WATER MANAGEMENT BRANCH
MINISTRY OF ENVIRONMENT
PROVINCE OF BRITISH COLUMBIA

CAMPBELL RIVER AREA
MIDDLE QUINSAM LAKE SUB-BASIN
WATER QUALITY ASSESSMENT AND OBJECTIVES

TECHNICAL APPENDIX

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1. INTRODUCTION

Quinsam Coal Limited is developing a surface coal mine in the Middle Quinsam Lake area, approximately 27 km west of Campbell River (Figures 1 and 2). Subsequent to completion of the Coal Guidelines Review Process, approval-in-principle was granted to Quinsam Coal Limited by the Environment and Land Use Committee in February 1983. One of the conditions of granting the approval-in-principle was that there be a Public Inquiry into the environmental aspects of the proposed project prior to permitting and licencing.

The Public Inquiry into the Quinsam Coal Project was held in October and November 1983. The Inquiry Commission reported to the Minister of Environment that "the Quinsam River and its watershed are very sensitive to environmental damage. Notwithstanding this fact, the Commission has also found that if proper care and attention are paid to the environmental aspects of the construction and operation of this mine, by both the Company and the Government control agencies, the mine can be brought into existence and be operated without doing appreciable damage to the surrounding environment or the Quinsam River fishery". The Commission also recommended that "the Ministry of Environment should prepare water quality objectives for the receiving waters in the mine site area...to protect the use of water for the fishery, recreation, aesthetics and domestic purposes".

This report contains an assessment of baseline water quality in that portion of the Quinsam River watershed which will be subject to waste discharges from the Quinsam Coal Project. The water bodies affected include the Quinsam River, Middle Quinsam Lake, Long Lake and the outflows from Long and Flume Lakes. Existing hydrological and water use information was also reviewed. Receiving water quality objectives are proposed for those characteristics which may be altered by future mining activity. These objectives are formulated to protect existing and anticipated water uses, and are based on consideration of current water quality criteria and existing water quality and hydrology in the Quinsam watershed.

Quinsam Coal Limited originally proposed operating at a production rate of 910 000 tonnes/yr, but started operating at a reduced production of 50 000 tonnes/yr during 1987. The assessment of waste discharges and the water quality objectives presented in this report are based on the proposed full scale operation.

2. HYDROLOGY

The Quinsam River is a major tributary to the Campbell River system and joins the Campbell River approximately 3 km from its estuary (Figure 1). The Quinsam River drains an area of 80 km^2, with headwaters originating at an elevation of approximately 1 700 m, and flows in a northerly and easterly direction through Upper Quinsam, Wokas, Middle Quinsam, and Quinsam Lakes.

Environment Canada (Water Survey of Canada) has maintained a stream gauging station (08H0005) at the mouth of the Quinsam River since 1956. Norecol Environmental Consultants and the Department of Fisheries and Oceans established a cooperative flow monitoring program in 1983-1984; monitoring included the inflow and outflow to Middle Quinsam Lake, the outflow to Long Lake and No Name Lake, and the Iron River. (Lukyn et al. 1985) (Figure 3). These data are summarized in Table 1. In addition, International Environmental Consultants calculated the flows at nine locations on a single occasion to estimate relative flows throughout the drainage system (Quinsam Coal Project, Volume III, Biophysical Inventory Appendices, 1980).

Flow is regulated by two dams, operated by B.C. Hydro which are located on the Quinsam River between Wokas and Middle Quinsam Lakes. Since 1957, B.C. Hydro has operated the Upper Quinsam - Wokas Lake Dam in conjunction with the diversion dam located about 3 km further downstream (Figure 2). Up to 14.8×10^7 m^3/yr is diverted into Campbell Lake via Gooseneck Lake for hydro electric generation. Under the terms of the provisional water licence, B.C. Hydro is required to provide a minimum flow to the Quinsam River above Middle Quinsam Lake of 0.283 m^3/s at all times. B.C. Hydro is also required to maintain flows further downstream in the Quinsam River outflow from Quinsam Lake of at least 1.7 m^3/s during February through May and September through November. Mean monthly flows diverted to Gooseneck Lake have varied from zero to 35 m^3/s with a historical average of 3.1 m^3/s (Power Records, B.C. Hydro). On the average, this represents about 72% of the flow of the Quinsam River. The remaining flow in the Quinsam River represents the major source of surface water to the study area; the Long Lake watershed contributes approximately 20% of the outflow from Middle Quinsam Lake (Table 1).

For the purpose of this assessment, the sub-basin is defined as that part of the surface water drainage located between the B.C. Hydro diversion and the confluence of the Iron and Quinsam Rivers. This area contains the Quinsam Coal Ltd. mine site, and includes portions of the Quinsam watershed which may be directly impacted by mining. This area is not impacted by other major existing or proposed resource developments with the possible exception of logging.

The total catchment area subject to mining disturbances at maximum mine development is approximately 681 ha. The Long Lake sub-basin is roughly 1 500 ha of which 288 ha will be controlled by the minesite drainage system. Therefore approximately 20% of the Long Lake drainage will become mine site drainage. The total catchment of Middle Quinsam Lake is 11 202 ha, of which approximately 1 500 ha is drained by the Long Lake sub-basin. About 72% of the inflow to Middle Quinsam Lake is diverted to Gooseneck Lake by the B.C. Hydro diversion (Table 1). Excluding the Long Lake drainage and the diverted flow, the 393 ha mine site area which drains directly to Middle Quinsam Lake occupies approximately 14% of the effective catchment of Middle Quinsam Lake.

The volumes of Middle Quinsam Lake and Long Lake are 2.82×10^6 m^3 and 1.14×10^6 m^3 respectively (Lake and Stream Inventory files, Ministry of Environment). Using the 1983 and 1984 flow data from Lukyn et al., (1985), and theoretical flow estimates from Norecol (1982), flushing rate estimates were calculated and are summarized in Table 2. For the purpose of evaluating the effect of flushing rate on phytoplankton production, summer flushing rates were calculated. From a hydrological point of view, these flushing rates are rapid.

3. WATER USES

3.1 FISHERIES AND AQUATIC LIFE

Wild anadromous salmonids migrate to within 2 km of Middle Quinsam Lake, where an impassable falls prevents upstream migration (Figure 2). All five species of Pacific Salmon plus steelhead and cutthroat utilize the Quinsam watershed. Natural escapements to the Quinsam River of all salmon species have averaged nearly 16 000 fish annually. Approximately 24 000 salmon produced naturally in the Quinsam watershed were caught in 1980. In addition to the natural production, the Quinsam River Hatchery, located approximately 3 km from the mouth, produces about 250 000 adult fish annually. Fish produced at the hatchery are released as ocean-ready smolts and as fingerlings which are released into natural rearing areas. The majority of coho fingerlings from the hatchery are introduced into the Quinsam watershed. A portion of the coho produced are introduced to the Middle Quinsam Lake and Long Lake systems of which approximately 50% reach the smolt stage and migrate seaward. Such a survival rate is considered very high, and is twice the survival rate of fingerlings introduced further downstream below the falls. The area between the B.C. Hydro diversion and the falls accounts for 30% of the total smolt production which is enumerated when migrating past the Quinsam River Hatchery. The annual net wholesale value of all Quinsam River salmon caught in 1981 was estimated at $2.6 million.

The Quinsam River also supports a valuable steelhead fishery, supporting 5 000 angler-days annually. In addition, 6 900 angling-days per year of effort was directed at resident cutthroat.

3.2 LICENCED WATER USE

Water licences in the Quinsam River watershed include one inactive irrigation withdrawal and diversion and storage licences for hydro-electric generation. The Greater Campbell River Water District has filed an application for withdrawal of water for domestic consumption. Quinsam Coal Ltd. does not intend to apply for any licences to withdraw water from the Quinsam River system.

The B.C. Hydro diversion represents the most significant water use in terms of quantity. The conditional water licence authorizes the diversion of 148×10^6 m^3 per year. On the average this represents roughly 72% of the flow of the Quinsam River at this location. During 1983 the proportion of the total flow diverted varied from 0% in October to 81% in March (Table 1). The licence is conditional on the maintenance of a minimum of 0.28 m^3/s in the Quinsam River below the diversion.

Although there are two irrigation licences recorded, they in fact refer to the same point of withdrawal. This withdrawal was required by the B.C. Forest Service to irrigate a tree nursery located on land leased from the Cape Mudge Indian Band on Indian Reservation No. 12 located near the Quinsam River Hatchery. There is presently no requirement for irrigation at the nursery; however, irrigation may be required sometime in the future. These two licences represent a potential use of 88 000 m^3/yr. Assuming a 100-day irrigation period this represents about 0.01 m^3/s.

The Quinsam River Hatchery is licenced to withdraw 0.28 m^3/s from the Quinsam River and 0.85 m^3/s from Cold Creek. Cold Creek is a tributary to the Quinsam River with its mouth near the hatchery. The hatchery may also request approval to withdraw up to 0.71 m^3/s during emergencies. Historically the majority of water for the hatchery is drawn from Cold Creek; however, future expansion of the facility will necessitate greater usage of Quinsam River water.

3.3 RECREATIONAL WATER USES

The Quinsam River watershed is accessible, undeveloped, unpopulated and is within 30 km of the city of Campbell River. The pristine water quality of this area has attracted various forms of water-based recreatioal activities, in particular fishing. No boat launching facilities exist, therefore boating is restricted to car-toppers, canoes or other light boats. There are some unorganized camp sites adjacent to the lakes. Logging roads provide access to most of the smaller water bodies.

It is expected that the operational full-scale mine will discourage recreational use of Middle Quinsam lake and Long Lake as a result of access restrictions and/or simply due to the proximity of waste rock dumps, settling ponds, diversion ditches, open pits and the movement of heavy equipment.

3.4 WATER USE DESIGNATIONS

For the purpose of setting water quality objectives which protect appropriate water uses, water use designations for certain portions of the Quinsam River watershed are proposed. The objectives will apply to Middle Quinsam Lake, Long Lake, the Quinsam River between Flume Lake outflow and Middle Quinsam Lake, the outflow streams from Flume Lake and Long Lake, and the Quinsam River between the Argonaut Road crossing and the confluence with the Iron River.

The surface waters adjacent to the proposed mine site are not considered suitable for domestic consumption or for recreational purposes during the life of the mine. However, due to the importance of this area for salmonid production, these waters are designated for aquatic life, in particular salmonid rearing, and for wildlife.

To maintain the present pristine water quality and to protect existing and potential water uses downstream from the mine site, the Quinsam River between the falls and the mouth of the Iron River is designated for all water uses, including aquatic life, wildlife, domestic use, recreational use and irrigation use (Figure 2).

4. WASTE DISCHARGES

4.1 INTRODUCTION

Presently, Quinsam Coal Ltd. has the only permitted waste discharge located in the Quinsam River watershed. Activities in the watershed which could be affecting water quality include coal mining, operation of a fish hatchery, logging, road building and regulation of flows by B.C. Hydro. At full operation the proposed Quinsam Coal Limited mine will discharge effluent from four settling ponds. One pond will discharge to Middle Quinsam Lake, the other three settling ponds will discharge into Long Lake (Figure 2).

Quinsam Coal Ltd. proposes to surface mine 18 million tonnes of coal reserves over a 20-year period. The mine will discharge water originating from the surface drainage system surrounding the disturbed area and from pumping of pits. Pit water will consist of groundwater and surface water. All mine site water will pass through settling ponds prior to discharge. The settling ponds will be equipped with automatic flocculent addition facilities. It is proposed that mine effluents will be discharged to surface waters at three locations: near the inflow to Middle Quinsam Lake, near the outflow from Lake Lake and near the centre of Long Lake (Figure 4). Sewage will be discharged to a septic drain field. There will be no water discharged from the coal preparation plant; wash water will be clarified and recycled within the plant. Thickener filter cake will be disposed of in the same manner as the waste rock. Refer to Figure 2 for location of the four settling ponds, the pits and waste dumps. Refer to the Quinsam Coal Project Addendum to Stage II, Volume 2 for further mine site details.

As of December 1987, Quinsam Coal Ltd. started operating at a reduced production rate of 50 000 tonnes/yr. and received a permit to discharge up to 0.54 m^3/s from settling pond 4 (PE 7008) near the inflow to Middle Quinsam Lake (Figure 7). The assessment and objectives in this report address the proposed full scale operation.

The water quality characteristics most likely to be directly impacted by the Quinsam Coal Project include suspended sediments, nitrogen, phosphorus, pH and metals. Increases of nitrogen and phosphorus can in turn result in excessive algal growth and hypolimnetic oxygen depletion. Nitrogen in the form of un-ionized ammonia, nitrite and nitrate can be toxic to aquatic life. Acidic pH and high metal concentrations are also harmful to aquatic life. Increases in suspended sediment loading can interfere with fish spawning and reduce aesthetic values and other water uses.

Settling pond effluents can be expected to be enriched in nitrogen compounds originating from nitrogenous explosive residues. Suspended sediments will be generated by the general disturbance associated with surface mining; a portion of the suspended sediment will originate from runoff from pits, dumps and roads, and some will originate from the diversion channels constructed to control mine site drainage. Increased phosphorus loading will originate from sewage disposal for the workforce, reclamation fertilization programs, mineralization of exposed materials and suspension of phosphorus-bearing sediment. Mineralization of exposed materials can also increase the concentration of many surface water constituents, including metals. Should acidic conditions occur, enhanced solubilization of metals will result. The process of pit dewatering will also introduce a groundwater component to the mine effluent, which may result in increases in the concentrations of a wide range of constituents.

The impact of mine effluent on the receiving surface waters is partly determined by the amount of dilution available upon discharge. The following sections briefly summarize expected Quinsam Coal Ltd. mine effluent quality, and estimate receiving water dilution for various flow regimes.

4.2 PARTICULATE MATTER

The concentration of suspended sediment in mine effluent is expected to be highly variable depending on climatological events. As all drainage from the mine site will be routed through settling ponds with automatic flocculation facilities, suspended sediment levels in the discharge can be controlled.

The settling ponds are designed to retain effluents for approximately 10 hours during a 1-in-10-year high flow event. It is possible that during low flow periods, seepage from the ponds may account for most of the outflow. Without flocculation, fine silt and clay sized particles will not be trapped in the settling ponds except during very low flows. Fine silt and clay requires between 10 to 200 hours to settle two metres under ideal conditions; Quinsam Coal Ltd. estimates that 15% of the suspended solids will be within this size fraction. A well-operated flocculation system can greatly enhance removal of these finer fractions during shorter retention times. Quinsam Coal Limited is committed to operating the settling pond system to maintain suspended sediment in the effluent below a monthly average of 25 mg/L with no single grab sample exceeding 50 mg/L (Hillier et al. 1984; page 36).

4.3 PHOSPHORUS

It is expected that mine effluent will have concentrations of phosphorus higher than background levels in surface waters. Mechanical disturbance and enhanced mineralization of large quantities of soil, till, rock and coal will introduce soluble and particulate phosphorus to surface waters draining the mine site. As groundwater contains higher concentrations of phosphorus than surface waters, the groundwater component of pit water pumped to settling ponds will also contribute to phosphorus concentrations. In addition, phosphorus originating from the mine's sewage system and loss of phosphorus from fertilizers used for reclamation will further contribute to phosphorus loading.

Not all phosphorus originating from the mining operation is immediately biologically available; however, it is not considered practical to predict relative amounts of the various phosphorus fractions. As a large portion of mine effluents is discharged to lakes we can assume that the majority of total phosphorus may potentially become biologically available. To simplify the prediction of phosphorus concentrations expected in the effluent, only total phosphorus is considered here.

Pommen and Nordin (1984) estimated the phosphorus loading originating from sewage, fertilization, groundwater and mine site surface waters. Using these loadings, effluent concentrations were estimated assuming the wet and dry weather settling pond flows provided by Norecol (1982). Using this method, the total phosphorus concentration predicted for settling pond 4 (Middle Quinsam Lake discharge) ranges from 0.020 mg/L to 0.084 mg/L. The total phosphorus concentration predicted for settling ponds, 1, 2 and 3 combined (Long Lake discharge) ranges from 0.010 mg/L to 0.027 mg/L. Refer to Table 3 for calculations. The wide range in these predictions is mainly due to the difference between the best and worst case assumptions used for estimated phosphorus losses from septic field sewage disposal and reclamation fertilization. Notably, these two sources are the most amenable to control. Hillier et al. (1983) concluded that implementing measures to minimize phosphorus input from sewage disposal and reclamation fertilization should be a priority and that such measures can be effective.

Erickson and Kelso (1986) reviewed various sources of phosphorus at the Quinsam Coal Project and evaluated the performance of operational surface coal mines in B.C. They concluded that Quinsam Coal Ltd. will likely discharge 0.02 mg/L total P (±0.01 mg/L).

4.4 NITROGEN

Mine effluents will be substantially enriched in nitrogen relative to receiving waters. Nitrogen originates from the use of fertilizers during reclamation and from leaching of nitrogenous blasting residuals. Nitrogen from blasting residuals is by far the major source. Quinsam Coal Ltd. proposes to use ANFO (Ammonium nitrate and fuel oil) and slurry explosives, both of which contain highly soluble ammonium and nitrate. Under aerobic conditions the majority of nitrogen is expected to be nitrified to nitrate (Pommen 1983).

Nitrogen losses from explosives use will vary depending on the amount of water present during blasting. ANFO is highly soluble; slurry is not as prone to dissolution and is therefore used under wet conditions. However, as slurry is used under the worst conditions, net nitrogen loss is higher. Knowing anticipated explosives usage (Quinsam Coal Ltd. 1982) nitrogen loading to surface waters can be estimatd using the method outlined by Pommen (1983). These loadings can then be converted to effluent concentrations using the settling pond flows presented by Norecol (1982).

The following assumptions and equations were used to calculate nitrogen loading and effluent concentrations from explosives use:

1) ANFO is used 70% of the time and slurry is used 30% of the time,
2) ANFO is 33% nitrogen and slurry is 20% nitrogen
3) Average annual nitrogen content (0.70)(0.33) + (0.30)(0.20) = 29.1%
4) 6% nitrogen loss factor under wet conditions and 1% nitrogen loss factor under dry conditions.
5) Settling pond 1 will receive loading from 1 943 565 kg/yr of explosives usage during the first year of mining (worst case)
6) Settling ponds 2 and 3 will receive loading from 853 255 kg/yr of explosives usage during mining years 12 to 15 (worst case)
7) Settling pond 4 will receiving loading from 4 595 978 kg/yr of explosives usage during mining years 2 to 11 (worst case)
8) $$\text{Nitrogen load kg/day} = \frac{\text{usage (kg/yr)}}{365} \times \text{average nitrogen content} \times \text{loss factor}$$
9) $$\text{Effluent concentration mg/L} = \frac{\text{nitrogen load (kg/day)}}{\text{pond flow (m}^3\text{/s)} \times 86.4}$$
10) Pond flows are as given in Norecol (1982) and Quinsam Coal Ltd (1982)

Settling Pond 1 (Long Lake Discharge)

flow regime	effluent flow (m^3/s)	nitrogen loss factor (%)	nitrogen load (kg/day)	effluent nitrogen concentration (mg/L)
7-day low flow	0.003	1%	15.5	59.8
dry weather	0.016	1%	15.5	11.2
wet weather	0.055	6%	93.0	19.6

Settling Ponds 2 and 3 (Long Lake discharge)

flow regime	effluent flow (m^3/s)	nitrogen loss factor (%)	nitrogen load (kg/day)	effluent nitrogen concentration (mg/L)
7-day low flow	0.025	1%	6.8	3.1
dry weather	0.053	1%	6.8	1.5
wet weather	0.173	6%	40.8	2.7

Settling Pond 4 (Middle Quinsam Lake Discharge)

flow regime	effluent flow (m^3/s)	nitrogen loss factor (%)	nitrogen load (kg/day)	effluent nitrogen concentration (mg/L)
7-day low flow	0.040	1%	36.6	10.6
dry weather	0.058	1%	36.6	7.3
wet weather	0.138	6%	220	18.5

These calculations suggest that nitrogen concentrations could approach 18.5 mg/L during mining years 2 through 11 in settling pond 4 which discharges to Middle Quinsam Lake. During mining years 12 through 15 effluent concentration will be approximately 50% lower. This pond will not begin discharging until the second year of operation. The nitrogen concentration expected in settling pond 1, which will discharge to the middle of Long Lake, could approach 60 mg/L during the first year of operation; a slight reduction could be expected during mining years 2 through 11. This pond will not discharge after 11 years of operation. Settling ponds 2 and 3, which have a combined discharge at the outlet of Long Lake, will only discharge about 3 mg/L of nitrogen during the most active mining period.

The above nitrogen losses are much lower than estimated by Norecol (1982). Norecol (1982) used nitrogen loss rates much higher than recommended by Pommen (1983). It should be emphasized that because these predictions are based on hypothetical flows and nitrogen loss rates which are derived from other mines, they should be interpreted as order of magnitude estimates only.

4.5 METALS

The potential for acid mine drainage exists for the Quinsam Coal Project. Acid mine drainage would result in a wide variety of metals contaminating mine effluents. However, Sturm (1983) concluded that the ratio of acid-neutralizing materials to acid-generating materials is high enough to preclude acid generation, if the appropriate materials-handling techniques are incorporated. Hillier et al. (1984) made several recommendations regarding the prevention of acid generation and also recommended contingency plans should prevention fail.

In the absence of acid generation, increased mineralization resulting from mining disturbances and pumping of pits to remove groundwater may result in mine effluent containing higher concentrations of a wide variety of metals relative to ambient surface waters. However, quantitative predictions cannot be made with any certainty. Hillier et al. (1984) concluded that under non-acid conditions metal levels could be elevated, but not to any significant degree.

4.6 EFFLUENT DISCHARGE FLOWS AND RECEIVING WATER FLOWS

Settling pond discharge-flows for various flow regimes have been estimated by Norecol (1982). These flow regimes include; dry year 7-day average low flow, average daily dry weather (July, August and September) flow, average daily wet weather (December, January and February) flow. Quinsam Coal Ltd. (1982) also provided estimates for the 1-in-10-year high flow. These flows were based on anticipated precipitation for the various catchment areas and maximum groundwater input due to pit dewatering. These flows are summarized in Tables 4 and 5. These tables also present actual and theoretical receiving water flows, and the resultant receiving to discharge water dilution ratios. Actual receiving water flows were measured during 1983, 1984, and 1985 (Lukyn et al. 1985; Norecol unpublished); the 7-day low flows and the wet and dry weather flows were estimated by inspection of the 1983-85 instantaneous flow values. The theoretical receiving water flows were found in Norecol (1982) and Quinsam Coal Ltd. (1982). In the case of Middle Quinsam Lake, both outflow and inflow data for the Quinsam River are presented. The inflow data are probably more meaningful because they are actual flows and the discharge is located near the inflow. The outflow values and the resultant dilution ratios are included for comparison purposes.

For settling pond 4, which will discharge into a marsh adjacent to Middle Quinsam Lake near the inflow, the lowest dilution ratio using either theoretical or actual Quinsam River water low flows was 8:1. It is assumed that additional flow originating from Flume Lake would be negligible. All the dilution ratios presented in Table 4 are based on comparisons of effluent flows and receiving water flows of roughly the same flow regime. Normally, mine drainage and ambient drainage vary concomitantly. However, in the case of the Quinsam River above Midddle Quinsam Lake, flows are regulated by the B.C. Hydro diversion dam. Inspection of the hydrographs of the Quinsam River inflow to Middle Quinsam Lake and the Quinsam River at the mouth near Campbell River (Figures 3, 4 and 5) indicates that during the three years for which there are comparable flow data, the inflow hydrographs tended to be highly truncated relative to the hydrograph of the Quinsam watershed as a whole, (particularly in the spring). Flow regulation maintains a fairly constant inflow during periods of rapid fluctuation in natural runoff. The minimum dilution ratio for settling pond 4 could be considerably less than 8:1 if high mine drainage flows occur during relatively low flow release from the diversion. Using the estimated average daily wet weather pond discharge and the actual receiving water 7-day average low flow which occurred in 1984, the dilution ratio is reduced to 3:1. If this pond discharge occurred when receiving water flows were equivalent to the minimum flow B.C. Hydro is required to provide under the terms of its conditional water licence (0.283 m^3/s), the resulting dilution ratio for settling pond 4 is 2:1.

With respect to the settling ponds discharging to Long Lake, the various effluent and receiving water flows and the resulting dilution ratios are presented in Table 5. Settling pond 3 discharges to settling pond 2 which in turn discharges into Long Lake near the outflow. Settling pond 1 discharges into Long Lake near the centre. For the purposes of calculating dilution ratios the settling pond effluent flows were combined. Table 5 also presents theoretical effluent flows and both theoretical and actual receiving water flows for various flow regimes.

The dilution ratios for the Long Lake discharges are well below 1:1 except for the high flow regimes. This is lower than expected given that the disturbed area represents roughly 20% of the catchment area for Long Lake which suggests the dilution ratio would be in the order of 4:1.

The lack of significant dilution for mine effluents entering Long Lake represents a major weakness in the mine plan as described at Stage II (Quinsam Coal Ltd. 1982).

4.7 INITIAL DILUTION ZONES

According to the Pollution Control Objectives For The Mining, Smelting and Related Industries (1979), an initial dilution zone (I.D.Z.) is defined as extending up to 100 m in all directions from a point of discharge and should not exceed 50% of the width of a water body. Receiving water quality objectives do not apply within the I.D.Z., but acutely toxic conditions should not occur. This zone may not intrude on restricted routes known to be followed by migrating salmon.

The low dilution potential under worst case flows indicated in section 4.6 suggests that the maximum initial dilution zone dimensions may be required to meet the receiving water quality objectives.

If 1) measures to prevent acid mine drainage are successful, and 2) reduced nitrogen species from blasting residuals become oxidized prior to discharge, and 3) suspended sediment levels do not exceed 25 mg/L in the effluent, it is unlikely that mine effluent will be acutely toxic to aquatic life. Consequently, the water quality within the I.D.Z. is not expected to be acutely toxic given the aforementioned assumptions.

There are, however, potential problems with regard to the location of the discharge sites as proposed by Quinsam Coal Ltd. (1982). Figures 6 and 7 indicate the location of the discharge sites and the resultant I.D.Z. which conforms to the distance requirements of the Pollution Control Objectives (1979). Figure 6 also presents an alternative discharge site and associated I.D.Z. which resolves some of the conflicts with aquatic life resources posed by the original location.

In the case of Long Lake, Quinsam Coal Ltd. has proposed that effluent from settling ponds 2 and 3 will enter the lake adjacent to the outlet stream. As indicated in Figure 6 the 100 m I.D.Z. would encompass the only migration corridor available to introduced coho salmon and resident cutthroat trout. The I.D.Z. also encompasses an area which is considered to provide good cover for rearing juveniles. Long Lake has steeply sloping shoreline for much of its length, the shallow zone at the outflow within the I.D.Z. represents a major portion of the limited good cover available. (Hawthorn 1984, Blackmun et al. 1985).

If effluent quality does not meet the receiving water quality objectives, the discharge from settling ponds 2 and 3 should be located at least 150 m from the outflow. It should be noted that the I.D.Z. should not exceed half the width of the water body. Figure 6 indicates the location and shape of the I.D.Z. which conforms to the maximum dimensions allowed by the Pollution Control Objectives (1979). The location and shape of the I.D.Z. for the discharge from settling pond 1 is also presented in Figure 6. In order to maximize the dilution capacity within these constrained dimensions, it may be desirable to discharge the effluent through high rate diffusers.

Quinsam Coal Ltd. is presently discharging effluent from settling pond 4 into a marsh near Middle Quinsam Lake adjacent to the inflow from the Quinsam River (Figure 7). The predominant flow from the marsh enters the outflow from Flume Lake which subsequently enters the Quinsam River near the inlet to Middle Quinsam Lake. Some flow from the marsh may enter the lake directly (Hawthorn, 1984). The Quinsam River is an important corridor for the migration of introduced coho salmon and resident cutthroat. This portion of the river is the major spawning habitat for resident cutthroat (Hawthorn, 1984). The extent of dilution and water quality improvement which will occur in this marsh before flows enter the Quinsam River is unclear.

5. WATER QUALITY ASSESSMENT AND OBJECTIVES

5.1 INTRODUCTION

Variables were selected for assessment and objective development if one or more of the following conditions were met:

1) background concentrations do not meet water quality criteria,
2) acid leaching tests produced concentrations which do not meet water quality criteria,
3) groundwater concentrations in the mine area do not meet water quality criteria,
4) water quality in test pits do not meet water quality criteria.
5) a water quality characteristic may be altered by a certain aspect of the mining operation to the extent that the water quality criterion may not be met.

The following variables were selected: pH, suspended sediment, turbidity, periphyton biomass, total phosphorus, nitrite, nitrate, ammonia, hypolimnetic dissolved oxygen, aluminum, arsenic, cadmium, cobalt, copper, iron, lead, manganese, mercury, nickel, silver and zinc.

The selection of the above variables for the development of receiving water quality objectives does not mean that a conflict with a designated water use is likely, but merely that the potential exists. It is acknowledged that many of the objectives proposed here may be exceeded due to natural events or causes other than that related to coal mining. In order to minimize this possibility, the objectives have been developed to accomodate natural background variation. The purpose of the objectives is to provide references against which operational water quality may be compared, and to provide guides for the development of effluent permit limits.

The most sensitive water use with respect to each variable will determine the objective. In most cases this was aquatic life. All of the metal objectives (except for aluminum) are expressed in terms of total rather than dissolved or extractable analyses; this is the most conservative measure of the presence of a toxic variable and therefore incorporates a safety margin. It is argued that because the Quinsam system is so remarkably free of particulate matter throughout the season, the added expense of measuring dissolved or other extractable fractions on a routine basis is unwarranted. It is recommended that, if any of the objectives proposed here for metals are exceeded, the dissolved fraction be included in further monitoring to assist interpretation.

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, licences, and orders, and the management of the fisheries and of the Province's land base. They will also provide a reference against which the state of water quality in a particular water body can be checked, and serve to make decisions on whether to initiate basin-wide water quality studies.

Prevention of acid generation during and after mining and the substantial dilution capacity of the receiving waters should avert any major increase in metal concentrations in the Quinsam watershed. However, occasional elevated metal concentrations have been reported during baseline monitoring; during operational monitoring objectives for some metals may be exceeded due to natural variability, sampling errors or analytical errors.

All of the 21 objectives are based on extensive pre-operational (historical background) data rather than operational upstream or control sites. The reason for this choice is that there are no ideally suited control sites. The mine will discharge into two small lakes and the only unaffected control sites within the watershed are the Quinsam River above Middle Quinsam Lake whose inflow is regulated by the B.C. Hydro diversion and the stream inflow to Long Lake, neither of which are expected to reflect lake quality at all times. Comparisons with upstream unaffected sites and Goosneck Lake (Figure 2) will be helpful for interpretational purposes, but objectives based on fixed references are considered more practical.

The objectives are presented in Table 6. They are designed to protect the water use most sensitive to each characteristic. The water uses considered include aquatic life, recreational use, aesthetic values and drinking use. Most objectives apply to the Middle Quinsam Lake Sub-basin which includes Middle Quinsam Lake, Long Lake, the outflow stream from Long Lake and Flume Lake, and the Quinsam River between the confluence of the Flume Lake outflow and the confluence with the Iron River. Some objectives only apply to certain portions of the sub-basin as specified in Table 6. This will ensure that if these objectives are met, all the water uses which now occur and are expected to occur will be protected. However, the objectives are not intended to apply further downstream due to: 1) possible influences from proposed developments in the Iron River, 2) other activities in the lower portion of the Quinsam watershed, and 3) the fact that baseline water quality downstream from the confluence of the Iron and Quinsam Rivers differs from water quality upstream.

The objectives apply outside the initial dilution zones as outlined in section 4.7, except the fish tissue objective for mercury which applies to fish caught at any point in the system.

Assessment of baseline water quality is based on data presented in Sneddon and Kelso (1983), Redenbach et al (1985), and Norris (in preparation). In addition, raw data collected by Norecol and reported by Quinsam Coal Limited (1985) for the period January 1983 to October 1984, and raw data used by MacIssaac and Stockner (1985) were used. All data found in the Ministry of Environment (MOE) EQUIS and SEAM computer data files, and other data collected by MOE staff which were not entered on computer files, have been used. The relatively small amount of data in Quinsam Coal (1980) and IEC (1982) were not used due to many apparently erroneous values and high detection limits. Data used from the above sources were compiled on a single computer data file (VAX) to facilitate the computation, and production of the data summaries presented here. All raw general water quality and raw metals data used in this assessment are presented in Appendix 1 and Appendix 2 respectfully.

As each sampling agency used slightly different sampling locations, certain sites have been pooled resulting in all sampling sites within the study area being reduced to a total of 7 sites which are referred to in this analysis. Refer to Table 7 for details on site groupings.

5.2 pH

The lowest pH generally considered harmless to fish is 6.5. However, values as low as 5 are not necessarily harmful unless other factors are present (EIFAC 1969, Thurston *et al.*, 1979). Thurston *et al.* (1979) recommend that no change greater than 0.5 units outside the seasonal maximum or minimum should occur to protect aquatic life. EPA (1986) and CCREM (1987) also concluded that to protect aquatic life pH should remain above 6.5 and below 9.0. A minimum pH of 6.5 is recommended for domestic drinking water uses to minimize corrosion to plumbing (Health and Welfare Canada 1979).

The overall median pH in the mainstem Quinsam system is estimated as 7.1, with values generally ranging from 6.0 to 8.3 indicating that pH varies over a wide range (Figure 8 and Table 8). The majority of these measurements were taken using standard field pH meters, therefore their precision may be questionable in view of the difficulties of obtaining reliable values in low ionic strength water. Approximately 3% of the pH measurements were below 6.5 (Table 9). Alkalinity ranged from 13 to 33 mg/L with an average of 22 mg/L (as $CaCO_3$)(Quinsam Coal Limited 1985), suggesting a moderately low buffering capacity. The pH of small streams, especially during periods of rainfall and snowmelt, were found to occasionally range from 5-6 (WCT 1980). These conditions were temporary and localized and were not considered as representative of the mainstem Quinsam system.

Acid mine drainage can potentially occur, although proper waste rock handling techniques are expected to eliminate this problem. Acid generation is of special concern to the Quinsam system due to the tendency toward naturally low background pH, moderately low buffering capacity, and the presence of a valuable fishery resource. A lower pH in receiving waters could increase the solubility of several toxic metals. Also, a reduction of pH would increase the concentration of free CO_2 which, under conditions of low O_2 availability, could be stressful to fish. Molluscs and crustaceans (zooplankton) also can be adversely affected due to the increased difficulty of absorbing Ca for shell and carapace construction under low pH conditions. A reduction in mollusc and crustacean production would in turn be detrimental to fish productivity. The following objective applies to the whole sub-basin.

OBJECTIVE - It is recommended that to protect aquatic life the 90th percentile pH for any 30-day period be greater than 6.5 and that the running 30-day median pH should not decline below 6.9.

The 90th percentile and median are based on at least 5 weekly samples taken in a period of 30 days.

5.3 ALUMINUM

Aluminum is the third most abundant element in the earth's crust. Little is known about aluminum toxicity to humans. Aluminum intake may be related to Alzheimer's Disease; aluminum in excess of 0.05 mg/L in the dialysate (water used) is harmful to patients undergoing artificial kidney dialysis. W.H.O. (1984) and EEC (1980) recommend a criterion of 0.2 mg/L to provide protection for domestic water use.

Recent studies of the effects of acid rain on aquatic life have shown that increased aluminum availability due to increased acidity results in aluminum toxicity to fish (Overrein *et al.*, 1981). The International Joint Commission (1977) and EPA (1973) suggest that to protect aquatic life total aluminum should not exceed 0.1 mg/L. More recent reviews have noted that aluminum toxicity is pH dependent (EPA, in preparation). CCREM (1987) recommends that total aluminum should not exceed 0.005 mg/L if pH is less than 6.5, and total aluminum should not exceed 0.1 mg/L if pH is greater than 6.5. The B.C. Ministry of Environment (Butcher 1988) recommends that to protect aquatic life the 30-day average dissolved aluminum not exceed 0.05 mg/L, and the maximum should be 0.10 mg/L when pH is ≥6.5.

Natural background levels of total aluminum in the Quinsam system ranged from 0.006 to 0.31 mg/L, with an average of 0.040 mg/L. About 24% of a sample size of 209 exceeded the 0.05 mg/L aquatic life criterion whereas 1.4% of the values exceeded the 0.1 mg/L criterion (Table 10). Dissolved aluminum ranged from 0.0001 to 0.071 mg/L, with an average of 0.026 mg/L. About 11% of the values exceeded 0.05 mg/L; no values exceeded 0.1 mg/L. Quinsam Coal Limited (1982) have reported consistently high concentrations in water from test pit areas and in groundwater from the proposed mine site. The pit water contained 0.085 to 0.118 mg/L total aluminum, with an average of 0.094 mg/L. Concentrations of dissolved aluminum in groundwater samples exceeded the 0.1 mg/L criterion. Dissolved aluminum in groundwater ranged from <0.005 mg/L to 0.80 mg/L with an average of 0.16 mg/L. Groundwater draining into the pits will be pumped to settling ponds and eventually discharged to surface waters.

Acid leaching tests reported by Quinsam Coal Limited (1980) indicated that large quantities of aluminum will be solubilized should acid mine drainage occur. The dissolved aluminum concentrations in the leachate from the 6 samples tested ranged from 36.1 to 284 mg/L.

The concentrations of aluminum in the groundwater, pit drainage and acid leachate tests suggest that the aluminum concentrations in receiving waters may be enhanced by the mining operation. The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life, it is recommended that the 30-day average dissolved aluminum should not exceed 0.05mg/L, and the maximum value at any time should not exceed 0.1 mg/L.

The average is based on at least 5 weekly samples taken in a period of 30 days.

5.4 ARSENIC

The Inland Waters Directorate (Demayo et al., 1979) recommends that total arsenic should not exceed 0.05 mg/L for the protection of aquatic life. This is the same criterion level recommended for drinking water (B.C. Ministry of Health 1983). A more recent review by CCREM (1987) supported the 0.05 mg/L criterion for aquatic life.

Background arsenic in the Quinsam system is well below this criterion. The highest surface water value recorded was 0.0012 mg/L total arsenic (Table 10). The total arsenic concentrations in the test pits were also found to be below the criterion, ranging from 0.005 to 0.022 mg/L (Quinsam Coal Limited 1982). Arsenic from the acid leaching tests was not detected using an extremely high detection limit of 2.5 mg/L (Quinsam Coal Limited 1980).

Groundwater testing has, however, indicated high levels of dissolved arsenic ranging from <0.001 to 0.24 mg/L, with an average of 0.06 mg/L (Quinsam Coal Limited 1982). The pumping of groundwater to the settling ponds may increase the arsenic loading to receiving waters. Other disturbances caused by mining, and the effect of acid mine drainage, cannot be predicted. The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life and drinking water uses, it is recommended that total arsenic not exceed 0.05 mg/L at any time.

5.5 CADMIUM

Aquatic life is the most sensitive water use with respect to cadmium. Sensitivity is greatest in soft water. In the study area, hardness as low as 10 mg/L is common, with values ranging from 8 to 25 mg/L. The Inland Waters Directorate (Reeder et al., 1979) recommends that total cadmium should not exceed 0.0002 mg/L to protect aquatic life. Roch et al. (1985) suggest that total cadmium should not exceed 0.00013 mg/L to protect aquatic life in Buttle Lake. Sigma (1983) recommends 0.0003 mg/L as the maximum acceptable dissolved cadmium for continuous exposure of hatchery salmonids in very soft waters. EPA (1986) developed a criterion which is a function of hardness. Assuming a hardness of 10 mg/L, EPA (1986) recommends that a 4-day average should not exceed 0.0002 mg/L more than once every 3 years and that the 1-hour average should not exceed 0.0003 mg/L more than once every 3 years.

Unfortunately, the detection limits generally employed in testing background levels in the Quinsam system were higher than the aforementioned criteria. Of the 225 analyses with detection limits ranging from 0.0001 to 0.01 mg/L, 4 detectable values were found of which 2 values exceeded the 0.0002 mg/L criterion (Table 10). Although data from Upper Quinsam Lake are not considered as representing pre-operational water quality in this assessment, it should be noted that Nordin et al. 1985 reported that in Upper Quinsam Lake total cadmium ranged from <0.0005 to 0.0018 mg/L, with at least 25% of the samples above the 0.0002 mg/L criterion.

Quinsam Coal Limited (1982) reported that total cadmium in samples collected from the test pits were all <0.0005 mg/L. However, dissolved cadmium levels in groundwater samples were much higher; 6 of 15 samples contained 0.001 mg/L and one sample contained 0.005 mg/L, the rest were <0.001 mg/L. Cadmium from the acid leaching tests was not detected using an extremely high detection limit of 0.20 mg/L (Quinsam Coal Limited 1980).

Sampling to date indicates that cadmium concentrations in the Quinsam system are less than <0.0005 mg/L. It also appears likely that background levels are <0.0001 mg/L, although this should be confirmed by further monitoring. The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life, it is recommended that the 30-day average total cadmium not exceed 0.0002 mg/L and that total cadmium not exceed 0.0003 mg/L at any time.

The average is based on at least 5 weekly samples collected in a 30-day period.

5.6 COBALT

Irrigation is the most sensitive water use with respect to cobalt. EPA (1972) and CCREM (1987) recommend that the maximum concentration for continuous use on all soils be 0.05 mg/L total cobalt.

All background values of total cobalt in the Quinsam system are below this criterion, and below detection, using detection limits ranging from 0.001 to 0.1 mg/L (Table 10). Water in the test pits was not analyzed for cobalt. Groundwater concentrations were <0.005 mg/L dissolved cobalt (Quinsam Coal Limited 1982).

Acid leaching tests suggest that high concentrations of cobalt could result from acid mine drainage, should it occur. Acid-generating samples contained 0.9 to 35 mg/L dissolved cobalt (Quinsam Coal Limited 1980). The following objective applies to the Quinsam River downstream from Middle Quinsam Lake to the confluence with the Iron River.

OBJECTIVE - To protect irrigation water use, it is recommended that total cobalt not exceed 0.05 mg/L at any time.

5.7 COPPER

Aquatic life is the most sensitive water use with respect to copper. Sensitivity increases as hardness decreases. In the study area, hardness as low as 10 mg/L is common, with values ranging from 8 to 25 mg/L. The Inland Waters Directorate (Demayo and Taylor 1981) recommends that total copper not exceed 0.002 mg/L to protect aquatic life. Roch et al. (1985) recommend a maximum total copper concentration of 0.0025 mg/L to protect aquatic life in Buttle Lake. Sigma (1983) recommends that to protect hatchery salmonids the continuous exposure to dissolved copper not exceed 0.002 mg/L in very soft waters. Criteria approved by the B.C. Ministry of Environment (Singleton 1987) depend on hardness: the 30-day average concentration of total copper should not exceed 0.002 mg/L when hardness is less than 50 mg/L, and the maximum concentration at any time should not exceed 0.003 mg/L if hardness is 10 mg/L.

Background levels in the Quinsam system often exceed these criteria. Approximately 7.9% of the 228 total copper analyses exceeded the 0.002 mg/L criterion. Total Cu concentrations ranged from <0.0005 to 0.035 mg/L, with the majority values <0.001 mg/L (Table 10). Copper concentrations from test pit samples fell within this range (Quinsam Coal Limited 1982). The average background concentration of several years data was 0.0018 mg/L (Table 10). This value is expected to be an overestimate, as undetectable values were assumed to be equal to the detection limit. The infrequent occurrence of total copper concentration between 0.002 and 0.035 mg/L cannot easily be accounted for. These occurrences are not associated with increased levels of suspended sediments; they are not associated with any particular sampling agency or sampling location. It is assumed that these occurrences will continue during operational water quality monitoring, and may result in the objective which is proposed in this report being exceeded without representing an increase over background concentrations. It is recommended that sampling frequency be temporarily increased above the minimum of 5 weekly samples in 30 days and that both total and dissolved analyses for copper be carried out when the proposed objective is exceeded. In order for this protocol to be helpful in interpreting the significance of occasional high values, the turnaround time between sampling and analysis for copper should be as short as possible.

Dissolved copper in groundwater ranged from <0.001 to 0.02 mg/L with an average of 0.003 mg/L; these values are higher than those in surface waters. (Quinsam Coal Limited 1982).

Acid leaching tests demonstrated that extremely high dissolved copper would result from acid mine drainage. Dissolved copper concentrations in the leachate ranged from 232 to 620 mg/L. (Quinsam Coal Limited 1980). The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life, it is recommended that the 30-day average of total copper not exceed 0.002 mg/L.

The average should be calculated from at least 5 weekly samples collected in a period of 30 days.

5.8 IRON

Domestic water use and aquatic life are both sensitive to iron. To minimize taste problems and laundry staining, dissolved Fe in water supplies should not exceed 0.3 mg/L (EPA 1986, Ministry of Health 1982). Adequate protection for aquatic life is afforded if total Fe remains below 0.3 mg/L (CCREM 1987).

Background levels of total iron in the Quinsam system range from 0.009 to 0.41 mg/L. Three values out of 219 total iron analyses exceeded the 0.3 mg/L criterion (Table 10); 2 of the 3 values were from samples near the bottom of Long Lake. The frequency of iron concentrations in excess of the criterion was higher downstream from the study area in the Iron River and in the Quinsam River downstream from the confluence with Iron River. This section of the Quinsam River is subject to greater quantities of suspended sediment from bank erosion (W.E. Mclean, personal communication) than the rest of the Quinsam system. Due to the large proportion of iron in suspended sediment, small quantities (<10 mg/L) of suspended sediment can produce total iron concentrations in excess of domestic water criteria.

Only dissolved iron is of importance for domestic use. Total iron analyses are, however, significant to fish and aquatic life as suspended iron precipitates may be detrimental (EPA 1976).

Groundwater contained between <0.03 to 0.35 mg/L dissolved iron with an average of 0.098 mg/L. Water in the test pits contained 0.023 to 0.19 mg/L total iron. (Quinsam Coal Limited 1982). Values from both these sources fall within the range of surface water levels and are below the criterion level.

Acid leaching tests, however, produced concentrations of dissolved iron ranging from 6 to 5 500 mg/L, indicating that acid mine drainage would enhance the concentration of iron in the receiving waters substantially. (Quinsam Coal Limited 1980). The following objective applies to the whole sub-basin.

OBJECTIVE - To protect domestic use and aquatic life it is recommended that the 30-day average total iron concentration not exceed 0.3 mg/L for surface waters.

The average is based on at least 5 weekly samples taken in a period of 30 days.

5.9 LEAD

Aquatic life is the most sensitive water use with respect to lead. The Inland Waters Directorate (Demayo et al. 1980) recommends lead concentrations not exceed 0.005 mg/L in soft waters (<95 mg/L as $CaCO_3$) to protect aquatic life. More recent reviews have resulted in the development of lead criteria which are based on a more precise relationship with hardness (EPA 1986). Criteria approved by the B.C. Ministry of Environment (Nagpal 1987) recommend that the 30-day average should not exceed 0.0035 mg/L and that the maximum value at any time should not exceed 0.0044 mg/L when hardness is 10 mg/L.

Background total lead in the Quinsam System ranges from <0.001 to 0.006 mg/L. The majority of values were below the detection limit of 0.001 mg/L. Three values out of 227 samples (0.006, 0.004 and 0.004 mg/L total lead) exceeded 0.003 mg/L. As is the case with copper (discussed in section 5.7), infrequent high lead values greater than the 0.005 mg/L objective proposed below may occur during operational monitoring. The recommended protocol, in this event, is to temporarily increase monitoring frequency above the minimum 5 weekly samples in 30 days and test for both total and dissolved lead. Turnaround time between sampling and analysis of lead must be as short as possible to ensure that the added samples are collected soon enough after the original high value to help interpretation of results.

No lead was detected in acid leaching tests using an extremely high detection limit of 0.7 mg/L (Quinsam Coal Limited 1980). The criterion level was not exceeded in the test pit water; groundwater also was found to contain lead levels below the criterion (Quinsam Coal Limited 1982). The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life, it is recommended that the 30-day average total lead not exceed 0.003 mg/L, and the maximum value at any time not exceed 0.005 mg/L.

The average is based on at least 5 weekly samples collected in a period of 30 days.

5.10 MANGANESE

Domestic water is the most sensitive water use with respect to manganese. Manganese can produce objectional taste and staining of laundry and plumbing. To protect domestic use, EPA (1976) and B.C. Ministry of Health (1982) recommend that the total manganese concentration not exceed 0.05 mg/L.

Background levels of total manganese in the Quinsam system range from <0.0009 to 0.25 mg/L (Table 10). All the manganese concentrations which exceed the 0.05 mg/L criterion were from deep lake samples. Surface manganese concentrations did not exceed the 0.05 mg/L criterion.

Dissolved manganese in groundwater ranged from 0.005 to 0.59 mg/L with an average of 0.09 mg/L. Four of the 15 groundwater sites exceeded the criterion level. Total manganese in the test pits did not exceed the criterion; values ranged from 0.002 to 0.037 mg/L. (Quinsam Coal Limited 1982).

Acid leaching tests indicated that, should acid mine drainage occur, high concentrations of manganese may be leached into surface waters. The test leachates which were acid producing contained 3.8 to 28 mg/L dissolved manganese (Quinsam Coal Limited 1980). The following objective applies to the Quinsam River downstream from Middle Quinsam Lake to the confluence with the Iron River.

OBJECTIVE - To protect domestic water use, it is recommended that total manganese not exceed 0.05 mg/L at anytime in surface waters.

5.11 MERCURY

Aquatic life is the most sensitive water use with respect to mercury. The consumption of fish by humans places further restrictions on acceptable mercury levels in fish tissues and surface waters. The Inland Waters Directorate (Reeder et al., 1979) recommends that to protect aquatic life and consumers of fish, the concentration of total mercury in water should not exceed 0.1 µg/L. Reeder et al. (1979) also recommend that fish tissue should not contain more than 0.5 mg/kg (wet weight) of mercury for the protection of all fish consumers. A more recent review by CCREM (1987) supports the use of the 0.1 µg/L criterion. B.C. Ministry of Environment criteria (Nagpal 1989) recommend a 30-day average of 0.02 µg/L and a maximum of 0.1 µg/L to protect aquatic life.

The background concentrations of total mercury in the Quinsam system are generally undetectable, that is, less than 0.1 or 0.5 µg/L. However, during June, July, August, September and October 1984, samples collected by Norecol reported by Quinsam Coal Limited (1985) from Middle Quinsam Lake and Long Lake contained total mercury levels ranging from 0.08 to 1.4 µg/L. The averages were 0.8 µg/L for surface waters of both lakes for this period. Dissolved mercury values were similarly elevated during this period. The facts that 1) similar values were reported for both Middle Quinsam Lake and Long Lake during the same periods, and 2) that these samples represent the only values greater than 0.05 µg/L collected between 1981 and 1986, suggest that these samples were contaminated.

Fish tissue data reported by IEC (1982) from Middle Quinsam and Long Lakes showed that all samples contained less than the 0.5 mg/kg (wet weight) protection level. The maximum mercury level reported was 0.27 mg/kg (wet weight); the average was 0.13 mg/kg (wet weight).

Groundwater concentrations of dissolved mercury ranged from <0.05 to 0.2 µg/L. Of the 15 sites sampled, 8 showed detectable levels ranging from 0.05 to 0.2 µg/L. One sample exceeded the criterion level of 0.1 µg/L. No detectable mercury was found in the test pit samples. (Quinsam Coal Limited 1982).

Mercury was not analysed in the acid leaching tests.

McKim et al. (1976) have reported concentration in fish up to 27 800 times the amount of mercury in the surrounding water under laboratory conditions. Due to the difficulty in detecting and interpreting total mercury levels in water, objectives are needed for both water and fish tissues to provide protection for aquatic life and consumers of fish. The following objectives apply to the whole sub-basin.

OBJECTIVE - To protect aquatic life and consumers of fish it is recommended that total mercury in water not exceed 0.1 µg/L at any time. The total mercury concentration in fish muscle should not exceed

0.5 mg/kg wet weight at any time. All fish species consumed by man should be tested. The fish sampled should include a representative proportion of old fish.

5.12 NICKEL

Aquatic life is the most sensitive water use with respect to nickel. Sensitivity to nickel increases as hardness decreases. The study area is considered as having exceptionally soft water with values typically as low as 10 mg/L. The Inland Waters Directorate (Taylor et al. 1979) recommends that to protect aquatic life total nickel should not exceed 0.025 mg/L in soft waters. EPA (1986) has developed hardness related formulae for calculating criteria values. Assuming a hardness of 10 mg/L, the EPA (1986) criterion for a 24-hour average is 0.017 mg/L, and the maximum value not to be exceeded at any time is 320 mg/L. CCREM (1987) groups all water with hardness ranging from 0-60 mg/L under one criterion of 0.025 mg/L.

Background levels of total nickel in the Quinsam system are below the 0.025 mg/L criterion (n=91). Only one detectable value of 0.005 mg/L was found using detection limits ranging from 0.001 to 0.025 mg/L (Table 10).

Dissolved nickel in groundwaters ranged from 0.005 to 0.052 mg/L. Two of 15 sites sampled exceeded the criterion with concentrations of 0.052 and 0.051 mg/L. No data are available on nickel in the test pit water. (Quinsam Coal Limited 1982).

Acid leaching tests indicate that acid mine drainage may result in high nickel concentrations reaching surface waters. Leachate from the acid-producing samples contained 0.82 to 1.54 mg/L dissolved nickel. (Quinsam Coal Limited 1980). The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life it is recommended that total nickel not exceed 0.025 mg/L at any time.

5.13 SILVER

Aquatic life is extremely sensitive to silver. As is the case with several other metals, silver toxicity is related to hardness. The Inland Waters Directorate (Taylor et al., 1980) recommends that total silver not exceed 0.0001 mg/L to protect aquatic life. Taylor et al. 1980 point out that natural background levels often exceed this criterion, and that routine analytical methods cannot detect levels this low. A recent review by CCREM (1987) recommended that aquatic life would be adequately protected by the 0.0001 mg/L criterion.

The majority of data from the Quinsam system indicate that total silver is undetectable at a detection limit of 0.0005 mg/L (Table 10). This detection limit is low by routine analytical standards, but is above the 0.0001 mg/L criterion.

No silver data are available from groundwater testing. Water in the test pits contained no detectable silver at a detection limit of 0.0005 mg/L (Quinsam Coal Limited 1982). Acid leaching tests did not detect silver using a high detection limit of 0.025 mg/L (Quinsam Coal Limited 1980).

An objective to protect aquatic life is proposed because of the extreme sensitivity of a broad spectrum of aquatic organisms. The following objective applies to the whole sub-basin.

> OBJECTIVE - To protect aquatic life it is recommended that total silver not exceed 0.0001 mg/L at any time. Values of <0.0005 mg/L would be considered to meet the objective until the detection limit can be lowered.

5.14 ZINC (Zn)

Aquatic life is the most sensitive water use with respect to zinc. The Inland Waters Directorate (Taylor and Demayo 1980) recommends that for soft water (<120 mg/L as $CaCO_3$) total zinc should not exceed 0.05 mg/L to protect aquatic life. Roch and McCarter (1984) recommend that total zinc not exceed 0.05 mg/L to protect aquatic life in Buttle Lake, B.C. CCREM (1987) tentatively recommended that total zinc not exceed 0.03 mg/L at any time.

Background total zinc in the Quinsam System ranges from <0.0005 to 0.012 mg/L, with no samples exceeding the 0.03 mg/L criterion (Table 10).

All but one of the 15 groundwater sites sampled had dissolved zinc concentrations below the criterion level of 0.03 mg/L. With the exception of the one high value of 0.76 mg/L, the concentrations ranged from <0.01 to 0.038 mg/L dissolved zinc. Test pit water contained zinc concentrations below the criterion (Quinsam Coal Limited 1982). No enhancement of surface water zinc concentrations is expected from these sources.

Acid leachate from samples exhibiting acid generation contained high dissolved zinc concentrations ranging from 0.92 to 2.19 mg/L (Quinsam Coal Limited 1980). The following objective applies to the whole sub-basin.

OBJECTIVE - To protect aquatic life, it is recommended that total zinc not exceed 0.03 mg/L at any time.

5.15 PARTICULATE MATTER

Particulate matter is usually measured in terms of its effect on light transmission qualities (turbidity) or the mass of solids which can be removed by filtration (non-filterable residue). Turbidity is the most appropriate measure of apparent water clarity which is the major concern for drinking water and recreation aesthetics. Non-filterable residue is a very sensitive measure of particulate matter which can be harmful to aquatic life, particularly fish and benthic invertebrates. Objectives for both turbidity and non-filterable residue are proposed here.

Singleton (1985) recommends that for raw waters of exceptional clarity (turbidity <5 NTU) which do not require treatment for the removal of particulate matter before drinking, turbidity should not exceed 1 NTU above background or a maximum of 5 NTU at any time. The Guidelines for Canadian Drinking Water Quality (1987) recommend that drinking water should have turbidity less than 1 NTU, but a maximum turbidity up to 5 NTU may be acceptable if disinfection is not compromised. The Quinsam system is exceptionally low in turbidity, and is not subject to major seasonal increases in turbidity normally associated with periods of high flows. The average background turbidity was <0.8 NTU, ranging from <0.1 to 3.0 NTU (Table 11). Consequently, treatment for turbidity would not necessarily be required.

To protect aquatic life, Singleton (1985) recommends that non-filterable residue should not exceed 10 mg/L over background (when background is <100 mg/L). Average background non-filterable residue in the Quinsam system was about 1.9 mg/L (N=251) with values ranging from 1.0 to 14.0 mg/L (Table 11).

Singleton (1985) also recommends that to protect salmonid spawning areas, no significant increase in benthic sedimentation of particles <3 mm in diameter should occur. No background data on stream benthic sedimentation are presently available. Should these data be made available before mining operations begin, an objective protecting several specific spawning areas in the Quinsam River could be developed.

To protect potential drinking water use downstream from the mine, the following turbidity objective applies to the Quinsam River downstream from the outflow at Middle Quinsam Lake to the confluence with the Iron River.

> OBJECTIVE: To protect domestic water use and high aesthetic qualities, the 30-day average turbidity should not exceed 1 NTU and the maximum turbidity should not exceed 5 NTU. High intensity rainfall events may cause turbidity to increase above the maximum level; in such circumstances the objective would be no increase greater than 1 NTU above upstream control sites.

To protect aquatic life, the following objective applies to the whole sub-basin.

OBJECTIVE: To protect aquatic life the 30-day average non-filterable residue should not exceed 5 mg/L, and the maximum value should not exceed 25 mg/L at any time. Rare high intensity rainfall events may cause non-filterable residue to exceed the maximum value; in such circumstances the objective would be no increase greater than 10 mg/L above upstream control sites.

The 30-day averages are based on a minimum of 5 weekly samples collected in a 30-day period. The upstream control sites should be upstream from any discharges and as close to them as possible.

5.16 STREAM PERIPHYTON BIOMASS

Nordin (1985) recommends the use of periphyton biomass expressed as chlorophyll *a* per unit area as a criterion for stream algal productivity. The use of nutrient concentrations as criteria for algal productivity is considered unsatisfactory in flowing waters. Not enough is known about the dynamics of periphyton production to predict the level of biomass under site specific conditions for various levels of nutrient supply. Chlorophyll *a* per unit area is a direct measure of how algal growth affects aesthetic values. Aesthetic values are the use most sensitive to algal growth; criteria based on this will also afford protection for other water uses.

Nordin (1985) has developed a criterion for stream periphyton biomass based on subjective aesthetic response and recommends that stream periphyton biomass on natural substrates should not exceed 50 mg/m^2.

Quinsam Coal Limited (1985) estimated stream periphyton biomass on natural substrates using chlorophyll *a* analysis. Some of the results from this survey are summarized in Table 12. The results indicate that chlorophyll *a* from individual samples ranged from 1.5 to 58.8 mg/m^3, with annual average values for each site being less than 14 mg/m^2.

The following objective applies to the Quinsam River downstream from the B.C. Hydro diversion to the confluence with the Iron River and the outflow streams from Flume and Long lakes.

OBJECTIVE: To protect the aesthetic quality and aquatic life of flowing waters, the average biomass of periphyton from 10 samples collected at one time from a single site, expressed in terms of chlorophyll a on natural substrate, should not exceed 50 mg/m^2.

5.17 NITROGEN AS A NUTRIENT FOR LAKE PHYTOPLANKTON

Inorganic nitrogen at high concentrations can be toxic to aquatic life and cause water to be unfit for human consumption. At much lower concentrations inorganic nitrogen functions mainly as a plant nutrient. In situations where nitrogen is in short supply in lakes, its availability regulates or limits phytoplankton growth. Generally speaking, phosphorus is more likely to be limiting phytoplankton growth than nitrogen, therefore the majority of lake management strategies are directed at restricting phosphorus inputs to lakes. The question of whether the lakes in the Quinsam system are phosphorus or nitrogen limited must be resolved before the appropriate water quality objective can be developed.

Hillier, Edgeworth and Lynch (1984) concluded that phosphorus was most likely limiting. DFO (1983) suggested the Quinsam system was phosphorus limited based on their experience from fertilization of other coastal lakes in B.C. Norecol Environmental Consultants (in Hillier, Edgeworth and Lynch 1984) considers the Quinsam system is phosphorus limited based on the N:P ratio of algal tissues.

The size of the data base has expanded considerably since the aforementioned reviews. Water quality data from Quinsam Coal Limited (1985), Sneddon and Kelso (1983) and Redenback et al. (1985) indicate that the summer epilimnetic monthly N:P ratio for the study area ranges from 4:1 to 152:1. The average N:P ratios from Middle Quinsam Lake and Long Lake were

42:1 and 29:1 respectively (Table 13). The N:P ratio was calculated using paired total nitrogen and total phosphorus data. These N:P ratios suggest that phytoplankton production is phosphorus limited in both lakes. A detailed analysis of the trophic status of Middle Quinsam and Long Lakes, which included nutrient bioassays, carried out by MacIsaac and Stockner (1985), demonstrated that Middle Quinsam may be slightly nitrogen limited and that Long Lake may be moderately nitrogen limited.

Quinsam Coal (1982) estimated that fertilization, sewage discharges and leaching of blasting residuals could result in a maximum of 4.5 mg/L of NO_3-N occurring in receiving waters. Hillier, Edgewroth and Lynch (1984) estimated nitrogen concentrations will range from 0.4-3.59 mg/L during mining operations. As total inorganic nitrogen levels (NH_4 plus NO_3) currently average roughly 0.01 mg/L (Table 14), the level of nitrogen predicted represents a 40-fold to 360-fold increase. Without a concomitant increase in phosphorus, the N:P ratio would rise substantially. These estimates demonstrate clearly that phosphorus will be the limiting nutrient during the operation of the mine if phosphorus loading remains the same.

Assuming Middle Quinsam Lake and Long Lake are presently nitrogen limited, how much increase in phytoplankton biomass can be expected given the possibility of a 40 to 360-fold increase in nitrogen and no increase in phosphorus? The prediction that phosphorus will become the limiting nutrient during the life of the mine allows the use of empirically derived quantitative relationships between phosphorus and chlorophyll a to calculate the expected phytoplankton biomass which could be supported by existing phosphorous concentrations. Using the existing average summer total P concentration of 0.004 mg/L for Middle Quinsam Lake and Long Lake found in Table 15(b) and employing six different empirical relationships (Dillon and Rigler 1975, Edmondson and Lehman 1981, Kerekes 1975, Nordin and McKean 1984, Prepas and Trew 1983, and Reckhow 1978), the concentration of chlorophyll a is predicted to range from 0.55 to 0.93 µg/L for Middle Quinsam Lake and Long Lake (Table 16). Presently, the average summer chlorophyll a concentrations for Middle Quinsam Lake range from 0.70 to

0.90 µg/L. In Long Lake present chlorophyll a concentrations range from 0.73 to 1.25 µg/L (McIsaac and Stockner 1985, Quinsam Coal Limited 1985, and Redenbach et al. 1985). The existing chlorophyll a concentrations are within the range of values predicted using the existing phosphorus concentrations. Consequently, no large increase in phytoplankton biomass is predicted from nitrogen enrichment alone. Chlorophyll a concentrations less than 2 µg/L are considered characteristic of oligotrophic waters. Middle Quinsam and Long Lakes are expected to remain oligotrophic if there is no further increase in phosphorus. No water quality objective for nitrogen is therefore proposed to prevent excessive phytoplankton growth.

5.18 NITROGEN AS A TOXICANT

5.18.1 Ammonia (NH_3)

Aquatic life is the most sensitive water use with respect to nitrogen. Un-ionized ammonia (NH_3) is the toxic component of total ammonia. The equilibrium between ionized and un-ionized ammonia is determined by pH and temperature. The toxicity of the un-ionized ammonia fraction also is affected by pH and temperature.

In the Quinsam system, total ammonia ranged from <0.002 to 0.105 mg/L-N, with the majority of values <0.01 (Table 17). The maximum value is well below the criteria proposed by Nordin and Pommen (1986) for all expected pH and temperature values. For those ammonia measurements where temperature and pH were measured concurrently, the un-ionized fraction was calculated using EPA (1986). Based on these measurements, the maximum un-ionized ammonia value was 0.27 µg/L-N (Table 17). This is well below the criteria proposed by EPA (1986) for all expected pH and temperature values.

The use of explosives comprised of ammonium nitrate can result in a significant increase in nitrogen in receiving waters. Under aerobic conditions the majority of nitrogen is expected to be converted to the nitrate form. Groundwater seepage contaminated with blasting residuals may result in forms of reduced nitrogen entering surface waters. The use of ammonium nitrate explosives and the high toxicity of un-ionized ammonia requires that an objective be recommended. The following objective applies to the whole sub-basin.

OBJECTIVE: To protect aquatic life, the 30-day average total ammonia nitrogen concentration should not exceed the value given in Table 18 and the maximum concentration should not exceed the value given in Table 19, for specific pH and temperature conditions.

The average is based on a minimum of five weekly samples taken in a period of 30 days.

5.18.2 Nitrite (NO_2)

Nitrite is highly toxic to aquatic life, and also can be a serious health risk to children under six months of age. Aquatic life is the most sensitive water use, therefore aquatic life criteria afford adequate protection for drinking water uses. Nordin and Pommen (1986) recommend that, to protect aquatic life, nitrite-nitrogen should not exceed 0.02 mg/L as a 30-day average and that the maximum concentration should not exceed 0.06 mg/L. Nitrite concentrations are usually very low or undetectable under aerobic conditions as nitrite is readily converted to nitrate as a result of biologically mediated nitrification. Nitrite can be formed from the incomplete nitrification of ammonia caused by low temperature, low oxygen and extreme pH. Background nitrite-nitrogen levels were largely undetectable and generally below 0.001 mg/L (Table 20). The highest detectable nitrite-nitrogen of 274 measurements was 0.002 mg/L-N. In view of significant increases in inorganic nitrogen concentrations expected during the operation of the mine an objective for nitrite is proposed. The following objective applies to the whole sub-basin.

OBJECTIVE: To protect aquatic life, the 30-day average nitrite-nitrogen concentration should not exceed 0.02 mg/L, and the maximum concentration should not exceed 0.06 mg/L at any one time. The average is based on a minimum of 5 weekly sampled collected in a period of 30 days.

5.18.3 Nitrate (NO_3)

Under the aerobic conditions expected at the mine site and in the receiving waters, the predominant nitrogen species released as a result of leaching of explosives residues, fertilization and sewage discharge will be nitrate. Worst case estimates suggest surface water nitrate nitrogen may approach 3.59 to 4.5 mg/L (Quinsam Coal 1982; Hillier, Edgeworth and Lynch 1984). Nordin and Pommen (1986) recommend that to protect aquatic life, nitrate nitrogen should not exceed 40 mg/L as a 30-day average and the maximum concentration should not exceed 200 mg/L. Background nitrate concentrations have ranged from <0.001 to 0.041 mg/L nitrate nitrogen (Table 20). The following objective applies to the whole sub-basin.

OBJECTIVE: To protect aquatic life from the toxic effects of nitrate, it is recommended that the 30-day average nitrate nitrogen not exceed 40 mg/L and that nitrate-nitrogen not exceed 200 mg/L at any time.

The average is based on a minimum of 5 weekly samples collected in a period of 30 days.

In addition, to protect potential drinking water use downstream from the mine, the following objective applies to the Quinsam River downstream from the outflow of Middle Quinsam lake to the confluence with the Iron River.

OBJECTIVE: To protect drinking water use it is recommended that nitrate nitrogen not exceed 10 mg/L at any time.

5.19 PHOSPHORUS

Based on the prediction that the Quinsam system will be phosphorus limited during the life of the mine, a phosphorus objective is proposed here to protect aquatic life and aesthetic values from excessive phytoplankton growth. The relationship between nutrients and phytoplankton production is considerably more predictable in lakes than in streams, therefore phosphorus rather than biomass can be used as a criterion in lakes. Nordin (1985) recommends that to protect drinking water uses, recreation uses and aquatic life in lakes from excessive phytoplankton growth, total phosphorous should not exceed 10 µg/L. For lakes with flushing rates less than 6 months, the 10 µg/L criterion refers to the average summer total phosphorus concentration (Nordin 1985).

In calculating the flushing rates of the Quinsam Lakes, only the outflow which occurred during the summer growing period, defined here as April through September inclusive, was used. The approximate flushing rate for Middle Quinsam Lake is estimated to be 34 - 38 days. The flushing rate for Long Lake may be between 72 to 178 days (Table 2). These relatively rapid flushing rates indicate that phytoplankton production is likely to be correlated with phosphorus concentrations persisting throughout the summer rather than be correlated with spring overturn phosphorus concentrations as would be the case in slower flushing lakes (Nordin 1985).

Total phosphorus in Middle Quinsam Lake and Long Lake ranged from 0.001 to 0.021 mg/L between February 1983 and November 1986 (Table 21). Mean summer total phosphorus in Middle Quinsam Lake and Long Lake during the four years of monitoring varied from approximately 0.001 to 0.009 mg/L (Table 15(a)). Figures 9 through 14 demonstrate the variability of total P relative to time of year and sampling agency. This variability is caused by several factors including rapid water exchange, use of different sampling locations, temporal variability, and sampling and analytical errors. During the summers of 1983, 1984 and 1986 in both lakes, total phosphorus in the water column rarely exceeded the 10 µg/L criterion, whereas the summer average values were significantly below the criterion.

The majority of limnological experience indicates that phytoplankton production is low (i.e.: oligotrophic), below 10 µg/L of total phosphorus. However, the data reported by Stockner and Shortreed (1985) demonstrate that coastal B.C. lakes which are fertilized in the spring with nitrogen and phosphorus show a much greater phytoplankton response than expected. The empirical phosphorus to chlorophyll a relationship presented by Stockner and Shortreed (1985) (log chlorophyll a = 0.92 log total P - 0.09) predicts that 10 µg/L of total P could result in 6.76 mg/m^3 of chlorophyll a, a concentration which is indicative of a highly eutrophic condition. Applying this equation to the present background summer total phosphorus concentrations indicates that present phytoplankton production is about 1/3 of what is predicted in terms of chlorophyll a. This suggests that production is either limited by a factor other than phosphorus, possibly nitrogen, or that the equation is inaccurate. The nitrogen enrichment bioassay results reported by McIsaac and Stockner (1985) support the nitrogen limitation hypothesis. The empirical relationships developed by other researchers presented in Table 16 predict that, given 10 µg/L total phosphorus, chlorophyll a will range from 2.04 to 2.82 mg/m^3. In view of the potential extra sensitivity of B.C. coastal lakes to phosphorus enrichment relative to other North American lakes and the general uncertainty in predicting lake response, it is recommended that the phosphorus objective for the Quinsam lakes be more conservative than the 10 µg/L criteria suggested by Nordin (1985).

Due to the uncertainty in predicting lake phytoplankton response, chlorophyll a should be monitored during the life of the mine to develop a site specific empirical rationship between phosphorus and chlorophyll a for Middle Quinsam and Long Lakes. In the mean time the following objective is recommended.

OBJECTIVE: To protect aquatic life, recreational values and other water uses from excessive phytoplankton growth, average summer total phosphorus should not exceed:

1) 0.006 mg/L in Middle Quinsam Lake, and
2) 0.007 mg/L in Long Lake.

The averages are based on samples taken at least every 3 weeks, from May to September, from near the surface, at the middle of the epilimnion and near the bottom of the epilimnion.

5.20 HYPOLIMNETIC DISSOLVED OXYGEN

The natural process of microbial degradation of organic matter in lake sediments consumes oxygen from bottom waters. At the end of the growing season, prior to winter destratification, the hypolimnion may approach anoxia. Extensive anoxic periods are associated with eutrophic conditions, as this can result in phosphorus release from the sediment.

Middle Quinsam Lake and Long Lake exhibit low dissolved oxygen concentrations in the hypolimnion. Dissolved oxygen in Middle Quinsam Lake declines below 4 mg/L during the late summer (Table 22). In Long Lake, dissolved oxygen below 4 mg/L may persist for 1-2 months at depths greater than 15 m (Table 23). MacIsaac and Stockner (1985) report that hypolimnetic oxygen in Long Lake declined 0.8 mg/L per month during the summers of 1983 and 1984.

The large increase expected in nitrogen loading and the potential increase in phosphorus loading associated with the Quinsam Coal Mine may enhance productivity and increase the hypolimnetic oxygen deficit in both lakes. The rapid flushing during the period of destratification during October through May will, however, help to minimize the impact of internal loading.

Rapid release of phosphorus from bottom sediments is likely to occur as the sediment water interface becomes anoxic. Bottom waters containing less than 3 mg/L dissolved oxygen can be lethal to adult fish; dissolved oxygen values ranging from 4-6 mg/L will have reduced value for supporting organisms utilized by fish (EPA 1986).

Aeration can be employed to maintain hypolimnetic oxygen concentrations. If aeration is employed, hypolimnetic aerators which aerate the hypolimnion without destratifying the water column are preferable as this will maintain overall lower water temperatures and minimize nutrient recycling (Nordin and McKean 1982).

OBJECTIVE: To protect aquatic life and aesthetic values, the concentration of dissolved oxygen in the hypolimnion in Middle Quinsam Lake and Long Lake should be greater than 3 mg/L at any time during June, July, and August.

5.21 HEPATIC METALLOTHIONEIN

Hepatic metallothionein is produced by fish in response to metal contamination. On September 10, 1984 the Ministry of Environment trapped and netted cutthroat and rainbow trout near the outlets of Long and Middle Quinsam Lakes for analysis of hepatic metallothionein (Table 24). The maximum level found was 78.9 nanomoles/g (wet); the average of 18 samples was 33.5 nanomoles/g. A level of 100 nanomoles/g represents a slight response to metals below incipient lethal levels (Roch et al. 1985). The levels found in fish from Long and Middle Quinsam Lakes are lower than found in rainbow trout held in clean water in laboratory conditions (M. Roch, personnal communication).

6. MONITORING RECOMMENDATIONS

The monitoring program required to determine if the objectives are being met is subject to negotiation, and may involve various concerned government agencies and Quinsam Coal Ltd. Ministry of Environment involvement is subject to budget and program priorities.

Suggested monitoring site locations are presented in Figure 2. The characteristics to be tested and the minimum sampling frequency are specified with the objectives in Table 6. Depending on initial monitoring results and changes to the mine plan these monitoring requirements will require updating. For example, mining in the Long Lake sub-basin may be delayed, therefore monitoring of Long Lake and its outflow may be delayed accordingly. Similarly, mining at a reduced scale with little or no positive discharge may justify reduced monitoring. Should an objective be exceeded, increased monitoring frequency and additional monitoring sites may be required to assist interpretation and to aid in planning corrective action. If a metal objective is exceeded, it is recommended that further metal testing include analysis of both total and dissolved fractions. Baseline monitoring indicates that occasional high values for copper, lead and mercury can be expected although these values may not represent prevailing conditions. If monitoring consists of the minimum frequency of 5 weekly samples in a 30-day period, a single isolated high value could result in the objective being exceeded without necessarily representing an actual increase relative to background data. It is therefore important to maintain a rapid turnaround between sampling and analysis to enable more detailed investigative sampling when objectives are exceeded and to distinguish between data variability and mining impacts.

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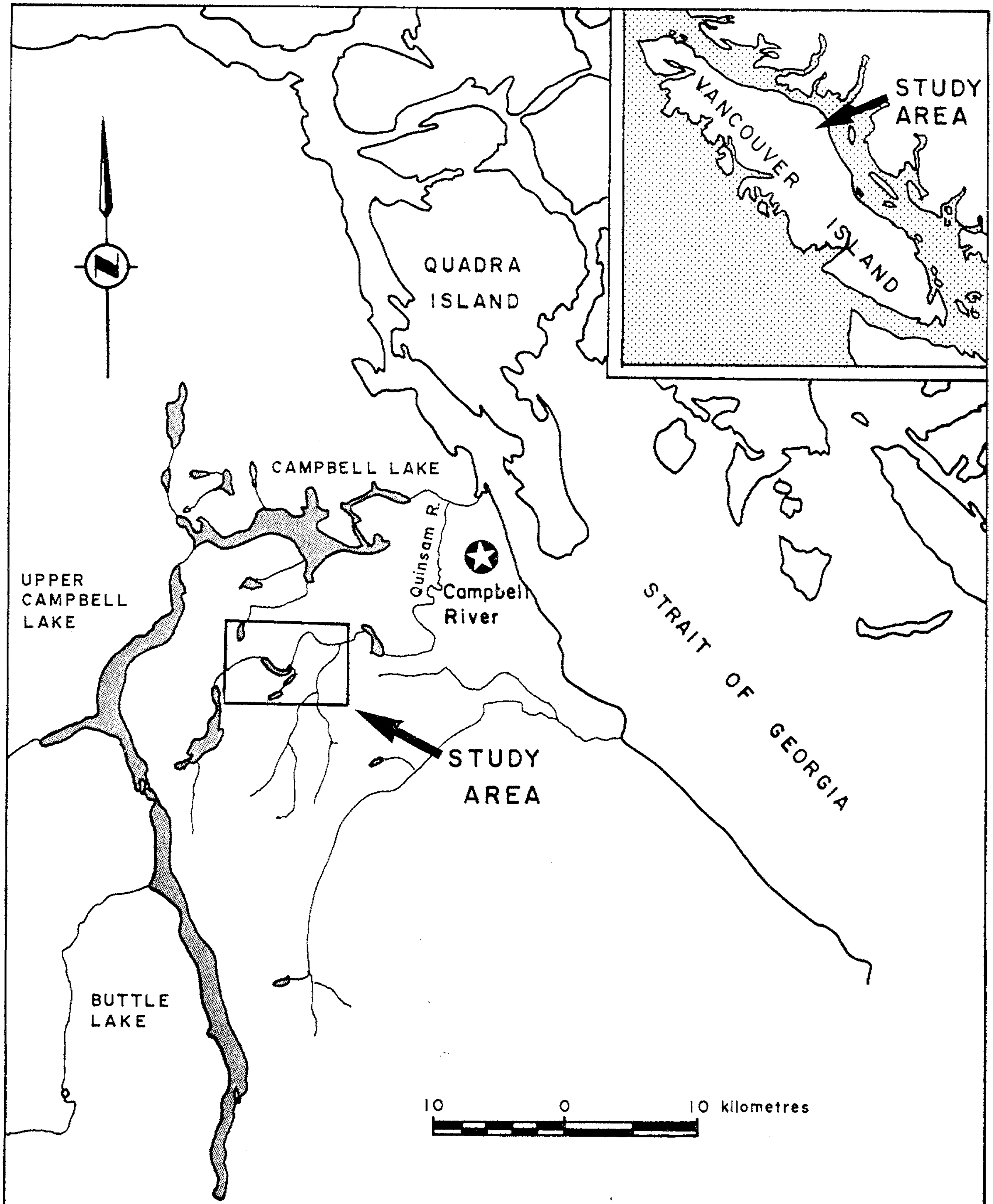


FIGURE I. LOCATION OF STUDY AREA

FIGURE 2. STUDY AREA AND MINE SITE DETAILS

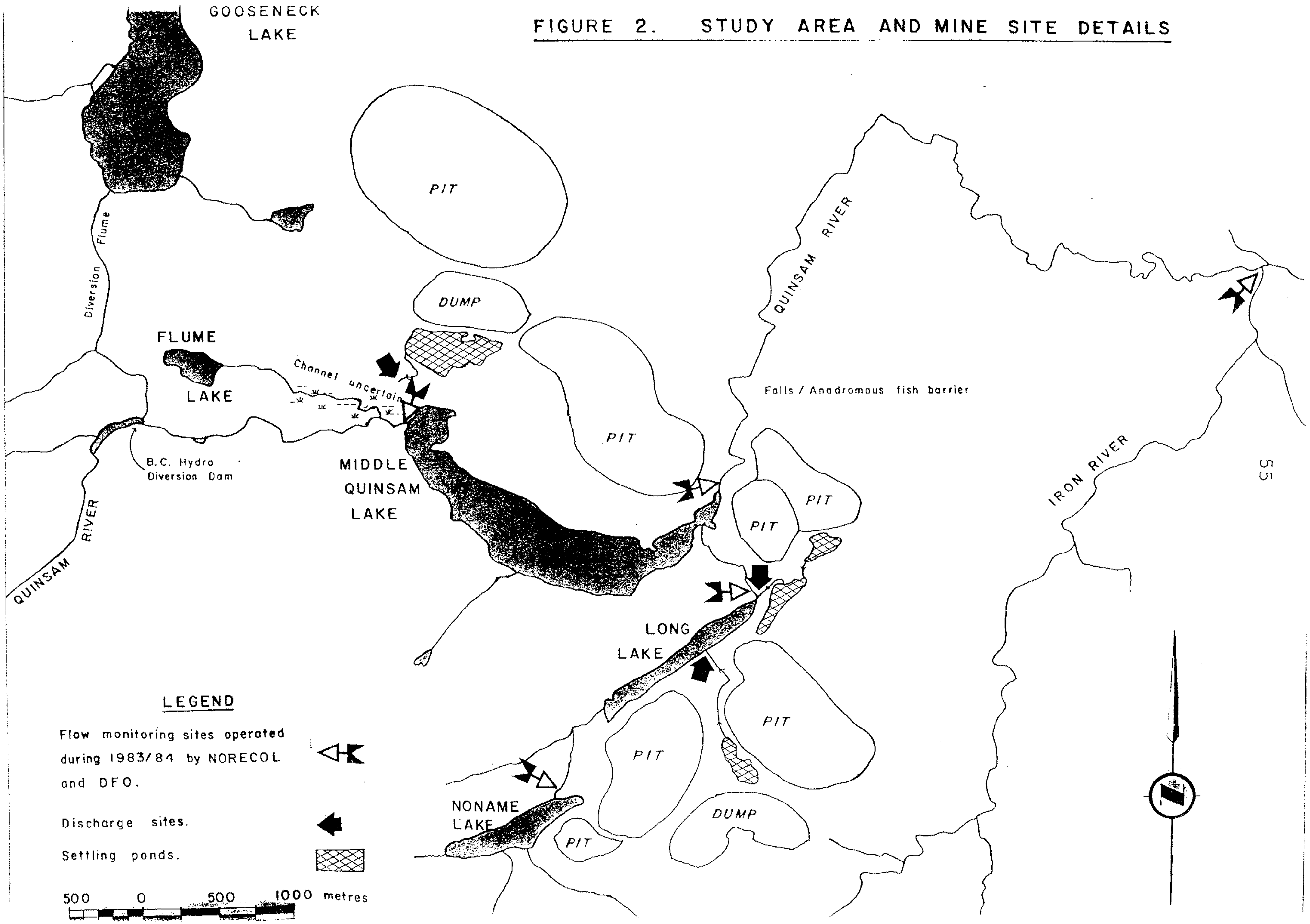


FIGURE 3. QUINSAM RIVER STREAMFLOW AT INFLOW TO MIDDLE QUINSAM LAKE AND AT MOUTH (1983)

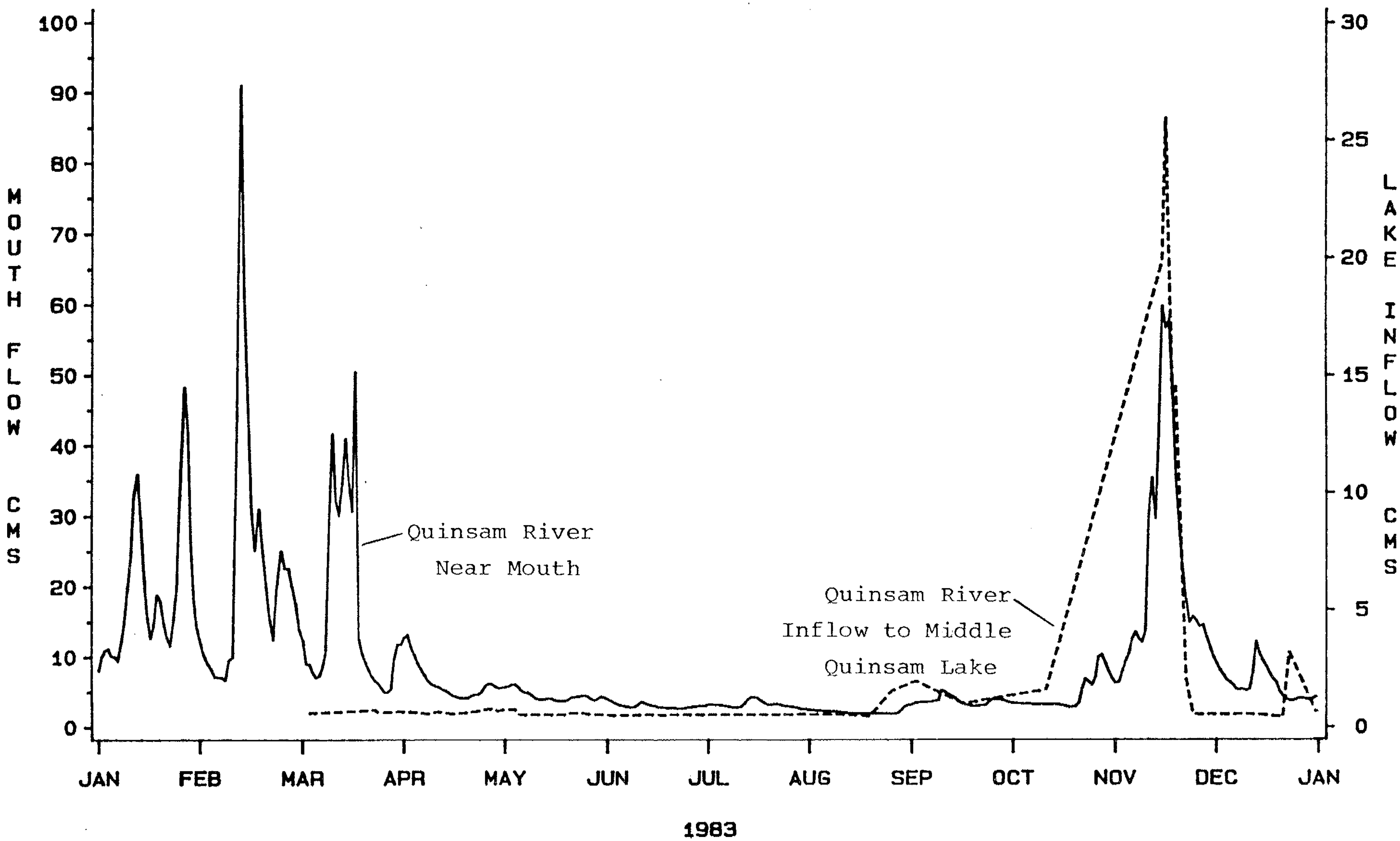


FIGURE 4. QUINSAM RIVER STREAMFLOW AT INFLOW TO MIDDLE QUINSAM LAKE AND AT MOUTH (1984)

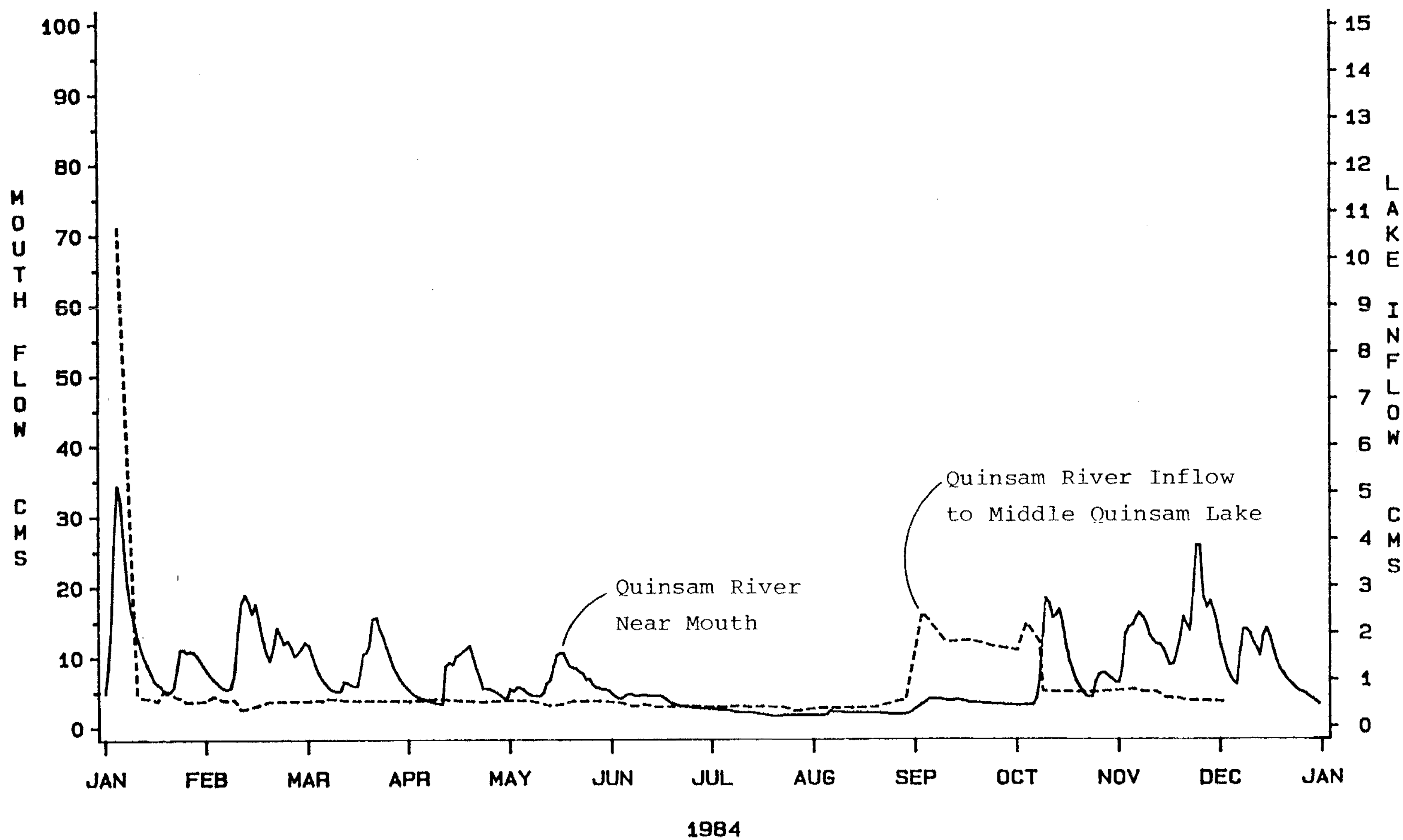
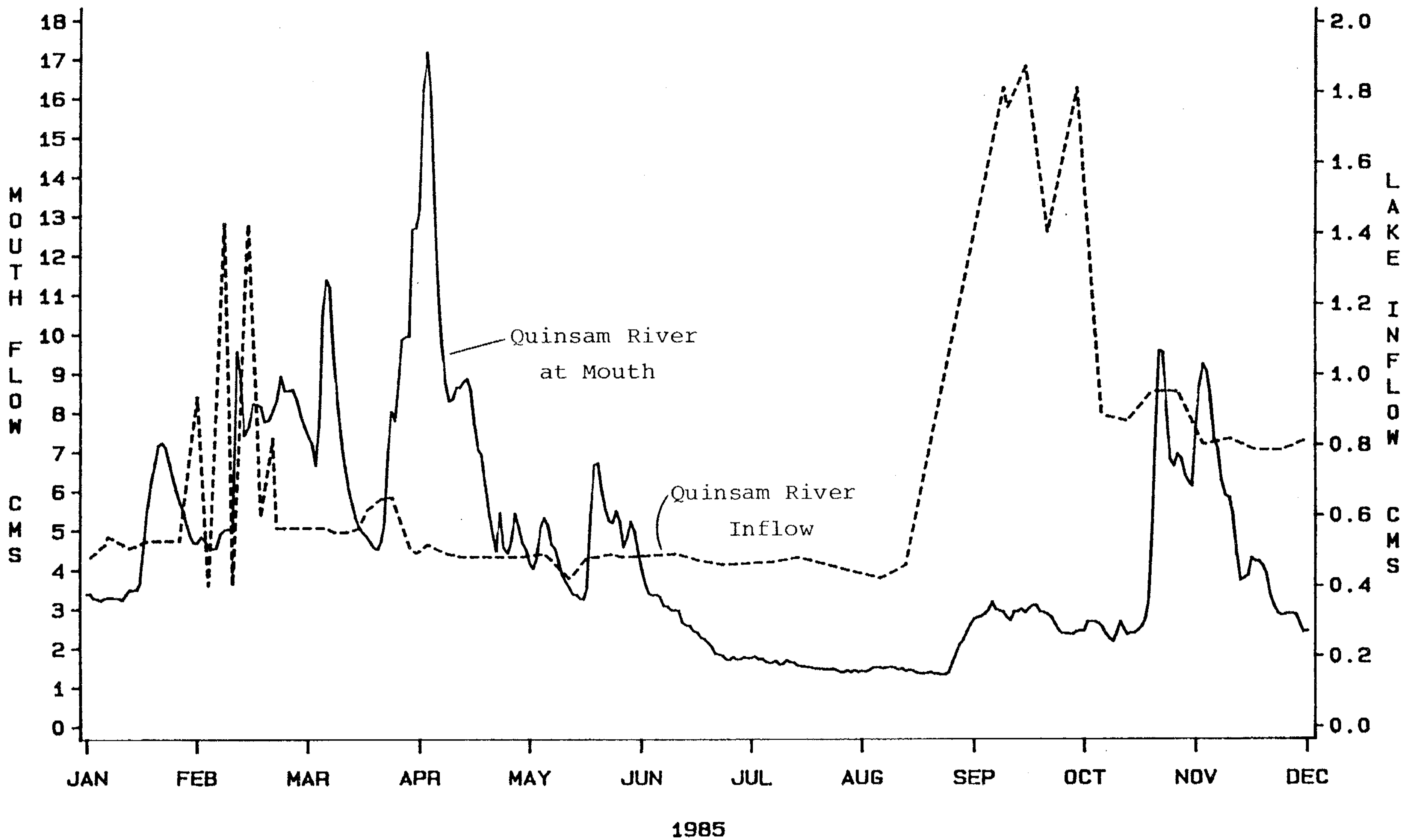


FIGURE 5. QUINSAM RIVER STREAMFLOW AT INFLOW TO MIDDLE QUINSAM LAKE AND AT MOUTH (1985)



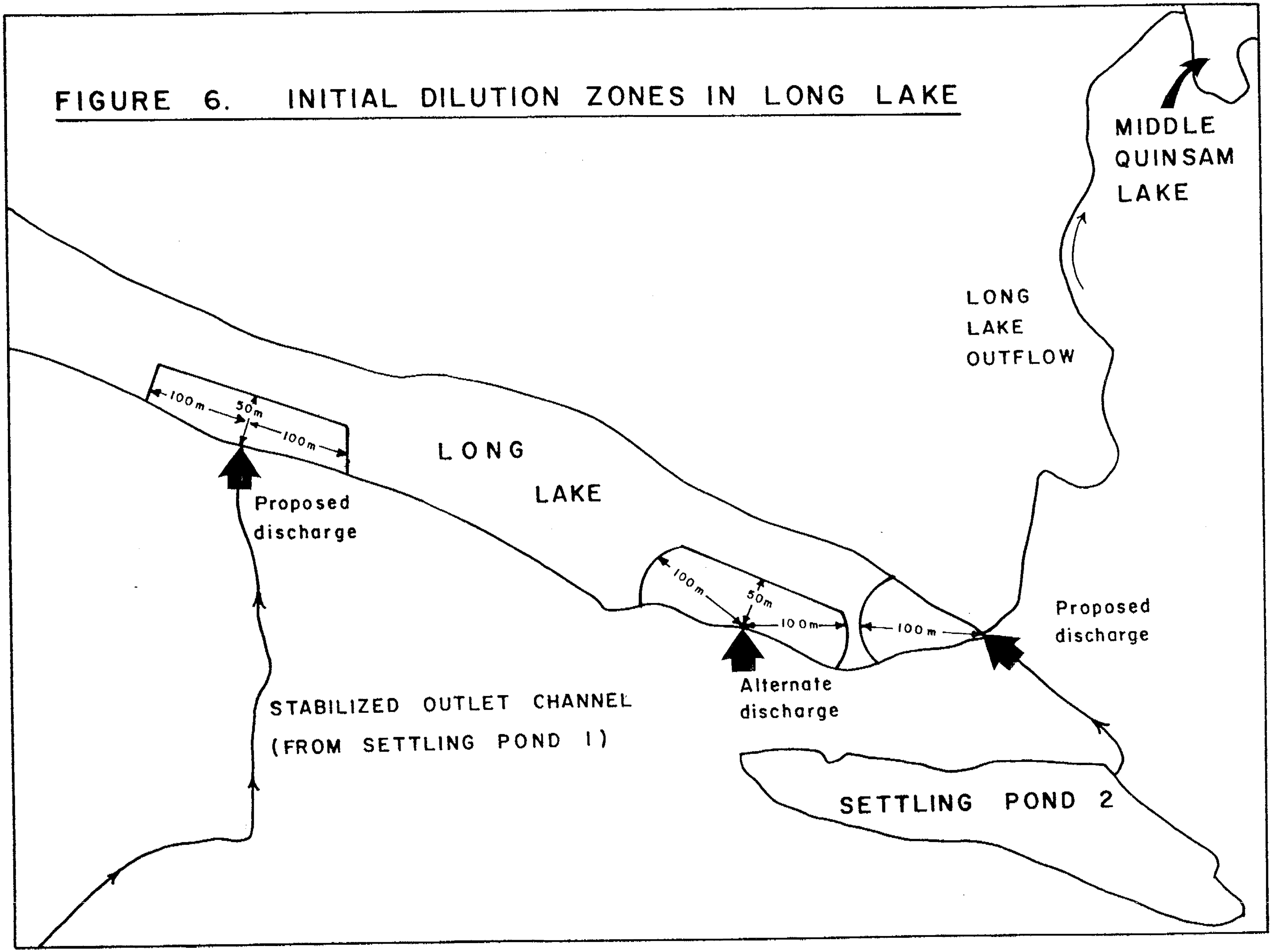


FIGURE 6. INITIAL DILUTION ZONES IN LONG LAKE

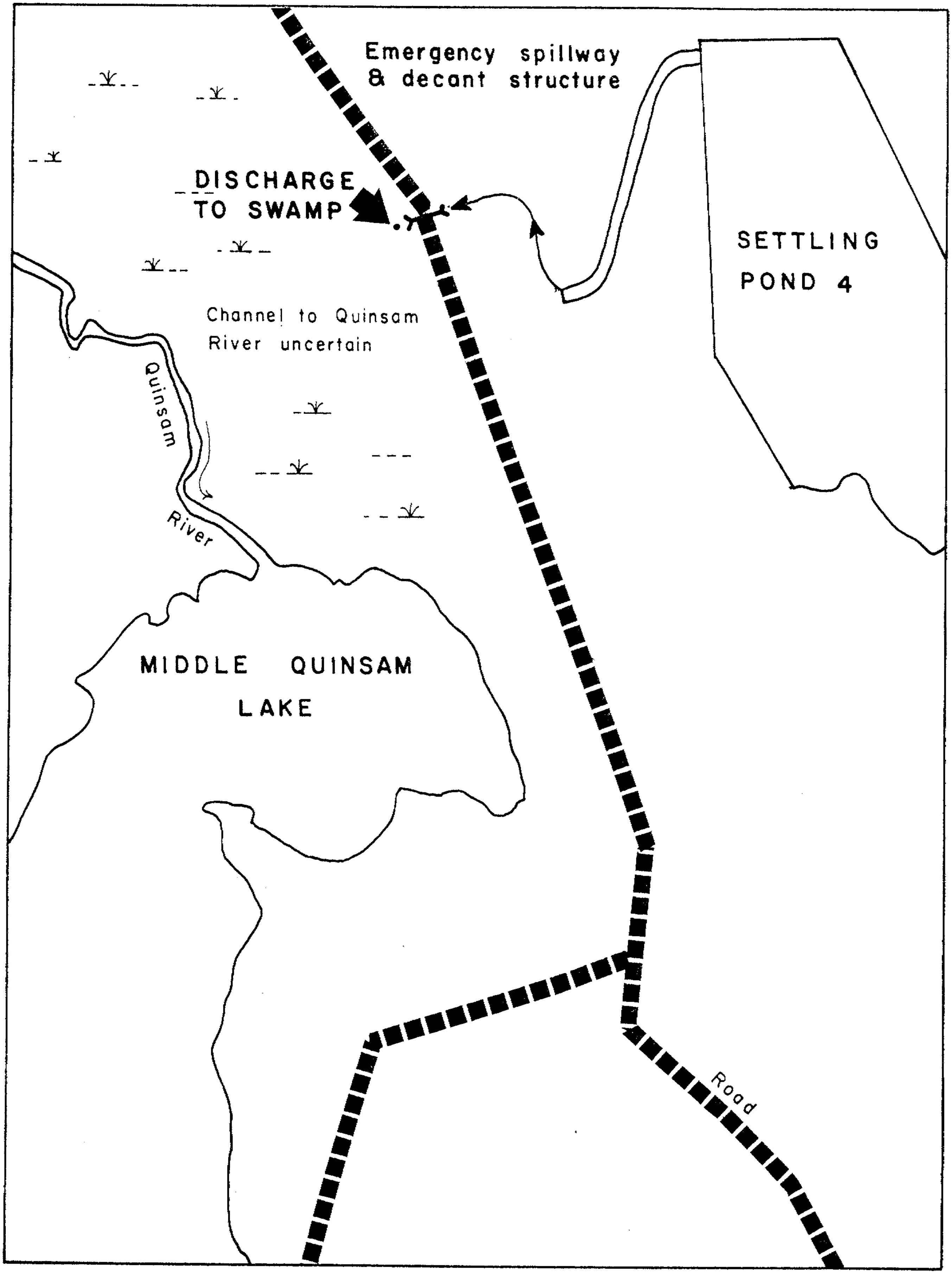


FIGURE 7. INITIAL DILUTION ZONES IN MIDDLE QUINSAM LAKE

FIGURE 8.
pH FREQUENCY DISTRIBUTION FOR ALL SITES

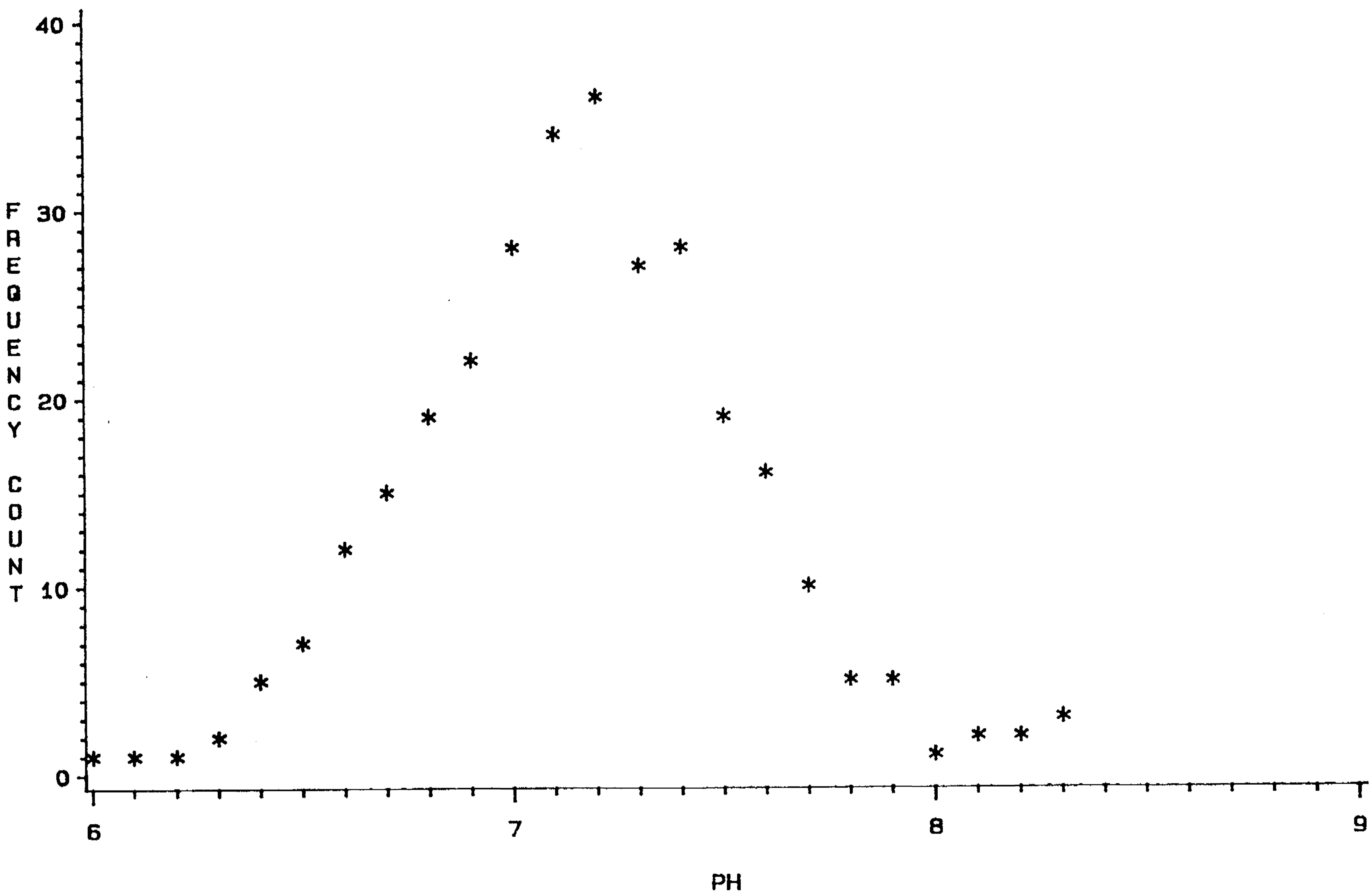


FIGURE 9.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR MIDDLE QUINSAM LAKE IN 1983

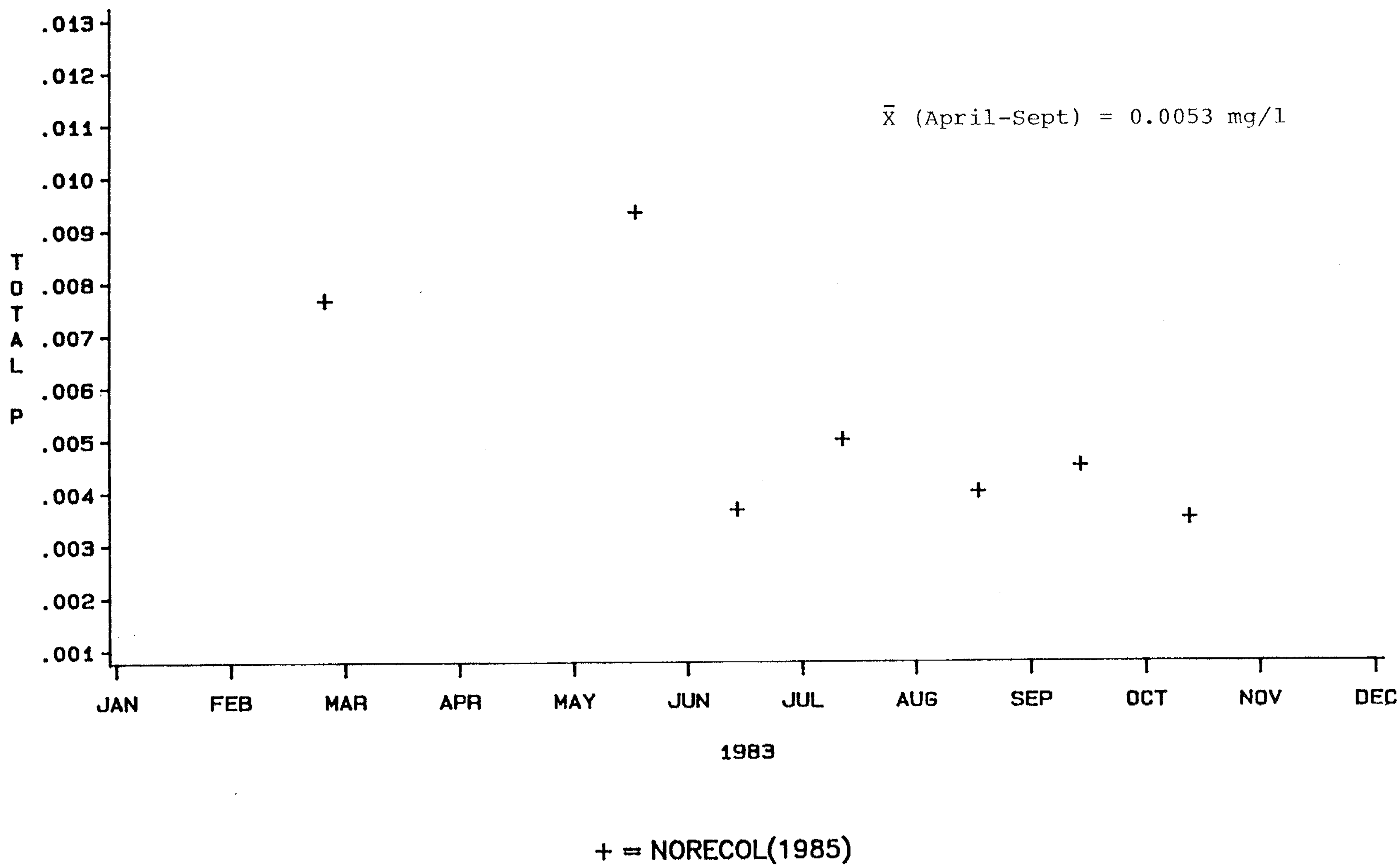


FIGURE 10.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR MIDDLE QUINSAM IN 1984

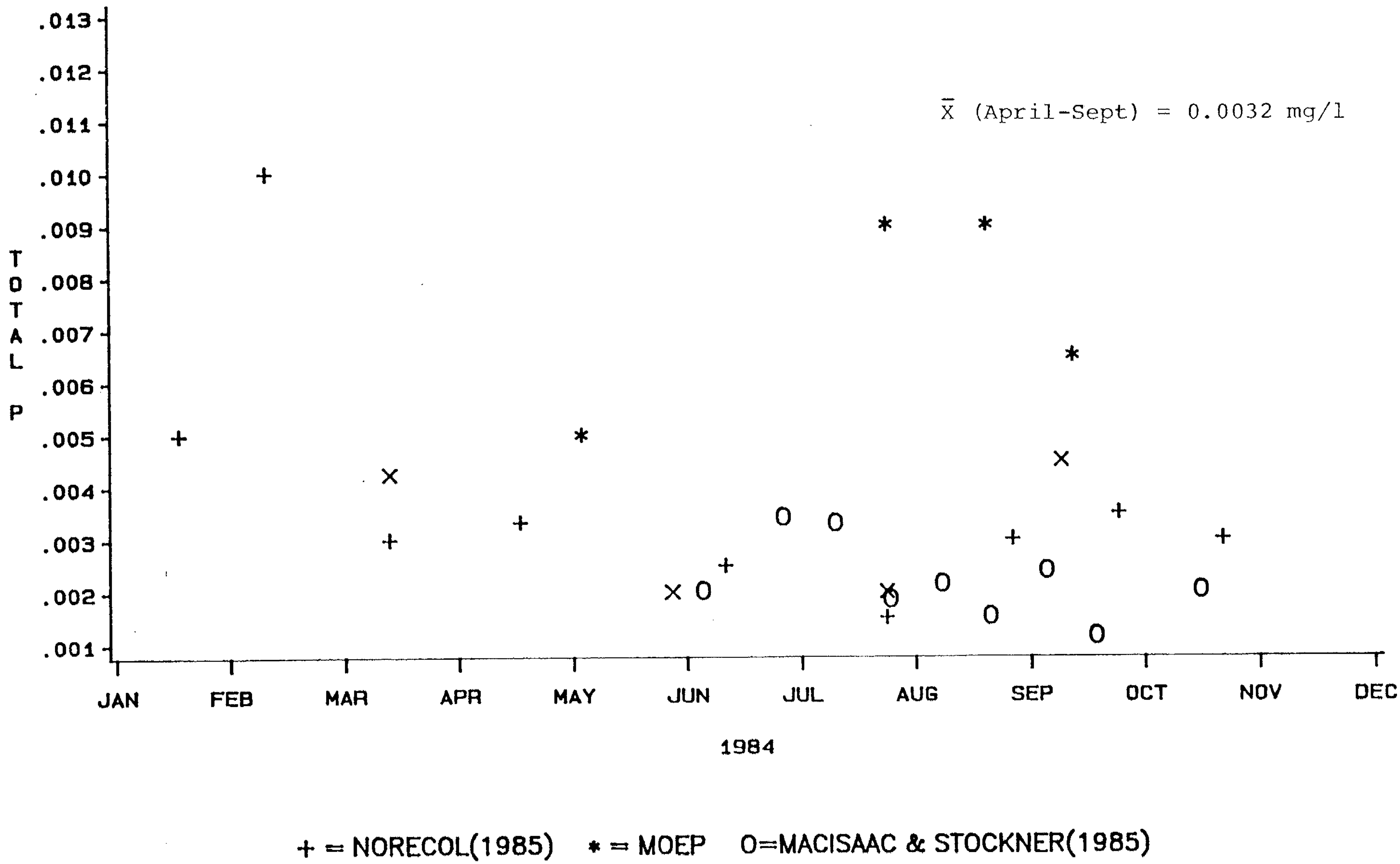


FIGURE 11.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR MIDDLE QUINSAM LAKE IN 1986

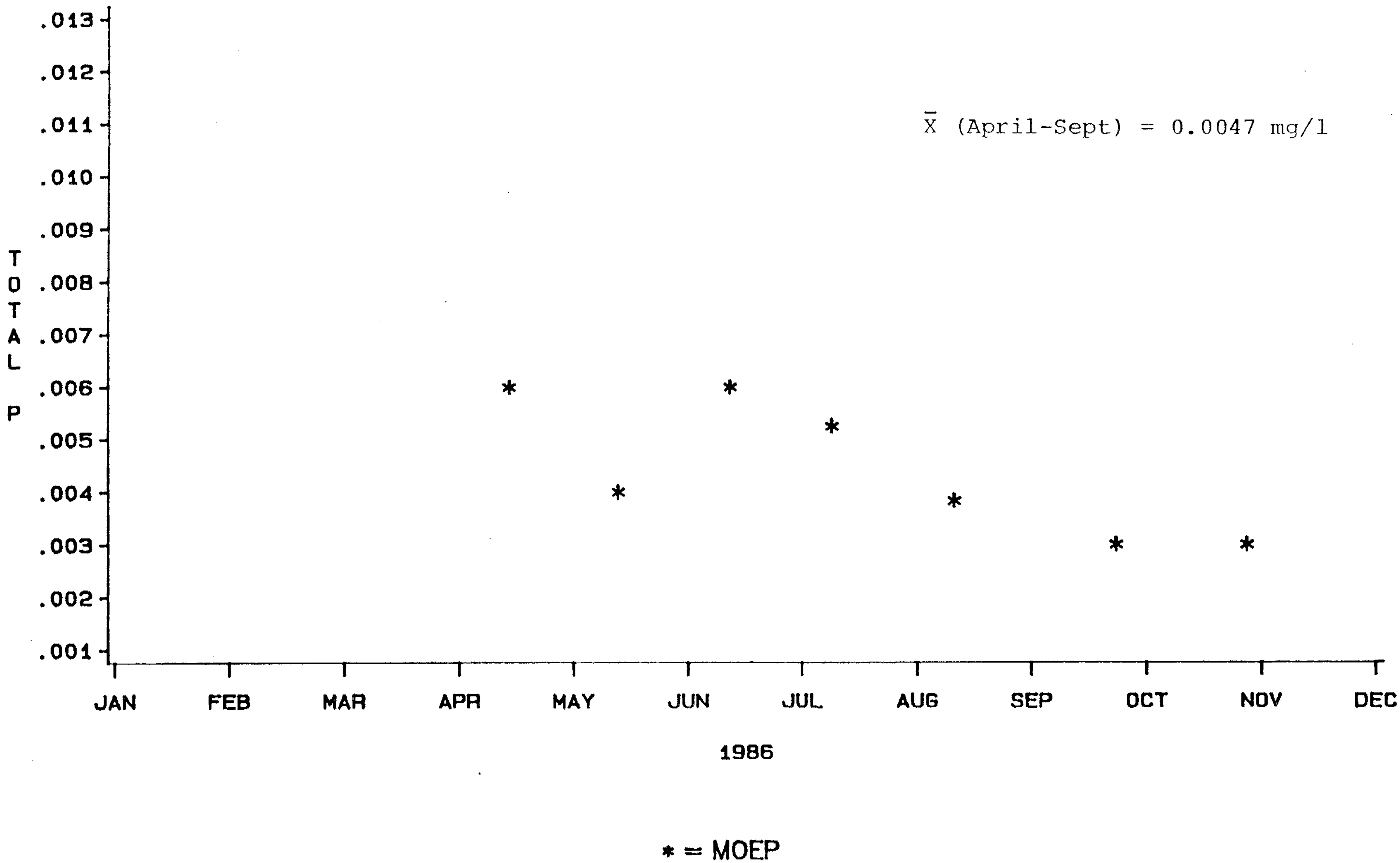


FIGURE 12.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR LONG LAKE IN 1983

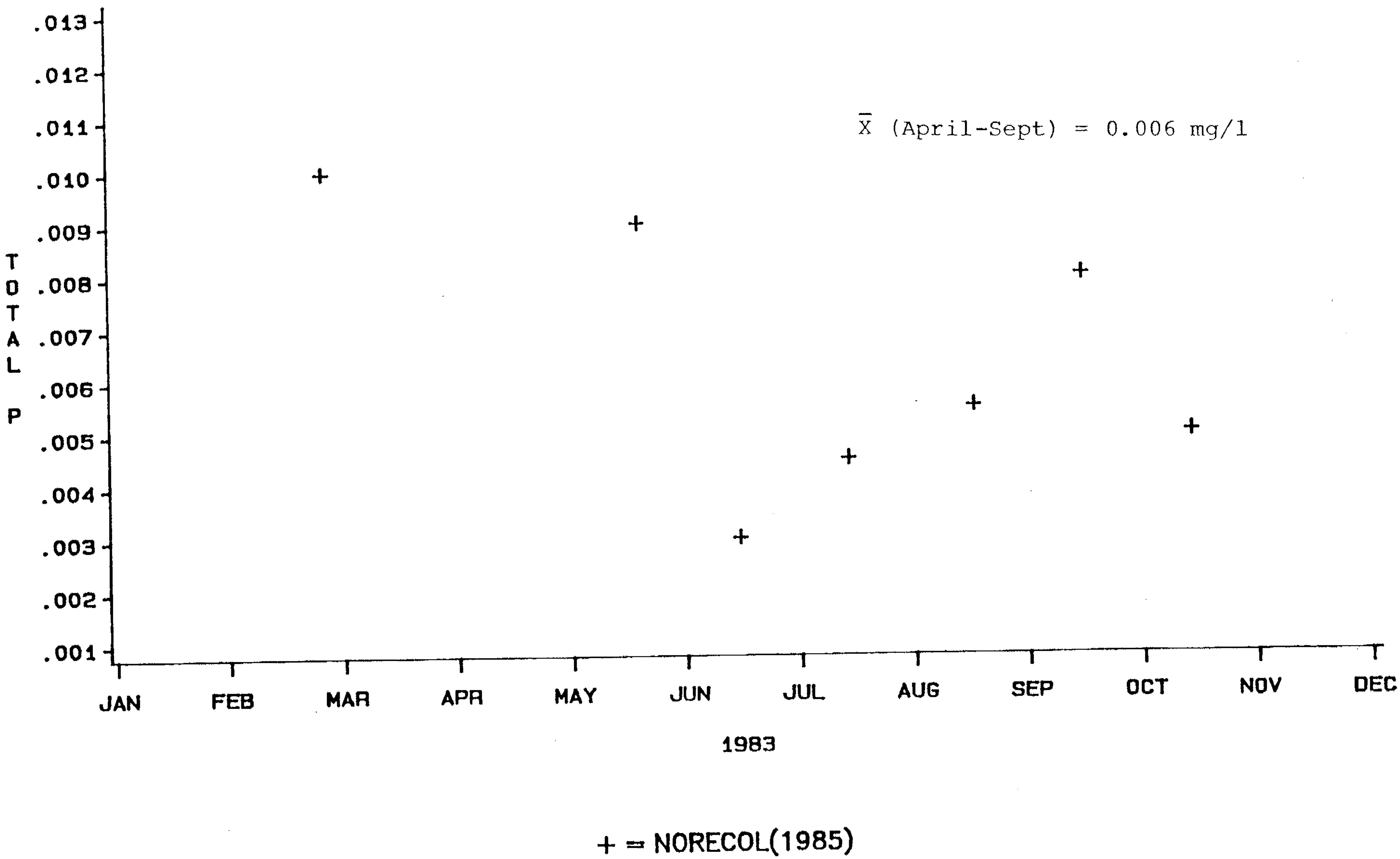


FIGURE 13.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR LONG LAKE IN 1984

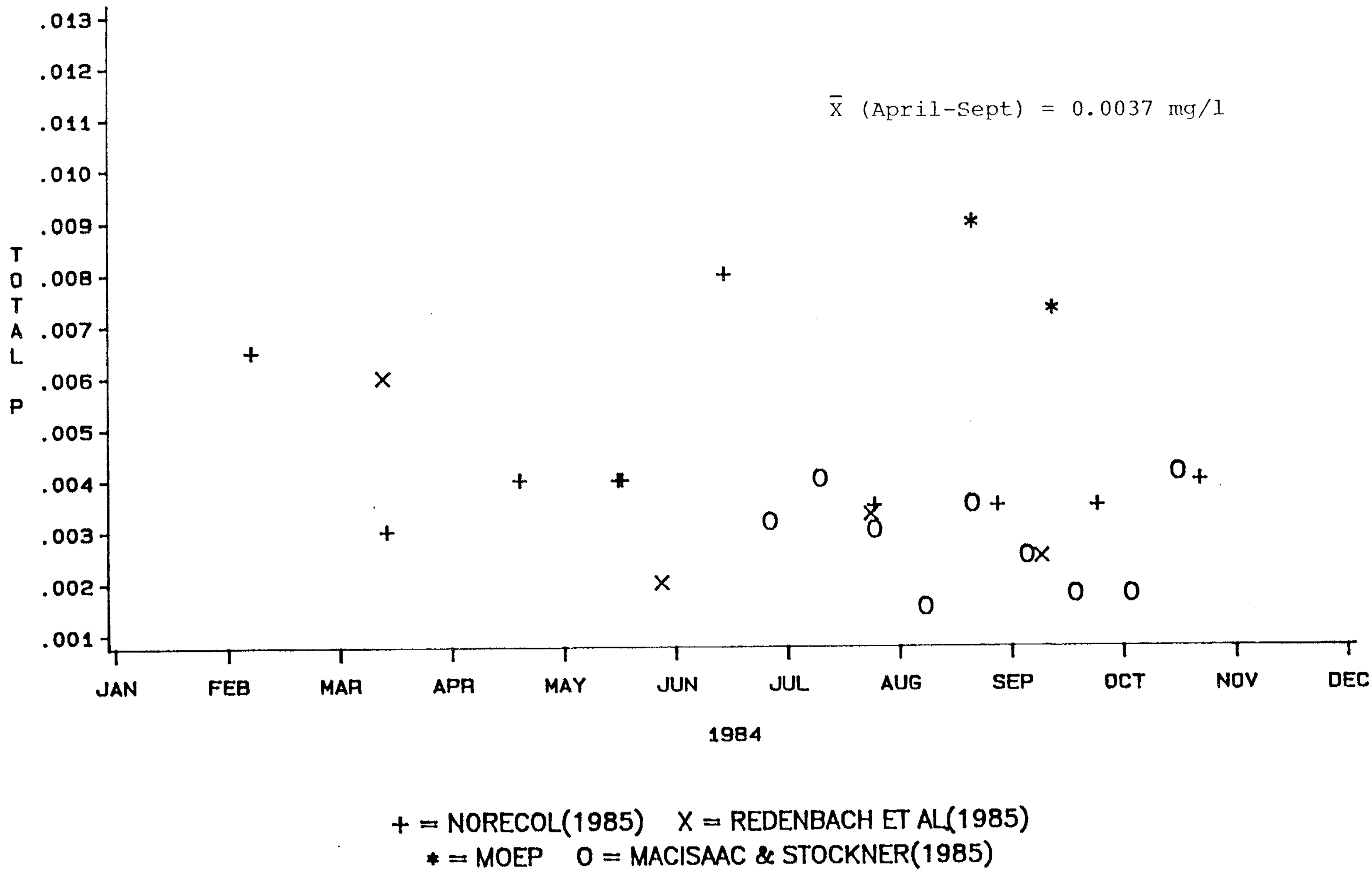


FIGURE 14.
TOTAL PHOSPHOROUS VALUES (MG/L) FOR LONG LAKE IN 1986

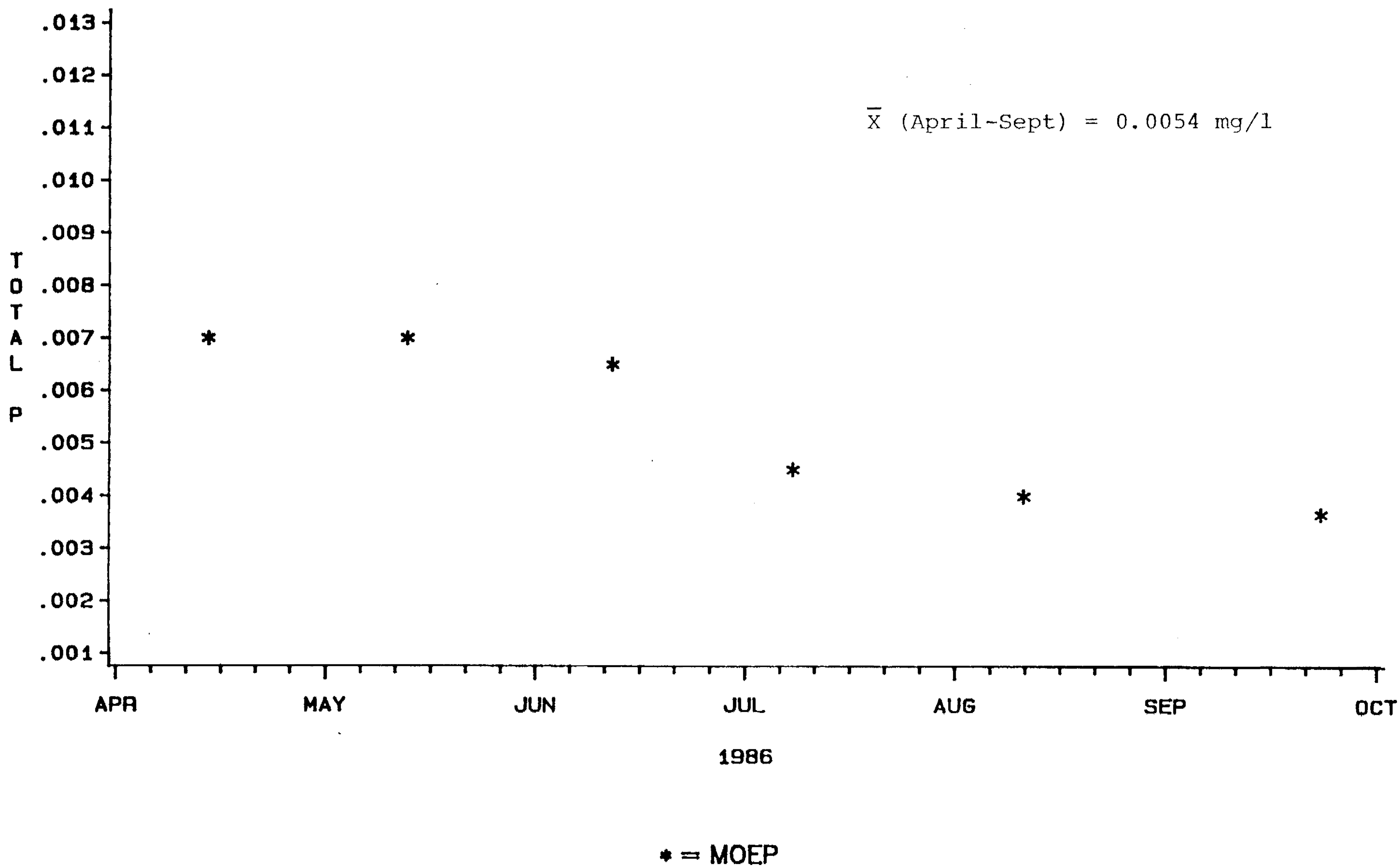


TABLE 1

MONTHLY MEAN FLOW SUMMARY FOR 1983-1985 (m^3/s)

	B.C. Hydro Diversion [1]	Middle Quinsam Lk. Inflow [2]	Approx. Percent Diverted [3]	Long Lake Outflow [2]	Middle Quinsam Lk. Outflow [2]	Approx. Percent Contribution from Long Lk. [4]	Quinsam R. near Campbell R. [5]
Feb. '83	8.21	-		1.17	-		22.5
March	2.83	0.653	81	0.578	2.118	27	16.5
April	1.13	0.698	62	0.162	1.140	14	6.38
May	1.13	0.579	66	0.065	0.067	11	4.45
June	1.42	0.505	74	0.019	0.626	3	2.99
July	2.83	0.532	84	0.136	0.755	18	3.15
August	2.27	0.757	75	0.010	0.826	1	2.11
September	0.28	1.476	16	0.016	2.114	1	3.64
October	-	3.337	-	0.013	1.386	1	4.57
November	4.25	11.081	28	1.924	9.826	20	22.6
December	2.55	0.916	74	0.317	0.942	34	6.09
			x = 62			x = 13	
January '84	1.13	2.055	35	0.950	3.944	24	12.3
February	5.66	0.556	91	0.746	1.658	45	11.3
March	5.38	0.575	90	0.529	1.422	37	8.56
April	5.10	0.563	90	0.295	1.007	30	6.32
May	3.68	0.536	87	0.509	1.453	35	6.59
June	2.55	0.454	85	0.162	0.681	24	3.78
July	1.70	0.420	80	0.027	0.5[6]	5	1.92
August	1.42	0.462	75	0.009	0.5[6]	2	1.93
September	-	1.959	-	0.020	2.096	1	3.47
October	1.98	1.083	65	0.634	2.270	28	8.02
November	3.96	0.654	86	1.061	3.146	32	14.2
December	5.10	0.527	91	0.606	1.557	39	8.51
			x = 80			x = 25	
January '85	2.27	0.518	81	0.269	0.865	31	4.63
February	2.83	0.831	77	0.275	1.575	17	7.02
March	3.23	0.569	85	0.557	1.390	40	7.62
April	5.66	0.487	92	0.699	1.570	45	8.27
May	3.96	0.467	89	0.149	0.724	21	4.68
June	3.96	0.473	89	0.111	0.601	18	2.50
July	2.12	0.469	82	0.005	0.500	1	1.54
August	0.76	0.440	63	0.002	0.500	0.5	1.55
September	0.68	1.729	28	0.001	2.059	0.05	2.79
October	0.14	0.913	13	0.080	1.165	7	4.32
November	0.85	0.797	52	0.413	1.470	28	4.87
December	-	0.734	-	0.329	1.173	28	5.35
			x = 68			x = 20	

TABLE 1 (Continued)

[1] Source: Power Records, B.C. Hydro. Mean flows calculated from daily readings.

[2] Source: Lukyn et al. (1985). Mean flows generally based on 5-10 measurement per month. Direct comparison between Middle Quinsam inflow, outflow and Long Lake outflow is valid as measurements for all three sites were taken on same days.

[3] $$\text{Approximate Percent Diverted} = \frac{\text{mean Flow B.C. Hydro Diversion}}{\text{Mean Flow B.C. Hydro Diversion} + \text{mean Flow Middle Quinsam Lake Inflow}} \times 100$$

[4] $$\text{Approximate percent Contribution to Middle Quinsam Lk Outflow from Long Lk Outflow} = \frac{\text{mean Long Lk outflow}}{\text{mean Middle Quinsam Lk Outflow}} \times 100$$

[5] Source: Water Survey of Canada, Station 08HD005. Means based on daily measurements.

[6] Low flow beyond staff calibration, flow value approximate.

TABLE 2

LAKE OUTFLOWS AND ESTIMATED FLUSHING RATES

	Mean Daily flow 1983 Summer[1] Lukyn *et al.*	Mean Daily flow 1984 Summer[1] Lukyn *et al.*	Mean Daily flow Dry Weather[2] (3 month x) Norecol 1982	Mean Annual 1983/84[3] Lukyn *et al.*
Middle Quinsam Lake Volume $2.82x10^6$ m^3	0.859 m^3/s 38 days	0.952 m^3/s 34 days	0.65 m^3/s 50 days	1.92 m^3/s 17 days
Long Lake Volume $1.14x10^6$ m^3	0.0743 m^3/s 178 days	0.184 m^3/s 72 days	--	0.383 m^3/s 34 days

[1] Summer refers to April through September inclusive.
[2] Dry weather defined as July, August and September flow based on IEC estimate.
[3] Mean flow based on 156 measurements taken at Middle Quinsam Lake Outflow and 190 measurements taken at Long Lake outflow during 1983 and 1984.

TABLE 3

PREDICTED TOTAL PHOSPHORUS IN MINE EFFLUENT

Settling Pond	Season	Sewage[1] (Kg/d-P)	Fertilizer[1] (Kg/d-P)	Settling Pond Water[1] (Kg/d-P)	Total Loading[1] (Kg/d-P)	Settling Pond Flow[2] (L/S)	Predicted Discharge Concentration[3] (mg/L -P)
4 (Discharge to Middle Quinsam L.)	Summer	0.04-0.22	0.04-0.13	0.03	0.1-0.4	58	0.020-0.080
	Winter	0.08-0.5	0.13-0.4	0.07	0.3-1.	138	0.025-0.084
1,2,3 Combined (Discharges to Long L.)	Summer	-	0.04-0.13	0.03	0.07-0.16	69	0.012-0.027
	Winter	-	0.13-0.4	0.1	0.2-0.5	228	0.010-0.025

1 From Pommen and Nordin 1984
2 From Norecol 1982 (Table 3.2-3)
3 Concentration (mg/L-P) = $\frac{\text{load (kg/d)}}{\text{flow (L/S)}} \times 11.57$

TABLE 4

MIDDLE QUINSAM LAKE FLOWS, SETTLING POND 4 DISCHARGE AND EFFLUENT DILUTION RATIOS

Flow Regime (m^3/s)	Middle Quinsam Outflow	Middle Quinsam Inflow	Settling Pond 4 Discharge	Effluent Dilution Ratio (based on outflow)	Effluent Dilution Ratio (based on inflow)
Dry Year 7-day x low flow[1]	0.33	-	0.040	8:1	-
Actual 7-day x low flow[2]	-	0.52('83) 0.41('84) 0.42('85)	-	-	13:1 ('83) 10:1 ('84) 11:1 ('85)
Mean daily "dry weather" flow (July, Aug., Sept.)[1]	0.65		0.058	11:1	-
Actual "dry weather" flow (1983-May, June, July; 1984-June, July, Aug.) 1985-April, May, June)	-	0.54('83) 0.45('84) 0.48('85)	-	-	9:1 ('83) 8:1 ('84) 9:1 ('85)
Mean daily "wet weather" flow (Dec., Jan., Feb.)[1]	2.22	-	0.138	16:1	-
Actual "wet weather" flow (Sept., Oct., Nov.)[2]	-	5.3 ('83) 1.2 ('84) 1.2 ('85	-	-	38:1 ('83) 9:1 ('84) 9:1 ('85)
High Flow	17.3[2]	25.9[2]	2.1[3]	8:1	12:1

[1] Theoretical Flows (Norecol 1982)

[2] Actual flows during 1983 and 1984 from Lukyn et al. 1985. Actual flow during 1985 from Norecol (unpublished).

[3] 1-in-10-year high flow (Quinsam Coal Limited 1982)

TABLE 5

LONG LAKE FLOWS, SETTLING PONDS 1, 2, & 3
DISCHARGE AND EFFLUENT DILUTION RATIOS

Flow Regime (m^3/s)	Long Lake Outflow	Settling Ponds 1,2,3 Combined Discharge	Effluent Dilution Ratio
Dry Year 7-day x low flow[1]		0.028	0.02:1 ('83) 0.07:1 ('84) 0:1 ('85)
Actual 7-day x low flow[2]	0.0006 ('83) 0.002 ('84) 0.000 ('85)		
Mean daily "dry weather" flow (July, Aug., Sept.)[1]		0.069	0.2 :1('83) 0.3 :1('84) <0.03:1('85)
Actual "dry weather" flow[2] (1983-Aug., Sept., Oct.; 1984-July, Aug., Sept.) 1985-July, Aug., Sept.)	0.013 ('83) 0.019 ('84) <0.002 ('85)		
Mean daily "wet weather" flow (Dec., Jan., Feb.)[1]		0.228	5:1 ('83) 4:1 ('84) 2:1 ('85)
Actual "wet weather" flow (1983-Nov., Dec., Jan.; 1984-Oct., Nov., Dec. 1985-Feb., Mar., April	1.14 ('83) 0.80 ('84) 0.53 ('85) 0.53 ('85)		
High Flow	6.2[2]	2.4[3]	3:1

[1] Theoretical Flows (Norecol 1982)
[2] Actual flows during 1983 and 1984 from Lukyn et al. (1985). Actual flows during 1985 from Norecol (unpublished).
[3] 1-in-10-year high flow (Quinsam Coal Limited 1982)

TABLE 6
WATER QUALITY OBJECTIVES

WATER BODIES	LONG LAKE	MIDDLE QUINSAM LAKE	FLUME AND LONG LAKE OUTFLOWS, AND UPPER QUINSAM RIVER[1]	QUINSAM RIVER DOWNSTREAM OF MIDDLE QUINSAM LAKE
DESIGNATED USES	Aquatic Life and Wildlife	Aquatic Life and Wildlife	Aquatic life and Wildlife	Aquatic life, wildlife, aesthetics, drinking and irrigation
Phosphorus (total)[2]	≤0.007 mg/L summer average	≤0.006 mg/L summer average	N.A	
Periphyton biomass[3]	N.A.		≤50 mg/m^2 chlorophyll-a average	
Turbidity[4]	N.A.			≤1.0 NTU 30-day average 5.0 NTU maximum (or 1 NTU above upstream control during major rainstorms)
Non-filterable[4] residue	≤5 mg/L 30-day average 25 mg/L maximum (or 10 mg/L above upstream control during major rainstorms)			
Total ammonia	30-day average and maximum are a function of pH and temperature as indicated by Tables 18 and 19			
Nitrate-N	≤40 mg/L 30-day average 200 mg/L maximum			10 mg/L maximum
Nitrite-N	≤0.02 mg/L 30-day average 0.06 mg/L maximum			
Hypolimnetic Dissolved Oxygen[5]	3 mg/L minimum during June, July, and August		N.A.	
pH[6]	≥6.5 30-day 90th percentile ≥6.9 running 30-day median			
Aluminum (dissolved)	≤0.05 mg/L 30-day average, 0.1 mg/L maximum			
Arsenic (total)	0.05 mg/L maximum			
Cadmium (total)	≤0.0002 mg/L 30-day average 0.0003 mg/L maximum			
Cobalt (total)	N.A.			0.05 mg/L maximum
Copper (total)	≤0.002 mg/L 30-day average			
Iron (total)	≤0.3 mg/L 30-day average			
Lead (total)	≤0.003 mg/L 30-day average, 0.005 mg/L maximum			
Manganese (total)	N.A.			0.05 mg/L maximum
Mercury (total)	≤0.0001 mg/L maximum 0.5 mg/kg maximum total Hg in fish muscle (wet weight)			
Nickel (total)	0.025 mg/L maximum			
Silver (total)[7]	0.0001 mg/L maximum			
Zinc (total)	0.03 mg/L maximum			

TABLE 6 (Continued)

Note: All 30-day average values should be calculated from at least 5 weekly samples taken in a period of 30 days.

[1]"Upper Quinsam River" refers to the Quinsam River between the confluence with Flume Lake outflow and the inflow to Middle Quinsam Lake.

[2]The growing season average phosphorus concentration is calculated from samples taken at least every 3 weeks, from May to September, from near the surface, at the middle of the epilimnion and near the bottom of the epilimnion.

[3]Average chlorophyll a per m^2 is calculated from at least 10 samples of periphytic algae taken at random from representative natural stream substrate at one time from a single site.

[4]The average is calculated from at least 5 weekly samples taken in a period of 30 days. Extra turbidity and non-filterable residue samples taken during major rainstorms should not be used in calculating the average, as this would bias the average upward. Only during major rainstorms, (i.e., when total precipitation exceeds 25 mm per 24 hour period), the objective may be based on comparison with upstream control monitoring.

[5]Hypolimnetic samples are to be collected 1 m above the bottom in the deepest portion of the lake during May to September at least every 3 weeks.

[6]The 90th percentile and median are calculated from at least 5 weekly samples taken during a period of one month.

[7]The objective is lower than the present minimum detection limit (0.0005 mg/L). Measurements of <0.0005 mg/L will be deemed to be meeting the objective until detection limits can be reduced. The objective should be used in back-calculating allowable discharge concentrations. Ag concentrations based on loading calculations also should meet the objective.

Table 7. SITE DESCRIPTIONS, SITE GROUPINGS, SITE NAME SYNONYMS AND DATA SOURCES

SITE 1 MIDDLE QUINSAM RIVER - UPSTREAM

AGENCY	AGENCY SITE NAME
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE 1
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE 126402
NORECOL (NOR)	SITE A (1985)

SITE 2 MIDDLE QUINSAM LAKE

AGENCY	AGENCY SITE NAME
DEPARTMENT OF FISHERIES AND OCEANS (DFO)	MID QUINSAM 1
DEPARTMENT OF FISHERIES AND OCEANS (DFO)	MID QUINSAM 2
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE A
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE 1132499
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE E206519
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE E206618
NORECOL (NOR)	SITE L

SITE 3 LONG LAKE

AGENCY	AGENCY SITE NAME
DEPARTMENT OF FISHERIES AND OCEANS (DFO)	LITTLE LONG 1
DEPARTMENT OF FISHERIES AND OCEANS (DFO)	LITTLE LONG 2
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE B
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE 1132500
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE E206619
NORECOL (NOR)	SITE M

SITE 4 LONG LAKE OUTFLOW

AGENCY	AGENCY SITE NAME
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE 4
NORECOL (NOR)	SITE F

SITE 5 FLUME CREEK/LAKE

AGENCY	AGENCY SITE NAME
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE 2
NORECOL (NOR)	SITE T

Table 7 (cont). SITE DESCRIPTIONS, SITE GROUPINGS, SITE NAME SYNONYMS AND DATA SOURCES

SITE 6 MIDDLE QUINSAM LAKE - OUTFLOW

AGENCY	AGENCY SITE NAME
DEPARTMENT OF FISHERIES AND OCEANS (DFO)	MID QUINSAM OUTLET
ENVIRONMENTAL PROTECTION SERVICE (EPS)	SITE 5
NORECOL (NOR)	SITE C

SITE 7 QUINSAM RIVER - DOWNSTREAM

AGENCY	AGENCY SITE NAME
MINISTRY OF ENVIRONMENT AND PARKS (MOEP)	SITE 126403
NORECOL (NOR)	SITE Q

NOTE: DFO data reported in MacIsaac and Stockner(1985); additional raw data provided by authors.

EPS data reported in Sneddon and Kelso (1983) and Redenbach et al (1985).

MOEP data from SEAM and EQUISE computer data files, Norris (in preparation) and from Water Management Branch and Waste Management Branch files.

NORECOL data presented in Quinsam Coal Limited (1985).

Table 8. SUMMARY OF PH AND HARDNESS

PH

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	35	7.3	8.2	6.4	7.2	7.4	7.5
2	MIDDLE QUINSAM LAKE	100	7.3	8.1	6.6	7.1	7.3	7.5
3	LONG LAKE	91	6.9	8.3	6.0	6.7	6.9	7.1
4	LONG LAKE STREAM	26	7.1	8.1	6.5	6.9	7.1	7.2
5	FLUME CREEK/LAKE	8	6.9	7.6	6.4	6.8	6.9	7.1
6	MIDDLE QUINSAM LAKE - OUTFLOW	12	7.3	7.8	6.9	7.0	7.3	7.6
7	QUINSAM RIVER - DOWNSTREAM	29	7.3	8.2	6.4	7.2	7.3	7.4

HARDNESS (MG/L AS $CaCO_3$)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	29	20.1	23.3	12.3	19.2	20.0	21.5
2	MIDDLE QUINSAM LAKE	64	18.5	24.0	13.9	16.9	18.2	20.2
3	LONG LAKE	68	11.5	21.4	7.9	10.2	11.5	12.5
4	LONG LAKE STREAM	23	12.1	14.6	8.0	11.2	12.2	13.9
5	FLUME CREEK/LAKE	8	21.0	24.5	15.5	18.2	21.8	23.9
6	MIDDLE QUINSAM LAKE - OUTFLOW	8	18.1	20.4	15.3	15.4	19.0	20.2
7	QUINSAM RIVER - DOWNSTREAM	24	16.7	22.1	11.8	14.9	16.5	18.2

Table 9. DISTRIBUTION OF PH VALUES FOR ALL SITES

PH	FREQUENCY	PERCENT	CUMULATIVE FREQUENCY	CUMULATIVE PERCENT
6.0	1	0.3	1	0.3
6.1	1	0.3	2	0.7
6.2	1	0.3	3	1.0
6.3	2	0.7	5	1.7
6.4	5	1.7	10	3.3
6.5	7	2.3	17	5.6
6.6	12	4.0	29	9.6
6.7	15	5.0	44	14.6
6.8	19	6.3	63	20.9
6.9	22	7.3	85	28.2
7.0	28	9.3	113	37.5
7.1	34	11.3	147	48.8
7.2	36	12.0	183	60.8
7.3	27	9.0	210	69.8
7.4	28	9.3	238	79.1
7.5	19	6.3	257	85.4
7.6	16	5.3	273	90.7
7.7	10	3.3	283	94.0
7.8	5	1.7	288	95.7
7.9	5	1.7	293	97.3
8.0	1	0.3	294	97.7
8.1	2	0.7	296	98.3
8.2	2	0.7	298	99.0
8.3	3	1.0	301	100.0

NOTE: ALL PH VALUES FROM ALL AGENCIES, ALL SITES AND ALL DEPTHS ARE REPRESENTED HERE

Table 10. SUMMARY OF TOTAL METALS [1]

METAL (MG/L)	N	MEAN [2]	MIN [3]	MAX	% < D.L.	MIN D.L.	MAX D.L.	AAA [4]	BBB	CCC	CRITERIA
TOTAL ALUMINUM	209	0.0398612	0.00600	0.3100	19.6172	0.02	0.05	1.43541	1.78571	1.62162	0.1000
TOTAL ARSENIC	219		0.00010	0.0012	68.9498	0.0001	0.25	14.15530	0.00000	0.00000	0.0500
TOTAL CADMIUM	225		0.00010	0.0005	98.6667	0.0001	0.01	93.33330	33.33330	6.66667	0.0002
TOTAL COBALT	87		0.00100	NDV	100.0000	0.001	0.1	35.63220	NDV	0.00000	0.0500
TOTAL COPPER	228	0.0017592	0.00050	0.0350	73.6842	0.0005	0.01	7.89474	18.33330	15.49300	0.0020
TOTAL IRON	219	0.0632420	0.00900	0.4100	5.0228	0.01	0.1	0.91324	0.96153	0.93023	0.3000
TOTAL LEAD	227		0.00100	0.0060	85.0220	0.001	0.1	8.81057	11.76470	1.89573	0.0030
TOTAL MANGANESE	209	0.0101656	0.00090	0.2500	11.4833	0.001	0.01	1.91388	2.16216	2.15054	0.0500
TOTAL MERCURY	222		0.00005	0.0014	87.8378	0.00005	0.05	11.26130	74.07410	10.36270	0.0001
TOTAL NICKEL	91		0.00100	0.0050	98.9011	0.001	0.05	0.00000	0.00000	0.00000	0.0500
TOTAL SILVER	166		0.00020	NDV	100.0000	0.0002	0.001	100.00000	NDV	100.00000	0.0001
TOTAL ZINC	230	0.0033426	0.00050	0.0120	40.8696	0.0005	0.01	0.00000	0.00000	0.00000	0.0300

D.L. = ANALYTICAL DETECTION LIMIT

AAA = % > CRITERION VALUE SELECTED FOR SCREENING. SEE TEXT FOR REFERENCES

BBB = % > CRITERION FOR DETECTABLE VALUES ONLY

CCC = % > CRITERION FOR DETECTABLE VALUES AND UNDETECTABLE VALUES USING MINIMUM DETECTION LIMITS

NDV = NO DETECTABLE VALUES

1 THIS TABLE SUMMARIZES ALL DATA FROM ALL AGENCIES, DEPTHS, DATES AND SITES FROM WITHIN THE STUDY AREA.

2 IN CALCULATING THE MEAN, UNDETECTABLE VALUES WERE ASSUMED TO BE EQUAL TO THE DETECTION LIMIT, THEREFORE THE MEAN MAY BE BIASED UPWARD. NO ESTIMATE MADE IF MAXIMUM VALUE IS LESS THAN THE DETECTION LIMIT.

3 MAXIMUMS BASED ON DETECTABLE VALUES ONLY. MINIMUM MAY INCLUDE UNDETECTABLE VALUES.

4 UNDETECTABLE VALUES GREATER THAN THE CRITERION WERE ASSUMMED TO EXCEED THE CRITERION.

Table 11. SUMMARY OF SUSPENDED SEDIMENT AND TURBIDITY

SUSPENDED SEDIMENT (MG/L AS NON-FILTERABLE RESIDUE)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	33	1.87273	5.3	1	1	1	2.0
2	MIDDLE QUINSAM LAKE	76	1.91053	6.0	1	1	1	2.0
3	LONG LAKE	79	2.24810	14.0	1	1	1	3.0
4	LONG LAKE STREAM	22	1.66818	5.3	1	1	1	1.3
5	FLUME CREEK/LAKE	7	2.75714	5.3	1	1	1	5.0
6	MIDDLE QUINSAM LAKE - OUTFLOW	8	4.03750	7.3	1	2	5	5.0
7	QUINSAM RIVER - DOWNSTREAM	26	1.24231	4.5	1	1	1	1.0
		GRAND MEAN	1.9					

TURBIDITY (NTU)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	32	0.739375	3.0	0.1	0.3000	1.00	1.000
2	MIDDLE QUINSAM LAKE	63	0.760952	1.0	0.1	0.3000	1.00	1.000
3	LONG LAKE	68	0.714265	1.0	0.1	0.1000	1.00	1.000
4	LONG LAKE STREAM	23	0.776522	1.0	0.1	0.6000	1.00	1.000
5	FLUME CREEK/LAKE	8	0.728750	1.7	0.1	0.1475	0.85	1.000
6	MIDDLE QUINSAM LAKE - OUTFLOW	6	0.116667	0.2	0.1	0.1000	0.10	0.125
7	QUINSAM RIVER - DOWNSTREAM	25	0.803200	1.0	0.1	0.5400	1.00	1.000
		GRAND MEAN	0.8					

Table 12. STREAM PERIPHYTON CHLOROPHYLL a (MG/M^2) ON NATURAL SUBSTRATES

DATE	QUINSAM RIVER UPSTREAM	QUINSAM RIVER DOWNSTREAM	LONG LAKE STREAM
MAY 1983	7.7	10.1	9.0
JUNE 1983	3.3	7.9	5.5
JULY 1983	58.8	10.7	23.2
AUGUST 1983	3.5	6.9	26.2
SEPTEMBER 1983	7.0	20.6	4.9
OCTOBER 1983	3.5	4.4	26.0
DECEMBER 1983	2.5	3.4	1.6
FEBRUARY 1984	1.6	8.7	2.0
MARCH 1984	3.5	4.2	1.5
APRIL 1984	1.8	5.1	3.1
MAY 1984	4.4	4.2	35.5
JUNE 1984	6.8	4.8	19.4
MEAN	8.7	7.6	13.2

NOTE: DATA FROM NORECOL (1985). VALUES BASED ON TOTAL CHLOROPHYLL a ANALYSIS OF NATURAL SUBSTRATES SAMPLED WITH A TOOTHBRUSH SAMPLER.

TABLE 13
TOTAL NITROGEN TO TOTAL PHOSPHORUS RATIOS

Lake	Year	Agency	April	May	June	July	August	Sept.	Oct.	
Middle Quinsam Lake	1983	EPS Norecol		5:1	16:1	12:1	18:1	8:1	43:1	
	1984	EPS Norecol	36:1	38:1 126:1	58:1	62:1 152:1	62:1	23:1 21:1	29:1	
	x		36:1	56:1	37:1	76:1	40:1	17:1	36:1	$\bar{x}$ 42:1
Long Lake	1983	EPS Norecol		4:1	9:1 24:1	17:1	16:1	13:1	19:1	
	1984	EPS Norecol	20:1	54:1 54:1	11:1	41:1 51:1	49:1	53:1	42:1	
	x		20:1	37:1	15:1	36:1	33:1	33:1	30:1	$\bar{x}$ 29:1

Note: Only nitrogen and phosphorus pairs in <10 m depth used. Each value in table represents $\bar{x}$ of 2-4 individual values from a single depth profile. Total nitrogen from EPS (Sneddon and Kelso 1983 and Redenbach et al. 1985) calculated as total dissolved nitrogen plus total particulate nitrogen. Total nitrogen from Norecol (1985) calculated as Kjeldahl plus nitrate.

Table 14. SUMMARY OF CALCULATED TOTAL NITROGEN AND TOTAL INORGANIC NITROGEN

TOTAL NITROGEN (MG/L - N CALCULATED AS KJELDAHL PLUS NITRATE

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	13	0.129208	0.250	0.063	0.085350	0.10900	0.173500
2	MIDDLE QUINSAM LAKE	72	0.102708	0.271	0.013	0.063500	0.08900	0.132000
3	LONG LAKE	72	0.123208	0.281	0.023	0.079250	0.11650	0.156500
4	LONG LAKE STREAM	22	0.150955	0.491	0.024	0.084000	0.12550	0.177250
5	FLUME CREEK/LAKE	4	0.111400	0.149	0.091	0.093825	0.10280	0.137575
6	MIDDLE QUINSAM LAKE - OUTFLOW	4	0.083575	0.112	0.029	0.043325	0.09665	0.110750
7	QUINSAM RIVER - DOWNSTREAM	18	0.131000	0.326	0.048	0.080750	0.10800	0.176250

TOTAL INORGANIC NITROGEN (MG/L - N CALCULATED AS AMMONIA PLUS NITRATE)

SITE NO.	SITE DESCRIPTION	N	MEAN	MIN	MAX	RANGE	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	35	0.0237429	0.008	0.048	0.040	0.01700	0.0250	0.0300
2	MIDDLE QUINSAM LAKE	146	0.0120822	0.005	0.135	0.130	0.00600	0.0080	0.0150
3	LONG LAKE	147	0.0126259	0.005	0.053	0.048	0.00600	0.0100	0.0150
4	LONG LAKE STREAM	26	0.0170923	0.006	0.039	0.033	0.01150	0.0150	0.0200
5	FLUME CREEK/LAKE	13	0.0135615	0.005	0.028	0.023	0.00600	0.0113	0.0220
6	MIDDLE QUINSAM LAKE - OUTFLOW	13	0.0136385	0.005	0.027	0.022	0.00500	0.0103	0.0235
7	QUINSAM RIVER - DOWNSTREAM	28	0.0193571	0.006	0.041	0.035	0.01325	0.0155	0.0270

Table 15(a). SUMMARY STATISTICS FOR QUINSAM TOTAL PHOSPHORUS DATA FOR EACH YEAR AND ALL AGENCIES (APRIL-SEPT)

SAMPLE SITE=(2) MIDDLE QUINSAM LAKE

YEAR	N	MEAN	SD	MIN	MAX	CI95 **
83	5	0.00530000	0.00231060	0.00366667	0.00933333	0.00286853
84	19	0.00320182	0.00195622	0.00100000	0.00900000	0.00094290
85	1	0.00600000	.	0.00600000	0.00600000	.
86	6	0.00468056	0.00124991	0.00300000	0.00600000	0.00131191

SAMPLE SITE=(3) LONG LAKE

YEAR	N	MEAN	SD	MIN	MAX	CI95 **
83	5	0.00600000	0.00247487	0.00300000	0.009	0.00307247
84	17	0.00369461	0.00173390	0.00150000	0.008	0.00089153
86	6	0.00544444	0.00155516	0.00366667	0.007	0.00163230

Table 15(b). SUMMARY STATISTICS FOR QUINSAM TOTAL PHOSPHORUS DATA POOLED FOR ALL AGENCIES IN ALL YEARS (APRIL-SEPT)

SAMPLE SITE=(2) MIDDLE QUINSAM LAKE

N	MEAN	SD	MIN	MAX	CI95 **
31	0.00391671	0.00204261	0.001	0.00933333	0.000749136

SAMPLE SITE=(3) LONG LAKE

N	MEAN	SD	MIN	MAX	CI95 **
28	0.00448125	0.00203956	0.0015	0.009	0.000790923

NOTE: THE MEAN OF ALL VALUES FOR EACH DEPTH PROFILE WAS CALCULATED USING SAMPLES FROM 0-10 METRES. THESE MEAN VALUES WERE USED TO CALCULATE THE ABOVE STATISTICS. SNEDDON AND KELSO (1983) TOTAL PHOSPHORUS VALUES FROM JUNE 22-24, 1983 EXCLUDED FROM ABOVE STATISTICS.

** 95% CONFIDENCE INTERVAL

Table 16. SUMMER MEAN PHOSPHORUS AND PREDICTED CHLOROPHYLL a RESPONSE

REFERENCE	EQUATION*	PREDICTED CHLOROPHYLL a ASSUMING TOTAL P EQUALS: 4 ug/l	6 ug/l	7 ug/l	10 ug/l
RECKHOW (1978)	LOG CHLORO A = 1.168 LOG P + 2.783	0.960	1.548	1.845	2.799
DILLON AND RIGLER (1974)	LOG CHLORO A = 1.449 LOG P - 1.136	0.545	0.981	1.226	2.056
KEREKES (1975)	LOG CHLORO A = 0.89 LOG P - 0.58	0.903	1.296	1.486	2.042
EDMONDSON AND LEHMAN (1981)	LOG CHLORO A = 1.35 LOG P - 0.90	0.818	1.414	1.741	2.818
PREPAS AND TREW (1983)	LOG CHLORO A = 1.62 LOG P - 1.19	0.610	1.177	1.510	2.692
NORDIN AND MCKEAN (1984)	LOG CHLORO A = 0.9873 LOG P - 0.6231	0.936	1.397	1.627	2.313
STOCKNER AND SHORTREED (1985)	LOG CHLORO A = 0.92 LOG P - 0.09	2.910	4.226	4.870	6.761

* Use µg/L-P to solve equations except for Rechow (1978) use mg/L-P

Table 17. SUMMARY OF AMMONIA

UN-IONIZED AMMONIA (MG/L - N, CALCULATED USING EPA 1986)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	27	0.0000505528	0.000171742	0.0000096550	0.0000174584	0.0000219680	0.0000761955
2	MIDDLE QUINSAM LAKE	63	0.0000438035	0.000153237	0.0000029967	0.0000156035	0.0000282761	0.0000652877
3	LONG LAKE	67	0.0000227459	0.000224057	0.0000014605	0.0000039286	0.0000079981	0.0000179271
4	LONG LAKE STREAM	26	0.0000369945	0.000182812	0.0000030712	0.0000125376	0.0000269889	0.0000424200
5	FLUME CREEK/LAKE	8	0.0000242104	0.000059669	0.0000055452	0.0000106125	0.0000228703	0.0000334518
6	MIDDLE QUINSAM LAKE - OUTFLOW	5	0.0000473360	0.000143714	0.0000124023	0.0000165204	0.0000273741	0.0000881325
7	QUINSAM RIVER - DOWNSTREAM	23	0.0000542381	0.000269273	0.0000071796	0.0000124023	0.0000282245	0.0000788062

TOTAL AMMONIA (MG/L - N)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	35	0.00811429	0.037	0.002	0.005000	0.007	0.01000
2	MIDDLE QUINSAM LAKE	171	0.00692982	0.105	0.003	0.004000	0.005	0.00800
3	LONG LAKE	162	0.00638889	0.022	0.003	0.004000	0.005	0.00800
4	LONG LAKE STREAM	26	0.00991154	0.028	0.005	0.005925	0.010	0.01000
5	FLUME CREEK/LAKE	13	0.00861538	0.023	0.002	0.004000	0.005	0.01150
6	MIDDLE QUINSAM LAKE - OUTFLOW	16	0.00601875	0.013	0.004	0.004000	0.005	0.00675
7	QUINSAM RIVER - DOWNSTREAM	28	0.00896429	0.025	0.005	0.005250	0.009	0.01000

TABLE 18

AVERAGE 30-DAY CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

pH	Temp. 0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
6.5	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.6	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.7	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
6.8	2.08	2.05	2.02	1.99	1.96	1.94	1.92	1.90	1.88	1.86	1.84
6.9	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.0	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.1	2.08	2.05	2.02	1.99	1.97	1.94	1.92	1.90	1.88	1.86	1.84
7.2	2.08	2.05	2.02	1.99	1.96	1.95	1.92	1.90	1.88	1.86	1.85
7.3	2.08	2.05	2.02	1.99	1.97	1.95	1.92	1.90	1.88	1.86	1.85
7.4	2.08	2.05	2.02	2.00	1.97	1.95	1.92	1.90	1.88	1.87	1.85
7.5	2.08	2.05	2.02	2.00	1.97	1.95	1.93	1.91	1.88	1.87	1.85
7.6	2.09	2.05	2.03	2.00	1.97	1.95	1.93	1.91	1.89	1.87	1.85
7.7	2.09	2.05	2.03	2.00	1.98	1.95	1.93	1.91	1.89	1.87	1.86
7.8	1.78	1.75	1.73	1.71	1.69	1.67	1.65	1.63	1.62	1.60	1.59
7.9	1.50	1.48	1.46	1.44	1.43	1.41	1.39	1.38	1.36	1.35	1.34
8.0	1.26	1.24	1.23	1.21	1.20	1.18	1.17	1.16	1.15	1.14	1.13
8.1	1.00	0.989	0.976	0.963	0.952	0.942	0.932	0.922	0.914	0.906	0.899
8.2	0.799	0.788	0.777	0.768	0.759	0.751	0.743	0.736	0.730	0.724	0.718
8.3	0.636	0.628	0.620	0.613	0.606	0.599	0.594	0.588	0.583	0.579	0.575
8.4	0.508	0.501	0.495	0.489	0.484	0.479	0.475	0.471	0.467	0.464	0.461
8.5	0.405	0.400	0.396	0.381	0.387	0.384	0.380	0.377	0.375	0.372	0.370
8.6	0.324	0.320	0.317	0.313	0.310	0.308	0.305	0.303	0.301	0.300	0.298
8.7	0.260	0.257	0.254	0.251	0.249	0.247	0.246	0.244	0.243	0.242	0.241
8.8	0.208	0.206	0.204	0.202	0.201	0.200	0.198	0.197	0.197	0.196	0.196
8.9	0.168	0.166	0.165	0.163	0.162	0.161	0.161	0.160	0.160	0.160	0.160
9.0	0.135	0.134	0.133	0.132	0.132	0.131	0.131	0.131	0.131	0.131	0.131

pH	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
6.5	1.82	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.6	1.82	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.7	1.83	1.81	1.80	1.78	1.77	1.64	1.52	1.41	1.31	1.22
6.8	1.83	1.81	1.80	1.78	1.77	1.64	1.52	1.42	1.32	1.22
6.9	1.82	1.81	1.80	1.78	1.77	1.64	1.53	1.42	1.32	1.22
7.0	1.83	1.81	1.80	1.79	1.77	1.64	1.53	1.42	1.32	1.22
7.1	1.83	1.81	1.80	1.79	1.77	1.65	1.53	1.42	1.32	1.23
7.2	1.83	1.81	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.3	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.4	1.83	1.82	1.80	1.79	1.78	1.65	1.53	1.42	1.32	1.23
7.5	1.83	1.82	1.81	1.80	1.78	1.66	1.54	1.43	1.33	1.23
7.6	1.84	1.82	1.81	1.80	1.79	1.66	1.54	1.43	1.33	1.24
7.7	1.84	1.83	1.81	1.80	1.79	1.66	1.54	1.44	1.34	1.24
7.8	1.57	1.56	1.55	1.54	1.53	1.42	1.32	1.23	1.14	1.07
7.9	1.33	1.32	1.31	1.31	1.30	1.21	1.12	1.04	0.970	0.904
8.0	1.12	1.11	1.10	1.10	1.09	1.02	0.944	0.878	0.818	0.762
8.1	0.893	0.887	0.882	0.878	0.874	0.812	0.756	0.704	0.655	0.611
8.2	0.714	0.709	0.706	0.703	0.700	0.651	0.606	0.565	0.527	0.491
8.3	0.571	0.568	0.566	0.564	0.562	0.523	0.487	0.455	0.424	0.396
8.4	0.458	0.456	0.455	0.453	0.452	0.421	0.393	0.367	0.343	0.321
8.5	0.369	0.367	0.366	0.366	0.365	0.341	0.318	0.298	0.278	0.261
8.6	0.297	0.297	0.296	0.296	0.296	0.277	0.259	0.242	0.227	0.213
8.7	0.241	0.240	0.240	0.241	0.241	0.226	0.212	0.198	0.186	0.175
8.8	0.196	0.196	0.196	0.197	0.198	0.185	0.174	0.164	0.154	0.145
8.9	0.160	0.161	0.161	0.162	0.163	0.153	0.144	0.136	0.128	0.121
9.0	0.132	0.132	0.133	0.134	0.135	0.128	0.121	0.114	0.108	0.102

- the average of the measured values must be less than the average of the corresponding individual values in Table 18.
- each measured value is compared to the corresponding individual values in Table 18. No more than one in five of the measured values can be greater than one-and-a-half times the corresponding objective values in Table 18.

TABLE 19

MAXIMUM CONCENTRATION OF TOTAL AMMONIA NITROGEN FOR PROTECTION OF AQUATIC LIFE (mg/L-N)

pH	Temp. 0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0
6.5	27.7	28.3	27.9	27.5	27.2	26.8	26.5	26.2	26.0	25.7	25.5
6.6	27.9	27.5	27.2	26.8	26.4	26.1	25.8	25.5	25.2	25.0	24.7
6.7	26.9	26.5	26.2	25.9	25.5	25.2	24.9	24.6	24.4	24.1	23.9
6.8	25.8	25.5	25.1	24.8	24.5	24.2	23.9	23.6	23.4	23.1	22.9
6.9	24.6	24.2	23.9	23.6	23.3	23.0	22.7	22.5	22.2	22.0	21.8
7.0	23.2	22.8	22.5	22.2	21.9	21.6	21.4	21.1	20.9	20.7	20.5
7.1	21.6	21.3	20.9	20.7	20.4	20.2	19.9	19.7	19.5	19.3	19.1
7.2	19.9	19.6	19.3	19.0	18.8	18.6	18.3	18.1	17.9	17.8	17.6
7.3	18.1	17.8	17.5	17.3	17.1	16.9	16.7	16.5	16.3	16.2	16.0
7.4	16.2	16.0	15.7	15.5	15.3	15.2	15.0	14.8	14.7	14.5	14.4
7.5	14.4	14.1	14.0	13.8	13.6	13.4	13.3	13.1	13.0	12.9	12.7
7.6	12.6	12.4	12.2	12.0	11.9	11.7	11.6	11.5	11.4	11.3	11.2
7.7	10.8	10.7	10.5	10.4	10.3	10.1	10.0	9.92	9.83	9.73	9.65
7.8	9.26	9.12	8.98	8.88	8.77	8.67	8.57	8.48	8.40	8.32	8.25
7.9	7.82	7.71	7.60	7.51	7.42	7.33	7.25	7.17	7.10	7.04	6.98
8.0	6.55	6.46	6.37	6.29	6.22	6.14	6.08	6.02	5.96	5.91	5.86
8.1	5.21	5.14	5.07	5.01	4.95	4.90	4.84	4.80	4.75	4.71	4.67
8.2	4.15	4.09	4.04	3.99	3.95	3.90	3.86	3.83	3.80	3.76	3.74
8.3	3.31	3.27	3.22	3.19	3.15	3.12	3.09	3.06	3.03	3.01	2.99
8.4	2.64	2.61	2.57	2.54	2.52	2.49	2.47	2.45	2.43	2.41	2.40
8.5	2.11	2.08	2.06	2.03	2.01	1.99	1.98	1.96	1.95	1.94	1.93
8.6	1.69	1.67	1.65	1.63	1.61	1.60	1.59	1.58	1.57	1.56	1.55
8.7	1.35	1.33	1.32	1.31	1.30	1.29	1.28	1.27	1.26	1.26	1.25
8.8	1.08	1.07	1.06	1.05	1.04	1.04	1.03	1.03	1.02	1.02	1.02
8.9	0.871	0.863	0.856	0.849	0.844	0.839	0.836	0.833	0.832	0.831	0.831
9.0	0.703	0.697	0.692	0.688	0.685	0.682	0.681	0.681	0.680	0.681	0.682

pH	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
6.5	25.2	25.0	24.8	24.6	24.5	24.3	24.2	24.0	23.9	23.8
6.6	24.5	24.3	24.1	23.9	23.8	24.6	23.5	23.3	23.3	23.2
6.7	23.7	23.5	23.3	23.1	23.0	22.8	22.7	22.6	22.5	22.4
6.8	22.7	22.5	22.3	22.2	22.0	21.9	21.8	21.7	21.6	21.5
6.9	21.6	21.4	21.3	21.1	21.0	20.8	20.7	20.6	20.5	20.4
7.0	20.3	20.2	20.0	19.9	19.7	19.6	19.5	19.4	19.3	19.2
7.1	18.9	18.8	18.7	18.5	18.4	18.3	18.2	18.1	18.0	17.9
7.2	17.4	17.3	17.2	17.1	16.9	16.8	16.8	16.7	16.6	16.5
7.3	15.9	15.7	15.6	15.5	15.4	15.3	15.2	15.2	15.1	15.1
7.4	14.2	14.1	14.0	13.9	13.9	13.8	13.7	13.6	13.6	13.5
7.5	12.6	12.5	12.4	12.4	12.3	12.2	12.2	12.1	12.1	12.0
7.6	11.1	11.0	10.9	10.8	10.8	10.7	10.7	10.6	10.6	10.5
7.7	9.57	9.50	9.43	9.37	9.31	9.26	9.22	9.81	9.15	9.12
7.8	8.18	8.12	8.07	8.02	7.97	7.93	7.90	7.87	7.84	7.82
7.9	6.92	6.88	6.83	6.79	6.75	6.72	6.69	6.67	6.65	6.64
8.0	5.81	5.78	5.74	5.71	5.68	5.66	5.64	5.62	5.61	5.60
8.1	4.64	4.61	4.59	4.56	4.54	4.53	4.51	4.50	4.49	4.49
8.2	3.71	3.69	3.67	3.65	3.64	3.63	3.62	3.61	3.61	3.61
8.3	2.97	2.96	2.94	2.93	2.92	2.92	2.91	2.91	2.91	2.91
8.4	2.38	2.37	2.36	2.36	2.35	2.35	2.35	2.35	2.35	2.36
8.5	1.92	1.91	1.91	1.90	1.90	1.90	1.90	1.90	1.91	1.92
8.6	1.55	1.54	1.54	1.54	1.54	1.54	1.55	1.55	1.56	1.57
8.7	1.25	1.25	1.25	1.25	1.25	1.26	1.26	1.27	1.28	1.29
8.8	1.02	1.02	1.02	1.02	1.03	1.03	1.04	1.05	1.06	1.07
8.9	0.832	0.834	0.838	0.842	0.847	0.853	0.861	0.870	0.880	0.891
9.0	0.684	0.688	0.692	0.698	0.704	0.711	0.720	0.729	0.740	0.752

Table 20. SUMMARY OF NITRITE, NITRATE, AND KJELDAHL N

NITRITE (MG/L - N)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	35	0.00242857	0.005	0.001	0.001	0.0010	0.00500
2	MIDDLE QUINSAM LAKE	85	0.00228235	0.005	0.001	0.001	0.0010	0.00500
3	LONG LAKE	83	0.00215663	0.005	0.001	0.001	0.0010	0.00500
4	LONG LAKE STREAM	26	0.00153846	0.005	0.001	0.001	0.0010	0.00100
5	FLUME CREEK/LAKE	8	0.00262500	0.005	0.001	0.001	0.0015	0.00500
6	MIDDLE QUINSAM LAKE - OUTFLOW	9	0.00466667	0.005	0.002	0.005	0.0050	0.00500
7	QUINSAM RIVER - DOWNSTREAM	28	0.00189286	0.005	0.001	0.001	0.0010	0.00175

NITRATE (MG/L - N)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	35	0.0156286	0.040	0.003	0.00800	0.015	0.02000
2	MIDDLE QUINSAM LAKE	146	0.0050205	0.030	0.001	0.00100	0.003	0.00700
3	LONG LAKE	147	0.0061020	0.041	0.001	0.00100	0.003	0.00700
4	LONG LAKE STREAM	26	0.0071808	0.024	0.001	0.00375	0.005	0.00850
5	FLUME CREEK/LAKE	13	0.0049462	0.020	0.001	0.00150	0.004	0.00565
6	MIDDLE QUINSAM LAKE - OUTFLOW	13	0.0082308	0.020	0.001	0.00100	0.005	0.01700
7	QUINSAM RIVER - DOWNSTREAM	28	0.0103929	0.030	0.001	0.00325	0.005	0.02000

KJELDAHL NITPOGEN (MG/L - N)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	9	0.129556	0.21	0.055	0.08200	0.1300	0.1850
2	MIDDLE QUINSAM LAKE	52	0.096558	0.27	0.010	0.04450	0.0740	0.1400
3	LONG LAKE	53	0.115868	0.26	0.019	0.06100	0.0910	0.1700
4	LONG LAKE STREAM	18	0.148111	0.48	0.020	0.07275	0.1150	0.1725
5	FLUME CREEK/LAKE	0	.	.	.	.	.	.
6	MIDDLE QUINSAM LAKE - OUTFLOW	0	.	.	.	.	.	.
7	QUINSAM RIVER - DOWNSTREAM	18	0.123444	0.31	0.043	0.07150	0.0905	0.1750

Table 21. TOTAL PHOSPHORUS SUMMARY BY SITE (MG/L - P)

SITE NO.	SITE DESCRIPTION	N	MEAN	MAX	MIN	P25	P50	P75
1	QUINSAM RIVER - UPSTREAM	36	0.00463056	0.014	0.001	0.00300	0.004	0.00500
2	MIDDLE QUINSAM LAKE	179	0.00377654	0.016	0.001	0.00200	0.003	0.00500
3	LONG LAKE	168	0.00452976	0.021	0.001	0.00225	0.004	0.00500
4	LONG LAKE STREAM	26	0.00492308	0.016	0.001	0.00300	0.004	0.00525
5	FLUME CREEK/LAKE	13	0.00541538	0.012	0.001	0.00300	0.004	0.00835
6	MIDDLE QUINSAM LAKE - OUTFLOW	17	0.00447647	0.011	0.002	0.00200	0.004	0.00600
7	QUINSAM RIVER - DOWNSTREAM	29	0.00520690	0.018	0.002	0.00300	0.005	0.00550

NOTE: DATA FOR ALL SAMPLING DATES

TABLE 22. MIDDLE QUINSAM LAKE DISSOLVED OXYGEN PROFILES (AUGUST-SEPTEMBER 1984)

	AUGUST 27 (NORECOL)		SEPTEMBER 9 (EPS)		SEPTEMBER 12 (MOEP)	
DEPTH (m)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)
0	19.5	8.5	15.4	10.0	–	–
1	19.5	8.5	15.4	9.7	15.4	8.2
2	19.5	8.4	15.4	9.7	–	–
3	19.5	8.5	15.4	9.7	15.4	8.4
4	19.5	8.4	15.4	9.6	–	–
5	19.5	8.4	15.4	9.5	15.2	8.2
6	19.5	8.4	15.3	9.5	–	–
7	19.5	8.5	15.3	9.5	15.0	8.1
8	18.5	8.6	15.0	9.3	14.8	7.9
9	15.0	8.6	14.8	9.2	14.1	7.7
10	14.5	7.6	14.2	8.0	–	–
11	13.0	6.4	13.1	6.3	12.3	3.6
12	13.0	5.5	12.4	5.4	–	–
13	–	–	12.1	4.4	12.0	2.3
14	–	–	11.9	3.8	–	–
15	–	–	11.9	3.5	12.0	1.8

NOTE: NORECOL DATA FROM NORECOL (1985), MOEP DATA FROM UNPUBLISHED FILES, AND EPS DATA FROM REDENBACH ET AL. (1985).

TABLE 23. LONG LAKE DISSOLVED OXYGEN PROFILES (JULY–OCTOBER 1984)

	JULY25 (NORECOL)		AUG21 (MOEP)		AUG27 (NORECOL)		SEPT9–12 (EPS)		SEPT12 (MOEP)		OCT22 (NORECOL)	
DEPTH (m)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)	TEMP (deg C)	D.O. (mg/L)
0	21.5	7.6	19.0	8.4	18.5	7.3	15.7	9.7	15.3	8.5	9.0	8.8
1	21.5	7.4	18.9	8.6	18.5	7.3	15.7	9.5	–	–	8.5	8.6
2	21.5	7.1	18.9	8.7	18.5	7.3	15.7	9.5	15.1	8.0	8.0	8.4
3	21.0	7.1	–	–	18.5	7.3	15.7	9.4	–	–	8.0	8.4
4	19.5	7.0	18.7	8.1	18.5	7.3	15.7	9.4	14.8	8.3	8.0	8.4
5	15.0	7.8	15.3	7.9	17.0	7.3	15.6	9.4	11.8	7.4	8.0	8.4
6	11.0	7.8	–	–	13.0	7.8	14.5	9.4	9.2	6.9	8.0	8.3
7	9.0	7.8	11.0	7.5	10.0	7.8	10.9	8.9	–	–	8.0	8.3
8	9.0	7.5	–	–	8.5	7.7	8.6	8.2	7.4	6.0	8.0	8.3
9	8.5	7.2	8.4	7.2	7.5	7.7	7.8	7.8	–	–	8.0	8.3
10	8.0	7.2	–	–	7.0	6.6	7.5	7.3	7.0	5.2	8.0	8.3
11	7.0	7.0	7.4	7.7	7.0	6.6	7.2	7.1	–	–	7.5	6.5
12	7.0	7.0	–	–	7.0	7.0	7.0	7.0	6.7	4.5	7.0	5.8
13	7.0	6.4	7.1	7.1	6.5	6.8	6.9	6.8	–	–	7.0	5.6
14	7.0	.6.4	–	–	6.5	6.2	6.8	6.6	6.6	3.8	7.0	4.6
15	6.5	6.4	6.9	6.6	6.5	6.2	6.6	6.0	–	–	6.5	4.0
16	6.5	5.6	–	–	6.5	6.2	6.5	5.3	6.5	3.5	6.5	3.6
17	6.5	5.5	6.6	5.4	6.5	5.4	6.4	4.7	–	–	6.5	3.0
18	–	–	–	–	–	–	6.4	4.2	–	–	–	–
19	–	–	6.5	5.1	–	–	6.4	3.8	–	–	–	–
20	–	–	–	–	–	–	–	–	–	–	–	–
21	–	–	6.4	4.5	–	–	–	–	–	–	–	–
22	–	–	6.4	4.6	–	–	–	–	–	–	–	–

NOTE: NORECOL DATA FROM NORECOL (1985), MOEP DATA IN UNPUIBLISHED FILES AND EPS DATA FROM REDENBACH ET AL.(1985).

TABLE 24 CUTTHROAT METALLOTHIONEIN (LIVER)

LONG LAKE

Sample	Lenght (mm)	Weight (gm)	Age (yr)	Metallothionein (nanomoles/g wet)
1	60	1.56	0+	
2	65	2.14	0+	41.7
3	75	4.31	0+	
8	74	3.71	0+	57.8
9	68	3.59	0+	
10	67	3.24	0+	24.1
12	71	3.15	0+	
13	57	1.94	0+	
15	62	2.28	0+	35.0
16	56	2.52	0+	

MIDDLE QUINSAM LAKE

Sample	Lenght (mm)	Weight (gm)	Age (yr)	Metallothionein (nanomoles/g wet)
4	56	1.97	0+	
5	57	1.82	0+	28.0
6	55	1.71	0+	
7	78	5.59	0+	18.3
11	354	460	0+	22.7
22*	192	91	2	28.6
23*	204	100	2	29.8
24	287	303	4	46.1
25	255	194	4	31.2
26	255	187	4	31.2
27	243	170	3	23.9
28	263	216	4	33.5
29	276	246	4	41.6
30	260	166	4	78.9
31	294	256	4	41.6
32	242	163	3	19.8

* RAINBOW TROUT

NOTE: IN SOME CASES SEVERAL LIVERS WERE COMBINED TO FACILITATE ANALYSIS.
SAMPLES ANALYZED BY MIKE ROCH, UNIVERSITY OF VICTORIA

APPENDIX 1

RAW DATA

GENERAL WATER QUALITY

NUTRIENTS
TEMPERATURE
pH
TURBIDITY
SUSPENDED SEDIMENT
HARDNESS

LEGEND

TPHOS	=	Total phosphorus (mg/L-P)
NH4	=	Total ammonia (mg/L-N)
NH3	=	Un-ionized ammonia, calculated using EPA(1986) (mg/L-N)
NO2	=	Nitrite (mg/L-N)
NO3	=	Nitrate (mg/L-N)
WTEMP	=	Water temperature (degrees celsius)
pH L	=	Lab pH
pH F	=	Field pH
TURB	=	Turbidity (NTU)
SS	=	Suspended sediment (mg/L non-filterable residue)
HARD	=	Hardness (mg/L-CaCO3)
KJEL	=	Kjeldahl nitrogen (mg/L-N)
TN	=	Total nitorgen (NO2 + NO3 + NH4) (mg/L-N)

SAMPLE SITE=SITE 1: QUINSAM RIVER - UPSTREAM

AGENCY	DAYTE	DEPTH	TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
EPS	23JUN83	.	0.0100	0.007	0.000150684	< 0.005	0.020	15.8	.	7.88	0.10	.	19.27	.	0.0900
EPS	28MAY84	0	0.0027	< 0.005	0.000011604	< 0.005	0.012	12.9	.	7.00	< 0.10	5.3	19.10	.	0.0700
EPS	24JUL84	0	0.0020	< 0.002	0.000043015	< 0.002	0.032	21.4	.	7.70	< 0.10	< 5.0	22.20	.	0.1030
EPS	09SEP84	0	0.0030	0.010	0.000017458	< 0.005	< 0.010	15.2	.	6.80	0.10	< 5.0	20.40	.	0.0897
EPS	10OCT84	0	.	.	.	.	.	.	.	.	< 0.10	< 5.0	.	.	.
MOE	31JUL79	0	0.0040	0.005	.	< 0.005	0.020	.	7.5	.	0.30	1.0	22.40	.	.
MOE	19NOV79	0	0.0040	< 0.005	.	< 0.005	0.020	.	7.5	.	0.30	1.0	20.10	.	.
MOE	14APR80	0	0.0030	0.006	.	< 0.005	< 0.020	.	7.4	.	0.40	1.0	.	.	.
MOE	25FEB81	0	0.0050	0.013	.	< 0.005	0.020	.	7.5	.	0.70	1.0	18.90	.	.
MOE	13MAY81	0	0.0050	0.006	.	< 0.005	0.020	.	7.5	.	0.30	1.0	20.00	.	.
MOE	20OCT82	0	0.0030	.	.	.	.	.	6.4	.	.	1.0	.	.	.
MOE	16NOV83	0	0.0080	0.008	.	< 0.005	0.040	.	7.6	.	1.00	5.0	.	.	.
MOE	07FEB84	0	0.0040	< 0.005	.	< 0.005	< 0.020	.	7.1	.	.	1.0	.	.	.
MOE	28MAY84	0	0.0060	0.005	0.000018507	< 0.005	0.020	13.0	7.2	.	0.30	2.0	19.50	.	.
MOE	28MAY84	0	0.0060	0.005	0.000018507	< 0.005	0.020	13.0	7.2	.	0.30	2.0	19.50	.	.
NOR	23JAN83	0	< 0.0050	0.009	0.000021968	< 0.002	0.011	2.0	.	7.40	< 0.10	< 1.0	19.00	.	.
NOR	25FEB83	0	0.0090	< 0.010	0.000171742	< 0.001	< 0.005	3.5	.	8.20	0.56	< 1.0	18.40	.	.
NOR	22MAR83	0	0.0050	< 0.010	0.000018172	< 0.001	< 0.005	4.0	.	7.20	0.90	1.6	19.40	.	.
NOR	19APR83	0	0.0050	< 0.010	0.000021568	< 0.001	< 0.005	9.0	.	7.10	< 1.00	< 1.0	20.00	.	.
NOR	15MAY83	0	< 0.0010	< 0.010	0.000079385	< 0.001	0.015	14.0	.	7.50	< 1.00	1.8	19.50	.	.
NOR	13JUN83	0	0.0020	< 0.010	0.000076196	< 0.001	< 0.005	16.5	.	7.40	< 1.00	1.2	21.40	.	.
NOR	11JUL83	0	0.0040	< 0.010	0.000046444	< 0.001	< 0.005	16.0	.	7.20	< 1.00	2.5	18.40	.	.
NOR	15AUG83	0	0.0050	< 0.010	0.000155230	< 0.001	0.009	20.0	.	7.60	< 1.00	< 1.0	20.30	.	.
NOR	12SEP83	0	0.0030	< 0.005	0.000029200	< 0.001	< 0.003	16.0	.	7.30	< 1.00	2.0	18.80	.	.
NOR	11OCT83	0	0.0050	< 0.005	0.000020743	< 0.001	< 0.003	11.5	.	7.30	< 1.00	1.6	12.30	.	.
NOR	15NOV83	0	0.0140	0.037	0.000078552	< 0.001	0.008	8.8	.	7.10	3.00	2.8	21.50	.	.
NOR	13DEC83	0	0.0030	< 0.010	.	< 0.001	0.024	4.0	.	.	< 1.00	< 1.0	19.70	.	.
NOR	17JAN84	0	0.0050	< 0.005	0.000011708	< 0.001	0.014	1.5	.	7.40	< 1.00	< 1.0	22.90	.	.
NOR	11FEB84	0	0.0080	0.007	0.000012721	< 0.001	0.023	4.0	.	7.20	< 1.00	< 1.0	23.30	0.097	0.1200
NOR	12MAR84	0	0.0030	0.007	0.000013799	< 0.001	0.015	5.0	.	7.20	< 1.00	< 1.0	22.10	0.094	0.1090
NOR	16APR84	0	0.0040	0.008	0.000021709	< 0.001	0.011	9.0	.	7.20	< 1.00	< 1.0	20.40	0.070	0.0810
NOR	14MAY84	0	0.0060	0.007	0.000012978	< 0.001	0.023	10.0	.	7.00	< 1.00	< 1.0	21.80	0.170	0.1930
NOR	13JUN84	0	0.0020	0.006	0.000051079	< 0.001	0.014	18.0	.	7.40	< 1.00	< 1.0	21.10	0.140	0.1540
NOR	24JUL84	0	0.0020	0.006	0.000125430	< 0.001	0.024	21.0	.	7.70	< 1.00	< 1.0	20.40	0.130	0.1540
NOR	27AUG84	0	0.0030	0.005	0.000053469	< 0.001	0.040	18.0	.	7.50	.	.	.	0.210	0.2500
NOR	24SEP84	0	0.0040	< 0.005	0.000009655	< 0.001	0.003	13.5	.	6.90	.	.	.	0.200	0.2030
NOR	22OCT84	0	0.0030	< 0.010	0.000073402	< 0.001	0.008	10.0	.	7.60	.	.	.	0.055	0.0630

GENERAL WATER QUALITY

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DATE	DEPTH		TPHOS		NH4	NH3	NO2		NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
DFO	05JUN84	1		0.002	<	0.004	.	.		0.002	14.9	.	.	.	.	.	.	.
DFO	05JUN84	3		0.002	<	0.004	.	.		0.001	14.6	.	.	.	.	.	.	.
DFO	05JUN84	5		0.002	<	0.004	.	.		0.001	14.0	.	.	.	.	.	.	.
DFO	05JUN84	10		0.002	<	0.004	.	.		0.002	12.0	.	.	.	.	.	.	.
DFO	26JUN84	1		0.003	<	0.004	.	.	<	0.001	19.2	.	.	.	.	.	.	.
DFO	26JUN84	1		0.003	<	0.004	.	.	<	0.001	19.7	.	.	.	.	.	.	.
DFO	26JUN84	3		0.007		0.008	.	.	<	0.001	18.9	.	.	.	.	.	.	.
DFO	26JUN84	5		0.002	<	0.004	.	.	<	0.001	17.9	.	.	.	.	.	.	.
DFO	26JUN84	9		0.002	<	0.004	.	.	<	0.001	12.6	.	.	.	.	.	.	.
DFO	10JUL84	1		0.002	<	0.004	.	.		0.001	20.5	.	.	.	.	.	.	.
DFO	10JUL84	1		0.004		0.005	.	.		0.001	.	.	.	.	.	.	.	.
DFO	10JUL84	3		0.002		0.005	.	.		0.001	19.6	.	.	.	.	.	.	.
DFO	10JUL84	3		0.005	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	10JUL84	5		0.003	<	0.004	.	.		0.001	18.8	.	.	.	.	.	.	.
DFO	10JUL84	5		0.004		0.006	.	.		0.001	.	.	.	.	.	.	.	.
DFO	10JUL84	9		0.003	<	0.004	.	.		0.001	14.0	.	.	.	.	.	.	.
DFO	25JUL84	1		0.001	<	0.004	.	.		0.001	22.8	.	.	.	.	.	.	.
DFO	25JUL84	1		0.001	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	25JUL84	3		0.002	<	0.004	.	.		0.001	22.5	.	.	.	.	.	.	.
DFO	25JUL84	3		0.003	<	0.004	.	.		0.002	.	.	.	.	.	.	.	.
DFO	25JUL84	5		0.002	<	0.004	.	.		0.001	21.2	.	.	.	.	.	.	.
DFO	25JUL84	10		0.002	<	0.004	.	.		0.002	13.5	.	.	.	.	.	.	.
DFO	08AUG84	1		0.002	<	0.004	.	.		0.002	19.1	.	.	.	.	.	.	.
DFO	08AUG84	1		0.002	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	08AUG84	3		0.002	<	0.004	.	.	<	0.001	19.0	.	.	.	.	.	.	.
DFO	08AUG84	3		0.003	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	08AUG84	5		0.002	<	0.004	.	.	<	0.001	18.7	.	.	.	.	.	.	.
DFO	08AUG84	5		0.002	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	08AUG84	8		0.002	<	0.004	.	.		0.002	16.5	.	.	.	.	.	.	.
DFO	08AUG84	8		0.002	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	21AUG84	1		0.001	<	0.004	.	.		0.003	19.8	.	.	.	.	.	.	.
DFO	21AUG84	1	<	0.001	<	0.004	.	.		0.004	.	.	.	.	.	.	.	.
DFO	21AUG84	3		0.002	<	0.004	.	.		0.002	19.6	.	.	.	.	.	.	.
DFO	21AUG84	3		0.001	<	0.004	.	.		0.002	.	.	.	.	.	.	.	.
DFO	21AUG84	5		0.002	<	0.004	.	.		0.003	19.5	.	.	.	.	.	.	.
DFO	21AUG84	10		0.002	<	0.004	.	.		0.002	14.4	.	.	.	.	.	.	.
DFO	05SEP84	1		0.002	<	0.004	.	.		0.002	.	.	.	.	.	.	.	.
DFO	05SEP84	1		0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	3		0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	3		0.002		0.013	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	5		0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	5		0.002		0.005	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	10		0.003	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	10		0.004		0.006	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	18SEP84	1	<	0.001	<	0.004	.	.		0.001	16.1	.	.	.	.	.	.	.
DFO	18SEP84	1	<	0.001	<	0.004	.	.		0.002	.	.	.	.	.	.	.	.
DFO	18SEP84	3	<	0.001	<	0.004	.	.		0.001	16.0	.	.	.	.	.	.	.

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DAYTE	DEPTH		TPHOS		NH4	NH3		NO2		NO3	WTEMP	PH_L	PH_F		TURB		SS	HARD	KJEL	TN
DFO	18SEP84	3.0		0.002	<	0.004	.		.		0.002	.	.	.		.		.	.	.	.
DFO	18SEP84	5.0	<	0.001	<	0.004	.		.		0.002	15.9	.	.		.		.	.	.	.
DFO	18SEP84	5.0		0.001	<	0.004	.		.		0.004	.	.	.		.		.	.	.	.
DFO	18SEP84	10.0	<	0.001	<	0.004	.		.		0.002	15.2	.	.		.		.	.	.	.
DFO	18SEP84	10.0	<	0.001	<	0.004	.		.		0.001	.	.	.		.		.	.	.	.
DFO	03OCT84	1.0	<	0.001	<	0.004	.		.		0.001	14.3	.	.		.		.	.	.	.
DFO	03OCT84	1.0	<	0.001	<	0.004	.		.	<	0.001	.	.	.		.		.	.	.	.
DFO	03OCT84	3.0	<	0.001	<	0.004	.		.		0.001	14.2	.	.		.		.	.	.	.
DFO	03OCT84	3.0	<	0.001	<	0.004	.		.		0.001	.	.	.		.		.	.	.	.
DFO	03OCT84	5.0	<	0.001	<	0.004	.		.		0.002	14.1	.	.		.		.	.	.	.
DFO	03OCT84	5.0	<	0.001	<	0.004	.		.		0.002	.	.	.		.		.	.	.	.
DFO	03OCT84	8.0		0.001	<	0.004	.		.		0.001	13.9	.	.		.		.	.	.	.
DFO	03OCT84	9.0	<	0.001	<	0.004	.		.		0.003	.	.	.		.		.	.	.	.
DFO	16OCT84	1.0		0.002		0.007	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	1.0		0.001		0.006	.		.		0.008	.	.	.		.		.	.	.	.
DFO	16OCT84	3.0		0.001		0.007	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	3.0		0.004		0.008	.		.		0.008	.	.	.		.		.	.	.	.
DFO	16OCT84	5.0		0.003		0.007	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	5.0		0.002		0.008	.		.		0.008	.	.	.		.		.	.	.	.
DFO	16OCT84	9.0		0.001		0.010	.		.		0.008	.	.	.		.		.	.	.	.
DFO	16OCT84	10.0		0.002		0.007	.		.		0.010	.	.	.		.		.	.	.	.
EPS	24JUN83	1.0		0.016*		0.007	.	<	0.005		0.020	.	.	7.80		0.2		.	20.4	.	0.109
EPS	24JUN83	5.0		0.013*		0.008	.	<	0.005		0.020	.	.	7.95		0.2		.	20.3	.	0.088
EPS	24JUN83	9.0		0.015*		0.010	.	<	0.005		0.020	.	.	7.28		0.2		.	17.5	.	0.087
EPS	24JUN83	10.0		0.014*		0.013	.	<	0.005		0.020	.	.	7.05		0.2		.	17.5	.	0.090
EPS	13MAR84	1.0		0.004	<	0.005	0.0000217940	<	0.005		0.011	6.3	.	7.50		0.1	<	5	16.0	.	0.125
EPS	13MAR84	2.0		0.005	<	0.005	0.0000137732	<	0.005		0.011	6.3	.	7.30	<	0.1	<	5	16.0	.	0.115
EPS	13MAR84	7.0		0.004	<	0.005	0.0000156035	<	0.005		0.012	5.0	.	7.40	<	0.1	<	5	16.0	.	0.081
EPS	13MAR84	10.0		0.004	<	0.005	0.0000096979	<	0.005		0.013	4.8	.	7.20	<	0.1	<	5	16.0	.	0.091
EPS	28MAY84	1.0	<	0.002	<	0.005	0.0000537610	<	0.005	<	0.002	15.0	.	7.60	<	0.1	<	5	16.9	.	0.070
EPS	28MAY84	4.0	<	0.002	<	0.005	0.0000480174	<	0.005	<	0.002	13.5	.	7.60	<	0.1		6	16.9	.	0.080
EPS	28MAY84	9.0	<	0.002		0.005	0.0000340820	<	0.005	<	0.002	12.0	.	7.50	<	0.1	<	5	16.9	.	0.078
EPS	28MAY84	13.0	<	0.002		0.008	0.0000778974	<	0.005		0.004	10.7	.	7.70	<	0.1		6	17.0	.	0.078
EPS	24JUL84	1.0	<	0.002		0.003	.	<	0.002		0.005	.	.	.		.		.	.	.	0.148
EPS	24JUL84	5.0		0.002		0.006	.	<	0.002	<	0.005	.	.	.		.		.	.	.	0.129
EPS	24JUL84	8.0		0.002		0.005	.	<	0.002	<	0.005	.	.	.		.		.	.	.	0.100
EPS	24JUL84	10.0		0.002		0.010	.	<	0.002		0.007	.	.	.		.		.	.	.	0.122
EPS	09SEP84	1.0		0.004		0.010	0.0000223026	<	0.005	<	0.010	15.4	.	6.90		0.2	<	5	20.5	.	0.110
EPS	09SEP84	6.0		0.005		0.010	0.0000350365	<	0.005	<	0.010	15.3	.	7.10		0.1	<	5	20.5	.	0.090
EPS	09SEP84	11.0		0.006		0.019	0.0000282761	<	0.005	<	0.010	13.1	.	6.80		0.2	<	5	19.3	.	0.103
EPS	09SEP84	15.0		0.006		0.105	.	<	0.005		0.030	.	.	.		.		.	.	.	0.200
MOE	03MAY84	0.0		0.005	<	0.005	.	<	0.005	<	0.020	.	7.5	.		.		.	.	.	.
MOE	24JUL84	0.0		0.009	<	0.005	.	<	0.005	<	0.020	.	7.7	.		.		.	18.1	.	.
MOE	20AUG84	0.5		0.008		0.007	.		.		.	.	7.5	.		0.3		.	20.7	.	.
MOE	20AUG84	6.0		0.008		.	.		.		.	.	.	.		.		.	.	.	.
MOE	20AUG84	9.0		0.011		.	.		.		.	.	.	.		.		.	.	.	.
MOE	20AUG84	13.0	3	0.007		.	.		.		.	.	.	.		.		.	.	.	.

* Not included in statistics

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DATE	DEPTH		TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
MOE	12SEP84	1.0		0.006	.	.	.	.	.	7.6	.	.	.	.	.	.
MOE	12SEP84	7.0		0.007	.	.	.	.	.	7.5	.	.	.	.	.	.
MOE	12SEP84	11.0	1	0.008	.	.	.	.	.	7.2	.	.	.	.	.	.
MOE	12SEP84	13.0	3	0.007	.	.	.	.	.	7.0	.	.	.	.	.	.
MOE	05DEC84	0.0		0.005	0.007	.	< 0.005	0.020	.	7.1	.	.	.	14.2	.	.
MOE	16SEP85	0.0		0.006	.	.	.	.	.	7.5	.	.	.	.	.	.
MOE	14APR86	0.5		0.006	< 0.005	.	.	.	.	7.1	.	.	2.0	.	.	.
MOE	13MAY86	0.0		0.004	< 0.005	.	.	.	.	7.0	.	0.40	1.0	.	.	.
MOE	12JUN86	1.0		0.005	0.005	.	< 0.005	.	.	7.0	.	.	2.0	.	.	.
MOE	12JUN86	5.0		0.007	< 0.005	.	< 0.005	.	.	7.0	.	.	2.0	.	.	.
MOE	12JUN86	12.0	2	0.008	0.012	.	< 0.005	.	.	6.8	.	.	2.0	.	.	.
MOE	09JUL86	0.0		0.005	0.008	.	< 0.005	.	.	7.5	.	.	.	.	.	.
MOE	09JUL86	5.0		0.006	0.006	.	< 0.005	.	.	6.9	.	.	.	.	.	.
MOE	09JUL86	5.0		0.006	< 0.005	.	< 0.005	.	.	7.3	.	.	.	.	.	.
MOE	09JUL86	10.0	0	0.004	0.005	.	< 0.005	.	.	7.2	.	.	.	.	.	.
MOE	11AUG86	0.5		0.003	< 0.005	.	.	.	.	7.6	.	.	1.0	.	.	.
MOE	11AUG86	0.5		0.003	< 0.005	.	.	.	.	7.7	.	.	1.0	.	.	.
MOE	11AUG86	6.0		0.005	< 0.005	.	.	.	.	7.2	.	.	1.0	.	.	.
MOE	11AUG86	6.0		0.003	< 0.005	.	.	.	.	7.6	.	.	.	.	.	.
MOE	11AUG86	10.0	0	0.003	< 0.005	.	.	.	.	7.7	.	.	1.0	.	.	.
MOE	11AUG86	10.0	0	0.006	< 0.005	.	.	.	.	7.2	.	.	1.0	.	.	.
MOE	23SEP86	1.0		0.003	< 0.005	.	.	.	.	7.3	.	.	1.0	.	.	.
MOE	23SEP86	1.0		0.003	< 0.005	.	.	.	.	7.3	.	.	1.0	.	.	.
MOE	23SEP86	4.0		0.003	< 0.005	.	.	.	.	7.3	.	.	1.0	.	.	.
MOE	23SEP86	4.0		0.003	< 0.005	.	.	.	.	7.3	.	.	1.0	.	.	.
MOE	23SEP86	9.0		0.003	< 0.005	.	.	.	.	7.2	.	.	1.0	.	.	.
MOE	28OCT86	1.0		0.003	0.011	.	.	.	.	7.0	.	.	1.0	.	.	.
MOE	28OCT86	1.0		0.003	0.009	.	.	.	.	7.0	.	.	1.0	.	.	.
MOE	28OCT86	4.0		0.003	0.007	.	.	.	.	7.1	.	.	1.0	.	.	.
MOE	28OCT86	9.0		0.003	0.009	.	.	.	.	7.1	.	.	1.0	.	.	.
NOR	24FEB83	0.0		0.008	< 0.010	0.000142549	< 0.001	< 0.005	4.0	.	8.1	0.68	< 1.0	14.1	.	.
NOR	24FEB83	2.5		< 0.003	< 0.010	0.000028771	< 0.001	< 0.005	4.0	.	7.4	0.81	1.2	13.9	.	.
NOR	24FEB83	5.0		0.012	< 0.010	0.000090418	< 0.001	0.013	4.0	.	7.9	0.65	1.6	15.7	.	.
NOR	18MAY83	1.0		0.008	< 0.010	.	< 0.001	< 0.005	16.0	.	.	< 1.00	< 1.0	18.7	0.051	0.056
NOR	18MAY83	3.0		0.010	< 0.010	.	< 0.001	< 0.005	16.0	.	.	< 1.00	< 1.0	18.9	0.033	0.038
NOR	18MAY83	6.0		0.010	< 0.010	.	< 0.001	0.005	13.0	.	.	< 1.00	< 1.0	17.8	0.031	0.036
NOR	14JUN83	1.0		0.004	< 0.010	0.000091601	< 0.001	< 0.005	19.0	.	7.4	< 1.00	< 1.0	21.6	0.062	0.067
NOR	14JUN83	3.0		0.004	< 0.010	0.000091601	< 0.001	< 0.005	19.0	.	7.4	< 1.00	< 1.0	21.6	0.049	0.054
NOR	14JUN83	5.0		0.003	< 0.010	0.000090273	< 0.001	< 0.005	18.8	.	7.4	< 1.00	< 1.0	21.8	0.051	0.056
NOR	12JUL83	1.0		0.004	< 0.010	0.000041293	< 0.001	< 0.005	17.5	.	7.1	< 1.00	1.6	19.4	0.031	0.036
NOR	12JUL83	5.0		0.006	< 0.010	0.000065288	< 0.001	< 0.005	17.5	.	7.3	< 1.00	3.6	20.7	0.081	0.086
NOR	12JUL83	10.0		0.005	< 0.010	0.000029352	< 0.001	< 0.005	10.0	.	7.2	< 1.00	1.6	17.9	0.061	0.066
NOR	18AUG83	1.0		0.004	< 0.010	0.000090556	< 0.001	< 0.005	22.0	.	7.3	< 1.00	6.0	21.3	0.035	0.040
NOR	18AUG83	7.0		0.004	< 0.010	0.000094998	< 0.001	< 0.005	19.5	.	7.4	< 1.00	< 1.0	19.9	0.095	0.100
NOR	18AUG83	11.0		0.005	< 0.010	0.000027248	< 0.001	< 0.005	12.0	.	7.1	< 1.00	1.0	18.3	0.020	0.025
NOR	14SEP83	1.0		0.004	< 0.005	0.000019894	< 0.001	< 0.003	17.0	.	7.1	< 1.00	1.2	19.8	< 0.010	0.013
NOR	14SEP83	6.0		0.005	< 0.005	0.000031457	< 0.001	< 0.003	17.0	.	7.3	< 1.00	2.4	17.6	0.062	0.065

GENERAL WATER QUALITY

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DATE	DEPTH	TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
NOR	14SEP83	12	0.006	< 0.005	0.000004153	< 0.001	< 0.003	11.5	.	6.6	< 1	4.0	17.0	0.051	0.054
NOR	13OCT83	1	0.003	< 0.005	0.000036791	< 0.001	< 0.003	13.0	.	7.5	< 1	< 1.0	22.1	0.120	0.123
NOR	13OCT83	6	0.004	< 0.005	0.000058060	< 0.001	< 0.003	13.0	.	7.7	< 1	1.2	23.6	0.180	0.183
NOR	13OCT83	13	0.003	0.025	0.000112014	< 0.001	< 0.003	12.5	.	7.3	< 1	1.6	24.0	0.120	0.123
NOR	14DEC83	1	0.004	< 0.010	0.000018172	0.002	0.010	4.0	.	7.2	< 1	2.4	19.2	0.043	0.053
NOR	14DEC83	5	0.002	0.014	0.000020216	< 0.001	0.011	4.0	.	7.1	< 1	2.0	19.5	0.100	0.111
NOR	14DEC83	11	0.004	< 0.010	0.000018928	< 0.001	0.007	4.5	.	7.2	< 1	2.0	19.9	0.180	0.187
NOR	18JAN84	1	0.005	< 0.005	0.000006652	< 0.001	0.023	3.0	.	7.1	< 1	< 1.0	17.7	0.110	0.133
NOR	18JAN84	5	0.005	< 0.005	0.000005737	< 0.001	0.009	4.0	.	7.0	< 1	< 1.0	19.9	0.054	0.063
NOR	18JAN84	12	0.005	< 0.005	0.000002997	< 0.001	0.015	4.5	.	6.7	< 1	< 1.0	22.0	< 0.020	0.035
NOR	10FEB84	1	0.010	0.008	0.000023016	< 0.001	0.017	4.0	.	7.4	< 1	< 1.0	18.3	0.056	0.073
NOR	10FEB84	5	0.011	< 0.005	0.000009464	< 0.001	0.008	4.5	.	7.2	< 1	< 1.0	22.5	0.071	0.079
NOR	10FEB84	10	0.009	< 0.005	0.000005970	< 0.001	0.017	4.5	.	7.0	< 1	< 1.0	23.9	0.051	0.068
NOR	13MAR84	1	0.003	< 0.005	0.000007024	< 0.001	0.005	6.5	.	7.0	< 1	< 1.0	19.2	0.072	0.077
NOR	13MAR84	6	0.003	< 0.005	0.000006481	< 0.001	0.007	5.5	.	7.0	< 1	< 1.0	19.0	0.040	0.047
NOR	13MAR84	12	0.002	< 0.005	0.000006481	< 0.001	0.007	5.5	.	7.0	< 1	1.6	19.2	0.026	0.033
NOR	17APR84	1	0.003	< 0.005	0.000013568	< 0.001	0.003	9.0	.	7.2	< 1	< 1.0	16.1	0.070	0.073
NOR	17APR84	5	0.003	0.021	0.000068922	< 0.001	0.003	8.5	.	7.3	< 1	< 1.0	16.6	0.090	0.093
NOR	17APR84	9	0.004	0.010	0.000026087	< 0.001	0.005	8.5	.	7.2	< 1	< 1.0	16.7	0.200	0.205
NOR	17APR84	12	0.003	0.008	0.000016586	< 0.001	0.004	8.5	.	7.1	< 1	< 1.0	16.9	0.040	0.044
NOR	15MAY84	1	0.001	< 0.005	0.000034082	< 0.001	0.001	12.0	.	7.5	< 1	1.2	15.5	0.140	0.141
NOR	15MAY84	6	0.001	0.005	0.000026086	< 0.001	0.001	11.5	.	7.4	< 1	< 1.0	16.1	0.110	0.111
NOR	15MAY84	12	0.002	0.011	0.000032287	< 0.001	0.002	10.0	.	7.2	< 1	< 1.0	15.7	0.230	0.232
NOR	11JUN84	1	0.003	< 0.005	0.000062375	< 0.001	0.001	17.0	.	7.6	< 1	< 1.0	17.7	0.013	0.014
NOR	11JUN84	9	0.002	0.007	0.000059964	< 0.001	0.001	12.0	.	7.6	< 1	< 1.0	17.6	0.220	0.221
NOR	11JUN84	12	0.003	0.012	0.000098923	< 0.001	0.002	11.5	.	7.6	< 1	< 1.0	17.0	0.180	0.182
NOR	24JUL84	1	< 0.001	0.005	0.000112197	< 0.001	0.003	22.0	.	7.7	< 1	< 1.0	18.2	0.220	0.223
NOR	24JUL84	6	0.002	0.006	0.000146286	< 0.001	0.002	20.0	.	7.8	< 1	< 1.0	17.1	0.160	0.162
NOR	24JUL84	12	0.005	0.007	0.000019822	< 0.001	0.001	12.5	.	7.1	< 1	< 1.0	16.1	0.270	0.271
NOR	27AUG84	1	0.003	0.006	0.000112663	< 0.001	0.001	19.5	.	7.7	.	.	.	0.210	0.211
NOR	27AUG84	8	0.003	0.007	0.000153237	< 0.001	< 0.001	18.5	.	7.8	.	.	.	0.160	0.161
NOR	27AUG84	12	0.004	0.005	0.000023277	< 0.001	< 0.001	13.0	.	7.3	.	.	.	0.220	0.221
NOR	24SEP84	1	0.004	< 0.005	0.000008598	< 0.001	0.001	15.0	.	6.8	.	.	.	0.140	0.141
NOR	24SEP84	5	0.003	0.007	0.000009565	< 0.001	0.003	15.0	.	6.7	.	.	.	0.016	0.019
NOR	24SEP84	12	0.004	0.008	0.000017312	< 0.001	0.003	15.0	.	6.9	.	.	.	0.130	0.133
NOR	22OCT84	1	0.003	< 0.005	0.000005853	< 0.001	0.009	10.0	.	6.8	.	.	.	0.076	0.085
NOR	22OCT84	6	0.003	0.008	0.000056476	< 0.001	0.008	9.5	.	7.6	.	.	.	0.080	0.088
NOR	22OCT84	12	0.001	0.005	0.000017753	< 0.001	0.010	9.5	.	7.3	.	.	.	0.080	0.090

GENERAL WATER QUALITY

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DAYTE	DEPTH	TPHOS		NH4	NH3	NO2		NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
DFO	26JUN84	1	0.003	<	0.004	.	.		0.001	18.5	.	.	.	.	.	.	.
DFO	26JUN84	3	0.003	<	0.004	.	.		0.001	18.3	.	.	.	.	.	.	.
DFO	26JUN84	3	0.004	<	0.004	.	.		0.003	18.2	.	.	.	.	.	.	.
DFO	26JUN84	5	0.003		0.005	.	.		0.002	13.2	.	.	.	.	.	.	.
DFO	26JUN84	5	0.003	<	0.004	.	.		0.001	12.7	.	.	.	.	.	.	.
DFO	26JUN84	10	0.003	<	0.004	.	.		0.002	9.8	.	.	.	.	.	.	.
DFO	26JUN84	15	0.003	<	0.004	.	.		0.006	6.7	.	.	.	.	.	.	.
DFO	10JUL84	1	0.003		0.008	.	.		0.002	.	.	.	.	.	.	.	.
DFO	10JUL84	1	0.004	<	0.004	.	.		0.001	18.8	.	.	.	.	.	.	.
DFO	10JUL84	3	0.004	<	0.004	.	.		0.001	.	.	.	.	.	.	.	.
DFO	10JUL84	3	0.004	<	0.004	.	.	<	0.001	18.3	.	.	.	.	.	.	.
DFO	10JUL84	5	0.004	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	10JUL84	5	0.004	<	0.004	.	.		0.001	13.8	.	.	.	.	.	.	.
DFO	10JUL84	10	0.005		0.005	.	.		0.003	.	.	.	.	.	.	.	.
DFO	10JUL84	10	0.004		0.010	.	.		0.006	7.3	.	.	.	.	.	.	.
DFO	25JUL84	1	0.002	<	0.004	.	.		0.002	21.8	.	.	.	.	.	.	.
DFO	25JUL84	1	0.003	<	0.004	.	.	<	0.001	21.5	.	.	.	.	.	.	.
DFO	25JUL84	3	0.002	<	0.004	.	.		0.002	20.9	.	.	.	.	.	.	.
DFO	25JUL84	3	.	<	0.004	.	.		0.001	20.9	.	.	.	.	.	.	.
DFO	25JUL84	5	0.004	<	0.004	.	.		0.001	15.5	.	.	.	.	.	.	.
DFO	25JUL84	5	.	<	0.004	.	.		0.001	14.8	.	.	.	.	.	.	.
DFO	25JUL84	10	0.003		0.005	.	.		0.003	7.4	.	.	.	.	.	.	.
DFO	25JUL84	10	0.004		0.006	.	.		0.005	7.5	.	.	.	.	.	.	.
DFO	08AUG84	1	0.002	<	0.004	.	.		0.001	19.6	.	.	.	.	.	.	.
DFO	08AUG84	1	0.001	<	0.004	.	.		0.002	19.5	.	.	.	.	.	.	.
DFO	08AUG84	3	0.002	<	0.004	.	.		0.001	19.5	.	.	.	.	.	.	.
DFO	08AUG84	3	0.002	<	0.004	.	.	<	0.001	19.4	.	.	.	.	.	.	.
DFO	08AUG84	5	0.001	<	0.004	.	.		0.002	17.2	.	.	.	.	.	.	.
DFO	08AUG84	5	0.001	<	0.004	.	.	<	0.001	16.6	.	.	.	.	.	.	.
DFO	08AUG84	8	0.002		0.005	.	.		0.002	9.1	.	.	.	.	.	.	.
DFO	08AUG84	10	0.001	<	0.004	.	.		0.018	8.2	.	.	.	.	.	.	.
DFO	21AUG84	1	0.002	<	0.004	.	.		0.001	19.0	.	.	.	.	.	.	.
DFO	21AUG84	1	0.002	<	0.004	.	.		0.001	18.8	.	.	.	.	.	.	.
DFO	21AUG84	3	0.002	<	0.004	.	.		0.001	18.6	.	.	.	.	.	.	.
DFO	21AUG84	3	0.002	<	0.004	.	.	<	0.001	18.5	.	.	.	.	.	.	.
DFO	21AUG84	5	0.004	<	0.004	.	.	<	0.001	17.8	.	.	.	.	.	.	.
DFO	21AUG84	5	0.010	<	0.004	.	.		0.009	18.1	.	.	.	.	.	.	.
DFO	21AUG84	10	0.002	<	0.004	.	.		0.002	8.0	.	.	.	.	.	.	.
DFO	21AUG84	10	0.004	<	0.004	.	.		0.006	8.6	.	.	.	.	.	.	.
DFO	05SEP84	1	0.003	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	1	0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	3	0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	3	0.003	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	5	0.002	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	5	0.003	<	0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	10	0.002		0.004	.	.	<	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	10	0.003	<	0.004	.	.		0.009	.	.	.	.	.	.	.	.

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DATE	DEPTH		TPHOS		NH4	NH3		NO2		NO3	WTEMP	PH_L	PH_F		TURB		SS	HARD	KJEL	TN
DFO	18SEP84	1.0		0.001	<	0.004	.		.		0.002	15.5	.	.		.		.	.	.	.
DFO	18SEP84	1.0		0.002	<	0.004	.		.		0.001	15.8	.	.		.		.	.	.	.
DFO	18SEP84	3.0		0.001	<	0.004	.		.		0.001	15.2	.	.		.		.	.	.	.
DFO	18SEP84	3.0		0.003	<	0.004	.		.		0.001	15.4	.	.		.		.	.	.	.
DFO	18SEP84	5.0		0.002	<	0.004	.		.		0.001	14.8	.	.		.		.	.	.	.
DFO	18SEP84	5.0		0.002		0.004	.		.		0.001	15.1	.	.		.		.	.	.	.
DFO	18SEP84	10.0		0.002	<	0.004	.		.		0.005	8.1	.	.		.		.	.	.	.
DFO	18SEP84	10.0	<	0.001	<	0.004	.		.		0.008	8.4	.	.		.		.	.	.	.
DFO	03OCT84	1.0		0.001		0.010	.		.		0.001	13.2	.	.		.		.	.	.	.
DFO	03OCT84	1.0		0.002	<	0.004	.		.		0.001	13.2	.	.		.		.	.	.	.
DFO	03OCT84	3.0		0.002	<	0.004	.		.		0.002	13.0	.	.		.		.	.	.	.
DFO	03OCT84	3.0		0.003		0.017	.		.		0.001	13.0	.	.		.		.	.	.	.
DFO	03OCT84	5.0		0.001	<	0.004	.		.		0.001	12.8	.	.		.		.	.	.	.
DFO	03OCT84	5.0		0.001		0.022	.		.		0.001	12.8	.	.		.		.	.	.	.
DFO	03OCT84	9.0		0.002	<	0.004	.		.		0.002	8.5	.	.		.		.	.	.	.
DFO	03OCT84	10.0		0.002	<	0.004	.		.		0.002	8.1	.	.		.		.	.	.	.
DFO	16OCT84	1.0		0.004	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	1.0		0.004	<	0.004	.		.		0.006	.	.	.		.		.	.	.	.
DFO	16OCT84	3.0		0.005	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	3.0		0.005	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	5.0		0.004	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	5.0		0.003	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
DFO	16OCT84	10.0		0.004	<	0.004	.		.		0.006	.	.	.		.		.	.	.	.
DFO	16OCT84	10.0		0.004	<	0.004	.		.		0.007	.	.	.		.		.	.	.	.
EPS	22JUN83	1.0		0.014*		0.006	.	<	0.005		0.020	.	.	7.85		0.1		.	11.40	.	0.141
EPS	22JUN83	4.0		0.012*		0.006	.	<	0.005		0.020	.	.	7.80		0.1		.	11.60	.	0.118
EPS	22JUN83	8.0		0.015*		0.006	.	<	0.005		0.020	.	.	7.50		0.1		.	9.71	.	0.084
EPS	22JUN83	15.0		0.012*		0.010	.	<	0.005		0.020	.	.	7.20		0.1		.	9.71	.	0.079
EPS	13MAR84	0.0		.		.	.		.		.	4.6	.	.		.		.	.	.	.
EPS	13MAR84	1.0		0.005		0.005	0.0000095415	<	0.005		0.012	4.6	.	7.20	<	0.1	<	5	10.00	.	0.135
EPS	13MAR84	4.0		0.007		0.008	0.0000151427	<	0.005		0.011	4.5	.	7.20	<	0.1	<	5	10.00	.	0.128
EPS	13MAR84	10.0		0.006		0.007	0.0000203044	<	0.005		0.013	4.1	.	7.40	<	0.1	<	5	10.00	.	0.135
EPS	13MAR84	16.0		0.007		0.013	0.0000367960	<	0.005		0.015	3.8	.	7.40	<	0.1	<	5	10.00	.	0.140
EPS	28MAY84	1.0	<	0.002	<	0.005	0.0000126204	<	0.005	<	0.002	14.0	.	7.00	<	0.1	<	5	11.90	.	0.112
EPS	28MAY84	4.0	<	0.002	<	0.005	0.0000108281	<	0.005	<	0.002	12.0	.	7.00	<	0.1	<	5	11.90	.	0.123
EPS	28MAY84	10.0	<	0.002	<	0.005	0.0000045061	<	0.005	<	0.002	6.7	.	6.80	<	0.1	<	5	11.00	.	0.090
EPS	28MAY84	15.0	<	0.002		0.008	0.0000055025	<	0.005	<	0.002	6.2	.	6.70	<	0.1	<	5	11.10	.	0.106
EPS	24JUL84	1.0		0.004		0.008	0.0000714155	<	0.002	<	0.005	21.8	.	7.30	<	0.1	<	5	14.80	.	0.150
EPS	24JUL84	5.0		0.003		0.003	0.0000082924	<	0.002	<	0.005	15.2	.	7.00	<	0.1	<	5	13.40	.	0.140
EPS	24JUL84	10.0		0.003		0.004	0.0000019736	<	0.002		0.005	7.8	.	6.50	<	0.1	<	5	11.50	.	0.120
EPS	24JUL84	16.0		0.002		0.010	0.0000057341	<	0.002		0.029	6.8	.	6.60	<	0.1	<	5	11.90	.	0.110
EPS	09SEP84	1.0		0.002		0.010	0.0000181285	<	0.005	<	0.010	15.7	.	6.80	<	0.1	<	5	13.70	.	.
EPS	09SEP84	6.0		0.003		0.010	0.0000262171	<	0.005	<	0.010	14.5	.	7.00	<	0.1	<	5	13.20	.	0.135
EPS	09SEP84	12.0		0.002		0.009	0.0000020884	<	0.005	<	0.010	7.0	.	6.20	<	0.1	<	5	10.90	.	0.100
EPS	09SEP84	18.0		0.005		0.014	0.0000019536	<	0.005		0.030	6.4	.	6.00	<	0.1	<	5	12.20	.	0.144
MOE	21AUG84	0.5		0.008		.	.		.		.	.	7.3	.		.		14	14.00	.	.
MOE	21AUG84	4.0		0.010		.	.		.		.	.	.	.		.		.	.	.	.

* Not included in statistics

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DATE	DEPTH		TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
MOE	21AUG84	11.0		0.009	.	.	.	.	.	.	.	.	.	.	.	.
MOE	21AUG84	20.0		0.011	.	.	.	.	.	.	.	.	.	.	.	.
MOE	12SEP84	1.0		0.007	.	.	.	.	.	7.4	.	.	.	.	.	.
MOE	12SEP84	4.0		0.009	.	.	.	.	.	7.4	.	.	.	.	.	.
MOE	12SEP84	8.0		0.006	.	.	.	.	.	6.9	.	.	.	.	.	.
MOE	12SEP84	16.0		0.008	.	.	.	.	.	6.7	.	.	.	.	.	.
MOE	14APR86	0.5		0.007	< 0.005	.	.	.	.	6.9	.	.	2.0	.	.	.
MOE	13MAY86	0.0		0.007	< 0.005	.	.	.	.	7.1	.	0.50	1.0	.	.	.
MOE	12JUN86	1.0		0.005	< 0.005	.	< 0.005	.	.	6.9	.	.	2.0	.	.	.
MOE	12JUN86	6.0		0.008	< 0.005	.	< 0.005	.	.	6.7	.	.	3.0	.	.	.
MOE	08JUL86	0.0		0.003	< 0.005	.	< 0.005	.	.	7.1	.	.	1.0	.	.	.
MOE	08JUL86	6.0		0.006	0.005	.	< 0.005	.	.	6.8	.	.	1.0	.	.	.
MOE	11AUG86	0.0		0.003	< 0.005	.	< 0.005	.	.	7.4	.	.	1.0	.	.	.
MOE	11AUG86	6.0		0.005	< 0.005	.	< 0.005	.	.	7.1	.	.	1.0	.	.	.
MOE	11AUG86	12.0	2	0.004	< 0.005	.	< 0.005	.	.	6.8	.	.	1.0	.	.	.
MOE	23SEP86	1.0		0.003	< 0.005	.	.	.	.	7.1	.	.	1.0	.	.	.
MOE	23SEP86	4.0		0.004	0.005	.	.	.	.	7.1	.	.	1.0	.	.	.
MOE	23SEP86	9.0		0.004	0.006	.	.	.	.	6.6	.	.	1.0	.	.	.
MOE	28OCT86	1.0		0.004	< 0.005	.	.	.	.	6.9	.	.	2.0	.	.	.
MOE	28OCT86	4.0		0.007	< 0.005	.	.	.	.	6.9	.	.	1.0	.	.	.
MOE	28OCT86	9.0		0.005	< 0.005	.	.	.	.	6.6	.	.	1.0	.	.	.
NOR	24FEB83	0.0		0.004	< 0.010	0.000224057	< 0.001	< 0.005	4.0	.	8.3	0.70	1.2	8.30	.	.
NOR	24FEB83	8.0		0.016	< 0.010	0.000224057	< 0.001	< 0.005	4.0	.	8.3	0.71	< 1.0	7.94	.	.
NOR	24FEB83	16.0		0.011	< 0.010	0.000224057	< 0.001	< 0.005	4.0	.	8.3	0.66	< 1.0	8.07	.	.
NOR	19MAY83	1.0		0.010	< 0.010	.	< 0.001	0.006	15.0	.	.	< 1.00	< 1.0	10.80	0.042	0.048
NOR	19MAY83	5.0		0.007	< 0.010	.	< 0.001	0.004	12.0	.	.	< 1.00	< 1.0	10.70	0.019	0.023
NOR	19MAY83	10.0		0.010	< 0.010	.	< 0.001	0.005	8.0	.	.	< 1.00	< 1.0	9.71	0.038	0.043
NOR	19MAY83	17.0		0.009	< 0.010	.	< 0.001	0.005	6.0	.	.	< 1.00	< 1.0	9.84	0.048	0.053
NOR	15JUN83	1.0		0.002	< 0.010	0.000043486	< 0.001	< 0.005	18.2	.	7.1	< 1.00	< 1.0	21.40	0.063	0.068
NOR	15JUN83	5.0		0.004	< 0.010	0.000011206	< 0.001	< 0.005	12.4	.	6.7	< 1.00	< 1.0	12.10	0.091	0.096
NOR	15JUN83	8.0		0.003	< 0.010	0.000007334	< 0.001	< 0.005	7.0	.	6.7	< 1.00	< 1.0	10.10	0.039	0.044
NOR	15JUN83	16.0		0.004	< 0.010	0.000004272	< 0.001	< 0.005	6.0	.	6.5	< 1.00	< 1.0	9.79	0.032	0.037
NOR	14JUL83	1.0		0.005	< 0.010	0.000010175	< 0.001	< 0.005	17.2	.	6.5	< 1.00	2.8	12.70	0.091	0.096
NOR	14JUL83	8.0		0.004	< 0.010	0.000002195	< 0.001	< 0.005	9.2	.	6.1	< 1.00	3.2	9.97	0.053	0.058
NOR	14JUL83	18.0		0.004	< 0.010	0.000002696	< 0.001	< 0.005	6.0	.	6.3	< 1.00	5.0	10.20	0.063	0.068
NOR	17AUG83	1.0		0.005	< 0.010	0.000068040	< 0.001	< 0.005	21.2	.	7.2	< 1.00	< 1.0	13.30	0.110	0.115
NOR	17AUG83	6.0		0.006	< 0.010	0.000020060	< 0.001	< 0.005	14.0	.	6.9	< 1.00	< 1.0	10.30	0.047	0.052
NOR	17AUG83	17.0		0.006	< 0.010	0.000005734	< 0.001	< 0.005	6.8	.	6.6	< 1.00	< 1.0	10.40	0.068	0.073
NOR	15SEP83	1.0		0.008	< 0.005	0.000010369	< 0.001	< 0.003	17.5	.	6.8	< 1.00	2.8	12.40	0.046	0.049
NOR	15SEP83	7.0		0.008	< 0.005	0.000004486	< 0.001	< 0.003	12.5	.	6.6	< 1.00	1.6	9.10	0.160	0.163
NOR	15SEP83	18.0		0.006	< 0.005	0.000001461	< 0.001	0.007	7.0	.	6.3	< 1.00	2.8	9.50	0.130	0.137
NOR	14OCT83	1.0		0.006	< 0.005	0.000027110	< 0.001	< 0.003	12.0	.	7.4	< 1.00	1.2	13.80	0.100	0.103
NOR	14OCT83	9.0		0.004	< 0.005	0.000004471	< 0.001	< 0.003	9.5	.	6.7	< 1.00	< 1.0	10.50	0.081	0.084
NOR	14OCT83	17.0		0.002	< 0.005	0.000001839	< 0.001	0.020	7.0	.	6.4	1.00	1.2	11.70	0.088	0.108
NOR	15DEC83	1.0		0.003	0.018	0.000032710	< 0.001	0.008	4.0	.	7.2	< 1.00	2.4	11.90	0.260	0.268
NOR	15DEC83	8.0		0.003	0.015	0.000017927	< 0.001	0.006	4.5	.	7.0	< 1.00	1.2	11.80	0.210	0.216
NOR	15DEC83	16.0		0.004	0.020	0.000015088	< 0.001	0.006	4.5	.	6.8	< 1.00	2.0	11.70	0.170	0.176

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DAYTE	DEPTH	TPHOS		NH4	NH3		NO2		NO3	WTEMP	PH_L	PH_F		TURB		SS	HARD	KJEL	TN
NOR	18JAN84	1	0.017		0.011	0.0000040905	<	0.001		0.021	1.5	.	6.6	<	1	<	1.0	11.1	0.190	0.211
NOR	18JAN84	8	0.021	<	0.005	0.0000022855	<	0.001		0.012	4.0	.	6.6	<	1	<	1.0	11.5	0.053	0.065
NOR	18JAN84	17	0.005	<	0.010	0.0000028845	<	0.001		0.021	4.0	.	6.4	<	1	<	1.0	12.6	0.088	0.109
NOR	07FEB84	1	0.007	<	0.005	0.0000032011	<	0.001		0.022	2.5	.	6.8	<	1		1.6	12.5	0.120	0.142
NOR	07FEB84	10	0.006		0.007	0.0000031996	<	0.001		0.015	4.0	.	6.6	<	1	<	1.0	13.4	0.150	0.165
NOR	07FEB84	17	0.004		0.007	0.0000025418	<	0.001		0.026	4.0	.	6.5	<	1	<	1.0	14.4	0.180	0.206
NOR	14MAR84	1	0.003	<	0.005	0.0000039286	<	0.001		0.005	5.0	.	6.8	<	1		1.6	12.9	0.045	0.050
NOR	14MAR84	10	0.003		0.006	0.0000035961	<	0.001		0.009	4.5	.	6.7	<	1	<	1.0	13.2	0.071	0.080
NOR	14MAR84	18	0.004	<	0.005	0.0000022855	<	0.001		0.016	4.0	.	6.6	<	1	<	1.0	14.4	0.027	0.043
NOR	19APR84	1	0.004		0.008	0.0000131807	<	0.001		0.003	8.5	.	7.0	<	1	<	1.0	11.5	0.062	0.065
NOR	19APR84	8	0.004	<	0.005	0.0000044344	<	0.001		0.006	6.5	.	6.8	<	1	<	1.0	11.5	0.090	0.096
NOR	19APR84	17	0.004		0.008	0.0000054146	<	0.001		0.008	6.0	.	6.7	<	1	<	1.0	11.2	0.060	0.068
NOR	16MAY84	1	0.004		0.010		<	0.001		0.001	11.5	.	.	<	1	<	1.0	10.8	0.260	0.261
NOR	17MAY84	7	0.004		0.008	0.0000079981	<	0.001		0.001	8.0	.	6.8	<	1	<	1.0	10.5	0.170	0.171
NOR	17MAY84	18	0.004		0.009	0.0000038444	<	0.001		0.002	6.0	.	6.5	<	1	<	1.0	10.7	0.110	0.112
NOR	14JUN84	1	0.007		0.005	0.0000314572	<	0.001		0.001	17.0	.	7.3	<	1	<	1.0	12.1	0.080	0.081
NOR	14JUN84	8	0.009		0.007	0.0000084645	<	0.001	<	0.001	7.5	.	6.9	<	1	<	1.0	11.6	0.090	0.091
NOR	14JUN84	17	0.006		0.006	0.0000042276	<	0.001	<	0.001	6.5	.	6.7	<	1	<	1.0	10.7	0.160	0.161
NOR	25JUL84	1	0.003		0.007	0.0000486678	<	0.001		0.001	21.5	.	7.2	<	1	<	1.0	13.2	0.190	0.191
NOR	25JUL84	6	0.004		0.007	0.0000070388	<	0.001		0.002	11.0	.	6.7	<	1	<	1.0	10.4	0.150	0.152
NOR	25JUL84	17	0.004		0.013	0.0000072770	<	0.001		0.018	6.5	.	6.6	<	1	<	1.0	10.6	0.200	0.218
NOR	28AUG84	1	0.003		0.007	0.0000618193	<	0.001	<	0.001	18.5	.	7.4		.		.	.	0.190	0.191
NOR	28AUG84	6	0.004	<	0.005	0.0000147120	<	0.001	<	0.001	13.0	.	7.1		.		.	.	0.140	0.141
NOR	28AUG84	16	0.003		0.012	0.0000084552	<	0.001		0.041	6.5	.	6.7		.		.	.	0.240	0.281
NOR	24SEP84	1	0.004		0.004	0.0000104869	<	0.001	<	0.001	14.5	.	7.0		.		.	.	0.170	0.171
NOR	24SEP84	7	0.003		0.007	0.0000129778	<	0.001		0.002	10.0	.	7.0		.		.	.	0.190	0.192
NOR	24SEP84	17	0.003	<	0.005	0.0000035230	<	0.001		0.020	6.5	.	6.7		.		.	.	0.230	0.250
NOR	22OCT84	1	0.005		0.010	0.0000130917	<	0.001		0.007	8.5	.	6.9		.		.	.	0.150	0.157
NOR	22OCT84	8	0.003	<	0.005	0.0000079179	<	0.001		0.005	8.0	.	7.0		.		.	.	0.150	0.155
NOR	22OCT84	17	0.006		0.008	0.0000070950	<	0.001		0.041	6.5	.	6.8		.		.	.	0.086	0.127

SAMPLE SITE=SITE 4: LONG LAKE STREAM

AGENCY	DATE	DEPTH		TPHOS		NH4	NH3		NO2		NO3	WTEMP	PH_L	PH_F		TURB		SS	HARD	KJEL	TN
EPS	23JUN83	.		0.0130		0.0080	0.000182812	<	0.005		0.0200	16.0	.	7.9		0.10		.	12.20	.	0.120
EPS	28MAY84	0	<	0.0020	<	0.0050	0.000032062	<	0.005	<	0.0020	14.2	.	7.4		0.13		5.3	12.00	.	0.114
EPS	24JUL84	0		0.0047		0.0057	0.000031073	<	0.002		0.0067	21.3	.	7.1	<	0.10	<	5.0	14.50	.	0.162
EPS	09SEP84	0		0.0023		0.0100	0.000008561	<	0.005	<	0.0100	14.9	.	6.5	<	0.10	<	5.0	14.20	.	0.131
NOR	23JAN83	0	<	0.0050	<	0.0050	0.000003071	<	0.002	<	0.0050	2.0	.	6.8	<	0.10	<	1.0	8.00	.	.
NOR	25FEB83	0	<	0.0030	<	0.0100	0.000136903	<	0.001	<	0.0050	3.5	.	8.1		0.73	<	1.0	8.06	.	.
NOR	22MAR83	0		0.0070	<	0.0100	0.000015665	<	0.001	<	0.0050	5.0	.	7.1		0.60	<	1.0	9.77	.	.
NOR	19APR83	0		0.0070	<	0.0100	0.000025220	<	0.001	<	0.0050	11.0	.	7.1	<	1.00	<	1.0	14.00	.	.
NOR	15MAY83	0		0.0030	<	0.0100	0.000038334	<	0.001	<	0.0050	16.5	.	7.1	<	1.00		1.0	10.80	0.072	0.077
NOR	13JUN83	0		0.0030	<	0.0100	0.000041293	<	0.001	<	0.0050	17.5	.	7.1	<	1.00	<	1.0	11.70	0.081	0.086
NOR	11JUL83	0		0.0050	<	0.0100	0.000025519	<	0.001	<	0.0050	17.2	.	6.9	<	1.00		2.4	12.60	0.073	0.078
NOR	15AUG83	0		0.0050	<	0.0100	0.000062381	<	0.001	<	0.0050	20.0	.	7.2	<	1.00	<	1.0	13.90	0.100	0.105
NOR	16SEP83	0		0.0040	<	0.0050	0.000035358	<	0.001	<	0.0030	15.5	.	7.4	<	1.00		1.2	11.80	0.041	0.044
NOR	14OCT83	0		0.0030	<	0.0050	0.000009639	<	0.001	<	0.0030	10.5	.	7.0	<	1.00		1.2	14.60	0.380	0.383
NOR	15NOV83	0		0.0160		0.0280	0.000026901	<	0.001		0.0110	7.5	.	6.8		1.00	<	1.0	12.50	0.480	0.491
NOR	13DEC83	0		0.0040		0.0190	0.000026336	<	0.001		0.0160	3.5	.	7.1	<	1.00	<	1.0	11.90	0.210	0.226
NOR	18JAN84	0		0.0050		0.0100	0.000003719	<	0.001		0.0240	1.5	.	6.6	<	1.00	<	1.0	11.20	0.170	0.194
NOR	11FEB84	0		0.0100		0.0070	0.000005879	<	0.001		0.0170	3.0	.	6.9	<	1.00	<	1.0	14.40	0.089	0.106
NOR	14MAR84	0		0.0020		0.0080	0.000007912	<	0.001		0.0080	5.0	.	6.9	<	1.00	<	1.0	13.10	0.070	0.078
NOR	17APR84	0		0.0030		0.0080	0.000015321	<	0.001		0.0040	7.5	.	7.1	<	1.00		1.6	11.20	0.020	0.024
NOR	17MAY84	0		0.0040		0.0170	0.000027077	<	0.001		0.0010	11.0	.	6.9	<	1.00	<	1.0	10.90	0.100	0.101
NOR	13JUN84	0		0.0040		0.0050	0.000045801	<	0.001	<	0.0010	19.0	.	7.4	<	1.00	<	1.0	12.20	0.180	0.181
NOR	25JUL84	0		0.0060		0.0120	0.000057406	<	0.001		0.0060	19.5	.	7.1	<	1.00	<	1.0	13.40	0.130	0.136
NOR	27AUG84	0		0.0030		0.0100	0.000046120	<	0.001		0.0060	19.0	.	7.1		.		.	.	0.170	0.176
NOR	24SEP84	0		0.0030		0.0060	0.000013504	<	0.001		0.0020	12.5	.	7.0		.		.	.	0.150	0.152
NOR	22OCT84	0	<	0.0010		0.0140	0.000037992	<	0.001		0.0060	9.0	.	7.2		.		.	.	0.150	0.156

SAMPLE SITE=SITE 5: FLUME CREEK/LAKE

AGENCY	DATE	DEPTH	TPHOS		NH4	NH3		NO2		NO3	WTEMP	PH_L	PH_F		TURB		SS	HARD	KJEL	TN
DFO	26JUN84	.	0.0040	<	0.004	.		.		0.0020	18.9	.	.		.		.	.	.	.
DFO	10JUL84	.	0.0070	<	0.004	.		.	<	0.0010	.	.	.		.		.	.	.	.
DFO	08AUG84	.	0.0010	<	0.004	.		.		0.0010	.	.	.		.		.	.	.	.
DFO	05SEP84	.	0.0030		0.005	.		.	<	0.0010	.	.	.		.		.	.	.	.
DFO	03OCT84	.	0.0020		0.005	.		.		0.0020	13.2	.	.		.		.	.	.	.
EPS	23JUN83	.	0.0120		0.005	0.0000596695	<	0.005		0.0200	16.4	.	7.6		0.13		.	21.77	.	0.0910
EPS	28MAY84	0	0.0057	<	0.005	0.0000109019	<	0.005		0.0063	15.1	.	6.9	<	0.10		5.3	17.80	.	0.1033
EPS	24JUL84	0	0.0030	<	0.002	0.0000105161	<	0.002	<	0.0050	20.8	.	7.1		0.20	<	5.0	24.30	.	0.1023

SAMPLE SITE=SITE 5: FLUME CREEK/LAKE

AGENCY	DATE	DEPTH	TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
EPS	09SEP84	0	0.0097	0.009	0.0000055452	< 0.005	< 0.010	13.6	.	6.4	0.7	< 5	24.5	.	0.149
NOR	15AUG83	0	0.0060	< 0.010	0.0000362486	< 0.001	< 0.005	22.0	.	6.9	< 1.0	< 1	22.6	.	.
NOR	15NOV83	0	0.0100	0.023	0.0000229944	< 0.001	0.004	8.0	.	6.8	1.0	< 1	15.5	.	.
NOR	11FEB84	0	0.0040	0.023	0.0000227462	< 0.001	< 0.005	5.0	.	6.9	< 1.0	< 1	19.4	.	.
NOR	14MAY84	0	0.0030	0.013	0.0000250615	< 0.001	0.002	10.5	.	7.0	1.7	< 1	21.8	.	.

SAMPLE SITE=SITE 6: MIDDLE QUINSAM LAKE - OUTFLOW

AGENCY	DATE	DEPTH	TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
DFO	24JUN84	1.0	0.0020	< 0.0040	.	.	0.002	18.9	.	.	.	.	.	.	.
DFO	10JUL84	.	0.0020	< 0.0040	.	.	< 0.001	.	.	.	.	.	.	.	.
DFO	08AUG84	.	0.0020	0.0040	.	.	0.001	.	.	.	.	.	.	.	.
DFO	05SEP84	.	0.0020	< 0.0040	.	.	< 0.001	.	.	.	.	.	.	.	.
DFO	03OCT84	.	0.0040	< 0.0040	.	.	< 0.001	13.9	.	.	.	.	.	.	.
EPS	23JUN83	.	0.0110	0.0060	0.000143714	< 0.005	0.010	18.5	.	7.84	0.1	.	19.87	.	0.0290
EPS	13MAR84	0.0	0.0037	< 0.0050	0.000012402	< 0.005	0.014	5.0	.	7.30	0.1	< 5.0	15.30	.	.
EPS	28MAY84	0.0	< 0.0020	< 0.0050	0.000032551	< 0.005	< 0.002	14.4	.	7.40	< 0.1	7.3	15.40	.	0.0863
EPS	24JUL84	0.0	0.0037	0.0053	0.000020639	< 0.002	0.005	23.0	.	6.90	< 0.1	< 5.0	20.40	.	0.1070
EPS	09SEP84	0.0	0.0047	0.0120	0.000027374	< 0.005	< 0.010	15.7	.	6.90	0.1	< 5.0	20.20	.	0.1120
EPS	10OCT84	0.0	.	.	.	.	.	.	.	.	0.2	< 5.0	.	.	.
MOE	02JUN83	0.0	0.0060	< 0.0050	.	< 0.005	< 0.020	.	7.6	.	.	.	18.10	.	.
MOE	24AUG83	0.0	0.0060	0.0050	.	< 0.005	< 0.020	.	7.6	.	.	.	20.00	.	.
MOE	26OCT83	0.0	0.0070	0.0070	.	< 0.005	< 0.020	.	7.3	.	.	.	15.50	.	.
MOE	12SEP84	0.0	0.0060	.	.	.	.	.	7.6	.	.	.	.	.	.
MOE	12MAR86	0.5	0.0050	0.0130	.	< 0.005	.	.	7.0	.	.	2.0	.	.	.
MOE	14APR86	0.5	0.0060	< 0.0050	.	.	.	.	7.1	.	.	2.0	.	.	.
MOE	28OCT86	0.5	0.0030	0.0080	.	.	.	.	7.0	.	.	1.0	.	.	.

SAMPLE SITE=SITE 7: QUINSAM RIVER - DOWNSTREAM

AGENCY	DATE	DEPTH	TPHOS	NH4	NH3	NO2	NO3	WTEMP	PH_L	PH_F	TURB	SS	HARD	KJEL	TN
MOE	31JUL79	0	0.005	0.008	.	< 0.005	0.020	.	7.5	.	0.40	1.0	22.1	.	.
MOE	19NOV79	0	0.005	0.010	.	< 0.005	0.030	.	7.5	.	0.30	1.0	18.2	.	.
MOE	14APR80	0	0.003	0.007	.	< 0.005	< 0.020	.	7.3	.	0.50	1.0	.	.	.
MOE	25FEB81	0	0.006	0.011	.	< 0.005	0.020	.	7.2	.	0.70	1.0	15.5	.	.
MOE	13MAY81	0	0.005	0.008	.	< 0.005	< 0.020	.	7.5	.	0.50	1.0	16.4	.	.
MOE	20OCT82	0	0.003	.	.	.	.	.	6.4	.	.	1.0	.	.	.
MOE	28MAY84	0	0.006	0.007	0.000027962	< 0.005	< 0.020	14.0	7.2	.	0.40	2.0	16.1	.	.
NOR	23JAN83	0	< 0.005	0.008	0.000012332	< 0.002	< 0.005	2.0	.	7.2	< 0.10	< 1.0	13.0	.	.
NOR	25FEB83	0	0.014	< 0.010	0.000178799	< 0.001	< 0.005	4.0	.	8.2	0.58	1.2	11.8	.	.
NOR	22MAR83	0	0.018	< 0.010	0.000019713	< 0.001	0.010	5.0	.	7.2	0.60	< 1.0	15.0	.	.
NOR	19APR83	0	0.005	< 0.010	0.000031729	< 0.001	< 0.005	11.0	.	7.2	< 1.00	< 1.0	18.0	.	.
NOR	15MAY83	0	0.003	< 0.010	0.000073410	< 0.001	< 0.005	16.0	.	7.4	< 1.00	1.0	17.8	0.043	0.048
NOR	13JUN83	0	0.003	< 0.010	0.000091601	< 0.001	< 0.005	19.0	.	7.4	< 1.00	< 1.0	21.3	0.072	0.077
NOR	11JUL83	0	0.003	< 0.010	0.000010024	< 0.001	< 0.005	17.0	.	6.5	< 1.00	4.5	19.3	0.081	0.086
NOR	15AUG83	0	0.004	< 0.010	0.000090556	< 0.001	< 0.005	22.0	.	7.3	< 1.00	< 1.0	20.4	0.078	0.083
NOR	12SEP83	0	0.006	< 0.005	0.000031457	< 0.001	< 0.003	17.0	.	7.3	< 1.00	< 1.0	18.8	0.059	0.062
NOR	11OCT83	0	0.004	< 0.005	0.000023277	< 0.001	< 0.003	13.0	.	7.3	< 1.00	< 1.0	12.9	0.130	0.133
NOR	15NOV83	0	0.012	0.025	0.000039590	< 0.001	0.016	8.0	.	7.0	1.00	< 1.0	14.7	0.310	0.326
NOR	13DEC83	0	0.005	0.013	0.000007180	< 0.001	0.016	3.5	.	6.7	< 1.00	< 1.0	17.8	0.120	0.136
NOR	17JAN84	0	0.004	< 0.005	0.000010109	< 0.001	0.022	2.5	.	7.3	< 1.00	< 1.0	16.3	0.100	0.122
NOR	11FEB84	0	0.006	< 0.005	0.000009086	< 0.001	0.022	4.0	.	7.2	< 1.00	< 1.0	16.5	0.072	0.094
NOR	14MAR84	0	0.002	< 0.005	0.000012402	< 0.001	0.012	5.0	.	7.3	< 1.00	< 1.0	17.2	0.070	0.082
NOR	17APR84	0	0.004	< 0.005	0.000021470	< 0.001	0.004	9.0	.	7.4	< 1.00	2.4	14.8	0.070	0.074
NOR	15MAY84	0	0.003	0.013	0.000044563	< 0.001	0.003	12.0	.	7.2	< 1.00	1.2	13.3	0.210	0.213
NOR	11JUN84	0	0.005	0.005	0.000122928	< 0.001	0.001	17.0	.	7.9	< 1.00	< 1.0	16.2	0.240	0.241
NOR	24JUL84	0	0.003	0.012	0.000269273	< 0.001	0.002	22.0	.	7.7	< 1.00	< 1.0	17.1	0.190	0.192
NOR	27AUG84	0	0.002	0.008	0.000078806	< 0.001	0.001	20.0	.	7.4	.	.	.	0.170	0.171
NOR	24SEP84	0	0.005	0.006	0.000012984	< 0.001	< 0.001	15.0	.	6.9	.	.	.	0.130	0.131
NOR	22OCT84	0	0.002	< 0.010	0.000028225	< 0.001	0.010	9.5	.	7.2	.	.	.	0.077	0.087

APPENDIX 2

RAW DATA

TOTAL METALS

ALUMINUM
ARSENIC
CADMIUM
COBALT
COPPER
IRON
LEAD
MANGANESE
MERCURY

LEGEND

AL = Aluminum
AS = Arsenic
CD = Cadmium
CO = Cobalt
CU = Copper
FE = Iron
PB = Lead
MN = Manganese
HG = Mercury
NI = Nickel
AG = Silver
ZN = Zinc

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 1: QUINSAM RIVER - UPSTREAM

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	23JUN83	.	< 0.050	< 0.0500	< 0.0005	< 0.005	0.0010	0.023	0.006	0.0010	< 0.00010	< 0.020	.	0.0040
EPS	24JUL84	0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.052	< 0.001	0.0020	< 0.00005	< 0.020	.	< 0.0020
MOE	31JUL79	0	.	< 0.0050	< 0.0005	.	< 0.0010	< 0.100	< 0.001	.	.	.	.	< 0.0050
MOE	19NOV79	0	.	< 0.0050	< 0.0005	.	< 0.0010	< 0.100	< 0.001	.	.	.	.	< 0.0050
MOE	14APR80	0	.	< 0.0050	< 0.0100	.	< 0.0100	< 0.010	< 0.100	.	< 0.00005	.	.	< 0.0100
MOE	25FEB81	0	.	< 0.0050	< 0.0005	.	< 0.0010	0.100	0.001	.	< 0.00005	.	.	0.0080
MOE	13MAY81	0	.	< 0.0050	< 0.0005	.	< 0.0010	0.100	< 0.001	.	< 0.00005	.	.	< 0.0050
MOE	20OCT82	0	0.020	< 0.2500	< 0.0100	< 0.100	< 0.0100	0.020	< 0.100	< 0.0100	.	< 0.050	.	< 0.0100
MOE	07FEB84	0	0.020	< 0.2500	< 0.0100	< 0.100	0.0100	0.040	< 0.100	< 0.0100	.	< 0.050	.	< 0.0100
MOE	28MAY84	0	< 0.020	< 0.2500	< 0.0100	< 0.100	< 0.0100	< 0.010	< 0.100	< 0.0100	< 0.00005	< 0.050	.	< 0.0100
MOE	28MAY84	0	< 0.020	< 0.2500	< 0.0100	< 0.100	< 0.0100	< 0.010	< 0.100	< 0.0100	< 0.00005	< 0.050	.	< 0.0100
NOR	23JAN83	0	0.016	< 0.0010	0.0002	.	0.0017	0.010	< 0.001	0.0014	< 0.00005	.	< 0.0002	< 0.0005
NOR	25FEB83	0	0.068	< 0.0005	< 0.0005	.	< 0.0005	0.031	< 0.001	0.0020	< 0.00010	.	< 0.0005	0.0010
NOR	22MAR83	0	0.055	< 0.0001	< 0.0005	.	0.0006	0.041	< 0.001	0.0030	< 0.00010	.	< 0.0005	0.0030
NOR	19APR83	0	0.043	< 0.0001	< 0.0005	.	< 0.0010	0.020	< 0.001	0.0040	< 0.00005	.	< 0.0005	0.0020
NOR	15MAY83	0	0.037	< 0.0001	< 0.0005	.	< 0.0010	0.016	< 0.001	0.0010	< 0.00005	.	< 0.0005	0.0010
NOR	13JUN83	0	0.031	< 0.0001	< 0.0005	.	0.0020	0.014	< 0.001	0.0020	< 0.00005	.	< 0.0005	0.0010
NOR	11JUL83	0	0.014	< 0.0001	< 0.0005	.	< 0.0010	0.016	< 0.001	0.0030	< 0.00005	.	< 0.0005	< 0.0010
NOR	15AUG83	0	0.031	< 0.0001	< 0.0005	.	0.0010	0.014	< 0.001	0.0180	< 0.00005	.	< 0.0005	0.0010
NOR	12SEP83	0	0.022	0.0001	< 0.0005	.	0.0030	0.023	< 0.001	0.0040	< 0.00005	.	< 0.0005	< 0.0010
NOR	11OCT83	0	0.065	0.0001	< 0.0005	.	0.0230	0.057	< 0.001	0.0250	< 0.00005	.	< 0.0005	< 0.0010
NOR	15NOV83	0	0.310	0.0002	< 0.0005	.	0.0050	0.083	< 0.001	0.0200	< 0.00005	.	< 0.0005	0.0050
NOR	13DEC83	0	0.025	< 0.0001	< 0.0005	.	0.0020	0.017	< 0.001	0.0020	< 0.00005	.	< 0.0005	0.0100
NOR	17JAN84	0	0.150	< 0.0005	< 0.0005	.	0.0100	0.023	< 0.001	0.0080	< 0.00005	.	< 0.0005	0.0050
NOR	11FEB84	0	0.030	< 0.0001	< 0.0005	.	< 0.0010	0.042	< 0.001	< 0.0010	< 0.00005	.	< 0.0005	0.0050
NOR	12MAR84	0	0.020	< 0.0001	< 0.0005	.	< 0.0010	0.042	< 0.001	0.0010	< 0.00005	.	< 0.0010	0.0020
NOR	16APR84	0	0.024	< 0.0001	< 0.0005	.	< 0.0010	0.009	< 0.001	0.0010	< 0.00005	.	< 0.0005	0.0020
NOR	14MAY84	0	0.026	< 0.0001	< 0.0005	.	< 0.0010	0.028	< 0.001	0.0010	< 0.00005	.	< 0.0005	0.0010
NOR	13JUN84	0	0.017	< 0.0001	< 0.0005	.	< 0.0010	0.021	< 0.001	0.0020	< 0.00005	.	< 0.0005	0.0020
NOR	24JUL84	0	0.039	0.0002	< 0.0005	.	< 0.0010	0.019	< 0.001	0.0020	< 0.00005	.	< 0.0005	0.0020
NOR	27AUG84	0	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	24SEP84	0	.	.	.	.	.	.	.	.	0.00005	.	.	.

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	24JUN83	1.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.042	< 0.001	0.006	< 0.00010	< 0.020	.	0.002
EPS	24JUN83	5.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.052	0.001	0.006	< 0.00010	< 0.020	.	< 0.002
EPS	24JUN83	9.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.047	0.002	0.009	< 0.00010	< 0.020	.	< 0.002
EPS	24JUN83	10.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.056	0.001	0.011	< 0.00010	< 0.020	.	< 0.002
EPS	24JUL84	1.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.039	< 0.001	0.003	< 0.00005	< 0.020	.	0.003
EPS	24JUL84	5.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.037	< 0.001	0.004	< 0.00005	< 0.020	.	< 0.002
EPS	24JUL84	10.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.023	< 0.001	0.002	< 0.00005	< 0.020	.	< 0.002
EPS	24JUL84	16.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.110	< 0.001	0.016	< 0.00005	< 0.020	.	< 0.002
MOE	03MAY84	0.0	< 0.020	< 0.2500	< 0.0005	< 0.100	< 0.0010	< 0.010	0.002	< 0.010	.	< 0.050	.	< 0.005
MOE	24JUL84	0.0	< 0.020	< 0.2500	< 0.0005	< 0.100	0.0010	0.100	< 0.001	< 0.010	.	< 0.050	.	< 0.010
MOE	20AUG84	0.5	0.030	< 0.2500	< 0.0001	< 0.100	< 0.0010	0.090	< 0.001	< 0.010	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	20AUG84	6.0	< 0.020	< 0.2500	< 0.0001	< 0.100	< 0.0010	0.070	< 0.001	< 0.010	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	20AUG84	9.0	0.040	< 0.2500	< 0.0001	< 0.100	< 0.0010	0.070	< 0.001	0.010	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	20AUG84	13.0	0.030	< 0.2500	< 0.0001	< 0.100	< 0.0010	0.100	< 0.001	0.050	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	12SEP84	1.0	.	.	< 0.0001	.	< 0.0010	.	< 0.001	.	< 0.05000	.	< 0.0005	< 0.005
MOE	12SEP84	7.0	.	.	< 0.0001	.	0.0020	.	0.002	.	< 0.05000	.	< 0.0005	0.009
MOE	12SEP84	11.0	.	.	< 0.0001	.	0.0020	.	< 0.001	.	< 0.05000	.	< 0.0005	0.010
MOE	12SEP84	13.0	.	.	< 0.0001	.	< 0.0010	.	< 0.001	.	< 0.05000	.	< 0.0005	< 0.005
MOE	05DEC84	0.0	0.040	< 0.2500	< 0.0100	< 0.100	< 0.0010	0.060	< 0.100	< 0.010	.	< 0.050	.	< 0.005
MOE	16SEP85	0.0	.	.	.	.	.	.	.	.	.	< 0.050	.	< 0.005
MOE	16SEP85	0.0	0.040	< 0.2500	< 0.0005	< 0.100	< 0.0010	0.050	< 0.001	< 0.010	.	< 0.050	.	< 0.005
MOE	14APR86	0.5	0.030	< 0.2500	< 0.0005	< 0.100	0.0010	< 0.010	< 0.001	< 0.010	.	< 0.050	.	< 0.005
MOE	13MAY86	0.0	< 0.020	< 0.2500	< 0.0100	< 0.100	0.0020	0.040	< 0.001	< 0.010	.	< 0.050	.	< 0.010
MOE	23SEP86	1.0	< 0.020	< 0.2500	< 0.0100	< 0.100	< 0.0010	< 0.010	< 0.001	< 0.010	.	< 0.050	.	< 0.010
MOE	23SEP86	1.0	< 0.020	< 0.2500	< 0.0100	< 0.100	< 0.0010	0.080	< 0.001	< 0.010	.	< 0.010	.	< 0.010
MOE	28OCT86	1.0	.	.	.	.	.	.	.	.	.	< 0.010	.	< 0.005
MOE	28OCT86	1.0	0.030	< 0.2500	< 0.0100	< 0.100	< 0.0010	0.050	< 0.100	0.010	.	< 0.010	.	< 0.005
NOR	24FEB83	0.0	0.066	< 0.0005	< 0.0005	.	< 0.0005	0.046	< 0.001	0.003	< 0.00010	.	< 0.0005	0.001
NOR	24FEB83	2.5	0.068	< 0.0005	< 0.0005	.	< 0.0005	0.046	< 0.001	0.003	< 0.00010	.	< 0.0005	< 0.001
NOR	24FEB83	5.0	0.076	< 0.0005	< 0.0005	.	< 0.0005	0.060	< 0.001	0.005	< 0.00010	.	< 0.0005	0.001
NOR	18MAY83	1.0	0.033	< 0.0001	< 0.0005	.	0.0010	0.036	0.001	0.006	< 0.00005	.	< 0.0005	< 0.001
NOR	18MAY83	3.0	0.030	< 0.0001	< 0.0005	.	< 0.0010	0.033	0.001	0.005	< 0.00005	.	< 0.0005	< 0.001
NOR	18MAY83	6.0	0.026	< 0.0001	< 0.0005	.	< 0.0010	0.029	0.001	0.005	< 0.00005	.	< 0.0005	0.001
NOR	14JUN83	1.0	0.022	< 0.0001	< 0.0005	.	< 0.0010	0.046	< 0.001	0.006	< 0.00005	.	< 0.0005	0.001
NOR	14JUN83	3.0	0.020	0.0001	< 0.0005	.	< 0.0010	0.048	< 0.001	0.006	< 0.00005	.	< 0.0005	< 0.001
NOR	14JUN83	5.0	0.056	0.0001	< 0.0005	.	0.0010	0.060	< 0.001	0.007	< 0.00050	.	< 0.0005	< 0.001
NOR	12JUL83	1.0	0.010	< 0.0001	< 0.0005	.	< 0.0010	0.029	0.001	0.005	< 0.00005	.	< 0.0005	0.002
NOR	12JUL83	5.0	0.007	< 0.0001	< 0.0005	.	< 0.0010	0.027	< 0.001	0.005	< 0.00005	.	< 0.0005	< 0.001
NOR	12JUL83	10.0	0.006	< 0.0001	< 0.0005	.	< 0.0010	0.017	< 0.001	0.007	< 0.00005	.	< 0.0005	0.001
NOR	18AUG83	1.0	0.017	< 0.0001	< 0.0005	< 0.001	< 0.0010	0.050	< 0.001	0.012	< 0.00005	< 0.001	< 0.0005	0.002
NOR	18AUG83	7.0	0.015	< 0.0001	< 0.0005	< 0.001	0.0010	0.024	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	18AUG83	11.0	0.016	< 0.0001	< 0.0005	< 0.001	0.0010	0.028	< 0.001	0.006	< 0.00005	< 0.001	< 0.0005	0.003

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 2: MIDDLE QUINSAM LAKE

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
NOR	14SEP83	1	0.012	< 0.0001	< 0.0005	.	0.002	0.086	0.004	0.008	< 0.00005	.	< 0.0005	0.004
NOR	14SEP83	6	0.012	0.0002	< 0.0005	.	0.002	0.025	0.001	0.008	< 0.00005	.	< 0.0005	0.001
NOR	14SEP83	12	0.015	0.0001	< 0.0005	.	0.001	0.080	0.003	0.038	< 0.00005	.	< 0.0005	0.002
NOR	13OCT83	1	0.016	< 0.0001	< 0.0005	.	< 0.001	0.043	< 0.001	0.020	< 0.00005	.	< 0.0005	0.005
NOR	13OCT83	6	0.018	0.0001	< 0.0005	.	< 0.001	0.039	< 0.001	0.014	< 0.00005	.	< 0.0005	0.004
NOR	13OCT83	13	0.016	0.0001	< 0.0005	.	0.002	0.220	< 0.001	0.250	< 0.00005	.	< 0.0005	< 0.001
NOR	14DEC83	1	0.043	0.0001	< 0.0005	< 0.001	< 0.001	0.070	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.003
NOR	14DEC83	5	0.036	0.0001	< 0.0005	< 0.001	< 0.001	0.040	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	14DEC83	11	0.032	< 0.0001	< 0.0005	< 0.001	< 0.001	0.050	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	18JAN84	1	0.069	< 0.0005	< 0.0005	.	0.002	0.043	0.004	0.005	< 0.00005	.	< 0.0005	0.004
NOR	18JAN84	5	0.069	< 0.0005	< 0.0005	.	0.001	0.029	< 0.001	0.004	< 0.00005	.	< 0.0005	0.003
NOR	18JAN84	12	0.051	< 0.0005	< 0.0005	.	0.001	0.030	0.001	0.007	< 0.00005	.	< 0.0005	0.002
NOR	10FEB84	1	0.022	< 0.0001	< 0.0005	< 0.001	< 0.001	0.036	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.002
NOR	10FEB84	5	0.023	< 0.0001	< 0.0005	< 0.001	< 0.001	0.038	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.003
NOR	10FEB84	10	0.025	< 0.0001	< 0.0005	< 0.001	< 0.001	0.034	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.005
NOR	13MAR84	1	0.029	< 0.0001	< 0.0005	.	0.002	0.053	< 0.001	0.006	< 0.00005	.	< 0.0010	0.003
NOR	13MAR84	6	0.029	< 0.0001	< 0.0005	.	< 0.001	0.074	< 0.001	0.007	< 0.00005	.	< 0.0010	0.004
NOR	13MAR84	12	0.028	< 0.0001	< 0.0005	.	< 0.001	0.062	< 0.001	0.008	< 0.00005	.	< 0.0010	0.002
NOR	17APR84	1	0.020	< 0.0001	< 0.0005	.	< 0.001	0.026	< 0.001	0.003	< 0.00005	.	< 0.0005	0.003
NOR	17APR84	5	0.017	< 0.0001	< 0.0005	.	< 0.001	0.026	< 0.001	0.003	< 0.00005	.	< 0.0005	0.002
NOR	17APR84	9	0.026	< 0.0001	< 0.0005	.	< 0.001	0.027	< 0.001	0.004	< 0.00005	.	< 0.0005	0.003
NOR	17APR84	12	0.021	< 0.0001	< 0.0005	.	< 0.001	0.026	< 0.001	0.003	< 0.00005	.	< 0.0005	0.003
NOR	15MAY84	1	0.014	< 0.0001	< 0.0005	< 0.001	< 0.001	0.031	< 0.001	0.002	< 0.00005	< 0.001	< 0.0005	0.002
NOR	15MAY84	6	0.012	< 0.0001	< 0.0005	< 0.001	< 0.001	0.019	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.001
NOR	15MAY84	12	0.010	< 0.0001	< 0.0005	< 0.001	< 0.001	0.032	< 0.001	0.002	< 0.00005	< 0.001	< 0.0005	0.002
NOR	11JUN84	1	0.012	< 0.0001	< 0.0005	.	< 0.001	0.035	< 0.001	0.003	0.00092	.	< 0.0005	0.003
NOR	11JUN84	9	0.011	< 0.0001	< 0.0005	.	< 0.001	0.033	< 0.001	0.003	0.00100	.	< 0.0005	0.002
NOR	11JUN84	12	0.011	< 0.0001	< 0.0005	.	< 0.001	0.035	< 0.001	0.004	0.00020	.	< 0.0005	0.003
NOR	24JUL84	1	0.028	0.0002	< 0.0005	.	< 0.001	0.032	< 0.001	0.003	0.00092	.	< 0.0005	0.004
NOR	24JUL84	6	0.030	0.0002	< 0.0005	.	< 0.001	0.025	< 0.001	0.003	0.00100	.	< 0.0005	0.003
NOR	24JUL84	12	0.026	0.0001	< 0.0005	.	< 0.001	0.025	< 0.001	0.003	0.00020	.	< 0.0005	0.003
NOR	27AUG84	1	.	.	.	.	.	.	.	.	0.00010	.	.	.
NOR	27AUG84	8	.	.	.	.	.	.	.	.	0.00019	.	.	.
NOR	27AUG84	12	.	.	.	.	.	.	.	.	0.00011	.	.	.
NOR	24SEP84	1	.	.	.	.	.	.	.	.	0.00063	.	.	.
NOR	24SEP84	5	.	.	.	.	.	.	.	.	0.00037	.	.	.
NOR	24SEP84	12	.	.	.	.	.	.	.	.	0.00008	.	.	.
NOR	22OCT84	1	.	.	.	.	.	.	.	.	0.00140	.	.	.
NOR	22OCT84	6	.	.	.	.	.	.	.	.	0.00034	.	.	.
NOR	22OCT84	12	.	.	.	.	.	.	.	.	0.00008	.	.	.

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DAYTE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	22JUN83	1.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.065	< 0.001	0.005	< 0.00010	< 0.020	.	< 0.002
EPS	22JUN83	4.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.041	< 0.001	0.005	< 0.00010	< 0.020	.	< 0.002
EPS	22JUN83	8.0	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.060	0.002	0.003	< 0.00010	< 0.020	.	< 0.002
EPS	22JUN83	15.0	< 0.050	< 0.0500	< 0.0005	< 0.005	0.0010	0.086	0.001	0.004	< 0.00010	< 0.020	.	< 0.002
EPS	24JUL84	1.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.305	< 0.001	0.004	< 0.00005	< 0.020	.	< 0.002
EPS	24JUL84	5.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.054	< 0.001	0.005	< 0.00005	< 0.020	.	< 0.002
EPS	24JUL84	8.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.035	< 0.001	0.006	< 0.00005	< 0.020	.	< 0.002
EPS	24JUL84	10.0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.094	< 0.001	0.007	< 0.00005	< 0.020	.	0.004
MOE	21AUG84	11.0	0.020	< 0.2500	< 0.0001	< 0.100	0.0030	0.060	0.004	< 0.010	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	21AUG84	20.0	< 0.020	< 0.2500	< 0.0001	< 0.100	0.0020	0.260	0.002	0.060	< 0.00005	< 0.050	< 0.0005	< 0.005
MOE	12SEP84	1.0	.	.	< 0.0001	.	< 0.0010	.	< 0.001	.	< 0.00005	.	< 0.0005	< 0.005
MOE	12SEP84	4.0	.	.	< 0.0001	.	< 0.0010	.	< 0.001	.	.	.	< 0.0005	0.008
MOE	12SEP84	8.0	.	.	.	.	< 0.0010	.	< 0.001	.	.	.	.	< 0.005
MOE	12SEP84	16.0	.	.	.	.	< 0.0010	.	< 0.001	.	.	.	.	< 0.005
MOE	14APR86	0.5	< 0.020	< 0.2500	< 0.0005	< 0.100	0.0010	0.240	< 0.100	0.020	.	< 0.050	.	< 0.005
MOE	13MAY86	0.0	< 0.020	< 0.2500	< 0.0100	< 0.100	0.0020	0.070	< 0.100	0.010	.	< 0.050	.	< 0.010
MOE	08JUL86	0.0	< 0.020	< 0.2500	< 0.0100	< 0.100	0.0020	0.050	< 0.100	< 0.010	.	< 0.050	.	< 0.010
MOE	08JUL86	6.0	.	.	.	.	.	.	.	.	.	< 0.050	.	0.010
MOE	08JUL86	6.0	< 0.020	< 0.2500	< 0.0100	< 0.100	0.0020	0.040	< 0.100	< 0.010	.	< 0.050	.	0.010
MOE	23SEP86	1.0	0.020	< 0.2500	< 0.0100	< 0.100	< 0.0010	0.040	< 0.001	< 0.010	.	< 0.050	.	< 0.010
MOE	28OCT86	0.0	.	.	.	.	.	.	.	.	.	< 0.050	.	< 0.005
MOE	28OCT86	0.0	< 0.020	< 0.2500	< 0.0100	< 0.100	0.0010	0.020	< 0.001	< 0.010	.	< 0.050	.	< 0.005
NOR	24FEB83	0.0	0.100	< 0.0005	< 0.0005	.	< 0.0005	0.064	< 0.001	0.003	< 0.00010	.	< 0.0005	0.003
NOR	24FEB83	8.0	0.080	< 0.0005	< 0.0005	.	< 0.0005	0.065	< 0.001	0.003	< 0.00010	.	< 0.0005	0.003
NOR	24FEB83	16.0	0.082	< 0.0005	< 0.0005	.	< 0.0005	0.069	< 0.001	0.003	< 0.00010	.	< 0.0005	0.004
NOR	19MAY83	1.0	0.031	0.0004	< 0.0005	.	< 0.0010	0.060	0.002	0.004	< 0.00005	.	< 0.0005	0.001
NOR	19MAY83	5.0	0.036	0.0004	< 0.0005	.	< 0.0010	0.061	0.001	0.007	< 0.00005	.	< 0.0005	0.001
NOR	19MAY83	10.0	0.044	0.0002	< 0.0005	.	0.0010	0.070	0.001	0.003	< 0.00005	.	< 0.0005	< 0.001
NOR	19MAY83	17.0	0.046	0.0003	< 0.0005	.	< 0.0010	0.120	0.001	0.012	< 0.00005	.	< 0.0005	< 0.001
NOR	15JUN83	1.0	0.028	0.0007	< 0.0005	.	< 0.0010	0.036	0.003	0.004	< 0.00005	.	< 0.0005	< 0.001
NOR	15JUN83	5.0	0.046	0.0001	< 0.0005	.	< 0.0010	0.032	< 0.001	0.003	< 0.00005	.	< 0.0005	0.002
NOR	15JUN83	8.0	0.058	0.0001	< 0.0005	.	< 0.0010	0.048	< 0.001	0.004	< 0.00005	.	< 0.0005	0.001
NOR	15JUN83	16.0	0.057	< 0.0001	< 0.0005	.	0.0020	0.110	< 0.001	0.008	< 0.00005	.	< 0.0005	0.001
NOR	14JUL83	1.0	0.015	0.0005	< 0.0005	.	< 0.0010	0.031	0.001	0.004	< 0.00005	.	< 0.0005	0.001
NOR	14JUL83	8.0	0.027	< 0.0001	< 0.0005	.	< 0.0010	0.062	< 0.001	0.004	< 0.00005	.	< 0.0005	0.001
NOR	14JUL83	18.0	0.027	< 0.0001	< 0.0005	.	< 0.0010	0.180	< 0.001	0.012	< 0.00005	.	< 0.0005	0.001
NOR	17AUG83	1.0	0.017	0.0007	< 0.0005	< 0.001	< 0.0010	0.040	< 0.001	0.007	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	17AUG83	6.0	0.035	0.0004	< 0.0005	< 0.001	0.0010	0.050	< 0.001	0.014	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	17AUG83	17.0	0.042	0.0004	0.0005	< 0.001	0.0010	0.240	< 0.001	0.028	< 0.00005	< 0.001	< 0.0005	0.001
NOR	15SEP83	1.0	0.013	0.0007	< 0.0005	.	0.0010	0.052	< 0.001	0.005	< 0.00005	.	< 0.0005	< 0.001
NOR	15SEP83	7.0	0.033	0.0001	< 0.0005	.	0.0010	0.045	0.002	0.009	< 0.00005	.	< 0.0005	0.001
NOR	15SEP83	18.0	0.044	0.0006	< 0.0005	.	0.0020	0.410	0.001	0.190	< 0.00005	.	< 0.0005	< 0.001

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 3: LONG LAKE

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
NOR	14OCT83	1	0.021	0.0007	< 0.0005	.	< 0.001	0.029	< 0.001	0.011	< 0.00005	.	< 0.0005	0.002
NOR	14OCT83	9	0.043	0.0001	< 0.0005	.	< 0.001	0.034	< 0.001	0.012	< 0.00005	.	< 0.0005	0.002
NOR	14OCT83	17	0.059	0.0007	< 0.0005	.	< 0.001	0.280	< 0.001	0.160	< 0.00005	.	< 0.0005	0.003
NOR	15DEC83	1	0.064	0.0002	< 0.0005	< 0.001	< 0.001	0.080	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.004
NOR	15DEC83	8	0.062	0.0002	< 0.0005	< 0.001	< 0.001	0.080	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.003
NOR	15DEC83	16	0.058	0.0003	< 0.0005	< 0.001	< 0.001	0.090	< 0.001	0.003	< 0.00005	< 0.001	< 0.0005	0.002
NOR	18JAN84	1	0.078	< 0.0005	< 0.0005	.	< 0.001	0.040	< 0.001	0.004	< 0.00005	.	< 0.0005	0.002
NOR	18JAN84	8	0.092	< 0.0005	< 0.0005	.	< 0.001	0.040	< 0.001	0.005	< 0.00005	.	< 0.0005	0.005
NOR	18JAN84	17	0.092	< 0.0005	< 0.0005	.	0.001	0.070	< 0.001	0.007	< 0.00005	.	< 0.0005	0.002
NOR	07FEB84	1	0.050	0.0001	< 0.0005	< 0.001	< 0.001	0.073	< 0.001	0.002	< 0.00005	< 0.001	< 0.0005	< 0.001
NOR	07FEB84	10	0.066	0.0002	< 0.0005	< 0.001	< 0.001	0.093	< 0.001	0.004	< 0.00005	< 0.001	< 0.0005	0.002
NOR	07FEB84	17	0.067	0.0004	< 0.0005	< 0.001	< 0.001	0.110	< 0.001	0.009	< 0.00005	< 0.001	< 0.0005	0.002
NOR	14MAR84	1	0.047	< 0.0001	< 0.0005	.	0.001	0.064	< 0.001	0.006	< 0.00005	.	< 0.0010	0.001
NOR	14MAR84	10	0.046	0.0002	< 0.0005	.	< 0.001	0.110	< 0.001	0.007	< 0.00005	.	< 0.0010	0.002
NOR	14MAR84	18	0.049	0.0005	< 0.0005	.	< 0.001	0.180	< 0.001	0.024	< 0.00005	.	< 0.0010	0.002
NOR	19APR84	1	0.049	0.0003	< 0.0005	.	< 0.001	0.064	< 0.001	0.004	< 0.00005	.	< 0.0005	0.004
NOR	19APR84	8	0.052	0.0003	< 0.0005	.	< 0.001	0.063	< 0.001	0.006	< 0.00005	.	< 0.0005	0.002
NOR	19APR84	17	0.049	0.0003	< 0.0005	.	< 0.001	0.082	< 0.001	0.006	< 0.00005	.	< 0.0005	0.001
NOR	16MAY84	1	0.038	0.0003	< 0.0005	< 0.001	< 0.001	0.037	< 0.001	0.005	< 0.00005	< 0.001	< 0.0005	0.004
NOR	17MAY84	7	0.039	< 0.0001	< 0.0005	< 0.001	< 0.001	0.099	< 0.001	0.009	< 0.00005	< 0.001	< 0.0005	0.002
NOR	17MAY84	18	0.044	< 0.0001	< 0.0005	< 0.001	< 0.001	0.043	< 0.001	0.005	< 0.00005	< 0.001	< 0.0005	0.002
NOR	14JUN84	1	0.028	0.0012	< 0.0005	.	< 0.001	0.040	< 0.001	0.005	0.00097	.	< 0.0005	0.003
NOR	14JUN84	8	0.035	0.0004	< 0.0005	.	< 0.001	0.048	< 0.001	0.003	0.00020	.	< 0.0005	0.003
NOR	14JUN84	17	0.040	0.0005	< 0.0005	.	< 0.001	0.110	< 0.001	0.013	0.00008	.	< 0.0005	0.002
NOR	25JUL84	1	0.019	0.0008	< 0.0005	.	< 0.001	0.034	< 0.001	0.002	0.00097	.	< 0.0005	0.003
NOR	25JUL84	6	0.030	0.0004	< 0.0005	.	< 0.001	0.035	< 0.001	0.003	0.00020	.	< 0.0005	0.003
NOR	25JUL84	17	0.044	0.0005	< 0.0005	.	< 0.001	0.083	< 0.001	0.010	0.00008	.	< 0.0005	0.003
NOR	28AUG84	1	.	.	.	.	.	.	.	.	0.00140	.	.	.
NOR	28AUG84	6	.	.	.	.	.	.	.	.	0.00016	.	.	.
NOR	28AUG84	16	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	24SEP84	1	.	.	.	.	.	.	.	.	0.00047	.	.	.
NOR	24SEP84	7	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	24SEP84	17	.	.	.	.	.	.	.	.	0.00008	.	.	.
NOR	22OCT84	1	.	.	.	.	.	.	.	.	0.00021	.	.	.
NOR	22OCT84	8	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	22OCT84	17	.	.	.	.	.	.	.	.	< 0.00005	.	.	.

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 4: LONG LAKE STREAM

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	23JUN83	.	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.0010	0.064	0.001	0.0120	< 0.00010	< 0.020	.	< 0.0020
EPS	24JUL84	0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.0010	0.139	< 0.001	0.0080	< 0.00005	< 0.020	.	< 0.0020
NOR	23JAN83	0	0.033	< 0.0010	< 0.0002	.	0.0005	0.044	< 0.001	0.0009	< 0.00005	.	< 0.0002	0.0008
NOR	25FEB83	0	0.084	< 0.0005	< 0.0005	.	< 0.0005	0.066	< 0.001	0.0030	< 0.00010	.	< 0.0005	0.0010
NOR	22MAR83	0	0.060	0.0002	< 0.0005	.	< 0.0005	0.041	< 0.001	0.0030	< 0.00010	.	< 0.0005	< 0.0010
NOR	19APR83	0	0.039	0.0002	< 0.0005	.	< 0.0010	0.043	< 0.001	0.0050	< 0.00005	.	< 0.0005	< 0.0010
NOR	15MAY83	0	0.038	0.0004	< 0.0005	.	< 0.0010	0.050	< 0.001	0.0070	< 0.00005	.	< 0.0005	0.0010
NOR	13JUN83	0	0.027	0.0003	< 0.0005	.	< 0.0010	0.050	< 0.001	0.0080	< 0.00005	.	< 0.0005	< 0.0010
NOR	11JUL83	0	0.014	0.0004	< 0.0005	.	< 0.0010	0.037	< 0.001	0.0060	< 0.00005	.	< 0.0005	< 0.0010
NOR	15AUG83	0	0.019	0.0006	< 0.0005	< 0.001	< 0.0010	0.090	< 0.001	0.0070	< 0.00005	< 0.001	< 0.0005	0.0020
NOR	16SEP83	0	0.017	0.0006	< 0.0005	.	0.0010	0.100	< 0.001	0.0070	< 0.00005	.	< 0.0005	0.0020
NOR	14OCT83	0	0.024	0.0005	< 0.0005	.	< 0.0010	0.042	< 0.001	0.0080	< 0.00005	.	< 0.0005	0.0030
NOR	15NOV83	0	0.060	0.0005	< 0.0005	< 0.001	< 0.0010	0.120	< 0.001	0.0150	< 0.00005	< 0.001	< 0.0005	0.0030
NOR	13DEC83	0	0.069	0.0002	< 0.0005	.	< 0.0010	0.068	< 0.001	0.0030	< 0.00005	.	< 0.0005	0.0020
NOR	18JAN84	0	0.079	< 0.0005	< 0.0005	.	< 0.0010	0.050	< 0.001	0.0040	< 0.00005	.	< 0.0005	0.0020
NOR	11FEB84	0	0.055	< 0.0001	< 0.0005	< 0.001	< 0.0010	0.040	< 0.001	0.0020	< 0.00005	< 0.001	< 0.0005	0.0030
NOR	14MAR84	0	0.045	0.0003	< 0.0005	.	< 0.0010	0.073	< 0.001	0.0070	< 0.00005	.	< 0.0010	0.0030
NOR	17APR84	0	0.047	< 0.0001	< 0.0005	.	< 0.0010	0.044	< 0.001	0.0050	< 0.00005	.	< 0.0005	0.0040
NOR	17MAY84	0	0.039	0.0003	< 0.0005	< 0.001	< 0.0010	0.037	< 0.001	0.0050	< 0.00005	< 0.001	< 0.0005	0.0030
NOR	13JUN84	0	0.027	0.0002	< 0.0005	.	< 0.0010	0.045	< 0.001	0.0050	< 0.00005	.	< 0.0005	0.0010
NOR	25JUL84	0	0.024	0.0007	< 0.0005	.	< 0.0010	0.100	< 0.001	0.0100	< 0.00005	.	< 0.0005	0.0040
NOR	27AUG84	0	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	24SEP84	0	.	.	.	.	.	.	.	.	< 0.00005	.	.	.

SAMPLE SITE=SITE 5: FLUME CREEK/LAKE

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	23JUN83	.	< 0.050	< 0.0500	< 0.0005	< 0.005	< 0.001	0.110	0.001	0.006	< 0.00010	< 0.02	.	< 0.002
EPS	24JUL84	0	< 0.050	< 0.0500	< 0.0006	< 0.005	< 0.001	0.218	< 0.001	0.015	< 0.00005	< 0.02	.	< 0.002
NOR	15AUG83	0	0.016	0.0003	< 0.0005	.	< 0.001	0.170	< 0.001	0.012	< 0.00005	.	< 0.0005	0.012
NOR	15NOV83	0	0.110	0.0003	< 0.0005	.	< 0.001	0.061	< 0.001	0.004	< 0.00005	.	< 0.0005	0.003
NOR	11FEB84	0	0.052	< 0.0001	< 0.0005	.	< 0.001	0.042	< 0.001	0.001	< 0.00005	.	< 0.0005	0.005
NOR	14MAY84	0	0.078	< 0.0001	< 0.0005	.	< 0.001	0.120	< 0.001	0.007	< 0.00005	.	< 0.0005	0.002

TOTAL METALS (mg/L)

SAMPLE SITE=SITE 6: MIDDLE QUINSAM LAKE - OUTFLOW

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
EPS	22JUN83	.	< 0.05	< 0.05	< 0.0005	< 0.005	< 0.001	0.049	0.001	0.008	< 0.00010	< 0.02	.	< 0.002
EPS	24JUL84	0.0	< 0.05	< 0.05	< 0.0006	< 0.005	< 0.001	0.218	< 0.001	0.015	< 0.00005	< 0.02	.	< 0.002
MOE	02JUN83	0.0	0.03	< 0.25	< 0.0005	< 0.100	0.002	0.090	0.001	0.010	.	< 0.05	.	0.010
MOE	24AUG83	0.0	< 0.02	< 0.25	< 0.0005	< 0.100	0.004	0.050	< 0.001	< 0.010	.	< 0.05	.	.
MOE	26OCT83	0.0	0.05	< 0.25	< 0.0100	< 0.100	0.010	0.090	< 0.100	0.020	.	< 0.05	.	0.010
MOE	12SEP84	0.0	.	.	.	.	< 0.001	.	.	.	.	.	.	.
MOE	14APR86	0.5	< 0.02	< 0.25	< 0.0005	< 0.100	0.001	0.020	< 0.100	< 0.010	.	< 0.05	.	< 0.005

SAMPLE SITE=SITE 7: QUINSAM RIVER - DOWNSTREAM

AGENCY	DATE	DEPTH	AL	AS	CD	CO	CU	FE	PB	MN	HG	NI	AG	ZN
MOE	31JUL79	0	.	< 0.0050	< 0.0005	.	0.0010	0.100	0.001	.	.	.	.	< 0.0050
MOE	19NOV79	0	.	< 0.0050	< 0.0005	.	< 0.0010	< 0.100	< 0.001	.	.	.	.	0.0060
MOE	14APR80	0	.	< 0.0050	< 0.0100	.	< 0.0100	< 0.010	< 0.100	.	< 0.00005	.	.	< 0.0100
MOE	25FEB81	0	.	< 0.0050	< 0.0005	.	< 0.0010	< 0.100	< 0.001	.	< 0.00005	.	.	0.0050
MOE	13MAY81	0	.	< 0.0050	< 0.0005	.	0.0010	0.100	< 0.001	.	< 0.00005	.	.	< 0.0050
MOE	20OCT82	0	0.040	< 0.2500	< 0.0100	< 0.100	< 0.0100	0.050	< 0.100	< 0.0100	.	< 0.050	.	< 0.0100
MOE	28MAY84	0	< 0.020	< 0.2500	< 0.0100	< 0.100	< 0.0100	0.050	< 0.100	< 0.0100	< 0.00005	< 0.050	.	< 0.0100
NOR	23JAN83	0	0.030	< 0.0010	0.0002	.	0.0008	0.043	< 0.001	0.0023	< 0.00005	.	< 0.0002	< 0.0005
NOR	25FEB83	0	0.070	< 0.0005	< 0.0005	.	< 0.0005	0.045	< 0.001	0.0030	< 0.00010	.	< 0.0005	0.0020
NOR	22MAR83	0	0.045	< 0.0001	< 0.0005	.	< 0.0005	0.043	< 0.001	0.0030	< 0.00010	.	< 0.0005	0.0020
NOR	19APR83	0	0.025	< 0.0001	< 0.0005	.	< 0.0010	0.055	< 0.001	0.0030	< 0.00005	.	< 0.0005	< 0.0010
NOR	15MAY83	0	0.029	< 0.0001	< 0.0005	.	< 0.0010	0.046	0.001	0.0060	< 0.00005	.	< 0.0005	0.0020
NOR	13JUN83	0	0.042	< 0.0001	< 0.0005	.	0.0030	0.058	< 0.001	0.0090	< 0.00005	.	< 0.0005	0.0010
NOR	11JUL83	0	0.028	< 0.0001	< 0.0005	.	< 0.0010	0.035	< 0.001	0.0070	< 0.00005	.	< 0.0005	< 0.0010
NOR	15AUG83	0	0.016	< 0.0001	< 0.0005	< 0.001	0.0010	0.050	< 0.001	0.0150	< 0.00005	< 0.001	< 0.0005	0.0020
NOR	12SEP83	0	0.013	< 0.0001	< 0.0005	.	0.0020	0.085	< 0.001	0.0100	< 0.00005	.	< 0.0005	< 0.0010
NOR	11OCT83	0	0.024	< 0.0001	< 0.0005	.	0.0030	0.041	< 0.001	0.0150	< 0.00005	.	< 0.0005	< 0.0010
NOR	15NOV83	0	0.090	0.0004	< 0.0005	< 0.001	0.0350	0.100	< 0.001	0.0110	< 0.00005	0.005	< 0.0005	0.0030
NOR	13DEC83	0	0.044	< 0.0001	< 0.0005	.	< 0.0010	0.050	< 0.001	0.0030	< 0.00005	.	< 0.0005	0.0030
NOR	17JAN84	0	0.080	< 0.0005	< 0.0005	.	0.0010	0.050	< 0.001	0.0040	< 0.00005	.	< 0.0005	0.0030
NOR	11FEB84	0	0.050	< 0.0001	< 0.0005	< 0.001	< 0.0010	0.051	< 0.001	0.0030	< 0.00005	< 0.001	< 0.0005	0.0040
NOR	14MAR84	0	0.031	< 0.0001	< 0.0005	.	< 0.0010	0.092	< 0.001	0.0070	< 0.00005	.	< 0.0010	0.0040
NOR	17APR84	0	0.029	< 0.0001	< 0.0005	.	< 0.0010	0.032	< 0.001	0.0040	< 0.00005	.	< 0.0005	0.0030
NOR	15MAY84	0	0.034	< 0.0001	< 0.0005	< 0.001	< 0.0010	0.039	< 0.001	0.0050	< 0.00005	< 0.001	< 0.0005	< 0.0010
NOR	11JUN84	0	0.031	< 0.0001	< 0.0005	.	< 0.0010	0.043	< 0.001	0.0070	< 0.00005	.	< 0.0005	0.0020
NOR	24JUL84	0	0.088	0.0002	< 0.0005	.	< 0.0010	0.085	< 0.001	0.0140	< 0.00005	.	< 0.0005	0.0030
NOR	27AUG84	0	.	.	.	.	.	.	.	.	< 0.00005	.	.	.
NOR	24SEP84	0	.	.	.	.	.	.	.	.	< 0.00005	.	.	.