DEPARTMENT OF ENVIRONMENT
ENVIRONMENTAL PROTECTION
PACIFIC REGION
YUKON BRANCH

ENVIRONMENTAL QUALITY OF RECEIVING WATERS AT UNITED KENO HILL MINES LTD. ELSA, YUKON

REGIONAL PROGRAM REPORT NO. 89-04

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ABSTRACT

During summer 1985, a receiving environment monitoring study was undertaken by Environmental Protection in the streams potentially influenced by the mining and milling operations of United Keno Hill Mines in the Elsa/Keno area of Yukon.

Some parameters exceeded the water quality guidelines for drinking water and aquatic life at specific station locations. Zinc and manganese levels were noted to be excessively high relative to the guidelines at several station locations. The inputs of metals from mine adit water flow and tailings pond effluent can be detected in the South McQuesten River, Stations 4 and 9.

Sediment chemistry data at specific stations reflect metals input from tailings pond input and a tailings dam break in 1978. As well, elevated metals levels were detected at locations (Stations 2,7) which suggest an influence from mine adit water flows or from undocumented historical tailings releases in previously mined areas. Elevated sediment metal levels were detected in the South McQuesten River at Stations 4 and 9.

Benthic invertebrates were sampled and identified. Generally the populations show good abundance and diversity of species although one location (Station 9) showed a major dominance by one group (*Simulium* sp.).

RÉSUMÉ

La Direction générale de la protection de l'environnement a entrepris, au cours de l'été 1985, une étude sur le contrôle des milieux récepteurs dans les cours d'eau susceptibles d'être influencés par les opérations d'extraction et de préparation de la United Keno Hill Mines dans la région de Elsa/Keno au Yukon.

A certains endroits bien précis, certains paramètres étaient plus élevés que les limites prévues dans les lignes directrices pour l'eau potable et la vie aquatique. Les concentrations de zinc et de manganèse étaient excessivement élevées à plusieurs endroits, comparativement aux limites prévues dans les lignes directrices. Les métaux provenant des eaux s'écoulant des galeries à flanc de coteau et des effluents des bassins à résidus peuvent être decelés aux stations 4 et 9 sur la rivière South McQuesten.

Les données sur la chimie des sédiments à différentes stations reflètent les rejets métalliques provenant des bassins à résidus et de la rupture, en 1978, d'un barrage retenant les eaux d'un bassin à résidus. De plus, on a decelé des concentrations élevées d'espèces métalliques à divers endroits (stations 2 et 7), ce qui traduit peut-être l'effet des eaux s'écoulant des galeries à flanc de coteau ou l'effet d'anciens rejets non documentés à partir de zones exlpoitées antérieurement. On a décalé des concentrations élevées de métaux dans les sédiments aux stations 4 et 9 sur la rivière South McQuesten.

On a prélevé et identifié des échantillons d'invertébrés benthiques. En général, l'abondance de ces populations sinsi que la diversité des espèces étaient bonnes, mais un groupe (*Simulium* sp.) était nettement dominant à un endroit (station 9).

ADDENDUM

On July 17, 1986 a follow-up water quality survey was conducted at selected locations in the study area to determine the origin of elevated metals found in Flat Creek in 1985 which did not appear to originate from the tailings pond decent (Station 5). The sites sampled included Station 5, Station 6, Station 7 and several small drainages found between these stations.

Among those locations sampled a diversion channel which diverts ground water around the tailings dam from the base of the valley wall on which the mill and town are located, was found to have higher levels of certain metals than the stations sampled. This seepage was not sampled in 1985.

The following table displays levels (mg/L ext.) of selected metals found at Station 5, Station 6, Station 7, the seepage channel and Galena Creek during the follow-up survey.

STATION	Ag	Cd	Fe	Zn
5	0.0009	<0.003	0.507	0.153
6	<0.0005	<0.002	0.080	0.004
7	<0.0005	0.003	0.208	0.228
seepage	0.0020	0.006	1.600	0.476
Galena Cr.	<0.0005	<0.002	0.840	0.122

Of the metals shown, Zn and Cd were the only metals at Station 7 to be in excess of the decant although the seepage showed the highest values overall for Ag and Fe.

The data clearly shows the seepage, and to a lesser degree, Galena Creek, contribute to the elevated Zn at Station 7. Other minor ground water seepages in the area were sampled but none showed elevated levels of the above metals.

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1.0 INTRODUCTION

An investigation of water quality, stream sediments and aquatic invertebrate populations was carried out by the Environmental Protection Service July 9-10 and August 21-22, 1985 in the South McQuesten River watershed in the vicinity of United Keno Hill Mine at Elsa, Yukon.

The purpose of the investigation was to determine if any significant impact from the mining and milling operations was detectable in the receiving waters, namely Flat Creek, Christal Creek and the South McQuesten River.

The information collected by this survey is compared with information from two previous surveys conducted by the Environmental Protection Service in 1974 - 1975 (Regional Program Report 78-14) and in 1980 (Regional Program Report 81-23). Further comparisons are made with water quality information available through the Northern Affairs Program, (1985), in Whitehorse, Yukon.

The parameters found, by the present study, to exceed recommended levels for drinking water or which are known to be toxic to freshwater invertebrates and fish are identified and discussed. Pollution trends which can be attributed to mine activities are also identified.

2.0 STUDY AREA

United Keno Hill Mine is located at the town of Elsa, Yukon (63° 55′ N, 135° 30′ W) approximately 450 kilometres by road north of Whitehorse via the Klondike and the Silver Trail Highways (see Figure 1).

Prospectors first took interest in this area in 1906 when silver, lead and zinc ore deposits were discovered on Galena Hill where the town of Elsa is now situated. A "stampede" resulted when major silver deposits were discovered in 1919. Ore deposits were high-graded for more than 20 years until 1942 when World War II brought most mining activity in the area to a halt (Sinclair et al, 1976).

In 1946 the United Keno Hill Mine Ltd. began mining and milling operations and have operated almost continuously for the past 40 years. Ore from several nearby adits is transported to a crusher and flotation/ recovery mill located at Elsa where lead, zinc and silver concentrates are extracted. The mill is currently operating at 300 tons per day with mineral recovery per ton estimated at 20 oz. silver, 1.4% zinc and 3% lead. Ore concentrates are eventually shipped to smelters in southern Canada for complete recovery (Northern Affairs Program, 1985).

Mill tailings and mine water are discharged and contained within a series of three dam structures immediately below the Elsa townsite. The mill discharges approximately 280 tons of water and waste ore (2 to 1 ratio) per day which is then treated with hydrated lime to precipitate heavy metals. In 1984, 39,200 kilograms of lime were added to the tailings (Northern Affairs Program, 1985). Treated effluent is eventually released into Flat Creek which in turn joins the South McQuesten River approximately 10 kilometres downstream from the tailings pond decant. Christal Creek, which originates at Christal Lake 10 kilometres east of Elsa, flows into the South McQuesten River approximately 12 kilometres upstream of the Flat Creek confluence. Although this tributary is not directly associated with the receiving waters it is affected by drainage from several mine adits on the north slope of Galena Hill and the south slope of Keno Hill.

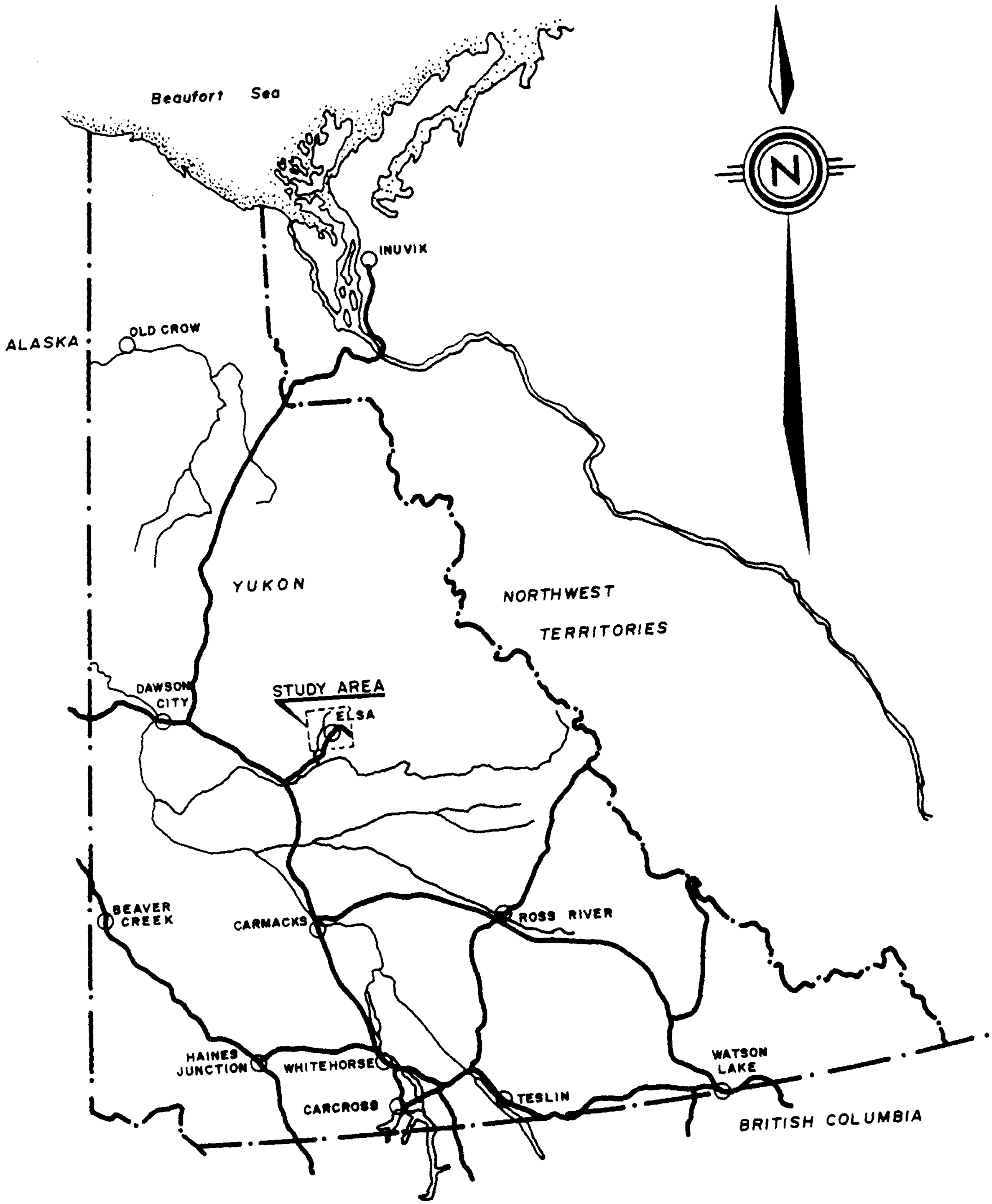


FIGURE I LOCATION OF STUDY AREA

3.0 METHODS

A total of 11 sampling stations were established in the study area, some of which coincide with those established in the two previous investigations, (Environmental Protection Service 1978, Bethel and Soroka, 1981). Table 1 provides station descriptions and Figure 2 identifies station locations. All stations were accessed by road except for Stations 2, 3 and 4 which were accessed by helicopter.

TABLE 1 STATION DESCRIPTION

STATION	DESCRIPTION
1	Christal Creek, 5 meters d/s of culvert at Keno City Road crossing.
2	Christal Creek, 15 meters u/s of confluence with South McQuesten River.
3	South McQuesten River, 50 meters u/s of Christal Creek confluence.
4	South McQuesten River, 50 meters d/s of Christal Creek confluence.
5	Tailings pond decant.
6	Flat Creek, u/s of Mayo/Elsa Highway.
7	Flat Creek, 600 meters u/s of confluence with South McQuesten River.
8	South McQuesten River, 50 meters u/s of Flat Creek confluence.
9	South McQuesten River, 50 meters d/s of Flat Creek confluence.
10	South McQuesten River, approximately 6 kilometers d/s of Flat Creek.
11	South McQuesten River at Bridge downstream of Haggart Creek.

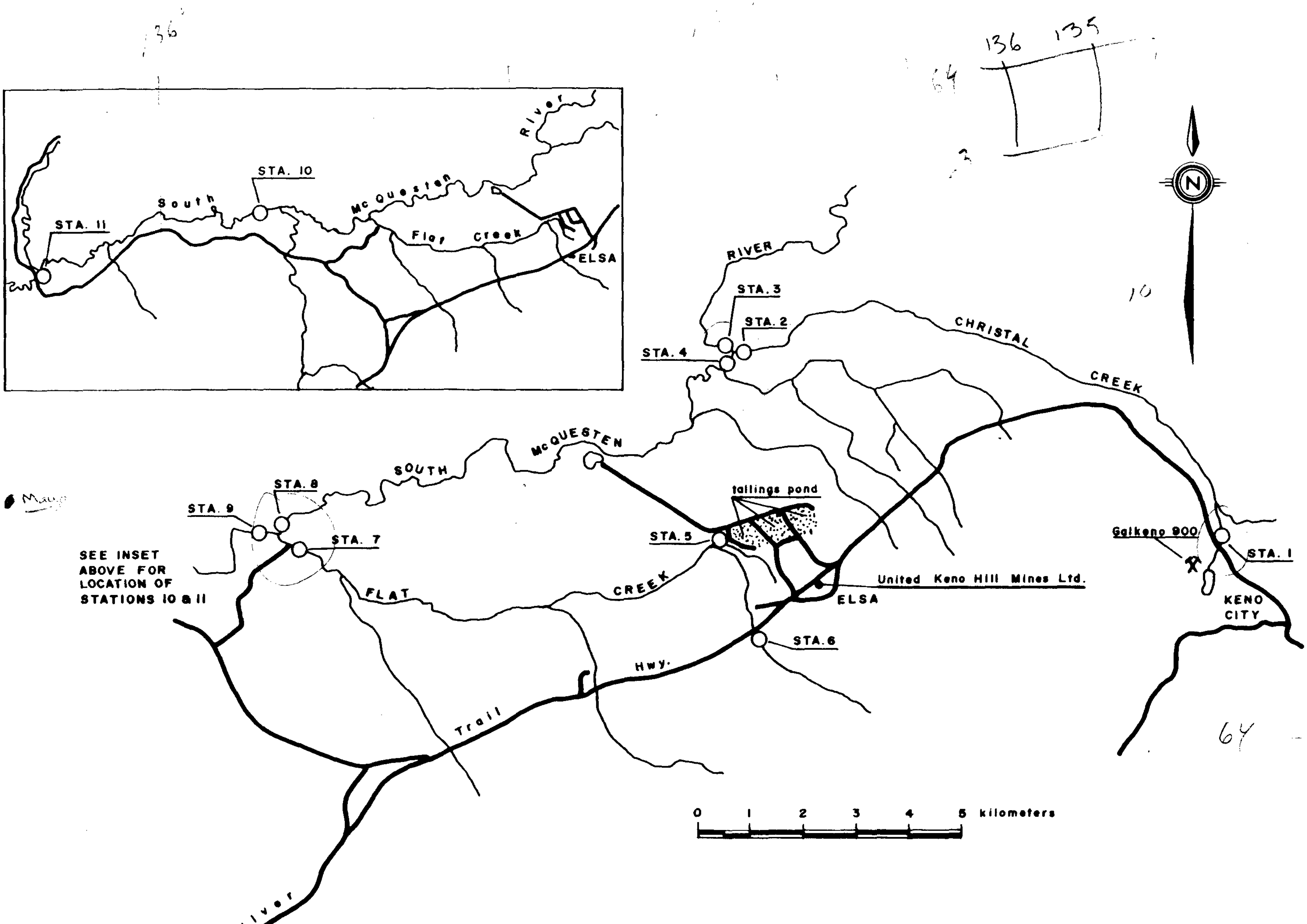


FIGURE 2 LOCATION OF SAMPLE STATIONS

During the July 9-10 sampling period, flow was not observed at the traditional tailings pond decant but water samples were collected from a pond immediately below the decant culvert. It was later determined that the tailing pond discharge was diverted to a second decant location, unknown to the field staff at the time of sampling.

During the August 21-22 sample period water samples were collected at the second decant location.

3.1 Water Quality and Quantity

In situ water quality measurements included temperature, conductivity, pH and dissolved oxygen. Temperature and conductivity were measured with a YSI Model 33 Temperature-Conductivity-Salinity Field Meter, pH was measured using a Fisher Scientific Model 640 Field Meter or Horiba Water Quality Checker and dissolved oxygen was measured with a YSI Model 57 Dissolved Oxygen Field Meter. The latter was calibrated using the water saturated air method as described in the YSI Manual. Readings were corrected for temperature, elevation and salinity. Percent saturation was calculated from oxygen saturation tables derived from APHA et al (1981). A full description of field equipment and measurements is given in Appendix I, Table 1.

Water quality samples, collected in triplicate at each station, included a 2 litre sample for nutrients analysis and a 100 ml sample for extractable metals analysis. Sample collection, preservation and analysis methods are shown in Appendix I, Table 1. The mean and standard deviation were calculated for each set of three samples collected. During sample collection in August, an attempt was made to characterize the channel cross section at stations on the South McQuesten River. One of each triplicate set was collected along the left bank, at mid stream and along the right bank of the river. Water quality data for each triplicate set in Appendix II, Table 2 is shown in this sequence (left bank, mid stream, right bank).

The parameters analysed in each nutrient sample are as follows:

pH	total phosphates
conductivity	nitrites
colour	nitrates
turbidity	ammonia
nonfilterable residue	sulfate
total alkalinity	chloride
total hardness	

The following parameters were analysed in each extractable metals sample:

aluminum (Al)	cobalt (Co)	silicon (Si)
antimony (Sb)	copper (Cu)	silver (Ag)
arsenic (As)	iron (Fe)	sodium (Na)
boron (B)	lead (Pb)	strontium (Sr)
barium (Ba)	magnesium (Mg)	tin (Sn)
beryllium (Be)	manganese (Mn)	titanium (Ti)
cadmium (Cd)	molybdenum (Mo)	vanadium (V)
calcium (Ca)	nickel (Ni)	zinc (Zn)
chromium (Cr)	selenium (Se)	

The analyses were completed at the Environmental Protection Service Laboratory, 4195 Marine Drive, West Vancouver, B.C.

Stream flow was measured at selected stations using a Marsh McBirney Electromagnetic Flow Meter. Ten velocity readings, in centimeters per second, were taken across the width of each South McQuesten River Station. On the narrower Christal and Flat Creek Stations usually four readings were taken. Stream flows were calculated by dividing the width of the stream into equal blocks, according to the number of readings taken, then the area of each block was determined (water depth X block width). This area was then multiplied by the stream velocity for each block giving a cubic meter per second value (m3/sec). All block flows were added together to arrive at a measured stream flow.

In some cases where excessive stream depth and velocity made it hazardous for field staff to effectively measure stream flow, discharge was calculated as described below:

July 9-10, 1986

Station 4 = Station 2 + Station 3
Station 8 = Station 9 - Station 7

August 21-22, 1986

Station 3 = Station 4 - Station 2
Station 9 = Station 7 + Station 8

Discharge could not be accurately determined at Stations 5 and 6 in July and at Stations 1, 5 and 6 in August because stream velocities encountered were less than the minimum velocity required by the instrumentation used.

3.2 Sediments

Sediment samples were collected in triplicate at each station, except for Stations 5 and 6, on both visits to the study area. A stainless steel sediment corer device was used to reduce the loss of very fine sediments from samples collected in fast flowing water. In calm or slow moving waters an aluminum scoop shovel was used to collect a sample. The samples were placed in paper geochemical sampling bags, packaged in plastic bags and then frozen within 48 hours of collection. A description of the corer sampler, sediment collection, preparation and analysis methods is given in Appendix I, Table 2.

Each sample was analysed for particle size composition and the following leachable metals:

aluminum (Al)	iron (Fe)	silicon (Si)
arsenic (As)	lead (Pb)	silver (Ag)
barium (Ba)	magnesium (Mg)	sodium (Na)
beryllium (Be)	manganese (Mn)	strontium (Sr)
cadmium (Cd)	mercury (Hg)	tin (Sn)
calcium (Ca)	molybdenum (Mo)	titanium (Ti)
chromium (Cr)	nickel (Ni)	vanadium (V)
cobalt (Co)	potassium (K)	zinc (Zn)
copper (Cu)	selenium (Se)	

Particle size analysis was carried out only on samples from Stations 7-11 inclusive. The sediment samples were analysed at the Environmental Protection Service Laboratory, 4195 Marine Drive, West Vancouver, B.C.

3.3 Bottom Fauna

Benthic invertebrate samples were collected at all stations except Stations 5 and 6. At each station sampled, 3 artificial substrate samplers were placed on the stream bed on July 9-10, 1985. The samplers used were cylindrical wire baskets (maximum volume = 0.0057 cubic meters) filled with local hand cleaned substrate material ranging from 2 cm to 6 cm in size. The samplers were placed in the stream where in situ measurements, water and sediment samples were collected. The samplers were left to be colonized for a period of 43 days. On August 21-22, 1985 the baskets were retrieved and immediately placed into a Wildco wash bucket with 0.5 mm mesh bottom. The bucket was held downstream during retrieval of the sampler in order to capture any escaping organisms. Large rock and wood debris was hand scrubbed in the wash bucket to remove invertebrates and then discarded. Invertebrates and fine debris from each basket were combined into a composite sample for each station. A 10% formalin solution was used to preserve the samples until sorting could be carried out.

The invertebrate samplers placed at Station 10 were vandalized during the sample period and so the data presented for this station is a result of three samples collected August 21-22 using a Surber Sampler (0.09 m^2).

Invertebrate identification and enumeration was carried out by Dr. C. Low, a consulting Invertebrate Biologist in Nanaimo, B.C.

Sorted invertebrate samples were later preserved with methanol and placed in storage at the Environmental Protection Service warehouse facility in Whitehorse.

3.4 Laboratory Quality Control

Systematic error and sample contamination during analysis at the EPS Laboratory are minimized through duplicate analysis, procedural blanks and the use of standard reference materials. Internal lab quality control is carried out routinely in all water and sediment analysis before results are released.

4.0 RESULTS AND DISCUSSION

4.1 Water Quality - Physical and Chemical Parameters

In situ measurement, nutrients and extractable metals results for both sample periods are presented in Appendix 11, Tables 1 and 2. Criteria recommended for drinking water and aquatic life are presented in Appendix 1, Table 4.

4.1.1 **Temperature.** In situ temperatures reflect seasonal changes. The South McQuesten River averaged 15°C on July 9-10 and 9°C on August 21-22. The tributaries surveyed were slightly cooler ranging from 7.5° C to 12.5°C in July and 4.0°C to 7.5°C in August.

4.1.2 **Flow.** Flow measurements were taken when possible during each visit to the study area except at Stations 4, 5, 6 and 8 on July 9-10 and Stations 3, 5, 6, 9 and 10 on August 21-22.

No discharge data was obtained for Station 5 on July 4-10 sampling period.

On August 21-22 a steady discharge from the tailings pond decant culvert was observed and was estimated by field staff at approximately 0.02 m^3/sec. Accurate measurements could not be obtained because of the shallow nature and slow velocity of the decant.

No flows were obtained at Station 6, Flat Creek, because the irregular stream bed and low level of water made it impossible to accurately measure with the instrumentation available.

Flows measured at stations on the South McQuesten River on July 9-10 were considerably higher than flows measured during the August 21-22 sample period. In July they ranged from 5.9 m^3/sec at Station 3, the furthest upstream station, to 9.7 m^3/sec. at Station 11 which is located furthest downstream. A similar degree of increase in flow in the South McQuesten River was also measured on August 21-22, ranging from 3.4 m^3/sec at Station 4 to 6.7 m^3/sec at Station 11 although total flow was much lower in August.

The flow at Station 7, Flat Creek, ranged from 0.07 m^3/sec in July to 0.06 m^3/sec in August.

Flows measured at Station 2, Christal Creek, showed no change between the sample periods.

4.1.3 **Dissolved Oxygen.** Percent dissolved oxygen saturation (%DO) was slightly higher on August 21-22 than on July 9-10. The South McQuesten River ranged from 82% to 97% during the July sample period. In August, %DO ranged from 95% to 104%.

%DO at Stations 1 and 2, Christal Creek and at Stations 6 and 7, Flat Creek, ranged from 80% to 99% over the two sample periods.

The high %DO at Station 5 on August 21-22 (119%) is a result of aeration occurring where the decant water discharges from the decant culvert into a small pool before flowing into Flat Creek.

4.1.4 **pH.** The slightly alkaline pH of waters in the study area are characteristic of this area (Environmental Protection Service, 1978). The South McQuesten River had a mean pH value of 8.15 (+/-0.16) in July and 7.89 (+/-0.18) in August. No significant change could be detected at Stations 4 and 9 immediately downstream of Christal Creek Flat Creek respectively. The lowest field pH recorded (7.65) on the South McQuesten River was at Station 9 on August 21-22 but this is not considered to be representative, as shown by the upstream pH of 7.90 at Station 8 and at Station 7, Flat Creek.

4.1.5 **Conductivity.** Conductivity measurements varied considerably throughout the study area. As Figure 3 demonstrates, conductivity in the receiving waters was elevated by decant from the tailing pond (Station 5). In situ values at Station 5 were 1190 umhos/cm on July 9-10 and 920 umhos/cm

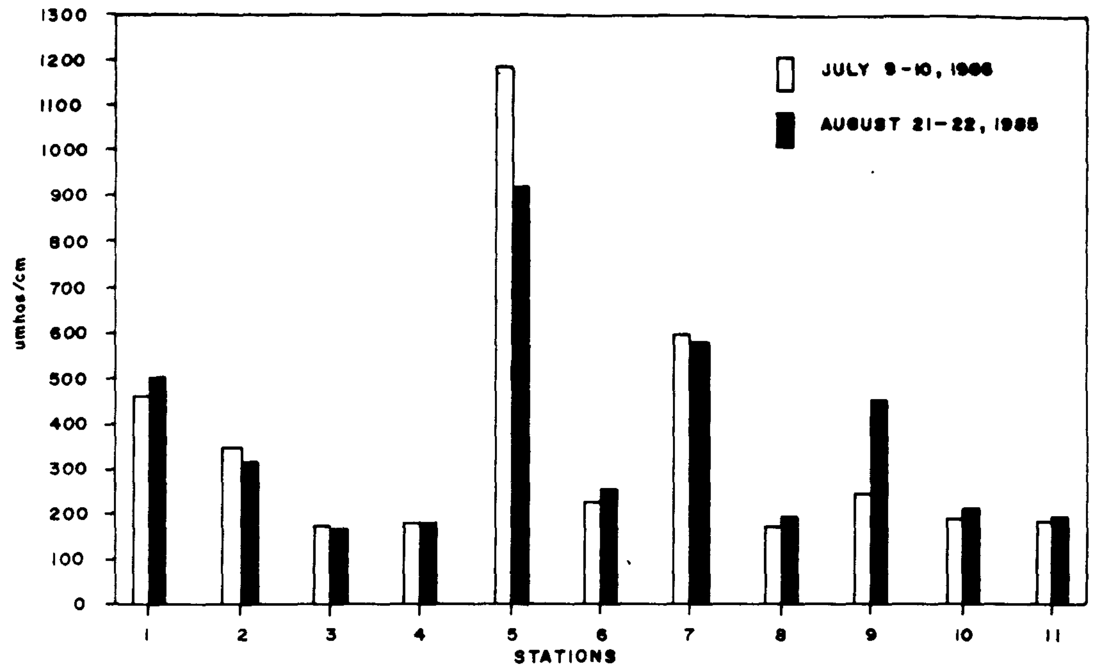
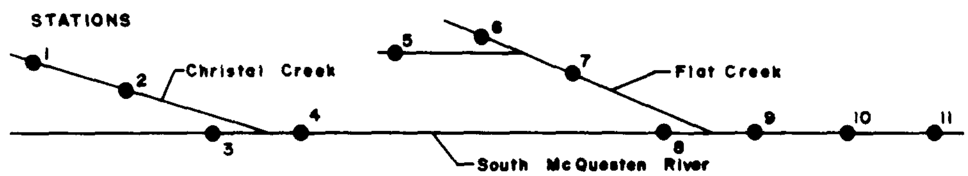


FIGURE 3 IN SITU CONDUCTIVITY



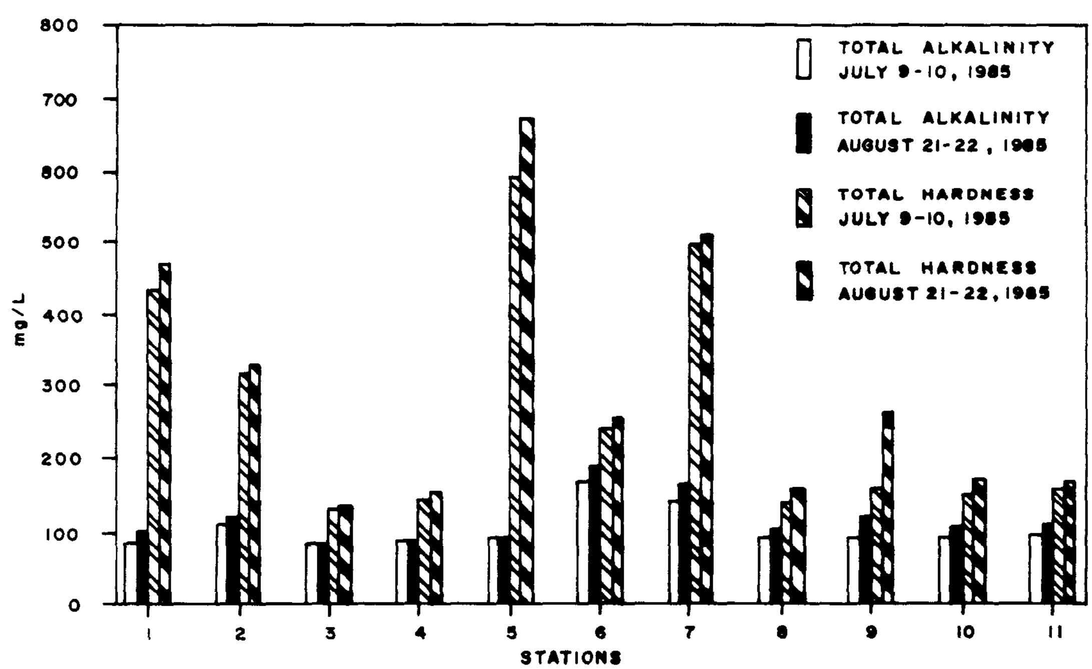


FIGURE 4 MEAN ALKALINITY AND HARDNESS

on August 21-22. This high input can be traced downstream at Station 7 and to a lesser extent at Station 9. The dilution effect of the South McQuesten River is more prevalent in July, when flows were higher, than in August as shown by the difference in conductivity at Station 9 from the two sampling periods. Further downstream at Station 10 and 11 conductivity is similar to background levels of 240 umhos/cm found at Station 3.

High conductivity was also detected in Christal Creek during both sample periods as shown by Figure 3, Stations 1 and 2. These elevated levels are suspected to reflect the influence of drainage from the Galkeno 900 adit which enters upstream of Station 1 at Christal Lake.

Data from each triplicate sample collected in August at Station 4 and 9 show the presence of a plume immediately downstream of where Christal Creek and Flat Creek join the South McQuesten River. At Station 4, lab conductivity across the river decreased from 310 umhos/cm along the left bank to 255 umhos/cm along the right bank. Lab conductivity at Station 3 was 250 umhos/cm across the full width of the river. A similar plume was detected at Station 9, where lab conductivity decreased from 680 umhos/cm along the left bank to 310 umhos/cm along the right bank. Lab conductivity at Stations 8, 10 and 11 show no indications of lateral gradient in conductivity and are similar to background levels.

Historically the Environmental Protection Service (1978) reported lower conductivity in receiving waters. In July, 1974 and June and July of 1975 conductivity of decant from the tailings pond was 380, 360 and 950 umhos/cm, respectively. Conductivity of the South McQuesten River upstream of Christal Creek was very similar to that found by the present study. Bethel and Soroka (1981) reported results similar to the present report except at Station 8 where lab conductivity averaged 530 umhos/cm over a three day period in August, 1980.

4.1.6 **Colour.** During the July sample period, colour measured 20 Relative Units (RU) at most stations except Stations 1 and 2 where it was 10 RU. Values during the August sample period were slightly lower with most stations averaging 10 RU except Stations 1 and 2 which were 5 RU. The higher values in July at most stations no doubt reflects increased organic loading commonly associated with peak flow periods, as observed.

4.1.7 **Turbidity.** Turbidity readings at Station 1, 5, and 7 during the July sample period and at Station 7 during the August sample period were slightly elevated relative to background turbidity at Station 3. The highest turbidity reading was 2.50 FTU at Station 7 July 9-10. Turbidity at Station 7 during both sample periods exceeded that found at Station 5 suggesting the source is other than the tailings pond decant. Background turbidity at Station 3 during July and August was 0.45 and 0.16 FTU, respectively.

4.1.8 **Non-filterable Residue (NFR).** NFR values were low or below the 5mg/L detection limit in most of the samples collected on both visits to the study area. The highest NFR level detected was 14 mg/L at Station 1 during the August sample period. NFR values in the 5 to 14 mg/L range were also detected at Station 1 on July 9-10 and at Stations 2, 4, 6, 7, 10 and 11 on August 21-22.

4.1.9 **Hardness and Alkalinity.** Water hardness changed little between the two sample periods but exceeded the 100 mg/L level recommended for drinking water at all stations. Elevated levels, ranging from 238 to 671 mg/L, were detected at Stations 1, 2, 5, 6 and 7. Background levels at Station 3 during July and August, 132 and 136 mg/L respectively, reflect the geology of the drainage area.

The elevated hardness found in Flat Creek, Station 7, can be detected at Station 9 on the South McQuesten River but, as Figure 4 shows, it returns to near background levels at Station 10 and 11. Water samples collected at Station 9 on August 21-22 show elevated hardness along the left bank indicating the presence of the Flat Creek plume.

Changes in water hardness also show a direct correlation with the changes in conductivity recorded during both sample periods.

Figure 4 also shows high alkalinity in Flat Creek at Station 6 during both sample periods but it is not directly related to the increase in hardness. During July and August alkalinity was 85.7 and 86.0 mg/L, respectively, at Station 3 and, as Figure 4 shows, it returns to near background levels at Station 10 and 11 after only a slight increase at Station 9. Samples collected August 21-22 at Station 9 confirm the presence of the Flat Creek plume as shown by the higher alkalinity along the left bank of the South McQuesten River.

Results from Environmental Protection Service (1978) and Bethel and Soroka (1981) compared with results from the present study show hardness was similar in the South McQuesten River but generally lower in Flat Creek and Christal Creek in past years at corresponding locations, as shown by Table 2.

TABLE 2 HISTORICAL COMPARISON OF ALKALINITY AND HARDNESS LEVELS(mg/L)

	EPS JULY 1974		EPS JULY 1975		EPS *AUG. 1980		EPS JULY 1985		EPS AUG.1985	
STATION	ALK.	HARD.	ALK.	HARD.	ALK.	HARD.	ALK.	HARD.	ALK.	HARD
1	N/A	160	79.2	260	N/A	N/A	82.9	432	103.3	468
2	N/A	190	10.4	210	N/A	N/A	110.7	313	120.3	326
3	N/A	100	73.3	100	N/A	N/A	85.7	132	86.0	136
4	N/A	N/A	N/A	N/A	N/A	N/A	86.2	141	89.6	154
5	N/A	440	80.2	440	52.1	739	93.0	591	92.6	671
6	N/A	820	N/A	N/A	N/A	N/A	168.3	238	187.3	254
7	N/A	240	117.8	220	130.0	342	143.3	494	163.0	509
8	N/A	110	78.2	110	118.0	255	89.7	140	100.6	156
9	N/A	290	86.1	120	85.0	126	92.1	158	119.7	260
10	N/A	N/A	N/A	N/A	N/A	N/A	93.0	148	106.0	170
11	N/A	N/A	N/A	N/A	N/A	N/A	96.6	155	108.7	168

* Three day mean.
N/A - Not Available

In July, 1974 and July, 1975 hardness ranged from 160 to 260 mg/L at Stations 1 and 2 while in the present study hardness was consistently higher, averaging 313 and 468 mg/L at the same locations. Water hardness similarly has increased at Stations 5 and 7 over the past 11 years. Since 1974 levels have increased from 440 to 671 mg/L at Station 5 and from 240 to 509 mg/L at Station 7. Hardness at Station 6 was found by the present study to be lower than Stations 5 and 7 but in July, 1974 it reached 820 mg/L (Environmental Protection Service, 1978).

Historical comparison of water hardness at Station 3 shows little change, suggesting that sustained mining activity in the area may be associated with the increases observed in receiving waters.

Alkalinity has increased slightly at all comparable stations since 1975. In July, 1975 it ranged from 73.3 to 117.8 mg/L while in August, 1985 it ranged from 86 to 187 mg/L.

4.1.10 **Sulfates.** Sulfates remained well below the 500 mg/L level recommended for drinking water at all stations except Station 5. In the present study sulfates at Station 5 averaged 497 mg/L in July and 540 mg/L in August. Average background levels found at Station 3 ranged from 30 mg/L in July to 42 mg/L in August. Bethel and Soroka (1981) reported sulfates at each station sampled but exceeded 500 mg/L only at Station 5 (663 mg/L).

4.1.11 **Chlorides.** Chlorides were elevated at Station 5 as compared with levels found at other stations in the study area. They averaged 18.9 and 14.3 mg/L, respectively, during the July and August sample periods but were well below the 250 mg/L level recommended for drinking water. It is believed the elevated chlorides at Station 5 are residuals of the calcium hypochlorite reagent used in a cyanide flotation circuit previously used at the mill. Bethel and Soroka (1981) reported similar levels at Stations 5, 7, 8 and 9. At Station 3 chloride levels averaged 0.7 and 0.2 mg/L during the sample periods.

4.1.12 **Phosphates.** Total phosphate, which was detected at several locations, generally is not considered to be toxic to aquatic organisms but levels as low as 0.002 mg/L have promoted algae growth under controlled conditions (Bothewll, 1985). Although mean concentrations found during both sample periods ranged from <0.002 to 0.016 mg/L, unusually high values of 0.049 and 0.059 mg/L were found in individual samples at Station 8 and Station 9, respectively, August 21/22. Since these values are not comparable to other samples collected at the same time and locations, it is believed they are a result of sample contamination or analytical error.

4.1.13 **Nitrite and Nitrate.** Nitrite was below detection limit (0.005 mg/L) in the July and August sample periods of the present study. In comparison, levels ranging from 0.014 to 0.075 mg/L exceeded the 0.001 mg/L criteria recommended for drinking water in August, 1980 at Stations 5, 7 and 8 (Bethel and Soroka, 1981).

Nitrate ranged from 0.003 to 0.16 mg/L in the present study. These levels are well below the 10 mg/L limit recommended for drinking water and do not pose a threat to aquatic life from the perspective of stimulating algal growth.

Bethel and Soroka (1981) reported nitrate at Stations 5, 7 and 9 within the range found in the present study.

4.1.14 **Total Ammonia.** Toxicity of ammonia has been attributed primarily to the unionized portion of total ammonia present (Thurston et al, 1974). Unionized ammonia concentrations increase with increasing pH, temperature and total ammonia.

Levels of total ammonia in the present study ranged from (0.005 to 0.13 mg/L in July and (0.005 to 0.16 mg/L in August. The unionized portion calculated from the highest total ammonia value found (0.16 mg/L) was 0.0009 mg/L, well below the criteria recommended for drinking water (0.5 mg/L) and the protection of aquatic life (0.02 mg/L). Bethel and Soroka (1981) reported three day averages of 1.45, 0.450, 0.040 and 0.007 mg/L total dissolved ammonia at Stations 5, 7, 8 and 9, respectively. The unionized portion of that found by Bethel and Soroka (1981) at Station 5 exceeded the 0.02 mg/L limit recommended for aquatic life.

4.2 Water Quality - Extractable Metals

Results of the extractable metals analysis for each sample is presented in Appendix II, Tables 1 and 2. Appendix I, Table 1 gives the detection limits for each parameter.

The following metals were below detection limits at all stations sampled July 9-10 and August 21-22:

July 9-10	August 21-22
arsenic (As)	arsenic (As)
beryllium (Be)	beryllium (Be)
chromium (Cr)	cobalt (Co)
antimony (Sb)	chromium (Cr)
selenium (Se)	antimony (Sb)
tin (Sn)	selenium (Se)
titanium (Ti)	titanium (Ti)
vanadium (V)	vanadium (V)

Boron (B), barium (Ba), calcium (Ca), molybdenum (Mo), nickel (Ni), phosphorous (P), silica (Si) and strontium (Sr) were detected in samples collected in July and August but were below the recommended levels for drinking water and aquatic life.

Magnesium (Mg), although not considered an environmental concern, was detected at all stations during both of the sample periods and graphically traces the tailings pond decant downstream of the point of discharge. As Figure 5 shows, the elevated levels discharged at Station 5 remain elevated at Station 7. At Station 9 the levels were higher during the August sample period because the South McQuesten River had less of a dilution affect than in July when flows were higher.

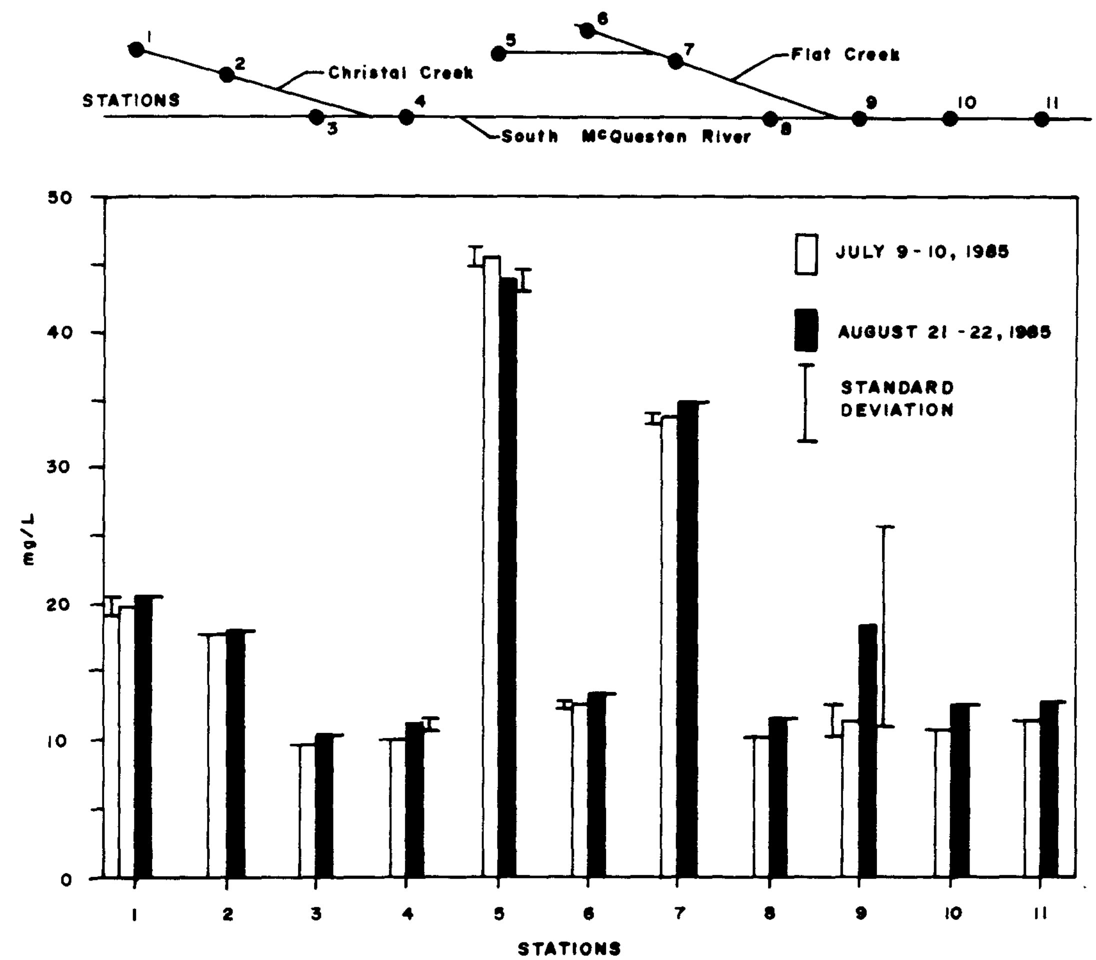


FIGURE 5 MEAN EXTRACTABLE *Mg* IN WATER

Plumes from Christal Creek and Flat Creek in the South McQuesten River were detected at Stations 4 and 9 respectively during the August sample period. This is shown by the higher levels of magnesium found along the left bank than what was found at midstream and near the right bank (see Appendix II, Table 2). Magnesium returned to near background levels downstream of Station 9.

4.2.1 **Silver (Ag).** Silver averaged 0.0024 mg/L at Station 5, on July 9-10. The analysis for this period also shows levels decreasing from 0.0024 mg/L at Station 5, to 0.0007 mg/L at Station 7, to 0.0005 mg/L along the left bank at Station 9. In August, silver was 0.0010 mg/L at Station 5 and below detection limit (0.0005 mg/L) at stations further downstream.

In all cases, silver was below the criteria of 0.05 mg/L recommended for drinking water. However, all levels detected by this survey did exceed the criteria of 0.0001 mg/L recommended for the protection of aquatic life.

Environmental Protection Service (1978) reported silver to be less than the detection levels of 0.01 mg/L in June, 1975 and 0.03 mg/L in July, 1975 at all stations sampled.

4.2.2 **Cadmium (Cd).** Table 3 compares cadmium levels from previous surveys with those found in the present study.

Cadmium has been detected at the present Station 5 on each visit shown except in August, 1980 where it was below the detection limit of 0.01 mg/L.

The results of the present study show cadmium higher in Christal and Flat Creek than in the South McQuesten River.

The elevated levels found in Christal Creek during the July sample period can be detected at Station 4 on the South McQuesten River. DIAND reported (pers. comm., 1985) high concentrations of heavy metals in drainage from an inactive adit, Galkeno 900, which flows into Christal lake. On July

17, 1985 cadmium was 0.012 mg/L at the adit and 0.003 mg/L in Christal Creek near Station 1. This clearly identifies one source of cadmium found at Station 1 and 2 of the present survey.

TABLE 3 HISTORICAL COMPARISON OF CADMIUM LEVELS IN WATER (mg/L)

STATION	EPS JULY 1974	EPS JUNE 1975	EPS JULY 1975	*EPS AUGUST 1980	EPS JULY 9-10 1985	EPS AUG. 21-22 1985
1	<0.01	<0.01	<0.01	N/A	0.0032	0.0016
2	<0.01	N/A	<0.01	N/A	0.0030	0.0020
3	<0.01	N/A	<0.01	N/A	0.0014	<0.0005
4	N/A	N/A	N/A	N/A	0.0018	<0.0005
5	0.06	0.03	0.05	<0.01	0.0024	0.0023
6	<0.01	N/A	N/A	N/A	0.0017	<0.0005
7	<0.01	0.01	<0.01	<0.01	0.0043	0.0018
8	<0.01	N/A	<0.01	<0.01	0.0019	<0.0005
9	<0.01	<0.01	<0.01	<0.01	0.0018	*0.0003
10	N/A	N/A	N/A	N/A	0.0019	<0.0005
11	N/A	N/A	N/A	N/A	0.0015	<0.0005

* Three day mean.
N/A - Not available

Cadmium was elevated at Station 5 during both sample periods but Station 7 on July 9-10 reflects an unusually high concentration which does not appear to originate from the tailings pond decant. The level found at Station 6 on the same day is lower than what was found in the decant, therefore this rules out the headwaters of Flat Creek as a potential source. There is insufficient information to determine the source but several small intermittent drainages entering Flat Creek between Station 5 and 7 are suspected.

Cadmium levels on August 21-22 show a well defined trend originating at the decant. Station 5 was 0.0023 mg/L, Station 7, Flat Creek, was 0.0018 mg/L and station 9, South McQuesten River, was 0.0008 mg/L along the left bank. Samples collected at midstream and along the right bank at Station 9 and at Station 10 and 11 were below the detection limit (0.0005 mg/L).

All detectable levels of cadmium were below the 0.005 mg/L criteria recommended for drinking water but exceeded the 0.0002 mg/L criteria recommended for aquatic life.

4.2.3 **Copper (Cu).** Table 4 compares copper levels reported by previous studies with that found by the present study.

TABLE 4 HISTORICAL COMPARISON OF COPPER LEVELS IN WATER (mg/L)

STATION	EPS JULY 1974	EPS JUNE 1975	EPS JULY 1975	*EPS AUGUST 1980	EPS JULY 9-10 1985	EPS AUG. 21-22. 1985
1	<0.01	<0.01	<0.01	N/A	0.003	<0.001
2	<0.01	N/A	<0.01	N/A	0.002	0.003
3	<0.01	N/A	<0.01	N/A	0.003	<0.001
4	N/A	N/A	N/A	N/A	0.003	0.002
5	0.60	0.19	0.22	0.047	0.012	0.012
6	<0.01	N/A	N/A	N/A	0.004	<0.001
7	<0.01	0.20	<0.01	<0.010	0.006	0.005
8	<0.01	N/A	<0.01	<0.010	0.003	0.002
9	<0.01	<0.01	<0.01	<0.010	0.002	0.001
10	N/A	N/A	N/A	N/A	0.002	<0.001
11	N/A	N/A	N/A	N/A	0.003	<0.001

* Three day mean.
N/A - Not available

Environmental Protection Service (1978) and Bethel and Soroka (1981) both reported copper as less than the detection limit (0.01 mg/L) at most stations sampled except at Station 5, the tailings pond decant.

The present study detected copper at most stations during each of the sample periods due to improved detection limits. The mean levels ranged from (0.001 to 0.012 mg/L. The maximum mean (0.012 mg/L) was detected at Station 5 but levels decrease downstream at Station 7 and return to near background levels in the South McQuesten River at Stations 9, 10 and 11.

All detected levels were below the criteria recommended for drinking water (1.0 mg/L). Station 7 on July 9-10 (0.006 mg/L) was the only station other than Station 5 where copper exceeded the criteria recommended for aquatic life (0.005 mg/L).

4.2.4 **Iron (Fe).** The levels of iron detected by the present survey were similar to those reported by Environmental Protection Service (1978) and Bethel and Soroka (1981). They exceeded the criteria of 0.3 mg/L recommended for drinking water in the current study at Station 1 in July (0.39 mg/L) and at Stations 5 and 7 during both sample periods (ranging from 0.30 to 0.52 mg/L).

Iron levels found in samples collected at Stations 4 and 9 on August 21-22 were higher along the left bank than at midstream and the right bank indicating the presence of plumes from Christal and Flat Creek in the South McQuesten River.

4.2.5. **Manganese (Mn).** Manganese detected by the present study ranged between 0.001 and 2.10 mg/L during the two sample periods. In July levels exceeded the 0.05 mg/L criteria recommended for aquatic life at most stations except Stations 3, 4 and 6. In August, levels decreased slightly and only exceed the 0.05 mg/L criteria at Stations 1, 2, 5 and 7.

Although elevated levels of manganese can be tolerated by some forms of freshwater aquatic life, available information suggests levels exceeding 0.1 mg/L may constitute an environmental hazard (Thurston et al, 1979). At Station 1, manganese ranged from 1.89 mg/L in July to 1.81 mg/L in August. DIAND conducted an adit survey July 16, 1985 (personal comm.), which detected 13.2 mg/l manganese in water draining from the Galkeno 900 adit upstream of Station 1. As well, elevated levels were detected at Station 7 in July (2.10 mg/L) and at Station 5 in August (1.04 mg/L). Since Station 5 was not sampled properly in July, it is unclear whether or not the high levels found at Station 7 originate from the tailings pond decant. Manganese was slightly elevated on both sample dates at Station 9 but returned to near background levels at Station 10 and 11.

Historically, manganese has been elevated in discharge from the mine tailings. In July of 1974 it was 16.0 mg/L (Environmental Protection Service, 1978) while in August, 1980 it averaged 1.95 mg/L over a three day period (Bethel and Soroka , 1981). The 1974 survey also reported elevated levels near Station 1 (6.1 mg/L).

4.2.6 <u>Lead</u>. During the July 9-10 sample period, lead was detected at all stations with means ranging from 0.018 mg/L to 0.026 mg/L. Nevertheless, one sample collected at Station 10 contained only 0.009 mg/L. These results were much higher than those found on August 21-22 and because there is no known reasons for the elevated levels, it is suspected that sample contamination or analytical error occurred. There is insufficient information available to suggest the levels found were characteristic of the study area during the month of July. Bethel and Soroka (1981), reported Pb levels as less than 0.08 mg/L in July 1978. However, Pb levels of up to 0.84 mg/L were observed at the decant in June 1975 (EPS, 1978). All mean levels were below the 0.05 mg/L criteria recommended for drinking but above the 0.01 mg/L criteria recommended for aquatic life.

On August 21-22, lead levels were at or below the detection limit of 0.001 mg/L at most stations except Stations 5 and 7 where they averaged 0.003 mg/L. In all cases in August, the levels present were well below the criteria recommended for drinking water and aquatic life.

4.2.7 <u>Zinc</u>. Table 5 compares results reported by previous surveys with that found in the present study.

Zinc at Station 5 has decreased over the period shown in Table 5. In July 1974, zinc was reported at 2.00 mg/L, whereas in the present survey, mean zinc levels were 0.22 mg/L in July and 0.09 mg/L in August.

Mean zinc exceeded the 0.03 mg/L criteria recommended for aquatic life at Stations 1, 2, 5, 7 and 9 during the July sample period and at Stations 1, 2, 4, 5, 7 and 9 during the August sample period. The highest mean levels detected, 0.928 mg/L in July and 0.825 mg/L in August at Station 1, exceeded the mine's water licence (Yukon Territory Water Board, 1985) requirement of 0.5 mg/L. The high zinc levels found at Station 1 originated at the Galkeno 900 adit where, on July 17, 1985 it was 25.8 mg/L (personal communication, 1985). Background mean levels at Station 3 were 0.008 mg/L in July and <0.002 mg/L in August.

TABLE 5 HISTORICAL COMPARISON OF ZINC LEVELS IN WATER (mg/L)

STATION	EPS JULY 1974	EPS JUNE 1975	EPS JULY 1975	*EPS AUGUST 1980	EPS JULY 9-10 1985	EPS AUG. 21-22. 1985
1	<0.17	0.28	0.22	N/A	0.928	0.825
2	N/A	N/A	0.16	N/A	0.327	0.433
3	0.01		0.01	N/A	0.008	<0.002
4	N/A	N/A	N/A	N/A	0.023	0.047
5	2.00	1.90	1.60	0.349	0.219	0.090
6	1.50	N/A	N/A	N/A	0.004	**0.003
7	0.73	0.77	0.60	0.349	0.231	0.215
8	0.02		0.07	0.244	0.019	0.028
9	0.59	0.74	0.09	0.052	0.029	0.065
10	N/A	N/A	N/A	N/A	0.022	0.027
11	N/A	N/A	N/A	N/A	0.016	0.017

* Three day mean.
** One of three samples contained 0.003 mg/L.
N/A - Not available

Although zinc was elevated at Station 5 during both sample periods, levels detected at Station 7 were higher, indicating, as have other parameters, that a source other than the tailings pond decant was influencing Flat Creek at the time of sampling. Levels at Station 6, upstream of Station 7, were well below that found at Stations 5 or 7.

During the August sample period, zinc levels were higher along the left bank of the South McQuesten River than at mid stream or along the right bank at Stations 4 and 9. This clearly identifies the plumes from Christal Creek and Flat Creek. The range at Station 4 was 0.084 to 0.003 mg/L, from left to right bank, while at Station 9, the range was 0.106 to 0.038 mg/L.

4.3 Stream Sediments

Particle size distribution (%) and leachable metals results are presented in Appendix III, Tables 1 through 4. Size distribution data is available only for Stations 7 through 11. Particle size analysis was not carried out by the laboratory on samples from Station 1 through 4 due to misinterpreted instructions. Leachable metals analysis results are available for all stations sampled.

4.3.1 Particle Size Distribution.

Overall the South McQuesten River sediments were observed to be comprised mainly of coarse material underlain with small amounts of sand and silt material. The particle size class most abundant in samples collected July 9-10 and August 21-22 was in the gravel size and larger (>2.0 mm) range. It was observed during sample collection that this range included material up to 40 mm in size, greatly influencing the overall weight distribution in each of the samples. Larger cobble material (>40mm) was present but was removed during sample collection. Sand material (<2.0 mm to >0.063 mm) represented from less than 1% to 16% of the composition of samples collected. The percentage of silt and clays (<0.063 mm) ranged from less than 1% to 6%.

Similar to South McQuesten River sediment samples, Flat Creek sediments at Station 7 were also comprised mainly of material in the >2.0 mm size range with small percentages of sand between 0.25 mm and 1.0 mm in size.

4.3.2 Sediment Metal Analysis.

Significant changes in certain sediment metals were detected between the two tributaries sampled, Christal Creek and Flat Creek, and the South McQuesten River. Figure 6 show mean Cd, Cu, Pb, Zn and As concentrations to be much higher at Stations 2 and 7 as compared with Station 3. Changes in sediment metals downstream of the tributaries was also detected as shown by the increase of the above metals at Station 4, downstream of Christal Creek, and more so at Station 9, downstream of Flat Creek. This can be explained, in part, by a tailings dam failure in August of 1978 which resulted in the deposition of significant

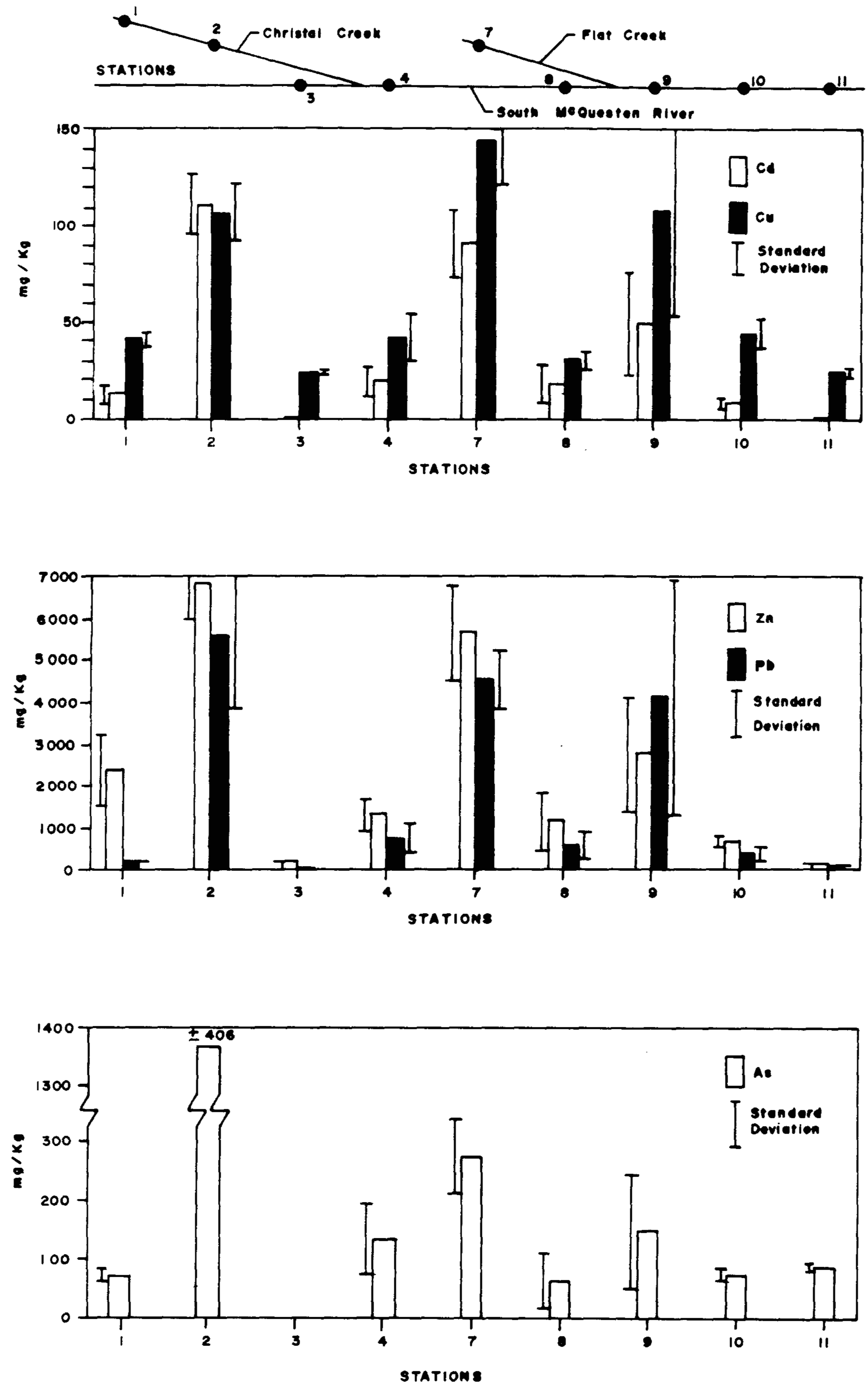


FIGURE 6 MEANS OF SELECTED METALS IN SEDIMENTS

amounts of tailings material into Flat Creek and the South McQuesten River downstream of Flat Creek. (Environmental Protection Service - Environmental Emergencies Significant Events Reports, 1978). However, the reasons for high metal concentrations in stream sediments at Station 2, Christal Creek, are unknown. It is speculated that mining activity in the Keno City area prior to the development of United Keno Hill Mines may have contributed but this cannot be substantiated.

4.4 Stream Benthic Fauna

Appendix IV, Table 1 shows the taxonomic classifications and distribution of invertebrates identified from samples collected in the present study.

Most invertebrates were keyed to genus and species where possible, or to genus or family level only, if full identification was not possible. Some individuals of the Orders Acari, Coleoptera, Tricoptera, Arachnida, Suborder Cyclopoida and Phylum Nematoda were not possible to identify beyond the taxonomic level given. Genera or species shown in brackets indicate that the identification was tentative.

Resh and Rosenberg (1984) review the ecology of aquatic insects and identify the difficulty of making generalizations about the relationship between aquatic invertebrates and substrate composition and the difficulty of generalizing about the effects of heavy metal pollution on aquatic insects.

4.4.1 **Taxonomic Features.** A total of 4,098 individuals, comprised of 67 different taxa, were collected from nine stations. The majority of the invertebrates collected were of the Class Insecta although several Nematodes, Molluscs and Copepods were also found. The artificial substrate samplers placed at Station 10 were vandalized, so the invertebrate information presented was collected August 21-22 using a Surber sampler (0.93 m2). No samples were collected at Station 5, the tailings pond decant, or at Station 6 on Flat Creek.

The greatest number of individuals were found at Station 9 (1,492) on the South McQuesten River. A total of 25 different taxa were identified of which 21 were keyed to the genus or species level. The most abundant organism, Simulium sp. represented 91% of the total number of individuals collected. Genera and species of Orders Plecoptera, Tricoptera and Ephemeroptera were also found but in low numbers.

Invertebrate abundance at other stations on the South McQuesten River varied considerably, ranging from 140 to 683 in number, but were much lower than Station 9.

At Station 3 where 683 individuals were collected, 21 of the 26 different taxa identified were keyed to the genus or species level. The dominant invertebrate was a Simulium sp. larvae (51%) and pupae (25%), representing 76% of the sample collected. The remaining sample included small percentages of organisms from Orders Ephemeroptera, Plecoptera, Tricoptera and Gastropoda and Phylum Nematoda.

At Station 4, immediately downstream of Christal Creek, 206 individuals were collected. A total of 27 different taxa were identified, 22 of them to the genus or species level. The dominant invertebrates were several genera of the Order Plecoptera representing 65% of the sample collected. They included Malenka sp. (18%), Acroneuria sp. (16%), Zapada sp. (11%), Alloperla sp. (8%), Utaperla sp. (6%), and Arcynopteryx sp. (2%). The remaining sample was comprised of 2 genera of the Order Tricoptera (14%) and 5 genera of the Order Ephemeroptera (10%). Simulium sp. larvae and pupae, which were predominant at other South McQuesten River stations (except station 10), represented only 5% of the invertebrates collected at Station 4.

The lowest abundance was found at Station 8 where 140 individuals comprised of 20 different taxa were collected. Eighteen of the taxa were identified to the genus or species level. Simulium sp. of the Order Diptera was the most abundant, representing 31% of the sample. Members of the Orders Ephemeroptera, Plecoptera and Tricoptera were also significant in numbers representing 16%, 26% and 23%, respectively, of the sample.

Since a different sampling method was required at Station 10 the results will not be compared with those found at other South McQuesten River stations. At Station 10, a total of 237 individuals were collected of which 16 of the 24 different taxa identified were identified to the genus or species level. Density was calculated at 850 individuals per square metre. The dominant invertebrate was of the Class Oligochaeta which represented 70% of the sample collected. The composition of the remaining sample was represented by invertebrates from the Orders Ephemeroptera, Plecoptera, Tricoptera, Diptera and the Phylum Nematoda.

At Station 11, Simulium sp. was the most abundant invertebrate found, making up 65% of the 500 individuals collected. The composition of the remaining sample was comprised of invertebrates from the Orders Plecoptera (23%), Ephemeroptera (5%) and Tricoptera (3%).

Invertebrate abundance varied considerably between the two stations on Christal Creek. At Station 1, 655 individuals were collected whereas at Station 2, only 90 were collected. The reason for this difference in abundance is suspected to be partly because of the finer substate found at Station 2 which provided a less suitable habitat for invertebrates than the larger material found at Station 1. This is based on observations of the sediment characteristics made during the first visit to the study area as there is no sediment particle size data for these two stations. At Station 1, 31 different taxa were identified, 23 to the species or genus level. The sample was dominated by several genera of the Order Diptera. Those found included Simulium sp. (36%), Cricotopus sp. (14%), Eukiefferiella sp. (6%) and Diplocladius sp. (9%). Chironomidae pupae represented 5% of the sample. Individuals from the Class Oligochaeta represented 12% of the sample collected. Similar composition was found at Station 2 but, as previously stated, in much lower numbers. Only 18 different taxa were identified, 11 to the species or genus level. The sample collected was dominated by several genera of the Order Diptera including Cricotopus sp. (21%), Heterotrissocladius sp. (11%), Cardiocladius sp. (2%), Brillia sp. (17%) and Chironomidae pupae (10%).

At Station 7, 95 individuals were collected which were classified into 14 different taxa. Only 9 species or genera were identified. The dominant group was of the Order Diptera, representing 42% of the sample. The genera found included Simulium sp. (14%), Cricotopus sp. (14%), Heterotrissocladius sp. (5%), Procladius sp. 1%) and Tipula sp. (2%). Chironomidae pupae (6%) were also found. The most abundant genus, Podmosta sp., of the Order Plecoptera represented 34% of the sample. The genus Arctopsyche sp. of the order Tricoptera represented 11% of the sample.

The above results describe the aquatic invertebrate populations at the respective stations, and although there is a degree of similarity among the stations, it is not possible to isolate individual parameters as causes for population variation. Simulium sp. is noted as being present and very abundant at most stations. This genus is characteristic of clear, fast flowing water in riffle areas where it is successful as a filterer. The abundance of Simulium sp. at the various stations is also correlated with higher zinc (Zn) and cadmium (Cd) levels so it may be showing a tolerance to Zn and Cd which other organisms tolerate less readily. Similar tolerance to heavy metals is referred to by Wiederholm (1984).

4.4.2 **Percent Similarity Index.** The benthic invertebrate communities found at all South McQuesten River stations, except Station 10, were compared using a Percent Similarity Index (PSC) formula described by Brock (1977):

$$Psc = 100 - 0.5 \sum^{k} | a-b |$$

where a and b are, for a given genus, percentages of the total samples A and B which that genus represents. The absolute value of their difference is summed over all genera, k. The PSC Index compares the percentage of genera present at two different locations but is not a comparison of total invertebrate abundance.

The greatest similarity was found between stations 9 and 11 where the index was 71%. Similarity between Station 3 and Stations 4, 8, 9 and 11 ranged from 28% to 44%. Similarity comparisons between all other stations never exceeded 48%.

TABLE 6 INVERTEBRATE POPULATION PERCENT SIMILARITY FOR SOUTH McQUESTEN RIVER STATIONS

(EXCEPT STATION 10)

STATION	11	9	8	4
3	42	32	44	28
4	35	15	48	
8	48	39		
9	71			

SUMMARY

The present survey shows an improvement in mine effluent water quality at Station 5 when compared with historical data previously reported by the Environmental Protection Service. Several events, such as changes in ore type, mill processes and improved mill tailings treatment have taken place in the past 12 years and undoubtedly have influenced effluent quality but the degree of influence cannot be determined by this report.

Results of the present survey have shown that mine drainage from the Galkeno 900 adit is the primary source of high metals concentrations found in Christal Creek. The highest extractable Zn concentration found in the study area on the dates sampled was at Station 1. This combined with other elevated metals concentrations exceed the standards recommended for drinking water and, in some cases, that recommended for the protection of aquatic life.

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APPENDICES

APPENDIX I

COLLECTION, PRESERVATION, ANALYSIS OR IDENTIFICATION METHODS AND WATER QUALITY CRITERIA

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE [1]	ANALYTICAL PROCEDURE	METHOD SECTION [2]
Temperature	0.1°C	In situ temperature reading.	YSI Conductivity Meter Model 33	
Flow		In situ flow measurments using a Marsh-McBirney electromagnetic current meter.	Cross-section of the stream was measured and the velocity of flow was calculated using the standard Price-type current meter method.	
Dissolved Oxygen	1.00 mg/1	In situ measurement. The instrument was calibrated in the field under water-saturated air condition.	YSI Dissolved Oxygen meter(in situ) Orion model 701 pH meter & Orion O_2 electrode(laboratory)	
pH	0.1 pH units	Small allquots of sample were taken and read soon after collection. No preservative. Instrument was calibrated using 7.0 buffering solution.	Potentiometric	080
Conductivity	0.2 umhos/cm	In situ measurement. Laboratory measurement, specific conductivity at 25°C. No preservative. The measurement was taken from the same sample as NH_3 below.	YSI Conductivity meter model 33 (in situ).Radiometer conductivity meter (CDM2D)(laboratory).	044

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE [1]	ANALYTICAL PROCEDURE	METHOD SECTION [2]
Ammonia NH_3-N	0.005 mg/l	Single samples collected in 2 litre linear polyethylene containers. Each container was rinsed 3 times with sample before it was filled. No preservatives. Stored at 4°C.	Phenol hypochlorite-colorimetric-automated	058
Colour	5 (colour units)	Same sample as NH_3.	Platinum-cobalt visual comparison	040
Turbibity	1.0 (FTU)	Same sample as NH_3.	Nephelometric turbidity	130
Non-Filterable Residue (NFR)	5.0 mg/l	Same sample as NH_3.	Filtration, drying and weighing of residue on filter	104
Filterable Residue (FR)	10.0 mg/l	Same sample as NH_3.	Filtration, drying and weighting of filtrate	100
Total Alkalinity	1.0 mg/l as $CaCO_3$	Same sample as NH_3.	Potentiometric titration	006
Total Phosphate T PO_4-P	0.005 mg/l	Same sample as NH_3.	Ascorbic acid-persulphate, automated autoclave digestion	086
Nitrate NO_2-N	0.005 mg/l	Same sample as NH_3.	Diazotization-colorimetric-automated	070

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (Continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE [1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Nitrate NO_3-N	0.01 mg/l	Same sample as NH_3 .	Cadmium-copper reduction-colorimetric-automated	072
Sulphate SO_4	1.0 mg/l	Same sample as NH_3.	Automated methylthymol-blue colorimetric	122
Chloride Cl	0.5 mg/l	Same sample as NH_3 .	Thiocyanate-combined reagent-colorimetric	024

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (Continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE [1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Extractable/Total/ Dissolved Metals	mg/l	Single or triplicate samples collected in 125 ml linear polyethylene bottles. Each bottle was rinsed 3 times with sample before filling. Preserved to a pH <1.5 using 1.0 ml concentrated HNO_3. Dissolved metals were collected in 125 ml linear polyethylene bottles rinsed 3 times with sample before filling. Filtered in field using 0.45 um cellulose nitrate filters. Preserved to pH <1.5 using 1.0 ml concentrated HNO_3.	<u>Inductively coupled argon plasma</u>	300
Al	0.05			
As	0.05			
B	0.001			
Ba	0.001			
Be	0.001			
Ca	0.05			
Cd	0.004			
Co	0.005			
Cr	0.005			
Cu	0.005			

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS (Continued)

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE [1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Extractable/Total/ Dissolved Metals (Continued)	mg/l			
Fe	0.005			
Mg	0.10			
Mn	0.001			
Mo	0.005			
Na	0.2			
Ni	0.02			
Pb	0.04			
Sb	0.05			
Se	0.05			
Si	0.01			
Sn	0.01			
Sr	0.002			
Ti	0.002			
V	0.01			
Zn	0.002			

APPENDIX I TABLE 1 WATER SAMPLE COLLECTION, PRESERVATION AND ANALYSIS METHODS

PARAMETER	DETECTION LIMIT	COLLECTION AND PRESERVATION PROCEDURE[1]	ANALYTICAL PROCEDURE	METHOD SECTION[2]
Cd	0.0005	Same as sample metals.	Graphite furnace-atomic absorption spectrometry	330
Cu	0.001	Same sample as metals.		
Pb	0.001	Same sample as metals.		
Ag	0.0005	Same sample as metals.	Graphite furnace-atomic absorption spectrometry	330
Total Hardness	0.030 mg/l	Same sample as metals		

Actual Hardness = 4.116Mg + 2.497Ca + 1.142Sr + 1.792Fe + 5.564Al + 1.531Zn + 1.822Mn

Ca/Mg Hardness = 4.116Mg + 2.497Ca

1 As described in Environment Canada (1976).
2 As described in Department of Environment (1979).

APPENDIX I TABLE 3 BOTTOM FAUNA COLLECTION, PRESERVATION AND IDENTIFICATION METHODS

FIELD COLLECTION, SAMPLING PROCEDURES AND PRESERVATION	LABORATORY PROCEDURES	IDENTIFICATION AND ENUMERATION
Artificial Substrate Sampler: Stream benthic invertebrates were collected Using cylindrical wire baskets (17 cm dia x 25 cm) filled with local stream bed rock material at each station. The stream bed material ranged from 2 to 6 cm in diameter. Rocks were lightly scrubbed by hand and placed into the baskets until full. Three samplers were placed at each station, tethered to shore using polypropylene rope and were allowed to colonize for about 43 days. When the samplers were retrieved they were quickly placed into a Wildco wash bucket with a 0.5 mm mesh bottom. All rock material was hand washed in the bucket to remove invertebrates.	Bottom fauna was removed from other material in a labelled vial containing 70% methanol.	Bottom fauna was sent to Dr. C. Low Consulting Invertebrate Biologist, Nanaimo, B.C. for identification to genus, species if possible, and enumeration.

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE(S)	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE(S)
Physical				
Colour (TCU)	< 15	1		
Temperature (°C)	15			
Odour and taste	Inoffensive	1		
Turbidity NTU	< 5	1		
Coliform-Total (count/100mL)	10	1	recreational water Total 500-1000/100ml	9
-Fecal	0	1	200 /100mL	9
Chemical				
*Alkalinity mg/l (Total)	Not considered a public health problem	4	>20	3
*Aluminum (Al) mg/l	Not considered a public health problem	7	0.1 at pH > 6.5	5
Ammonia total (NH3-N) mg/l	0.5	4	2.2 at pH 6.5 temp 10°C 1.37 at pH 8.0 temp 10°C	10
Antimony (Sb) mg/l				
Arsenic (As) total mg/l	0.05	1	< 0.05	10
Barium (Ba) mg/l	1.0	1	5.0	7
Boron (B) mg/l	5.0	1		
*Cadmium (Cd) total mg/l	0.005	1	0.0002 for hardness 0-60mg/l CaC03 0.0008 for hardness 60-120mg/l CaC03 0.0013 for hardness 120-180 CaC03 0.0018 for hardness >180 CaC03	10
Calcium (Ca) mg/l	75-200	7		
Chloride (Cl) mg/l	<250 aesthetic objectives	1		
Chlorine (total residual) mg/l			0.002	
**Chromium (Cr) total mg/l	0.05	1	0.02 to protect fish 0.002 to protect aquatic life	10
Cobalt (Co) mg/l				
Conductivity @ 25°C (umhos/cm)	Depends on dissolved salts	7	150-500	6

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE (continued)

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE(S)	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE
*Copper (Cu) total mg/l	<1.0 aesthetic objectives	1	0.002 at hardness 0-120mg/l CaC03 0.004 at hardness 120-180mg/l CaC03 0.006 at hardness >180mg/l CaC03	
Cyanide (CN) mg/l	0.2	1	0.005 (free)	10
Dissolved oxygen (% saturation)	Near 100%	4	>5.0 mg/L	10
Fluoride (F)mg/l	1.5	1	1.5	7
Hardness (Total) as mg/L CaC03	80-100	1		
Iron (Fe) total mg/l	<0.3 aesthetic objective	1	0.3	10
Lead (Pb) total mg/l	0.05	1	0.001 at hardness 0-60mg/l CaC03 0.002 at hardness 60-120mg/l CaC03 0.004 at hardness 120-180mg/l CaC03 0.007 at hardness > 180mg/l CaC03	10
Magnesium (Mg) mg/l	50	4		
Manganese (Mn) mg/l	<0.05 aesthetic objective	1	1.0	7
Mercury (Hg) total mg/l	0.001	1	0.0001	10
Molybdenum (Mo) mg/l				
Nickel (Ni) total mg/l	0.25	2	0.025 at hardness 0-60mg/l CaC03 0.065 at hardness 60-120mg/l CaC03 0.11 at hardness 120-180 CaC03 0.15 at hardness >180	10
Nitrate (NO3-N) mg/l	10	1		
Nitrite (NO2-N) mg/l	1.0	1	0.06	10
pH units	6.5 - 8.5	1	6.5 - 9.0	10
Phosphate (PO4) mg/l	0.2	8		
*Phosphorus (P) mg/l (Total)			0.020 to prevent algae	5
Potassium (K) mg/l				
Residue: Filterable mg/l (Total dissolved solids)	<500 aesthetic objective	4	70 - 400 with a maximum of 2000	6
Residue: Non-Filterable (mg/) (TSS)			increase of 10mg/l with bkgd<100mg/l increase of 10% above bkgd with bkgd >100.0mg/l	8 10

APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE (continued)

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE(S)	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE
**Selenium (Se) total mg/l	0.01	1	0.001	10
Silica (Si) mg/l				
*Silver (Ag) total mg/l		1	0.0001	10
Sodium (Na) mg/l		1		
Strontium (Sr) mg/l	10	1		
Sulphate (S04) mg/l	500	1		
Sulphide (as H2S) mg/l	<0.05	1		
Tin (Sn) mg/l	Not present in natural waters	7		
Titanium (Ti) mg/l				
Total Inorganic Carbon (TIC)				
Total Organic Carbon (TOC)	5.0	5		
Uranium mg/l	0.02	1		10
Vanadium (V)				
Zinc (Zn) mg/l	<5.0 aesthetic objective	1	0.030	10

* Use graphite furnace analysis for the lab detection limit to be less than the recommended levels.
** Lab detection limit > recommended levels.

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APPENDIX I TABLE 4 WATER QUALITY CRITERIA FOR DRINKING WATER AND AQUATIC LIFE

SUBSTANCE	RECOMMENDED LEVEL(S) FOR DRINKING WATER	REFERENCE(S)	RECOMMENDED LEVEL(S) FOR AQUATIC LIFE	REFERENCE(S)

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APPENDIX II

WATER QUALITY

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985.

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURA-TION	COLOR (FTU)
1	1	0.2	1.8	0.065	10.1	7.91	7.8	457	750	9.7	99	10
	2						7.9		750			10
	3						7.9		750			10
	$\bar{x}$						7.9		750			10
	S.D.						0.1		0			0
2	4	0.4	4.5	0.12	9.5	8.23	8.2	348	550	10.2	94	10
	5						8.2		550			10
	6						8.1		550			10
	$\bar{x}$						8.2		550			10
	S.D.						0.1		0			0
3	7	0.4	12.8	5.9	16.0	8.40	8.0	170	240	8.3	86	20
	8						8.0		240			20
	9						8.0		240			20
	$\bar{x}$						8.0		240			10
	S.D.						0		0			0
4	10	N/A	N/A	6.0 *	16.0	8.30	8.0	180	250	8.6	96	20
	11						8.1		255			20
	12						8.1		250			20
	$\bar{x}$						8.1		252			20
	S.D.						0.1		3			0

* Determined from the sum of Station 3 and Station 2.

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9 - 10, 1985 (continued)

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURATION	COLOR (FTU)
5	13	N/A	1.0	N/A	15.0	7.21	7.9	1190	1200	7.5	84	20
	14						7.8		1200			20
	15						8.0		N/A			20
	$\bar{x}$						7.9		1200			20
	S.D.						0.1		0.0			0
6	16	0.1	1.1	N/A	7.5	8.05	8.2	223	420	10.6	98	20
	17						8.2		415			20
	18						8.3		420			20
	$\bar{x}$						8.2		418			20
	S.D.						0.1		3			0
7	19	0.3	1.7	0.07	12.5	7.80	8.1	600	880	8.4	80	20
	20						7.9		880			20
	21						8.0		880			20
	$\bar{x}$						8.0		880			20
	S.D.						0.1		0			0
8	22	N/A	N/A	8.2 *	16.0	8.10	8.1	170	255	8.5	97	20
	23						8.0		255			20
	24						8.1		255			20
	$\bar{x}$						8.1		255			20
	S.D.						0.1		0			0

* Determined from the difference between Station 9 and Station 7.

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURA-TION	COLOR (FTU)
9	25	0.5	15.0	8.3	15.0	8.06	8.0	250	335	8.0	84	20
	26						8.1		255			20
	27						8.2		255			20
	$\bar{x}$						8.1		255			20
	S.D.						0.1		46			0
10	28	0.4	19.9	8.1	15.0	7.95	8.1	190	270	9.3	82	20
	29						8.1		270			20
	30						8.1		270			20
	$\bar{x}$						8.1		270			20
	S.D.						0.0		0			0
11	31	0.5	30.0	9.7	13.5	8.10	8.2	185	275	9.3	92	20
	32						8.1		275			20
	33						8.1		280			20
	$\bar{x}$						8.1		270			20
	S.D.						0.0		0			0

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CACO3) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPHATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
1	1	1.30	80.3	419	280	0.9	0.012	<0.005	0.037	0.011	9
	2	1.30	80.7	425	290	0.9	0.022	<0.005	0.037	0.008	9
	3	1.30	87.8	451	240	0.8	0.014	<0.005	0.035	0.009	7
	$\bar{x}$	1.30	82.9	432	270	0.9	0.016	0.005	0.036	0.009	8
	S.D.	0.00	4.2	17	26	0.1	0.005	0.0	0.001	0.002	1
2	4	0.63	110.0	309	160	0.7	0.002	<0.005	0.018	0.005	<5
	5	0.53	111.0	314	140	0.7	0.006	<0.005	0.017	0.005	<5
	6	0.53	111.0	317	160	0.7	<0.002	<0.005	0.017	0.005	<5
	$\bar{x}$	0.56	110.7	313	153	0.7	<0.003	<0.005	0.017	0.000	<5
	S.D.	0.06	0.6	4	12	0.0	0.000	0.0	0.001	0.000	0
3	7	0.45	85.7	132	30	0.7	0.007	<0.005	0.011	0.009	<5
	8	0.43	85.7	132	30	0.8	0.007	<0.005	0.010	0.009	<5
	9	0.48	85.7	133	30	0.7	0.007	<0.005	0.010	0.010	<5
	$\bar{x}$	0.45	85.7	132	30	0.7	0.007	<0.005	0.010	0.009	<5
	S.D.	0.03	0.0	1	0	0.1	0.000	0.0	0.001	0.001	0
4	10	0.48	85.7	141	40	0.8	0.010	<0.005	0.010	0.007	<5
	11	0.45	86.4	143	30	0.8	0.010	<0.005	0.011	0.008	<5
	12	0.45	86.4	139	30	0.9	0.008	<0.005	0.010	0.008	<5
	$\bar{x}$	0.46	86.2	141	33	0.8	0.009	<0.005	0.010	0.008	<5
	S.D.	0.02	0.4	2	6	0.1	0.001	0.0	0.001	0.001	0

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CACO3) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
5	13	2.30	93.5	592	480	18.7	0.007	<0.005	0.060	0.126	<5
	14	2.30	92.8	583	510	19.0	0.006	<0.005	0.064	0.130	<5
	15	2.30	92.8	599	500	18.9	0.007	<0.005	0.065	0.136	<5
	$\bar{x}$	2.30	93.0	591	497	18.9	0.007	<0.005	0.063	0.131	<5
	S.D.	0.00	0.4	8	15	0.2	0.001	0.0	0.003	0.005	0
6	16	0.15	168.0	242	40	0.5	0.005	<0.005	0.070	0.005	<5
	17	0.15	168.0	237	50	0.7	0.005	<0.005	0.073	0.005	<5
	18	0.15	169.0	236	50	0.7	0.005	<0.005	0.071	0.005	<5
	$\bar{x}$	0.15	168.3	238	47	0.7	0.005	<0.005	0.071	0.000	<5
	S.D.	0.00	0.6	3	6	0.1	0.000	0.0	0.002	0.000	0
7	19	2.50	146.0	492	300	5.1	0.004	<0.005	0.087	0.013	<5
	20	2.50	142.0	490	310	5.1	0.007	<0.005	0.080	0.015	<5
	21	2.80	142.0	499	310	4.7	0.004	<0.005	0.088	0.010	<5
	$\bar{x}$	2.60	143.3	494	307	5.0	0.005	<0.005	0.088	0.013	<5
	S.D.	0.17	2.3	5	6	0.2	0.002	0.0	0.001	0.003	0
8	22	1.30	90.0	140	40	0.7	0.007	<0.005	0.016	0.011	<5
	23	1.00	89.0	140	40	0.7	0.008	<0.005	0.013	0.011	<5
	24	0.55	90.0	140	30	0.7	0.008	<0.005	0.013	0.012	<5
	$\bar{x}$	0.95	89.7	140	37	0.7	0.008	<0.005	0.014	0.011	<5
	S.D.	0.38	0.6	0	6	0.0	0.001	0.0	0.002	0.001	0

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CAC03) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
5	13	2.30	93.5	592	480	18.7	0.007	<0.005	0.060	0.126	<5
	14	2.30	92.8	583	510	19.0	0.006	<0.005	0.064	0.130	<5
	15	2.30	92.8	599	500	18.9	0.007	<0.005	0.065	0.136	<5
	$\bar{x}$	2.30	93.0	591	497	18.9	0.007	<0.005	0.063	0.131	<5
	S.D.	0.00	0.4	8	15	0.2	0.001	0.0	0.003	0.005	0
6	16	0.15	168.0	242	40	0.5	0.005	<0.005	0.070	0.005	<5
	17	0.15	168.0	237	50	0.7	0.005	<0.005	0.073	0.005	<5
	18	0.15	169.0	236	50	0.7	0.005	<0.005	0.071	0.005	<5
	$\bar{x}$	0.15	168.3	238	47	0.7	0.005	<0.005	0.071	0.000	<5
	S.D.	0.00	0.6	3	6	0.1	0.000	0.0	0.002	0.000	0
7	19	2.50	146.0	492	300	5.1	0.004	<0.005	0.087	0.013	<5
	20	2.50	142.0	490	310	5.1	0.007	<0.005	0.080	0.015	<5
	21	2.80	142.0	499	310	4.7	0.004	<0.005	0.088	0.010	<5
	$\bar{x}$	2.60	143.3	494	307	5.0	0.005	<0.005	0.088	0.013	<5
	S.D.	0.17	2.3	5	6	0.2	0.002	0.0	0.001	0.003	0
8	22	1.30	90.0	140	40	0.7	0.007	<0.005	0.016	0.011	<5
	23	1.00	89.0	140	40	0.7	0.008	<0.005	0.013	0.011	<5
	24	0.55	90.0	140	30	0.7	0.008	<0.005	0.013	0.012	<5
	$\bar{x}$	0.95	89.7	140	37	0.7	0.008	<0.005	0.014	0.011	<5
	S.D.	0.38	0.6	0	6	0.0	0.001	0.0	0.002	0.001	0

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CACO3) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
9	25	0.68	97.1	186	60	1.2	0.006	<0.005	0.021	0.015	<5
	26	0.55	90.0	144	40	0.6	0.007	<0.005	0.014	0.013	<5
	27	0.48	89.3	143	20	0.5	0.007	<0.005	0.013	0.013	<5
	$\bar{x}$	0.57	92.1	158	40	0.8	0.007	<0.005	0.016	0.014	<5
	S.D.	0.10	4.3	25	20	0.4	0.001	0.0	0.004	0.001	0.0
10	28	0.53	92.1	148	30	0.6	0.007	<0.005	0.015	0.012	<5
	29	0.53	93.5	148	30	0.9	0.007	<0.005	0.015	0.012	<5
	30	0.48	93.5	149	40	1.0	0.009	<0.005	0.015	0.013	<5
	$\bar{x}$	0.51	93.0	148	33	0.8	0.008	<0.005	0.015	0.012	<5
	S.D.	0.03	0.8	1	6	0.2	0.001	0.0	.000	0.001	0.0
11	31	0.63	95.7	157	37	1.0	0.007	<0.005	0.017	0.010	<5
	32	0.68	95.7	153	38	1.0	0.007	<0.005	0.017	0.008	<5
	33	0.65	98.5	156	36	1.1	0.009	<0.005	0.016	0.010	<5
		0.65	96.6	155	37	1.0	0.008	<0.005	0.017	0.009	<5
	S.D.	0.03	1.6	2	1	0.1	0.001	0.0	0.001	0.001	0.0

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985

STATION	SAMPLE NUMBER	Ag (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Mg (mg/L)	Mn (mg/L)
1	1	<0.0005	<0.05	0.015	0.045	<0.001	134.0	0.0037	<0.005	<0.005	0.002	0.381	19.0	1.840
	2	<0.0005	<0.05	0.000	0.045	<0.001	136.0	0.0031	<0.005	<0.005	0.003	0.383	19.2	1.850
	3	<0.0005	<0.05	0.009	0.049	<0.001	144.0	0.0029	<0.005	<0.005	0.004	0.416	20.8	1.970
	$\bar{x}$	<0.0005	<0.05	0.008	0.046	<0.001	138.0	0.0032	<0.005	<0.005	0.003	0.393	19.7	1.887
	S.D.	0.0	0.0	0.008	0.002	0.0	5.3	0.0004	0.0	0.0	0.001	0.020	1.0	0.072
2	4	<0.0005	<0.05	0.006	0.043	<0.001	95.0	0.0029	<0.005	<0.005	0.002	0.089	17.4	0.087
	5	<0.0005	<0.05	0.011	0.044	<0.001	96.2	0.0031	<0.005	<0.005	0.002	0.091	17.8	0.086
	6	<0.0005	<0.05	0.014	0.044	<0.001	96.9	0.0031	<0.005	<0.005	0.002	0.086	18.0	0.086
	$\bar{x}$	<0.0005	<0.05	0.010	0.044	<0.001	96.0	0.0030	<0.005	<0.005	0.002	0.089	17.7	0.086
	S.D.	0.0	0.0	0.004	0.001	0.0	1.0	0.0001	0.0	0.0	0.000	0.000	0.3	0.001
3	7	<0.0005	<0.05	0.020	0.044	<0.001	36.8	0.0018	<0.005	<0.005	0.003	0.182	9.6	0.030
	8	<0.0005	<0.05	0.002	0.044	<0.001	36.7	0.0016	<0.005	<0.005	0.003	0.228	9.7	0.050
	9	<0.0005	<0.05	0.011	0.044	<0.001	36.9	0.0009	<0.005	<0.005	0.002	0.186	9.8	0.030
	$\bar{x}$	<0.0005	<0.05	0.011	0.044	<0.001	36.8	0.0014	<0.005	<0.005	0.003	0.199	9.7	0.07
	S.D.	0.0	0.0	0.009	0.000	0.0	0.1	0.0005	0.0	0.0	0.001	0.025	0.1	0.012
4	10	<0.0005	<0.05	0.014	0.045	<0.001	39.3	0.0020	<0.005	<0.005	0.003	0.223	10.1	0.041
	11	<0.0005	<0.05	0.007	0.045	<0.001	40.1	0.0015	<0.005	<0.005	0.003	0.218	10.2	0.041
	12	<0.0005	<0.05	0.015	0.045	<0.001	39.0	0.0018	<0.005	<0.005	0.003	0.89	10.0	0.035
	$\bar{x}$	<0.0005	<0.05	0.012	0.045	<0.001	39.5	0.0018	<0.005	<0.005	0.003	0.10	10.1	0.039
	S.D.	0.0	0.0	0.004	0.000	0.0	0.6	0.0003	0.0	0.0	0.00	0.018	0.1	0.003

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	Ag (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Mg (mg/L)	Mn (mg/L)
5	13	0.0022	<0.05	0.026	0.026	<0.001	161.0	0.0017	<0.005	<0.005	0.012	0.384	45.8	0.563
	14	0.0026	<0.05	0.028	0.028	<0.001	158.0	0.0030	0.007	<0.005	0.013	0.652	44.6	0.863
	15	0.0023	<0.05	0.027	0.027	<0.001	163.0	0.0025	<0.005	<0.005	0.012	0.529	46.3	0.740
	$\bar{x}$	0.0024	<0.05	0.027	0.027	<0.001	160.7	0.0024	<0.007	<0.005	0.012	0.522	45.6	0.722
	S.D.	0.0002	0.0	0.001	0.001	0.0	2.5	0.0007	0.0	0.0	0.001	0.134	0.9	0.151
6	16	<0.0005	<0.05	0.075	0.075	<0.001	75.8	0.0017	<0.005	<0.005	0.003	0.070	12.8	0.003
	17	<0.0005	<0.05	0.027	0.074	<0.001	74.2	0.0018	<0.005	<0.005	0.003	0.069	12.5	0.003
	18	<0.0005	<0.05	0.012	0.072	<0.001	74.0	0.0016	<0.005	<0.005	0.005	0.066	12.2	0.002
	$\bar{x}$	<0.0005	<0.05	0.038	0.074	<0.001	74.7	0.0017	<0.005	<0.005	0.004	0.068	12.5	0.003
	S.D.	0.00	0.0	0.033	0.002	0.0	1.0	0.0001	0.0	0.0	0.001	0.002	0.3	0.001
7	19	0.0008	<0.05	0.031	0.032	<0.001	140.0	0.0044	<0.005	<0.005	0.006	0.300	33.6	2.090
	20	0.0006	<0.05	0.013	0.032	<0.001	139.0	0.0043	<0.005	<0.005	0.006	0.295	33.3	2.080
	21	0.0007	<0.05	0.000	0.033	<0.001	142.0	0.0042	<0.005	<0.005	0.005	0.305	34.2	2.120
	$\bar{x}$	0.0007	<0.05	0.015	0.032	0.001	140.3	0.0043	<0.005	<0.005	0.006	0.300	33.7	2.097
	S.D.	0.0001	0.0	0.016	0.001	0.0	1.5	0.0001	0.0	0.0	0.001	0.005	0.5	0.021
8	22	<0.0005	<0.05	0.006	0.050	<0.001	38.9	0.0018	<0.005	<0.005	0.005	2.209	10.2	0.051
	23	<0.0005	<0.05	0.012	0.050	<0.001	39.1	0.0018	<0.005	<0.005	0.002	0.206	10.2	0.048
	24	<0.0005	<0.05	0.015	0.050	<0.001	38.8	0.0020	<0.005	<0.005	0.003	0.219	10.3	0.051
	$\bar{x}$	<0.0005	<0.05	0.011	0.050	<0.001	38.9	0.0019	<0.005	<0.005	0.003	0.211	10.2	0.050
	S.D.	0.0	0.0	0.005	0.0	0.0	0.2	0.0001	0.0	0.0	0.002	0.007	0.1	0.002

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	Ag (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Co (mg/L)	Cr (mg/L)	Cu (mg/L)	Fe (mg/L)	Mg (mg/L)	Mn (mg/L)
9	25	0.0005	<0.05	0.019	0.051	<0.001	52.0	0.0019	<0.005	<0.005	0.002	0.207	13.3	0.227
	26	0.0005	<0.05	0.009	0.050	<0.001	40.0	0.0016	<0.005	<0.005	0.001	0.202	10.5	0.057
	27	<0.0005	<0.05	0.020	0.050	<0.001	39.8	0.0019	<0.005	<0.005	0.002	0.217	10.5	0.057
	$\bar{x}$	<0.0005	<0.05	0.016	0.050	<0.001	43.9	0.0018	<0.005	<0.005	0.002	0.209	11.4	0.113
	S.D.	0.0	0.0	0.006	0.001	0.0	7.0	0.0002	0.0	0.0	0.001	0.008	1.6	0.099
10	28	<0.0005	<0.05	0.030	0.052	<0.001	41.3	0.0019	<0.005	<0.005	0.002	0.202	10.9	0.067
	29	<0.0005	<0.05	0.018	0.052	<0.001	41.2	0.0019	<0.005	<0.005	0.002	0.202	10.9	0.067
	30	<0.0005	<0.05	0.000	0.052	<0.001	41.3	0.0020	<0.005	<0.005	0.002	0.202	10.9	0.065
	$\bar{x}$	<0.0005	<0.05	0.016	0.052	<0.001	41.3	0.0019	<0.005	<0.005	0.002	0.202	10.9	0.066
	S.D.	0.0	0.0	0.015	.000	0.0	0.1	0.0001	0.0	0.0	0.0	0.000	0.0	0.001
11	31	<0.0005	<0.05	0.012	0.056	<0.001	43.2	0.0012	<0.005	<0.005	0.002	0.226	11.6	0.071
	32	<0.0005	<0.05	0.026	0.056	<0.001	42.3	0.0016	<0.005	<0.005	0.003	0.269	11.4	0.072
	33	<0.0005	<0.05	0.000	0.058	<0.001	43.2	0.0016	<0.005	<0.005	0.003	0.240	11.4	0.078
	$\bar{x}$	<0.0005	<0.05	0.013	0.057	<0.001	42.9	0.0015	<0.005	<0.005	0.003	0.245	11.5	0.074
	S.D.	0.0	0.0	0.013	0.001	0.0	0.5	0.0002	0.0	0.0	0.0	0.022	0.1	0.004

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
1	1	<0.005	1.4	<0.02	0.09	0.028	<0.05	<0.05	2.1	<0.01	0.188	<0.002	<0.005	0.901
	2	<0.005	1.4	<0.02	0.08	0.024	<0.05	<0.05	2.1	<0.01	0.190	<0.002	<0.005	0.907
	3	<0.005	1.5	<0.02	0.08	0.020	<0.05	<0.05	2.1	<0.01	0.205	<0.002	<0.005	0.975
	$\bar{x}$	<0.005	1.4	<0.02	0.08	0.024	<0.05	<0.05	2.1	<0.01	0.194	<0.002	<0.005	0.928
	S.D.	0.0	0.0	0.	0.01	0.004	0.0	0.0	0.0	0.0	0.009	0.0	0.0	0.041
2	4	<0.005	1.3	<0.02	<0.05	0.019	<0.05	<0.05	2.1	<0.01	0.176	<0.002	<0.005	0.323
	5	<0.005	1.3	<0.02	<0.05	0.018	<0.05	<0.05	2.1	<0.01	0.178	<0.002	<0.005	0.327
	6	<0.005	1.4	<0.02	<0.05	0.019	<0.05	<0.05	2.1	<0.01	0.181	<0.002	<0.005	0.330
	$\bar{x}$	<0.005	1.3	<0.02	<0.05	0.019	<0.05	<0.05	2.1	<0.01	0.178	<0.002	<0.005	0.327
	S.D.	0.0	0.1	0.	0.0	0.001	0.0	0.0	0.0	0.0	0.003	0.0	0.0	0.004
3	7	<0.005	1.0	<0.02	<0.05	0.021	<0.05	<0.05	1.3	<0.01	0.143	<0.002	<0.005	0.006
	8	<0.005	1.0	<0.02	<0.05	0.015	<0.05	<0.05	1.3	<0.01	0.146	<0.002	<0.005	0.014
	9	<0.005	1.0	<0.02	<0.05	0.017	<0.05	<0.05	1.3	<0.01	0.145	<0.002	<0.005	0.004
	$\bar{x}$	<0.005	1.0	<0.02	<0.05	0.018	<0.05	<0.05	1.3	<0.01	0.145	<0.002	<0.005	0.008
	S.D.	0.0	0.0	0.0	0.0	0.003	0.0	0.0	0.0	0.0	0.002	0.0	0.0	0.005
4	10	<0.005	1.0	<0.02	<0.05	0.023	<0.05	<0.05	1.3	<0.01	0.148	<0.002	<0.005	0.023
	11	<0.005	1.0	<0.02	<0.05	0.017	<0.05	<0.05	1.3	<0.01	0.150	<0.002	<0.005	0.024
	12	<0.005	1.0	<0.02	<0.05	0.021	<0.05	<0.05	1.3	<0.01	0.145	<0.002	<0.005	0.021
	$\bar{x}$	<0.005	1.0	<0.02	<0.05	0.020	<0.05	<0.05	1.3	<0.01	0.148	<0.002	<0.005	0.023
	S.D.	0.0	0.0	0.0	0.0	0.003	0.0	0.0	0.0	0.0	0.003	0.0	0.0	0.002

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985 (continued)

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
5	13	<0.005	57.8	<0.02	<0.05	0.020	<0.05	<0.05	0.4	<0.01	0.340	<0.002	<0.005	0.187
	14	<0.005	56.0	<0.02	<0.05	0.027	<0.05	<0.05	0.4	<0.01	0.334	<0.002	<0.005	0.247
	15	<0.005	58.7	<0.02	<0.05	0.024	<0.05	<0.05	0.4	<0.01	0.345	<0.002	<0.005	0.222
	$\bar{x}$	0.005	57.5	<0.02	<0.05	0.024	<0.05	<0.05	0.4	<0.01	0.340	<0.002	<0.005	0.219
	S.D.	0.0	1.4	0.0	0.0	0.004	0.0	0.0	.0	0.0	0.006	0.0	0.0	0.030
6	16	<0.005	1.0	<0.02	<0.05	0.026	<0.05	<0.05	2.1	<0.01	0.311	<0.002	<0.005	0.004
	17	<0.005	1.0	<0.02	<0.05	0.022	<0.05	<0.05	2.1	<0.01	0.306	<0.002	<0.005	0.004
	18	<0.005	1.0	<0.02	<0.05	0.015	<0.05	<0.05	2.1	<0.01	0.297	<0.002	<0.005	0.003
	$\bar{x}$	<0.005	1.0	<0.02	<0.05	0.021	<0.05	<0.05	2.1	<0.01	0.305	<0.002	<0.005	0.004
	S.D.	0.0	0.0	0.0	0.0	0.006	0.0	0.0	0.0	0.0	0.007	0.0	0.0	0.001
7	19	0.006	12.0	<0.02	<0.05	0.023	<0.05	<0.05	1.7	<0.01	0.257	<0.002	<0.005	0.330
	20	0.006	11.9	<0.02	<0.05	0.022	<0.05	<0.05	1.7	<0.01	0.256	<0.002	<0.005	0.327
	21	<0.005	12.3	<0.02	<0.05	0.019	<0.05	<0.05	1.7	<0.01	0.263	<0.002	<0.005	0.335
	$\bar{x}$	<0.006	12.1	<0.02	<0.05	0.021	<0.05	<0.05	1.7	<0.01	0.259	<0.002	<0.005	0.331
	S.D.	0.0	0.2	0.0	0.0	0.002	0.0	0.0	0.0	0.0	0.004	0.0	0.0	0.004
8	22	<0.005	1.1	<0.02	<0.05	0.025	<0.05	<0.05	1.2	<0.01	0.146	<0.002	<0.005	0.019
	23	<0.005	1.1	<0.02	<0.05	0.027	<0.05	<0.05	1.2	<0.01	0.146	<0.002	<0.005	0.019
	24	0.007	1.1	<0.02	<0.05	0.027	<0.05	<0.05	1.2	<0.01	0.147	<0.002	<0.005	0.020
	$\bar{x}$	<0.007	1.1	<0.02	<0.05	0.026	<0.05	<0.05	1.2	<0.01	0.146	<0.002	<0.005	0.019
	S.D.	0.0	0.0	0.0	0.0	0.001	0.0	0.0	.0	0.0	0.001	0.0	0.0	0.001

APPENDIX II TABLE 1 WATER QUALITY RESULTS FOR JULY 9-10, 1985

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
9	25	0.005	2.4	<0.02	<0.05	0.026	<0.05	<0.05	1.2	<0.01	0.160	<0.002	<0.005	0.049
	26	0.006	1.2	<0.02	<0.05	0.019	<0.05	<0.05	1.2	<0.01	0.148	<0.002	<0.005	0.020
	27	0.005	1.2	<0.02	<0.05	0.026	<0.05	<0.05	1.2	<0.01	0.148	<0.002	<0.005	0.019
	$\bar{x}$	0.005	1.6	<0.02	<0.05	0.024	<0.05	<0.05	1.2	<0.01	0.152	<0.002	<0.005	0.029
	S.D.	0.001	0.7	0.0	0.0	0.004	0.0	0.0	.0	0.0	0.007	0.0	0.0	0.017
10	28	<0.005	1.3	<0.02	<0.05	0.027	<0.05	<0.05	1.4	<0.01	0.152	<0.002	<0.005	0.024
	29	0.009	1.4	<0.02	<0.05	0.026	<0.05	<0.05	1.4	<0.01	0.152	<0.002	<0.005	0.022
	30	<0.005	1.3	<0.02	<0.05	0.009	<0.05	<0.05	1.4	0.01	0.152	<0.002	<0.005	0.021
	$\bar{x}$	<0.009	1.3	<0.02	<0.05	0.021	<0.05	<0.05	1.4	<0.01	0.152	<0.002	<0.005	0.022
	S.D.	0.0	0.1	0.0	0.0	0.010	0.0	0.0	0.0	0.0	0.000	0.0	0.0	0.002
11	31	0.006	1.6	<0.02	<0.05	0.017	<0.05	<0.05	2.0	<0.01	0.164	<0.002	<0.005	0.016
	32	<0.005	1.5	<0.02	<0.05	0.022	<0.05	<0.05	1.7	<0.01	0.161	<0.002	<0.005	0.015
	33	0.009	1.5	<0.02	<0.05	0.022	<0.05	<0.05	1.6	<0.01	0.160	<0.002	<0.005	0.018
	$\bar{x}$	<0.008	1.5	<0.02	<0.05	0.020	<0.05	<0.05	1.8	<0.01	0.162	<0.002	<0.005	0.016
	S.D.	0.0	0.1	0.0	0.0	0.003	0.0	0.0	0.2	0.0	0.002	0.0	0.0	0.002

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985

NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURA-TION	COLOR (FTU)
1	1	N/A	N/A	N/A	6.5	7.60	7.4	500	800	10.4	89	5
	2						7.5		800			5
	3						6.9		800			5
	$\bar{x}$						7.3		800			5
	S.D.						0.3		0			0
2	4	0.3	3.0	0.12	5.0	7.90	7.5	312	580	11.3	92	5
	5						6.9		580			5
	6						7.3		580			5
	$\bar{x}$						7.2		580			5
	S.D.						0.3		0			0
3	7	N/A	N/A	3.3 *	11.0	8.10	7.6	165	250	10.4	97	10
	8						7.5		250			10
	9						7.5		250			10
	$\bar{x}$						7.5		250			10
	S.D.						0.1		0			0
4	10	0.6	9.6	3.451	10.0	8.00	6.9	180	310	10.3	95	10
	11						5.0		290			10
	12						9.0		255			10
	$\bar{x}$						7.1		285			10
	S.D.						0.3		28			0

* Determined from the difference between Station 4 and Station 2

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURA-TION	COLOR (FTU)
5	13	N/A	N/A	N/A	12.6	7.90	7.4	920	1250	11.8	119	10
	14						7.3		1250			10
	15						7.1		1250			10
	$\bar{x}$						7.3		1250			10
	S.D.						0.2		0			0
6	16	N/A	N/A	N/A	4.0	7.70	7.8	252	450	10.8	90	<5
	17						7.4		450			<5
	18						7.3		450			<5
	$\bar{x}$						7.5		450			<5
	S.D.						0.3		0			0
7	19	0.1	118	0.060	7.5	7.90	7.5	580	900	20.4	88	10
	20						7.5		900			10
	21						7.8		900			10
	$\bar{x}$						7.6		900			10
	S.D.						0.2		0			0
8	22	0.5	15.8	3.0	9.3		7.3	195	285	22.0	101	10
	23						7.9		285			10
	24						7.5		285			10
	$\bar{x}$						7.6		285			10
	S.D.						0.3		0			0

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	AVG. DEPTH (m)	WIDTH (m)	FLOW (m3/s)	TEMP. (C)	pH INSITU	pH LAB	COND. (umhos/cm) INSITU	COND. (umhos/cm) LAB	DISOLVED OXYGEN (mg/L)	%DO SATURA-TION	COLOR (FTU)
9	25	N/A	N/A	3.1 *	8.3	7.65	8.0	450	680	10.5	99	10
	26						8.0		390			10
	27						7.9		310			10
	$\bar{x}$						8.0		460			10
	S.D.						0.1		195			0
10	28	N/A	N/A	N/A	10.1	8.00	8.0	210	310	10.5	104	10
	29						7.6		310			10
	30						8.0		310			10
	$\bar{x}$						7.9		310			10
	S.D.						0.2		0			10
11	31	0.5	29.0	6.7	7.5	7.70	8.1	197	320	10.6	97	10
	32						8.3		310			10
	33						8.6		310			10
	$\bar{x}$						8.0		313			10
	S.D.						0.4		6			0

* Determine from the sum of Station 7 and Station 8

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985

NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CAC03) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
1	1	0.30	105.0	463	270	0.7	0.005	<0.005	0.075	0.020	14
	2	0.30	102.0	471	310	0.8	0.005	<0.005	0.077	0.012	7
	3	0.30	103.0	469	300	0.8	0.003	<0.005	0.077	0.011	<5
	$\bar{x}$	0.30	103.3	468	293	0.8	0.004	<0.005	0.076	0.014	<11
	S.D.	0.00	1.5	4	21	0.1	0.001	0.0	0.001	0.005	0
2	4	0.40	119.0	325	170	0.6	<0.002	<0.005	0.055	0.005	10
	5	0.40	121.0	327	160	0.5	<0.002	<0.005	0.054	0.005	5
	6	0.40	121.0	326	160.0	0.5	<0.002	<0.005	0.055	<0.005	6
	$\bar{x}$	0.40	120.3	326	163	<0.6	<0.002	<0.005	0.055	<0.005	7
	S.D.	.00	1.2	1	6	0.0	0.000	0.0	0.001	0.0	3
3	7	0.15	86.2	135	53	<0.5	<0.002	<0.005	0.008	0.006	<5
	8	0.15	85.7	136	37	<0.5	<0.002	<0.005	<0.005	0.006	<5
	9	0.18	86.2	136	36	0.5	<0.002	<0.005	<0.005	0.006	<5
	$\bar{x}$	0.16	86.0	136	42	0.5	<0.000	<0.002	0.008	0.006	<5
	S.D.	0.02	0.3	1	10	0.0	0.000	0.0	0.0	0.0	0
4	10	0.23	91.3	169	56	<0.5	<0.002	<0.005	0.012	0.007	<5
	11	0.23	91.3	157	52	<0.5	0.005	<0.005	0.008	0.008	6
	12	0.15	86.2	136	37	0.6	<0.002	<0.005	<0.005	<0.005	<5
	$\bar{x}$	0.20	89.6	154	48	<0.6	<0.002	<0.005	<0.010	<0.008	<6
	S.D.	0.05	2.9	17	10	0.0	0.000	0.0	0.0	0.0	0

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CAC03) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRITE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
5	13	0.63	92.8	663	530	14.3	0.003	<0.005	0.074	0.074	<5
	14	0.58	93.1	680	550	14.2	0.002	<0.005	0.078	0.078	<5
	15	0.68	91.9	671	540	14.4	0.004	<0.005	0.079	0.079	<5
	$\bar{x}$	0.63	92.6	671	540	14.3	0.003	<0.005	0.077	0.077	<5
	S.D.	0.05	0.6	9	10	0.1	0.001	0.0	0.003	0.003	0
6	16	<0.01	188.0	255	55	<0.5	<0.002	<0.005	0.078	0.078	<5
	17	<0.01	187.0	254	48	<0.5	<0.002	<0.005	0.078	0.078	<5
	18	<0.01	187.0	254	48	<0.5	<0.002	<0.005	0.079	0.079	<5
	$\bar{x}$	<0.01	187.3	254	50	<0.5	<0.002	<0.005	0.078	0.078	<5
	S.D.	0.00	0.6	1	4	0.0	0.000	0.0	0.001	0.001	0
7	19	1.80	163.0	507	300	6.6	0.006	<0.005	0.160	0.160	6
	20	2.00	163.0	508	290	6.9	0.004	<0.005	0.160	0.160	13
	21	2.00	163.0	511	300	6.9	<0.002	<0.005	0.160	0.160	<5
	$\bar{x}$	1.93	163.0	509	297	6.8	<0.005	<0.005	0.160	0.160	<10
	S.D.	0.12	0.0	2	6	0.2	0.000	0.0	0.000	0.000	0
8	22	0.20	98.8	157	45	0.7	0.059	<0.005	0.016	0.016	<5
	23	0.18	102.0	156	44	0.7	0.003	<0.005	0.008	0.008	<5
	24	0.18	101.0	155	41	0.7	0.002	<0.005	0.053	0.053	<5
	$\bar{x}$	0.19	100.6	156	43	0.7	0.021	<0.005	0.026	0.026	<5
	S.D.	0.01	1.6	1	2	0.0	0.033	0.0	0.024	0.024	0

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	TURB. (FTU)	T.ALK. (as CACO3) (mg/L)	T.HARD (as CaCO3) (mg/L)	SULFATE (mg/L)	CHLORIDE (mg/L)	PHOSPATE (mg/L)	NITRATE (mg/L)	NITRATE (mg/L)	AMMONIA (mg/L)	NFR (mg/L)
9	25	0.53	145.0	380	200	4.0	<0.002	<0.005	0.090	0.090	<5
	26	0.28	113.0	227	80	1.5	<0.002	<0.005	0.036	0.036	<5
	27	0.33	101.0	173	125	0.8	0.049	<0.005	0.014	0.014	<5
	$\bar{x}$	0.38	119.7	260	135	2.1	<0.049	<0.005	0.047	0.047	<5
	S.D.	0.13	22.7	107	61	1.7	0.000	0.0	0.039	0.039	0
10	28	0.28	106.0	170	48	0.7	0.006	<0.005	0.009	0.009	7
	29	0.25	106.0	170	47	0.7	0.003	<0.005	0.009	0.009	<5
	30	0.15	106.0	169	46	0.7	0.003	<0.005	0.008	0.008	<5
	$\bar{x}$	0.23	106.0	170	47	0.7	0.004	<0.005	0.009	0.009	<7
	S.D.	0.07	0.0	1	1	0.0	0.002	0.0	0.001	0.001	0
11	31	0.38	113.0	173	43	0.8	<0.002	<0.005	0.006	0.010	7
	32	0.35	108.0	167	44	0.6	<0.002	<0.005	0.016	0.009	<5
	33	0.48	105.0	165	46	0.6	<0.002	<0.005	0.021	0.009	<5
	$\bar{x}$	0.40	108.7	168	44	0.7	<0.002	<0.005	0.014	0.009	<7
	S.D.	0.07	4.0	4	2	0.1	0.000	0.0	0.008	0.001	0

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Ag mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Mg mg/L	Mn mg/L
1	1	<0.0005	<0.05	0.022	0.056	<0.001	150.0	0.0017	<0.005	<0.005	<0.001	0.188	20.3	1.790
	2	<0.0005	<0.05	0.000	0.058	<0.001	152.0	0.0015	<0.005	<0.005	<0.001	0.204	20.7	1.830
	3	<0.0005	<0.05	0.010	0.057	<0.001	152.0	0.0015	<0.005	<0.005	<0.001	0.199	20.6	1.800
	$\bar{x}$	<0.0005	<0.05	0.011	0.057	<0.001	151.3	0.0016	<0.005	<0.005	<0.001	0.197	20.5	1.807
	S.D.	0.0	0.0	0.011	0.001	0.0	1.2	0.0001	0.0	0.0	0.0	0.008	0.2	0.021
2	4	<0.0005	<0.05	0.028	0.052	<0.001	99.7	0.0019	<0.005	<0.005	<0.001	0.145	18.0	0.278
	5	<0.0005	<0.05	0.022	0.053	<0.001	101.0	0.0021	<0.005	<0.005	<0.001	0.147	18.1	0.280
	6	<0.0005	<0.05	0.028	0.052	<0.001	100.0	0.0020	<0.005	<0.005	0.008	0.154	18.1	0.281
	$\bar{x}$	<0.0005	<0.05	0.026	0.052	<0.001	100.2	0.0020	<0.005	<0.005	<0.008	0.149	18.1	0.280
	S.D.	0.0	0.0	0.003	0.001	0.0	0.7	0.0001	0.0	0.0	0.0	0.005	0.1	0.002
3	7	<0.0005	<0.05	0.019	0.043	<0.001	36.6	<0.0005	<0.005	<0.005	<0.001	0.101	10.3	0.018
	8	<0.0005	<0.05	0.022	0.044	<0.001	37.1	<0.0005	<0.005	<0.005	<0.001	0.109	10.5	0.018
	9	<0.0005	<0.05	0.015	0.044	<0.001	36.9	N/A	<0.005	<0.005	<0.001	0.107	10.4	0.018
	$\bar{x}$	<0.0005	<0.05	0.019	0.044	<0.001	36.9	<0.0005	<0.005	<0.005	<0.001	0.103	10.4	0.018
	S.D.	0.0	0.0	0.004	0.001	0.0	0.3	0.0	0.0	0.0	0.0	0.002	0.1	0.000
4	10	<0.0005	<0.05	0.006	0.046	<0.001	47.7	0.0005	<0.005	<0.005	0.001	0.149	11.8	0.073
	11	<0.0005	<0.05	0.006	0.045	<0.001	44.0	0.0005	<0.005	<0.005	<0.001	0.118	11.3	0.048
	12	<0.0005	<0.05	0.025	0.044	<0.001	37.1	0.0005	<0.005	<0.005	0.004	0.107	10.5	0.019
	$\bar{x}$	<0.0005	<0.05	0.012	0.045	<0.001	42.9	0.0005	<0.005	<0.005	<0.002	0.125	11.2	0.047
	S.D.	0.0	0.0	0.011	0.001	0.0	5.4	0.0000	0.0	0.0	0.0	0.022	0.7	0.027

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Ag mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Mg mg/L	Mn mg/L
5	13	<0.0010	<0.05	0.019	0.017	<0.001	193.0	0.0024	<0.005	<0.005	0.013	0.466	43.0	1.050
	14	<0.0010	<0.05	0.032	0.017	<0.001	197.0	0.0023	<0.005	<0.005	0.012	0.441	44.6	1.050
	15	<0.0010	<0.05	0.013	0.017	<0.001	195.0	0.0023	<0.005	<0.005	0.012	0.442	43.8	1.030
	$\bar{x}$	<0.0010	<0.05	0.021	0.017	<0.001	195.0	0.0023	<0.005	<0.005	0.012	0.443	43.8	1.043
	S.D.	0.0	0.0	0.010	0.000	0.0	2.0	0.0001	0.0	0.0	0.001	0.022	0.8	0.012
6	16	<0.0005	<0.05	0.025	0.079	<0.001	79.8	<0.0005	<0.005	<0.005	<0.001	0.030	13.3	0.002
	17	<0.0005	<0.05	0.014	0.080	<0.001	79.4	<0.0005	<0.005	<0.005	<0.001	0.028	13.4	0.001
	18	<0.0005	<0.05	0.000	0.081	<0.001	79.5	<0.0005	<0.005	<0.005	<0.001	0.032	13.4	0.001
	$\bar{x}$	<0.0005	<0.05	0.013	0.080	<0.001	79.6	<0.0005	<0.005	<0.005	<0.001	0.030	13.4	0.001
	S.D.	0.0	0.0	0.013	0.001	0.0	0.2	0.00	0.0	0.0	0.0	0.002	0.1	0.001
7	19	<0.0005	<0.05	0.014	0.027	<0.001	145.0	0.0018	<0.005	<0.005	0.005	0.549	34.8	0.598
	20	<0.0005	<0.05	0.001	0.027	<0.001	145.0	0.0018	<0.005	<0.005	0.005	0.512	35.0	0.596
	21	<0.0005	<0.05	0.001	0.026	<0.001	146.0	0.0017	<0.005	<0.005	0.004	0.437	35.0	0.524
	$\bar{x}$	<0.0005	<0.05	0.005	0.027	<0.001	145.0	0.0018	<0.005	<0.005	0.005	0.499	34.9	0.573
	S.D.	0.00	0.0	0.008	0.001	0.0	0.6	0.0001	0.0	0.0	0.001	0.057	0.1	0.042
8	22	<0.0005	<0.05	0.017	0.054	<0.001	43.1	<0.0005	<0.005	<0.005	0.006	0.129	11.7	0.042
	23	<0.0005	<0.05	0.017	0.054	<0.001	43.0	<0.0005	<0.005	<0.005	<0.001	0.125	11.6	0.041
	24	<0.0005	<0.05	0.005	0.054	<0.001	42.8	<0.0005	<0.005	<0.005	<0.001	0.124	11.6	0.041
	$\bar{x}$	<0.0005	<0.05	0.013	0.054	<0.001	43.0	<0.0005	<0.005	<0.005	<0.006	0.126	11.6	0.041
	S.D.	0.00	0.0	007	0.000	0.0	0.2	0.00	0.0	0.0	0.0	0.003	0.1	0.001

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985

NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Ag mg/L	As mg/L	B mg/L	Ba mg/L	Be mg/L	Ca mg/L	Cd mg/L	Co mg/L	Cr mg/L	Cu mg/L	Fe mg/L	Mg mg/L	Mn mg/L
9	25	<0.0005	<0.05	0.008	0.060	<0.001	108.0	<0.0005	<0.005	<0.005	0.002	0.248	26.3	0.234
	26	<0.0005	<0.05	0.027	0.056	<0.001	63.7	<0.0005	<0.005	<0.005	0.001	0.166	16.3	0.104
	27	<0.0005	<0.05	<0.001	0.055	<0.001	47.8	<0.0005	<0.005	<0.005	<0.001	0.134	12.8	0.055
	$\bar{x}$	<0.0005	<0.05	0.017	0.057	<0.001	73.2	<0.0005	<0.005	<0.005	<0.002	0.183	18.5	0.055
	S.D.	0.00	0.0	0.0	0.003	0.0	31.2	0.00	0.0	0.0	0.0	0.059	7.0	0.055
10	28	<0.0005	<0.05	0.008	0.057	<0.001	47.0	<0.0005	<0.005	<0.005	0.001	0.163	12.5	0.048
	29	<0.0005	<0.05	0.027	0.058	<0.001	47.0	<0.0005	<0.005	<0.005	0.001	0.167	12.6	0.049
	30	<0.0005	<0.05	0.001	0.058	<0.001	46.9	<0.0005	<0.005	<0.005	0.001	0.156	12.6	0.048
	$\bar{x}$	<0.0005	<0.05	0.012	0.058	<0.001	47.0	<0.0005	<0.005	<0.005	0.001	0.162	12.6	0.048
	S.D.	0.00	0.0	0.013	0.001	0.0	0.1	0.00	0.0	0.0	0.0	0.006	0.1	0.001
11	31	<0.0005	<0.05	0.014	0.068	<0.001	47.8	<0.0005	<0.005	<0.005	<0.001	0.269	12.7	0.055
	32	<0.0005	<0.05	0.023	0.062	<0.001	45.7	<0.0005	<0.005	<0.005	<0.001	0.225	12.7	0.042
	33	<0.0005	<0.05	0.017	0.059	<0.001	45.1	<0.0005	<0.005	<0.005	<0.001	0.214	12.6	0.038
	$\bar{x}$	<0.0005	<0.05	0.018	0.063	<0.001	46.2	<0.0005	<0.005	<0.005	<0.001	0.236	12.7	0.045
	S.D.	0.00	0.0	0.005	0.005	0.0	1.4	0.00	0.0	0.0	0.0	0.029	0.1	0.009

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
1	1	<0.005	1.5	0.02	<0.05	<0.001	<0.05	<0.05	3.2	<0.01	0.223	<0.002	<0.005	0.816
	2	<0.005	1.5	0.02	<0.05	<0.001	<0.05	<0.05	3.4	<0.01	0.225	<0.002	<0.005	0.836
	3	<0.005	1.4	<0.02	<0.05	0.001	<0.05	<0.05	3.2	<0.01	0.225	<0.002	<0.005	0.824
	$\bar{x}$	<0.005	1.5	<0.02	<0.05	<0.001	<0.05	<0.05	3.3	<0.01	0.224	<0.002	<0.005	0.825
	S.D.	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.001	0.0	0.0	0.010
2	4	<0.005	1.3	<0.02	<0.05	0.002	<0.05	<0.05	3.0	<0.01	0.192	<0.002	<0.005	0.429
	5	<0.005	1.3	<0.02	<0.05	0.001	<0.05	<0.05	3.1	<0.01	0.194	<0.002	<0.005	0.435
	6	<0.005	1.3	<0.02	0.06	0.001	<0.05	<0.05	2.9	<0.01	0.192	<0.002	<0.005	0.436
	$\bar{x}$	<0.005	1.3	<0.02	<0.06	0.001	0.05	0.05	3.0	<0.01	0.193	<0.002	<0.005	0.433
	S.D.	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.1	0.0	0.001	0.0	0.0	0.004
3	7	<0.005	1.2	<0.02	<0.05	0.002	<0.05	<0.05	1.8	0.03	0.151	<0.002	<0.005	<0.002
	8	<0.005	1.2	<0.02	<0.05	0.001	<0.05	<0.05	1.9	<0.01	0.153	<0.002	<0.005	<0.002
	9	<0.005	1.2	<0.02	<0.05	0.001	<0.05	<0.0	1.6	<0.01	0.153	<0.002	<0.005	<0.002
	$\bar{x}$	<0.005	1.2	<0.02	<0.05	0.001	<0.05	<0.05	1.8	<0.03	0.152	<0.002	<0.005	<0.002
	S.D.	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.2	0.0	0.001	0.0	0.0	0.0
4	10	<0.005	1.3	<0.02	0.05	0.001	<0.05	<0.05	1.8	<0.01	0.162	<0.002	<0.005	0.084
	11	<0.005	1.3	<0.02	<0.05	0.001	<0.05	<0.05	1.7	<0.01	0.158	<0.002	<0.005	0.053
	12	<0.005	1.2	<0.02	<0.05	<0.001	<0.05	<0.05	1.6	<0.01	0.153	<0.002	<0.005	0.003
	$\bar{x}$	<0.005	1.3	<0.02	<0.05	<0.001	<0.05	<0.05	1.7	<0.01	0.158	<0.002	<0.005	0.047
	S.D.	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.005	0.0	0.0	0.041

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
5	13	<0.005	44.3	<0.02	0.10	0.003	<0.05	<0.05	0.9	<0.01	0.370	<0.002	<0.005	0.092
	14	<0.005	46.5	<0.02	0.07	0.003	<0.05	<0.05	0.9	<0.01	0.387	<0.002	<0.005	0.090
	15	<0.005	45.5	<0.02	0.06	0.003	<0.05	<0.05	0.9	<0.01	0.380	<0.002	<0.005	0.089
	$\bar{x}$	<0.005	45.4	<0.02	0.08	0.003	<0.05	<0.05	0.9	<0.01	0.379	<0.02	<0.005	0.090
	S.D.	0.0	1.1	0.0	0.02	0.000	0.0	0.0	0.0	0.0	0.009	0.0	0.0	0.002
6	16	<0.005	1.1	<0.02	<0.05	0.002	<0.05	<0.05	2.5	0.03	0.333	<0.002	<0.005	<0.002
	17	<0.005	1.1	<0.02	<0.05	0.001	<0.05	<0.05	2.4	0.03	0.336	<0.002	<0.005	<0.002
	18	<0.005	1.1	<0.02	<0.05	0.001	<0.05	<0.05	2.4	0.02	0.337	<0.002	<0.005	0.003
	$\bar{x}$	<0.005	1.1	<0.02	0.05	0.001	<0.05	<0.05	2.4	0.03	0.335	<0.002	<0.005	<0.003
	S.D.	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.1	0.01	0.002	0.0	0.0	0.0
7	19	<0.005	16.8	<0.02	0.09	0.003	<0.05	<0.05	2.4	<0.01	0.290	<0.002	<0.005	0.218
	20	<0.005	17.1	<0.02	0.06	0.003	<0.05	<0.05	2.3	<0.01	0.292	<0.002	<0.005	0.215
	21	<0.005	17.0	<0.02	0.10	0.002	<0.05	<0.05	2.3	<0.01	0.292	<0.002	<0.005	0.212
	$\bar{x}$	<0.005	17.0	<0.02	0.08	0.003	<0.05	<0.05	2.3	<0.01	0.291	<0.002	<0.005	0.215
	S.D.	0.0	0.2	0.0	0.02	0.001	0.0	0.0	0.1	0.0	0.001	0.0	0.0	0.003
8	22	<0.005	1.3	<0.02	0.06	0.001	<0.05	<0.05	1.6	<0.01	0.158	<0.002	<0.005	0.031
	23	<0.005	1.3	<0.02	0.07	<0.001	<0.05	<0.05	1.6	<0.01	0.157	<0.002	<0.005	0.028
	24	<0.005	1.3	<0.02	0.05	<0.001	<0.05	<0.05	1.6	<0.01	0.156	<0.002	<0.005	0.026
	$\bar{x}$	<0.005	1.3	<0.02	0.06	< .001	<0.05	<0.05	1.6	<0.01	0.157	<0.002	<0.005	0.028
	S.D.	0.0	0.0	0.0	0.01	0.0	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.003

APPENDIX II TABLE 2 WATER QUALITY RESULTS FOR AUGUST 21-22, 1985
NOTE: Triplicate Values for each station are shown in order of left bank, midstream and right bank

STATION	SAMPLE NUMBER	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
9	25	<0.005	9.8	<0.02	0.06	0.001	<0.05	<0.05	2.4	<0.01	0.236	<0.002	<0.005	0.052
	26	<0.005	4.0	<0.02	0.06	0.001	<0.05	<0.05	1.7	<0.01	0.182	<0.002	<0.005	0.052
	27	<0.005	1.9	<0.02	0.06	<0.001	<0.05	<0.05	1.7	0.02	0.165	<0.002	<0.005	0.038
	$\bar{x}$	<0.005	5.2	<0.02	0.06	<0.001	<0.05	<0.05	1.9	<0.02	0.194	<0.002	<0.005	0.065
	S.D.	0.0	4.1	0.0	0.00	0.0	0.0	0.0	0.4	0.0	0.037	0.0	0.0	0.036
10	28	<0.005	1.7	<0.02	<0.05	<0.001	<0.05	<0.05	1.7	0.02	0.167	<0.002	<0.005	0.024
	29	<0.005	1.7	<0.02	<0.05	0.001	<0.05	<0.05	1.7	0.02	0.169	<0.002	<0.005	0.027
	30	<0.005	1.7	<0.02	<0.05	<0.001	<0.05	<0.05	1.7	<0.01	0.169	<0.002	<0.005	0.031
	$\bar{x}$	<0.005	1.7	<0.02	<0.05	<0.001	<0.05	<0.05	1.7	<0.02	0.168	<0.002	<0.005	0.027
	S.D.	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.001	0.0	0.0	0.004
11	31	<0.005	1.9	<0.02	<0.05	<0.001	<0.05	<0.05	1.9	<0.01	0.176	<0.002	<0.005	0.020
	32	<0.005	1.8	<0.02	<0.05	<0.001	<0.05	<0.05	2.5	0.01	0.183	<0.002	<0.005	0.016
	33	<0.005	1.8	<0.02	<0.05	<0.001	<0.05	<0.05	2.5	<0.01	0.184	<0.002	<0.005	0.014
	$\bar{x}$	<0.005	1.8	<0.02	<0.05	<0.001	<0.05	<0.05	2.3	<0.01	0.181	<0.002	<0.005	0.017
	S.D.	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.3	0.0	0.004	0.0	0.0	0.003

APPENDIX III

STREAM SEDIMENTS DATA

APPENDIX III TABLE 1 PERCENT SEDIMENT SIZE DISTRIBUTION FOR JULY 9-10, 1985
NOTE: No Particle Size Results for Stations 1, 2, 3 and 4.

		SIZE RANGE (mm)						
STATION	SAMPLE NUMBER	>2.0	2.0-1.0	01.0-0.5	0.5-0.25	0.25-0.15	0.15-0.063	<0.063
7	1	89.0	5.7	3.4	1.3	0.2	0.2	0.2
	2	78.7	8.1	7.6	4.4	0.4	0.3	0.5
	3	59.2	8.6	20.5	10.7	0.4	0.3	0.3
	$\bar{x}$	75.6	7.5	10.5	5.5	0.3	0.3	0.3
	S.D.	15.1	1.6	8.9	4.8	0.1	0.1	0.2
8	4	67.6	13.6	11.5	5.2	0.9	0.5	0.7
	5	72.9	14.1	9.3	2.5	0.3	0.3	0.6
	6	78.9	11.2	6.9	1.9	0.3	0.4	0.4
	$\bar{x}$	73.1	13.0	9.2	3.2	0.5	0.4	0.6
	S.D.	5.7	1.6	2.3	1.8	0.3	0.1	0.2
9	7	78.0	4.5	6.5	6.1	1.1	1.6	2.2
	8	78.9	1.1	1.9	5.7	2.0	3.2	7.2
	9	78.9	1.1	1.9	5.7	2.0	3.2	7.2
	$\bar{x}$	78.6	2.2	3.4	5.8	1.7	2.7	5.6
	S.D.	0.5	2.0	2.7	0.2	0.5	0.9	2.9
10	10	79.6	14.4	5.2	0.4	0.0	0.1	0.3
	11	82.0	12.9	3.8	0.5	0.2	0.2	0.4
	12	84.4	6.8	5.9	2.0	0.2	0.2	0.5
	$\bar{x}$	82.0	11.4	5.0	1.0	0.1	0.2	0.4
	S.D.	2.4	4.0	1.1	0.9	0.1	0.1	0.1
11	13	82.0	6.1	5.5	5.4	0.5	0.3	0.2
	14	67.9	8.6	13.1	0.9	1.0	0.4	8.1
	15	77.8	6.8	8.4	5.1	1.0	0.5	0.4
	$\bar{x}$	75.9	7.2	9.0	3.8	0.8	0.4	2.9
	S.D.	7.2	1.3	3.8	2.5	0.3	0.1	4.5

APPENDIX III TABLE 2 PERCENT SEDIMENT SIZE DISTRIBUTION FOR AUGUST 21-22, 1985 (continued)
NOTE: No Particle Size Results For Stations 1, 2, 3 and 4.

		SIZE RANGE (mm)						
STATION	SAMPLE NUMBER	>2.0	2.0-1.0	01.0-0.5	0.5-0.25	0.25-0.15	0.15-0.063	<0.063
7	1	75.4	6.3	10.8	6.3	0.5	0.4	0.3
	2	55.8	6.7	20.5	14.6	1.0	0.6	0.8
	3	59.5	4.5	19.0	14.1	1.1	0.9	0.9
	$\bar{x}$	63.6	5.8	16.8	11.7	0.9	0.6	0.7
	S.D.	10.4	1.2	5.2	4.7	0.3	0.3	0.3
8	4	83.0	5.4	3.6	4.0	1.4	1.2	1.4
	5	78.2	4.4	3.5	2.8	2.4	4.3	4.4
	6	0.3	5.7	4.0	4.9	1.7	1.6	1.8
	$\bar{x}$	80.5	5.2	3.7	3.9	1.8	2.4	1.5
	S.D.	2.4	0.7	0.3	1.1	0.5	1.7	1.6
9	7	86.3	6.1	4.3	1.8	0.3	0.4	0.8
	8	85.0	5.6	5.2	3.1	0.4	0.4	0.3
	9	87.8	5.3	3.5	2.1	0.3	0.4	0.6
	$\bar{x}$	86.4	5.7	4.3	2.3	0.3	0.4	0.6
	S.D.	1.4	0.4	0.9	0.7	0.1	0.0	0.3
10	10	74.9	15.7	7.6	0.9	0.2	0.2	0.5
	11	76.5	15.0	7.0	0.6	0.2	0.3	0.4
	12	3.9	18.3	6.7	0.5	0.1	0.2	0.3
	$\bar{x}$	75.1	16.3	7.1	0.7	0.2	0.2	0.4
	S.D.	1.3	1.7	0.5	0.2	0.1	0.1	0.1
11	13	69.7	11.0	14.1	3.9	0.6	0.4	0.3
	14	69.1	14.1	9.9	4.9	0.7	0.6	0.7
	15	75.4	9.5	8.0	6.1	0.6	0.2	0.2
	$\bar{x}$	71.4	11.5	10.7	5.0	0.6	0.4	0.4
	S.D.	3.5	2.3	3.1	1.1	0.1	0.2	0.3

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985

STATION NUMBER	SAMPLE NUMBER	Al (mg/kg)	As (mg/kg)	Ba (mg/Kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
1	1	10100	72	467	<2	19700	14.1	16.9	60.1	42.2	30400	8520	2760
	2	8720	70	393	<2	18800	10.5	12.8	27.9	37.2	28400	8350	2990
	3	9160	82	511	<2	16800	20.0	19.5	33.0	41.0	31400	8180	1990
	$\bar{x}$	9330	75	457	<2	18430	14.9	16.4	40.3	40.1	30100	8350	2580
	S.D.	705	6	60	0	1480	4.8	3.4	17.3	2.6	1530	170	524
2	4	5500	1730	140	<2	7260	130	3.0	16.0	121	116000	5720	<0.2
	5	6480	1520	178	<2	7440	123	7.2	17.7	112	102000	5660	<0.2
	6	5170	1900	126	<2	7300	124	7.8	16.3	126	125000	5880	<0.2
	$\bar{x}$	5720	1720	148	<2	7330	126	6.0	16.7	120	114000	5750	<0.2
	S.D.	681	190	27	0	95	3.8	2.6	0.9	7.1	11600	114	0
3	7	10900	<8	199	<2	12200	0.8	9.0	23.2	24.4	26300	8420	604
	8	10800	<8	202	<2	13800	0.6	8.4	23.7	23.2	25400	9070	556
	9	11500	<8	215	<2	13600	0.4	7.8	25.4	26.6	26600	8880	594
	$\bar{x}$	11100	<8	205	<2	13200	0.6	8.4	24.1	24.7	26100	8790	585
	S.D.	379	0	9	0	872	0.2	0.6	1.2	1.7	624	334	25

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985 (continued)

STATION NUMBER	SAMPLE NUMBER	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
4	10	10200	174	216	<2	15400	24.8	8.2	23.4	42.6	34900	9800	3130
	11	10800	188	228	<2	10500	28.3	9.3	24.6	44.5	36000	6770	3120
	12	9930	163	231	<2	8670	27.4	14.4	25.0	64.4	31600	5640	3170
	$\bar{x}$	10310	175	225	<2	11500	26.8	10.6	24.3	50.5	34200	7400	3140
	S.D.	445	13	8	0	3480	1.8	3.3	0.8	12.1	2290	2150	26
7	19	6510	242	331	<.2	7010	84.6	14.7	22.8	136	45000	3990	<.2
	20	6940	267	309	<.2	8020	82.7	11.3	21.8	134	48800	4340	<.2
	21	4670	197	275	<.2	5260	72.3	14.5	18.7	112	38300	2830	<.2
	$\bar{x}$	6040	235	305	<.2	6760	79.9	13.5	21.1	127	44000	3720	<.2
	S.D.	1210	35	28	0	1400	6.6	1.9	2.1	13.3	5320	790	0
8	22	9460	9	194	<.2	10700	5.2	8.4	26.3	29.6	22900	6110	1670
	23	8720	51	284	<.2	10800	14.7	12.3	24.6	33.1	24600	6910	2630
	24	6100	22	186	<.2	6640	7.4	9.0	24.0	22.6	17300	4710	2340
	$\bar{x}$	8100	27	221	<.2	9380	9.1	9.9	25.0	28.4	21600	5910	2210
	S.D.	1760	22	54	0	2370	5.0	2.1	1.2	5.3	3820	1110	492

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985 (continued)

STATION NUMBER	SAMPLE NUMBER	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
9	25	6280	230	1560	<.2	8430	49.7	15.1	21.8	145.0	39800	4310	<.2
	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	27	4870	275	346	<.2	5720	63.6	7.4	19.7	156.0	45800	3620	488
	$\bar{x}$	5575	253	953	<0.2	7080	56.7	11.3	20.8	151	42800	3965	<488
	S.D.	—	—	—	—	—	—	—	—	—	—	—	—
10	28	9500	77	365	<.2	10700	9.5	13.5	26.7	47.3	28200	7480	2670
	29	8210	53	245	<.2	5770	6.6	9.9	27.1	36.5	24200	4780	2260
	30	8540	79	226	<.2	12500	13.2	9.5	35.6	32.6	24700	8340	2680
	$\bar{x}$	8750	70	279	<0.2	9660	9.8	11.0	29.8	38.8	25700	6870	2540
	S.D.	670	14	75	0	3484	3.3	2.2	5.0	7.6	2180	1860	240
11	31	7330	89	105	<.2	3070	1.3	15.0	26.6	23.9	26700	3100	583
	32	7310	86	95	<.2	3150	0.3	16.0	29.4	22.3	30100	3150	509
	33	7320	82	74	<.2	2650	0.5	16.4	23.7	22.8	27100	3030	465
	$\bar{x}$	7320	86	91	<.2	2960	0.7	15.5	26.7	23	28000	3090	519
	S.D.	10	4	16	0	269	0.5	0.9	2.9	0.8	1860	60	60

N/A - Not available

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985 (continued)

STATION NUMBER	SAMPLE NUMBER	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
1	1	13.2	285	83	1520	204	60	<2	56.2	780	44.4	2190
	2	6.0	180	55	1220	178	60	<2	47.4	710	39.4	1730
	3	9.8	180	90	1120	260	60	<2	46.9	582	40.6	3580
	$\bar{x}$	9.7	215	76	1290	214	60	<2	50.2	691	41	2500
	S.D.	3.6	61	19	208	42	0	0	5.2	100	3	963
2	4	25.2	125	11	702	7160	70	<2	19.0	270	33.1	7860
	5	21.4	130	16	768	6300	80	<2	21.6	287	33.8	7640
	6	29.2	115	11	684	8220	60	<2	18.9	248	33.4	7600
	$\bar{x}$	25.3	123	13	718	7230	70	<2	19.8	268	33	7700
	S.D.	3.9	8	3	44	962	10	0	1.5	20	0	140
3	7	5.3	285	28	1050	37	60	2	40.2	692	46.0	169
	8	4.6	255	27	1060	19	70	<2	42.1	740	45.4	144
	9	4.1	265	30	1120	19	60	2	44.0	770	48.2	155
	$\bar{x}$	4.7	268	28	1080	25	63	<2	42.1	734	47	156
	S.D.	0.6	15	2	38	10	6	0	1.9	39	1	13

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985 (continued)

STATION NUMBER	SAMPLE NUMBER	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
4	10	7.2	220	30	972	929	60	2	36.0	520	39.3	1600
	11	6.6	215	32	995	1090	60	6	38.9	574	42.7	1730
	12	7.9	190	35	1010	1010	70	9	33.9	523	38.1	1670
	$\bar{x}$	7.2	208	32	992	1010	63	6	36.3	539	40	1670
	S.D.	0.7	16	3	19	81	6	4	2.5	30	2	65
7	19	<.8	180	49	505	4420	800	27	29.1	346	28.2	5080
	20	<.8	170	51	549	4350	810	11	31.0	385	31.4	5070
	21	<.8	120	38	388	3480	480	3	22.5	306	22.7	4610
	$\bar{x}$	<0.8	157	46	481	4080	697	14	27.5	345	27	4920
	S.D.	0	32	7	83	524	188	12	4.5	39	4	269
8	22	<.8	340	25	672	258	700	8	28.3	1200	49.6	390
	23	<.8	230	24	776	424	740	<2	28.6	813	39.1	798
	24	<.8	170	20	554	228	740	8	20.1	568	26.9	419
	$\bar{x}$	<0.8	247	23	667	303	727	<8	25.7	860	39	536
	S.D.	0	86	3	111	106	23	0	4.8	319	11	228

APPENDIX III TABLE 3 SEDIMENT METALS ANALYSIS FOR JULY 9-10, 1985

STATION NUMBER	SAMPLE NUMBER	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
9	25	<.8	190	50	610	4730	560	<2	34.1	478	30.3	3300
	26	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	27	<.8	120	22	501	9120	770	13	19.1	284	23.0	3390
	$\bar{x}$	<0.8	155	36	556	6920	665	<13	26.6	381	27	3340
	S.D.	—	—	—	—	—	—	—	—	—	—	—
10	28	<.8	360	40	959	393	650	25	33.5	623	38.3	695
	29	<.8	270	32	761	349	800	29	26.0	589	33.6	498
	30	<.8	190	37	695	716	810	24	30.9	574	34.8	852
	$\bar{x}$	<0.8	273	36	805	486	753	26	30.1	595	36.0	682
	S.D.	0	85	4	137	200	90	3	3.8	25	2.0	177
11	31	<.8	220	25	516	99	740	35	25.0	483	30.5	122
	32	<.8	160	27	569	34	830	<2	26.7	518	35.6	85.4
	33	<.8	180	25	476	47	810	15	23.5	448	28.0	88.8
	$\bar{x}$	<0.8	187	26	520	60	793	<20	25.1	483	31.0	99.0
	S.D.	0	31	1	47	34	47	18	1.6	35	4.0	20.0

N/A - Not available

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22

STATION	SAMPLE #	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
1	1	6860	49	286	<2	17900	5.8	10.6	19.6	40.9	28700	8190	2830
	2	7150	69	468	<2	16300	15.8	18.7	25.9	40.4	28900	7900	1670
	3	7510	79	395	<2	17100	15.9	17.9	24.0	48.0	31300	8390	1760
	$\bar{x}$	7170	66	383	<2	17100	12.5	15.7	23.2	43.1	29600	8160	2090
	S.D.	326	15	92	0	800	5.8	4.5	3.2	4.3	1450	246	645
2	4	7340	1030	186	<2	7440	93.9	14.9	16.2	90.8	73500	5760	230
	5	7640	1040	183	<2	7340	95.4	9.2	15.9	95.4	78900	6040	7
	6	8440	963	201	<2	8260	99.5	8.8	17.4	94.0	72400	6110	163
	$\bar{x}$	7810	1010	190	<2	7680	96.3	11.0	16.5	93.4	74900	5970	133
	S.D.	569	42	10	0	505	2.9	3.4	0.8	2.4	3480	185	114
3	7	10300	<8	226	<2	9390	1.0	10.0	20.2	25.8	31500	7030	612
	8	9570	<8	198	<2	9920	<.3	1.6	18.6	21.4	23900	7550	456
	9	9620	<8	170	<2	10100	0.9	7.1	19.4	24.6	23500	7670	424
	$\bar{x}$	9830	<8	198	<2	9800	0.6	6.2	19.4	23.9	26300	7420	497
	S.D.	408	0	28	0	369	0.6	4.3	0.8	2.3	4510	340	101

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22 (continued)

STATION	SAMPLE #	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
4	10	9790	126	177	<2	9190	14.3	8.3	18.9	33.1	30600	6760	3020
	11	10900	143	266	<2	10200	19.6	8.9	21.6	46.2	36400	7040	2900
	12	9630	27	225	<2	11000	6.5	10.1	20.3	26.9	28300	7850	1730
	$\bar{x}$	10100	99	223	<2	10100	13.5	9.1	20.3	35.4	31800	7220	2550
	S.D.	692	63	45	0	907	6.6	1.9	1.4	9.9	4170	566	713
7	19	6170	291	376	<2	10200	99.9	16.4	21.8	156.0	49800	500	<.2
	20	5620	278	348	<2	7340	87.6	13.0	23.1	149.0	51900	3690	<.2
	21	7410	387	521	<2	10800	123.0	24.2	24.7	179.0	56200	4500	<.2
	$\bar{x}$	6400	319	415	<2	9450	104	17.9	23.2	161.3	52600	2900	<0.2
	S.D.	917	60	93	0	1850	18.0	5.7	1.5	15.7	3260	2120	0
8	22	7260	119	116	<2	10100	31.0	9.0	18.4	34.6	31600	6760	2 130
	23	7550	78	105	<2	7100	29.6	8.1	17.7	36.5	22600	5050	2530
	24	7840	110	125	<2	8880	26.6	7.6	20.1	36.2	28600	6150	2400
	$\bar{x}$	7550	102	115	<2	8690	29.1	8.2	18.7	35.8	27600	5990	2350
	S.D.	290	22	10	0	1510	2.2	0.7	1.2	1.0	4580	867	204

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22 (continued)

STATION	SAMPLE #	Al (mg/kg)	As (mg/kg)	Ba (mg/kg)	Be (mg/kg)	Ca (mg/kg)	Cd (mg/kg)	Co (mg/kg)	Cr (mg/kg)	Cu (mg/kg)	Fe (mg/kg)	Mg (mg/kg)	Mn (mg/kg)
9	25	7520	106	797	<2	33900	54.9	18.8	23.9	85.8	24700	20200	627
	26	5070	117	814	<2	7740	48.4	13.2	28.6	132.0	35800	3980	<.2
	27	8480	173	1080	<2	10600	85.0	23.2	26.6	132.0	32900	5360	<.2
	$\bar{x}$	7020	132	897	<2	17400	62.8	18.4	26.4	117	31100	9850	<627
	S.D.	1760	36	159	0	14300	19.5	5.0	2.4	26.7	5750	8990	0
10	28	11100	67	392	<2	7830	11.2	11.7	34.7	47.9	38100	6690	2610
	29	6970	85	288	<2	4740	7.6	9.6	23.0	47.8	27600	3510	2520
	30	8810	78	333	<2	6620	8.0	9.0	34.1	56.1	30200	5010	2730
	$\bar{x}$	8960	77	338	<2	6400	8.9	10.1	30.6	50.6	32000	5070	2620
	S.D.	2070	9	52	0	1560	2.0	1.4	6.6	4.8	5470	1590	105
11	31	7750	88	122	<2	2950	0.7	9.4	24.8	27.8	26700	3120	505
	32	8330	93	129	<2	3560	1.1	13.2	34.2	30.4	29700	3300	875
	33	7500	81	93	<2	3420	0.5	9.8	32.4	26.4	33300	3110	503
	$\bar{x}$	7860	87	115	<2	3310	0.8	10.8	30.5	28.2	29900	3177	628
	S.D.	426	6	19	0	320	0.3	2.1	5.0	2.0	3310	107	214

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22 (continued)

STATION	SAMPLE #	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
1	1	<0.8	130	42	1160	68	460	<2	45.3	520	35.5	1180
	2	<0.8	140	69	1190	224	690	<2	47.5	506	34.1	2990
	3	<0.8	120	67	1050	154	770	<2	48.8	500	33.8	2800
	$\bar{x}$	<0.8	130	59	1130	149	640	<2	47.2	509	34.5	2320
	S.D.	0.0	10	15	74	78	161	0	1.8	10	0.9	995
2	4	<0.8	100	29	871	4090	800	<2	24.1	234	32.9	5940
	5	<0.8	110	25	861	4320	520	<2	24.0	247	34.4	5920
	6	<0.8	120	34	888	3710	660	<2	27.4	245	34.4	6430
	$\bar{x}$	<0.8	110	29	873	4040	660	<2	25.2	242	33.9	6100
	S.D.	0.0	10	5	14	308	140	0	1.9	7	0.9	289
3	7	<0.8	210	31	1080	37	500	3	35.5	497	43.4	201
	8	<0.8	180	27	1110	14	460	<2	36.6	511	40.6	137
	9	<0.8	160	29	1090	20	230	<2	34.6	471	39.5	168
	$\bar{x}$	<0.8	183	29	1090	24	397	<3	35.6	493	41.2	169
	S.D.	0.0	25	2	15	12	146	2	1.0	20	2.0	32

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22

STATION	SAMPLE #	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
4	10	<0.8	160	30	1000	538	350	<2	34.0	396	38.1	1060
	11	<0.8	190	35	1060	753	530	<2	40.2	396	42.7	1480
	12	<0.8	170	30	1130	98	460	<2	36.8	533	43.1	633
	$\bar{x}$	<0.8	173	32	1063	463	447	<2	37.0	442	41.3	1060
	S.D.	0.0	15	3	65	334	91	0	3.1	79	2.8	424
7	19	<0.8	140	56	490	4810	890	11	38.6	338	28.9	6010
	20	<0.8	120	48	484	4660	800	32	33.4	278	27.0	5500
	21	<0.8	180	79	550	5720	1140	7	52.0	284	30.9	8090
	$\bar{x}$	<0.8	147	61	508	5060	943	17	41.3	300	28.9	6530
	S.D.	0.0	31	16	36	574	176	13	9.6	33	2.0	1370
8	22	<0.8	180	20	719	804	750	6	23.7	753	35.1	1940
	23	<0.8	180	18	704	1010	740	<2	21.7	636	33.4	1820
	24	<0.8	190	25	748	816	660	11	25.9	660	36.0	1730
	$\bar{x}$	<0.8	183	21	724	877	717	9	23.8	683	34.8	1830
	S.D.	0.0	6	4	22	116	49	6	2.1	62	1.3	105

APPENDIX III TABLE 4 SEDIMENT METALS ANALYSIS FOR AUGUST 21 - 22

STATION	SAMPLE #	Mo (mg/kg)	Na (mg/kg)	Ni (mg/kg)	P (mg/kg)	Pb (mg/kg)	Si (mg/kg)	Sn (mg/kg)	Sr (mg/kg)	Ti (mg/kg)	V (mg/kg)	Zn (mg/kg)
9	25	<0.8	210	61	683	2290	900	8	37.6	538	32.6	3110
	26	<0.8	150	58	507	5270	600	34	28.7	556	30.4	2750
	27	<0.8	190	82	717	3610	750	16	37.8	534	36.2	4280
	$\bar{x}$	<0.8	183	67	636	3720	750	19	34.7	543	33.1	3380
	S.D.	0.0	31	13	113	1490	150	13	5.2	12	2.9	800
10	28	<0.8	230	53	1050	282	1000	25	33.2	552	38.0	764
	29	<0.8	210	41	971	198	810	27	25.6	360	30.7	522
	30	<0.8	230	43	927	246	820	25	29.9	621	44.0	639
	$\bar{x}$	<0.8	223	46	983	242	877	26	29.6	511	37.6	642
	S.D.	0.0	12	6	62	42	107	1	3.8	135	6.7	121
11	31	<0.8	220	30	494	41	890	9	24.9	509	29.2	105
	32	<0.8	180	30	585	73	900	16	29	573	37.1	151
	33	<0.8	180	26	613	43	900	6	27.4	721	44.8	93
	$\bar{x}$	<0.8	193	29	564	52	897	10	27.1	601	37.0	116
		0.0	23	2	62	18	6	5	2.1	109	7.8	31

APPENDIX IV

BOTTOM FAUNA DATA

APPENDIX IV TABLE 1 TAXANOMIC LIST OF BOTTOM FAUNA

NUMBER		INVERTEBRATE
1	Order:	Acari
	Class:	Insecta
2	Family:	Aphididae, unid, nymph
3	Order:	Coleoptera, unid., larva
4	Family:	Haliplidae, unid., adult
	Order:	Hymenoptera
5	Family:	Formicidae
	Order:	Ephemeroptera
	Family:	Baetidae
6		Baetis sp.
	Family:	Heptageniidae
7		Rithrogena sp.
8		Cinygmula sp.
	Family:	Leptophlebiidae
	Family:	Ephemerellidae
9		Ephemerella sp. unid., damaged
10		Ephemerella (drunella)
11		Ephemerella doddsi
12		Ephemerella infrequens
	Family:	Siphlonuridae
13		Ameletus sp.
	Order:	Plecoptera
	Family:	Pteronarcidae
14		Pteronarcys dorsata
15		Pteronarcys californica
16		Pteronarcys regularis
	Family:	Perlidae
17		Acroneuria sp.
	Family:	Perlodidae
18		Cultus sp.
19		Arcynopteryx (compacta)
20		Isoperla sp.

APPENDIX IV TABLE 1 TAXANOMIC LIST OF BOTTOM FAUNA

NUMBER		INVERTEBRATE
21	Family:	Chloroperlidae
		Alloperla sp.
22		Utaperla sp.
23	Family:	Capniidae, unid.
	Family:	Nemouridae
24		Zapada (oregonensis)
25		Podmosta sp.
26		Malenka sp.
	Order:	Trichoptera
27		Trichoptera pupa, unid.
	Family:	Hydropsychidae
28		Arctopsyche sp.
	Family:	Hydroptilidae
29		Oxyethira sp.
30		Hydroptila sp.
	Family:	Brachycentridae
31		Brachycentrus sp.
	Family:	Limnephilidae
32		(Clostoeca) sp.
33		Onocosmoecus sp.
34		Rhyaccophila (acropedes)
35		Rhyaccophila vaccua
	Order:	Diptera
	Family:	Simulidae
36	Family:	Simulidae, adult, dam.
37		Simulium sp. pupae
38		Simulium sp. larvae
39	Family:	Chironomidae, adult
40		Chironomidae pupae
	Subfamily:	Orthocladiinae

APPENDIX IV TABLE 1 TAXANOMIC LIST OF BOTTOM FAUNA

NUMBER		INVERTEBRATE
41		*Cricotopus* sp.
42		*Heterotrissocladius* sp.
43		*Cardiocladius* sp.
44		*Eukiefferiella* sp.
45		*Diplocladius* sp.
46		*Brillia* sp.
	Subfamily:	Chironominae
47		*Micropsectra* sp.
48		*Rheotanytarsus* sp.
49		*Stenochironomus* sp.
	Subfamily:	Diamesinae
50		*Diamesa* sp.
51		*Procladius* sp.
	Family:	Tipulidae
52		Tipulidae pupae
53		*Tipula* sp.
	Family:	Psychodidae
54		*Psychoda* sp.
	Family:	Empididae
55		*Chelifera* sp.
56	Phylum:	Nematoda
	Phylum:	Annelida
	Class:	Oligochaeta
57	Family:	Enchytraeidae
58	Family:	Tubificidae, unid., uv.
59		*Tubifex* sp.
	Order:	Lumbriculida
	Family:	Lumbriculidae
60		*Kincaidiana hexatheca*

APPENDIX IV TABLE 1 TAXANOMIC LIST OF BOTTOM FAUNA

NUMBER		INVERTEBRATE
	Phylum:	Mollusca
	Order:	Gastropoda
	Family:	Lymnaeidae
61		*Stagnicola* *(kennicotti)*
	Family:	Valvatidae
62		*Valvata* *sincera*
	Family:	Coelenterata
63		*Hydra* sp.
	Phylum:	Copepoda
	Suborder:	Calanoida
64		*Diaptomus* sp.
65	Suborder:	Cyclopoida
	Order:	Amphipoda
	Suborder:	Haustoridae
66		*Pontoporela* sp.
67	Order:	Arachnida

APPENDIX IV TABLE 2 INVERTEBRATE DISTRIBUTION

NUMBER		INVERTEBRATE	STA.1	% of Total	STA.2	% of Total	STA.3	% of Total	STA.4	% of Total	STA.7	% of Total
1	Order:	Acari	3	0.5		0.0	1	0.1	1	0.5		0.0
2	Family:	Aphididae, unid, nymph		0.0		0.0		0.0		0.0	2	2.1
3	Order:	Coleoptera, unid., larva		0.0		0.0		0.0	4	1.9		0.0
4	Family:	Haliplidae, unid., adult		0.0		0.0		0.0		0.0		0.0
5	Family:	Formicidae		0.0	1	1.1		0.0		0.0		0.0
6		Baetis sp.	2	0.3		0.0	9	1.3	7	3.4		0.0
7		Rithrogena sp.		0.0		0.0	11	1.6	1	0.5		0.0
8		Cinygmula sp.		0.0		0.0	4	0.6	1	0.5		0.0
9		Ephemerella sp. unid., dam.		0.0		0.0		0.0		0.0		0.0
10		Ephemerella (Drunella)		0.0		0.0		0.0	1	0.5	1	1.1
11		Ephemerella doddsi		0.0		0.0		0.0		0.0		0.0
12		Ephemerella infrequens		0.0		0.0	8	1.2	11	5.3		0.0
13		Ameletus sp.	3	0.5		0.0		0.0		0.0		0.0
14		Pteronarcys dorsata		0.0		0.0		0.0	1	0.5		0.0
15		Pteronarcys californica		0.0		0.0	5	0.7	5	2.4		0.0
16		Pteronarcys regularis		0.0		0.0		0.0	1	0.5		0.0
17		Acroneuria sp.		0.0		0.0	26	3.8	32	15.5		0.0
18		Cultus sp.		0.0		0.0	1	0.1		0.0		0.0
19		Arcynopteryx (compacta)	4	0.6	3	3.3		0.0	4	1.9		0.0
20		Isoperla sp.		0.0		0.0		0.0		0.0		0.0
21	Family:	Alloperla sp.		0.0		0.0		0.0	16	7.8		0.0
22		Utaperla sp.	1	0.2		0.0	3	0.4	13	6.3		0.0
23	Family:	Capniidae, unid.	5	0.8	7	7.8		0.0	1	0.5	7	7.4
24		Zapada (oregonensis)	49	7.5	3	3.3	20	2.9	23	11.2		0.0
25		Podmosta sp.	7	1.1		0.0	1	0.1		0.0	32	33.7
26		Malenka sp.		0.0		0.0	8	1.2	38	18.4		0.0
27		Trichoptera pupa, unid.	2	0.2		0.0		0.0		0.0		0.0
26		Arctopsyche sp.	1	0.2		0.0	44	6.4	22	10.7	11	11.6
29		Oxyethira sp.	1	0.2		0.0		0.0		0.0		0.0
30		Hydroptila sp.		0.0		0.0		0.0		0.0		0.0
31		Brachycentrus sp.		0.0		0.0	1	0.1		0.0		0.0
32		(Clostoeca) sp.	4	0.6	2	2.2		0.0		0.0		0.0
33		Onocosmoecus sp.		0.0		0.0		0.0		0.0		0.0
34		Rhyaccophila (acropedes)	1	0.2		0.0	4	0.6	6	2.9		0.0
35		Rhyaccophila vaccua	1	0.2		0.0		0.0		0.0		0.0
36	Family:	Simulidae, adult, dam.		0.0		0.0		0.0		0.0		0.0
37		Simulium sp. pupae	93	14.2	1	1.1	347	50.8	2	1.0	4	4.2
38		Simulium sp. larvae	144	22.0	10	11.1	169	24.7	9	4.4	9	9.5
39	Family:	Chironomidae, adult		0.0		0.0	1	0.1		0.0		0.0
40		Chironomidae pupae	30	4.6	9	10.0		0.0	1	0.5	6	6.3

APPENDIX IV TABLE 2 INVERTEBRATE DISTRIBUTION

NUMBER		INVERTEBRATE	STA.8	% of Total	STA.9	% of Total	STA.10	% of Total	STA.11	% of Total
1	Order:	Acari		0.0		0.0	1	0.4		0.0
2	Family:	Aphididae, unid, nymph		0.0		0.0		0.0		0.0
3	Order:	Coleoptera, unid., larva		0.0		0.0		0.0		0.0
4	Family:	Haliplidae, unid., adult		0.0	1	0.1		0.0		0.0
5	Family:	Formicidae		0.0		0.0		0.0		0.0
6		Baetis sp.	8	5.7	4	0.3	10	4.2	8	1.6
7		Rithrogena sp.	5	3.6	1	0.1		0.0	2	0.4
8		Cinygmula sp.		0.0		0.0		0.0		0.0
9		Ephemerella sp. unid., dam.		0.0		0.0		0.0	2	0.4
10		Ephemerella (Drunella)	4	2.9	3	0.2	1	0.4	10	2.0
11		Ephemerella doddsi		0.0		0.0		0.0	3	0.6
12		Ephemerella infrequens	5	3.6	12	0.8		0.0		0.0
13		Ameletus sp.		0.0		0.0		0.0		0.0
14		Pteronarcys dorsata	5	3.6	10	0.7		0.0		0.0
15		Pteronarcys californica		0.0		0.0		0.0		0.0
16		Pteronarcys regularis	4	2.9	12	0.8		0.0	9	1.8
17		Acroneuria sp.	21	15.0	12	0.8	1	0.4	18	3.6
18		Cultus sp.		0.0		0.0		0.0		0.0
19		Arcynopteryx (compacta)	2	1.4	4	0.3	2	0.8	2	0.4
20		Isoperla sp.		0.0		0.0		0.0	6	1.2
21		Alloperla sp.		0.0	1	0.1	10	4.2	34	0.0
22		Utaperla sp.		0.0		0.0		0.0		0.0
23		Capniidae, unid.		0.0		0.0		0.0		0.0
24		Zapada (oregonensis)		0.0	1	0.1		0.0	34	6.8
25		Podmosta sp.		0.0	2	0.1		0.0		0.0
26		Malenka sp.	4	2.9	4	0.3	1	0.4	45	9.0
27		Trichoptera pupa, unid.		0.0		0.0		0.0		0.0
28		Arctopsyche sp.	30	21.4	36	2.4	7	3.0	13	2.6
29		Oxyethira sp.		0.0		0.0		0.0		0.0
30		Hydroptila sp.		0.0		0.0	2	0.8	1	0.2
31		Brachycentrus sp.		0.0		0.0	2	0.8	1	0.2
32		(Clostoeca) sp.		0.0	1	0.1		0.0		0.0
33		Onocosmoecus sp.	1	0.7		0.0		0.0		0.0
34		Rhyaccophila (acropedes)	1	0.7	1	0.1		0.0		0.0
35		Rhyaccophila vaccua		0.0		0.0		0.0		0.0
36	Family:	Simulidae, adult, dam.		0.0		0.0	1	0.4		0.0
37		Simulium sp. pupae	1	0.7	15	1.0		0.0	13	2.6
38		Simulium sp. larvae	42	30.0	1347	90.3	2	0.8	312	62.4
39	Family:	Chironomidae, adult		0.0	1	0.1		0.0		0.0
40		Chironomidae pupae	1	0.7	3	0.2	2	0.8	2	0.4

* Station 10 samples collected with Surber Sampler.

APPENDIX IV TABLE 2 INVERTEBRATE DISTRIBUTION

NUMBER		INVERTEBRATE	STA.1	% of Total	STA.2	% of Total	STA.3	% of Total	STA.4	% of Total	STA.7	% of Total
41		Cricotopus sp.	94	14.4	19	21.1	1	0.1	1	0.5	13	13.7
42		Heterotrissocladius sp.		0.0	10	11.1		0.0	1	0.5	5	5.3
43		Cardiocladius sp.	2	0.3	2	2.2	1	0.1	2	1.0		0.0
44		Eukiefferiella sp.	39	6.0		0.0		0.0		0.0		0.0
45		Diplocladius sp.	61	9.3		0.0		0.0		0.0		0.0
46		Brillia sp.	3	0.5	15	16.7		0.0		0.0		0.0
47		Micropsectra sp.		0.0		0.0	1	0.1	1	0.5		0.0
48		Rheotanytarsus sp.		0.0		0.0	1	0.1		0.0		0.0
49		Stenochironomus sp.		0.0		0.0		0.0		0.0		0.0
50		Diamesa sp.	12	1.8		0.0		0.0		0.0		0.0
51		Procladius sp.		0.0		0.0		0.0		0.0	1	0.0
52		Tipulidae pupae	1	0.2		0.0		0.0		0.0		0.0
53		Tipula sp.	7	1.1	1	1.1		0.0		0.0	2	2.1
54		Psychoda sp.		0.0		0.0		0.0		0.0		0.0
55		Chelifera sp.		0.0		0.0		0.0		0.0		0.0
56	Phylum:	Nematoda	4	0.6	1	1.1	3	0.4	1	0.5		0.0
57	Family:	Enchytraeidae	75	11.5	1	1.1	2	0.3		0.0		0.0
58	Family:	Tubificidae, unid., uv.		0.0	1	1.1	5	0.7		0.0		0.0
59		Tubifex sp.		0.0	3	3.3		0.0		0.0		0.0
60		Kincaidiana hexatheca	2	0.3		0.0		0.0		0.0		0.0
61		Stagnicola (kennicotti)		0.0		0.0	6	0.9		0.0		0.0
62		Valvata sincera		0.0		0.0		0.0		0.0		0.0
63		Hydra sp		0.0		0.0		0.0		0.0		0.0
64		Diaptomus sp.	3	0.5		0.0		0.0		0.0		0.0
65	Suborder:	Cyclopoida	1	0.2		0.0		0.0		0.0	1	1.1
66		Pontoporeia sp.	1	0.2		0.0		0.0		0.0		0.0
67	Order:	Arachnida		0.0	1	1.1		0.0		0.0	1	1.11
TOTAL NUMBER PER STATION			655		90		683		206		95	

APPENDIX IV TABLE 2 INVERTEBRATE DISTRIBUTION

NUMBER		INVERTEBRATE	STA.8	% of Total	STA.9	% of Total	STA.10	% of Total	STA.11	% of Total
41		Cricotopus sp.	1	0.7	6	0.4	9	3.8	2	0.4
42		Heterotrissocladius sp.		0.0	8	0.5		0.0	2	0.4
43		Cardiocladius sp.		0.0	4	0.3		0.0	1	0.2
44		Eukiefferiella sp.		0.0		0.0		0.0		0.0
45		Diplocladius sp.		0.0		0.0		0.0		0.0
46		Brillia sp.		0.0		0.0		0.0		0.0
47		Micropsectra sp.	1	0.7		0.0	2	0.8	1	0.2
48		Rheotanytarsus sp.		0.0		0.0		0.0		0.0
49		Stenochironomus sp.		0.0		0.0	1	0.4		0.0
50		Diamesa sp.		0.0		0.0		0.0		0.0
51		Procladius sp.		0.0		0.0		0.0		0.0
52		Tipulidae pupae		0.0		0.0	1	0.4		0.0
53		Tipula sp.		0.0		0.0	2	0.8		0.0
54		Psychoda sp.		0.0	1	0.1	1	0.4	3	0.6
55		Chelifera sp.		0.0		0.0	6	2.5		0.0
56	Phylum:	Nematoda		0.0	2	0.1	5	2.1	4	0.8
57	Family:	Enchytraeidae	1	0.7		0.0	165	69.6	4	0.8
58	Family:	Tubificidae, unid., uv.		0.0		0.0		0.0		0.0
59		Tubifex sp.		0.0		0.0		0.0		0.0
60		Kincaidiana hexatheca		0.0		0.0		0.0		0.0
61		Stagnicola (kennicotti)	2	1.4		0.0		0.0		0.0
62		Valvata sincera	1	0.7		0.0		0.0		0.0
63		Hydra sp		0.0		0.0		0.0	1	0.2
64		Diaptomus sp.		0.0		0.0		0.0		0.0
65	Suborder:	Cyclopoida		0.0		0.0		0.0		0.0
66		Pontoporeia sp.		0.0		0.0		0.0		0.0
67	Order:	Arachnida		0.0		0.0	1	0.4		0.0
TOTAL NUMBER PER STATION			140		1492		237		500	

*Station 10 samples collected with Surber Sampler.