FISHERIES AND ENVIRONMENT CANADA
ENVIRONMENTAL PROTECTION SERVICE
YUKON BRANCH
PACIFIC REGION

ASSESSMENT OF THE WATER QUALITY AND BIOLOGICAL CONDITIONS IN WATERSHEDS SURROUNDING THE UNITED KENO HILL MINE, ELSA, YUKON, DURING THE SUMMERS OF 1974 AND 1975

Regional Program Report: 78-14

by: Environmental Protection Service,
Yukon Branch

June 1978

Errata to be inserted in front of Regional Program Report No. 78-14 entitled United Keno Hill Mines Report which received limited distribution as a form of manuscript report in 1979 by the Environmental Protection Service, Pacific and Yukon Region of Environment Canada.

ERRATA

TABLE 2 WATER CHEMISTRY

Station	Date	Field				Laboratory						
		Temp. °C	Conductivity uh mos/cm	Dissolved Oxygen	pH	pH	NFR	Total Alkalinity	Colour Pt-Co Units	Turbidity FTU	Turbidity JTU	Total Hardness
1	July/74						87.0		5		58.0	820
2	July/74	14.5	310	9.9	6.5		L2.5		45		3.2	240
	June/75	9.5	153	10.2	8.3							
	July/75	15.0	325	8.85	8.05	8.0	8.0	117.8	44	.03		220
3	July/74	17.0	175	10.7	8.1		7.0		10		0.5	110
	June/75	9.0	95	9.5	8.1							
	July/75	18.2	170	7.95	8.1	8.0	23.0	78.2	26	L.01		110
4	July/74	18.0	153	10.9	7.8		L2.5		20		0.7	100
	June/75	9.8	100	10.1	7.9							
	July/75	20.5	165	8.9	8.0	8.0	10.0	73.3	24	L.01		100
5	July/74	10.5	210	10.4	7.4		L2.5		10		0.4	190
	June/75	6.0	135	11.8	8.5							
	July/75	11.3	284	8.2	8.1	8.1	5.0	10.4	12	L0.1		210
6	July/74	3.5	165	4.4	7.4		4.0		20		0.2	130
	June/75	3.5	125	12.2	8.8							
	July/75	3.8	160	10.3	7.9	7.7	8.0	57.4	15	L0.1		180
7	July/74	17.0	242	8.4	7.7		6.0		20		0.9	160
	June/75	7.0	97	10.4	8.8							
	July/75	11.5	420	8.6	7.9	7.7	11.0	79.2	17	0.1		260
8	July/74	6.7	47	11.3	7.2		17.0		10		2.9	23
	June/75	2.0	30	12.3	9.2							
	July/75	8.3	54	11.4	7.7	7.5	12.0	23.8	7	0.2		36
9	July/74	5.2	46	13.1	7.3		L2.5		5		0.2	
	June/75	2.0	30	12.5	8.7							
	July/75	8.3	43	11.6	7.9	7.7	13.0	22.8	6	0.1		35
10	July/74	10.5	226	7.9	7.5		L2.5		40		7.4	290
	June/75	9.0	150	10.0	8.7							
	July/75	15.2	230	-	8.1	8.1	8.0	86.1	29	0.2		120
11	July/74	17.0	380	7.8	7.1		8.0		55		12.0	440
	June/75	10.8	360	0.0	7.7							
	July/75	26.0	950	7.5	9.0	9.0	16.0	80.2	17	0.3		440

L = less than

ERRATA

TABLE 3 EXTRACTABLE METALS (ppm)

Station	Date	Sb	Cd	Cu	Fe	Pb	Ba	Mn	Mo	Ca	Mg	Ni	Ag	Zn	Hg
1	15/07/74		L0.01	L0.01		1.5	(1)	6.1	L0.1	320.0	57.5			1.5	
2	15/07/74		L0.01	L0.02		L0.02	(1)	2.3	L0.1	66.0	17.89			0.73	
	06/06/75	L0.3	0.01	0.20		0.24	0.7		L0.3			L0.1	L0.01	0.77	
	09/07/75	L0.3	L0.01	L0.01	0.34	0.06	(1)		L0.3	60.0	16.00	L0.1	L0.03	0.60	L0.4
3	15/07/74		L0.01	L0.01		L0.02	(1)	0.05	L0.1	27.0	9.10			0.02	
	06/06/75														
	09/06/75	L0.3	L0.10	L0.01	0.34	0.03	(1)		L0.3	30.0	8.10	L0.01	L0.03	0.07	L0.4
4	15/07/74		L0.01	L0.01		L0.02	(1)	0.03	L0.1	26.0	9.17			0.01	
	06/06/75														
	09/07/75	L0.3	L0.10	L0.01	0.18	L0.02	(1)		L0.3	28.0	8.00	L0.1	L0.03	0.01	L0.4
5	15/07/74		L0.01	L0.01		L0.02	(1)	0.04	L0.1	54.0	13.16				0.1
	06/06/75														
	09/07/75	L0.3	L0.01	L0.01	0.13	L0.02	(1)		L0.3	62.0	15.00	L0.1	L0.03	0.16	L0.4
6	15/07/74	L0.3	L0.01	L0.01		L0.02	(1)	0.05	L0.1	48.0	2.90			0.36	0.4
	06/06/75	L0.3	L0.01	L0.01		L0.02	0.08		L0.03			L0.1	L0.01	0.61	
	09/07/75		L0.01	L0.01	0.03	L0.02	(1)		L0.3	52.0	11.00	L0.1	L0.03	0.15	L0.4
7	15/07/74		L0.01	L0.01		L0.02	(1)	0.19	L0.1	60.0	3.20			0.17	
	06/06/75	L0.3	L0.10	L0.01		L0.02	0.18		L0.3			L0.1	L0.01	0.28	
	09/07/75	L0.3	L0.01	L0.01	0.39	L0.02	(1)		L0.3	78.0	16.00	L0.1	L0.03	0.22	L0.4
8	15/07/74		L0.01	L0.01		L0.02	(1)	0.09	L0.1	5.6	2.26			0.02	
	06/06/75														
	09/07/75	L0.3	L0.01	L0.01		L0.02	(1)		L0.3	11.0	2.00	L0.1	L0.03	0.02	L0.4
9	15/07/74		L0.01	L0.01		L0.02	(1)	L0.03	L0.1	8.6	2.01				
	06/06/75														
	09/07/75	L0.3	L0.01	L0.01	0.10	L0.02	(1)		L0.3	11.0	1.90	L0.1	L0.03	0.02	L0.4
10	15/07/74		L0.01	L0.01		L0.02	(1)	1.7	L0.1	59.0	35.00			0.59	
	06/06/75	L0.3	L0.10	L0.10		L0.02	9.01		L0.3			L0.1	L0.01	0.74	
	09/07/75	L0.3	L0.01	L0.01	0.21	L0.01	(1)		L0.3	32.0	9.00	L0.1	L0.03	0.09	
11	15/07/74		0.06	0.60		L0.02	(1)	16.0	L0.1	130.0	28.09			2.00	
	06/06/75	L0.3	0.03	0.19		0.84	0.2		L0.3			L0.1	L0.01	1.90	
	09/07/75	L0.3	0.05	0.22	0.57	0.14	(1)		L0.3	130.0	27.0	L0.1	L0.03	1.60	L0.4

(1) Ca Interference for all samples
L = less than

ABSTRACT

Surveys were conducted during the early summer of 1974 and 1975 at United Keno Hill Mines in the Yukon Territory. The parameters examined included water chemistry, trace metals, benthic species diversity, fish concentrations, and toxicity testing. The results indicated that zinc concentrations as high as 2.0 ppm were present in the waters of Flat Creek below the tailings pond decant, which was well above the Water Use Licence limit of 0.5 ppm. Copper, cadmium, and lead concentrations were found to be above the limits of the licence, intermittently. Benthic species diversity and fish density were reduced in Flat Creek below the tailings pond decant. Bioassay samples collected from the tailings pond decant were found to be toxic on 2 occasions out of 12 sampling times.

RÉSUMÉ

On a étudié les mines de United Keno Hill, dans les Territoires du Nord-Ouest, au début des étés de 1974 et 1975. Les paramètres examinés comprenaient la chimie de l'eau, les éléments oligométalliques, la diversité de la faune benthique, la présence de poisson et la toxicité. Les résultats ont indiqué que les eaux de Flat Creek contenaient jusqu'à 2,0 ppm de zinc en aval de l'étang de décantation des stériles, soit beaucoup plus que ne le permet la limite de 0,5 ppm qu'établit le Permis d'utilisation des eaux. Les concentrations de cuivre, de cadmium et de plomb ne dépassaient les limites permises par le permis qu'occasionnellement. La diversité des espèces benthiques et les populations de poissons se trouvaient réduites en aval de l'étang de décantation. Les échantillons prélevés du bassin de décantation des stériles pour les bio-essais se sont révélés toxiques au cours de deux périodes d'analyse sur 12.

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SUMMARY

1. Levels of zinc were found to be elevated in association with the tailings pond discharge into Flat Creek. The levels ranged from 1.6 - 2.0 ppm in the decant water to 0.74 ppm in the water of the South McQuesten River below its confluence with Flat Creek.

2. Concentrations of cadmium, copper, and lead were found to range intermittently above the allowable concentrations prescribed in the Water Board Licence. Cadmium and copper were found in concentrations of 0.06 and 0.6 ppm, respectively, at the tailings pond decant on July 7, 1974, while lead was found at a concentration of 0.84 ppm at the tailings pond decant on June 6, 1975.

3. A significant reduction in benthic species diversity, as sampled with artificial substrate samplers, was observed to extend down Flat Creek as far as the South McQuesten River.

4. Only one pike (Esox lucius) was caught during the electro-fishing in Flat Creek. This was a significant reduction in fishing success as compared to the other sites fished. Although the concentrations of trace metals in Flat Creek were not toxic, the lack of fishing may have been attributable to avoidance reactions or a decrease in benthic food organisms.

5. Bioassay samples from the tailings pond decant were found to be toxic to fish on two occasions. On July 15, 1974, the 96 hour LC_{50} was 42.5% while on June 6, 1975, the 96 hour LC_{50} was found to be 91%.

1 INTRODUCTION

Surveys were conducted during the early summer of 1974 and 1975 at United Keno Hill Mines in the Yukon Territory. The purpose of the surveys was to establish a baseline of information prior to the issuance of a Water Use Licence under the Northern Inland Waters Act in order to monitor changes in environmental conditions reflected in the routine sampling under the terms of the licence.

1.1 Background (from Sinclair et al, 1976)

"The properties situated mainly on Keno Hill and Galena Hill, are readily accessible by an all-weather road from Mayo, 32 miles to the south. Ore concentrates are trucked 277 miles to Whitehorse, then transferred to the White Pass and Yukon Route and shipped by rail to Skagway.

Silver-bearing galena was first discovered on Galena Creek in 1906 and small tonnages of high-grade ore were shipped from 1913 to 1919. Following the discovery of the No. 9 vein by Louis Beauvette in 1919, which resulted in a stampede, numerous important prospects were located. Since then there has been almost continuous production from veins in the area, except for the period 1942 to 1946.

The area is underlain by graphitic and sericitic schist, phyllite and quartzite which have been divided into three units: a lower schist, a central quartzite, and an upper schist (Units 1, 2 and 3, Boyle, 1965). Formerly considered to be part of the Precambrian Yukon Group metasediments, the lower schist and central quartzite are now considered to be Jurassic and Lower Cretaceous respectively, based on stratigraphic correlations (Tempelman-Kluit, 1970). The age of the upper schist is uncertain. Metadiorite and metagabbro, locally referred to as "greenstone", occurs as conformable lenses and sills in the lower schist and central quartzite. Granite stocks of Cretaceous age outcrop northwest and southeast of Galena and Keno Hills and related quartz-feldspar porphyry dikes are present locally throughout the area.

The metasediments form the southern limb of a large, open anticline and dip gently to the southeast. There are two systems of steeply-dipping faults, one trending northeast and the other northwest.

The ore deposits consist of veins developed in dilatant zones in northeast-trending faults cutting thick-bedded quartzite and greenstone. The principal ore minerals are galena, sphalerite, freibergite and chalcopyrite. Gangue minerals include siderite and pyrite.

In 1975, United Keno Hill Mines Limited operated six mines in the Keno-Galena Hills area with a total production of 90 860 tons of ore averaging 35.0 ounces per ton silver, 4.0 per cent lead and 1.2 per cent zinc. Production was mainly from the Husky Mine, followed by the No Cash and Keno Mines. The Elsa, Townsite and Dixie Mines produced lesser amounts of ore. Development work at the Husky included 511 feet of drifting on the third level, of which 160 feet was in ore. In addition, 356 feet of cross-cutting were completed on the third level to provide diamond drill stations for exploration below the third level. Three minor ore zones were found beneath the bottom of the shaft and studies were underway at the end of the year to determine the feasibility of mining these zones. At the No Cash Mine, development work consisted of 181 feet of cross-cutting and 1386 feet of drifting and sub-drifting which developed 48 feet of ore. Underground development at the Keno Mine, including the Shamrock Project, consisted of 184 feet of cross-cutting and 662 feet of drifting, of which 271 feet were in ore. Several favourable structures were indicated by overburden drilling but the targets are too deep to be explored from surface and underground drifting is required to delineate the targets. At the Elsa Mine, development work consisted of 364 feet of subdrifting on the 500 level, 143 feet of which developed ore. At the end of the year, raising was underway to test a high-grade intersection found above the 200-foot level by overburden drilling. Although some244 feet of

cross-cutting and 206 feet of drifting were completed at the Townsite, this mine was closed in 1975 because of the low grade of the ore. At the Dixie Mine, development work totalled 190 feet of cross-cutting and 432 feet of drifting. Although no ore was developed, the mine is considered to have potential.

United Keno continued its program of overburden drilling on Galena, Keno and Sourdough Hills. In addition to the small ore zone in the Elsa 200 area, the drilling outlined four areas which warrant further work. Surface exploration was also carried out on the KPO-LEO claims optioned from Cima Resources Limited.

The following summary of operations in 1973, 1974 and 1975 is taken from annual reports of the company:

	1975	1974	1973
Tons Milled	90 860	93 232	94 819
Daily Average (tons)	249	255.4	259.8
Mill Heads:			
Silver (oz/ton)	34.96	37.93	34.99
Lead (%)	4.03	4.22	4.04
Zinc (%)	1.15	1.15	0.92
Metal Production:			
Silver (oz/ton)	2 917 920	3 237 205	3 134 828
Lead (lb)	6 407 368	6 737 719	7 262 400
Zinc (lb)	620 763	545 357	1 345 062
Cadmium (lb)	8 758	7 330	17 944
Metal Sales	$15 696 435	$17 480 540	$11 614 473
Ore Reserves (tons)	121 737	105 632	84 500
Silver (oz/tons)	39.3	44.0	47.4
Lead (%)	4.7	4.9	5.8
Zinc (%)	1.1	1.2	1.5

1.2 Study Area

The study area for this program was in the vicinity of Elsa, Y.T. (population 250) which is the center for United Keno Hill Mines' activities. Elsa is located at 63°55' N by 135°29' W (Figure 1). The only other settlement in the study area is Keno City which is practically deserted, having only approximately 10 full-time residents.

Two distinct watersheds were incorporated into the study (Figure 2). The main watershed under consideration was associated with the south McQuesten River and received the decant water from the tailings pond below the mine's milling operation. The other watershed which was examined briefly was the Lightning Creek/Thunder Gulch watershed where a small placer gold mining operation was located.

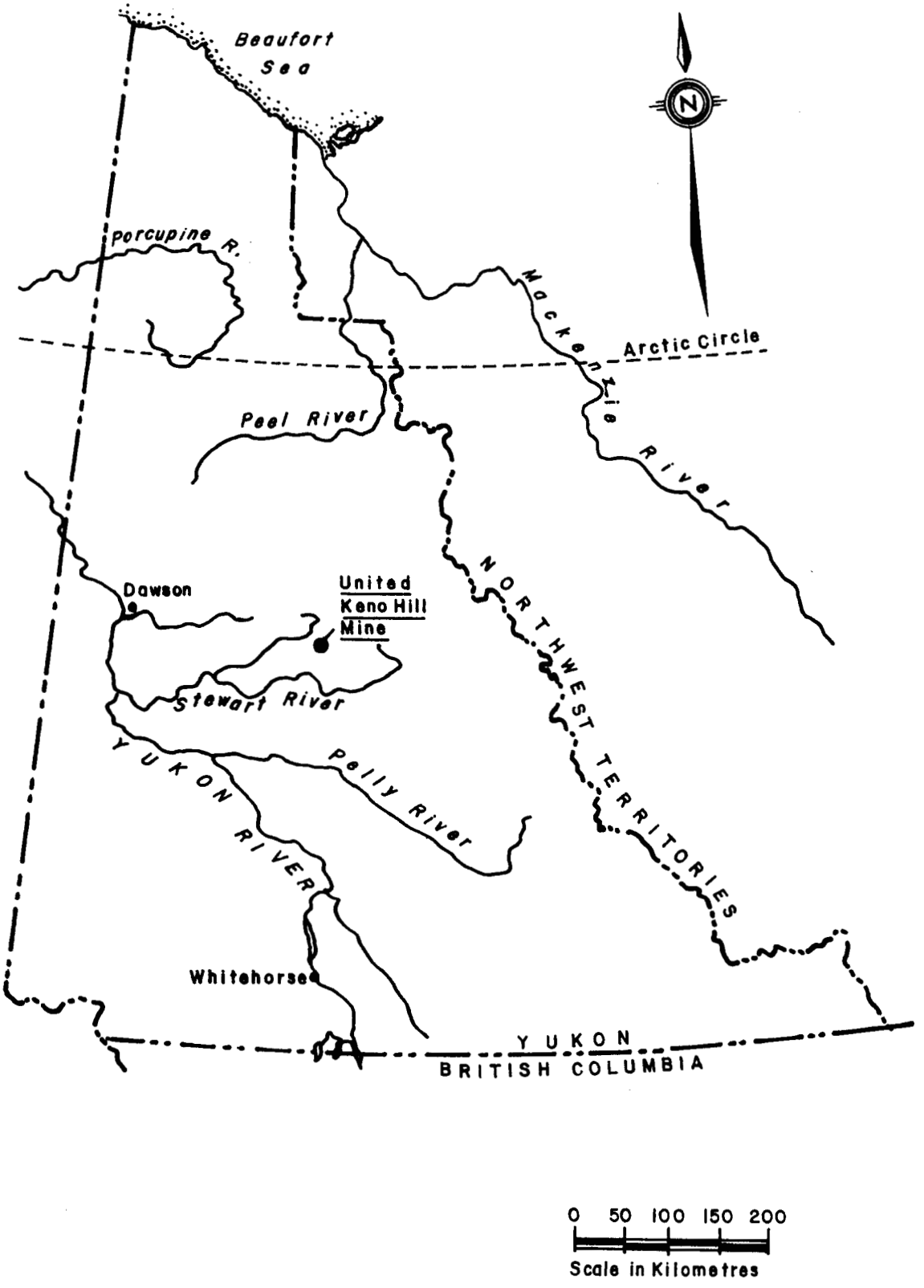

FIGURE 1 LOCATION MAP

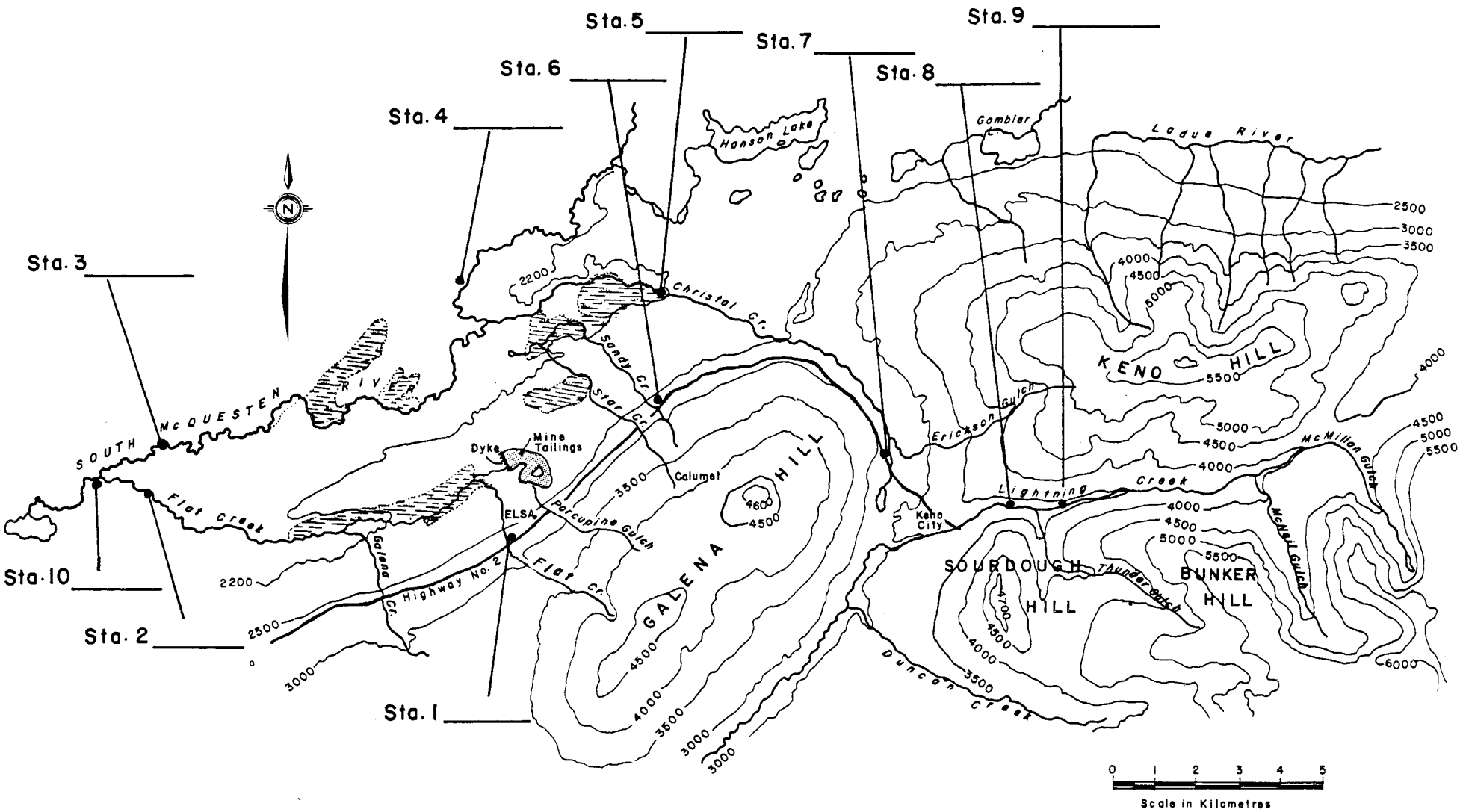

Figure 2: Sample station locations United Keno Hill Mine survey.

2 METHODS AND MATERIALS

Surveys were conducted in the study area on three occasions: July 8-16, 1974; June 5-6, 1975; and July 7-9, 1975. During the 1974 surveys, the 11 stations indicated in Figure 2 were sampled; while in 1975, Station 1 was eliminated from the program. The stations sampled are described in Table 1.

2.1 Water Quality

Water samples for chemical analysis were collected at all of the stations indicated in Table 1. In all cases temperature, conductivity, and pH were measured in the field using a standard centigrade thermometer, a "Yellow Springs Instrument" direct reading salinity - conductivity - temperature meter (C9089-1), and a Model 296 "Radiometer" pH meter, respectively. Samples for dissolved oxygen were fixed immediately with manganous sulphate and axide, and later acidified with sulfuric acid and titrated with sodium thiosulphate within one week, according to the axide modification of the Winkler method (APHA, 1971). Samples were also obtained for analysis for non-filterable residues, turbidity, colour, hardness, and the following extractable metals:

June, 1974	June, 1975*	July, 1975
Cadmium (Cd)	Antimony (Sb)	Antimony (Sb)
Calcium (Ca)	Barium (Ba)	Barium (Ba)
Copper (Cu)	Cadmium (Cd)	Cadmium (Cd)
Magnesium (Mg)	Copper (Cu)	Calcium (Ca)
Manganese (Mn)	Lead (Pb)	Copper (Cu)
Molybdenum (Mo)	Molybdenum (Mo)	Iron (Fe)
Lead (Pb)	Nickel (Ni)	Lead (Pb)
Zinc (Zn)	Silver (Ag)	Magnesium (Mg)
	Zinc (Zn)	Mercury (Hg)
		Molbydenum (Mo)
		Nickel (Ni)
		Silver (Ag)
		Zinc (Zn)

* At Stations 2, 6, 7, 10, and 11

TABLE 1 SAMPLING STATIONS, UNITED KENO HILL MINES LTD.

Station	Location
1	(1974 only) Drainage from the Husky Mine.
2	On Flat Creek, 500 metres above the confluence of the South McQuesten River and Flat Creek.
3	On South McQuesten River, above its confluence with Flat Creek.
4	On South McQuesten River, 1 km above its confluence with Christal Creek.
5	On Christal Creek, at the bridge on the Hanson Lake road.
6	On Sandy Creek, at road culvert 3 km NE of townsite.
7	On Christal Creek, 1 km NW of Keno on road between Elsa and Keno.
8	On Lightning Creek, below unnamed creek used for placer mining.
9	On Lightning Creek, above unnamed creek used for placer mining.
10	On South McQuesten River, below its confluence with Flat Creek.
11	On decant from mill tailings pond.

These samples were collected in acid-washed, polyethylene 1-litre bottles and preserved according to the methods outlined in Environment Canada (1972). They were subsequently transported to the West Vancouver laboratory of the Environmental Protection Service for analysis.

2.2 Benthic Fauna

The benthic fauna of the streams in the study area was sampled in both the 1974 and 1975 surveys. In the 1974 survey, a one square foot (366 cm) circular sample was employed to sample the biota. Triplicate samples were obtained using this apparatus at each of Stations 3, 4, 5, 7, 8, 9, and 10. The fauna contained in the triplicate samples was combined into one composite sample for enumeration.

In the 1975 survey, artificial substrate samplers were used in an attempt to obtain a more representative sample than the circular sampler could provide. The artificial substrate samplers consisted of chrome-plated barbeque chicken baskets (17 cm diameter x 25 cm long) filled with rocks of a uniform size, obtained from the creek bed or nearby floodplain and wiped clean before use. The approximate surface area contained in each basket was 6000 ± 1000 cm^2. These samplers were submerged at each of Stations 2, 3, 4, 5, 7, 8, 9, and 10 for a period of one month, being secured to the bank by means of a rope. Station 6 was also sampled but with a surber sampler rather than an artificial substrate sampler.

Upon collection of the invertebrates, they were preserved in 70% methanol for future sorting and cursory identification at the laboratory in Whitehorse. Final identification and enumeration of the 1974 samples was completed in Whitehorse, while the 1975 samples were identified by the personnel at Envirocon Ltd. of Vancouver, B.C.

Species diversity and evenness indices were calculated for each station using the following formulae (Pielou, 1967):

$$\text{Species Diversity } (H') = \Sigma\ P_i \log P_i$$

where $P_i = n_i/N$

n_i = the number of individuals in the ith species

N = the total number of individuals sampled

$$\text{Evenness } (J) = \frac{\Sigma\ P_i \log P_i}{\log s}$$

where s = the total number of species samples and $J_{max} = 1$

Pielou (1966, 1967).

2.3 Fish

Test fishing with electro-fishing gear was conducted in 1974 and 1975 at Stations 2, 3, 4, 5, 8, 9, and 10 (Station 7 was fished in 1975 only). Test fishing was conducted utilizing a Smith-Root Type VIII Electro Fisher and barrier nets. The barrier nets were placed downstream of the electro-fishing apparatus and approximately 30 metres of stream were fished before inspecting the nets.

The total length of time during which the electro-fishing gear was turned on was recorded for each station. The fish in the barrier nets were collected and identified, the numbers for each sample site being recorded.

Samples of fish tissue and liver were obtained for analysis to determine concentrations of copper, zinc, and lead. The analysis for these parameters was completed by the Environmental Protection Service Chemistry Laboratory in West Vancouver.

2.4 Bioassays

Bioassay samples were collected on nine occasions as indicated below:

July 15, 1974	Station 11
July 15, 1974	Station 1
July 15, 1974	Station 2
June 6, 1975	Station 11
July 9, 1975	Station 11

August 22, 1975	Station 11	Tailings Decant
		Settling Decant
September 22, 1975	Station 11	
May 25, 1976	Station 11	
July 5, 1976	Station 11	
August 25, 1976	Station 11	
October 29,1976	Station 11	

The samples were collected in clean 5-gallon plastic jerry cans and shipped to the Environmental Protection Service Bioassay Laboratory in West Vancouver. The bioassays were done using coho salmon fry (Oncorhynchus kisutch) and rainbow trout (Salmo gairdneri) in a 96 hour static bioassay.

3 RESULTS AND DISCUSSION

3.1 Water Quality

The results obtained from the water quality sampling are contained in Tables 2 and 3.

Conductivity associated with the tailings pond discharge was slightly elevated (Station 11 - up to 950 uh mos/cm); however, this did not continue significantly beyond Station 2 so that it appears as if most of the salts associated with the discharge had precipitated before extending too far, spatially. Dissolved oxygen concentrations were high throughout the study area with the exception of Station 6 in July, 1974 (4.4 mg/l), which was probably an error in methodology. The pH values obtained were slightly alkaline which is typical of the area. The pH values obtained at the tailings pond decant ranged from 7.1 to 7.8; however, pH values of approximately 9.0 would have effected a more complete precipitation of metallic salts. Total alkalinity, colour, and turbidity did not appear to be a problem in this study. Total hardness displayed an increased value of 820 at Station 1 adjacent to Husky Mine, and 440 at Station 11, the tailings pond decant.

Elevated metal concentrations were generally found in association with the tailings pond decant and runoff from the Husky Mine. It is useful to compare the values obtained in sampling with the prescribed limits for metal concentrations in the Water Licence for United Keno Hill Mines issued by the Yukon Territory Water Board. These limits are outlined in Table 4.

Zinc concentrations appeared to be the biggest problem associated with the tailings pond discharge. Concentrations of 1.6 - 2.0 ppm were obtained in the decant water which are well above the upper limit of 0.5 mg/l as prescribed in the Water Licence. High concentrations of zinc (1.5 ppm) were also obtained in the drainage water from the Husky Mine. Zinc was still found in concentrations ranging from 0.6 - 0.77 ppm in the waters of Flat Creek at Station 2, approximately 5 miles downstream from the tailings

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6	July/74	3.5	165	4.4	7.4		4.0		20		0.2	130
	June/75	3.5	125	12.2	8.8							
	July/75	3.8	160	10.3	7.9	7.7	8.0	57.4	15	0.1		180
7	July/74	17.0	242	8.4	7.7		6.0		20		0.9	160
	June/75	7.0	97	10.4	8.8							
	July/75	11.5	420	8.6	7.9	7.7	11.0	79.2	17	0.1		260
8	July/74	6.7	47	11.3	7.2		17.0		10		2.9	23
	June/75	2.0	30	12.3	9.2							
	July/75	8.3	54	11.4	7.7	7.5	12.0	23.8	7	0.2		36
9	July/74	5.2	46	13.1	7.3		2.5		5		0.2	
	June/75	2.0	30	12.5	8.7							
	July/75	8.3	43	11.6	7.9	7.7	13.0	22.8	6	0.1		35
10	July/74	10.5	226	7.9	7.5		2.5		40		7.4	290
	June/75	9.0	150	10.0	8.7							
	July/75	15.2	230	-	8.1	8.1	8.0	86.1	29	0.2		120
11	July/74	17.0	380	7.8	7.1		8.0		55		12.0	440
	June/75	10.8	360	0.0	7.7							
	July/75	26.0	950	7.5	9.0	9.0	16.0	80.2	17	0.3		440

TABLE 3 EXTRACTABLE METALS (ppm)

Station	Date	Sb	Cd	Cu	Fe	Pb	Ba	Mn	Mo	Ca	Mg	Ni	Ag	Zn	Hg
1	15/07/74		0.01	0.01		1.5	(1)	6.1	0.1	320.0	57.5			1.5	
2	15/07/74		0.01	0.02		0.02	(1)	2.3	0.1	66.0	17.89			0.73	
	06/06/75	0.3	0.01	0.20		0.24	0.7		0.3			0.1	0.01	0.77	
	09/07/75	0.3	0.01	0.01	0.34	0.06	(1)		0.3	60.0	16.00	0.1	0.03	0.60	0.4
3	15/07/74		0.01	0.01		0.02	(1)	0.05	0.1	27.0	9.10			0.02	
	06/06/75														
	09/06/75	0.3	0.10	0.01	0.34	0.03	(1)		0.3	30.0	8.10	0.01	0.03	0.07	0.4
4	15/07/74		0.01	0.01		0.02	(1)	0.03	0.1	26.0	9.17			0.01	
	06/06/75														
	09/07/75	0.3	0.10	0.01	0.18	0.02	(1)		0.3	28.0	8.00	0.1	0.03	0.01	0.4
5	15/07/74		0.01	0.01		0.02	(1)	0.04	0.1	54.0	13.16				0.1
	06/06/75														
	09/07/75	0.3	0.01	0.01	0.13	0.02	(1)		0.3	62.0	15.00	0.1	0.03	0.15	0.4
6	15/07/74	0.3	0.01	0.01		0.02	(1)	0.05	0.1	48.0	2.90			0.36	0.4
	06/06/75	0.3	0.01	0.01		0.02	0.08		0.03			0.1	0.01	0.61	
	09/07/75		0.01	0.01	0.03	0.02	(1)		0.3	52.0	11.00	0.1	0.03	0.15	0.4
7	15/07/74		0.01	0.01		0.02	(1)	0.19	0.1	60.0	3.20			0.17	
	06/06/75	0.3	0.10	0.01		0.02	0.18		0.3			0.1	0.01	0.28	
	09/07/75	0.3	0.01	0.01	0.39	0.02	(1)		0.3	78.0	16.00	0.1	0.03	0.22	0.4
8	15/07/74		0.01	0.01		0.02	(1)	0.09	0.1	5.6	2.26			0.02	
	06/06/75														
	09/07/75	0.3	0.01	0.01		0.02	(1)		0.3	11.0	2.00	0.1	0.03	0.02	0.4
9	15/07/74		0.01	0.01		0.02	(1)	0.03	0.1	8.6	2.01				
	06/06/75														
	09/07/75	0.3	0.01	0.01	0.10	0.02	(1)		0.3	11.0	1.90	0.1	0.03	0.02	0.4
10	15/07/74		0.01	0.01		0.02	(1)	1.7	0.1	59.0	35.00			0.59	
	06/06/75	0.3	0.10	0.10		0.02	9.01		0.3			0.1	0.01	0.74	
	09/07/75	0.3	0.01	0.01	0.21	0.01	(1)		0.3	32.0	9.00	0.1	0.03	0.09	
11	15/07/74		0.06	0.60		0.02	(1)	16.0	0.1	130.0	28.09			2.00	
	06/06/75	0.3	0.03	0.19		0.84	0.2		0.3			0.1	0.01	1.90	
	09/07/75	0.3	0.05	0.22	0.57	0.14	(1)		0.3	130.0	27.0	0.1	0.03	1.60	0.4

(1) Ca Interference for all samples

TABLE 4 CONDITIONS OF YUKON TERRITORY WATERBOARD WATER LICENCE

Suspended Solids.....not greater than 25 mg/l
pH.....not less than 6.5 pH units
Colour.....not greater than 20 Pt-Co units
Turbidity.....not greater than 15 Jackson Turbidity Units

		mg/l
Antimony	extractable	0.1
Arsenic	dissolved	0.05
Barium	extractable	1.0
Cadmium	extractable	0.05
Copper	extractable	0.3
Cyanide	total	0.05
Lead	extractable	0.2
Mercury	extractable	0.005
Molybdenum	extractable	0.5
Nickel	extractable	0.5
Selenium	extractable	0.05
Silver	extractable	0.1
Zinc	extractable	0.5

pond discharge. At Station 10 on the South McQuesten River, elevated levels of up to 0.74 ppm zinc were still apparent. That the zinc originated with the tailings pond discharge into Flat Creek was evident from the fact that values in the South McQuesten River at Station 3 above its confluence with Flat Creek ranged from 0.02 - 0.07 mg/l, significantly lower than those values obtained below the confluence. Slightly elevated levels of zinc (0.15 - 0.61 ppm) were also found at Station 6 in the waters of Sandy Creek, the drainage system from the Townsite Mine, and at Station 7 (0.17 - 0.28 ppm).

Some problems were apparent in the concentrations of the other metals; however, none were problematic to the same extent as zinc. During the 1974 survey, cadmium was measured in the decant water at a level of 0.06 ppm which is 0.01 ppm over the allowable limit as outlined in the Water Board Licence. This elevated concentration level did not, however, persist for any distance downstream from the decant. Copper was also observed to be at a concentration of 0.6 ppm during the 1974 survey which is 0.3 ppm over the allowable limit. This did not, however, persist downstream either.

On two occasions at two different stations, high concentrations of lead were revealed. At Station 1 on the drainaage from Husky Mine in 1974, a lead concentration of 1.5 ppm was obtained. In 1975, lead was found in the decant water from the tailings pond at 0.84 ppm and this persisted in the water resulting in a concentration of 0.24 ppm at Station 2, five miles downstream. It may be seen from Table 4 that the allowable discharge limit for lead is 0.2 mg/l.

It should be noted that antimony and mercury could not be measured to the level required by the Water Board Licence and, therefore, it is difficult to make any inferences with respect to these two parameters.

It may be seen from the previous discussion that although there were isolated cases of increased metal concentrations, the only metal which was consistently high, such that the passage of the metal could be traced through the watershed, was zinc. The isolated increases in metal concentrations should be monitored reasonably closely. However, it would seem that zinc is a perpetuating problem which should be corrected.

In the Lightning Creek - Thunder Gulch watershed, no correlations between water quality and the presence of the placer mining operation on Thunder Gulch could be made from the data collected.

3.2 Benthic Fauna

The results of the benthic sampling programs for 1974 and 1975 are depicted in Tables 5 and 6. It may be seen from examination of these tables that the 1974 sampling using the circular sampler yielded fewer organisms than the artificial substrate samplers used the following year. The dominant faunal forms obtained in the 1974 sampling were Dipterans, being mainly black fly larvae (Simulidae). The diversity indices were generally high with the exception of Stations 5 and 7 (Table 7). However, due to the low numbers of animals collected, it was not possible to draw any concrete conclusions from these data. Station 7 had an exceptionally low diversity index; however, this value was probably distorted by the high number (462) of black fly (Simulidae) larvae in the sample.

The 1975 sampling using artificial substrate samplers was much more successful with respect to number or organisms obtained, thereby making the data more representative of the community structure. Table 8 contains the diversity and evenness indices for the fauna obtained in this program as well as the diversities for the station calculated on the individuals grouped for each station.

From Table 6, it is apparent that Station 2 had fewer species than stations on the South McQuesten River and that if the Simulids were excluded from consideration, Station 10 downstream of the confluence of Flat Creek and the South McQuesten River had fewer species than Stations 3 and 4. When considering the diversity indices, one can be misled by the high diversity at Station 2 because even though these are few species, they have a fairly even distribution resulting in a diversity of 0.5775. The impact of Flat Creek on the South McQuesten River can also be seen by the very sparce Ephemeropteran and Plecopteran populations at Station 10 as compared to Station 3.

TABLE 5 SPECIES COLLECTED IN 1974 SAMPLING

Taxon		Stations						
		3	4	5	7	8	9	10
Plecoptera	- Hastaperla sp	6	8	-	-	-	1	-
	Acroneuria sp	-	3	-	-	-	-	-
	Isoperla sp	-	-	-	-	1	-	1
	Paraperla sp	-	-	-	-	-	31	-
	Nemoura (Zapada) sp	-	-	-	-	-	2	1
Ephemeroptera	- Ephemerella sp	-	1	-	-	-	-	-
	Centroptilum sp	-	-	-	-	1	1	3
	Pseudocleon sp	-	-	-	-	-	1	6
	Cinygmula sp	-	-	-	-	-	9	-
Diptera	- Simulidae	11	1	2	462	-	5	19
	Hemorodromia sp	2	-	-	-	-	-	1
	Pentaneura sp	5	2	3	2	1	19	6
	Spaniotoma sp	4	10	23	11	13	32	4
	Corynoneura sp	-	11	-	-	2	5	-
	Tendipedini (pupae)	-	-	2	-	-	-	-
	Chironomidae (unidentified)	-	-	-	-	2	-	-
	Chinomini (pupae)	-	-	-	-	-	4	-
	Unidentified Diptera	-	-	-	-	1	1	-
Coleoptera	- Hydrometridae	-	-	-	-	1	-	-
	Curculionidae	-	-	-	-	-	-	1
	Unidentified Coleoptera	-	-	1	-	-	-	-
Hydracarina	- Lebertia sp	3	-	-	-	-	-	-
	Neoranopsis sp	3	-	-	-	-	-	-
	Wettina sp	5	1	-	-	-	-	-
	Mediopsis sp	-	3	-	-	-	-	-
	Sperchonopsis sp	-	-	-	-	-	1	-
	Teutonia sp	-	-	-	-	-	-	3
	Unidentified Hydracarina A	3	1	-	2	-	-	1
	Unidentified Hydracarina B	-	1	-	-	-	-	-
Unknown Insect		1	-	-	-	-	-	-
Oligochaeta		4	2	-	-	8	52	-
Cottidae (Juvenile)		-	-	-	-	-	-	1

TABLE 6 SPECIES COLLECTED IN 1975 SAMPLING

Taxon	Stations																											
	2			3			4			5			6			7			8			9			10		
	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C	A	B	C
Mite (Unidentified)	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Heterscope septentrionalis	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-	-	-	-	-	-	-	-	-
Isoperla sp	-	-	-	-	-	-	-	5	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Alloperla sp	-	-	-	1	1	-	-	-	4	-	-	-	-	-	-	-	-	-	-	3	2	3	2	-	-	1	-
Hastaperla sp	-	-	-	-	4	-	-	-	-	-	2	-	-	-	-	-	-	-	2	-	2	3	-	-	-	-	-
Kathroperla sp	-	-	-	-	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Paraperla sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	10	-	-	-
P. frontalis	-	-	-	-	-	-	10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Neoperla clymene	-	-	-	-	-	-	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Isogenus sp	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	1	1	-	-	-	1	-	-	-
Perlodidae (Adults)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
Pteronarcella sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Pteronarcys dorsata	-	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	4	-	2
Taeniopteryx sp	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Nemoura sp	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	15	-	-	-	-	1
Nemoura (Zapada) sp	-	-	-	-	28	-	-	-	-	63	46	-	-	75	-	-	-	-	30	16	1	-	19	55	2	2	-
Acroneuria sp	-	-	-	3	7	-	-	6	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	3	1	1
Perlesta placida	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Diura sp	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Unidentified Plecoptera	-	-	-	-	-	-	2	-	-	4	-	-	-	-	-	-	-	-	-	-	1	-	-	-	2	-	-
Unidentified Adult Plecoptera	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Cinygmula sp	-	-	-	1	1	1	-	-	3	-	1	-	-	-	-	-	-	-	5	4	16	16	2	4	-	-	-
Epeorus sp	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Arthroplea sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Rithrogena sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	5	-	2	-	2	-	-	-
Baetis sp A	-	-	-	-	-	1	-	-	-	-	7	-	-	-	-	-	-	-	26	9	5	39	14	-	-	-	-
Baetis sp B	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-
Ameletus sp	-	-	-	-	-	-	-	-	-	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ephemerella sp	-	-	-	3	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	1
Pseudocleon sp	-	-	-	1	24	-	-	-	-	-	-	-	-	-	-	1	-	-	18	27	-	-	-	14	-	-	-
Centroptilum sp	-	-	-	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	3	14	15	39	1	8	-	-	-
Rhyacophilia sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Atopsyche sp	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-
Lepidostomatidae	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Caborius sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-
Platycentropus sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Astenophylax sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-
Hesperophylax sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-
Cheumatopsyche sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	-
Brachycentrus sp	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	2	1	-
Autopsyche sp	-	-	-	5	-	6	-	-	-	-	-	-	-	-	-	-	-	-	-	6	-	-	-	-	-	-	-
Carynoneura sp	-	-	-	35	-	-	2	15	5	-	-	-	-	-	-	-	1	7	-	12	-	-	-	-	4	27	9
Tendipedinae	-	-	2	9	151	2	25	23	4	-	120	90	-	8	-	47	9	83	189	24	51	31	16	136	51	71	50
Clirunodimidae (unidentified)	-	-	2	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Brillia sp	-	-	1	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	3	-	-	-
Cardiocladius sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	-	-	-	1	-	-	-	-	-	-
Cricotopus sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Pentaneura	-	-	-	-	-	-	-	-	1	39	26	-	-	-	-	-	1	3	-	4	-	-	1	12	-	-	-
Tendipedae (pupa)	-	-	-	-	2	-	-	-	-	1	-	-	-	-	-	-	-	-	2	-	-	-	-	1	-	-	-
Antocha sp	-	-	-	-	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tipula sp	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophilia sp	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Simulium sp	-	-	-	567	62	204	8	111	113	223	102	-	-	1	-	4	-	1	34	-	765	6	21	11	2100	1125	920
Simulium sp (pupa) A	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	3
S. occidentale	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Limnophora sp	-	-	-	-	-	-	-	-	-	-	2	-	-	1	-	-	-	-	-	-	-	-	-	-	-	3	-
Roederodes sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-
Ditiscidae	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Bellura sp	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-
Acentropus sp	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
Ochteridae sp	-	-	-	-	-	-	-	-	-	-	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-
Ochteridae sp (Adult)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-
Unidentified Insect Larvae	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
Unidentified Adult Insects	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-
Slavina appendiculata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	-	-	-	-	-	-	-	-	-	-	-
Unidentified Oligochaetes	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	6	2	-	-	-	-	2	-	-	-	-
Sphaerium sp	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

TABLE 7 DIVERSITY AND EVENNESS: 1974 SAMPLE SERIES

Station	Diversity	Evenness
3	0.9737	0.9350
4	0.8992	0.8332
5	0.3960	0.5666
7	0.0719	0.1181
8	0.7135	0.7477
9	0.9918	0.8433
10	0.8443	0.7824

TABLE 8 DIVERSITY AND EVENNESS: 1975 SAMPLE SERIES

Station No.	Sample	Diversity	Grouped Diversity	Evenness	Grouped Evenness
2	A	-	-	-	-
	B	-	-	-	-
	C	0.5775	-	0.8262	-
3	A	0.2255	-	0.1968	-
	B	0.6246	0.4471	0.5834	0.3382
	C	0.1165	-	0.1497	-
4	A	0.8135	-	0.7538	-
	B	0.4689	0.6381	0.5192	0.4623
	C	0.3885	-	0.3885	-
5	A	0.5879	-	0.5879	-
	B	0.4969	0.6277	0.5207	0.5213
	C	-	-	-	-
6 (Surber)	A	-	-	-	-
	B	0.2578	-	0.3309	-
	C	-	-	-	-
7	A	0.3067	-	0.4338	-
	B	0.7706	0.5225	0.8076	0.4443
	C	0.3540	-	0.3340	-
8	A	0.6146	-	0.5518	-
	B	1.0368	0.6446	0.8426	0.4303
	C	0.2412	-	0.2165	-
9	A	0.8202	-	0.7876	-
	B	0.9570	0.9358	0.8868	0.6694
	C	0.6821	-	0.5544	-
10	A	0.0759	-	0.0795	-
	B	0.1697	0.2002	0.1726	0.1747
	C	0.1376	-	0.1524	-

The low numbers of individuals at Stations 6 and 7 may also be related to the mining activity as the stream at Station 6 receives mine drainage from an abandoned mine and the stream at Station 7 receives drainage from an abandoned tailings disposal area.

The difference in diversity at Stations 8 and 9 tend to indicate that the placer operation at Thunder Gulch has an impact on Lightning Creek; however, the species represented at both stations are very similar.

3.3 Fish

A summary of the results of the electro-fishing program is included in Table 9. It may be seen from examination of this table that the stations where the most successful fishing was obtained were along the South McQuesten River (i.,e., Stations 3, 4, and 10). Very little success was achieved in the fishing at Station 2, the low fish populations probably being attributable to the tailings pond decant further upstream in Flat Creek. Although the bioassay sample at Station 2 was non-toxic, the lack of fish in Flat Creek could possibly be related to the high concentrations of zinc and copper in the water. Avoidance reactions to concentrations of 0.01 mg/l of zinc have been observed in rainbow trout and to concentrations of 0.004 mg/l of copper in Atlantic salmon (Sprague, 1964 and 1968). The lack of fish at Station 2 may also be a function of the low numbers of benthic food invertebrates found at that location The low numbers of invertebrates were also assumed to be a function of the increased metal concentrations resulting from the tailings pond decant.

The lack of fish at Stations 5 and 7 could probably be attributed more to the fact that these creeks were small with a relatively steep gradient rather than a direct effect from the mine.

At Stations 8 and 9, relating to the placer mining operation on Thunder Gulch, only one grayling (Thymallus arcticus) was caught at Station 9 downstream of the placer operation. This is not enough information on which to draw any conclusions relative to the effects of this operation on the local fish populations.

TABLE 9 ELECTRO-FISHING RESULTS

Station	Year	Numbers of Fish Caught Per Minute of Fishing Time					
		Catastomas catastomas	Thymallus arcticus	Cottus cognatus	Lamperta japonica	Coregonus clupeaformis	Esox lucius
2	1974	0	0	0	0	0	0
	1975	0	0	0	0	0	0.28
3	1974	0	9.71	1.94	0	0.16	0
	1975	0	3.27	0.19	0	0	0
4	1974	0	2.27	1.92	0.09	0	0
	1975	0	0.35	0.09	0	0	0.09
5	1974	0	0	0	0	0	0
	1975	0	2.54	0	0	0	0
7	1974	----------No Sample----------					
	1975	0	0	0	0	0	0
8	1974	0	0	0	0	0	0
	1975	0	0	0	0	0	0
9	1974	0	0.19	0	0	0	0
	1975	0	0	0	0	0	0
10	1974	0	25.87	0.11	0	0.11	0.11
	1975	0.08	0	1.49	0	0	0.08

3.4 Bioassays

The results of the bioassays are contained in Table 10. It may be seen from examination of this table that on two occasions the samples obtained from the tailings decant for bioassay purposes were found to be toxic. On July 15, 1974, the 96 hr LC_{50} was 42.5% while on June 6, 1975, the 96 hr LC_{50} was 91%. The rest of the samples obtained were found to be non-toxic. These results illustrated the need to tighten control over fluctuation in the concentrations of toxic metals being discharged from the tailings pond.

TABLE 10 SUMMARY OF BIOASSAY RESULTS

Collection Date	Station	Toxicity
July 15, 1974	Station 11 - Tailings Decant	96 Hr LC_{50} = 42.5%
July 15, 1974	Station 1	Non-toxic
July 15, 1974	Station 2	Non-toxic
June 6, 1975	Station 11 - Tailings Decant	96 Hr LC_{50} = 91%
July 9, 1975	Station 11 - Tailings Decant	Non-toxic
August 22, 1975	Station 11 - Tailings Decant	Non-toxic
August 22, 1975	Settling Decant	Non-toxic
September 22, 1975	Station 11 - Tailings Decant	Non-toxic
May 25, 1976	Station 11 - Tailings Decant	Non-toxic
July 5, 1976	Station 11 - Tailings Decant	Non-toxic
August 25, 1976	Station 11 - Tailings Decant	Non-toxic
October 29, 1976	Station 11 - Tailings Decant	Non-toxic

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