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ENVIRONMENT CANADA
CONSERVATION AND PROTECTION
ENVIRONMENTAL PROTECTION
PACIFIC AND YUKON REGION

RECEIVING WATER AND EFFLUENT QUALITY
AT SCOTTIE GOLD MINES
IN 1982 AND 1983

Regional Data Report DR 87-02

By

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1 INTRODUCTION

Scottie Gold Mines Ltd. was operating a 200 ton per day underground gold mine and mill at Summit Lake, approximately 20 miles north of Stewart, B.C.

The mine discharged the tailings into pools on the bottom of Summit Lake at the headwaters of the Salmon River. The lake is subject to a jökulhlaup once a year, emptying in a very short period of time, and flowing below the Salmon Glacier. It is only below the glacier that the salmon species are present.

The purpose of the survey was to document the water quality of the mine discharge and Summit Lake and determine if there were any contaminants such as cyanide and heavy metals.

2 STUDY AREA

The mine is located in the Salmon River valley above the tree line. Most of the samples were located in Summit Lake (Figure 1) and below the salmon glacier on the Salmon River (Figure 2). Each of the sites is described in Table 1.

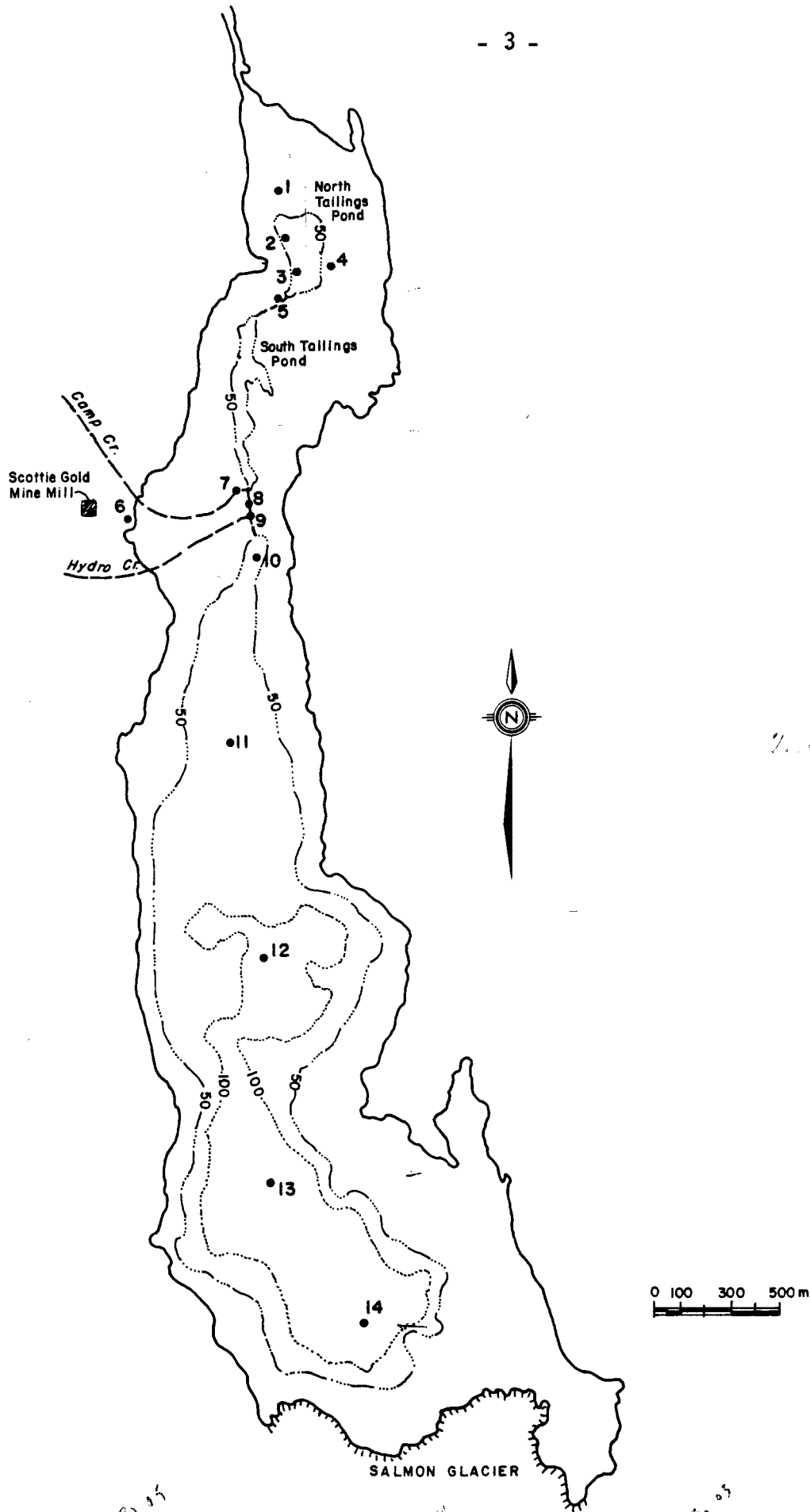


FIGURE 1 LOCATION OF WATER SAMPLING STATIONS IN SUMMIT LAKE

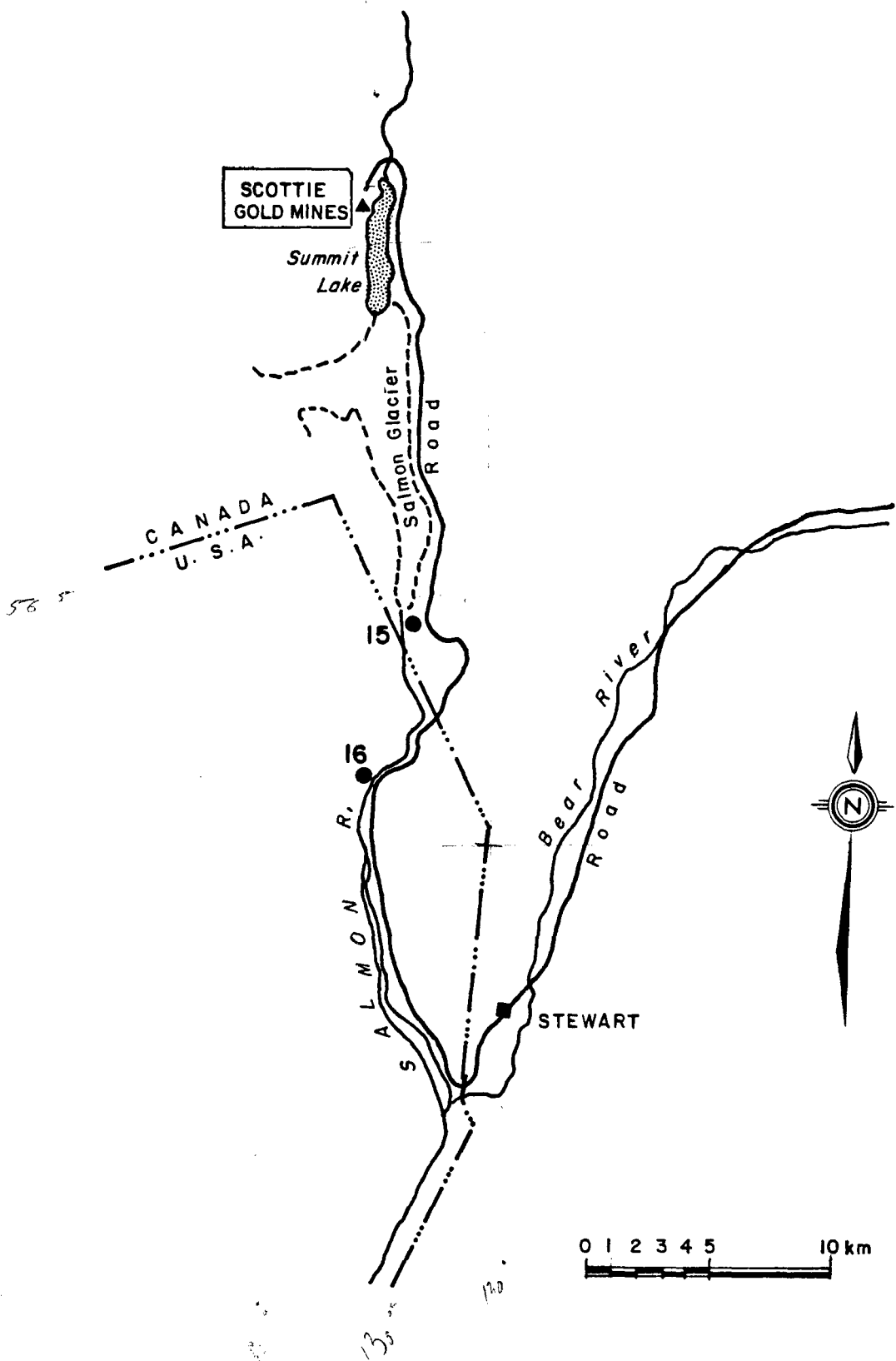


FIGURE 2 LOCATION MAP OF SCOTTIE GOLD MINES LTD. AND WATER SAMPLING STATIONS IN SALMON RIVER

TABLE 1 **SITE DESCRIPTIONS**

STATION	LOCATION
1	Tailings depression, northern side.
2	Tailings discharge.
3	Tailings depression, several metres south of the tailings discharge.
4	Tailings depression, eastern side.
5	Overflow from tailings depression.
6	Minewater.
7	Camp Creek mouth.
8	Reclaim barge.
9	Overflow from reclaim barge.
10	Summit Lake 100 m from Camp Creek mouth.
11	Summit Lake, 1000 metres from reclaim barge.
12	Summit Lake, 2000 metres from reclaim barge.
13	Summit Lake, 3000 metres from reclaim barge.
14	Summit Lake, above Salmon glacier.
15	Salmon River at the toe of the Salmon glacier.
16	Salmon River at Mile 20.

3 MATERIAL AND METHOD

Receiving water samples were comprised of grab samples collected on May 3, 1982; July 6, 1982; July 26, 27, 28 and 29, 1982; and July 11 and 12, 1983. The samples were analysed for pH, sulphate (except July 6, 1982), total residue, non-filterable residue, ammonia, total cyanide, weak acid dissociable cyanide, thiocyanate, cyanate (except in all July 1982 samplings) and total and dissolved metals. Samples at Station 8 on July 26, 1982 were analysed only for total cyanide, thiocyanate, cyanide weak acid dissociable and total and dissolved metals.

Tailings discharge samples were decanted and then preserved for cyanide and filtered for dissolved metals. No decantation was performed for the total metal sample. Tailings discharge samples were not preserved for heavy metals due to the suspected high cyanide level.

The residues, sulphate, and ammonia samples were kept cool with wet ice until analysed. Total metal samples of 250 ml each were preserved the same day with 1 ml of nitric acid. Dissolved metal samples of 100 ml each were filtered on the same day through a 0.45 micron cellulose nitrate filter and then preserved with 0.5 ml nitric acid. All samples were delivered to the Environmental Protection Laboratory in West Vancouver.

The Inductively Coupled Argon Plasma or ICAP scan, an automatic atomic emissions spectrophotometer, was used for the total and dissolved metal analysis and gave a reading of twenty-six metals. If the copper, lead, or cadmium readings were below the ICAP detection limit, the samples were rerun on the graphite furnace of the atomic absorption spectrophotometer to obtain a lower detection limit.

Total cyanide samples were collected in 500 ml bottles, preserved with sodium hydroxide pellets, and stored in the dark at 4°C. The samples were analysed at EP, West Vancouver lab with the tetracyanonickelate colorimetric method. The detection limit of the analysis is 0.03 mg/l. Thiocyanide samples were complexed with iron and analysed by colorimetric method. The detection limit is 2.0 mg/l. Weak acid dissociable samples were

slightly acidified to pH 4.5 to 6.0 and then analysed by colorimetric method. Detection limit is 0.03 mg/l. Cyanate samples were determined by ammonia analysis before and after hydrolysis of cyanate. The detection limit is 0.005 mg/l.

4 PHYSICAL AND CHEMICAL RESULTS

The reclaim water (Station 8) did not vary much between the morning and afternoon on May 3, 1982. The contaminant level of this site was the highest of the four consecutive samplings performed on July 6, 1982; July 26 and 27, 1982; and on July 12, 1983. The major contaminants were total cyanide with 27.3 and 26.6 mg/l, and total copper which reached 9.0 mg/l. A reduction of cyanide levels was observed on July 6, 1982 with 0.11 mg/l, and less than the detection limit on July 26, and 27, 1982. The detection limit was 0.03 mg/l for the samples in 1982 and 0.01 in 1983. No cyanides were detected in the survey in 1983. A decrease of the copper level was observed on July 6, 1982 with 0.12 mg/l, on July 26 with 0.01 mg/l, July 27 with 0.023 mg/l; on July 12, 1983 the copper level could not be detected.

On July 6, 1982 the copper concentrations ranged from .011 mg/l to 0.145 mg/l at the north end of Summit Lake (Stations 1 to 5). The south part of Summit Lake (Stations 10 to 14) showed levels of 0.044 to 0.046 mg/l, while no copper could be detected below the Salmon glacier (Stations 15 and 16). The total cyanide levels in the north end were 0.13 and 0.19 mg/l, while the concentrations at the south end of Summit Lake ranged between 0.05 and 0.08 mg/l.

The July 27, 1982 sampling showed an increase in heavy metals concentrations near the north end of the tailings pond. The surface water at Site #13 at the southern part of Summit Lake was 0.49 mg/l total copper. The Salmon River Station #15 showed a copper level above the CCREM (Canadian Council of Resources and Environment Ministers) water quality criteria of 0.002 mg/l with a level of 0.011 mg/l. No total cyanides were detected at the south end, while at the north end, levels were 0.11 and 0.12 mg/l.

On July 12, 1983 the water quality of the north end of Summit Lake improved, while the south end still showed copper levels of 0.064 mg/l. Copper concentrations of 0.007 mg/l were found below the Salmon glacier but the dissolved fraction was below the detection limit, with low hardness (21 mg/l), and non-filterable residue of 57 mg/l. No cyanides were detected in Summit Lake, and below the Salmon glacier.

TABLE 2 WATER QUALITY RESULTS FROM THE MORNING AND AFTERNOON OF MAY 3, 1982 AT STATION 8

PARAMETER*	A.M. RESULTS		P.M. RESULTS	
pH (rel. units)	10.6		10.6	
non-filterable residues	< 5.0		8.0	
total residues	524.0		537.0	
SO ₄	78.5		75.0	
ammonia	1.35		1.40	
total cyanide	27.3		26.6	
weak acid dissociable cyanide	22.8		25.4	
cyanate (CNO)	12.2		16.2	
thiocyanate (CNS)	55.0		61.0	
total hardness	219.0		227.0	
	TOTAL	DISSOLVED	TOTAL	DISSOLVED
As	< 0.05	< 0.05	0.09	0.13
Ba	0.011	0.009	0.011	0.01
Be	0.001	< 0.001	< 0.001	< 0.001
Cd	0.002	< 0.002	0.003	0.005
Co	0.12	< 0.005	0.132	0.013
Cr	< 0.005	< 0.005	< 0.005	< 0.005
Cu	9.0	5.35	8.8	6.34
Hg	< 0.05	< 0.05	< 0.05	< 0.05
Mn	0.04	0.005	0.046	0.02
Mo	0.016	0.013	0.015	0.012
Ni	1.94	0.03	0.06	0.04
P	0.4	0.17	0.38	0.19
Pb	0.03	< 0.02	0.03	< 0.02
Sb	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	0.07	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.288	0.288	0.283	0.301
Ti	0.019	0.017	0.032	0.027
V	< 0.01	< 0.01	< 0.01	< 0.01
Zn	3.64	3.68	3.68	3.51
Al	1.1	0.76	1.28	0.6
Fe	4.16	1.08	3.59	0.175
Si	2.3	1.4	1.8	1.2
Mg	0.8	0.5	0.8	0.4
Na	64.8	66.6	65.9	65.2
Ca	82.7	85.2	83.7	83.2

* mg/l unless otherwise stated

TABLE 3 WATER QUALITY RESULTS ON JULY 6, 1982 AT RECEIVING WATER SITES DOWNSTREAM OF SCOTTIE GOLD MINES

PARAMETER (mg/l)*	STATION 3		STATION 5		STATION 7	
pH (relative units)	7.3		7.9		7.2	
non-filterable residue	5.0		< 5.0		< 5.0	
total residue	89.0		81.5		109.0	
ammonia	0.185		0.027		0.016	
total CN	0.13		0.19		< 0.03	
CNwad ¹	< 0.03		< 0.03		< 0.03	
CNS ²	< 2.0		1.3		< 2.0	
total hardness	34.7		33.6		18.0	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Ba	0.008	0.005	0.012	0.005	0.005	0.002
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cr	< 0.006	0.01	< 0.006	< 0.005	< 0.006	< 0.005
Cu	0.14	0.027	0.145	0.031	0.011	0.12
Hg	< 0.06	< 0.05	< 0.06	< 0.06	< 0.06	< 0.05
Mn	0.027	0.012	0.049	0.013	0.012	0.003
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Pb	0.02	< 0.02	0.025	< 0.02	< 0.02	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.06	< 0.05	< 0.06	< 0.05	< 0.01	< 0.01
Sr	0.063	0.062	0.068	0.066	0.02	0.019
Ti	0.01	< 0.002	0.032	0.002	0.013	< 0.002
V	< 0.01	< 0.01	0.015	< 0.01	< 0.01	< 0.01
Zn	0.115	0.026	0.041	0.008	0.035	0.017
Al	0.33	0.05	0.79	< 0.05	0.29	< 0.05
Fe	0.681	0.055	1.82	0.014	0.564	0.029
Si	1.2	0.8	1.9	0.7	0.9	0.4
Mg	0.5	0.4	0.7	0.2	0.4	0.3
Na	8.5	8.1	10.0	10.4	1.1	1.0
Ca	14.0	13.0	14.0	13.1	7.1	6.7

* unless otherwise stated

¹ CNwad - weak acid dissociable cyanide

² CNS - thiocyanate

CONTINUED...

TABLE 3 (Continued)

PARAMETER (mg/l)*	STATION 8		STATION 9		STATION 10	
pH (relative units)	7.5		7.4		6.9	
non-filterable residue	< 5.0		< 5.0		13.0	
total residue	83.0		59.0		62.0	
ammonia	0.043		0.055		0.057	
total CN	0.11		0.08		0.08	
CNwad ¹	< 0.03		< 0.03		< 0.03	
CNS ²	< 2.0		< 2.0		< 2.0	
total hardness	38.6		27.3		28.6	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Ba	0.008	0.006	0.006	0.004	0.011	0.004
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.006	< 0.005	< 0.006	< 0.005	0.006	< 0.005
Cr	0.007	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cu	0.12	0.026	0.073	0.025	0.086	0.06
Hg	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Mn	0.022	0.015	0.015	0.011	0.044	0.015
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Pb	< 0.02	< 0.02	< 0.02	< 0.02	0.03	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.06	< 0.05	< 0.06	< 0.05	< 0.01	< 0.01
Sr	0.07	0.071	0.046	0.046	0.046	0.044
Ti	0.007	< 0.002	0.003	< 0.002	0.024	< 0.002
V	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	0.065	0.039	0.032	0.03	0.173	0.097
Al	0.28	0.11	0.14	< 0.05	0.64	< 0.05
Fe	0.493	0.013	0.326	0.031	1.59	0.063
Si	1.2	0.9	0.9	0.7	1.5	0.7
Mg	0.5	0.5	0.4	0.3	0.7	0.4
Na	6.3	6.5	5.7	5.6	4.0	3.8
Ca	14.9	14.4	10.9	10.2	11.7	10.6

* unless otherwise stated

¹ CNwad - weak acid dissociable cyanide

² CNS - thiocyanate

CONTINUED...

TABLE 3 (Continued)

PARAMETER (mg/l)*	STATION 12		STATION 14		STATION 15	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
pH (relative units)	7.3		7.2		-	
non-filterable residue	32.0		41.0		-	
total residue	77.0		189.0		-	
ammonia	0.056		0.061		-	
total CN	0.08		0.05		0.08	
CNwad ¹	0.05		0.05		< 0.03	
CNS ²	< 2.0		< 2.0		< 2.0	
total hardness	31.4		31.9		20.7	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Ba	0.033	0.007	0.043	0.008	0.09	0.008
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	0.006	< 0.005	0.009	< 0.005	< 0.006	< 0.005
Cr	0.006	< 0.005	< 0.006	< 0.005	0.007	< 0.005
Cu	0.046	0.043	0.044	0.046	0.007	-
Hg	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Mn	0.083	0.028	0.106	0.035	0.119	0.004
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.06	< 0.05	0.09	< 0.06	0.11	< 0.05
Pb	0.03	< 0.02	0.09	< 0.02	< 0.02	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.064	0.06	0.066	0.06	0.051	0.032
Ti	0.057	< 0.002	0.087	0.003	0.237	0.005
V	0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	0.077	0.032	0.052	0.015	0.02	0.004
Al	1.76	< 0.05	2.46	0.15	4.88	0.15
Fe	2.34	0.066	3.31	0.266	4.98	0.11
Si	3.4	0.7	4.5	0.8	9.2	0.5
Mg	1.4	0.7	1.8	0.8	2.3	0.3
Na	1.1	0.9	1.1	0.9	1.0	0.4
Ca	12.3	11.2	12.2	10.9	8.1	6.9

¹ CNwad - weak acid dissociable cyanide

² CNS - thiocyanate

CONTINUED...

TABLE 4 WATER QUALITY RESULTS ON JULY 26, 1982 AT STATION 8

PARAMETER (mg/l)		
total CN	< 0.03	
weak acid dissociable CN	< 0.03	
thiocyanate	< 2.0	
	TOTAL	DISSOLVED
As	< 0.06	< 0.06
B	< 0.001	< 0.001
Ba	0.005	0.005
Be	< 0.001	< 0.001
Cd	< 0.002	< 0.002
Co	< 0.006	0.012
Cr	< 0.006	< 0.006
Cu	0.01	0.043
Mn	0.027	< 0.001
Mo	< 0.006	< 0.006
Ni	< 0.02	< 0.02
P	< 0.06	< 0.06
Pb	< 0.02	< 0.02
Sn	< 0.01	< 0.01
Sr	0.054	0.054
Ti	0.007	< 0.002
V	< 0.01	< 0.01
Zn	0.023	< 0.002
Al	0.16	< 0.06
Fe	0.545	< 0.006
Si	1.0	0.7
Ca	11.3	10.4
Mg	0.4	< 0.1
Na	2.6	2.9
Hardness, Total	17.8	-

TABLE 5 SCOTTIE GOLD MINES LTD. - ANALYSES OF RECEIVING WATER FROM GRAB SAMPLES COLLECTED JULY 27, 1982

PARAMETER (mg/l)*	STATION 1		STATION 4		STATION 5	
pH (relative units)	7.9		8.0		7.6	
total residue	217.0		227.0		125.0	
non-filterable residue	13.0		6.0		11.0	
ammonia	0.115		0.380		0.080	
sulphate	79.0		79.0		40.0	
total CN	0.12		0.11		< 0.03	
CNwad ¹	< 0.03		0.03		< 0.03	
CNS ²	12.0		11.4		3.2	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
B	0.096	< 0.001	0.096	< 0.001	< 0.001	< 0.001
Ba	0.008	0.004	0.01	0.004	0.017	0.006
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	0.014	0.012	0.013	0.012	0.008	0.007
Cr	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cu	0.172	0.138	0.155	0.112	0.072	0.011
Hg	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Mn	0.036	0.004	0.045	0.002	0.041	0.008
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Pb	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.096	0.064	0.099	0.064	0.085	0.047
Ti	0.01	< 0.002	0.017	< 0.002	0.019	< 0.002
V	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	0.081	0.008	0.08	< 0.002	0.013	< 0.002
Al	0.44	0.07	0.64	0.07	0.65	0.06
Fe	1.48	0.056	1.83	0.064	0.998	0.03
Si	1.40	0.9	1.70	0.9	1.8	0.9
Ca	19.6	17.2	20.0	17.0	17.0	14.3
Mg	0.8	0.4	0.9	0.4	0.7	0.4
Na	38.1	33.9	38.4	34.0	14.4	12.3
Hardness, total	45.1		44.8		37.7	

* unless otherwise stated
¹ CNwad - weak acid dissociable
² CNS - thiocyanate

CONTINUED...

TABLE 5 (Continued)

PARAMETER (mg/l)*	STATION 8		STATION 11		STATION 12	
pH (relative units)	7.5		7.4		7.5	
total residue	64.0		98.0		90.0	
non-filterable residue	6.0		50.0		44.0	
ammonia	0.095		0.065		0.055	
sulphate	17.5		11.1		10.7	
total CN	< 0.03		< 0.03		< 0.03	
CNwad ¹	< 0.03		< 0.03		< 0.03	
CNS ²	< 2.0		< 2.0		< 2.0	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
B	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Ba	0.008	0.003	0.052	0.006	0.046	0.005
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cr	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cu	0.023	< 0.005	0.044	0.025	0.039	0.021
Hg	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Mn	0.02	< 0.001	0.12	0.022	0.105	0.017
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.06	< 0.05	0.12	< 0.05	0.11	< 0.05
Pb	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.044	0.013	0.062	0.024	0.061	0.023
Ti	0.006	< 0.002	0.088	< 0.002	0.075	< 0.002
V	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	0.017	0.005	0.027	< 0.002	0.03	0.003
Al	0.28	< 0.05	2.84	0.11	2.49	0.07
Fe	0.327	0.005	3.57	0.16	3.03	0.066
Si	0.9	0.6	4.6	0.6	4.1	0.6
Ca	9.8	8.2	11.4	9.1	11.0	8.8
Mg	0.4	0.2	1.8	0.5	1.6	0.5
Na	4.9	4.3	1.4	0.8	1.2	0.7
Hardness, total	21.3		25.6		24.4	

* unless otherwise stated
¹ CNwad - weak acid dissociable
² CNS - thiocyanate

CONTINUED...

TABLE 5 (Continued)

PARAMETER (mg/l)*	STATION 13		STATION 14		STATION 15	
pH (relative units)	7.6		7.5		8.3	
total residue	116.0		99.0		397.0	
non-filterable residue	57.0		50.0		136.0	
ammonia	0.080		0.065		0.028	
sulphate	11.6		10.6		4.1	
total CN	< 0.03		< 0.03		< 0.03	
CNwad ¹	< 0.03		< 0.03		< 0.03	
CNS ²	< 2.0		< 2.0		< 2.0	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
B	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Ba	0.056	0.006	0.052	0.005	0.077	0.004
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002	< 0.002
Co	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cr	0.007	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Cu	0.49	0.018	0.038	0.016	0.011	< 0.005
Hg	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Mn	0.135	0.02	0.119	0.016	0.103	< 0.001
Mo	< 0.006	< 0.005	< 0.006	< 0.005	< 0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	0.13	< 0.05	0.13	< 0.05	0.13	< 0.05
Pb	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
Sb	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Se	< 0.06	< 0.05	< 0.06	< 0.05	< 0.06	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.062	0.023	0.06	0.021	0.038	< 0.001
Ti	0.01	< 0.002	0.09	< 0.002	0.18	< 0.002
V	< 0.01	< 0.01	0.01	< 0.01	< 0.02	< 0.01
Zn	0.037	< 0.002	0.071	0.018	0.018	< 0.002
Al	3.1	0.07	2.88	0.07	3.9	0.09
Fe	4.02	0.039	3.64	0.03	3.69	0.028
Si	5.0	0.5	4.7	0.5	6.7	0.2
Ca	11.5	9.1	10.9	8.6	6.0	3.8
Mg	1.9	0.5	1.8	0.5	1.7	0.1
Na	1.4	0.8	1.3	0.8	0.9	0.2
Hardness, total	25.3		23.8		10.5	

* unless otherwise stated
¹ CNwad - weak acid dissociable
² CNS - thiocyanate

CONTINUED...

TABLE 6 SCOTTIE GOLD MINES - TAILINGS DISCHARGE (STATION 2) QUALITY IN 1982

PARAMETER (mg/l) ¹	MAY 3 A.M.		MAY 3 P.M.		JULY 26 13:30 h	
pH (rel. units)	11.9		11.8		9.3	
non-filt. residue	313.0		52.0		26000.0	
total residue	19800.0		13100.0		31800.0	
SO ₄	430.0		364.0		1330.0	
NH ₃	9.50		8.0		4.25	
total CN	86.8		96.7		234.0	
CNwad ²	55.8		69.4		50.0	
CNO	29.1		15.0		-	
CNS	580.0		445.0		1120.0	
Hardness	3680.0		2700.0		66900.0	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	367.0	< 0.05	380.0	0.12	150.0	140.0
Ba	5.04	0.081	4.97	0.052	4.3	3.9
Be	< 0.05	< 0.001	< 0.05	< 0.001	< 0.3	< 0.03
Cd	14.3	< 0.002	15.1	< 0.002	4.6	3.71
Co	618.0	0.176	717.0	0.184	19.0	20.3
Cr	5.3	< 0.005	5.1	< 0.005	3.0	2.8
Cu	198.0	< 0.005	205.0	0.057	194.0	171.0
Hg	< 3.0	< 0.05	< 3.0	< 0.05	*0.0074	-
Mn	410.0	0.01	415.0	0.002	245.0	216.0
Mo	< 0.3	< 0.005	< 0.3	< 0.005	11.0	7.5
Ni	6.0	0.14	7.0	0.07	< 6.0	< 0.6
P	313.0	0.27	334.0	0.18	120.0	108.0
Pb	268.0	< 0.02	261.0	< 0.02	140.0	128.0
Sb	< 3.0	< 0.05	4.0	< 0.05	-	-
Se	< 3.0	0.11	< 3.0	0.13	-	-
Sn	< 0.5	< 0.01	< 0.5	< 0.01	< 3.0	< 0.3
Sr	21.3	2.54	20.9	2.18	9.6	9.32
Ti	150.0	< 0.002	185.0	0.004	90.5	91.8
V	44.0	< 0.01	44.2	< 0.01	19.0	18.9
Zn	749.0	0.086	742.0	0.011	457.0	409.0
Al	5560.0	0.07	5490.0	0.13	2760.0	2680.0
Fe	12000.0	1.27	12000.0	10.6	16400.0	15500.0
Si	2070.0	0.7	1550.0	0.5	1840.0	1710.0
Mg	4060.0	0.5	4010.0	1.9	1840.0	1840.0
Na	750.0	715.0	1050.0	1070.0	2050.0	1930.0
Ca	15800.0	1080.0	17200.0	1460.0	6430.0	6270.0

¹ Results in mg/l unless otherwise stated

² CNwad - weak acid dissociable cyanide

NOTE: Mercury samples marked with * have been done in the following method due to high sediment content.

1) Samples were well shaken, poured out, and centrifuged.

2) Liquid portion was then run as regular water sample.

3) Sediment portion was dried and run as sediment sample.

4) Both results were then converted and combined so final result is in mg/l Hg.

TABLE 6 (Continued)

PARAMETER (mg/l) ¹	JULY 27		JULY 28 09:15 h	
pH (rel. units)	10.8		10.6	
non-filt. residue	51400.0		58700.0	
total residue	166000.0		108000.0	
SO ₄	3300.0		3750.0	
NH ₃	5.0		4.20	
total CN	116.0		139.0	
CNwad ²	7.00		14.8	
CNO	-		-	
CNS	620.0		530.0	
Hardness	216.0		280.0	
	TOTAL	DISS.	TOTAL	DISS.
As	210.0	< 0.06	180.0	< 0.06
Ba	5.0	0.012	4.2	0.001
Be	< 0.3	< 0.001	< 0.3	< 0.001
Cd	5.3	< 0.002	4.6	< 0.002
Co	25.0	0.282	29.0	0.058
Cr	5.0	0.015	4.0	< 0.006
Cu	198.0	6.68	171.0	7.37
Hg	*0.0111	-	*0.0142/0.0304 ³	-
Mn	382.0	0.014	298.0	0.006
Mo	13.0	0.047	9.0	0.027
Ni	< 7.0	0.24	< 6.0	150.0
P	170.0	< 0.06	150.0	< 0.06
Pb	190.0	< 0.02	163.0	< 0.02
Sb	-	-	-	-
Se	-	-	-	-
Sn	< 3.0	< 0.01	< 3.0	< 0.01
Sr	14.2	0.327	11.1	0.238
Ti	128.0	0.009	109.0	0.006
V	31.0	< 0.01	27.0	< 0.01
Zn	618.0	0.085	513.0	0.06
Al	4260.0	1.17	3370.0	3.21
Fe	23300.0	35.9	19800.0	42.9
Si	2080.0	0.7	1790.0	0.7
Mg	2890.0	0.5	2260.0	0.3
Na	1960.0	2810.0	2430.0	2400.0
Ca	10100.0	57.1	8070.0	44.7

¹ Results in mg/l unless otherwise stated

³ Mercury sampled A.M. and P.M.

² CNwad - weak acid dissociable cyanide

NOTE: Mercury samples marked with * have been done in the following method due to high sediment content.

- 1) Samples were well shaken, poured out, and centrifuged.
- 2) Liquid portion was then run as regular water sample.
- 3) Sediment portion was dried and run as sediment sample.
- 4) Both results were then converted and combined so final result is in mg/l Hg.

TABLE 7 SCOTTIE GOLD MINES - MINEWATER (STATION 6) QUALITY IN 1982

PARAMETER (mg/l) ¹	MAY 3 A.M.		MAY 3 P.M.		JULY 28 10:50 h	
pH (rel. units)	7.8		7.8		9.2	
non-filt. residue	314.0		361.0		1174.0	
total residue	717.0		923.0		1173.0	
SO ₄	122.0		128.0		84.0	
NH ₃	14.0		14.0		0.431	
total CN	< 0.03		< 0.03		2.27	
CNwad ²	< 0.03		< 0.03		0.15	
CNO	< 2.0		< 2.0		11.8	
CNS	9.99		< 0.005		-	
Hardness	193.0		202.0		231.0	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	0.14	< 0.05	0.3	0.18	2.7	0.31
Ba	0.1	0.038	0.098	0.039	0.171	0.036
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.006	< 0.001
Cd	0.015	< 0.002	0.022	< 0.002	0.05	0.006
Co	0.364	< 0.005	0.483	< 0.005	0.44	0.033
Cr	0.012	< 0.005	0.018	< 0.005	0.06	0.013
Cu	0.355	0.169	0.459	0.133	2.63	0.74
Hg	< 0.05	< 0.05	< 0.05	< 0.05	< 0.002*	-
Mn	1.01	0.129	1.16	0.146	4.06	0.734
Mo	0.034	0.011	0.048	0.009	0.1	< 0.006
Ni	< 0.02	< 0.02	0.04	< 0.02	< 0.1	< 0.02
P	0.41	< 0.05	0.49	< 0.05	2.0	0.34
Pb	0.44	< 0.02	0.65	< 0.02	2.6	0.55
Sb	0.1	0.11	0.11	0.13	-	-
Se	< 0.05	< 0.05	< 0.05	< 0.05	-	-
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.06	< 0.01
Sr	1.81	1.67	1.82	1.8	0.192	0.078
Ti	0.584	0.015	0.645	0.046	2.47	0.282
V	0.08	< 0.01	0.09	< 0.01	0.39	0.06
Zn	1.48	0.095	1.09	0.046	7.0	0.926
Al	14.8	< 0.05	14.2	< 0.05	56.6	9.9
Fe	55.6	0.477	43.7	0.111	317.0	41.6
Si	22.3	3.1	18.2	2.9	64.8	12.4
Mg	14.9	5.4	14.6	5.2	34.4	6.0
Na	24.4	23.5	24.4	22.0	41.0	55.3
Ca	109.0	70.5	100.0	67.6	106.0	29.6

¹ Results in mg/l unless otherwise stated

² CNwad - weak acid dissociable cyanide

NOTE: Mercury samples marked with * have been done in the following method due to high sediment content.

- 1) Samples were well shaken, poured out, and centrifuged.
- 2) Liquid portion was then run as regular water sample.
- 3) Sediment portion was dried and run as sediment sample.
- 4) Both results were then converted and combined so final result is in mg/l Hg.

TABLE 7 (Continued)

PARAMETER (mg/l) ¹	JULY 28 P.M.		JULY 29 08:30 h	
pH (rel. units)	8.9		9.0	
non-filt. residue	438.0		287.0	
total residue	957.0		1220.0	
SO ₄	71.0		70.0	
NH ₃	0.028		0.525	
total CN	1.04		1.10	
CNwad ²	< 0.03		< 0.03	
CNO	6.0		336.0	
CNS	-		-	
Hardness	29.1		30.3	
	TOTAL	DISS.	TOTAL	DISS.
As	1.0	0.06	0.84	< 0.06
Ba	0.096	0.003	0.054	0.003
Be	< 0.006	< 0.001	< 0.001	< 0.001
Cd	0.03	< 0.002	0.017	< 0.002
Co	0.24	0.007	0.107	< 0.006
Cr	0.04	< 0.006	0.023	< 0.006
Cu	1.04	0.161	0.877	0.235
Hg	< 0.0002*	-	< 0.0002*	-
Mn	1.9	< 0.001	1.53	0.005
Mo	0.1	< 0.006	0.04	< 0.005
Ni	< 0.1	< 0.02	< 0.02	< 0.02
P	1.1	< 0.06	1.28	< 0.06
Pb	1.1	< 0.02	1.11	< 0.02
Sb	< 0.3	-	-	-
Se	< 0.3	-	-	-
Sn	< 0.06	< 0.01	< 0.01	< 0.01
Sr	0.13	0.043	0.157	0.075
Ti	1.19	< 0.002	0.654	0.002
V	0.15	< 0.01	0.11	< 0.01
Zn	2.86	0.013	2.27	0.023
Al	25.6	0.14	17.1	0.14
Fe	132.0	0.601	106.0	0.985
Si	30.7	0.4	19.8	0.5
Mg	15.6	0.2	10.6	0.4
Na	34.0	31.1	21.8	23.9
Ca	42.4	10.5	66.8	10.4

¹ Results in mg/l unless otherwise stated

² CNwad - weak acid dissociable cyanide

NOTE: Mercury samples marked with * have been done in the following method due to high sediment content.

- 1) Samples were well shaken, poured out, and centrifuged.
- 2) Liquid portion was then run as regular water sample.
- 3) Sediment portion was dried and run as sediment sample.
- 4) Both results were then converted and combined so final result is in mg/l Hg.

TABLE 8 RECEIVING WATER QUALITY AT SCOTTIE GOLD MINE - JULY 12, 1983

PARAMETER (mg/l)*	STATION 1		STATION 4		STATION 8	
pH (relative units)	7.4		8.0		7.3	
turbidity (FTU)	3.4		3.4		11.0	
conductivity (umhos/cm)	154.0		142.6		81.4	
non-filterable residue	22.0		21.0		26.0	
filterable residue	107.0		101.0		82.0	
total residue	129.0		122.0		109.0	
sulphate	48.0		41.4		18.7	
total CN	< 0.01		< 0.01		< 0.01	
thiocyanate	1.59		1.53		< 0.1	
cyanate	-					
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	0.006	0.038	0.006	< 0.001	0.007	0.004
Ba	0.02	0.007	0.025	0.007	0.035	0.007
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Co	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cr	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Cu	0.009	0.006	0.008	0.003	< 0.001	0.002
Hg	-	-	-	-	-	-
Mn	0.069	0.026	0.075	0.023	0.073	0.015
Mo	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	< 0.05	< 0.05	0.05	< 0.05	0.08	< 0.05
Pb	0.004	0.001	0.005	< 0.001	0.006	< 0.001
Sb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.082	0.077	0.076	0.072	0.072	0.067
Ti	0.037	< 0.002	0.049	< 0.002	0.072	< 0.002
V	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Zn	0.014	0.007	0.017	0.006	0.025	0.007
Al	1.09	< 0.05	1.4	< 0.05	2.01	< 0.05
Fe	1.68	0.044	2.02	0.025	2.87	0.037
Si	2.4	0.9	2.9	0.8	3.7	0.6
Ca	17.1	16.6	15.7	15.6	12.8	12.2
Mg	1.0	0.5	1.1	0.5	1.3	0.6
Na	13.3	12.8	11.3	10.9	1.9	1.8
Hardness, Ca,Mg	43.6		40.9		32.6	
Hardness, total	44.0		41.2		33.0	

1 all units in mg/l unless otherwise stated
 2 Diss. = Dissolved

TABLE 8 (Continued)

PARAMETER (mg/l)*	STATION 12		STATION 14		STATION 16	
pH (relative units)	7.5		8.8		7.7	
turbidity (FTU)	24.0		27.0		25.0	
conductivity (umhos/cm)	77.0		44.5		49.4	
non-filterable residue	27.0		125.0		72.0	
filterable residue	54.0		11.0		57.0	
total residue	81.0		136.0		129.0	
sulphate	15.3		6.9		7.3	
total CN	-		-		< 0.01	
thiocyanate	< 1.0		< 1.0		< 1.0	
cyanate	0.15		< 0.01		-	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
B	< 0.001	0.052	< 0.001	0.037	0.006	0.051
Ba	0.067	0.02	0.12	0.031	0.083	0.012
Be	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001	< 0.001
Cd	0.006	0.007	< 0.0005	< 0.0005	< 0.0005	< 0.0005
Co	0.009	< 0.005	0.012	< 0.005	0.006	< 0.005
Cr	0.007	0.024	< 0.005	0.017	< 0.005	< 0.005
Cu	0.064	0.1	0.013	0.009	0.007	< 0.005
Hg	-	-	-	-	-	-
Mn	0.106	0.051	0.178	0.044	0.101	0.009
Mo	< 0.005	< 0.005	< 0.005	< 0.005	0.006	< 0.005
Ni	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02	< 0.02
P	0.11	0.29	0.5	0.31	0.12	< 0.05
Pb	0.005	0.004	0.004	0.002	0.002	< 0.001
Sb	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Se	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05	< 0.05
Sn	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01	< 0.01
Sr	0.067	0.059	0.068	0.037	0.066	0.044
Ti	0.128	0.02	0.342	0.044	0.217	0.003
V	0.01	< 0.01	0.02	< 0.01	< 0.01	< 0.01
Zn	0.057	0.048	0.049	0.033	0.025	0.003
Al	3.73	0.79	6.07	1.05	3.84	< 0.05
Fe	3.9	1.42	5.88	1.33	3.72	0.056
Si	7.2	1.6	11.0	1.9	7.2	0.5
Ca	11.5	11.2	11.0	7.2	9.9	7.9
Mg	2.0	1.1	2.5	0.8	1.7	0.4
Na	2.1	1.7	1.2	0.4	1.0	0.6
Hardness, Ca,Mg	32.4		21.2		21.6	
Hardness, total	39.6		29.6		22.0	

1 all units in mg/l unless otherwise stated
 2 Diss. = Dissolved

TABLE 9 TAILINGS DISCHARGE QUALITY AT SCOTTIE GOLD MINES IN JULY 1983

PARAMETER (mg/l)*	TAILINGS DISCHARGE (STATION 2)					
	JULY 11		JULY 12 A.M.		JULY 12 P.M.	
pH (relative units)	8.2		8.8		-	
non-filterable residue	220000.0		219000.0		-	
total residue	154000.0		378000.0		-	
total alkalinity, CaCO ₃	44.0		-		-	
total acidity, CaCO ₃	2.0		-		-	
total sulphate	2265.0		-		-	
ammonia	7.85		-		-	
total CN	-		10.0		-	
CNwad ¹	0.28		0.45		-	
thiocyanate (CNS)	25.3		22.5		-	
cyanate (CNO)	170.0		-		-	
	TOTAL	DISS.	TOTAL	DISS.	TOTAL	DISS.
As	60.0	< 0.05	30.0	< 0.05	30.0	< 0.05
B	< 0.5	0.052	0.2	0.023	0.2	0.034
Ba	15.4	0.094	5.5	0.078	6.3	0.077
Be	< 0.5	< 0.001	< 0.2	< 0.001	< 0.2	< 0.001
Cd	3.0	< 0.002	0.9	< 0.002	1.1	< 0.002
Co	40.0	0.167	25.0	0.137	25.0	0.139
Cr	4.0	< 0.005	1.0	< 0.005	1.0	< 0.005
Cu	101.0	0.012	38.0	0.2	45.0	0.186
Hg	-	-	-	-	-	-
Mn	287.0	0.031	130.0	0.029	133.0	0.028
Mo	4.0	0.041	1.0	0.031	1.0	0.032
Ni	< 10.0	< 0.02	< 4.0	< 0.02	< 4.0	< 0.02
P	110.0	0.46	40.0	< 0.05	50.0	< 0.05
Pb	120.0	< 0.02	42.0	< 0.02	49.0	< 0.02
Sb	< 30.0	0.17	< 10.0	0.19	< 10.0	0.19
Se	< 30.0	0.2	< 10.0	0.16	< 10.0	0.16
Sn	< 5.0	< 0.01	< 2.0	< 0.01	< 2.0	< 0.01
Sr	8.3	0.669	6.7	0.602	6.0	0.601
Ti	156.0	< 0.002	50.6	< 0.002	57.8	< 0.002
V	23.0	< 0.01	9.0	< 0.01	10.0	< 0.01
Zn	221.0	0.012	86.8	0.01	90.8	0.009
Al	4100.0	0.22	1390.0	0.09	1600.0	0.1
Fe	11900.0	0.346	5170.0	0.09	1600.0	0.1
Si	6360.0	0.8	1780.0	1.0	2100.0	1.0
Ca	6090.0	159.0	4660.0	136.0	3980.0	136.0
Mg	2650.0	3.5	940.0	3.2	1050.0	3.2
Na	1100.0	935.0	890.0	765.0	850.0	762.0

* all units in mg/l unless otherwise stated

¹ CNwad - weak acid dissociable