ENVIRONMENT CANADA
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PACIFIC AND YUKON REGION

QUINSAM COAL DEVELOPMENT

A MONITORING REPORT ON THE EFFLUENT AND RECEIVING ENVIRONMENT
- 1989/1990 -

Regional Program Report 90-09

By

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JULY 1990

ABSTRACT

Concerns expressed by the Commission of Inquiry (acid mine drainage, metals, sediment, nutrients and eutrophication) are addressed by monitoring receiving waters in the vicinity of the Quinsam Coal Mine and mine effluent. Receiving water quality is similar to the baseline data. All results are less than the Canadian Water Quality (CCME) Guidelines established to protect aquatic life. Periphyton growth is phosphorus limited throughout but becomes more pronounced with distance downstream of Middle Quinsam Lake. Periphytic biomass is generally low with the exception of Station 5A which exceeds the B.C. Water Quality Criterion for the protection of aesthetics and recreation. Current monitoring data is usually lower than Quinsam Coal Corporation's (QCC) baseline data.

Effluent monitoring of the Settling Pond 4 discharge indicates that total dissolved phosphorus occassionally exceeds the permitted level, while iron exceeds the permit levels consistently. Settling Pond 4 discharges have significantly higher levels of dissolved iron than the surface flow into the pond. At Middle Quinsam Lake Road, however several acid mine drainage indicator parameters (conductivity, sulphate, hardness) were elevated relative to baseline data. Discharges from Settling Pond 4, which collects surface drainage from the 2N open pit, are 6-7% of that expected from precipitation data collected concurrently.

RESUME

Les soucis exprimés par la Commission d'Enquête (drainage minier acide, métaux, sédiments, éléments nutritifs, et eutrophication) ont été adressés par l'échantillonnage et la surveillance des eaux réceptrices près de la mine de charbon Quinsam et de son effluent. La qualité des eaux réceptrices est similaire aux données de base. Tous les résultats sont moins élevés que les lignes directrices de Qualité des Eaux Canadiennes (CCME) établies pour la protection de la vie aquatique. La croissance du périphyton est limitée par le phosphore partout mais devient plus prononcée avec la distance en aval du lac Middle Quinsam. La biomasse périphytique est générallement basse, excepté pour la station 5A où le critère de qualité des eaux de la Colombie-Britannique pour la protection de l'esthétique et récréation est dépassé. Les présentes données d'échantillonnage sont habituellement plus basses que les données de base de la mine de charbon Quinsam Coal Corporation (QCC).

Les échantillons d'effluent de l'étang de sédimentation #4 indiquent que le phosphore dissous total est occasionnellement au dessous du niveau du permit, tandis que le fer dépasse les limites de permit constamment. L'étang de sédimentation #4 décharge des niveaux significativement plus élevés de fer que le taux de l'influent. A la route Middle Quinsam Lake, par contre, plusieurs indiquant du drainage minier acide paramètres (conductivité, sulphates et dureté) étaient élevés relativement aux données de base. Les décharges de l'étang #4, qui collecte les eaux de drainage de surface de la carrière 2N, sont 6-7% des prédictions de précipitation basées sur les données ramassées simultanément.

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1.0 INTRODUCTION

Quinsam Coal Corporation (QCC) began construction of the 2N Pit and Settling Pond in the fall of 1987. Mining activities followed in December 1987, when the B.C. Ministry of Environment and Parks, Waste Management Branch (MOEP) issued a permit (PE 7008) for the release of coal mine effluent into the surface waters of the Quinsam drainage. The permit limits mining activities to the 2N and 3N pits and requires that the company regulate and monitor the effluent discharge and monitor the water quality of the receiving environment, both surface and groundwater. The permit is staged and requires an increase in monitoring activities as the mine expands in size.

Federal and provincial government agencies in December 1987, decided to monitor the effluent and receiving waters during the initial mining phases, to ensure that acid generation, release of heavy metals, nutrient enrichment and sedimentation did not adversely affect the Quinsam drainage. The information (effluent quality and quantity) would also be used to determine permit levels for discharges into more sensitive areas, i.e. Long Lake, that may be mined at some later date.

The Quinsam Technical Review Committee, established at the recommendation of the Inquiry Commission, requested Environmental Protection (EP), MOEP and QCC to report receiving water and effluent data for the initial phase of mining. This report presents effluent and receiving water quality and biological data collected by EP from April 1, 1989 to March 31, 1990. Data comparisons are made to baseline data collected by QCC in the winters of 1982/83 and 1983/84 and baseline data collected by EP from 1985 to 1987. In addition, operational monitoring data from the two previous years of operation are compared to the data presented in this report.

2.0 STUDY AREA

The Quinsam drainage is located in the coastal-Douglas fir biogeoclimatic zone on the eastern slopes of Vancouver Island and covers an area of 210 km^2. The Quinsam River flows northeast, joining the Campbell River three km upstream of its estuary (Figure 1). The study area is located in the upper half of the Quinsam drainage at an elevation of 300m, approximately 20 km southwest of the Quinsam-Campbell confluence. The Quinsam drainage, having been logged in the 1950's, has a well established second growth. Total precipitation in 1989 was approximately 800mm and was concentrated in the fall and winter months (October to March).

Flows in the Quinsam River are regulated by two British Columbia Hydro dams located at the outlet of Upper Quinsam and Wokas lakes and diverted by a third dam 1.9 km upstream of Middle Quinsam Lake. Minimum flows of 0.3 and 1.7 cms are maintained upstream of Middle Quinsam Lake and at the outlet of Lower Quinsam Lake, respectively. The remaining flow is diverted via Gooseneck Lake into the Campbell system where it is used for hydroelectric generation. All other flows in the Quinsam drainage are not regulated.

Stream stations shown in Figures 1 and 2 were established prior to the start of mining. Water quality and biota were monitored at two control stations the Quinsam River (station 1) and Flume Creek (station 2), both upstream of the Quinsam Coal Development. Receiving water quality and biota were also monitored at two stations downstream of the development (Quinsam River - stations 5 and 8). In the summers of 1987, 88 and 89, an additional station, station 5A, was located 0.5 km downstream of Middle Quinsam Lake, primarily to monitor the response of periphytic growth.

Effluent was monitored before (2N Pit - sump and Settling Pond 4 - inflow) and after (Settling Pond 4 outflow and at Middle Quinsam Lake Road culvert) treatment in the settling pond. The point of compliance for the company's permit is the discharge from Settling Pond 4.

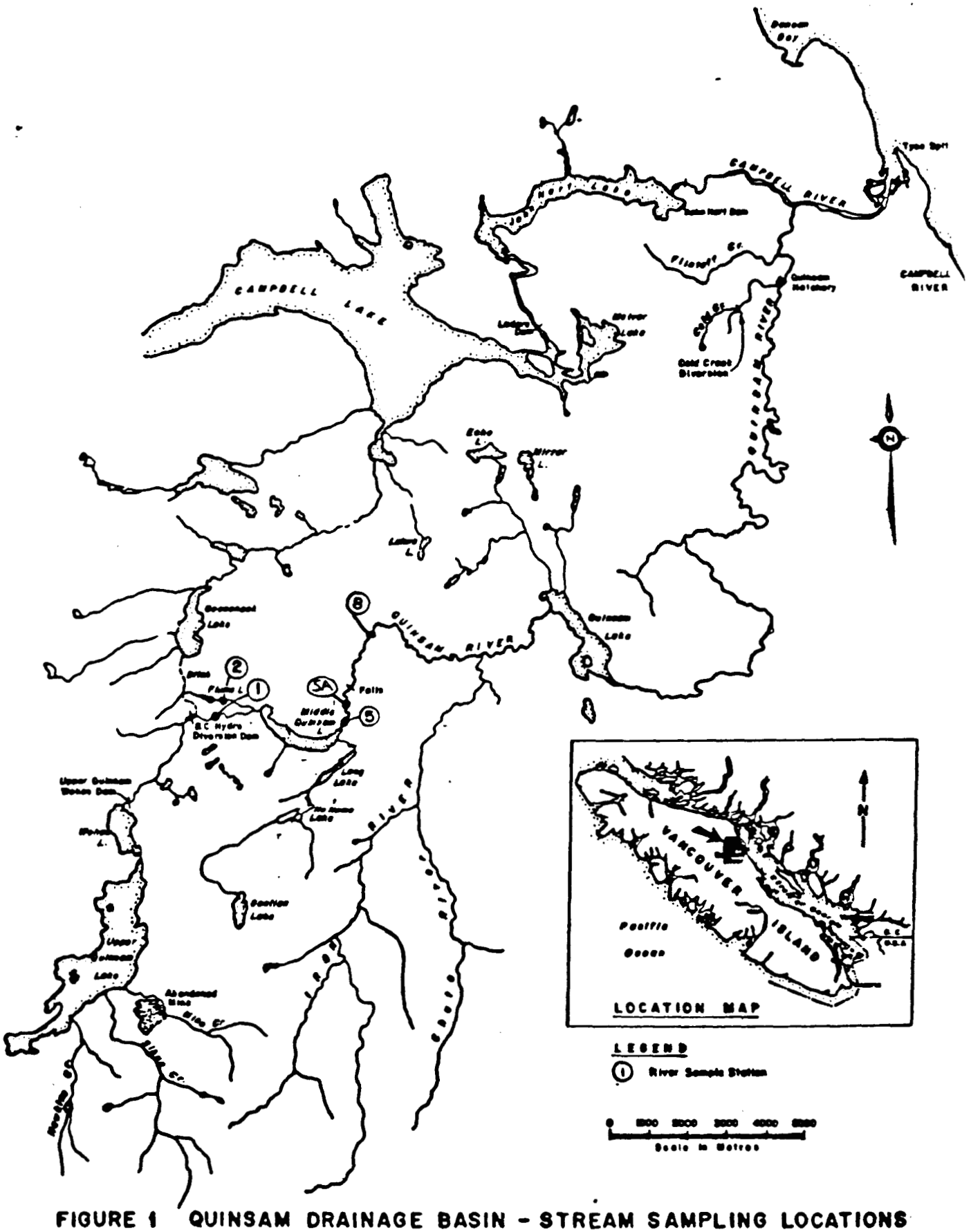

FIGURE 1 QUINSAM DRAINAGE BASIN - STREAM SAMPLING LOCATIONS

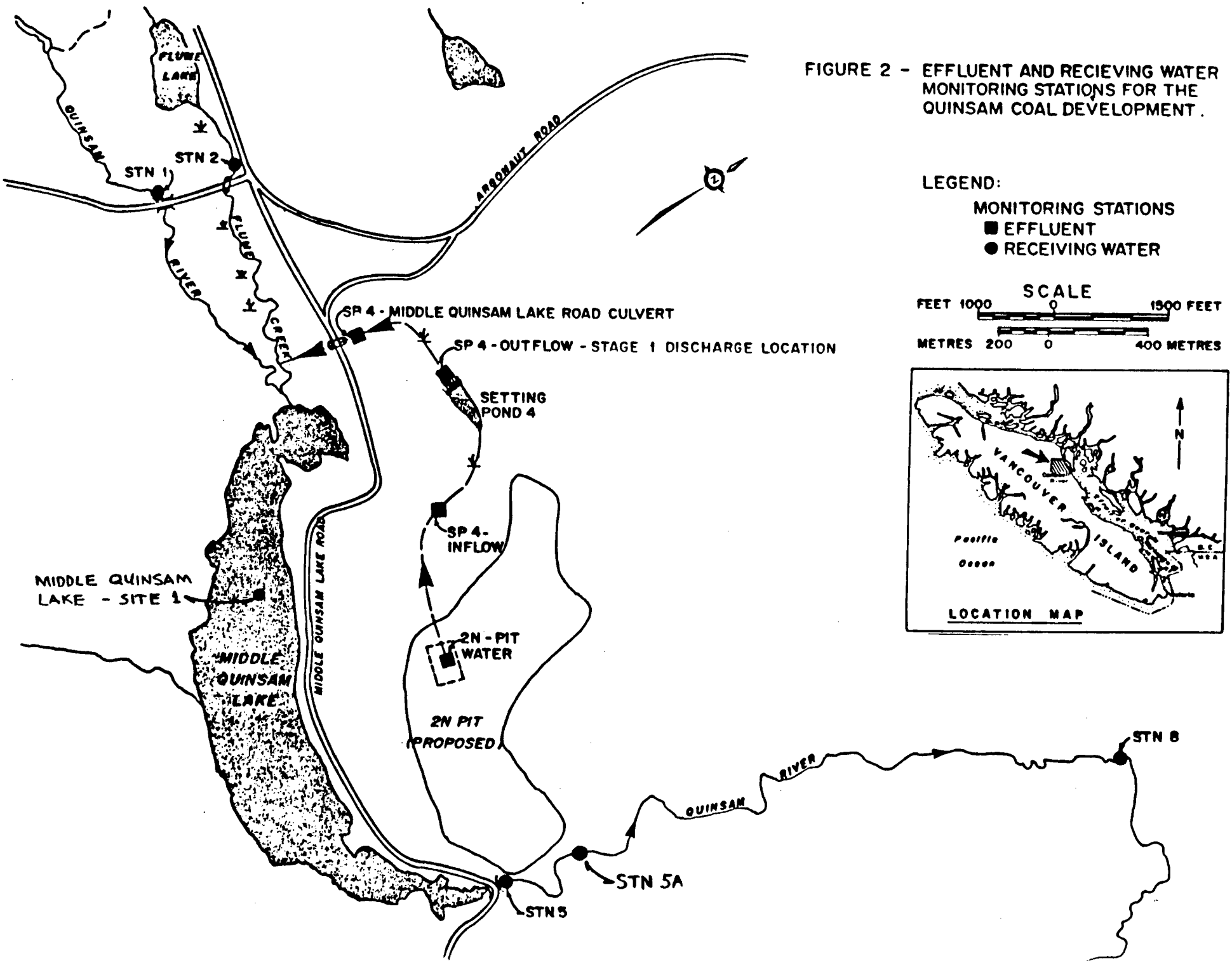

FIGURE 2 - EFFLUENT AND RECIEVING WATER MONITORING STATIONS FOR THE QUINSAM COAL DEVELOPMENT.

3.0 METHODS AND MATERIALS

Water and effluent samples were collected at approximately two month intervals from June to October, 1989. Triplicate grab samples were collected at all stream and river stations. Effluent was sampled as a single grab sample. Results are presented in the accompanying tables.

Temperature, pH, conductivity and dissolved oxygen were measured *in situ* with a Hydrolab Model 4041. A summary of field methods, sample preparation and preservation, and parameters is presented in Table 1. Dissolved metal and phosphorus samples were filtered in the field. All samples were kept on ice and in the dark and delivered to the EP Laboratory in West Vancouver within 24 hours.

Periphyton samples were collected in July, August and October. Samples were scraped from the leading and upper surfaces of 10 - 25 cm cobbles taken from depths ranging from 0.1 - 0.4 m. The only exception to this was at station 5A where samples were scraped directly from the sandstone bedrock at depths of less than 0.1 m. Each sample was a composite of scrapings from three separate cobbles. Samples were replicated 8 times at each station in order to reduce variability to acceptable levels. The samples were split three ways; species identification and enumeration, nitrogen and phosphorus ratios and total pigments. Total pigment samples were filtered and frozen while samples for N:P ratios were kept on ice and in the dark. Samples for species identification were preserved with Lugol's solution.

River flows were calculated from readings taken from existing staff gauges at stations 1 and 5. In addition, flows were measured at stations 1, 5 and 8 using a Marsh-McBirney Model II velocity meter.

TABLE 1 SUMMARY OF PARAMETERS, LABORATORIES, INSTRUMENTS AND SAMPLE PRESERVATION

	LABORATORY	FIELD PREPARATION
Temperature	Hydrolab 4041	- in situ measurement
Dissolved Oxygen	Hydrolab 4041	- in situ measurement
Conductivity	Hydrolab 4041	- in situ measurement
pH	Hydrolab 4041	- in situ measurement
Turbidity	EP Lab	
Alkalinity	EP Lab	
Residues	EP Lab	
Sulphate	EP Lab	
Nitrate	EP Lab	
Nitrate	EP Lab	
Ammonia	EP Lab	
Total Phosphorus	EP Lab	
Total Dissolved Phosphorus	EP Lab	- filter through prewashed 0.45 u Sartorius cellulose acetate filters
Total Metals *	EP Lab	- acidify with conc HNO3
Total Metals *	EP Lab	- filter through 0.45 u Sartorius cellulose nitrate filters then acidify with Conc HNO3
Total Pigment	EP Lab	- filter through GFC glass fiber filters and freeze

* Metals are routinly analyzed by Inductively Coupled Argon Plasma techniques. To achieve lower detection limits for Al, Cd, Cu and Pb, these metals are analyzed by Graphite Furnace and Atomic Absorption methods.

Sample dates were: 5 June 1989
18 July 1989
22 August 1989
16 October 1989

Several metals, consistently below the detection limit, are reported separately in Table 2.

4.0 RESULTS

4.1 Detection Limits

Table 2 Heavy Metals in Water, At or Below the Detection Limit

4.2 Receiving Water Quality

a) Table 3 - Station 1 - Quinsam River 1 km u/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

b) Table 4 - Station 2 - Flume Creek 1 km u/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

c) Table 5 - Station 5 - Quinsam River 25 m d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

d) Table 6 - Station 5A - Quinsam River .5 km d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

e) Table 7 - Station 8 - Quinsam River 3 km d/s Middle Quinsam Lake
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

TABLE 2 HEAVY METALS IN WATER AT OR BELOW THE DETECTION LIMITS

METAL	ICAP DETECTION LIMIT (mg/L)
Antimony (Sb)	0.05
Beryllium (Be)	0.001
Nickel (Ni)	0.02
Selenium (Se)	0.05
Vanadium (V)	0.005

TABLE 3 RECEIVING WATER QUALITY STATION 1 (QUINSAM RIVER - 1 km U/S MIDDLE QUINSAM LAKE)

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	FLOW	TEMP	DO	pH	COND	ACID	ALK	SO4	NFR	FR	TR	TURB	HARD	Si	TDP	TP	NO3	NO2	NH3
	cms	deg C		rel u	uS/cm							JTU	HT						
89/06/05	.75	17.3	8.7	7.6	46.8	1.5	22.2	<1.0	<5.0	31.8	31.8	<.10	22.8	1.5	<.002	.002	.012	<.005	<.005
89/07/18	.57	17.7	4.6	7.7	44.0	1.0	20.9	2.0	<5.0	33.8	33.8	<.10	21.7	1.4	<.002	<.002	.015	<.005	.006
89/08/22	.66	17.1	8.9	7.5	47.7	1.6	21.7	3.0	<5.0	32.0	32.0	.10	23.0	1.4	.006	<.002	.009	<.005	<.005
89/10/16	1.13	12.1	10	7.2	47.0	1.9	21.0	3.0	<5.0	31.8	31.8	<.10	22.9	1.4	<.002	<.002	.006	<.005	<.005
GRAND MEAN	**.8**	**16.0**	**8.0**	**7.5**	**46.4**	**1.5**	**21.4**	**2.3**	**<5.0**	**32.3**	**32.3**	**<.10**	**22.6**	**1.4**	**.003**	**<.002**	**.011**	**<.005**	**<.005**
STD ERROR	**.2**	**2.7**	**2.3**	**.2**	**1.6**	**.4**	**.6**	**1.0**	**0**	**1.0**	**1.0**	**0**	**.6**	**.03**	**.002**	**0**	**.004**	**0**	**.001**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	.006	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.006	<.001	<.01	<.0005	<.05	.012	<.002	<.002	7.7	.8	.7
89/07/18	.010	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.009	<.001	<.01	<.0005	<.05	.012	<.002	.004	7.4	.8	.7
89/08/22	.014	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	<.005	<.001	<.01	<.0005	<.05	.012	<.002	.005	7.9	.8	.7
89/10/16	.006	<.05	<.01	<.001	<.0001	<.005	.005	<.0005	.005	.001	<.01	<.0005	<.05	.013	<.002	.006	7.6	.8	.7
GRAND MEAN	**.009**	**<.05**	**<.01**	**<.001**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.006**	**<.001**	**<.01**	**<.0005**	**<.05**	**.012**	**<.002**	**.004**	**7.6**	**.8**	**.7**
STD ERROR	**.004**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**.002**	**0**	**0**	**0**	**0**	**0**	**0**	**.002**	**.2**	**0**	**0**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	.009	<.05	.01	.003	<.0001	<.005	<.005	.0010	.018	.002	<.01	<.0005	<.05	.012	.002	.003	7.5	.8	.7
89/07/18	.028	.05	<.01	.002	<.0001	<.005	<.005	.0020	.062	.004	<.01	<.0006	<.05	.012	.002	.009	7.5	.8	.7
89/08/22	.022	<.05	<.01	<.001	<.0001	<.005	<.005	<.0006	.018	.003	<.01	<.0006	<.05	.012	<.002	<.002	7.3	.8	.8
89/10/16	.026	<.05	<.01	<.001	<.0001	<.005	<.005	<.0006	.028	.002	<.01	<.0006	<.05	.013	.005	.004	7.6	.8	.7
GRAND MEAN	**.021**	**<.05**	**<.01**	**.001**	**<.0001**	**<.005**	**<.005**	**.0010**	**.032**	**.003**	**<.01**	**<.0006**	**<.05**	**.012**	**.003**	**.005**	**7.5**	**.8**	**.7**
STD ERROR	**.009**	**0**	**0**	**.001**	**0**	**0**	**0**	**.0006**	**.021**	**.001**	**0**	**0**	**0**	**.0003**	**.002**	**.003**	**.1**	**0**	**.1**

TABLE 4 RECEIVING WATER QUALITY STATION 2 (FLUME CREEK - 1 km U/S MIDDLE QUINSAM LAKE)

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05		18.5	5.1	7.0	49.2	4.7	22.2	<1.0	<5.0	33.3	33.3	.20	23.0	1.6	<.002	.004	.005	<.005	<.005
89/07/18		18.4	4.6	7.5	53.0	1.3	25.4	2.0	<5.0	44.3	44.3	.80	28.2	1.8	.003	.005	<.005	<.005	<.005
89/08/22		20.5	3.8	7.5	58.0	1.6	25.9	2.0	<5.0	42.6	42.6	.70	28.3	2.3	.003	.003	.006	<.005	<.005
89/10/16		8.8	7.1	6.8	48.2	6.8	20.9	2.3	<5.0	36.3	36.3	.50	21.9	2.1	.005	.009	.008	<.005	.013
GRAND MEAN		**16.6**	**5.1**	**7.2**	**52.1**	**3.6**	**23.6**	**1.8**	**<5.0**	**39.1**	**39.1**	**.55**	**25.3**	**2.0**	**.006**	**.005**	**.006**	**<.005**	**.007**
STD ERROR		**5.2**	**1.4**	**.4**	**4.4**	**2.6**	**2.4**	**.6**	**0**	**5.2**	**.3**	**.26**	**3.4**	**.3**	**.005**	**.003**	**.002**	**0**	**.004**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	<.002	<.05	.02	.005	<.0001	<.005	<.005	<.0005	.144	.027	<.01	<.0005	<.05	.019	<.002	<.002	7.5	1	1.1
89/07/18	.011	<.05	<.01	.006	<.0001	<.005	<.005	<.0005	.345	.053	<.01	<.0005	<.05	.024	<.002	<.002	9.1	1.2	1.1
89/08/22	.003	<.05	<.01	.005	<.0001	<.005	<.005	<.0005	.587	.065	<.01	<.0005	<.05	.024	<.002	<.002	9.0	1.1	1.3
89/10/16	.005	<.05	<.01	.005	<.0001	<.005	<.005	<.0006	.356	.014	<.01	<.0005	<.05	.018	<.002	.007	6.9	1.0	1.5
GRAND MEAN	**.005**	**<.05**	**.012**	**.005**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.358**	**.040**	**<.010**	**<.0005**	**<.05**	**.021**	**<.002**	**.003**	**8.1**	**1.1**	**1.3**
STD ERROR	**.004**	**0**	**.003**	**.001**	**0**	**0**	**0**	**0**	**.181**	**.023**	**0**	**0**	**0**	**.003**	**0**	**.002**	**1.1**	**.1**	**.2**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	<.002	<.05	.01	.005	<.0001	<.005	<.005	<.0005	.298	.022	<.01	<.0005	<.05	.018	<.002	<.002	7.1	.9	1.1
89/07/18	.051	<.05	<.01	.006	<.0001	<.005	<.005	.0010	1.02	.062	<.01	<.0006	<.05	.023	.006	<.002	9.0	1.1	1.2
89/08/22	.031	.07	.01	.006	<.0001	<.005	<.005	<.0006	1.49	.063	<.01	<.0006	<.05	.023	<.002	<.002	8.5	1.0	1.3
89/10/16	.065	<.05	.01	<.005	<.0001	<.005	<.005	<.0006	.660	.017	<.01	<.0006	<.05	.018	.008	.028	6.9	1.0	1.6
GRAND MEAN	**.037**	**.055**	**.01**	**.005**	**<.0001**	**<.005**	**<.005**	**.0007**	**.868**	**.041**	**<.01**	**<.0006**	**<.05**	**.020**	**.004**	**.009**	**7.9**	**1.0**	**1.3**
STD ERROR	**.027**	**.010**	**0**	**.001**	**0**	**0**	**0**	**.0002**	**.510**	**.025**	**0**	**0**	**0**	**.0027**	**.003**	**.013**	**1.0**	**.1**	**.2**

TABLE 5 RECEIVING WATER QUALITY STATION 5 (QUINSAM RIVER 25 m D/S MIDDLE QUINSAM LAKE)

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05	2.01	21.9	8.4	7.5	53.0	1.6	20.2	2.7	<5.0	34.3	34.3	<.10	22.4	1.5	<.002	.003	<.005	<.005	.010
89/07/18		20.0	8.7	7.8	48.0	1.2	20.4	3.7	<5.0	36.3	36.3	.10	22.7	1.1	<.002	<.002	<.005	<.005	<.005
89/08/22		18.8	8.7	7.4	53.0	1.2	20.9	4.0	<5.0	34.3	34.3	.10	23.6	1.3	.002	<.002	<.005	<.005	<.005
89/10/16		12.4	9.1	7.4	39.3	2.4	21.1	3.0	<5.0	35.0	35.0	<.10	23.3	1.4	<.002	<.002	.005	<.005	.009
GRAND MEAN	**2.01**	**18.3**	**8.7**	**7.5**	**48.3**	**1.6**	**20.6**	**3.3**	**<5.00**	**35**	**35.0**	**<.10**	**23.0**	**1.3**	**.002**	**.002**	**<.005**	**.005**	**.007**
STD ERROR		**4.1**	**.3**	**.2**	**6.5**	**.6**	**.4**	**.6**	**0**	**.9**	**.9**	**0**	**.5**	**.2**	**0**	**.001**	**0**	**0**	**.003**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	<.002	<.05	.01	<.001	<.0001	<.005	<.005	<.0005	.024	.006	<.01	<.0005	<.05	.017	<.002	<.002	7.4	.9	1.6
89/07/18	.005	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.015	.002	<.01	<.0005	<.05	.013	<.002	<.002	7.5	.9	1.3
89/08/22	.008	.05	.02	<.001	<.0001	<.005	<.005	<.0005	.021	<.001	<.01	<.0005	<.05	.016	<.002	<.002	8	.9	1.2
89/10/16	.002	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.033	.007	<.01	<.0005	<.05	.015	<.002	<.002	7.9	.9	1
GRAND MEAN	**.004**	**<.05**	**.012**	**<.001**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.023**	**.004**	**<.01**	**<.0005**	**<.05**	**.015**	**<.002**	**<.002**	**7.7**	**.9**	**1.3**
STD ERROR	**.003**	**0**	**.003**	**0**	**0**	**0**	**0**	**0**	**.007**	**.003**	**0**	**0**	**0**	**.002**	**0**	**0**	**.3**	**0**	**.2**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	<.002	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.047	.008	<.01	<.0005	<.05	.017	<.002	.003	7.1	.9	1.6
89/07/18	.022	<.05	<.01	.001	<.0001	<.005	<.005	.0012	.053	.007	<.01	<.0006	<.05	.017	.002	.005	7.3	.9	1.4
89/08/22	.077	<.05	.01	.002	<.0001	<.005	<.005	.0020	.172	.008	<.01	<.0006	<.05	.016	.007	<.002	7.5	.8	1.2
89/10/16	.025	<.05	.01	.001	<.0001	<.005	<.005	<.0006	.068	.012	<.01	<.0006	<.05	.014	.006	.003	7.9	.9	1.1
GRAND MEAN	**.032**	**<.05**	**<.01**	**.001**	**<.0001**	**<.005**	**<.005**	**.0011**	**.085**	**.009**	**<.01**	**<.0006**	**<.05**	**.016**	**.004**	**.003**	**7.4**	**.9**	**1.3**
STD ERROR	**.032**	**0**	**0**	**0**	**0**	**0**	**0**	**.0007**	**.059**	**.002**	**0**	**0**	**0**	**.0013**	**.003**	**.001**	**.3**	**0**	**.2**

TABLE 6 RECEIVING WATER QUALITY STATION 5A (QUINSAM RIVER .5 km D/S MIDDLE QUINSAM LAKE)

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05	not sampled routinely																	
89/07/18	19.5		7.8	48.0	1.6	20.4	3.7	<5.0	36.3	36.3	.1	23.1	1.3	<.002	.003	<.005	<.005	<.005
89/08/22	18.9	8.7	7.5	53.0	1.3	20.9	1.7	<5.0	33.7	33.7	.1	24.0	1.3	.002	<.002	<.005	<.005	<.005
89/10/16	not sampled routinely																	
GRAND MEAN	**19.2**	**8.7**	**7.7**	**50.5**	**1.5**	**20.7**	**2.7**	**<5.0**	**35.0**	**35.0**	**.1**	**23.6**	**1.3**	**<.002**	**.002**	**<.005**	**<.005**	**<.005**
STD ERROR	**.4**		**.2**	**3.5**	**.2**	**.4**	**1.4**	**0**	**1.8**	**0**	**0**	**.6**	**0**	**0**	**0**	**0**	**0**	**0**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18	.006	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.018	.001	<.01	<.0005	<.05	.017	<.002	<.002	7.7	1.0	1.4
89/08/22	.006	<.05	<.01	<.001	<.0001	<.005	<.005	<.0005	.021	.002	<.01	<.0005	<.05	.016	<.002	<.002	8.0	.9	1.2
89/10/16																			
GRAND MEAN	**.006**	**.05**	**<.010**	**<.001**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.020**	**.002**	**<.01**	**<.0005**	**<.05**	**.017**	**<.002**	**<.002**	**7.9**	**1.0**	**1.3**
STD ERROR	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**.002**	**.001**	**0**	**0**	**0**	**.001**	**0**	**0**	**.3**	**0**	**.1**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18	.012	<.05	<.01	.001	<.0001	<.005	<.005	.0013	.043	.008	<.01	<.0006	<.05	.016	<.002	.003	7.4	.9	1.4
89/08/22	.098	.05	<.01	.001	<.0001	<.005	<.005	.0008	.052	.006	<.01	<.0006	<.05	.016	<.002	<.002	7.5	.8	1.2
89/10/16																			
GRAND MEAN	**.055**	**<.05**	**<.01**	**.001**	**<.0001**	**<.005**	**<.005**	**.0011**	**.048**	**.007**	**<.01**	**<.0006**	**<.05**	**.016**	**<.002**	**.003**	**7.5**	**.9**	**1.3**
STD ERROR	**.061**	**0**	**0**	**0**	**0**	**0**	**0**	**.0004**	**.006**	**.001**	**0**	**0**	**0**	**0**	**0**	**.001**	**.1**	**0**	**.1**

TABLE 7 RECEIVING WATER QUALITY STATION 8 (QUINSAM RIVER 3 km D/S MIDDLE QUINSAM LAKE)

(units – mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05		21.8	7.9	7.7	53.0	1.3	21.0	2.7	<5.0	34.0	34.0	<.1	22.6	1.5	<.002	.002	.020	<.005	<.005
89/07/18		17.2	8.8	7.6	48.8	1.0	21.4	4.0	<5.0	35.3	35.3	<.1	23.5	1.3	<.002	<.002	.017	<.005	<.005
89/08/22		17.6	8.8	7.5	54.3	1.5	20.9	3.0	<5.0	35.3	35.3	<.1	23.9	1.3	.002	.002	.008	<.005	<.005
89/10/16	1.87	12.6	11.4	7.5	50.0	1.3	20.9	3.0	<5.0	36.3	36.3	<.1	23.2	1.4	.002	.005	.008	<.005	<.005
GRAND MEAN		**17.3**	**9.2**	**7.6**	**51.5**	**1.3**	**21.1**	**3.2**	**<5.0**	**35.2**	**35.2**	**<.1**	**23.3**	**1.4**	**<.002**	**.003**	**.013**	**<.005**	**<.005**
STD ERROR		**3.7**	**1.5**	**.1**	**2.6**	**.2**	**.2**	**.6**	**0**	**.9**	**.9**	**0**	**.5**	**.1**	**.000**	**.001**	**.006**	**0**	**0**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	< .002	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.013	.001	<.01	<.0005	<.05	.018	<.002	<.002	7.5	.9	1.6
89/07/18	.006	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.013	<.001	<.01	<.0005	<.05	.017	<.002	.002	7.8	1.0	1.4
89/08/22	.005	.07	<.01	<.001	<.0001	<.005	<.005	<.0005	.016	<.001	<.01	<.0005	<.05	.016	<.002	<.002	8.0	.9	1.3
89/10/16	.003	<.05	<.01	.001	<.0001	<.005	<.005	<.0005	.027	.002	<.01	<.0005	<.05	.015	<.002	<.002	7.8	.9	1.0
GRAND MEAN	**.004**	**.06**	**<.01**	**<.001**	**<.0001**	**<.005**	**<.005**	**<.0005**	**.017**	**.010**	**<.001**	**<.0005**	**<.05**	**.017**	**<.002**	**<.002**	**7.8**	**.9**	**1.3**
STD ERROR	**.002**	**.01**	**0**	**0**	**0**	**0**	**0**	**0**	**.007**	**0**	**0**	**0**	**0**	**.001**	**0**	**0**	**.2**	**0**	**.2**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	< .002	<.05	<.01	.002	<.0001	<.005	<.005	<.0005	.036	.003	<.01	<.0005	<.05	.018	<.002	.006	7.2	.9	1.7
89/07/18	.008	<.05	.01	.002	<.0001	<.005	<.005	.0015	.067	.005	<.01	<.0006	<.05	.018	<.002	.003	7.5	1.0	1.5
89/08/22	.011	<.05	.01	.002	<.0001	<.005	<.005	<.0005	.035	.003	<.01	<.0006	<.05	.016	<.002	<.002	7.7	.9	1.3
89/10/16	.047	<.05	.01	.001	<.0001	<.005	<.005	.0008	.070	.004	<.01	<.0006	<.05	.015	.010	.005	7.8	.9	1.1
GRAND MEAN	**.017**	**<.05**	**<.01**	**.001**	**<.0001**	**<.005**	**<.005**	**.0008**	**.052**	**.004**	**<.01**	**<.0006**	**<.05**	**.017**	**.004**	**.004**	**7.6**	**.9**	**1.4**
STD ERROR	**.020**	**0**	**0**	**.001**	**0**	**0**	**0**	**.0005**	**.019**	**.001**	**0**	**0**	**0**	**.0014**	**.004**	**.002**	**.3**	**.1**	**.3**

4.3 Effluent Quality

a) Table 8 - 2N Pit Water
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

b) Table 9 - Settling Pond 4 - Inflow
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

c) Table 10 - Settling Pond 4 - Outflow
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

d) Table 11 - Middle Quinsam Lake Road - Culvert
- A Physical and Chemical
- B Dissolved Metals
- C Total Metals

TABLE 8 EFFLUENT QUALITY 2N PIT WATER

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05	20.6	5.8	8.1	2800	4.7	171	1500	<5.0	2600	2600	.1	1100	1.5	.002	.005	5.44	.095	.173
89/07/18	not sampled																	
89/08/22	19.0		8.1	2500	<1.0	111	1200	24.0	2290	2314	13.0	831	2.5	.008	.016	4.81	.320	.742
89/10/16	9.0	7.8	8.0	2800	5.1	143	970	56.0	1990	2046	38.0	613	2.3	.002	.020	5.34	.730	2.41
MEAN	**16.2**	**6.8**	**8.1**	**2700**	**3.6**	**142**	**1223**	**28.3**	**2293**	**2320**	**17.0**	**848**	**2.1**	**.004**	**.014**	**5.20**	**.382**	**1.11**
STD DEV	**6.3**	**1.4**	**.1**	**173**	**2.3**	**30**	**266**	**26**	**305**	**277**	**19**	**244**	**.5**	**.003**	**.008**	**.3**	**.322**	**1.16**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	< .002	<.05	.81	.043	<.0001	.005	<.005	.0091	<.005	.275	<.01	<.0005	<.05	4.55	<.002	<.002	378	36.2	354
89/07/18																			
89/08/22	.012	.09	1.01	.046	<.0001	<.005	<.005	.0099	.011	.120	.03	<.0005	.05	3.31	<.002	<.002	293	23.1	353
89/10/16	.042	<.05	1.00	.066	<.0001	<.005	<.005	.0100	<.005	.110	.04	<.0005	<.05	2.23	<.002	.003	220	14.9	338
MEAN	**.019**	**.06**	**.94**	**.052**	**<.0001**	**<.005**	**<.005**	**.0097**	**.007**	**.168**	**.03**	**<.0005**	**<.05**	**3.36**	**<.002**	**.002**	**297**	**24.7**	**348**
STD DEV	**.021**	**.02**	**.11**	**.013**	**0**	**0**	**0**	**.0005**	**.003**	**.093**	**.02**	**0**	**0**	**1.16**	**0**	**.001**	**79.1**	**10.7**	**9.0**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05	.191	<.05	.78	.043	<.0001	<.005	<.005	.0099	.038	.314	<.01	<.0005	<.05	4.53	.004	<.002	368	35.6	367
89/07/18																			
89/08/22	.450	<.05	1.13	.049	<.0001	<.005	<.005	.0163	.267	.133	.03	<.0006	<.05	3.49	.010	<.002	296	24.6	388
89/10/16	1.690	<.05	1.05	.072	<.0001	<.005	<.005	.0119	1.25	.134	.04	<.0006	<.05	2.22	.104	.004	227	15.8	345
MEAN	**.777**	**<.05**	**1.05**	**.072**	**<.0001**	**<.005**	**<.005**	**.0127**	**.518**	**.194**	**.03**	**<.0006**	**<.05**	**3.41**	**.039**	**.003**	**297**	**25.3**	**367**
STD DEV	**.801**	**0**	**.18**	**.015**	**0**	**0**	**0**	**.003**	**.644**	**.104**	**.02**	**0**	**0**	**1.16**	**.056**	**.001**	**70.5**	**9.92**	**21.5**

TABLE 9 EFFLUENT QUALITY SETTLING POND 4 INFLOW

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	TEMP	DO	pH	COND	ACID	ALK	SO4	NFR	FR	TR	TURB	HARD	Si	TDP	TP	NO3	NO2	NH3
	deg C		rel u	uS/cm							JTU	HT						
89/06/05	no flow																	
89/07/18	no flow																	
89/08/22	18.9	10.3	8.1	2250	<1.0	129	1200	<5.0	2070	2070	2.3	661	1.6	.009	.011	4.73	.102	.380
89/10/16	9.4	12.8	8.0	1230	2.6	91.3	600	<5.0	1070	1070	.7	557	2.6	<.002	.005	.066	<.005	.012
MEAN	**14.2**	**11.6**	**8.1**	**1740**	**1.8**	**110**	**900**	**<5.0**	**1570**	**1570**	**1.5**	**609**	**2.1**	**.006**	**.008**	**2.40**	**.054**	**.196**
STD DEV	**6.7**	**1.8**	**.1**	**721**	**1.1**	**27**	**424**	**0**	**707**	**707**	**1.1**	**74**	**.7**	**.005**	**.004**	**3.3**	**.069**	**.260**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18																			
89/08/22	.017	<.05	.83	.043	<.0001	.008	.006	.0082	<.005	.083	.01	<.0005	.07	2.61	<.002	.106	227	21.9	281
89/10/16	.018	<.05	.19	.030	.0001	<.005	<.005	.0037	<.005	.317	<.01	<.0005	<.05	1.28	<.002	.085	165	34.9	93.8
MEAN	**.018**	**<.05**	**.51**	**.037**	**<.0001**	**.007**	**.006**	**.0060**	**<.005**	**.200**	**<.01**	**<.0005**	**.06**	**1.95**	**<.002**	**.096**	**196**	**28.4**	**187**
STD DEV	**.001**	**0**	**.45**	**.009**	**0**	**.002**	**.001**	**.0032**	**0**	**.165**	**0**	**0**	**.014**	**.94**	**0**	**.015**	**43.8**	**9.2**	**132**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18																			
89/08/22	.211	.05	1.01	.051	<.0001	<.005	<.005	.0147	.312	.104	.02	<.0006	<.05	3.13	.005	.122	256	26.3	351
89/10/16	.215	<.05	.20	.031	<.0001	<.005	<.005	.0075	.314	.335	<.01	<.0006	<.05	1.29	.008	.090	168	36.4	96.5
MEAN	**.213**	**<.05**	**.61**	**.041**	**<.0001**	**<.005**	**<.005**	**.0111**	**.313**	**.220**	**.02**	**<.0006**	**<.05**	**2.21**	**.007**	**.106**	**212**	**31.4**	**224**
STD DEV	**.003**	**0**	**.57**	**.014**	**0**	**0**	**0**	**.005**	**.001**	**.163**	**.01**	**0**	**0**	**1.30**	**.002**	**.023**	**62**	**7.1**	**180**

TABLE 10 EFFLUENT QUALITY SETTLING POND 4 OUTFLOW

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	TEMP	DO	pH	COND	ACID	ALK	SO4	NFR	FR	TR	TURB	HARD	Si	TDP	TP	NO3	NO2	NH3
	deg C		rel u	uS/cm							JTU	HT						
89/06/05	no flow																	
89/07/18	no flow																	
89/08/22	18.8	7.4	7.8	1030	<1.0	115	400	<5.0	835	835	2.8	283	1.5	.012	.014	<.005	<.005	<.005
89/10/16	10.9	6.1	7.5	1030	10.2	130	400	<5.0	842	842	6.5	323	2.2	.004	.010	<.005	<.005	.052
MEAN	**14.9**	**6.8**	**7.7**	**1030**	**5.6**	**123**	**400**	**<5.0**	**839**	**4.7**	**4.7**	**303**	**1.9**	**.008**	**.012**	**<.005**	**<.005**	**.029**
STD DEV	**5.6**	**.9**	**.2**	**0**	**6.5**	**11**	**0**	**0**	**4.9**	**2.6**	**2.6**	**28**	**.5**	**.006**	**.003**	**0**	**0**	**.033**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18																			
89/08/22	.010	<.05	.15	.038	<.0001	<.005	<.005	.0022	.368	.202	<.01	<.0005	<.05	.89	<.002	.034	91.5	12.6	102
89/10/16	.015	<.05	.17	.043	<.0001	<.005	<.005	.0030	.405	.127	<.01	<.0005	<.05	1.00	<.002	.081	104	14.8	125
MEAN	**.013**	**<.05**	**.16**	**.041**	**<.0001**	**<.005**	**<.005**	**.0026**	**.387**	**.165**	**<.01**	**<.0005**	**<.05**	**.94**	**<.002**	**.058**	**97.8**	**13.7**	**114**
STD DEV	**.004**	**0**	**.01**	**.004**	**0**	**0**	**0**	**.0006**	**.026**	**.053**	**0**	**0**	**0**	**.08**	**0**	**.033**	**8.8**	**1.6**	**16**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18																			
89/08/22	.046	<.05	.20	.049	<.0001	<.005	<.005	.0057	.866	.263	<.01	<.0006	<.05	1.13	.007	.042	111	16.0	139
89/10/16	.114	<.05	.16	.043	<.0001	<.005	<.005	.0020	1.27	.130	<.01	<.0006	<.05	.991	.008	.003	105	15.1	127
MEAN	**.080**	**<.05**	**.18**	**.046**	**<.0001**	**<.005**	**<.005**	**.0039**	**1.07**	**.197**	**<.01**	**<.0006**	**<.05**	**1.061**	**.008**	**.023**	**108**	**15.6**	**133**
STD DEV	**.048**	**0**	**.03**	**.004**	**0**	**0**	**0**	**.0026**	**.29**	**.094**	**0**	**0**	**0**	**.098**	**.001**	**.028**	**4.2**	**.6**	**8.5**

TABLE 11 EFFLUENT QUALITY MIDDLE QUINSAM LAKE ROAD - CULVERT

(units - mg/L, except as noted)

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ACID	ALK	SO4	NFR	FR	TR	TURB JTU	HARD HT	Si	TDP	TP	NO3	NO2	NH3
89/06/05	no flow																	
89/07/18			6.9	600	<1.0	33.0	270	<5.0	500	500	<.1	187	4.7	<.002	<.002	.016	<.005	<.005
89/08/22	no flow																	
89/10/16	no flow																	
MEAN			**6.9**	**600**	**<1.0**	**33.0**	**270**	**<5.0**	**500**	**500**	**<.1**	**187**	**4.7**	**<.002**	**<.002**	**.016**	**<.005**	**<.005**

B DISSOLVED METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18	.022	<.05	.08	.037	<.0001	<.005	<.005	.0025	<.005	<.001	<.01	<.0005	<.05	.545	<.002	<.002	59.4	9.3	67.8
89/08/22																			
89/10/16																			
MEAN	**.022**	**<.05**	**.08**	**.037**	**<.0001**	**<.005**	**<.005**	**.0025**	**<.005**	**<.001**	**<.01**	**<.0005**	**<.05**	**.545**	**<.002**	**<.002**	**59.4**	**9.3**	**67.8**

C TOTAL METALS

DATE	Al	As	B	Ba	Cd	Co	Cr	Cu	Fe	Mn	Mo	Pb	Sn	Sr	Ti	Zn	Ca	Mg	Na
89/06/05																			
89/07/18	.079	<.05	.06	.036	.0001	<.005	<.005	.0058	.016	<.001	<.01	<.0006	<.05	.525	<.002	.002	56.8	8.3	66.3
89/08/22																			
89/10/16																			
MEAN	**.079**	**<.05**	**.06**	**.036**	**.0001**	**<.005**	**<.005**	**.0058**	**.016**	**<.001**	**<.01**	**<.0006**	**<.05**	**.525**	**<.002**	**.002**	**56.8**	**8.3**	**66.3** {S

4.4 Periphyton

Table 12 - Periphyton Summary

TABLE 12 PERIPHYTON - SUMMARY

STATION	DATE	TOTAL NITRO (g/m2)	TOTAL PHOS (g/m2)	N:P (atomic)	CHL a (mg/m2)	PHAEO-PHYTON (mg/m2)	TOTAL PIGMENT (mg/m2)
1	89/07/18	5.08	.203	55	10.2	10.9	21.1
	89/08/22	6.02	.256	52	22.3	8.38	30.7
	89/10/16	5.62	.245	51	23.1	2.44	25.5
	GRAND MEAN	**5.57**	**.235**	**53**	**18.5**	**7.24**	**25.8**
	STD ERROR	**.47**	**.03**	**2.4**	**7.2**	**4.3**	**4.8**
5	89/07/18	2.44	.082	66	4.10	1.58	5.68
	89/08/22	2.73	.111	54	4.04	1.59	5.63
	89/10/16	6.16	.254	54	16.6	5.20	21.8
	GRAND MEAN	**3.78**	**.149**	**58**	**8.25**	**2.79**	**11.0**
	STD ERROR	**2.1**	**.09**	**6.8**	**7.2**	**2.1**	**9.3**
5A	89/07/18	8.72	.328	59	21.1	3.19	24.29
	89/08/22	6.95	.252	61	61.1	13.3	74.40
	89/10/16	not sampled routinely					
	GRAND MEAN	**7.84**	**.290**	**60**	**0**	**8.25**	**49.3**
	STD ERROR	**1.3**	**.05**	**1.6**	**28.3**	**7.1**	**35.4**
8	89/07/18	1.67	.053	70	2.37	1.14	3.51
	89/08/22	1.87	.050	83	2.98	1.35	4.33
	89/10/16	2.77	.052	118	8.29	2.48	10.8
	GRAND MEAN	**2.10**	**.052**	**90**	**4.55**	**1.66**	**6.20**
	STD ERROR	**.6**	**0**	**25**	**3.3**	**.7**	**4.0**

5.0 DISCUSSION

5.1 Comparison of Selected EP Data on Effluent, Receiving Water Quality and Biological Parameters (April 1989 - March 1990)

A comparison of seventeen parameters representing QCC permit requirements and Federal concerns that were expressed to the provincial Commission of Inquiry in 1983 are as follows:

Acid Mine Drainage - pH, conductivity and sulphate
Heavy Metals - dissolved Al, Cu, Fe, Pb and Zn
Nutrients - phosphorus (total and dissolved), nitrate, nitrite and ammonia
Sedimentation - non filterable residue and turbidity

In addition, alkalinity and hardness are compared in order to detect changes in the effluent and receiving water buffering capacities.

Comparisons are made between receiving water quality parameter means and Canadian Water Quality Guidelines (CCME, 87), (Table 13) for freshwater aquatic life as well as between effluent parameter means and permitted levels. Student's t test is used to determine the level of significance of the respective changes in the selected parameters. The level of significance in this case is 0.05 (5%), a conventionally used biological statistic. To compute means, grand means, standard deviations and standard errors, all values that are less than the detection limit are assumed to equal the detection limit. As a result, increases are underestimated when compared to values consistently below the detection limit. Additionally, as standard deviations and errors reported may be large relative to the mean and grand mean values and the number of samples collected is small, care must be used to interpret the data presented in this report.

Dissolved iron and total dissolved phosphorus in the SP4 discharge exceed PE7008 permit levels (Appendix B). Phosphorus marginally exceeds the permitted level by 20%, 1 of 2 times sampled, however, the mean value is less

TABLE 13 COMPARISON OF SELECTED RECEIVING WATER AND EFFLUENT DATA MEANS (1)
(APRIL 1989 - MARCH 1990)

AREA OF CONCERN	PARAMETER	STATION CONTROLS 1 (n=4)	CONTROLS 2 (n=4)	RECEIVING 5 (n=4)	RECEIVING 5A (n=2)	RECEIVING 8 (n=4)	EFFLUENT SP4-OUT (n=2)	EFFLUENT MQLR (n=1)	CCME GUIDELINE
ACID MINE DRAINAGE	pH (Rel.U.)	7.5	7.2	7.5	7.7	7.6	7.7	6.9	6.5 - 9.0
	Conduct (uS/cm)	46.4	52.1	48.0	50.5	51.5	1030	600	
	Sulphate	2.3	1.8	3.3	2.7	3.2	400	270	
	Alkalinity	21.4	23.6	20.6	20.7	21.1	123	33.0	
	Hardness	22.6	25.3	23.0	23.6	23.3	303	187	
HEAVY METALS	Al (diss)	.006	.005	.004	.006	.004	.013	.022	.1
	Cu (diss)	<.0005	<.0005	<.0005	<.0005	<.0005	.0026	.0025	.002 (2)
	Fe (diss)	.006	.358	.023	.020	.017	.387	<.005	.3
	Pb (diss)	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	<.0005	.001 (2)
	Zn (diss)	.004	.003	<.002	<.002	<.002	.058	<.002	.03
NUTRIENTS	Tot Dis PO4	.003	.006	.002	<.002	<.002	.008	<.002	
	Tot PO4	<.002	.005	.002	.002	.003	.012	<.002	
	Nitrate	.011	.006	.005	<.005	.013	<.005	.016	
	Nitrite	<.005	<.005	.005	<.005	<.005	<.005	<.005	.06
	Ammonia	<.005	.007	.007	<.005	<.005	.029	<.005	(3)
SEDIMENTATION	Non Filt Res.	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	
	Turbid (JTU)	<.1	.55	<.1	.1	<.1	4.7	<.1	
EUTROPHICATION (periphyton & phytoplankton)	TN:TP (atomic)	53	-	58	60	90	-	-	
	TOTAL PIGMENTS (mg/m2)	26	-	11	49	6.2	-	-	

(1) units in mg/L, unless otherwise noted
(2) @ hardness < 60 mg/L
(3) 2.2 @ pH 6.5 & temp 10C; 1.37 @ pH 8.0 & temp 10C

than permitted. Iron exceeds the permit 2 of 2 times by an average of 1.3 times and is the only significantly elevated parameter in the effluent (0.5% probability). The remaining permitted parameters are consistently within the levels. Several non-permitted parameters used as indicators for acid mine drainage (conductivity, alkalinity, hardness and sulphate) increased from 2.6 to 4.3 times the previous years values (Redenbach, 1989).

Dissolved iron levels at station 2 were high relative to the other control station and receiving water monitoring stations. Receiving water quality at station 5 was very similar to control stations 1 and 2. Although water quality was only monitored twice (July & August) at station 5A, .5 km downstream of MQL, all results are similar to the control stations and the monitoring station at the outlet of MQL. Water quality at station 8 is similar to the control stations. There are no significant differences between parameter means of the control stations when compared to the downstream receiving water quality monitoring stations (5, 5A and 8). All parameters in the receiving waters with the exception of iron at station 2, are within the guidelines set out in CCME 87.

Atomic nitrogen:phosphorus ratios at the four stations monitored (Tables 12, 13 and 14) demonstrate that periphytic algal productivity is phosphorus limited (mean 63, range 53 - 90) during the growing season. Phosphorus deficiency is least pronounced at the control station and increases with distance downstream. This suggests that phosphorus is possibly limiting periphytic algal growth in the receiving environment.

Periphyton biomass (chlorophyll a and phaeopigments) is low at all stations (mean 23 mg/m^2, range 6.2 - 49 mg/m^2), during the spring, summer and fall. With the exception of station 5A located immediately adjacent to and down slope from the eastern extremity of the 2N-Pit, the average pigment level is 49 mg/m^2. Periphyton pigment levels at Station 5A exceed the B.C. MOE Water Quality criterion for the protection of aesthetics and recreational values (50 mg/m^2) and approaches the criterion for the protection of aquatic life (100 mg/m^2) during the summer months.

5.2 Comparison of Selected EP Monitoring Data (April 1989 - March 1990) to QCC Baseline Data (1983 - 1984)

Data collected from June to October 1989 by EP was compared to the QCC baseline data (1983 and 1984) to verify that there are no other factors influencing the receiving water quality subsequent to QCC's collection of baseline data (Table 14). As in Section 5.1 the same parameter means are compared using the same criteria, i.e. student's t test to determine if significant changes between baseline and operation monitoring have occurred.

EP operational monitoring and QCC baseline water quality data are very similar at both control stations. Three parameters differ significantly at station 1. Total phosphorus and dissolved aluminum and iron, are 40, 25 and 50% respectively of the QCC baseline data. At station 2, three parameter means differ. QCC baseline data for ammonia and dissolved aluminum are significantly higher while dissolved iron is lower than the EP data. At both control stations the differences in the parameter means are likely due to analytical uncertainties, as the values are near the limit of detection. Small uneven data sets also reduce the ability to detect differences in the means with a similar degree of confidence in the significance of the change.

At station 5, three parameters (sulphate and dissolved aluminum and copper) differ significantly from the QCC baseline data. The dissolved metals are lower than the historical data whereas sulphate is higher.

Station 8 is the least similar of the river monitoring stations. Six parameter means; dissolved aluminum and iron, turbidity sulphate, periphyton biomass and N:P ratios differ significantly. EP values for dissolved aluminum and iron and turbidity vary from 10 - 40% of the QCC baseline data. Sulphate and periphyton N:P ratios have increased from 2 to 3 times. There are several possible reasons for these differences at station 8; uneven and small data sets, different sampling locations and techniques and different laboratory analytical methods, are but a few.

TABLE 14 COMPARISON OF SELECTED EP MONITORING DATA MEANS (APRIL 1989 - MARCH 1990) AND QCC BASELINE DATA MEANS (JANUARY 1983 - OCTOBER 1984) BIOLOGICAL MONITORING DATA ARE FROM COMPARABLE SEASONS

(units in mg/l, except as noted)

AREA OF CONCERN	PARAMETER	STATION: CONTROLS 1 QCC (n=22)	CONTROLS 1 EP (n=4)	CONTROLS 2 QCC (n=4)	CONTROLS 2 EP (n=4)	RECEIVING 5 QCC (n=22)	RECEIVING 5 EP (n=4)	RECEIVING 8 QCC (n=13	RECEIVING 8 EP (n=4)	EFFLUENT SP4-MQLR QCC (n=5)	EFFLUENT SP4-MQLR EP (n=1)
ACID MINE DRAINAGE	pH (Rel.U.)	7.4	7.5	6.9	7.2	7.3	7.5	7.2	7.6	7.2	6.9
	Cond (uS/cm)	37.0	46.4	36.5	52.1	32.9	48.0	36.6	51.5	22.0	600
	Sulphate	1.8	2.3	<1.0	1.8	1.4	3.3	1.3	3.2	<1.0	270
	Alkalinity	24.9	21.4	25.9	23.6	22.9	20.6	24.9	21.1	19.4	33.0
	Hardness	20.0	22.6	19.8	25.3	16.4	23.0	19.0	23.3	12.0	187
HEAVY METALS	Al (diss)	.023	.006	.033	.005	.025	.004	.022	.004	.071	.022
	Cu (diss)	<.0010	<.0005	<.0010	<.0005	.0023	<.0005	<.0010	<.0005	<.0010	.0025
	Fe (diss)	.012	.006	.048	.358	.028	.023	.094	.017	.032	<.005
	Pb (diss)	<.0010	<.0005	<.0010	<.0005	<.0010	<.0005	<.0010	<.0005	<.0010	<.0005
	Zn (diss)	.002	.004	.003	.003	.002	<.002	.002	<.002	.001	<.002
NUTRIENTS	Total Diss P	.003	.003	.004	.006	.003	.002	.002	<.002	.004	<.002
	Total P	.005	<.002	.006	.005	.005	.002	.004	.003	.006	<.002
	Nitrate	.012	.011	.004	.006	.007	.005	.020	.013	.013	.016
	Nitrite	<.001	<.005	<.001	<.005	<.001	.005	<.001	<.005	<.001	<.005
	Ammonia	.009	<.005	.017	.007	.009	.007	.011	<.005	.012	<.005
SEDIMENTATION	Non Filt. Res	1.3	<5.0	<1.0	<5.0	1.3	<5.0	1.5	<5.0	1.5	<5.0
	Turbidity (QCC=NTU; EP=JTU)	<1.0	<.1	1.18	.55	<1.0	<.1	1.1	<.1	<1.0	<.1
EUTROPHICATION (periphyton & phytoplankton)	TN/TP (atomic)	55	53	-	-	50	58	33	90	-	-
	Total Pigments (mg/m2)	20	26	-	-	11	11	17	6.2	-	-

Historically, QCC baseline monitoring data for periphytic nitrogen and phosphorus demonstrated that algal productivity is phosphorus limited at all stations during the spring and summer months. This has changed little at stations 1 and 5, however, phosphorus has become significantly more limited at Station 8. Periphyton biomass (chlorophyll a and phaeopigments) data from 1989 are very similar to the QCC baseline data at stations 1 and 5. EP periphyton biomass data at Station 8 in 1989, is significantly less than the QCC baseline data when compared to data from the same season. As mentioned above there are several possible reasons for the differences.

MQLR is the least similar of the receiving water monitoring stations. Seven parameters differ significantly from the QCC baseline data. Sulphate, conductivity, hardness and dissolved copper show significant increases. Dissolved aluminum and iron and total phosphorus are significantly elevated. Several activities associated with mining such as the use of explosives, land clearing, exposure of soils, unweathered minerals and rock result in increased levels of the above mentioned parameters in mine effluent discharges. EP monitoring of the effluent stream from the sump in the 2N pit to the outlet of the settling pond shows elevated levels in the effluent concentration. Table 15 lists several parameters; several dissolved metals (barium, boron, calcium, copper, magnesium, sodium and strontium), alkalinity, conductivity, hardness, filterable residue, sulphate and nitrogen decrease in concentration with distance from the pit. However, the dissolved iron and phosphorus and turbidity increase and peak in the settling pond discharge. The reason(s) for this is not clear at present but it is suspected that groundwater discharges affect the effluent stream prior to the compliance point and downstream of the compliance point in the receiving environment.

TABLE 15 COMPARISON OF SELECTED PARAMETERS SHOWING TRENDS IN THE EFFLUENT STREAM (APRIL 1989 - MARCH 1990) *

PARAMETER	2N PIT	SP4 -IN	SP4 -OUT	MQLR
Diss. B	.94	.51	.16	.08
Diss. Ba	.052	.037	.041	.037
Diss. Ca	297	196	98	59
Diss. Cu	.0097	.0060	.0026	.0025
Diss. Fe	.007	<.005	.387	<.005
Diss. Mg	25	28	14	9.3
Diss. Mn	.168	.200	.165	<.001
Diss. Na	348	187	114	68
Diss. Sr	3.4	2.0	.94	.55
Alkalinity	142	110	123	33
Ammonia	1.11	.196	.029	<.005
Conductivity (uS/cm)	2700	1740	1030	600
Hardness	848	609	303	187
Nitrate	5.2	2.4	<.005	.016
Nitrite	.38	.054	<.005	<.005
Diss. Phosphorus	.004	.006	.008	<.002
Total Phosphorus	.014	.008	.012	<.002
Residue, Filt.	2293	1570	839	500
Residue, Non Filt.	28	<5.0	<5.0	<5.0
Sulphate	1223	900	400	270
Turbidity (JTU)	17	1.5	4.7	<.1

* units in mg/L, except as noted

5.3 Comparison of QCC Effluent Discharge Volumes and Predicted Discharges from Settling Pond 4 (April 1989 - March 1990)

QCC monitoring data indicates that the mean discharge from Settling Pond 4 is less than 1% of the allowable discharge stated in PE 7008 for the stage 1 operations. The maximum daily flow from the pond is 3% of the permitted discharge. Similarly, QCC precipitation monitoring data and calculated area of disturbance indicates that the discharge from the pond is approximately 5% of the expected flow. The majority of the precipitation, received from late fall to early spring when evaporation and transpiration is minimal, does not account for a significant portion of the annual water budget at the mine site. It appears that approximately 95% of the precipitation received on the minesite is not discharged from the treatment pond.

Questions regarding this issue should be addressed to determine:

- the reasons for such a large difference between the actual and predicted discharges from the treatment pond,
- where the discharge occurs, and
- if there is an impact on the receiving environment beyond the monitoring that is required for PE 7008.

6.0 CONCLUSION

At the outlet of Settling Pond 4, two parameters exceeded permit levels as set out in PE7008. Total dissolved phosphorus exceeded permit levels 50% of the time while dissolved iron exceeded the permit level 100% of the time. The quality of the discharge into Settling Pond 4 however, does not show the same degree of contamination. Therefore the contaminants in the discharge from Settling Pond 4 must originate from at least two sources. The most likely source of the contamination is groundwater. To answer this and other questions related to this, groundwater quality, quantity and flow direction should be re-examined.

A comparison of the current receiving water quality to the historical baseline data indicates no impact at the receiving water stations. Small data sets of unequal size, large standard deviations and intermittent flows make it difficult to determine differences with any degree of confidence.

Periphytic algal biomass in the Quinsam River both up and down stream of the existing mine range from 3.5 to 74 mg/m^2. The average values at stations 1, 5 and 8 are similar to or less than the baseline data. However at Station 5A, immediately to the east and down gradient of the 2N pit, algal pigment concentrations exceed B.C. MOE water quality criteria for aesthetics. Mid-summer pigment levels range from 24 to 74 mg/m^2, exceeding the criteria for aesthetics (50 mg/m^2). The reason(s) for this anomally should be determined. As discussed in Sections 5.2 and 5.3, a potential source for nutrients is groundwater.

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ACKNOWLEDGEMENTS

The author wishes to acknowledge the assistance of staff from Environmental Protection, Pacific and Yukon Region; Paul Kluckner and laboratory staff for chemical analyses; Isobel Booth and Gerry Mitchel for field assistance, Bryan Kelso for report editing and Heather Hindle for word processing and editing. Additionally, I would like to thank Barry Lawley (Department of Fisheries and Oceans, Habitat Management) for his assistance in the field.

APPENDIX A

QUINSAM COAL CORPORATION - BASELINE DATA (1983-1984)

Table A1	QCC Baseline Data - Station 1 (Quinsam River u/s Middle Quinsam Lake)
Table A2	QCC Baseline Data - Station 5 (Quinsam River d/s Middle Quinsam Lake)
Table A3	QCC Baseline Data - Station 8 (Quinsam River u/s Iron River)
Table A4	QCC Baseline Data - Station 2 (Flume Creet at Argonaut Road)
Table A5	QCC Baseline Data - Settling Pond 4 (Middle Quinsam Lake Road Culvert)

TABLE A1 QCC BASELINE DATA STATION 1 (QUINSAM RIVER 1 km u/s MIDDLE QUINSAM LAKE) *

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/01/23		2.0		7.4	34		19.0	<5.0		<1.0	<.10		<.005	.011	<.002	.009
83/02/25		3.5	12.8	8.2	35		18.4	<1.0		<1.0	.56	.008	.009	<.005	<.001	<.010
83/03/22	.67	4.0	13.2	7.2	45		19.4	<1.0		1.6	.90	.004	.005	<.005	<.001	<.010
83/12/13	.52	4.0	12.2		35	26.4	19.7	2.0		<1.0	<1.00	.002	.003	.024	<.001	<.010
84/01/17	.56	1.5	13.6	7.4	26	26.4	22.9	2.0		<1.0	<1.00	.004	.005	.014	<.001	<.005
84/02/11	.41	4.0	12.4	7.2	24	24.2	23.3	2.0		<1.0	<1.00	.007	.008	.023	<.001	.007
84/03/12	.57	5.0	12.2	7.2	23	22.8	22.1	1.7		<1.0	<1.00	.002	.003	.015	<.001	.007
MEAN	**.54**	**3.4**	**12.7**	**7.4**	**31.7**	**25.0**	**20.7**	**2.1**		**1.1**	**.79**	**.005**	**.005**	**.014**	**<.001**	**.008**
STD DEV	**.09**	**1.2**	**.6**	**.4**	**7.9**	**1.8**	**2.0**	**1.4**		**.2**	**.35**	**.003**	**.002**	**.008**	**.000**	**.002**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.015	.0007	.009	<.001	.001
83/02/25	.039	<.0005	.007	<.001	.001
83/03/22	.024	<.0005	.009	<.001	.001
83/12/13	.020	<.0010	.009	<.001	.004
84/01/17	.046	.0010	.013	<.001	.004
84/02/11	.027	<.0010	.008	<.001	.003
84/03/12	.020	<.0010	.024	<.001	.001
MEAN	**.027**	**.0008**	**.011**	**<.001**	**.002**
STD DEV	**.011**	**.0002**	**.006**	**0**	**.002**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.016	.0017	.010	<.001	<.0005
83/02/25	.068	<.0005	.031	<.001	.0010
83/03/22	.055	.0006	.041	<.001	.0030
83/12/13	.025	.0020	.017	<.001	.0100
84/01/17	.150	.0100	.023	<.001	.0050
84/02/11	.030	<.0010	.042	<.001	.0050
84/03/12	.020	<.0010	.042	<.001	.0020
MEAN	**.052**	**.0024**	**.029**	**<.001**	**.0038**
STD DEV	**.047**	**.0034**	**.013**	**0**	**.0033**

* (units - mg/l, except as noted)

TABLE A2 QCC BASELINE DATA STATION 5 (QUINSAM RIVER 25 m d/s MIDDLE QUINSAM LAKE) *

A PHYSICAL & CHEMICAL

DATE	FLOW cms	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/01/23		2.0		7.2	25		13.0	<5.0		<1.0	<.10		<.005	<.005	<.002	.008
83/02/25		4.0	12.8	8.2	28		11.8	<1.0		1.2	.58	.006	.014	<.005	<.001	<.010
83/03/22		5.0	14.2	7.2	28		15.0	<1.0		<1.0	.60	.005	.018	.010	<.001	<.010
83/12/13	.832	3.5	13.0	6.7	35	23.1	17.8	<1.0	28	<1.0	<1.00	.003	.005	.016	<.001	.013
84/01/17	1.557	2.5	12.7	7.3	32	22.0	16.3	1.8	22	<1.0	<1.00	.003	.004	.022	<.001	<.005
84/02/11	3.110	4.0	12.1	7.2	28	20.2	16.5	<1.0	22	<1.0	<1.00	.005	.006	.022	<.001	<.005
84/03/12	1.390	5.0	12.2	7.3	32	20.9	17.2	1.5	24	<1.0	<1.00	.001	.002	.012	<.001	<.005
MEAN	**1.722**	**3.7**	**12.8**	**7.3**	**29.7**	**21.6**	**15.4**	**1.8**	**24**	**1.0**	**<.75**	**.004**	**.008**	**.013**	**<.001**	**.008**
STD DEV	**.976**	**1.1**	**.8**	**.4**	**3.4**	**1.3**	**2.2**	**1.5**	**2.8**	**.1**	**.35**	**.002**	**.006**	**.007**	**.000**	**.003**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.021	.0005	.028	<.001	<.0005
83/02/25	.043	<.0005	.026	<.001	.001
83/03/22	.029	<.0005	.016	<.001	<.001
83/12/13	.029	<.0010	.032	<.001	.002
84/01/17	.051	<.0010	.024	<.001	.003
84/02/11	.040	<.0010	.033	<.001	.004
84/03/12	.023	<.0010	.054	<.001	.002
MEAN	**.034**	**<.0008**	**.030**	**<.001**	**.002**
STD DEV	**.011**	**.0003**	**.012**	**0**	**.001**

B TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/01/23	.030	.0008	.043	<.001	<.0005
83/02/25	.070	<.0005	.045	<.001	.0020
83/03/22	.045	<.0005	.043	<.001	.0020
83/12/13	.044	<.0010	.050	<.001	.0030
84/01/17	.080	.0010	.050	<.001	.0030
84/02/11	.050	<.0010	.051	<.001	.0040
84/03/12	.031	<.0010	.092	<.001	.0040
MEAN	**.050**	**<.0008**	**.053**	**<.001**	**.0026**
STD DEV	**.019**	**.0002**	**.017**	**0**	**.0012**

* (units - mg/l, except as noted)

TABLE A3 QCC BASELINE DATA STATION 8 (QUINSAM RIVER u/s IRON RIVER) *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	RFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/12/13	4.0	11.5	7.0	35	22.0	16.8	1.5		1.2	1.00	.003	.004	.073	.001	.017
84/02/09	4.0	12.1	7.1	31	27.5	18.3	<1.0		<1.0	1.80	.004	.005	.047	.001	.024
84/03/15	5.0	10.8	7.0	33	20.9	18.1	<1.0		<1.0	<1.00	.002	.003	.026	<.001	<.005
MEAN	**4.3**	**11.5**	**7.0**	**33**	**23.5**	**17.7**	**1.2**		**1.1**	**1.27**	**.003**	**.004**	**.049**	**<.001**	**.015**
STD DEV	**.6**	**.7**	**.1**	**2**	**3.5**	**.8**	**.3**		**.1**	**.46**	**.001**	**.001**	**.024**	**0**	**.010**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/12/13	.048	<.001	.100	<.001	.001
84/02/09	.063	<.001	.083	<.001	.003
84/03/15	.022	<.001	.140	<.001	.001
MEAN	**.044**	**<.001**	**.108**	**<.001**	**.002**
STD DEV	**.021**	**0**	**.029**	**0**	**.001**

B TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/12/13	.076	<.001	.160	<.001	.003
84/02/09	.190	<.001	.160	<.001	.003
84/03/15	.030	<.001	.150	<.001	.003
MEAN	**.099**	**<.001**	**.157**	**<.001**	**.003**
STD DEV	**.082**	**0**	**.006**	**0**	**0**

* (units - mg/l, except as note)

TABLE A4 QCC BASELINE DATA STATION 2 (FLUME CREEK AT ARGONAUT ROAD) *

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/11/15	8.0	10.0	6.8	28	20.0	15.5	<1.0		<1.0	< 1.00	.006	.010	.004	<.001	.023
84/02/11	5.0	11.6	6.9	33	28.6	19.4	<1.0		<1.0	< 1.00	.004	.004	.005	<.001	.023
MEAN	**6.5**	**10.8**	**6.8**	**30.5**	**24.3**	**17.5**	**<1.0**		**<1.0**	**< 1.00**	**.005**	**.007**	**.005**	**<.001**	**.023**
STD DEV	**2.1**	**1.1**	**.1**	**3.5**	**6.1**	**2.8**	**0**		**0**	**0**	**.001**	**.004**	**.001**	**0**	**0**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/11/15	.070	<.001	.029	<.001	.002
84/02/11	.024	<.001	.028	<.001	.002
MEAN	**.047**	**<.001**	**.029**	**<.001**	**.002**
STD DEV	**.033**	**0**	**.001**	**0**	**0**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/11/15	.110	<.001	.061	<.001	.003
84/02/11	.052	<.001	.042	<.001	.005
MEAN	**.081**	**<.001**	**.052**	**<.001**	**.004**
STD DEV	**.041**	**0**	**.013**	**0**	**.001**

* (units - mg/l, except as noted)

TABLE A5 QCC BASELINE DATA SETTLING POND 4 - MIDDLE QUINSAM LAKE ROAD CULVERT

A PHYSICAL & CHEMICAL

DATE	TEMP deg C	DO	pH rel u	COND uS/cm	ALK	HARD	SO_4	FR	NFR	TURB JTU	TDP	TP	NO_3	NO_2	NH_3
83/02/25	4.0	12.6	8.2	21		8.8	<1.0		<1.0	.15	.004	.008	.006	<.001	<.010
83/11/15	7.8	12.6	6.8	23	16.0	11.5	<1.0		<1.0	< 1.00	.007	.009	<.005	<.001	<.020
84/02/07	1.0	13.4	6.8	22	20.9	13.2	<1.0		<1.0	< 1.00	.004	.006	.040	.001	.006
MEAN	**4.3**	**12.9**	**7.3**	**22**	**18.5**	**11.2**	**<1.0**		**<1.0**	**< .72**	**.005**	**.008**	**.017**	**<.001**	**<.012**
STD DEV	**3.4**	**.5**	**.8**	**1**	**3.5**	**2.2**	**0**		**0**	**.49**	**.002**	**.002**	**.020**	**0**	**.007**

B DISSOLVED METALS

DATE	Al	Cu	Fe	Pb	Zn
83/02/25	.081	<.0005	.021	<.001	.001
83/11/15	.130	<.0010	.026	<.001	.002
84/02/07	.099	<.0010	.050	<.001	.001
MEAN	**.103**	**<.0008**	**.032**	**<.001**	**.001**
STD DEV	**.025**	**.0003**	**.016**	**0**	**.001**

C TOTAL METALS

DATE	Al	Cu	Fe	Pb	Zn
83/02/25	.085	<.0005	.023	<.001	.001
83/11/15	.170	<.0010	.033	<.001	.004
84/02/07	.100	<.0010	.051	<.001	.001
MEAN	**.118**	**<.0008**	**.036**	**<.001**	**.002**
STD DEV	**.045**	**.0003**	**.014**	**0**	**.002**

APPENDIX B

QUINSAM COAL CORPORATION - PE 7008 (STAGE 1 OPERATION)

TABLE B1 QCC Permitted Parameter Limits for PE 7008 - Stage 1 Operation

TABLE B1 QCC PERMITTED PARAMETER LIMITS FOR PE 7008 - STAGE 1 OPERATION

PARAMETER	ALLOWABLE LEVELS AT SP 4 OUTLET
A) Physical/Chemical (mg/l)	
Flow (CMS)	0.54
Non Filterable Residue	25 daily composite 35 hourly composite
pH (rel. units)	6.0 - 8.0
Ammonia	1.0
Total Dissolved Phosphorus	0.01
B) Dissolved Metals (mg/l)	
Aluminum	0.5
Copper	0.02
Iron	0.3
Lead	0.05
Zinc	0.1
C) Biota Monitoring (Quinsam River)*	
Periphyton (mg/m^2)	50 aesthetics 100 aquatic life

* B.C. MOE W/Q Criteria for Nutrients & Algae