, chum, and pink salmon. Consumptive water licenses are 457 $m^3/d$ for drinking water and 124 $dam^3$/year for irrigation. On the North Alouette, the quantities for consumptive water licenses are 27 $m^3/d$ and 19.1 $dam^3$/year, respectively.

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**WASTE WATER DISCHARGES**

Since all the tributaries are in an urban environment, each is subject to spills which can enter them through separated sewer systems. Although such spills are not discussed further, they could, potentially, have more impact than most of the permitted discharges discussed below.

Only two operations have waste management permits near Kanaka Creek. These are a landfill with a leachate collection system and a dog kennel which uses a septic tank and tile field. The most significant contaminant sources are likely agriculture, and possibly septic tanks.

Four operations with permits issued pursuant to the Waste Management Act are located near the Alouette River or Alouette Lake, which three are domestic sewage discharges, and a metal refining operation. Of most concern would be non-point sources such as agricultural operations, marinas, and one wood preservation facility using anti-sapstain chemicals.

Permitted discharges to the Coquitlam River system include effluents from ready-mix concrete and gravel operations. Non-point sources include septic tanks, limited areas of agriculture, a small closed landfill and refuse site, and, of most importance, surface runoff from the gravel operations.

The most important operations with permits in the Brunette River watershed are two oil refineries which discharge treated stormwater runoff. Of greater importance, however, are a large number of urban stormwater outfalls.

Precipitation in all the tributary watersheds was calculated to be a major potential source of contaminants entering the water bodies.

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**WATER QUALITY ASSESSMENT**

Kanaka Creek is slightly acidic, with background levels reflecting the acidic nature of rainfall in the Lower Mainland are. The buffering capacity to acidic inputs can be minimal at times, with the water being very soft, especially in its upper reaches. Some high total chromium, copper, iron, and lead values exceed working water quality criteria to protect aquatic life, but these levels do not reflect anthropogenic activity. Nitrite, nitrate, and ammonia are low and of no concern; however, phosphorus values have been high enough to cause nuisance algal growths in areas of optimal water velocities for growth. These algal blooms and their associated oxygen-demand can, especially in the lower reaches, cause low dissolved oxygen levels and wide ranges of percent saturation. Fecal coliforms are such that complete water treatment plus disinfection would be required prior to drinking, but the water is generally of high enough quality to permit primary-contact recreation.

The pH of the Pitt, Alouette, and North Alouette rivers can be slightly acidic. The buffering capacity to acidic inputs is minimal, at times, and the water is soft. Some total chromium, copper, iron and lead values exceed aquatic life criteria, but these levels are believed to be naturally occurring. Nitrite, nitrate and ammonia are low, but phosphorus levels in the Alouette and North Alouette Rivers are suspected to be high enough to cause algal blooms. This is reflected in low dissolved oxygen levels and wide fluctuations of percent saturation in the lower reaches of the two rivers. Dissolved oxygen levels are high in upstream reaches of the two rivers, throughout the Pitt River, and in Pitt and Alouette lakes. Dissolved and suspended solids are generally low. Levels of fecal coliforms in the Alouette and Pitt Lakes are low enough to permit primary-contact recreational use, but are higher in the Alouette and Pitt rivers. Complete treatment plus disinfection would be required for drinking water from the rivers.

The pH of the Coquitlam River is slightly acidic just downstream from Coquitlam Lake, but reaches neutral values towards the mouth. The buffering capacity to acidic inputs ranges from moderate to low, and the water is very soft. Iron, manganese, aluminum, and copper values exceed aquatic life criteria, but the values are believed to be naturally high. Nitrite, nitrate and ammonia levels are low; however, phosphorus concentrations increase along the length of the river. Dissolved oxygen levels are high, and percent saturation values do not vary greatly, so algal problems are not suspected to be present. Suspended solids can be high and can occur naturally of from runoff from gravel operations. Solids can settle and cause degradation of spawning beds. Fecal coliform levels are low just downstream from Coquitlam Lake, but increase towards the mouth so that complete treatment plus disinfection would be required for drinking water, although primary-contact recreation would not be affected.

The pH of the Brunette River system is slightly acidic. It has a moderate buffering capacity to acidic inputs, soft water and high values exceeding aquatic life criteria for aluminum, chromium, copper, iron, lead, mercury, and zinc. Some of these values are naturally occurring, but others are due to anthropogenic activity. Ammonia and nitrite concentrations, although elevated, are below aquatic life criteria. Phosphorus in Burnaby Lake exceeds the upper level recommended for salmonids. Dissolved oxygen concentrations are low and below aquatic life criteria in Still Creek and Burnaby Lake, but are higher in the Brunette River. Suspended solids are high throughout the watershed, likely as a result of the impact of storm-water discharges. Fecal coliform levels are high throughout the watershed, and primary-contact recreation criteria are not achieved throughout the year.

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**WATER QUALITY OBJECTIVES**

Provisional water quality objectives proposed for Kanaka Creek, the Pitt River, the Coquitlam River, and Brunette River systems are summarized in Table 1**.** The objectives are based on working criteria for water quality and on available data on ambient water quality, waste discharges, water uses, and stream flows. 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.

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 water bodies. They will guide the evaluation of water quality, the issuing of permits, licenses, and order, 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 water body can be checked, and server 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 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 objectives proposed for the Pitt River downstream from Pitt Lake have been reviewed by the Executive of the Fraser River Estuary Management Program. The Executive agreed with the objectives except for a minor difference regarding dissolved oxygen.

Designated water uses for all the water bodies are protection of aquatic life and wildlife. Drinking water with complete treatment plus disinfection is a designated use for Kanaka Creek, the Pitt River, and Alouette, and North Alouette rivers, while drinking water with disinfection only is a designated water use in Pitt and Alouette lakes. Coquitlam Lake is a drinking water supply for the GVRD but does not need objectives since the lake is in a protected watershed with only limited controlled human access and is not used for recreation. Recreation (i.e. swimming) is a designated use in Kanaka Creek, Pitt and Alouette lakes, and the Coquitlam River system downstream from Coquitlam Lake. Livestock watering and irrigation are designated uses in Kanaka Creek and the Pitt and Coquitlam river systems.

Short-term and long-term objectives are proposed for Kanaka Creek and the Brunette River system for bacteriological quality and dissolved oxygen. Short-term objectives are less strict and reflect the fact that water quality is presently degraded for certain uses. Long-term objectives indicate that the Ministry of Environment considers it feasible to upgrade water quality for those uses.

Provisional objectives for bacteriological quality based on Ministry criteria vary according to whether the water is used for recreation or drinking. Drinking water, with varying levels of treatment, is the most sensitive designated use. A restrictive objective has been proposed for Or Creek to maintain its present very low bacteriological levels for future users.

Objectives have been proposed for suspended solids based on Ministry criteria to prevent possible physical damage to aquatic life. Objectives for turbidity, also based on Ministry criteria, are meant to protect drinking water use and address the effect of light attenuation on aquatic life. Suspended solids can be increased by urban stormwater discharges in the Brunette River system and by stormwater runoff from gravel operations in the Coquitlam River system. In the Brunette River and Coquitlam River systems, an objective for substrate sedimentation based on Ministry criteria is also proposed to protect spawning beds.

Agricultural runoff, septic tanks drainage, and urban stormwater runoff can impact on ammonia and nitrite levels, therefore objectives based on Ministry criteria are proposed for these characteristics to protect aquatic life. Due to high chloride levels in Still Creek and high measured nitrite levels, an objective for nitrite related to chloride levels is proposed for Still Creek.

Periphyton chlorophyll-*a* objectives are proposed for flowing waters based on Ministry criteria which were developed on the basis of a mixed algal community. A more restrictive objective is proposed for Kanaka Creek and the Coquitlam River system where recreation is the designated use requiring lower concentrations of chlorophyll-*a*.

Different dissolved oxygen levels, based upon the Ministry's modification of the CCREM (now known as the CCME) criteria, are proposed for water bodies, depending upon fish species present (e.g. Brunette River supports salmonids but it is not believed that Still Creek does). Objectives for dissolved oxygen levels in Burnaby Lake differ from those in Pitt or Alouette Lake since Burnaby Lake is too shallow to have a hypolimnion, and has been considered a slow moving stream in this assessment.

An objective is proposed for pH as a range in all water bodies except the Coquitlam River system. The upper value will control the formation of toxic quantities of ammonia and the lower values will guard against effects from acidic precipitation. The pH in the Coquitlam River is naturally less than the lowest value in the range, therefore little concern exists about the formation of toxic concentrations of ammonia at high pH levels.

The objectives proposed for total lead in the water column and fish of the Brunette River system reflect the existence of high lead concentrations in this watershed and are based upon Ministry criteria. The amount of lead contributed from human activity should be minimized.

Objectives are proposed for chlorophenols in the water column, bottom sediments, and fish muscle in the Pitt River, since chlorophenols can enter with runoff from a sawmill near the river. The proposed chlorophenol objectives are consistent with those that exist in the Fraser River, near the Pitt River confluence.

## WATER QUALITY MONITORING

A summary of recommended routine water quality monitoring is given in Table 5. Recommended monitoring is the minimum required to check that water quality objectives are being achieved, to finalize provisional objectives that have been proposed, or to increase the accuracy of the information collected.

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

## TABLES

**Table 1a.** Provisional Water Quality Objectives for the Tributaries to the Fraser River along the North Shore (Kanaka Creek, Pitt Lake and River, Alouette Lake and River, North Alouette River, Coquitlam River).

<table>
<tr><th>Water Bodies</th><th>Kanaka Creek</th><th>Pitt Lake</th><th>Alouette Lake</th><th>Pitt River</th><th>Alouette River</th><th>North Alouette River</th><th>Coquitlam River</th></tr>
<tr><td rowspan="2">Designated Uses</td><td rowspan="2">aquatic life, wildlife, drinking water with complete treatment and disinfection, recreation, livestock, irrigation</td><td colspan="5">aquatic life, wildlife, livestock, irrigation</td><td rowspan="2">aquatic life, wildlife, recreation, livestock, irrigation</td></tr>
<tr><td colspan="2">drinking water with disinfection only, recreation</td><td>drinking water with complete treatment and disinfection</td><td colspan="2">drinking water with complete treatment and disinfection, recreation</td></tr>
<tr><td>fecal coliforms</td><td>less than or equal to 200/100 mL maximum (short-term)<br>less than</td><td colspan="2">less than or equal to 10/100 mL 90th percentile</td><td colspan="2">less than or equal to 200/100 mL geometric mean (short-term)<br>less than or equal to 100/100 mL 90th percentile (long-term)</td><td>less than or equal to 100/100 mL 90th</td><td>less than or equal to 200/100 mL geometric mean<br>less than or equal to</td></tr>
</table>

| | | | | | |
|---|---|---|---|---|---|
| | or equal to 100/100 mL 90th percentile (long-term) | | | percentile | 100/100 mL 90th percentile |
| *Escherichia coli* | less than or equal to 200/100 mL maximum (short-term)<br>less than or equal to 100/100 mL 90th percentile (long-term) | less than or equal to 10/100 mL 90th percentile | less than or equal to 77/100 mL geometric mean (short-term)<br>less than or equal to 100/100 mL 90th percentile (long-term) | less than or equal to 100/100 mL 90th percentile | less than or equal to 77/100 mL geometric mean<br>less than or equal to 100/100 mL 90th percentile |
| enterococci | less than or equal to 50/100 mL maximum (short-term)<br>less than or equal to 25/100 mL 90th percentile (long-term) | less than or equal to 3/100 mL 90th percentile | less than or equal to 200/100 mL geometric mean (short-term)<br>less than or equal to 25/100 mL 90th percentile (long-term) | less than or equal to 25/100 mL 90th percentile | less than or equal to 20/100 mL geometric mean<br>less than or equal to 25/100 mL 90th percentile |
| *Pseudomonas aeruginosa* | not applicable | | | | less than or equal to 2/100 mL 75th percentile |
| suspended solids | 10 mg/L maximum increase when u/s is less than or equal to 100 mg/L<br>10% maximum increase when u/s is greater than 100 mg/L | | | | |
| substrate sedimentation | no significant increase by weight in particulate matter less than 3 mm in diameter | | | | |

<table>
<tr><td>turbidity</td><td colspan="5">1 NTU maximum increase when u/s is less than 5 NTU<br>5 NTU maximum increase when u/s is less than or equal to 50 NTU<br>10% maximum increase when u/s is greater than 50 NTU</td></tr>
<tr><td>total ammonia</td><td colspan="5">see <u>Table 2.</u> and <u>Table 3.</u></td></tr>
<tr><td>nitrite nitrogen</td><td colspan="5">less than or equal to 0.02 mg/L average<br>0.06 mg/L maximum</td></tr>
<tr><td>periphyton chlorophyll-a</td><td>less than or equal to 50 mg/$m^2$average</td><td>not applicable</td><td colspan="2">less than or equal to 100 mg/$m^2$ average</td><td>less than or equal to 50 mg/$m^2$average</td></tr>
<tr><td>total phosphorus</td><td colspan="5">not applicable</td></tr>
<tr><td>dissolved oxygen</td><td>8.0 mg/L minimum<br>11.0 mg/L minimum when embryo or larvae present (November to March)</td><td>not applicable</td><td colspan="3">8.0 mg/L minimum<br>11.0 mg/L minimum when embryo or larvae present (November to March)</td></tr>
<tr><td>pH</td><td>6.5 to 8.5 (long-term)</td><td colspan="4">6.5 to 8.5 or maximum 0.2 change when u/s is less than 6.5</td></tr>
<tr><td>chlorophenols</td><td colspan="2">not applicable</td><td>0.2 micrograms/L in water<br>0.1 micrograms/g wet weight maximum</td><td colspan="2">not applicable</td></tr>
</table>

| | | | |
|---|---|---|---|
| | | **in fish muscle 0.01 micrograms/g dry weight maximum in surface sediments** | |

**Table 1b.** Provisional Water Quality Objectives for the Tributaries to the Fraser River along the North Shore (Scott Creek, Hoy Creek, Or Creek, Still Creek, Brunette River, Deer Lake and Burnaby Lake).

| **Water Bodies** | **Scott Creek** | **Hoy Creek** | **Or Creek** | **Brunette River** | **Still Creek** | **Deer Lake** | **Burnaby Lake** |
|---|---|---|---|---|---|---|---|
| **Designated Uses** | **aquatic life, wildlife, recreation, livestock, irrigation** | | | **aquatic life, wildlife** | | **aquatic life, wildlife, primary contact recreation (long term)** | |
| **fecal coliforms** | **less than or equal to 200/100 mL geometric mean less than or equal to 100/100 mL 90th percentile** | | **less than or equal to 10/100 mL 90th percentile** | **not applicable** | | **less than or equal to 200/100 mL geometric mean (long-term) less than or equal to 400/100 mL 90th percentile (long-term)** | |
| ***Escherichia coli*** | **less than or equal to 77/100 mL geometric mean less than or equal to 100/100 mL 90th percentile** | | **less than or equal to 10/100 mL 90th percentile** | **not applicable** | | **less than or equal to 77/100 mL geometric mean (long-term)** | |
| **enterococci** | **less than or equal to 20/100 mL geometric mean** | | **less than or equal to 25/100** | **not applicable** | | **less than or equal to 20/100 mL geometric mean** | |

<table>
<tr><td></td><td>less than or equal to 25/100 mL 90th percentile</td><td>mL 90th percentile</td><td colspan="2"></td><td colspan="2">(long-term)</td></tr>
<tr><td>Pseudomonas aeruginosa</td><td colspan="2">less than or equal to 2/100mL 75th percentile</td><td colspan="3">not applicable</td><td>less than or equal to 2/100mL 75th percentile (long-term)</td></tr>
<tr><td>suspended solids</td><td colspan="6">10 mg/L maximum increase when u/s is less than or equal to 100 mg/L<br>10% maximum increase when u/s is greater than 100 mg/L</td></tr>
<tr><td>substrate sedimentation</td><td colspan="3">no significant increase by weight in particulate matter less than 3 mm in diameter</td><td colspan="3">not applicable</td></tr>
<tr><td>turbidity</td><td colspan="6">1 NTU maximum increase when u/s is less than 5 NTU<br>5 NTU maximum increase when u/s is less than or equal to 50 NTU<br>10% maximum increase when u/s is greater than 50 NTU</td></tr>
<tr><td>total ammonia</td><td colspan="6">see Table 2. and Table 3.</td></tr>
<tr><td>nitrite nitrogen</td><td colspan="3">less than or equal to 0.02 mg/L average<br>0.06 mg/L maximum</td><td colspan="3">see Table 4.</td></tr>
<tr><td>periphyton chlorophyll-a</td><td colspan="2">less than or equal to 50 mg/$m^2$ average</td><td colspan="2">less than or equal to 100 mg/$m^2$ average</td><td colspan="2">not applicable</td></tr>
<tr><td>total phosphorus</td><td colspan="4">not applicable</td><td colspan="2">less than or equal to 0.015 mg/L (long-term)</td></tr>
<tr><td rowspan="2">dissolved oxygen</td><td colspan="2" rowspan="2">8.0 mg/L minimum<br>11.0 mg/L minimum when embryo or larvae present (November to March)</td><td>8 mg/L minimum</td><td colspan="3">6.0 mg/L minimum (short-term)<br>8.0 mg/L minimum (long-term)</td></tr>
<tr><td colspan="4">11.0 mg/L minimum when embryo or larvae present (November to March, long-term)</td></tr>
</table>

<table>
<tr><td>pH</td><td>6.5 to 8.5 or maximum 0.2 change when u/s is less than 6.5</td><td colspan="2">6.5 to 8.5</td></tr>
<tr><td>total chromium</td><td>not applicable</td><td colspan="2">0.020 mg/L maximum (long-term)</td></tr>
<tr><td>total copper</td><td>not applicable</td><td colspan="2">0.005 mg/L maximum (long-term) when hardness is greater than 30 mg/L<br>0.004 mg/L maximum (long-term) when hardness is between 20 and 30 mg/L<br>less than or equal to 0.002 mg/L average (long-term)<br>30 micrograms/g (dry weight) maximum in sediments (long-term)</td></tr>
<tr><td rowspan="2">total lead</td><td rowspan="2">not applicable</td><td>0.018 mg/L maximum (long-term)<br>less than or equal to 0.004 mg/L average (long-term)</td><td>0.012 mg/L maximum (long-term)<br>less than or equal to 0.004 mg/L average (long-term)</td></tr>
<tr><td colspan="2">0.8 micrograms/g (wet weight) maximum in edible fish flesh<br>5 micrograms/g (dry weight) maximum in sediments (long-term)</td></tr>
<tr><td>total mercury</td><td>not applicable</td><td colspan="2">0.1 micrograms/L maximum (long-term)<br>less than or equal to 0.02 micrograms/L average (long-term)<br>0.5 micrograms/g (wet weight) maximum in edible fish flesh<br>0.07 micrograms/g (dry weight) maximum in sediments (long-term)</td></tr>
<tr><td>total zinc</td><td>not applicable</td><td colspan="2">0.03 mg/L maximum (long-term)<br>0.07 micrograms/g (dry weight) maximum in sediments (long-term)</td></tr>
</table>

***Note: The objectives apply to discrete samples from all parts of the water bodies, except from initial dilution zones of effluents. These excluded initial dilution zones are defined as extending up to 100 m 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. In the Pitt River, the initial dilution zone will occupy no more than 25% of the stream width, and can extend up to 100 m upstream from a discharge at times of tide reversal. These excluded dilution zones in lakes are defined as extending up to 100 m horizontally in all directions, but not to exceed 25% of the width of the water body. This exclusion does not apply to objectives for fish as noted below.***

***1. For fecal coliforms, Escherichia coli, enterococci, Pseudomonas aeruginosa and nitrite the average, geometric mean and the 75th and 90th percentiles are calculated from at least 5 weekly samples taken in a period of 30 days. For values recorded as less than the detection limit, the detection limit itself should be used in calculating the statistic.***

***2. For fecal coliforms, Escherichia coli, enterococci, dissolved oxygen, total chromium, total copper, total lead, total mercury and total zinc long-term objectives indicate situations where existing water quality does not suit all desired water uses, but it is considered feasible to improve the water quality over time. Short-term objectives protect water uses to a certain degree until the long-term objectives can be achieved.***

***3. For pH, suspended solids, substrate sedimentation and turbidity the increase (in pH, mg/L, NTU or %) is over levels measured at a site upstream from a discharge or series of discharges and as close to them as possible, and applies to downstream levels. For substrate sedimentation, the increase is measured on the basis of the average of at least three samples collected upstream and downstream, and the significant increase will be defined as no difference greater than 10%. In lakes, substrate sedimentation will usually be measured at the mouths of creeks where fish spawn.***

***4. For periphyton chlorophyll-a, total copper, total lead and total mercury the average is calculated from at least 5 randomly located samples from natural substrates at each site on any one sampling date.***

***5. pH measurments can be made in-situ but must be confirmed in the laboratory if the objective is not achieved.***

***6. The term chlorophenols means the sum of tri-, tetra- and pentachlorophenol which may be present in water, sediment or fish.***

***7. For total copper, total lead, total mercury, total zinc and chlorophenols The maximum value should not be exceeded in bottom surface sediments taken in any part of the sub-basin, except in the initial dilution zones of effluents. The average of at least 3 replicate sediment samples taken from the same site should be used to check the objective.***

***8 For total lead, total mercury and chlorophenols the objective applies only to fish muscle tissue, not the whole fish or organs, of a fish of any species caught in any part of the sub-basin including the initial dilution zones of effluents.***

***9 For fecal coliforms, Escherichia coli, enterococci and Pseudomonas aeruginosa in the Coquitlam River the objectives of less than or equal to 100/100mL fecal coliforms and Escherichia coli and less than or equal to 25/100 mL enterococci, as 90th percentiles apply only between Coquitlam Lake and the southern boundary of the Coquitlam River Park. The objectives of less than or equal to 200/100mL fecal***

*coliforms, less than or equal to 77/100 mL Esherichia coli and less than or equal to 20/100mL enterococci, as geometric means, and less than 2/100mL Pseuomonas aeruginosa as the 75th percentile, apply only to the Coquitlam River below Coquitlam River Park and to Scott and Hoy Creeks.*
*10 For total phosphorus the objective applies only in Burnaby Lake at a depth of 1 meter, and is the average of monthly measurements from April to October.*

**Table 5.** Recommended Water Quality Monitoring for the Tributaries to the Fraser River along the North Shore.

| Sites | Frequency and Timing | Characteristics to be Measured |
|---|---|---|
| Kanaka Creek at sites 0300024 and 0300025 | 5 samples in a 30-day period, June through August and again December through March | pH; hardness; total and dissolved chromium, copper, lead, iron and zinc; nitrite, nitrate and ammonia nitrogen; chlorophyll-*a*; total phosphorus; substrate sedimentation; dissolved orthophosphorus and oxygen; temperature; fecal coliforms, enterococci and *Escherichia coli* |
| Pitt River at site 0300012 plus a site upstream, Alouette River at sites 0300014 and 0300015 and North Aloutte River at sites 0300017 and 0300018 | | pH; hardness; total and dissolved chromium, copper, lead, iron and zinc; nitrite, nitrate and ammonia nitrogen; chlorophyll-*a*; total phosphorus; substrate sedimentation; dissolved orthophosphorus and oxygen; temperature; fecal coliforms, enterococci and *Escherichia coli*; turbidity; suspended solids; chlorophenols in water, sediments and fish at site 0300012 |
| Or Creek at site 1189002, | | pH; hardness; total and |

| | | |
|---|---|---|
| **Scott Creek at site 1189007, Coquitlam River at sites 0300019, 0300010 and downstream from gravel operations** | | **dissolved aluminum, copper, iron and manganese; nitrite, nitrate and ammonia nitrogen; chlorophyll-*a*; total phosphorus; substrate sedimentation; dissolved orthophosphorus and oxygen; temperature; fecal coliforms, enterococci and *Escherichia coli*; turbidity; suspeded solids;** |
| **Alouette lake at site 0300016 and Pitt Lake at site 0300013** | **once a year in July or August** | **pH; dissolved oxygen; temperature; fecal coliforms, enterococci and *Escherichia coli*** |
| **Still Creek at site 0300008, Burnaby Lake at site 0300009, Brunette River at sites 0300111 and 0300112** | **5 samples in a 30-day period, mid-June through mid-September and again October through February** | **pH; dissolved oxygen; specific conductivity; total hardness; total and dissolved chromium, lead, copper, iron and zinc; total mercury, copper, lead and zinc in sediments; lead and mercury in fish; ammonia; nitrite; chloride; orthophosphorus, total phosphorus; suspended solids, turbidity; fecal coliforms; enterococci; *Escherichia coli*; chlorophyll-*a*in Burnaby Lake only; periphyon chlorophyll-*a* at all sites except Burnaby Lake; benthic sedimentation in the Brunette River only.** |

***Note: Sampling may need to be increased to check objectives, depending on circumstances.***
***Site numbers are those used by the Ministry of Environment in its computerized data file.***

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