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ENVIRONMENT CANADA  
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PACIFIC & YUKON REGION  
WHITEHORSE, YUKON

BASELINE STUDY OF SEDIMENTS  
AND WATER QUALITY  
OF THE  
WILLIAMS AND MERRICE CREEK WATERSHEDS,  
YUKON

Regional Program Report No. 96-03

by

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ABSTRACT

In August of 1994, staff from the Yukon Division of Environmental Protection conducted a baseline study of sediments and water quality along Merrice, Nancy Lee and Williams Creek approximately 40 km. north of Carmacks, Yukon. The study was conducted in response to Western Copper Holdings Limited's proposed mine development in the area.

In situ water quality and stream sediments were evaluated at all six sample stations except station 4, where no sediment samples were collected. In situ water quality parameters indicated that the streams are typical of similar sized drainages found in other parts of Yukon. Nitrite concentration of 0.274 mg/L, found at Station 1, were approximately five times higher than at the other stations sampled. All nutrient and metal parameters were below maximum allowable concentration recommended for drinking water. Guidelines established for the protection of aquatic life were exceeded for Nitrite at Station 1 and total Cr at Station 5 (in one of three samples taken).

Stream sediment metals concentrations were comparable between sites sampled in the study area. The concentrations of comparable elements in the present study were, in most cases, consistent with stream sediment data collected previously in 1992. The exceptions are Aluminum, Cobalt, Chromium, Iron, Strontium, Titanium, Vanadium and Zinc. Mean concentrations for these metals in the present study tended to be equal to or slightly higher than the maximum values reported for 1992. The reason for this is not clear, however, increased exploration activity along Williams Creek may be a contributing factor.

Résumé

En Août 1994, le personnel du service de protection de l'Environnement (Division du Yukon) a entrepris une étude de base sur la qualité des sédiments et de l'eau le long des ruisseaux Merice, Nancy Lee et William. Ces ruisseaux se situent approximativement 40 kilomètres au nord de Carmacks, Yukon. L'étude fut conduite en réponse au projet minier de Western Copper Holdings Limited.

La qualité des eaux in situ, les analyses de l'eau et des sédiments furent évaluées à toutes les stations (six en tout) excepté à la station 4 où les sédiments ne furent pas échantillonnés. Les résultats de l'analyse de la qualité in situ de l'eau indiquent que ces ruisseaux sont typiques de cours d'eau de même dimension au Yukon. À la station 1, les concentrations de nitrates étaient de 0.274 mg/l soit cinq fois plus hautes qu'aux autres stations échantillonnées. Les éléments nutritifs et les métaux lourds dans l'eau étaient plus bas que les concentrations permises selon les normes canadiennes pour l'eau potable. Les normes canadiennes pour la protection de la vie aquatique n'ont pas été dépassées sauf pour les nitrates à la station 1 et pour le chromium total à la station 5 (un échantillon sur trois).

Les concentrations de métaux des sédiments étaient comparables entre les sites échantillonnés. Les résultats des analyses de sédiments étaient, pour la plus part, comparables aux autres sites échantillonnés en 1992. Les exceptions sont l'aluminium, le cobalt, chromium, strontium, titanium, vanadium et zinc. Les concentrations moyennes de ces éléments, dans la présente étude, semblent être égales ou légèrement supérieures aux valeurs reportées en 1992. La raison pour cet état n'est pas claire, par contre, l'augmentation d'activités d'exploration le long de ruisseau William peut être un facteur en cause.

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1.0 INTRODUCTION

Copper mineralization at Williams Creek was discovered in 1970. The primary copper minerals were found to be azurite, malachite and cuprite. Extensive drilling was performed in 1991 to further define the deposits. Since 1991 exploration has continued and the plan for mine development has progressed to the Initial Environmental Evaluation (IEE) and Environmental Assessment stage.

At present, Western Copper Holdings Limited plans to develop an open pit mine to extract 12.5 million tonnes of ore graded at 1.15 % copper and 0.014 % gold per ton. The company proposes to use sulphuric acid and a conventional heap leach methodology by operating a solvent extraction/ electrowinning process to extract copper from the ore.

Baseline water quality data and stream sediment data was collected in August, 1994 by Environmental Protection Staff in response to the mine development plans.

## 2.0 STUDY AREA

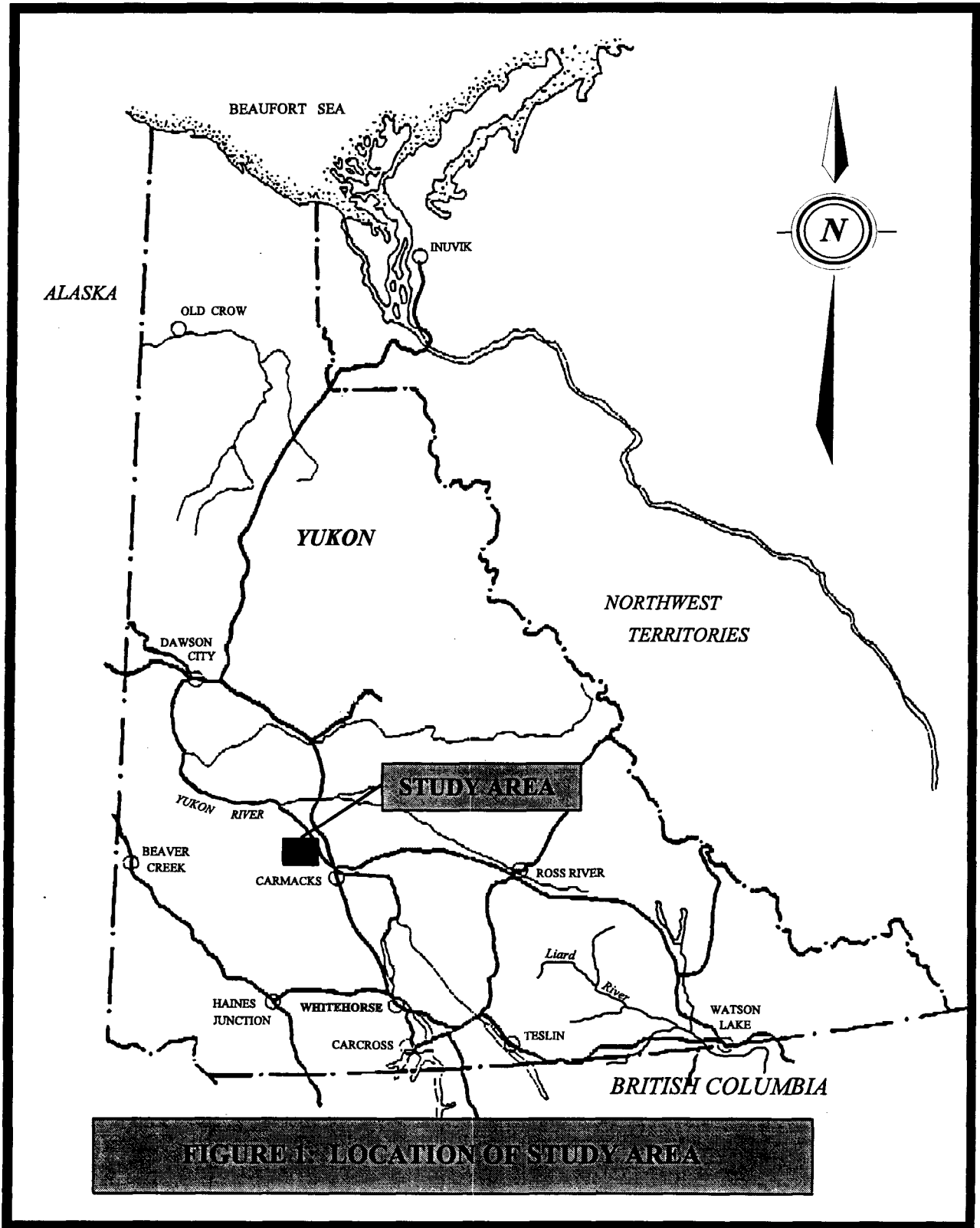
The location of the Williams Creek Property is approximately 200 km northwest of Whitehorse and 48 road kilometres northwest of Carmacks (see Figure 1). The study area was accessed via the Yukon River using a river boat and by using an existing access road to reach the mine camp and main deposit area.

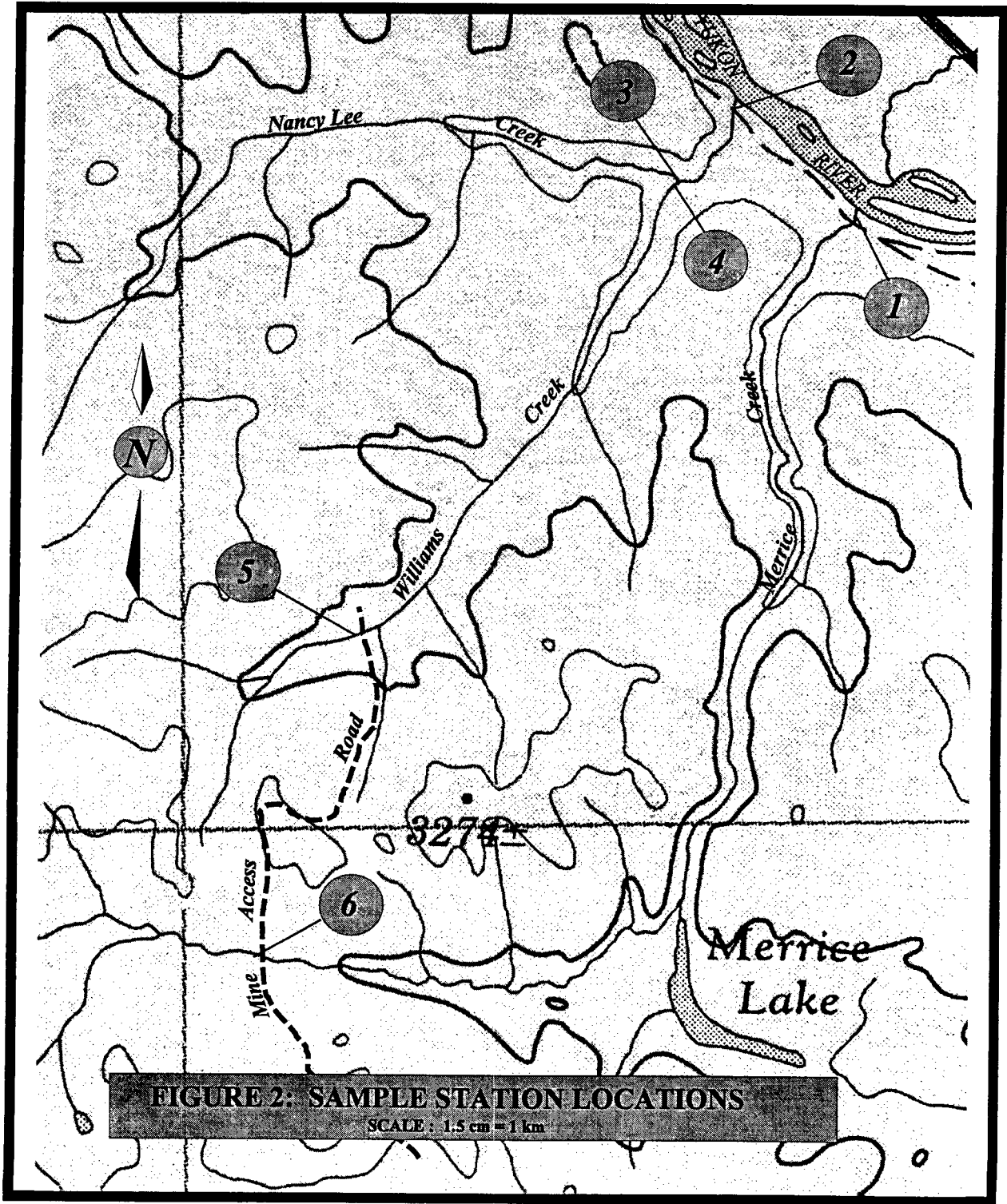
The study area consists of Merrice, Nancy Lee and Williams Creek watersheds (see Figure 2). Merrice Creek empties into the Yukon River upstream of the Williams Creek outlet. The main ore deposit is located near the upper reaches of Williams Creek. Nancy Lee Creek joins Williams Creek approximately 1.5 km upstream of the Yukon River confluence.

The topography of the surrounding area consists of well rounded hills less than 1070 m in elevation. South-facing slopes are steeper, better drained and less eroded than the north-facing slopes. The vegetation on the south slopes consists mainly of aspen, poplar and pine while on the north facing slopes, vegetation is comprised mostly of spruce, alder, willow and thick undergrowth (Burns and Gibson, 1990).

Six sample sites were established in the study area (See Figure 2 for exact locations). Water quality and stream sediments were characterized at all of the sample sites except for station 4, where only water quality was analyzed. Where possible, flow estimates for each of the tributary stream sites were determined. A description of each of the stations, comments and G.P.S. coordinates for each sample site are provided in Table 1.







**FIGURE 2: SAMPLE STATION LOCATIONS**  
SCALE : 1.5 cm = 1 km

TABLE 1 SAMPLE STATION DESCRIPTIONS

Station Number / Description	Sample Date	(GPS Coor.)	Comments
1 Merrice Creek @ Yukon River	30-Aug-94	62/ 22.90 N 136/ 34.96 W	Banks stable; over grown with willow & alder. Stream bed primarily cobble inter-dispersed with reaches of fine to coarse gravel and sand. Sampled approximately 70m u/s of Yukon River.
2 Williams Creek @ Yukon River	30-Aug-94	62/ 23.93 N 136/ 36.62 W	Stream stable; undergrowth consists of alder, willow and poplar. Stream bed heavily laden with wood debris, leaf detritus and organic material; primarily gravel (fine to coarse) with sand and some cobble. Sampled approximately 100m u/s of Yukon River.
3 Nancy Lee Creek u/s of Williams Creek	30-Aug-94	62/ 22.09 N 136/ 37.72 W	Substrate primarily large cobble intermixed with large gravel; very fine sediments. Heavy algae growth on cobbles. Approximately 5 m u/s of Williams.
4 Williams Creek u/s of Nancy Lee Creek.	30-Aug-94	Not taken.	Substrate primarily large cobble imixed with fine sediments. Heavy algae growth on cobbles. No sediment were samples collected.
5 Williams Creek u/s of mine road	31-Aug-94	62/ 20.00 N 136/ 41.92 W	Substrate primarily a mixture of fine sand, organic matter and wood debris. Stream bed appears to have been scraped with a cat at one time and thus is not representative of natural conditions. Approximately 100 m from camp. Staff gauge approximately 20 m below culvert, water level at 0.11 m mark.
6 Merrice Creek @ mine road crossing.	31-Aug-94	62/ 17.84 N 136/ 41.59 W	Wide shallow stream channel upstream of bridge crossing. Substrate primarily coarse gravels and sands.

### 3.0 METHODS

#### 3.1 Water Quality and Quantity

Collection and preservation of water samples was carried out as outlined in the "Sampling for Water Quality" handbook published by Environment Canada. All sites visited during the study were sampled for dissolved, extractable and total metals:

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

Conductivity, pH, filterable residue, non-filterable residue, ammonia, nitrite, nitrite+nitrate, orthophosphate, sulphate, colour, turbidity, hardness, chloride and total phosphorus were also analyzed in each of the water samples. Single grab samples were collected at each station with the exception of Station 5, where water samples were collected in triplicate.

In situ measurements obtained include water flow estimates (as total discharge), temperature, pH, conductivity and dissolved oxygen. Stream depth and velocity were measured using a wading rod and a Marsh McBirney Model 201D Portable Water Current Meter. Velocity was determined using the "Sixth Tenths depth" method. Total discharge is calculated in accordance with ASTM Standard D 3858-79 (ASTM, 1984) In situ temperature, pH, conductivity and dissolved oxygen measurements were obtained using an Applied Microsystems Ltd. Aquamate 1000 multi probe and data logger. The instrumentation was deployed at each site for a minimum period of 20 minutes allowing for the collection and logging of data at 10 second intervals. The exception was Williams Creek , upstream of Nancy Lee Creek, where the Aquamate was in the water for only 10 minutes. In situ measurements given are based on a mean value of the interval measurements recorded by the data logger.

For the purpose of field sampling quality assurance and quality control (QA/QC) triplicate samples were collected at one station and a hidden blank was included with the sample set for chemical analysis. Water samples were submitted to the Pacific Environmental Science Centre in Vancouver for analysis.

The procedures used in the analysis of water samples were in accordance with the Environment Canada - Laboratories Standard Operating Procedures Manual.

### 3.2 Sediments

Sediment samples were collected in triplicate at Stations 1, 3 and 4 using a plexiglass core tube sampling device. Each individual sediment grab sample was placed in acid washed 250 ml glass jars. Sediment samples were sieved to less than 150 $\mu$ m (100 Mesh Size) and analyzed for the following metals concentrations:

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

Sediment samples were submitted to the Pacific Environmental Science Centre in Vancouver for metals and particle size analysis.

#### 4.0 RESULTS AND CONCLUSIONS

##### 4.1 Water Quantity and Quality

A summary of in situ measurements is given in Appendix I, Table 1. In situ measurements such as temperature, conductivity, pH and dissolved oxygen showed that Williams, Merrice and Nancy Lee Creek are typical of small to medium size drainages found in other parts of Yukon (Mathers, et al, 1981). Nitrite concentration of 0.274 mg/L, found at Station 1, were approximately five times higher than at the other stations sampled. All nutrient and metal parameters were below maximum allowable concentration recommended for drinking water (CCME, 1995). Guidelines established for the protection of aquatic life (CCME, 1995) were exceeded for Nitrite at Station 1 and total Cr at Station 5 (in one of three samples taken). Stream sediment metals concentrations were comparable to other sites previously sampled in the study area.

The elevated concentration of Cu found in the "Field Blank" for the dissolved, extractable and total fractions (0.0022 to 0.0031 mg/L) is a result of low level contamination from a water distillation apparatus in use at the Environmental Protection's Whitehorse Laboratory at the time the study took place.

##### 4.2 Stream Sediments

Sediment metals analysis and the particle size analysis of the sediment is provided in Appendix II Table 1 and 2, respectively. Very little variability was noted between the sites sampled. A comparison of the Williams Creek and Nancy Lee Creek data with stream sediment data collected in 1992 by Western Copper Holdings (P.A. Harder and Associates, 1994) was made. The concentrations of comparable elements in the present study were, in most cases, consistent with the 1992 data.

The exceptions are Aluminum, Cobalt, Chromium, Iron, Strontium, Titanium, Vanadium and Zinc. Mean concentrations for these metals in the present study tended to be equal to or slightly higher than the maximum values reported for 1992. The reason for this is not clear, however, increased exploration activity along Williams Creek may be a contributing factor.

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APPENDIX I



APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	DATE	LATITUDE (GPS)	LONGITUDE (GPS)	MEAN DEPTH (m)	STREAM WIDTH (m)	MEAN VELOCITY (m/sec)	DISCHARGE (m <sup>3</sup> /sec)	TEMP (C°)
1	Merrice Creek @ Yukon River	30-Aug-94	62° 22.90	136° 34.96	0.19	2.8	0.11	0.06	3.70
2	Williams Creek @ Yukon River	30-Aug-94	62° 23.93	136° 36.62	0.11	2.8	0.02	0.01	4.54
3	Nancy Lee Creek u/s of Williams Cr.	30-Aug-94	62° 22.09	136° 37.72	n/a	n/a	n/a	n/a	4.93
4	Williams Creek u/s of Nancy Lee Creek	30-Aug-94	62° 22.09	136° 37.72	n/a	n/a	n/a	n/a	6.31
5	Williams Creek u/s of mine road	31-Aug-94	62° 20.00	136° 41.92	n/a	n/a	n/a	n/a	4.91
	Williams Creek u/s of mine road	31-Aug-94	62° 20.00	136° 41.92	n/a	n/a	n/a	n/a	(see above)
	Williams Creek u/s of mine road	31-Aug-94	62° 20.00	136° 41.92	n/a	n/a	n/a	n/a	(see above)
6	Merrice Creek @ mine road crossing	31-Aug-94	62° 17.84	136° 41.59	0.14	3.8	0.09	0.06	7.16
	Field Blank (metals only)	31-Aug-94							

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	pH INSITU	pH LAB	IN SITU COND. (µmhos/cm)	LAB COND. (µmhos/cm)	DISOLVED OXYGEN (mg/L)	TURB. (FTU)	TOTAL ALK. (asCaCO3) (mg/L)
1	Merrice Creek @ Yukon River	8.00	8.07	n/a	235	n/a	0.20	111
2	Williams Creek @ Yukon River	8.08	8.13	240.97	386	10.72	0.20	156
3	Nancy Lee Creek u/s of Williams Cr.	7.66	7.89	231.93	367	9.63	0.50	145
4	Williams Creek u/s of Nancy Lee Creek	8.01	8.10	251.50	421	10.25	0.40	163
5	Williams Creek u/s of mine road	7.70	7.94	316.91	520	9.23	0.55	223
	Williams Creek u/s of mine road	(see above)	7.95	(see above)	518	(see above)	0.53	223
	Williams Creek u/s of mine road	(see above)	7.98	(see above)	518	(see above)	0.66	223
6	Merrice Creek @ mine road crossing	7.96	8.08	195.10	290	10.24	1.00	145

Field Blank (metals only)

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	(Diss.)			(Extr.)			SULFATE (mg/L)
		BR (mg/L)	HARDNESS (asCaCO3) (mg/L)	TOTAL HARDNESS (mg/L)	HARDNESS (asCaCO3) (mg/L)	TOTAL HARDNESS (mg/L)	(Extr.)	
1	Merrice Creek @ Yukon River	< 0.05	110	111	109	110	12.2	
2	Williams Creek @ Yukon River	< 0.05	187	188	185	186	50.0	
3	Nancy Lee Creek u/s of Williams Cr.	< 0.05	175	176	177	178	47.4	
4	Williams Creek u/s of Nancy Lee Creek	< 0.05	195	196	195	195	56.8	
5	Williams Creek u/s of mine road	< 0.05	223	225	225	226	54.4	
	Williams Creek u/s of mine road	< 0.05	224	225	225	227	55.9	
	Williams Creek u/s of mine road	< 0.05	224	225	226	227	55.5	
6	Merrice Creek @ mine road crossing	< 0.05	138	139	137	138	11.9	
Field Blank (metals only)		<	0.4	<	0.4	<	0.4	

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	CHLORIDE (mg/L)	TOTAL P (mg/L)	NITRITE+ NITRATE (mg/L)	NITRATE (mg/L)	NITRITE (mg/L)	AMMONIA (mg/L)	FLORIDE (mg/L)
1	Merrice Creek @ Yukon River	0.78	0.003	0.281	< 0.005	0.274	0.005	0.18
2	Williams Creek @ Yukon River	1.64	0.005	0.009	< 0.005	0.045	0.004	0.44
3	Nancy Lee Creek u/s of Williams Cr.	1.44	0.007	0.008	< 0.005	0.011	0.013	0.48
4	Williams Creek u/s of Nancy Lee Creek	1.69	0.011	0.045	< 0.005	0.039	0.005	0.33
5	Williams Creek u/s of mine road	1.70	0.017	0.029	< 0.005	0.028	0.018	0.43
	Williams Creek u/s of mine road	1.64	0.016	0.029	< 0.005	0.029	0.017	0.46
	Williams Creek u/s of mine road	1.72	0.017	0.029	< 0.005	0.030	0.017	0.44
6	Merrice Creek @ mine road crossing	0.75	0.008	0.008	< 0.005	0.010	0.010	0.22

Field Blank (metals only)

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	FR (mg/L)	NFR (mg/L)	Ag (mg/L)	GF Diss.	ICP Diss.	ICP Diss.	ICP Diss.	ICP Diss.	ICP Diss.
					Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)		
1	Merrice Creek @ Yukon River	160	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		
2	Williams Creek @ Yukon River	280	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		
3	Nancy Lee Creek u/s of Williams Cr.	270	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		
4	Williams Creek u/s of Nancy Lee Creek	280	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		
5	Williams Creek u/s of mine road	330	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.02		
	Williams Creek u/s of mine road	340	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.02		
	Williams Creek u/s of mine road	330	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.02		
6	Merrice Creek @ mine road crossing	200	< 10	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		
	Field Blank (metals only)		<	< 0.01	< 0.0005	< 0.05	< 0.05	< 0.01		

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cd (mg/L)	GF Diss. (mg/L)	Co (mg/L)	Cr (mg/L)
1	Merrice Creek @ Yukon River	0.088	< 0.001	32.9	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005
2	Williams Creek @ Yukon River	0.047	< 0.001	52.7	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005
3	Nancy Lee Creek u/s of Williams Cr.	0.042	< 0.001	51.2	< 0.005	< 0.0001	< 0.005	< 0.005	0.008
4	Williams Creek u/s of Nancy Lee Creek	0.06	0.001	56.1	< 0.005	< 0.0001	< 0.005	< 0.005	0.010
5	Williams Creek u/s of mine road	0.066	0.001	54.4	< 0.005	< 0.0001	< 0.005	< 0.005	0.021
	Williams Creek u/s of mine road	0.066	< 0.001	54.4	< 0.005	< 0.0001	< 0.005	< 0.005	0.008
	Williams Creek u/s of mine road	0.065	< 0.001	54.2	< 0.005	< 0.0001	< 0.005	< 0.005	0.007
6	Merrice Creek @ mine road crossing	0.071	< 0.001	39.0	< 0.005	< 0.0001	< 0.005	< 0.005	0.017
	Field Blank (metals only)	< 0.001	< 0.001	< 0.1	< 0.005	< 0.0001	< 0.005	< 0.005	0.010

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	ICP Diss. Cu (mg/L)	GF Diss. Cu (mg/L)	ICP Diss. Fe (mg/L)	ICP Diss. K (mg/L)	ICP Diss. Mg (mg/L)	ICP Diss. Mn (mg/L)	ICP Diss. Mo (mg/L)
1	Merrice Creek @ Yukon River	< 0.005	0.0014	< 0.005	1.1	6.7	< 0.001	< 0.01
2	Williams Creek @ Yukon River	< 0.005	0.0024	0.008	1.1	13.0	0.003	< 0.01
3	Nancy Lee Creek u/s of Williams Cr.	< 0.005	0.0029	0.029	0.9	11.4	< 0.001	< 0.01
4	Williams Creek u/s of Nancy Lee Creek	< 0.005	0.0019	< 0.005	1.1	13.3	< 0.001	< 0.01
5	Williams Creek u/s of mine road	< 0.005	< 0.0005	0.123	1.3	21.3	0.025	< 0.01
	Williams Creek u/s of mine road	< 0.005	< 0.0005	0.120	1.3	21.5	0.022	< 0.01
	Williams Creek u/s of mine road	< 0.005	< 0.0005	0.120	1.3	21.4	0.022	< 0.01
6	Merrice Creek @ mine road crossing	< 0.005	0.0013	0.148	0.8	9.9	0.032	< 0.01
	Field Blank (metals only)	< 0.005	0.0022	< 0.005	< 0.1	< 0.1	< 0.001	< 0.01

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	GF Diss.	ICP Diss.	Sb (mg/L)	Se (mg/L)
1	Merrice Creek @ Yukon River	6.0	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
2	Williams Creek @ Yukon River	10.0	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
3	Nancy Lee Creek u/s of Williams Cr.	8.8	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
4	Williams Creek u/s of Nancy Lee Creek	11.3	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
5	Williams Creek u/s of mine road	22.8	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.07
	Williams Creek u/s of mine road	23.1	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
	Williams Creek u/s of mine road	23.1	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05
6	Merrice Creek @ mine road crossing	8.8	< 0.02	< 0.1	< 0.05	0.0044	< 0.05	< 0.05	< 0.05
	Field Blank (metals only)	< 0.1	< 0.02	< 0.1	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05



APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)	Ag (mg/L)
1	Merrice Creek @ Yukon River	5.27	< 0.05	0.298	< 0.002	< 0.01	< 0.002	< 0.01
2	Williams Creek @ Yukon River	7.14	< 0.05	0.622	< 0.002	< 0.01	< 0.002	< 0.01
3	Nancy Lee Creek u/s of Williams Cr.	7.72	< 0.05	0.573	< 0.002	< 0.01	< 0.002	< 0.01
4	Williams Creek u/s of Nancy Lee Creek	7.33	< 0.05	0.646	< 0.002	< 0.01	< 0.002	< 0.01
5	Williams Creek u/s of mine road	6.89	< 0.05	0.792	< 0.002	< 0.01	< 0.002	< 0.01
	Williams Creek u/s of mine road	6.94	< 0.05	0.797	0.003	< 0.01	< 0.002	< 0.01
	Williams Creek u/s of mine road	6.94	< 0.05	0.799	< 0.002	< 0.01	< 0.002	< 0.01
6	Merrice Creek @ mine road crossing	6.35	< 0.05	0.366	< 0.002	< 0.01	0.005	< 0.01
	Field Blank (metals only)	< 0.05	< 0.05	< 0.001	< 0.002	< 0.01	< 0.002	< 0.01

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	GF Extr.	Ag (mg/L)	Al (mg/L)	As (mg/L)	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)
1	Merrice Creek @ Yukon River	< 0.0005	< 0.05	< 0.05	< 0.01	< 0.088	< 0.001	< 0.001	32.7
2	Williams Creek @ Yukon River	< 0.0005	< 0.05	< 0.05	0.02	0.048	< 0.001	< 0.001	52.9
3	Nancy Lee Creek u/s of Williams Cr.	< 0.0005	< 0.05	< 0.05	0.01	0.044	< 0.001	< 0.001	51.8
4	Williams Creek u/s of Nancy Lee Creek	< 0.0005	< 0.05	< 0.05	0.01	0.061	< 0.001	< 0.001	56.1
5	Williams Creek u/s of mine road	< 0.0005	< 0.05	< 0.05	0.02	0.066	< 0.001	< 0.001	54.7
	Williams Creek u/s of mine road	< 0.0005	< 0.05	< 0.05	0.02	0.066	< 0.001	< 0.001	54.9
	Williams Creek u/s of mine road	< 0.0005	< 0.05	< 0.05	0.02	0.067	< 0.001	< 0.001	55.2
6	Merrice Creek @ mine road crossing	< 0.0005	< 0.05	< 0.05	0.01	0.073	< 0.001	< 0.001	38.4
	Field Blank (metals only)	< 0.0005	< 0.05	< 0.05	< 0.01	< 0.001	< 0.001	< 0.001	< 0.1

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cd (mg/L)	GF Diss. (mg/L)	ICP Diss. (mg/L)	Co (mg/L)	Cr (mg/L)
1	Merrice Creek @ Yukon River	0.088	< 0.001	32.9	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	< 0.005
2	Williams Creek @ Yukon River	0.047	< 0.001	52.7	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	< 0.005
3	Nancy Lee Creek u/s of Williams Cr.	0.042	< 0.001	51.2	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.008
4	Williams Creek u/s of Nancy Lee Creek	0.06	0.001	56.1	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.010
5	Williams Creek u/s of mine road	0.066	0.001	54.4	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.021
	Williams Creek u/s of mine road	0.066	< 0.001	54.4	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.008
	Williams Creek u/s of mine road	0.065	< 0.001	54.2	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.007
6	Merrice Creek @ mine road crossing	0.071	< 0.001	39.0	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.017
	Field Blank (metals only)	< 0.001	< 0.001	< 0.1	< 0.005	< 0.0001	< 0.005	< 0.005	< 0.005	0.010

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	K (mg/L)	Mg (mg/L)	Mn (mg/L)	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)
1	Merrice Creek @ Yukon River	1.1	6.7	0.001	< 0.01	5.9	< 0.02	< 0.1
2	Williams Creek @ Yukon River	1.1	12.8	0.003	< 0.01	9.9	< 0.02	< 0.1
3	Nancy Lee Creek u/s of Williams Cr.	0.9	11.5	0.006	< 0.01	8.9	< 0.02	< 0.1
4	Williams Creek u/s of Nancy Lee Creek	1.1	13.2	< 0.001	< 0.01	11.3	< 0.02	< 0.1
5	Williams Creek u/s of mine road	1.2	21.4	0.023	< 0.01	23.1	< 0.02	< 0.1
	Williams Creek u/s of mine road	1.3	21.4	0.025	< 0.01	23.0	< 0.02	< 0.1
	Williams Creek u/s of mine road	1.3	21.5	0.024	< 0.01	23.1	< 0.02	< 0.1
6	Merrice Creek @ mine road crossing	0.9	9.9	0.036	< 0.01	8.7	< 0.02	< 0.1
	Field Blank (metals only)	< 0.1	< 0.1	< 0.001	< 0.01	< 0.1	< 0.02	< 0.1

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Pb (mg/L)	Pb (mg/L)	Sb (mg/L)	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)
		ICP Extr.	GF Extr.	ICP Extr.	ICP Extr.	ICP Extr.	ICP Extr.	ICP Extr.
1	Merrice Creek @ Yukon River	< 0.05	< 0.0005	< 0.05	< 0.05	5.24	< 0.05	0.296
2	Williams Creek @ Yukon River	< 0.05	< 0.0005	< 0.05	< 0.05	7.13	< 0.05	0.623
3	Nancy Lee Creek u/s of Williams Cr.	< 0.05	< 0.0005	< 0.05	< 0.05	7.76	< 0.05	0.577
4	Williams Creek u/s of Nancy Lee Creek	< 0.05	< 0.0005	< 0.05	< 0.05	7.33	< 0.05	0.644
5	Williams Creek u/s of mine road	< 0.05	< 0.0005	< 0.05	< 0.05	6.94	< 0.05	0.798
	Williams Creek u/s of mine road	< 0.05	0.0006	< 0.05	< 0.05	6.95	< 0.05	0.800
	Williams Creek u/s of mine road	< 0.05	< 0.0005	< 0.05	< 0.05	6.97	< 0.05	0.802
6	Merrice Creek @ mine road crossing	< 0.05	0.0009	< 0.05	< 0.05	6.33	< 0.05	0.362
	Field Blank (metals only)	< 0.05	< 0.0005	< 0.05	< 0.05	< 0.05	< 0.05	< 0.001

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	ICP Extr.	ICP Extr.	ICP Extr.	ICP Extr.	ICP Total	GF Total	ICP Total	ICP Total
		Ti (mg/L)	V (mg/L)	Zn (mg/L)	Ag (mg/L)	Ag (mg/L)	Ag (mg/L)	Al (mg/L)	As (mg/L)
1	Merrice Creek @ Yukon River	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
2	Williams Creek @ Yukon River	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
3	Nancy Lee Creek u/s of Williams Cr.	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
4	Williams Creek u/s of Nancy Lee Creek	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
5	Williams Creek u/s of mine road	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
	Williams Creek u/s of mine road	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
	Williams Creek u/s of mine road	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0007	< 0.0007	< 0.06	< 0.06
6	Merrice Creek @ mine road crossing	0.004	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06
	Field Blank (metals only)	< 0.002	< 0.01	< 0.002	< 0.01	< 0.0006	< 0.0006	< 0.06	< 0.06

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	B (mg/L)	Ba (mg/L)	Be (mg/L)	Ca (mg/L)	Cd (mg/L)	Cd (mg/L)	GF Total	ICP Total
1	Merrice Creek @ Yukon River	< 0.01	0.092	< 0.001	34.5	< 0.006	< 0.0001	< 0.0001	< 0.006
2	Williams Creek @ Yukon River	0.02	0.050	< 0.001	56.9	< 0.006	< 0.0001	< 0.0001	< 0.006
3	Nancy Lee Creek u/s of Williams Cr.	0.02	0.046	< 0.001	54.2	< 0.006	< 0.0001	< 0.0001	< 0.006
4	Williams Creek u/s of Nancy Lee Creek	0.02	0.062	< 0.001	57.7	< 0.006	< 0.0001	< 0.0001	< 0.006
5	Williams Creek u/s of mine road	0.03	0.070	< 0.001	58.0	< 0.006	< 0.0001	< 0.0001	< 0.006
	Williams Creek u/s of mine road	0.03	0.069	< 0.001	56.2	< 0.006	< 0.0001	< 0.0001	< 0.006
	Williams Creek u/s of mine road	0.03	0.072	< 0.001	56.9	< 0.006	< 0.0001	< 0.0001	< 0.006
6	Merrice Creek @ mine road crossing	< 0.01	0.074	< 0.001	39.7	< 0.006	< 0.0001	< 0.0001	< 0.006
	Field Blank (metals only)	< 0.01	< 0.001	< 0.001	< 0.1	< 0.006	< 0.0001	< 0.0001	< 0.006

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Cr (mg/L)	Cu (mg/L)	Cu (mg/L)	GF Total	ICP Total	ICP Total	ICP Total	ICP Total	ICP Total	ICP Total	Mg (mg/L)	Mn (mg/L)
1	Merrice Creek @ Yukon River	< 0.006	< 0.006	0.0013	0.009	1.1	7.2	< 0.001					
2	Williams Creek @ Yukon River	< 0.006	< 0.006	0.0024	0.026	1.0	13.9	0.004					
3	Nancy Lee Creek u/s of Williams Cr.	0.011	< 0.006	0.0031	0.082	1.0	12.4	0.004					
4	Williams Creek u/s of Nancy Lee Creek	0.020	< 0.006	0.0015	0.015	1.3	14.1	< 0.001					
5	Williams Creek u/s of mine road	0.013	0.012	< 0.0006	0.187	1.4	23.2	0.028					
	Williams Creek u/s of mine road	0.025	< 0.006	0.0019	0.170	1.4	22.8	0.026					
	Williams Creek u/s of mine road	0.015	< 0.006	0.0009	0.166	1.4	23.1	0.028					
6	Merrice Creek @ mine road crossing	< 0.006	< 0.006	0.0010	0.210	0.9	11.0	0.038					
	Field Blank (metals only)	0.006	< 0.006	0.0031	< 0.006	< 0.1	< 0.1	< 0.001					



APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Mo (mg/L)	Na (mg/L)	Ni (mg/L)	P (mg/L)	Pb (mg/L)	GF Total	ICP Total
1	Merrice Creek @ Yukon River	< 0.01	6.2	< 0.02	< 0.1	< 0.06	< 0.0006	< 0.06
2	Williams Creek @ Yukon River	< 0.01	10.0	< 0.02	< 0.1	< 0.06	0.0007	< 0.06
3	Nancy Lee Creek u/s of Williams Cr.	< 0.01	9.3	< 0.02	< 0.1	< 0.06	0.0009	< 0.06
4	Williams Creek u/s of Nancy Lee Creek	< 0.01	11.6	< 0.02	< 0.1	< 0.06	< 0.0006	< 0.06
5	Williams Creek u/s of mine road	< 0.01	24.3	< 0.02	< 0.1	< 0.06	0.0009	< 0.06
	Williams Creek u/s of mine road	< 0.01	23.7	< 0.02	< 0.1	< 0.06	0.0009	< 0.06
	Williams Creek u/s of mine road	< 0.01	24.1	< 0.02	< 0.1	< 0.06	0.0008	< 0.06
6	Merrice Creek @ mine road crossing	< 0.01	9.0	< 0.02	< 0.1	< 0.06	< 0.0006	< 0.06
	Field Blank (metals only)	< 0.01	< 0.1	< 0.02	< 0.1	< 0.06	0.0008	< 0.06

APPENDIX I TABLE 1 WATER QUALITY WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

STATION	LOCATION	Se (mg/L)	Si (mg/L)	Sn (mg/L)	Sr (mg/L)	Ti (mg/L)	V (mg/L)	Zn (mg/L)
1	Merrice Creek @ Yukon River	< 0.06	5.34	< 0.06	0.308	< 0.002	< 0.01	0.002
2	Williams Creek @ Yukon River	< 0.06	7.46	< 0.06	0.665	< 0.002	< 0.01	0.003
3	Nancy Lee Creek u/s of Williams Cr.	< 0.06	7.99	< 0.06	0.600	0.003	< 0.01	0.003
4	Williams Creek u/s of Nancy Lee Creek	< 0.06	7.37	< 0.06	0.659	0.003	< 0.01	< 0.002
5	Williams Creek u/s of mine road	< 0.06	7.15	< 0.06	0.839	0.003	< 0.01	0.023
	Williams Creek u/s of mine road	< 0.06	6.96	< 0.06	0.817	0.004	< 0.01	0.003
	Williams Creek u/s of mine road	< 0.06	7.06	< 0.06	0.828	0.005	< 0.01	0.003
6	Merrice Creek @ mine road crossing	< 0.06	6.38	< 0.06	0.374	0.003	< 0.01	< 0.002
	Field Blank (metals only)	< 0.06	< 0.06	< 0.06	< 0.001	< 0.002	< 0.01	0.003

APPENDIX II

APPENDIX II TABLE 1 SEDIMENT METALS DATA

WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

Station	Location	Date	Latitude	Longitude	Ag (ug/g)	Al (ug/g)	As (ug/g)
1	Merrice Creek @ Yukon River	30-Aug-94	62° 22.90	136° 34.96	< 2.0 ± 0.0	18133 ± 340	9.0 ± 0.8
2	Williams Creek @ Yukon River	30-Aug-94	62° 23.93	136° 36.62	< 2.0 ± 0.0	13133 ± 544	< 8.0 ± 0.0
3	Nancy Lee Creek u/s of Williams Creek	30-Aug-94	62° 22.09	136° 37.72	< 2.0 ± 0.0	10920 ± 1180	< 8.0 ± 0.0
5	Williams Creek u/s of mine road	31-Aug-94	62° 20.00	136° 41.92	< 2.0 ± 0.0	11467 ± 967	< 8.0 ± 0.0
6	Merrice Creek @ mine road	31-Aug-94	62° 17.84	136° 41.59	< 2.0 ± 0.0	11200 ± 374	< 8.0 ± 0.0

Average based on 3 grab samples. ± = standard deviation.

APPENDIX II TABLE 1 SEDIMENT METALS DATA

WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

Station	Location	Ba (ug/g)	Be (ug/g)	Ca (ug/g)	Cd (ug/g)	Co (ug/g)	Cr (ug/g)
1	Merrice Creek @ Yukon River	322.3	1.0	12200	< 0.8	12.3	37.6
		± 24.4	± 0.0	± 245	± 0.0	± 0.9	± 0.8
2	Williams Creek @ Yukon River	206.7	0.8	10293	< 0.8	9.4	29.8
		± 21.0	± 0.1	± 706	± 0.0	± 0.5	± 0.7
3	Nancy Lee Creek u/s of Williams Creek	192.3	0.7	9517	< 0.8	9.0	30.7
		± 32.5	± 0.0	± 966	± 0.0	± 0.3	± 1.8
5	Williams Creek u/s of mine road	160.7	0.7	8810	< 0.8	8.3	23.3
		± 12.8	± 0.1	± 807	± 0.0	± 0.9	± 1.3
6	Merrice Creek @ mine road	170.3	0.6	7593	< 0.9	8.6	28.0
		± 9.1	± 0.0	± 260	± 0.1	± 0.8	± 2.8

Average based on 3 grab samples. ± = standard deviation.

APPENDIX II TABLE 1 SEDIMENT METALS DATA

WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

Station	Location	Cu (ug/g)	Fe (ug/g)	K (ug/g)	Mg (ug/g)	Mn (ug/g)	Mo (ug/g)
1	Merrice Creek @ Yukon River	30.6 ± 1.2	30967 ± 205	1927 45	6677 ± 145	838.0 ± 195.0	< 2.0 ± 0.0
2	Williams Creek @ Yukon River	23.4 ± 1.9	23667 ± 881	1673 110	5213 ± 146	387.3 ± 63.7	< 2.0 ± 0.0
3	Nancy Lee Creek u/s of Williams Creek	60.7 ± 10.3	28333 ± 4793	1210 151	4427 ± 209	597.0 ± 110.5	< 2.0 ± 0.0
5	Williams Creek u/s of mine road	11.2 ± 1.4	21033 ± 1034	1171 127	4400 ± 312	347.7 ± 14.9	< 2.0 ± 0.0
6	Merrice Creek @ mine road	10.7 ± 0.5	22533 ± 3499	962 32	4013 ± 169	716.7 ± 48.5	< 2.0 ± 0.0

Average based on 3 grab samples. ± = standard deviation.

APPENDIX II TABLE 1 SEDIMENT METALS DATA

WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

Station	Location	Na (ug/g)	Ni (ug/g)	P (ug/g)	Pb (ug/g)	Sb (ug/g)	Si (ug/g)
1	Merrice Creek @ Yukon River	470.0 ± 14.1	34.7 ± 3.4	1133 ± 47	12.0 ± 2.8	< 8.7 ± 0.9	598 ± 8
2	Williams Creek @ Yukon River	466.7 ± 47.8	22.3 ± 1.2	960 ± 33	10.3 ± 2.1	< 8.0 ± 0.0	365 ± 84
3	Nancy Lee Creek u/s of Williams Creek	463.3 ± 122.8	22.3 ± 2.1	903 ± 71	8.7 ± 0.9	< 8.3 ± 0.5	309 ± 5
5	Williams Creek u/s of mine road	356.7 ± 34.0	19.3 ± 0.9	940 ± 22	< 8.0 ± 0.0	< 8.0 ± 0.0	386 ± 71
6	Merrice Creek @ mine road	296.7 ± 4.7	22.3 ± 1.9	940 ± 14	< 8.0 ± 0.0	< 8.0 ± 0.0	375 ± 64

Average based on 3 grab samples. ± = standard deviation.

APPENDIX II TABLE 1 SEDIMENT METALS DATA

WILLIAMS CREEK STUDY, 30 AND 31 OF AUGUST, 1994

Station	Location	Sn (ug/g)	Sr (ug/g)	Ti (ug/g)	V (ug/g)	Zn (ug/g)
1	Merrice Creek @ Yukon River	12.7 ±	119.7 ±	1010 36	87.7 1.7	78.5 3.3
2	Williams Creek @ Yukon River	< ±	108.2 9.4	887 9	69.7 2.4	56.2 2.0
3	Nancy Lee Creek u/s of Williams Creek	< ±	98.0 14.2	949 45	86.3 16.7	47.6 1.1
5	Williams Creek u/s of mine road	< ±	105.9 12.2	854 74	53.3 3.1	47.8 2.7
6	Merrice Creek @ mine road	< ±	68.2 2.8	796 82	66.0 11.4	50.0 3.3

Average based on 3 grab samples. ± = standard deviation.



Station	Location	F<0.063 mm (%)	WF 0.15 mm (%)	WF 0.25 mm (%)	WF 0.5 mm (%)	WF 1 mm (%)	WF 2 mm (%)	WF>2 mm (%)	WTWT (g)
1	Merrice Creek @ Yukon River	1 ±	2	3	8	15	28	72	303
		0 ±	0	1 ±	3 ±	4 ±	2 ±	2 ±	42
2	Williams Creek @ Yukon River	3 ±	7	13	24	32	46	54	285
		1 ±	2 ±	2 ±	4 ±	6 ±	8 ±	8 ±	57
3	Nancy Lee Creek u/s of Williams Creek	1 ±	3	8	16	22	32	68	273
		0 ±	1 ±	1 ±	2 ±	3 ±	5 ±	5 ±	29
5	Williams Creek u/s of mine road	11 ±	31	56	86	97	67	0	127
		2 ±	6 ±	13 ±	10 ±	3 ±	47 ±	0 ±	23
6	Merrice Creek @ mine road	1 ±	3	6	12	22	34	66	232
		0 ±	1 ±	1 ±	3 ±	5 ±	6 ±	6 ±	17

Average based on 3 grab samples. ± = standard deviation.