Environment Canada
Environmental Protection Service
Pacific Region
Yukon Branch

BASELINE STUDY OF THE WATERSHEDS NEAR THE TOM PROPERTY, MACMILLAN PASS, YUKON TERRITORY

Regional Program Report No. 83-14

by

I. K. Soroka and M.E. Jack

July, 1983

ABSTRACT

A predevelopment study was undertaken by the Environmental Protection Service in the watersheds near the TOM Property in MacMillan Pass, Yukon in July, 1981.

The presence of ore minerals in the study area is reflected by their presence in water and sediment. All streams have soft water with low buffering capacity. With the exception of the South MacMillan River all sampling streams show very low natural pH levels and elevated metal concentrations that make them unsuitable for drinking water and aquatic life. This is probably why the numbers of bottom fauna collected were low.

The metals of concern when a mine and mill become active will be arsenic, cadmium, copper, manganese, nickel, silver, lead and zinc.

RÉSUMÉ

En juillet 1981, le Service de la protection de l'environnement a entrepris une étude préliminaire portant sur les bassins hydrologiques situés pres de la concession TOM, au col MacMillan (Yukon).

L'analyse de l'eau et des sédiments a révélé la présence de minerais dans la région sur laquelle a porté l'étude. L'eau douce des cours d'eau de la région a une faible capacité comme solution tampon. Si l'on excepte le bras sud de la rivière MacMillan tous les cours d'eau étudiés ont un pH naturel très bas et de fortes concentrations de métaux, ce qui rend leur eau impropre à la consommation et à la vie aquatique. C'est probablement pourquoi le nombre d'échantillons de faune benthique prélevés a été si bas.

Les métaux qu'on peut s'attendre à trouver lorsque la mine et l'usine seront en activité sont l'arsenic, le cadmium, le cuivre, le manganèse, le nickel, l'argent, le plomb et le zinc.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF FIGURES

LIST OF TABLES

1 INTRODUCTION

The Environmental Protection Service conducted a study on July 7, 1981 to obtain background information on the water quality, sediment composition and bottom fauna in the watershed of the TOM property in the MacMillan Pass area (See Figure 1). The information derived from the study will enable the Environmental Protection Service to assess the quality of the streams in the vicinity of the TOM property, which is expected to be developed as a fully operational mine and camp.

At the time of the study the property was in the final exploration stage with a thirty to fifty person camp on site.

1.1 Background

Original staking occurred on the TOM claims in MacMillan Pass in 1951, when mineralization was discovered by Hudson Bay Exploration and Development Company Ltd. prospectors working off the Canol Road (Marchand, 1978). Intense development work continued by the company, primarily on the discovery or "West" zone during a three year period between 1951 and 1953. The development work consisted of geological mapping, soil sampling and trenching, as well as 5436 m (17,853 ft) of diamond drilling in 39 holes (Freberg 1976).

Because of its remote location, the property lay idle until 1966 when a small crew resurveyed the original grid set up in 1951 and conducted geological mapping, geochemical soil surveys and a magnetometer survey (Freberg 1976). Further work in 1967 resulted in the discovery of an additional nearby mineralization, the "East" zone. A total of 4946 m (16,130 ft) of diamond drilling was completed on the East zone by 1968 in conjunction with additional geochemical sampling and mapping (Carne 1979). During the summer of 1969 the company rebuilt

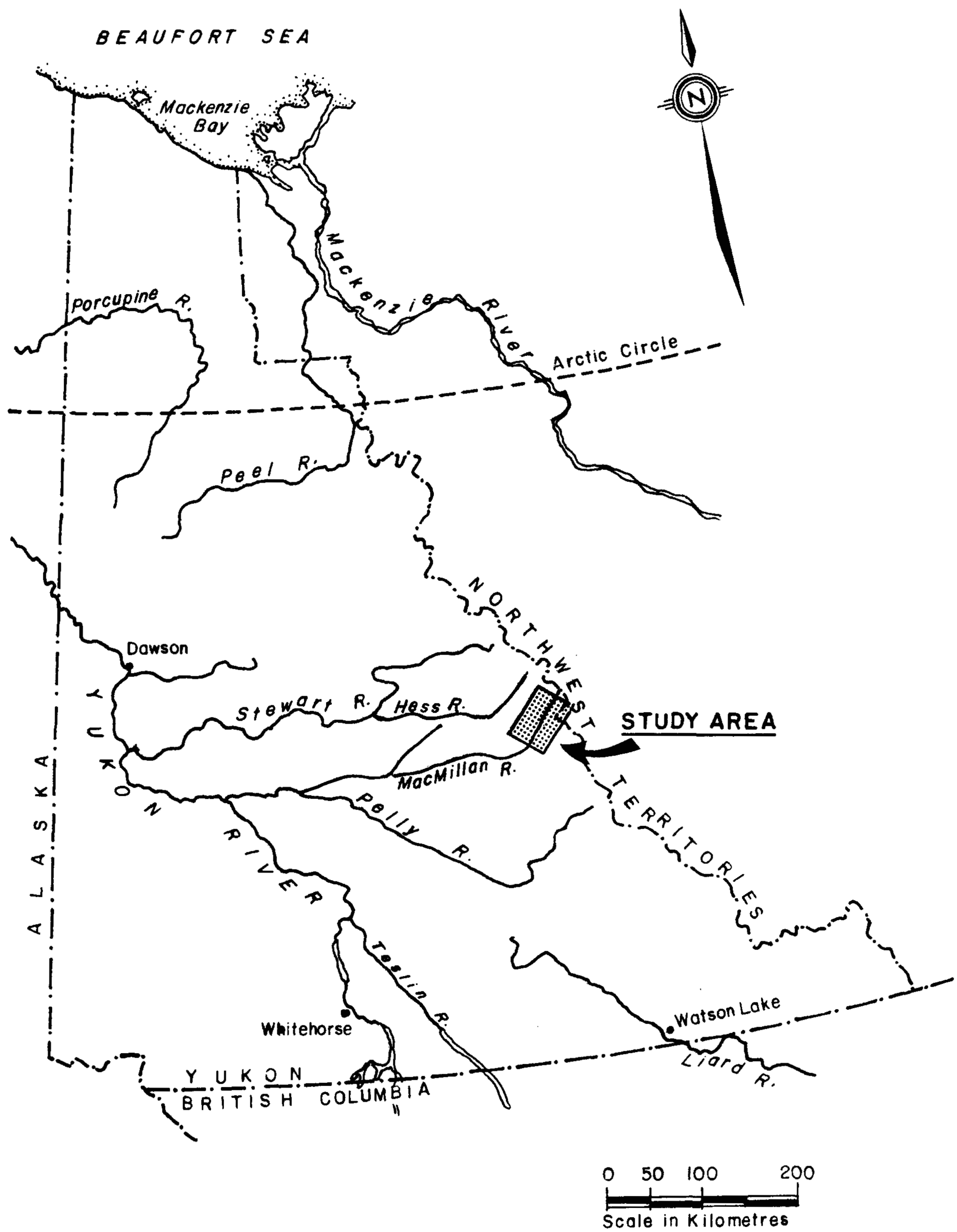

FIGURE I LOCATION OF THE TOM PROPERTY STUDY AREA the Canol Road from Ross River to the property and upgraded the existing airstrip (Craig and Laporte, 1970).

Interest in the area was recently renewed with the 1975 discovery of another barite-lead-zinc-silver mineralization deposit six kilometers west of the original TOM claims (Carne, 1979). Further work was conducted during the summer of 1978 (Marchand, 1978) and in August 1979 additional claims were staked to cover a possible southern extension of mineralization on the main TOM Group (Department of Indian and Northern Affairs 1981) (see Figure 2).

During the 1981-1982 season, the Hudson Bay Mining and Smelting Company Ltd. operated under a water authorization for the camp under the Northern Inland Waters Act. The company set up a 30 to 50 person camp which was fully operational between March 20, 1981 and November 20, 1981. The camp's daily water requirement was estimated at 9000 litres per day (2000 IGPD) and was pumped from Sekie Creek 1. All camp sewage was treated in a small package sewage treatment plant and was discharged to a tile field. Any drainage from the tile field would have entered Sekie Creek 2 upstream of Station 4. The camp is located near the TOM mine adits, elevation 1455 m (4774 ft) and is accessible by a 3 km company road which leaves the Canol Road at Sekie Creek 2. Two portals at the same elevation but 50 m apart currently exist at the mine. They join at the main adit, 35 m inside the mine.

During the 1981-82 season Hudson Bay Mining and Smelting Company Ltd. also operated under a water authorization for underground development under the Northern Inland Waters Act. Mine seepage water was used for mining operations. Waste water was treated in a settling pond inside the mine and was then pumped from a clean water sump outside to form Rust Creek which then flowed into Sekie Creek 2.

Over the summer, mine water discharge was estimated to be 765 litres/minute (170 gal/min) and was pumped intermittently from the clean water sump. In the winter of 1981-82 the mine water discharge was estimated to be 1035 litre/min (230 gal/min) and again was intermittently pumped.

In March 1982 bad ground and excess water forced termination of the underground development 100 m (350 ft) short of target. At that time, a total of 1800 m (6038 ft) of full face development and an additional equivalent footage of 200 m (642 ft) of miscellaneous excavation was completed. Following the termination, the lower drifts were allowed to fill with water and previous historical data suggests that unpumped flow from the portal will stabilize at 540-810 litres/min (120 - 180 gal/min). At this time the TOM camp site is on standby with a watchman/caretaker on duty. His duties are to maintain the camp and assets, collect water samples and record weather observations on a regular basis.

Snow survey data was collected halfway between the airstrip and the camp in the winter of 1981-82 by Hudson Bay Mining and Smelting Company Ltd. Wind gauge readings at the MacMillan Pass airstrip were also taken and weather data was collected.

Baseline information on the MacMillan Pass area has been collected by several groups. General environmental studies include those by: Amax Environmental Services Group, 1976; Gill, 1975; McNicholl (editor) 1980; and Pearson and Associates, 1981. Water quality studies include those by: Brown, 1982; Monenco Consultants Ltd., 1982; and Pearson and Associates, 1982. Waterflows, wildlife and/or fish information is reported by: Gill, 1979; and the Department of Indian Affairs and Northern Development, 1982. These reports are mentioned as references for additional information but an evaluation of their contents is not a part of this report.

Due to its remote location, the eventual development of a mine on the TOM property will probably depend on the concurrent development of other properties in the area so that joint facilities can be used. The North Canol road must also be improved and this is being planned within the next few years.

1.2 Mineralization Description

A strata bound zinc-lead deposit exists at the TOM property in the MacMillan Pass area. The TOM property and the nearby JASON property (Figure 2) contain two physically separate galena-sphalerite-barite lenses in black shale of the lower Earn Group or "Black Clastic". Both are near the north east margin of the Selwyn Basin, (Department of Indian Affairs and Northern Development, 1981).

The mineralization on the TOM property occurs in two tabular bodies. The East zone is 160 m long, 3 m to 20 m thick and dips steeply west. The West zone, a much larger body with a length of about 1200 m and a thickness of 3 m to 60 m, dips 50° to 70° west. (Carne, 1979). As of May 1982, the proven and probable reserves are 9.8 million tonnes (10.8 million tons) averaging 75.5 gm/tonne (2.2 oz/ton) silver (Ag), 7.5% zinc (Zn) and 6.4% lead (Pb) (Bidwell, 1982). Some of the minerals that are present in the ore are: galena (PbS), sphalerite (ZnS), pyrite (FeS_2), chalcopyrite ($CuFeS_2$), chalcocite (Cu_2S), bournonite ($PbCu SbS_3$), boulangerite ($Pb_5Sb_4S_11$), tetrahedrite ($Cu_{12}(Ag)Sb_4S_{13}$), proustite (Ag_3AsS_3), and pyrargyrite (Ag_3SbS_3). They occur with quartz and siderite ($FeCO_3$) (Carne, 1979).

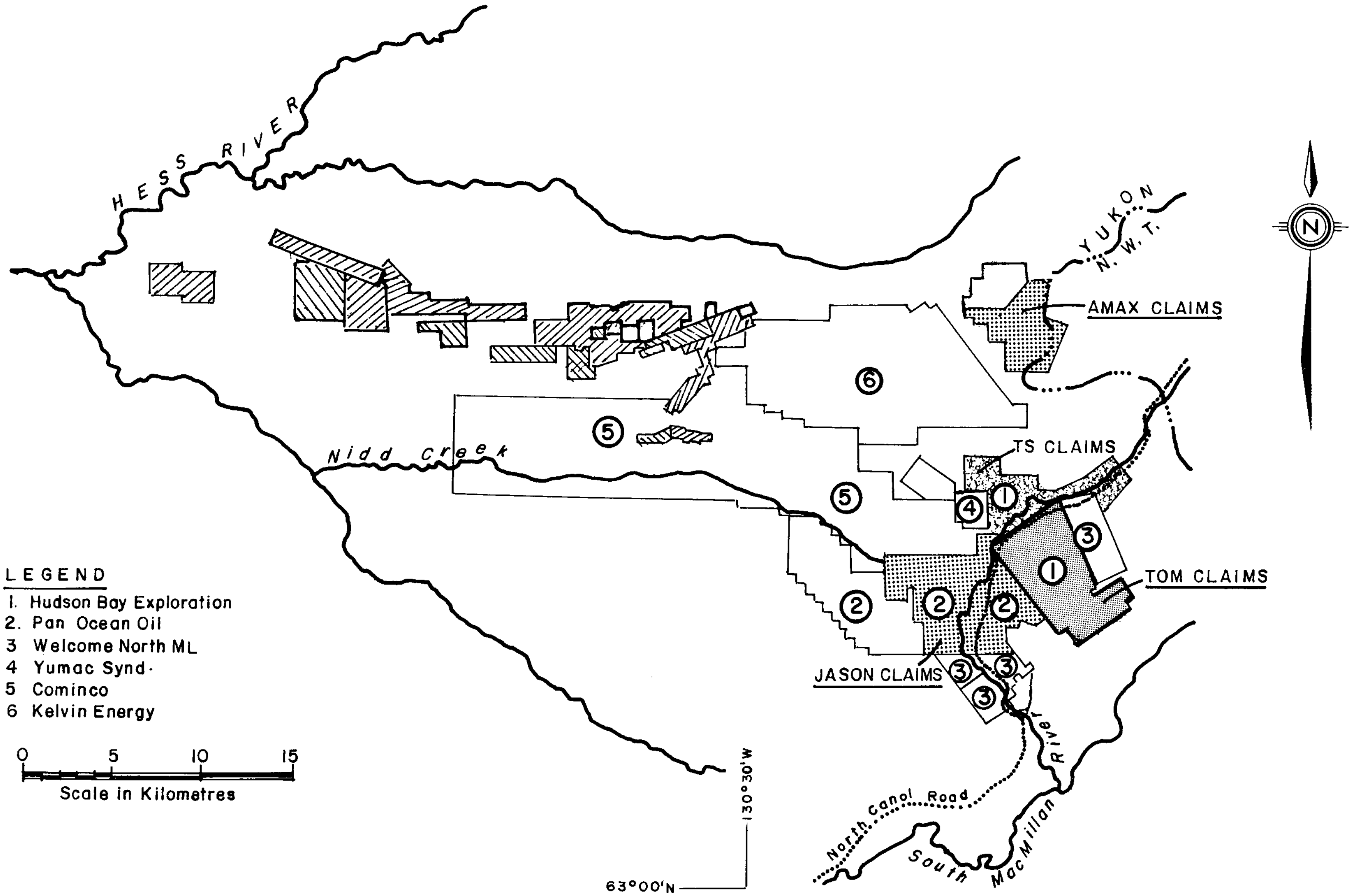

FIGURE 2 LOCATION OF TOM PROPERTY RELATIVE TO OTHER PROPERTIES IN THE MacMILLAN PASS AREA (November 1981)

2 STUDY AREA

The TOM property is located within the Selwyn Mountain Range near the divide between the Yukon and MacKenzie River drainage systems, in an area called MacMillan Pass. The property lies primarily above the timber line. A sparse cover of stunted alpine trees and shrubs exist at lower elevations along the flanks of the river valley.

The TOM property is located 9 km west of the Yukon-Northwest Territories border at coordinates 63° 08'N and 130° 06'W, and the claims lie on the south side of the Canol Road. The claims are 222 km from Ross River and 624 km (380 miles) from Whitehorse by road. The underground workings and permanent camp are accessible via a 3 km road leaving the Canol Road at Sekie Creek 2. A gravel surfaced 600 metre airstrip is located between the Canol Road and the South MacMillan River on the northern section of the property.

Hudson Bay Exploration and Development Company Ltd. owns the TOM property. These claims are bordered to the west by Aberford Resources Ltd., who own the JASON property. Other major claim groups in the area, including the Amax Tungsten property, are shown in Figure 2. It is likely that some of these will be developed into mines simultaneously in order to take full advantage of joint facilities in this remote region.

The water bodies that would be affected by further development of the TOM property are the South MacMillan River, which runs to the north of the property, and some of its tributaries. The South MacMillan River is part of the Yukon River system. Arctic grayling, chinook salmon, whitefish and slimy sculpins are known to use some reaches of the South MacMillan River. The river is also used by recreational canoeists and kayakers.

Elevations of the study area vary from 1180 m to 1465 m. The climate at MacMillan Pass is more severe than Whitehorse because of its higher elevation and more northerly location. Environment Canada does not collect meteorological data near the TOM property, but data can be extrapolated from Tsichu River, elevation 1265 m, located 24 km north in the Northwest Territories. The 20 year mean annual temperature at Tsichu River was calculated to be -7.7°C with a mean temperature in July of 10°C. The extreme temperatures recorded from the years 1975 to 1981 were -51.1°C and 27.2°C. Precipitation is relatively heavy because Tsichu River and the Tom property are located on the south westerly windward slopes of the MacKenzie/Selwyn mountain range. The annual precipitation at Tsichu River is approximately 500 mm. Of this 500 mm, 200 mm falls as rain and 300 mm falls as snow. As a comparison, the Whitehorse area mean annual temperature is -1.3°C. The Whitehorse mean annual precipitation is approximately 270 mm and is relatively evenly divided between rain and snow (Wahl, 1981). Because the TOM property is at a relatively higher elevation than the surrounding topography it will probably have lesser extremes of temperature than the Tsichu River.

Sample stations were located on the South MacMillan River and its tributaries. In total, ten sample sites were chosen, and their locations are shown in Figure 3. A description of the sample sites is provided in Table 1. Sample sites are illustrated by photographs in Figures 4 - 13.

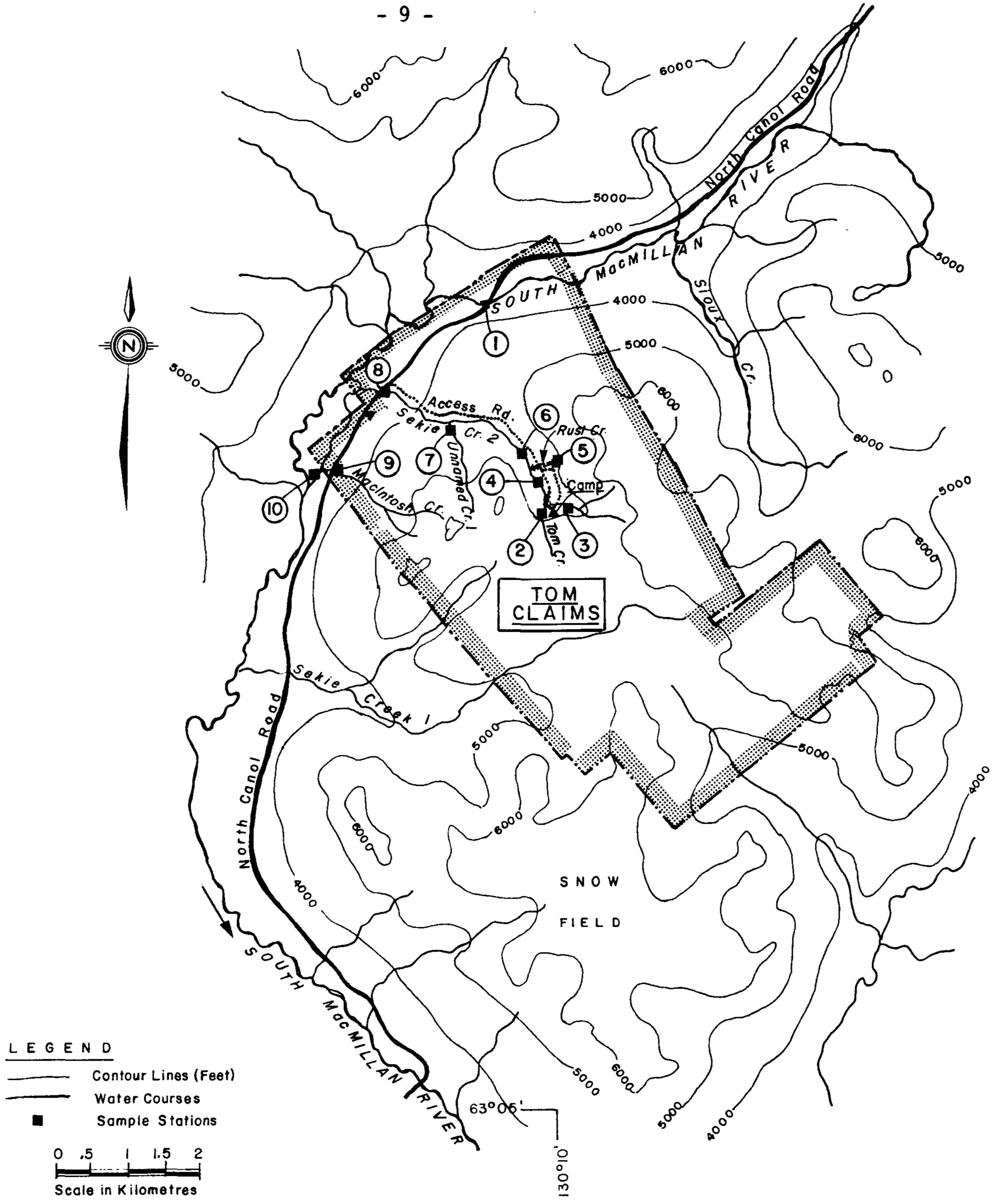

FIGURE 3 TOM PROPERTY STUDY AREA - SHOWING CREEKS, MINERAL CLAIMS AND SAMPLE STATIONS

TABLE 1 DESCRIPTION OF SAMPLE SITES IN THE TOM PROPERTY STUDY AREA

STATION	LOCATION	STREAM BOTTOM	REMARKS
1	63°11'N 130°10'W on the South MacMillan River 150 m upstream from South Macmillan River Bridge #3 and 2 km upstream of its confluence with Sekie Creek 2. Elevation 1186 m (3980 ft). Sample time: 1545 hr.	Large gravel is interspersed with sand and small cobble. 90% of the gravel was discarded from sediment sample.	River braided and banks stable. Vegetation includes buckbrush, spruce, grasses and lichens. 0% shade. River looks suitable for fish but too large for electrofishing.
2	63°10'N 130°09'W on TOM Creek, 8 m upstream of camp backfill and 25 m upstream of waterfall. Elevation 1455 m (4774 ft). Sample time: 2055 hr.	Bedrock is covered with gravel. 95% of the gravel was discarded from sediment sample.	Bank stability is fair. Sparse lichen and moss cover rocks to water's edge. 0% shade. Waterfall, approximately 25 m downstream, acts as a fish barrier.
3	63°10'N 130°09'W on Sekie Creek 2. 10 m upstream of the camp and 4 m upstream of an access road ford. Located upstream of its confluence with Tom Creek. Elevation 1465 m (4806 ft). Sample time: 1950 hr.	Bedrock is covered with gravel. 95% of the gravel was discarded from sediment sample.	Bank stability is fair. Sparse lichen, moss, grasses and labrador tea cover rocks to water's edge. Waterfall 10 m downstream acts as a barrier to fish.
4	63°10'N 130°09'W on Sekie Creek 2, 50 m below its confluence with Tom Creek and 25 m above its confluence with Rust Creek. Located downstream of the camp. Elevation 1415 m (4642 ft). Sample time: 1745 hr.	Gravel and some sand cover bedrock. 95% of the gravel was discarded from sediment sample.	Bank stability is fair. Sparse vegetation consists of lichens and moss. 0% shade. Unlikely fish habitat due to high water velocity and a lack of pools. Unsuitable for electrofishing.
5	63°10'N 130°09'W. Mine adit near the TOM camp. Adit water pumped intermittently from a metal pipe to form Rust Creek. Rust Creek flows 50 m downstream into Sekie Creek 2. Elevation 1440 m (4724 ft). Sample time: 1735 hr.	Adit water flows over mine adit waste rock after it leaves culvert from mine portal to far side of road.	Bottom fauna, fish and sediments were not taken because the water was flowing from a pipe into a receiving culvert. No vegetation. Unsuitable for fish or bottom fauna.

DRAFT COPY

APPENDIX ~~5.2~~ 6.2 CADMIUM CONCENTRATIONS IN SURFACE WATERS OF YUKON TERRITORY

	LOCATION			DATE	NUMBER OF SAMPLES	TOTAL Cd CONCENTRATION(ug/L)		REFERENCE
	DESCRIPTION	LATITUDE	LONGITUDE			Geometric Mean[1]	Range	
1				July 81	1	3.4	✓	39
2				✓	1	3.9	[illegible]	39
3				✓	1	2.3	✓	39
4				✓	1	10.1		39
5	Mine adit water			✓	1	5.5	[illegible]	39
6A				✓	1	19.4	15.75 ✓	39
6B				✓	1	12.1		39
7				✓	1	<1.0	✓	39
8A				✓	1	19.5	18.45 ✓	39
8B				✓	1	17.4		39
9				✓	1	3.8	✓	39
10				✓	1	3.0	✓	39

APPENDIX 82 CADMIUM CONCENTRATIONS IN SEDIMENTS OF ~~BRITISH COLUMBIA~~ YUKON

DRAFT COPY

LOCATION				DATE	NUMBER OF SAMPLES	CADMIUM CONCENTRATION (mg/kg Dry Weight)		REFERENCE	
SITE NO.	DESCRIPTION	LATITUDE	LONGITUDE			MEAN[1]	RANGE		←
1				July 1981	3 ✓	1.016	0.829-1.34	0.878	39
2				✓	3 ✓	0.577	<0.57-<0.58	<0.58	39
3				✓	3 ✓	0.573	<0.57-<0.53	<0.57	39
4				✓	3 ✓	0.697	0.64-0.81	0.64	39
6				✓	3 ✓	4.313	1.39-6.25	5.27	39
7				✓	3 ✓	0.57	<0.56-<0.53	<0.57	39
8				✓	3 ✓	3.573	2.36-4.15	3.71	39
9				✓	3 ✓	0.577	<0.57-<0.58	<0.58	39
10				✓	3 ✓	5.497	4.84-6.13	5.52	39

no5

TABLE 1 DESCRIPTION OF SAMPLE SITES IN THE TOM PROPERTY STUDY AREA (continued)

STATION	LOCATION	STREAM BOTTOM	REMARKS
6A	63°10'N 130°09'W on Sekie Creek 2, 15 m downstream from its confluence with Rust Creek and approximately 90 m downstream from its confluence with TOM Creek. Elevation 1410 m (4626 ft). Sample time: 1035 hr.	Gravel and some sand cover bedrock. 95% of gravel was discarded from the sediment sample.	Bank stability is fair. Sparse vegetation includes lichen and moss. 0% shade. Turbid adit water was being pumped into Rust Creek at this time. Unlikely fish habitat due to high water velocity and lack of pools. Unsuitable for electrofishing.
6B	Same as 6A. Sample time: 1100 hr.	Same as 6A.	Adit water was not being pumped into Rust Creek at this time. Water appeared less turbid in Sekie Creek 2.
7	63°10'N 130°11'W on Unnamed Creek 1, 15 m upstream from its confluence with Sekie Creek 2 and 1.9 km downstream of Station 6. Elevation 1326 m (4350 ft). Sample time: 1635 hr.	Bedrock is covered by hard packed cobble and fine sediment. 95% of gravel was discarded from sediment sample.	Bank very stable and covered with moss, willows, spruce and grasses. 0% shade. Creek flows through very steep ravine with waterfalls 0.5 km upstream that act as a barrier to fish. Water too shallow for electrofishing.
8A	63°10'N 130°12'W on Sekie Creek 2, 90 m upstream of its intersection with the North Canol Road, 15 m from the TOM camp access road and 2.9 km downstream of Station 6. Elevation 1180 m (3870 ft). Sample time: 1200 hr.	Medium gravel and coarse sand on bedrock. 95% of gravel was discarded from sediment sample.	Bank very stable. Sparse vegetation includes buckbrush, mosses and lichens. 0% shade. Waterfall 60 m upstream acts as a barrier to fish. Turbid adit water was being pumped into Rust Creek at this time. Unlikely fish habitat due to high water velocity and lack of pools. Unsuitable for electrofishing.

TABLE 1 DESCRIPTION OF SAMPLE SITES IN THE TOM PROPERTY STUDY AREA (continued)

STATION	LOCATION	STREAM BOTTOM	REMARKS
8B	Same as 8A. Sample time: 1145 hr.	Same as 8A.	Adit water was not being pumped into Rust Creek at this time. Water appeared less turbid in Sekie Creek 2.
9	63°10'N 130°13'W on MacIntosh Creek, 5 m upstream of its intersection with the North Canol Road and 100 m upstream of Station 10 on the South MacMillan River. Elevation 1183 m (3880 ft). Sample time: 1315 hr.	Stream bottom consists of gravel and cobbles cemented together with rust coloured sediment. 95% of gravel was discarded from the sediment sample.	Bank very stable. Vegetation includes buckbrush, mosses and lichens. 0% shade. Stream bottom and banks are an orange colour. Unlikely fish habitat and too shallow to electrofish.
10	63°10'N 130°13'W on the South MacMillan River 100 m from the North Canol Road and 200 m downstream of its confluence with MacIntosh Creek. 4.2 km downstream of Station 1. Elevation 1151 m (3775 ft). Sample time: 1355 hr.	Cobbles, small flat shale to fine sediment. 95% of gravel was discarded from the sediment samples which were collected from a gravel bar.	Banks very stable. River meanders. Vegetation includes buckbrush, grasses and moss. Area around the river is swampy. 0% shade. River looks suitable for fish was was too large for electrofishing.

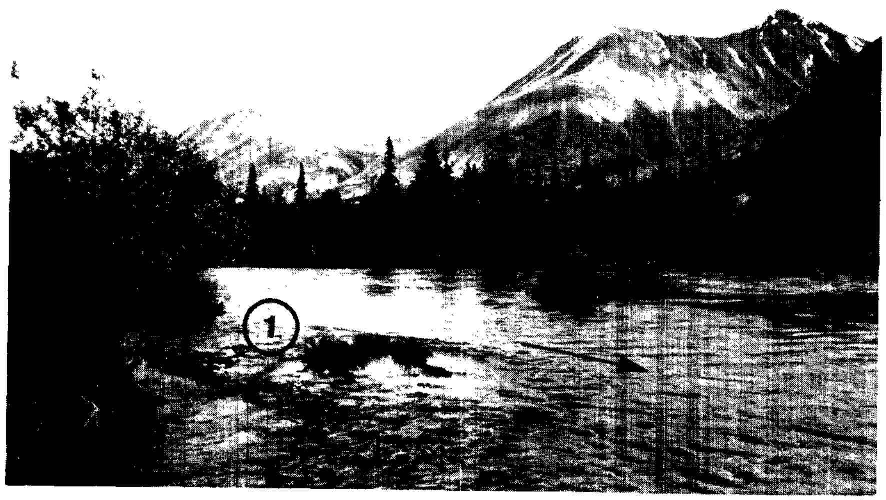

FIGURE 4 STATION 1 ON THE SOUTH MACMILLAN RIVER, 150 METRES UPSTREAM FROM SOUTH MACMILLAN RIVER BRIDGE 3. VEGETATION CONSISTS OF BUCKBRUSH, SPRUCE AND GRASSES.

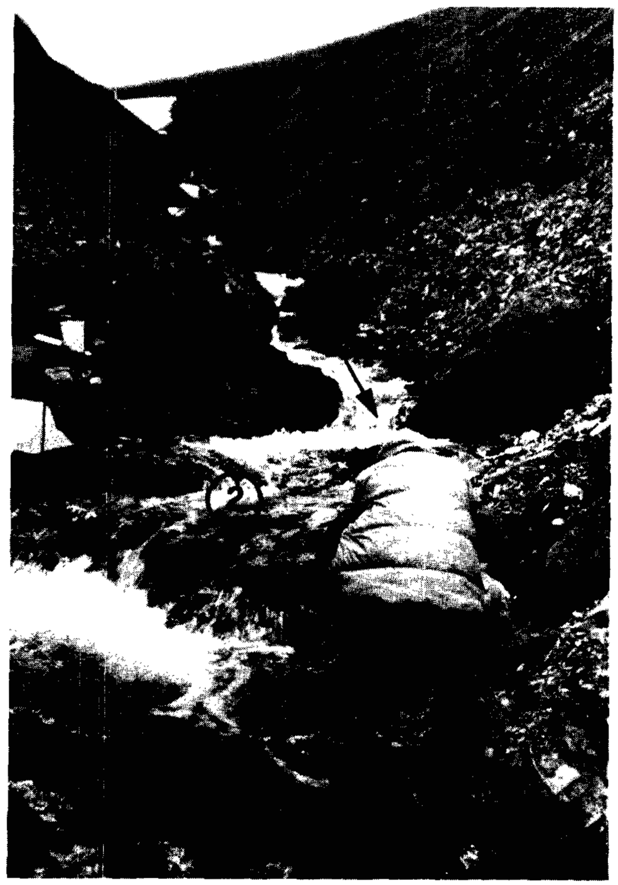

FIGURE 5 STATION 2 ON TOM CREEK 8 METRES UPSTREAM OF CAMP BACKFILL AND 30 METRES UPSTREAM OF A WATERFALL WHICH ACTS AS A BARRIER TO FISH. LICHEN AND MOSS SPARSELY COVER ROCKS TO THE WATER'S EDGE.

FIGURE 6 STATION 3 ON SEKIE CREEK 2, 10 METRES UPSTREAM OF THE TOM CAMP. LICHEN, MOSS, GRASSES AND LABRADOR TEA SPARSELY COVER ROCKS TO THE WATER'S EDGE. FALLS JUST DOWNSTREAM OF STATION ARE A BARRIER TO FISH.

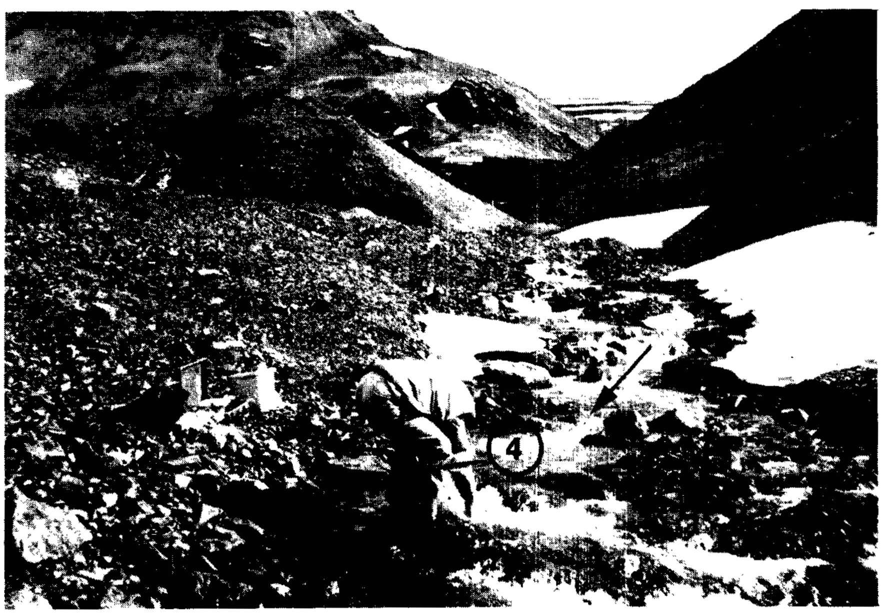

FIGURE 7 STATION 4 ON SEKIE CREEK 2, 50 METRES BELOW ITS CONFLUENCE WITH TOM CREEK. VEGETATION CONSISTS OF SPARSE LICHEN AND MOSS ON ROCKS.

FIGURE 8 STATION 5 LOCATED AT THE TOM MINE ADIT NEAR THE TOM CAMP. ADIT WATER IS PUMPED INTERMITTENTLY TO FORM RUST CREEK. NO VEGETATION IN DISTURBED AREA OF MINE PORTAL.

FIGURE 9 STATION 6 ON SEKIE CREEK 2, 15 METRES DOWNSTREAM FROM ITS CONFLUENCE WITH RUST CREEK. VEGETATION CONSISTS OF SPARSE LICHEN AND MOSS ON SCREE ROCKS. WATER QUALITY GREATLY CHANGED DURING INTERMITTENT DISCHARGE OF ADIT WATER FROM RUST CREEK.

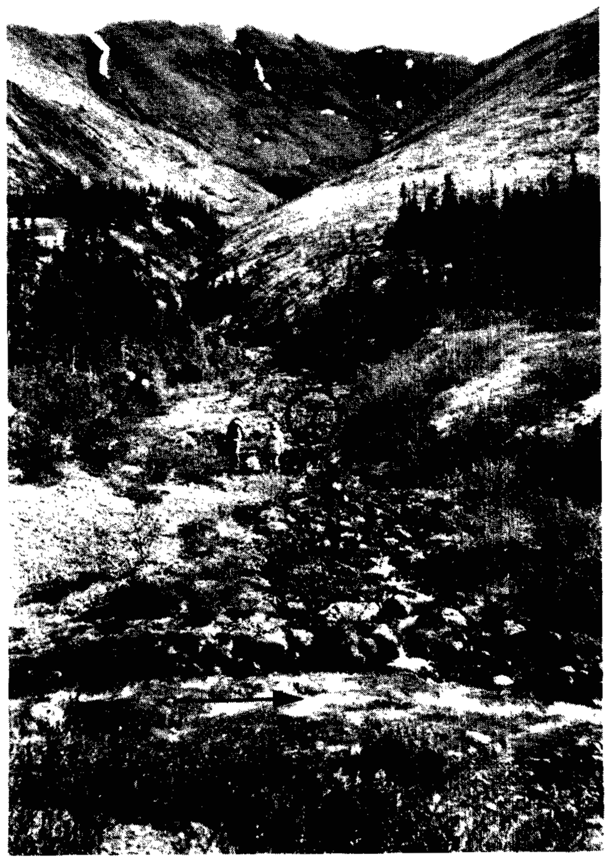

FIGURE 10 STATION 7 ON UNNAMED CREEK 1, 15 METRES UPSTREAM FROM ITS CONFLUENCE WITH SEKIE CREEK 2. VEGETATION CONSISTS OF MOSSES, WILLOWS, SPRUCE AND GRASSES. STEEP RAVINE WITH WATERFALLS .5 KM UPSTREAM WHICH ACTS AS A BARRIER TO FISH.

FIGURE 11 STATION 8 ON SEKIE CREEK 2, 90 METRES UPSTREAM OF ITS INTERSECTION WITH THE NORTH CANOL ROAD. SPARSE VEGETATION INCLUDES BUCKBRUSH, MOSSES AND LICHENS. WATER QUALITY GREATLY CHANGED DURING INTERMITTENT DISCHARGE OF ADIT WATER FROM RUST CREEK.

FIGURE 12 STATION 9 ON MACINTOSH CREEK, 5 METRES UPSTREAM OF ITS INTERSECTION WITH THE NORTH CANOL ROAD. VEGETATION INCLUDES BUCKBRUSH, MOSSES AND LICHENS.

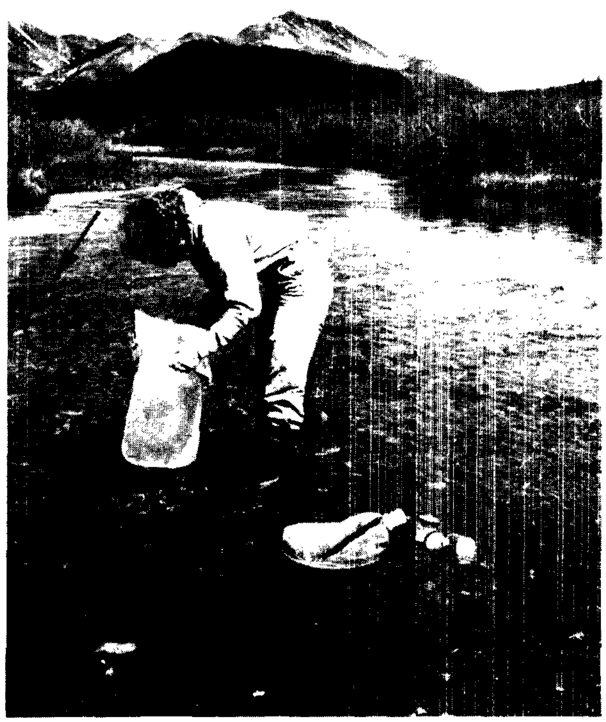

FIGURE 13 STATION 10 ON THE SOUTH MACMILLAN RIVER 200 METRES DOWNSTREAM OF ITS CONFLUENCE WITH MACINTOSH CREEK. VIEW UPSTREAM. AREA AROUND THE RIVER IS SWAMPY. LUSH VEGETATION INCLUDES BUCKBRUSH, GRASSES AND MOSS.

3 METHODS

Access to sample sites 1, 4, 5, 6, 8, 9 and 10 was by truck. Sample sites 2, 3 and 7 required a short hike. Each station with the exception of Stations 6 and 8 was sampled once on July 7, 1981. Water quality at Stations 6 and 8 was sampled at two different times on July 7, 1981 to assess the influence of the intermittent discharge of adit water into Rust Creek. Samples 6A and 8A were collected when mine adit water was being discharged into Rust Creek and subsequently into Sekie Creek 2. Within one hour of collection at Stations 6A and 8A a second sample was collected at the same locations, now called Stations 6B and 8B, at which time mine adit water was not being pumped into Rust Creek.

3.1 Water Quality

Water samples were collected and preserved at each of the ten (10) sample sites as described in Appendix I, Table 1.

Temperature, pH, flow and conductivity were measured in the field by the Environmental Protection Service staff. Dissolved Oxygen (DO) was measured the same day as collected in camp at MacMillan Pass. All other water quality analyses were done by Laboratory Services, Environmental Protection Service, 4195 Marine Drive, West Vancouver, B.C. Analytical methods are described in Appendix I, Table 1.

Single grab samples of water were collected and preserved where necessary for analysis of conductivity, pH, colour, turbidity, filterable residue (FR), non-filterable residue (NFR), total alkalinity, total hardness, total inorganic carbon (TIC), total organic carbon (TOC), total phosphates, nitrite, nitrate, ammonia, sulphate, cyanide, chloride and the following extractable metals:

Aluminum (Al)	Copper (Cu)	Selenium (Se)
Antimony (Sb)	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)

The percent dissolved oxygen (% DO) saturation was calculated by first determining the dissolved oxygen saturation concentration (S') from the formula:

$$S' = S \frac{P}{760}$$ (APHA et al 1975)

where S' = dissolved oxygen (DO) saturation concentration at the in situ temperature and atmospheric pressure

S = dissolved oxygen (DO) saturation concentration at sea level for in situ temperature

P = atmospheric pressure in mm of mercury (mm Hg) at site elevation

The percent dissolved oxygen saturation was obtained by using the ratio of field dissolved oxygen and S' in the following formula:

$$\frac{\text{Field DO}}{S'} \times 100 = \text{\% DO Saturation}$$

where Field DO = Dissolved Oxygen concentration measured in the field

3.2 Sediments

Sediment samples were collected at the same time as water samples at all stations on July 7, 1981. However, sediments were not collected at Station 5 as the adit water came directly from the mine and into a metal pipe. Four sediment samples were collected at each site, using an aluminum shovel to scoop the samples into labelled Whirl Pak bags. A description of sediment collection, preparation and analysis methods is given in Appendix I, Table 2. All sediment samples were shipped to Vancouver by air for analysis at Laboratory Services, Environmental Protection Service, West Vancouver, British Columbia.

One sediment sample per station was analysed for cyanide concentration. The other three sediment samples were each analyzed for particle size and the following leachable metals:

Aluminum (Al)	Iron (Fe)	Selenium (Se)
Antimony (Sb)	Lead (Pb)	Silicon (Si)
Arsenic (As)	Magnesium (Mg)	Silver (Ag)
Barium (Ba)	Manganese (Mn)	Sodium (Na)
Beryllium (Be)	Mercury (Hg)	Strontium (Sr)
Cadmium (Cd)	Molybdenum (Mo)	Tin (Sn)
Calcium (Ca)	Nickel (Ni)	Titanium (Ti)
Chromium (Cr)	Phosphorus (P)	Vanadium (V)
Copper (Cu)	Potassium (K)	Zinc (Zn)

3.3 Bottom Fauna

Bottom fauna were sampled at nine of the ten Environmental Protection Service sampling stations. The adit, Station 5, was unsuitable for bottom fauna collection as the water was flowing out of the mine through a metal pipe. Samples were collected at the same time as water and sediment samples on July 7, 1981. Three samples were collected at each site using a 30 cm x 30 cm Surber sampler (total area is 900 cm^2) with a mesh size of 0.76 mm. Bottom fauna collection, preservation and identification methods are given in Appendix I, Table 3.

Diversity indices were calculated from the bottom fauna data collected, using the formula described by Pielou (1975) as follows:

$$\text{Species Diversity } (H') = -\sum_{i=1}^{g}(P_i \log_{10} P_i)$$

where $P_i = n_i/N$

n_i = total number of individuals in the ith genus in one sample

N = total number of individuals identified to genus and/or species taxonomic level in one sample

g = total number of genera in one sample

The use of individuals identified to genus level instead of to species level results in slightly lower diversity indices (H') values (Hughes, 1978). Individuals that weren't identified to genus or species level were not included in the species diversity calculation but are listed in Appendix IV, Tables 1 and 2.

3.4 Fish

The study objective was to collect fish by electrofishing in order to obtain tissue samples for metals analysis. However, all stations presented difficulties to electrofishing and this method could not be used. Notes were made on whether sample streams looked suitable for fish habitat.

4 RESULTS AND DISCUSSION

4.1 Water Quality

TOM property water quality data is listed in Appendix II. Detection limits and analytical procedures for water quality are found in Appendix I, Table 1. All values were compared to the recommended levels for drinking water and aquatic life which are listed in Appendix I, Table 4.

Some of the parameters exceeding drinking water criteria were turbidity, ammonia (NH_3-N), hardness, nitrite (NO_2-N), aluminum (Al), arsenic (As), cadmium (Cd), iron (Fe), lead (Pb), manganese (Mn) and nickel (Ni). Ammonia concentrations and hardness were found to be the highest at Station 5 (mine adit) and during pumping of the mine at Station 6A (Sekie Creek 2). Ammonia was also found to be high at Station 8A, 8B (Sekie Creek 2) and Station 9 (MacIntosh Creek). Nitrite exceeded drinking water standards at Stations 5, 6 and 8. Elevated ammonia and nitrite levels at these stations could be attributed to explosives used in the underground mining operation. High values for turbidity at all stations except 1 and 7 could be associated with elevated levels of iron as well as other dissolved and suspended matter in the water. Aluminum and manganese levels were high at all sample locations except at Station 7 (Unnamed Creek). High levels for arsenic were exhibited at Stations 6A, 8A, 8B and 9 (MacIntosh Creek). It is assumed that these levels were attributable to natural elevated levels found in ground water. The same could be said for the elevated cadmium levels which were found at Stations 4, 6A, 6B, 8A, 8B (Sekie Creek 2) and Station 9 (MacIntosh Creek). Nickel levels exceeded recommended levels for drinking water at Station 9 and values for lead exceeded the limits for drinking water at Stations 5, 6A, 6B, 8A and 8B. Dramatic increases in lead levels occurred at Station 6A and 8A, which suggests that the pumping of adit discharge was the main source of contamination. Supporting data from Station 5 (adit), however, does not reflect this. Since sample collection at this site occurred much later in the day it is probable that work in the mine had changed and was no longer contributing lead and other constituents to the adit water. All measurements of selenium (Se) in the study area were below the analysis detection limit of 0.075 mg/l Se, although this detection limit is above the drinking water level of 0.01 mg/l Se. The concentrations of all the elevated metals reflect the presence of minerals containing them in the TOM ore body.

The total organic carbon analysis on Sekie Creek 2 above and below the exploration camp showed no increase below the camp suggesting that waste water from the camp was not affecting Sekie Creek 2.

A review of the TOM property water quality data indicates that several parameters did not meet with the recommended levels for aquatic life. At Station 7 (Unnamed Creek) non-filterable residue and conductivity are low for supporting healthy aquatic life. Total phosphate (PO_4-P) reached very high levels at Station 9 (MacIntosh Creek). Iron levels exceeded recommended levels for aquatic life in all stations except Station 1 (South MacMillan River), and Station 7 (Unnamed Creek). Arsenic levels were high at Stations 6A, 8A, 8B and 9. Aluminum levels were above recommended levels for all sample stations. High cadmium levels were demonstrated for all stations except for Station 7, which had a measurement below the detection limit of 0.0010 mg/l, although this detection limit is greater than the recommended aquatic life level of 0.0002 mg/l. Copper concentration was high at all sample locations except for Station 5 (mine adit) and Station 7. Nickel occurred in high concentrations at all stations except at Station 2 (TOM Creek) and Station 7 (Unnamed Creek).

Elevated background levels for lead were found upstream of the adit at Stations 3 and 4 as well as downstream at Stations 6B, 8B and 10. However, even higher, more dramatic levels were found during adit pumping at Stations 6A and 8A. Station 5 (adit) did not reflect this due to the time at which the samples were taken here. Zinc (Zn) exceeded recommended levels for aquatic life at all stations except

Station 7. Naturally high background levels were also found for zinc but once again a marked increase was seen at Station 6A, which suggests that adit discharge was contributing to the contamination. Dissolved oxygen was lower than the recommended levels at Station 9. These low levels could be attributed to ground water in the area and/or chemical interferences which have frequently arisen with the dissolved oxygen measurement. Background pH levels were found to be nearly 2 pH units below the 6.5 lower criteria limit at Stations 2, 3, 4, 6B, 7, 8B and 9. Station 8A also had a low pH, apparently not affected by mine adit discharge at the time Station 8A was sampled.

Mining activities on the TOM property have affected Sekie Creek 2 as was illustrated by the higher levels of turbidity, arsenic, copper, iron, nickel, lead and zinc in downstream Sekie Creek 2 when compared to upstream Stations 2, 3 and 4. Turbidity was increased by the flow of mine adit water into Sekie Creek 2.

Background stations on Sekie Creek 2 and MacIntosh Creek already have low pH levels and high metal concentrations that make them unsuitable for drinking water and aquatic life.

In the South MacMillan River parameters such as aluminium, cadmium, copper, nickel and zinc were slightly elevated over recommended levels for aquatic life. Due to its low buffering capacity, the addition of more acid and metals to the South Macmillan River during mine development would be detrimental.

4.2 Sediments

4.2.1 Sediment Metal Concentrations. Sediment metal concentrations are given in Appendix III, Table 1. Sediment metal concentrations are compared to those in other Yukon streams as given in Mathers et al, 1981. Metals that were higher are shown for each station in Table 2. Many metals are present in high concentrations reflecting the minerals present in the area, but the highest levels were found at Stations 6 and 8 which are downstream of adit discharge. The presence of some of

TABLE 2 TOM PROPERTY STATIONS WITH HIGH SEDIMENT METALS CONCENTRATIONS

Station	Location	High metal concentrations
1	South MacMillan River	As, Ba, Cd, Cu, Ni, Zn
2	Tom Creek	As, Ba, Cu, Fe, V
3	Sekie Creek 2	As, Ba, Hg, Pb
4	Sekie Creek 2	As, Ba, Cd, Hg, Pb, Zn
6	Sekie Creek 2	As, Ba, Cd, Cu, Fe, Hg, Pb, V, Zn
7	Unnamed Creek	As, Ba, Fe, Pb, V
8	Sekie Creek 2	As, Ba, Cd, Fe, Hg, Pb, V, Zn
9	MacIntosh Creek	As, Ba, Fe, V
10	S. MacMillan River	As, Ba, Cd, Cu, Ni, Pb, Zn

these metals has already been noted in the water quality results. Further disturbance and future mine and mill development may cause the leaching of other metals present at high levels in sediments, to the aquatic environment.

4.2.2 Sediment Particle Size Analysis. The results of the sediment particle size analysis are given in Appendix III, Table 2. Most of the sediment samples were coarse with a high percentage of the particles larger than 149 um. Station 3 (Sekie Creek 2) had the finest sediment with 32% finer than 149 um. Only the portion of sediment smaller than 149 um was analysed for metals since these particles are judged to have the most effect on the aquatic environment.

4.3 Bottom Fauna

A taxonomic list of bottom fauna collected in the TOM property study is given in Appendix IV, Table 1. Appendix IV, Table 2 lists the numbers of individuals in each taxonomic group in each sample, and the diversity index for that sample. A summary of the TOM property bottom fauna numbers and diversity is given in Table 3.

The diversity index is a measure of community structure and relative stability. Communities of high diversity are characterized by large numbers of species with no single species overwhelmingly abundant. Communities of low diversity contain few species some of which are represented in disproportionately high numbers. Generally diversity values greater than 0.90 in $\log_{10}$ (or 3.0 in $\log_2$) are found in unpolluted, productive waters while heavily polluted waters have values less than 0.30 in $\log_{10}$ (or 1.0 in $\log_2$), (Archibald, et al, 1981).

The diversity indices and numbers per m^2 in this study area are lower than those reported for other alpine streams in the nearby Howard's Pass area of Yukon by Archibald, et al, 1981. Stations 1, 3, 6, 8 and 9 displayed zero diversity while Stations 2, 4, 7 and 10

TABLE 3 SUMMARY OF THE TOM PROPERTY BOTTOM FAUNA DIVERSITY INDICES AND NUMBERS

STATION NUMBER	DIVERSITY (H')	NUMBER PER FT^2	CALCULATED NUMBER PER M^2
1-1	0	0	0
1-2	0	1	11
1-3	0	0	0
2-1	0	13	140
2-2	0	23	247
2-3	0.29	28	301
3-1	0	1	11
3-2	0	2	22
3-3	0	0	0
4-1	0	0	0
4-2	0.22	6	65
4-3	0	0	0
5-1	x	x	x
5-2	x	x	x
5-3	x	x	x
6-1	0	1	11
6-2	0	0	0
6-3	0	0	0
7-1	0.25	56	603
7-2	0.19	38	409
7-3	0.29	29	312
8-1	0	0	0
8-2	0	0	0
8-3	0	1	11
9-1	0	21	226
9-2	0	18	194
9-3	0	8	86
10-1	0	0	0
10-2	0.48	3	32
10-3	0.28	3	32

x = not sampled

demonstrated very low diversity and numbers. Station 5 (mine adit) was not suitable for sampling. The low diversity values found can be more appropriately attributed to the low pH, cold climate, low hardness and low conductivity values seen for these waters than to pollution. As a result, the streams sampled in this study appear to have a low capability to support bottom fauna and thus fish population.

A total of 252 bottom fauna were collected in the TOM property study area. Stations 1 and 10 (South MacMillan River) had low counts of one and six individuals respectively. Stations 3, 4, 6 and 8 (Sekie Creek 2) also had low counts of three, six, one and one individuals respectively. Station 7 far surpassed all other station counts with a total of 123 individuals or 49% of the total bottom fauna collected.

The most abundant genus was Heterotrissocladius sp. with 99 individuals collected. This genus belongs to the Order Diptera, Phylum Arthropoda. A review of taxonomic groups found at TOM and at Howard's Pass (Archibald, et al, 1981) shows that seven of the eleven found in the TOM study were common to both. However, 54 taxononic groups were identified at Howard's Pass as opposed to 11 in the TOM study.

REFERENCES

Amax Environmental Services Group, Environmental Report on the MacMillan Tungsten Property. Unpublished Report, Amax Northwest Mining Co. Ltd., Vancouver, B.C., 1976.

Anonymous, Guidelines for Establishing Water Quality Objective for the Territorial Waters of the Yukon and Northwest Territories. Report of the Working Group on Water Quality Objective to the Chairman, Water Boards, Yukon and Northwest Territories, July (1977).

APHA, AWWA, WPCF, Standard Methods for the Examination of Water and Wastewater. 14th Ed. (1975).

Archibald, P.L. and B.E. Burns, A Baseline Survey of the Water Quality and Biological Conditions in the Streams of the Howard's Pass Area, Yukon Territory. Environmental Protection Service, Regional Program Report 81-13 (1981).

Bentinck, W.C., et al, Aquatic Insects of California. University of California Press, Los Angeles, California, U.S.A. (1956).

Berry, L.G. and B. Mason, Mineralogy. W.H. Freeman and Company, San Francisco and London, Copyright, 1959.

Bidwell, G., Personal Communication, May 12, 1982. District Manager, Hudson Bay Exploration and Development Corporation Ltd., Whitehorse, Y.T. (1982).

Brown, G., JASON Property - Results of Water Quality Analyses, MacMillan Pass 1976-1981. Unpublished report, Pan Ocean Oil Ltd., Calgary, Alberta (1982).

REFERENCES (Continued)

Burns, B.E., Water Quality Investigations of Placer Gold Mining Streams in the Yukon Territory. Contaminants Contract Fund. Contract No. 05SB. KE114-0-2308, Unpublished 1980 data (1980).

California State Water Resources Control Board, Water Quality Criteria. Publication No. 3-A, Second Edition by McKee & Wolf (1963).

Carne, R.C. 1979, Geological Setting and Stratiform Mineralization TOM Claims, Yukon Territory. Department of Indian and Northern Affairs (1979).

Craig, D.B. and P.J. Laporte, 1972, North of 60 - Mineral Industry Report 1969 and 1970. Vol. 1 - Yukon Territory and South Western Sector, District of Mackenzie; Canada, Dept. of Indian Affairs and Northern Development, Northern Natural Resources and Environment Branch, Report EGS 1972-1.

Davidson, J., Personal Communication, (1981).

Department of Environment, Department of Fisheries and Oceans, Laboratory Manual. Environmental Protection Service, Fisheries and Marine Service (1979).

Department of Indian Affairs and Northern Development, Initial Environmental Evaluation of the North Canol Road. Unpublished report submitted to the Regional Environmental Review Committee of Department of Indian Affairs and Northern Development, Whitehorse, Yukon (1982).

REFERENCES (Continued)

Department of Indian Affairs and Northern Development, Yukon Geology and Exploration 1979 - 1980. Northern Affairs Program - Yukon Region, 1981b.

Environment Canada, Pollution Sampling Handbook. Pacific Region Laboratory Services, Fisheries Operations and Environmental Protection Service, West Vancouver, B.C. (1976).

Environment Canada, Annual Meteorological Summary 1978. Whitehorse (A), Yukon and Outlying Stations in Yukon and Northwestern British Columbia. Atmospheric Environment Service (1979).

Environment Canada, Annual Meteorological Summary 1979. Whitehorse (A), Yukon and Outlying Stations in Yukon and Northwestern British Columbia. Atmospheric Environment Service (1980).

Freberg, R.A., TOM Property, MacMillan Pass, Yukon Territory (Abst.); Can. Inst. Min. Metal, Bull., Vol. 69, p. 667 (1976) as quoted in Carne, 1979.

Gill, D., Cirque Lake IBP Study Area. Unpublished report submitted to Environmental Services Group, Amax Inc., Denver, Colorado, U.S.A. (1975).

Gill, D., Large Mammals of the MacMillan Pass Area, Northwest Territories and Yukon. Amax Northwest Mining Co. Ltd., Vanouver, B.C. (1979).

REFERENCES (Continued)

Health and Welfare Canada, Guidelines for Canadian Drinking Water Quality 1978. Supply and Services, Canada (1979).

Hughes, B.D., "The Influence of Factors Other Than Pollution on the Value of Shannon's Diversity Index for Benthic Macro-Invertebrates in Streams". Water Research Vol. 12, p. 359 (1978).

Inland Waters Directorate, Guidelines for Surface Water Quality, Vol. 1, Inorganic Chemical Substances. Environment Canada, Ottawa (1979, 1980).

Jack, M.E., and T.R. Osler, Baseline Study of the Watersheds Near the JASON Property, MacMillan Pass, Yukon Territory, Regional Program Report. Unpublished draft (1982).

Low, C.J. Ph.D., Personal Communication. Invertebrate Biologist Consultant, 33 Milton Street, Nanaimo, B.C. (January 1982).

Mathers, J.S., N.O. West and B. Burns, Aquatic and Wildlife Resources of Seven Yukon Streams Subject to Placer Mining. Government of Canada, Dept. of Fisheries and Oceans - Pacific Region (1981).

Marchand, M., J.A. Morin and D.B. Craig, Mineral Industry Report 1977 Yukon Territory. Department of Indian and Northern Affairs EGS 1978-9 (1978).

McNicholl, M. editor, Initial Environmental Assessment of JASON Property, MacMillan Pass Area, Yukon Territory. Unpublished report submitted to Pan Ocean Oil Ltd., by BEAK Consultants, Calgary, Alberta (1980).

REFERENCES (Continued)

Merritt, R.W. and K.W. Cummins, An Introduction to the Aquatic Insects of North America. Kendall/Hunt Publishing Company, Dubuque, Iowa (1978).

Monenco Consultants Ltd., Aquatic Studies at MacMillan Pass, Yukon Territory. Unpublished report submitted to Pan Ocean Oil Ltd., Calgary, Alberta (1982).

Morin, J.A., W.A. Sinclair, D.B. Craig, and M. Marchand, Mineral Industry Report 1976 Yukon Territory. Department of Indian and Northern Affairs, EGS 1977-1 pp. 114-115 (1977).

Ontario Ministry of the Environment, Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of Environment. (1978).

Pearson, A. and Associates, An Overview Description of Environmental Characteristics of the MacMillan Pass Area, Yukon Territory. Unpublished report submitted to Hudson Bay Mining and Smelting Co. Ltd., Whitehorse, Yukon (1981).

Pearson, A. and Associates, Wildlife and Aquatic Resources of the Area Adjacent to the Tom Property, MacMillan Pass, Yukon Territory. Unpublished Report submitted to Hudson Bay Mining and Smelting Co. Ltd., Whitehorse, Yukon (1982).

Pielou, E.C., Ecological Diversity, John Wiley and Sons Inc., Toronto, Chapter 1, Page 8 (1975).

REFERENCES (Continued)

Sinclair, W.D., J.A. Morin, D.B. Craig and M. Marchand, Mineral Industry Report 1975 Yukon Territory. Department of Indian and Northern Affairs, EGS 1976-15 pp. 6, 28. (1976).

Soroka, I. and M.E. Jack, Baseline Study of the Watershed Near Marbaco Mine, B.C. and Marbaco Mill, Yukon Territory. Environment Canada, Environmental Protection Service - Yukon Branch, Regional Program Report (In Press) (1982).

Thurston, R.V., R.C. Russo, C.M. Fetteroff, Jr., T.A. Edsall, and Y.M. Barber, Jr. (Eds.), A Review of the EPA Red Book: Quality Criteria for Water. Water Quality Section, American Fisheries Society, Bethesda, MD., 313p. (1979).

Wahl, H.E., Climate of Yukon. Atmospheric Environment Service, Whitehorse, Environment Canada. Unpublished report (1981).

ACKNOWLEDGEMENTS

The authors would like to thank all the Environmental Protection Service regular and 1981 summer staff for their involvement in sample collection, lab analysis, drafting, typing and manuscript review.

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		In situ temperature reading.	Standard Centigrade Thermometer	
Flow		Flow measurements taken for general evaluation purposes only.	Cross-section of stream was estimated and the velocity of flow was measured by noting the time it took a twig to travel a given length of the stream, i.e., 5 m. Flow measurement given in m^3/s.	
Dissolved Oxygen	1.00 mg/L	Duplicate samples collected in 300 mL glass BOD bottles. The BOD bottles were *rinsed 3 times* with sample before filling. Preserved with 2 mL manganese sulphate and 2 mL alkali-iodide-azide solution and shaken 15 times. A water seal was maintained and DO analysis was done within 7 days.	Iodometric Azide Modification Winkler Titration Method	048
pH		Small aliquots of sample were taken and read soon after collection. No preservative.	Potentiometric	080
Conductivity	0.2 umhos/cm	In situ measurement. Laboratory measurement. No preservative. The measurement was taken from the same as NH_3 below.	YSI Conductivity Meter Model 33 Radiometer Conductivity Meter (CDMC) with radiometer conductivity cell.	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	0.0050 mg/L	Single samples collected in 2 litre linear polyethylene containers. The 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
Turbidity	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 weighing of filtrate	100
Total Alkalinity	1.0 mg/L as $CaCO_3$	Same sample as NH_3.	Potentiometric Titration	006
Total Organic Carbon (TOC)	1.0 mg/L	Single samples collected in 100 mL glass jars. No preservative. Stored at 4°C.	Carbon Infra-red Analyzer	016
Total Inorganic Carbon (TIC)	1.0 mg/L	Same sample as TOC	Carbon Infra-red Analyzer	016
Total Phosphate T PO_4-P	0.0050 mg/L	Same sample as NH_3.	Acid-persulphate, Autoclave Digestion	086

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]
Nitrite NO_2-N	0.0050 mg/L	Same sample as NH_3.	Diazotization-Colorimetric-Automated	070
Nitrate NO_3-N	0.010 mg/L	Same sample as NH_3.	Cadmium Copper Reduction Colorimetric Automated	072
Sulphate SO_4	1.00 mg/L	Same sample as NH_3.	Barium Chloranilate -UV Spectrophotometric	122
Chloride Cl	0.50 mg/L	Same sample as NH_3.	Thiocyanate-Combined Reagent-Colorimetric	024
Cyanide CN	0.03 mg/L	Sample was collected in a 1 litre nalgene wide mouth bottle, which was rinsed 3 times with sample before filling. The sample was preserved with NaOH pellets to pH >12 and stored at 4°C.	Tetracyanonickelate (II) - UV - Colorimetric	032
Silica Total Si	0.50 mg/L	Same sample as NH_3.	Ascorbic Acid Reduction - Colorimetric	118
Mercury Total Hg	0.00020 mg/L	Single samples were collected in a 200 mL linear polyethylene bottle. Preserved with a 10 mL of nitric dichromate solution.	Open Flameless System for Hg-AAS Determination	211 224 284 411

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 Metals	mg/L	Single samples collected in 200 mL linear polyethylene bottles. The bottle was rinsed 3 times with sample before filling. Preserved to a pH <1.5 using 2.0 mL concentrated HNO_3.	Inductively Coupled Argon Plasma (ICAP) combined with Optical Emission Spectrometer (OES)	210 592
Al	0.050			
As	0.075			
Ba	0.0015			
Be	0.0010			
Ca	0.050			
Cd	0.0040			
Co	0.0075			
Cr	0.0075			
Cu	0.0050			
Fe	0.0050			
Mg	0.10			
Mn	0.0010			
Mo	0.015			
Na	0.50			
Ni	0.040			
Pb	0.040			
Sb	0.040			
Se	0.075			
Sn	0.10			
Sr	0.0020			
Tl	0.0040			
V	0.020			
Zn	0.0050			

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]
Cd	0.0010	Same sample as metals.	Graphite Atomic Absorption Flameless Technique (AAS)	Atomic Absorption Jerrel-Ash 850 Manual
Cu	0.0010	Same sample as metals.		
Pb	0.0010	Same sample as metals.		
Zn	0.0010	Same sample as metals.		
Ag	0.030 mg/L	Same sample as metals.	Flame Atomic Absorption Spectrophotometry	210 290
K	0.010 mg/L	Same sample as metals.	Flame Atomic Emission Spectrophotometry	210 423
Total Hardness	0.030 mg/L as $CaCO_3$	Same sample as metals.	The sum of the ICAP results for Mg x 4.116 and Ca x 2.497 reported as mg/l $CaCO_3$	

1 As described in Environment Canada (1976).

2 As described in Department of Environment (1979).

APPENDIX I TABLE 2 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS

PARAMETER	COLLECTION/PREPARATION	ANALYSIS	METHOD CODE[1]
All Parameters	Creek and River Stations: Sediment samples were collected using an aluminum shovel to scoop sample into pre-labelled Whirl-Pak bags. Four samples were taken at each station. Samples were kept cool and were frozen (-19°C) as soon as possible.		
Cyanide CN	Some distilled water was added to a known weight of sediment sample before starting the digestion step in the analytical procedure.	Tetracyanonickelate (II) - UV - Colorimetric Method	032
Mercury Hg (Total)	Sample was freeze-dried for 48 hours to remove water. Sample was sieved through a size 100 mesh (.15 mm) stainless steel sieve. The portion passing through was analyzed for mercury. Sample was completely oxidized by digestion with H_2SO_4 and H_2O_2.	Atomic Absorption Spectrophotometer - Open Flameless System	231 236 238 275 284 411
Metals (Leachable) Al Ba Be Ca Cd Cr Cu	Same as Mercury except portion passing through was analyzed for metals. Sample was leached with HCl and HNO_3. The sample was heated for 3 hours.	Inductively Coupled Argon Plasma (ICAP) Combined with Optical Emission Spectrometer (OES)	231 236 238 242

APPENDIX I TABLE 2 SEDIMENT COLLECTION, PREPARATION AND ANALYSIS METHODS (continued)

PARAMETER	PREPARATION	ANALYSIS	METHOD CODE[1]
Metals (Leachable) (continued)			
Fe			
Mg			
Mn			
Mo			
Na			
Ni			
P			
Pb			
Si			
Sn			
Sr			
Ti			
V			
Zn			
As	Same as other metals.	Hydride Generation ICAP	J. Davidson
[2]Sb	Same as other metals.	Hydride Generation ICAP	EPS Lab
[2]Se	Same as other metals.	Hydride Generation ICAP	
Ag	Same as other metals.	Flame Atomic Absorption Spectrophotometry	290
Cd	Same as other metals.	Graphite Flameless Atomic Absorption	Jerrel-Ash 850 Manual
K	Same as other metals.	Flame Atomic Emission Spectrophotometry	423
Particle Size	Sample was freeze-dried.	Standard Sieving Operation	078

1 Department of Environment, Department of Fisheries and Oceans, Laboratory Manual, Environmental Protection Service, Fisheries and Marine Service (1979).

2 The concentrations of Sb and Se are for information only since the analysis method has not yet been fully tested.

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

FIELD COLLECTION, SAMPLING PROCEDURES AND PRESERVATION	LABORATORY PROCEDURES	IDENTIFICATION AND ENUMERATION
Surber Sampler: Creek and river samples were taken using a Surber Sampler with a 60 cm long net (mesh size 0.76 mm). Area sampled was 900 cm^2 (1 ft^2). Surber samples were washed into a cup at the bottom of a plankton net (.75 mm mesh size), put in separate labelled glass jars and preserved with 10% formalin. 3 samples were taken at each station.	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)
<u>Physical</u>				
Colour Pt. Counts	15	1		
Odour and taste	0	1		
Turbidity J.T.U.	5	1		
<u>Chemical</u>				
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	5
Ammonia (NH_3-N) mg/L	0.5 (Total)	4	0.02 (un-ionized)	3
Antimony (Sb) mg/L				
Arsenic (As) mg/L	0.05	1	0.05	2
Barium (Ba) mg/L	1.0	1	5.0	7
Boron (Bo) mg/L	1.0	1		
Cadmium (Cd) mg/L	0.005	1	0.0002	2
Calcium (Ca) mg/L	75-200	7		
Chloride (Cl) mg/L	250	1		
Chromium (Cr) mg/L	0.05	1	0.04	2
Cobalt (Co) mg/L				
Conductivity @ 25°C (umhos/cm)	Depends on dissolved salts	7	150-500	6
Copper (Cu) mg/L	1.0	1	0.005	5
Cyanide (CN) mg/L	0.2	1	0.005	3
Dissolved oxygen (% saturation)	Near 100%	4	$\geq$5.0 mg/L	3

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(S)
Fluoride (F) mg/L	1.5	1	1.5	7
Hardness (Total) as mg/L $CaCO_3$	80-100	1		
Iron (Fe) mg/L	0.3	1	1.0	3
Lead (Pb) mg/L	0.05	1	0.005 (soft H_2O*)	2
			0.01 (hard H_2O*)	2
Magnesium (Mg) mg/L	50	4		
Manganese (Mn) mg/L	0.05	1	1.0	7
Mercury (Hg) mg/L	0.002	1	0.0001-0.0002	2
Molybdenum (Mo)				
Nickel (Ni) mg/L	0.25	2	0.025 (soft H_2O*)	2
			0.25 (hard H_2O*)	2
Nitrate (NO_3-N) mg/L	10	1		
Nitrite (NO_2-N) mg/L	0.001	1		
pH units	6.5 - 8.5	1	6.5 - 9.0	3
Phosphorus (P) mg/L (Total)			0.020 to prevent algae	5
Potassium (K) mg/L				
Residue: Filterable mg/L (Total dissolved solids)	1000	4	70 - 400 with a maximum of 2000	6
Residue: Non-Filterable (mg/L)				
Selenium (Se) mg/L	0.01	1	0.01	2
Silica (Si) mg/L				
Silver (Ag) mg/L	0.05	1	0.0001	2
Sodium (Na) mg/L	20	1		
Strontium (Sr) mg/L	10	1		
Sulphate (SO_4) mg/L	500	1		
Tin (Sn) mg/L	Not present in natural waters	7		
Titanium (Ti) mg/L				

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(S)
Total Inorganic Carbon (TIC)				
Total Organic Carbon (TOC)	5.0	5		
Vanadium (V)				
Zinc (Zn) mg/L	5.0	1	0.030	5

* Soft water has a total hardness less than 95 mg/L as $CaCO_3$. Hard water has a total hardness of more than 95 mg/L as $CaCO_3$ (Reference 6).

REFERENCES:

1. Health & Welfare Canada, Guidelines for Canadian Drinking Water Quality 1978, Supply and Services, Canada (1979).

2. Inland Waters Directorate, Guidelines for Surface Water Quality, Vol. 1, Inorganic Chemical Substances. Environment Canada, Ottawa (1979, 1980).

3. Thurston, R.V., R.C. Russo, C.M. Fetteroff Jr., T.A. Edsall, and Y.M. Barber Jr. (Eds.), A Review of the EPA Red Book: Quality Criteria for Water. Water Quality Section, American Fisheries Society, Bethesda, MD, 313p. (1979).

4. Anonymous, Guidelines for Establishing Water Quality Objectives for the Territorial Waters of the Yukon and Northwest Territories. Report of the Working Group on Water Quality Objectives to the Chairmen, Water Boards, Yukon and Northwest Territories, July (1977).

5. Ontario Ministry of the Environment, Water Management - Goals, Policies, Objectives and Implementation Procedures of the Ministry of the Environment. (1978).

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(S)

6. Environment Canada, Pollution Sampling Handbook. Pacific Region Laboratory Services, Fisheries Operations and Environmental Protection Service, West Vancouver, B.C. (1976).

7. California State Water Resources Control Board, Water Quality Criteria. Publication No. 3-A Second Edition by McKee and Wolf. (1963).

APPENDIX II

WATER QUALITY DATA

APPENDIX II   TOM PROPERTY WATER QUALITY DATA - JULY 7, 1981

STATION NUMBER	FLOW m^3/s	TEMP (°C)	D.O. (mg/L)	% D.O. SATURATION (%)	IN SITU pH	LAB pH	IN SITU CONDUCTIVITY (umhos/cm)	LAB CONDUCTIVITY (umhos/cm)	COLOUR (colour units)	TURBIDITY (FTU)	N.F.R. (mg/L)
1	6.9 (e)	9	9.53	95	7.60	6.5	80	139	<5	2.0	8.5
2	0.09(e)	4	10.10	92	4.60	3.6	80	158	7	5.5	9.5
3	0.06(e)	6	10.35	99	4.30	3.4	128	205	<5	24.0	35.0
4	0.08(e)	7	9.80	95	3.95	3.5	131	224	<5	13.0	8.5
5	-	5	8.05	75	6.75	7.5	270	480	5	47.0	45.5
6A	0.08(e)	4	10.10	91	6.25	6.6	130	324	5	140	361
6B	0.08(e)	4	10.48	95	3.98	3.5	129	240	<5	15.0	10.0
7	0.04(e)	6	10.55	100	4.20	4.2	30	40.9	<5	<1.0	<5
8A	0.4(e)	6	8.70	80	3.55	3.3	230	433	5	82.0	98.0
8B	0.4 (e)	6	9.50	88	3.50	3.2	218	429	<5	10.0	10.0
9	0.03(e)	8	4.45	43	3.30	2.9	500	885	5	120	39.0
10	1.8 (e)	7	9.50	89	6.50	7.0	110	175	<5	6.3	14.0

(e) very rough estimate

APPENDIX II TOM PROPERTY WATER QUALITY DATA - JULY 7, 1981 (continued)

STATION NUMBER	F. RESIDUE (mg/L)	TOTAL ALKALINITY (mg/L as $CaCO_3$)	TOTAL HARDNESS (mg/L as $CaCO_3$)	T.O.C. (mg/L C)	T.I.C. (mg/L C)	TOTAL PO_4-P (mg/L)	NO_2-N (mg/L)	NO_3-N (mg/L)	*NH_3-N (mg/L)	SO_4 (mg/L)	CN (mg/L)	Cl (mg/L)
1	93	5.60	48.2	-	-	0.0080	<0.0050	0.033	0.0073	43.5	<0.03	<0.50
2	90	-	10.1	-	-	0.0440	<0.0050	0.067	0.0699	41.3	<0.03	<0.50
3	83	-	6.6	1.0	<1.0	0.0081	<0.0050	0.115	0.0520	41.5	<0.03	0.52
4	94	-	10.7	1.0	<1.0	0.0260	<0.0050	0.089	0.0829	53.2	<0.03	0.59
5	335	36.8	200.0	-	-	0.0230	0.310	2.24	2.68	179	<0.03	0.68
6A	223	8.80	123.0	-	-	0.0380	0.106	1.38	1.84	129	<0.03	0.69
6B	122	-	17.6	-	-	0.0240	0.0056	0.151	0.126	42.9	<0.03	0.57
7	54	-	-	-	-	<0.0050	<0.0050	0.182	0.0126	9.35	<0.03	<0.50
8A	253	-	50.8	-	-	0.130	0.0220	0.398	0.865	147	<0.03	0.59
8B	227	-	25.6	1.0	<1.0	0.0180	<0.0050	0.169	0.675	136	<0.03	0.61
9	607	-	41.1	-	-	1.10	<0.0050	0.187	0.876	162	<0.03	0.59
10	119	19.2	71.0	-	-	0.0180	<0.0050	0.044	0.0223	57.9	<0.03	0.62

*The un-ionized fraction of all these concentrations was calculated to be <0.02 mg/L

APPENDIX II TOM PROPERTY WATER QUALITY DATA - JULY 7, 1981 (continued)

STATION NUMBER	Ag mg/L	Al mg/L	As 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	Hg mg/L	K mg/L
1	<0.030	1.32	<0.075	0.0317	<0.001	12.8	0.0034	<0.0075	<0.0075	0.0102	0.628	<0.00020	0.392
2	<0.030	2.89	<0.075	0.196	<0.001	3.29	0.0039	0.0137	<0.0075	0.0233	4.12	<0.00020	0.611
3	<0.030	2.60	<0.075	0.0909	<0.001	1.77	0.0023	0.0123	<0.0075	0.0510	2.37	<0.00020	0.448
4	<0.030	3.45	<0.075	0.107	<0.001	3.15	0.0101	0.0149	<0.0075	0.0576	3.48	<0.00020	0.572
5	<0.030	0.708	<0.075	0.255	<0.001	63.5	0.0055	0.0365	<0.0075	0.0037	7.14	<0.00020	4.26
6A	<0.030	5.87	0.136	0.659	<0.001	39.9	0.0194	0.0942	0.0118	0.141	29.7	<0.00020	2.24
6B	<0.030	3.60	<0.075	0.278	<0.001	5.25	0.0121	0.0178	<0.0075	0.0672	4.14	<0.00020	0.630
7	<0.030	0.52	<0.075	0.115	<0.001	0.228	<0.0010	<0.0075	<0.0075	0.0012	0.0331	<0.00020	0.323
8A	<0.030	11.1	0.167	0.501	<0.001	15.4	0.0195	0.0741	0.0093	0.0567	21.1	<0.00020	1.29
8B	<0.030	10.5	0.157	0.177	<0.001	7.09	0.0174	0.0607	<0.0075	0.0471	15.6	<0.00020	0.932
9	<0.030	32.9	0.445	0.0151	0.0019	6.94	0.0328	0.178	0.0330	0.0945	49.7	<0.00020	2.04
10	<0.030	1.58	<0.075	0.0445	<0.001	18.8	0.0030	0.0076	<0.0075	0.0094	1.50	<0.00020	0.422

APPENDIX II TOM PROPERTY WATER QUALITY DATA - JULY 7, 1981 (continued)

STATION NUMBER	Mg mg/L	Mn mg/L	Mo mg/L	Na mg/L	Ni mg/L	Pb mg/L	Sb mg/L	Se mg/L	Si mg/L	Sn mg/L	Sr mg/L	Tl mg/L	V mg/L	Zn mg/L
1	3.94	0.0637	<0.015	<0.50	0.055	<0.0010	<0.040	<0.075	2.59	<0.10	0.0527	<0.0040	<0.020	0.231
2	0.45	0.0603	<0.015	<0.50	<0.040	<0.0010	<0.040	<0.075	3.17	<0.10	0.0162	<0.0040	0.022	0.230
3	0.53	0.0678	<0.015	<0.50	0.051	0.0172	<0.040	<0.075	3.78	<0.10	0.0181	<0.0040	<0.020	0.137
4	0.68	0.123	<0.015	<0.50	0.055	0.0420	<0.040	<0.075	3.54	<0.10	0.0187	<0.0040	<0.020	1.55
5	10.0	0.552	<0.015	1.93	0.098	0.0590	<0.040	<0.075	3.11	<0.10	0.215	0.0095	<0.020	1.06
6A	5.63	0.586	<0.015	1.04	0.126	3.33	<0.040	<0.075	3.46	<0.10	0.124	0.0268	<0.020	3.62
6B	1.08	0.157	<0.015	<0.50	0.064	0.0940	<0.040	<0.075	3.58	<0.10	0.0248	<0.0040	<0.020	1.99
7	<0.10	0.0076	<0.015	<0.50	<0.040	<0.0010	<0.040	<0.075	4.14	<0.10	0.0103	<0.0040	<0.020	0.0297
8A	3.00	0.293	<0.015	<0.50	0.188	0.596	<0.040	<0.075	5.29	<0.10	0.0556	0.0106	0.036	2.29
8B	1.91	0.210	<0.015	<0.50	0.164	0.080	<0.040	<0.075	4.68	<0.10	0.0321	<0.0040	0.024	2.15
9	5.77	0.246	<0.015	<0.50	0.491	<0.0010	<0.040	<0.075	9.06	<0.10	0.0385	<0.0040	0.266	1.79
10	5.84	0.0571	<0.015	<0.50	0.059	0.0033	<0.040	<0.075	2.38	<0.10	0.0652	<0.0040	<0.020	0.287

APPENDIX III

SEDIMENT DATA

APPENDIX III TABLE 1 TOM PROPERTY SEDIMENT CHEMISTRY DATA - JULY 7, 1981
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	CN *w/w	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn
1-1	<2	<4.84	18500	65.1	6280	0.831	1620	0.878	29.5	121.0	52300	0.296	2270	1200	387.0
1-2		<4.90	19300	70.7	5920	0.808	1680	1.34	33.5	131.0	53900	0.348	2290	1220	463.0
1-3		<4.89	18600	60.5	6420	0.855	1610	0.829	30.2	122.0	51600	0.382	2230	1220	370.0
2-1	<2	<4.98	10900	128.0	5640	<0.166	388.0	<0.58	60.0	33.1	143000	0.368	2040	594.0	31.6
2-2		<4.86	12000	165.0	10200	<0.324	405.0	<0.57	70.9	43.1	176000	0.336	1970	623.0	33.3
2-3		<4.92	11200	136.0	5560	<0.164	408.0	<0.58	63.3	35.5	75800	0.336	2030	595.0	35.6
3-1	<0.2	<4.88	5540	52.8	5880	<0.163	180.0	<0.57	21.4	28.5	42900	0.722	1280	275.0	13.6
3-2		<4.96	4370	30.8	3160	<0.166	116.0	<0.58	11.8	16.6	16600	0.649	1050	169.0	8.06
3-3		<4.84	5630	52.1	6020	<0.161	180.0	<0.57	20.8	26.8	40400	0.672	1300	285.0	14.5
4-1	<0.2	<4.95	7490	38.8	5750	<0.165	147.0	0.64	20.4	18.8	30800	0.911	1870	532.0	35.6
4-2		<4.95	8060	53.6	6080	<0.165	213.0	0.81	22.4	19.7	35000	0.869	1960	581.0	34.6
4-3		<4.93	7910	58.8	5850	<0.163	174.0	0.64	23.9	19.3	39600	0.961	1970	554.0	36.0
6-1	<0.2	<4.88	8700	97.0	5670	<0.163	489.0	1.39	46.3	31.1	106000	1.14	1790	635.0	59.2
6-2		<4.87	10100	78.7	5380	<0.163	3820	5.27	38.8	50.9	63500	1.50	1930	1030	178.0
6-3		<4.94	11100	76.8	5460	<0.165	6050	6.28	42.3	62.2	67200	2.11	1980	1270	209.0

* w/w means mg/kg wet weight, total sample. All other measurements in this table are given in mg/kg dry weight for the portion passing a 150 um sieve.

APPENDIX III TABLE 1 TOM PROPERTY SEDIMENT CHEMISTRY DATA - JULY 7, 1981 (continued)
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	CN *w/w	Ag	Al	As	Ba	Be	Ca	Cd	Cr	Cu	Fe	Hg	K	Mg	Mn
7-1		<4.98	7220	57.0	5180	<0.166	221.0	<0.58	36.1	16.4	155000	0.438	1820	451.0	11.4
7-2		<4.90	9200	64.9	5420	<0.163	218.0	<0.57	38.5	17.4	117000	0.812	2300	569.0	12.6
7-3		<4.83	7300	58.7	3960	<0.161	254.0	<0.56	38.1	16.8	154000	0.622	1790	468.0	12.9
8-1	<0.2	<4.88	7330	114.0	6110	<0.165	323.0	4.15	26.9	32.4	64700	1.61	1760	459.0	56.8
8-2		<4.97	7890	194.0	6180	<0.166	327.0	2.86	51.4	38.1	112000	1.14	1710	488.0	54.2
8-3		<4.88	7410	155.0	5790	<0.163	376.0	3.71	36.5	37.8	91900	1.24	1570	481.0	64.8
9-1		<4.85	8080	117.0	4390	<0.323	163.0	<0.58	72.4	16.7	171000	0.332	1880	549.0	9.17
9-2		<4.87	8340	129.0	3700	<0.325	208.0	<0.58	78.9	14.7	190000	0.261	1930	619.0	10.0
9-3		<4.91	6620	143.0	2860	<0.327	215.0	<0.57	84.0	15.4	210000	0.276	1540	480.0	8.10
10-1	<0.2	<4.97	18200	84.5	5520	0.654	3590	6.13	36.9	119.0	64300	0.344	2050	1250	695.0
10-2		<4.83	18600	74.6	5490	0.676	3440	5.52	32.9	113.0	61600	0.289	2060	1240	580.0
10-3		<4.89	19000	61.9	5770	0.733	3610	4.84	29.4	115.0	53300	0.345	1970	1560	337.0

* w/w means mg/kg wet weight, total sample. All other measurements in this table are given in mg/kg dry weight for the portion passing a 150 um sieve.

APPENDIX III TABLE 1 TOM PROPERTY SEDIMENT CHEMISTRY DATA - JULY 7, 1981 (continued)
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	Mo	Na	Ni	P	Pb	***Sb	***Se	Si	Sn	Sr	Ti	V	Zn
1-1	6.24	86.2	68.6	1610	28.6	5.77	4.66	2700	<16.1	41.5	171.0	128.0	386.0
1-2	11.5	<83.2	73.7	1680	31.6	4.99	4.69	3010	<16.3	41.5	175.0	128.0	407.0
1-3	6.67	<89.5	68.9	1570	28.0	4.79	4.42	3150	<16.3	41.4	180.0	129.0	383.0
2-1	17.1	<87.9	10.8	4590	<6.63	16.5	15.1	2930	<16.6	50.3	285.0	1090	46.7
2-2	24.3	<162.0	<15.9	6150	<13.0	18.9	16.3	3210	<32.4	51.6	254.0	1350	57.9
2-3	14.3	<82.0	15.7	4910	<6.56	16.4	15.8	3050	<16.4	50.4	290.0	1130	51.7
3-1	16.9	175.0	<6.50	732.0	126.0	7.87	7.78	3490	<16.3	33.0	90.7	181.0	22.9
3-2	14.2	148.0	<6.61	298.0	64.4	6.36	6.39	3360	<16.6	26.8	58.3	82.3	8.26
3-3	16.8	167.0	<6.45	693.0	133.0	8.44	8.76	3350	<16.2	33.9	90.8	174.0	19.8
4-1	19.7	<82.5	8.17	972.0	188.0	10.4	9.86	3450	<16.5	38.0	150.0	235.0	244.0
4-2	19.7	85.8	<6.60	1110	242.0	12.8	12.6	2770	<16.5	39.2	164.0	261.0	296.0
4-3	17.8	<81.7	<6.54	1260	171.0	13.4	12.9	3020	<16.3	38.9	169.0	303.0	223.0
6-1	11.3	102.0	14.1	2800	1520	15.6	12.1	5590	<16.3	45.8	179.0	741.0	707.0
6-2	13.9	82.8	26.7	1780	409.0	15.1	11.8	3800	<16.3	49.4	196.0	422.0	1490
6-3	15.5	117.0	29.7	1810	552.0	13.9	11.0	4010	<16.4	57.3	220.0	426.0	1740

*** Concentrations of Sb and Se are given for information only since method is not fully tested.

APPENDIX III TABLE 1 TOM PROPERTY SEDIMENT CHEMISTRY DATA - JULY 7, 1981 (continued)
(all concentrations given in mg/kg dry weight unless otherwise noted)

STATION	Mo	Na	Ni	P	Pb	***Sb	***Se	Si	Sn	Sr	Ti	V	Zn
7-1	20.7	<82.9	<6.64	702.0	36.7	14.1	19.7	4950	<16.6	32.6	145.0	712.0	21.0
7-2	30.8	<81.6	<6.52	847.0	61.4	17.9	27.7	2810	<16.3	38.9	181.0	590.0	16.5
7-3	19.2	<83.0	<6.44	715.0	36.5	15.3	21.5	2950	<16.1	32.7	145.0	764.0	16.8
8-1	6.40	<82.1	7.07	1060	586.0	11.3	9.97	2680	<16.4	35.5	144.0	310.0	1280
8-2	<4.40	<82.8	14.4	2080	502.0	12.4	10.3	2930	<16.6	36.9	139.0	521.0	1240
8-3	4.16	<81.3	10.1	1490	503.0	11.7	9.65	4080	<16.3	40.1	137.0	429.0	1370
9-1	7.79	<162.0	<12.9	5120	<12.9	7.71	11.5	4630	<32.3	27.1	118.0	2100	15.3
9-2	<13.0	<162.0	<13.0	5520	<13.0	6.82	10.7	4330	<32.5	23.6	117.0	2360	12.7
9-3	10.6	<164.0	<13.1	6100	<13.1	6.62	11.0	4140	<32.7	22.1	97.6	2590	11.7
10-1	10.1	<82.8	133.0	2720	67.4	5.98	5.27	4240	<16.6	57.6	176.0	218.0	839.0
10-2	8.78	81.3	119.0	2500	80.7	5.91	5.25	4030	<16.1	56.1	184.0	207.0	778.0
10-3	9.64	<83.0	99.9	2160	73.1	5.40	4.92	4520	<16.3	55.5	189.0	184.0	706.0

*** Concentrations of Sb and Se are given for information only since method is not fully tested.

APPENDIX III TABLE 2 TOM PROPERTY SEDIMENT PARTICLE SIZE ANALYSIS - JULY 7, 1981

STATION NUMBER	PERCENT CONCENTRATION				
	>500 um	250-500 um	150-250 um	63-150 um	<63 um
1-1	65.7	21.0	7.7	4.5	1.1
1-2	67.8	20.7	6.6	3.2	1.7
1-3	80.9	13.3	3.4	1.9	0.5
2-1	95.0	2.9	0.9	0.5	0.7
2-2	85.6	8.5	3.2	1.6	1.1
2-3	86.3	8.3	3.0	1.5	0.9
3-1	36.2	19.6	16.4	18.0	9.8
3-2	16.4	13.3	22.0	14.1	34.2
3-3	38.7	25.8	16.9	13.9	4.7
4-1	46.2	23.7	14.5	12.1	3.5
4-2	57.7	19.3	11.7	8.2	3.1
4-3	74.0	13.3	6.5	4.9	1.3
6-1	87.1	5.4	3.0	2.8	1.7
6-2	83.5	6.1	3.4	2.2	4.8
6-3	73.7	9.2	5.4	6.6	5.1
7-1	76.0	11.9	5.8	4.5	1.8
7-2	79.6	8.0	3.9	4.2	4.3
7-3	71.1	13.9	6.8	4.7	3.5
8-1	74.4	12.4	6.8	3.8	2.6
8-2	82.6	11.9	3.6	1.4	0.5
8-3	81.0	11.9	4.1	2.0	0.9
9-1	71.8	12.2	5.9	5.4	4.7
9-2	62.8	13.4	6.9	8.7	8.2
9-3	66.7	13.3	6.6	7.2	6.2
10-1	72.7	15.9	6.5	3.3	1.6
10-2	81.7	12.0	4.1	1.7	0.5
10-3	65.9	9.6	8.8	10.0	5.7

APPENDIX IV

BOTTOM FAUNA DATA

APPENDIX IV TABLE 1 BOTTOM FAUNA TAXONOMIC GROUPS FOUND IN THE TOM PROPERTY WATERSHED (Numbers 1, 2, 3 etc. are cross-referenced to data in Appendix IV, Table 2).

	Phylum:	Arthropoda
	Class:	Insecta
	Order:	Plecoptera
	Family:	Nemouridae
1.		_Zapada_ sp.
2.	Order:	Diptera unidentified adult
3.	Family:	Culicidae adult
4.	Family:	Chironomidae adult
5.		Chironomidae pupae
	Subfamily:	Orthocladiinae
6.		_Epoicocladius_ sp.
7.		_Eukiefferiella_ sp.
8.		_Heterotrissocladius_ sp.
9.		_Psectrocladius_ sp.
10.		_Thienemanniella_ sp.
11.	Order:	Hymenoptera adult

APPENDIX IV TABLE 2 TOM PROPERTY BOTTOM FAUNA DATA - JULY 7, 1981

TAXONOMIC GROUP	Station 1			Station 2			Station 3			Station 4			Station 5		
	1-1	1-2	1-3	2-1	2-2	2-3	3-1	3-2	3-3	4-1	4-2	4-3	5-1	5-2	5-3
1 <u>Zapada</u> sp.	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
2 Diptera unidentified adult	-	-	-	-	-	-	1	-	-	-	1	-	x	x	x
3 Culicidae adult	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
4 Chironomidae adult	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
5 Chironomidae pupae	-	-	-	1	5	11	-	-	-	-	-	-	x	x	x
6 <u>Epoicocladius</u> sp.	-	1	-	-	-	-	-	-	-	-	1	-	x	x	x
7 <u>Eukiefferiella</u> sp.	-	-	-	-	-	7	-	-	-	-	-	-	x	x	x
8 <u>Heterotrissocladius</u> sp.	-	-	-	12	18	10	-	2	-	-	4	-	x	x	x
9 <u>Psectrocladius</u> sp.	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
10 <u>Thienemanniella</u> sp.	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
11 Hymenoptera adult	-	-	-	-	-	-	-	-	-	-	-	-	x	x	x
Column Total	0	1	0	13	23	28	1	2	0	0	6	0	x	x	x
Total Number (N)	0	1	0	12	18	17	0	2	0	0	5	0	x	x	x
Diversity (H')	0	0	0	0	0	0.29	0	0	0	0	0.22	0	x	x	x

x = not sampled

APPENDIX IV TABLE 2 TOM PROPERTY BOTTOM FAUNA DATA - JULY 7, 1981 (continued)

TAXONOMIC GROUP	Station 6			Station 7			Station 8			Station 9			Station 10		
	6-1	6-2	6-3	7-1	7-2	7-3	8-1	8-2	8-3	9-1	9-2	9-3	10-1	10-2	10-3
1 Zapada sp.	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2 *Diptera unidentified adult*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3 Culicidae adult	-	-	-	3	1	1	-	-	-	-	-	-	-	-	-
4 Chironomidae adult	-	-	-	13	7	9	-	-	-	3	2	1	-	-	-
5 Chironomidae pupae	1	-	-	12	5	6	-	-	1	8	1	1	-	-	-
6 Epoicocladius sp.	-	-	-	1	4	5	-	-	-	-	-	-	-	1	-
7 Eukiefferiella sp.	-	-	-	2	-	-	-	-	-	-	-	-	-	-	-
8 Heterotrissocladius sp.	-	-	-	23	21	8	-	-	-	-	-	-	-	1	-
9 Psectrocladius sp.	-	-	-	-	-	-	-	-	-	10	15	6	-	1	2
10 Thienemanniella sp.	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
11 Hymenoptera adult	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Column Total	1	0	0	56	38	29	0	0	1	21	18	8	0	3	3
Total Number (N)	0	0	0	27	25	13	-	-	-	10	15	6	0	3	3
Diversity (H')	0	0	0	0.25	0.19	0.29	-	-	-	0	0	0	0	0.48	0.28