Boojum Research Limited

HOPE BROOK GOLD MINES LTD.

ASSESSMENT OF SEEPAGE CHARACTERISTICS WASTE ROCK PILE AND HOLDING POND

by

M. Kalin and R.O. van Everdingen

for

HOPE BOOK GOLD MINES LTD.

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In fulfilment of Purchase Order No. 03549

139 AMELIA STREET, TORONTO, ONTARIO M4X-1E6, 1-416-963-9420

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HOPE BROOK GOLD

The Characteristics of the Seepages from the Waste-Rock Pile

1. Background and Objectives

The waste-rock pile which was started in the spring of 1987, contained approximately 2.7 million tons by July, 1988. Low grade ore located at the eastern portion of the pile is higher in pyrite, indicates that some segregation of the waste material has taken place.

Concern has arisen that acid mine drainage is occurring in the pile. Some seepages, following the paths of small creeks which originally ran through the area now underlying the waste-rock pile, display the characteristics resulting from such acid generation.

It was not anticipated that acid generation would be a concern. Waste-rock deposition takes place by integrating limestone, and in light of its relatively low pyrité content, it was believed that any onset of acid mine drainage would not occur prior to the waste-rock being used as backfill, i.e. not before the end of 1988. The use of backfill material is estimated to occur at a rate of 1500/tpd.

Acidification found in some of the seeps emerging from the pile gave rise to the question of whether the onset of AMD is indeed serious. Can individual seeps originating either from portions of the waste-rock pile or from previously existing creeks be localized? If the answer is yes, then limited treatment and/or containment within the peat/fen area below the pile is possible. However, if the entire waste-rock pile is generating acid, the establishment of a treatment plant may be necessary.

The installation of a treatment plant has both economic and environmental implications. Neutralization by the addition of chemicals alters the water characteristics and may affect fish survival and should, therefore, be carefully considered.

In order to protect Cinq Cerf Brook, a focused study was carried out to address the questions of acid generation in the waste-rock pile and in the seepages and creeks emerging from the pile and from the holding pond.,

2.0 METHODS AND MATERIALS

Data from three monitoring stations were summarized (Stations 1, 18 and 20), representing inflow into the holding pond, seepages leaving the holding pond, and the final effluent leaving to Cinq Cerf Brook.

Three areas were selected for water sampling on site, and these are outlined on Map 1. These areas represent (1) the area around the tailings pond where construction had occurred; (2) undisturbed background water characteristics along the main access road where a natural iron rich seep was discovered; and (3) the areas around the waste-rock pile and the holding pond.

pH and electrical conductivity were measured at a number of points in each of these areas, designated by letters, and samples were collected for analysis at some of these points.

A total metal scan was performed on unfiltered samples, and determinations were made of alkalinity/acidity levels, by a certified laboratory, Assayers (Ontario) Limited.

3.0 RESULTS

3.1 Field investigation of creeks

In Tables 1 to 3, the measurement and sampling sites, their description and the pH and conductivity values determined in the field and re-determined prior to analysis in the laboratory in Toronto, are reported. The locations of all sampled points are given on Map 1. The sampling areas are indicated by circles and the approximate sampling locations by numbers.

Five samples have been collected in the inactive tailings area and the non-disturbed background areas (Areas 1 and 2). The samples were in transit for approximately 10 days and from the re-determination of pH, slight differences can be noted (Table 1). The water has natural buffering capacity, expressed by either slight acidification or neutralization. The conductivity is very low, ranging from 20 to 45 umhos/cm, and the pH ranges from 4.7 to 6.3.

In Table 2, the field data for the area of the waste-rock pile are presented. Drainage I represents the water of Gold Pond and the diversion ditch, whereas Drainage II represents the seeps emerging from the toe of the pile.

Table 1: Inactive tailings area and Non -disturbed background

Area	WaterSite Sample Code	Description	FIELD, May 12 Temp. deg C	pH	Cond. uS/cm	LAB, May 27 Temp. deg C	pH	Cond. uS/cm
1 (1)		Creek at tailings line outfall (runoff division)	11	6.05	10			
(2)	403	Second pond below inactive tailings line	18	5.90	20	10	6.11	20
(3)		Mud puddle (with algae)	25	3.99	45			
(4)	406	Nostoc pond, with algae in thick mats	18	5.80	40	15	6.36	40
2 (5)		Clear water pond above road	22	4.30	45			
(6)		Lower end of pond	23	4.60	30			
(7)	396	Flow beside large rock, above culvert	22	4.70	30	7	4.60	20
(8)		Channel below culvert at end of disturbed section	21	5.30	30			
(9)		Channel, halfway to next pond east	17	5.40	30			
(10)		Next pond east	19	5.50	30			
(11)		Pond inflow from iron-rich seep	8	5.30	60			
(12)	389	Iron-rich seep	7	4.70	50	17	6.20	62
(13)	391	Creek, above Bridge #1	19	6.34	20	11	4.92	18
3 (14)		Outflow from pond beside road (with bluegreens)	22	6.90	35			
15		Pond	23	7.00	30			

Table 2: Waste Rock, Creeks and Seepages

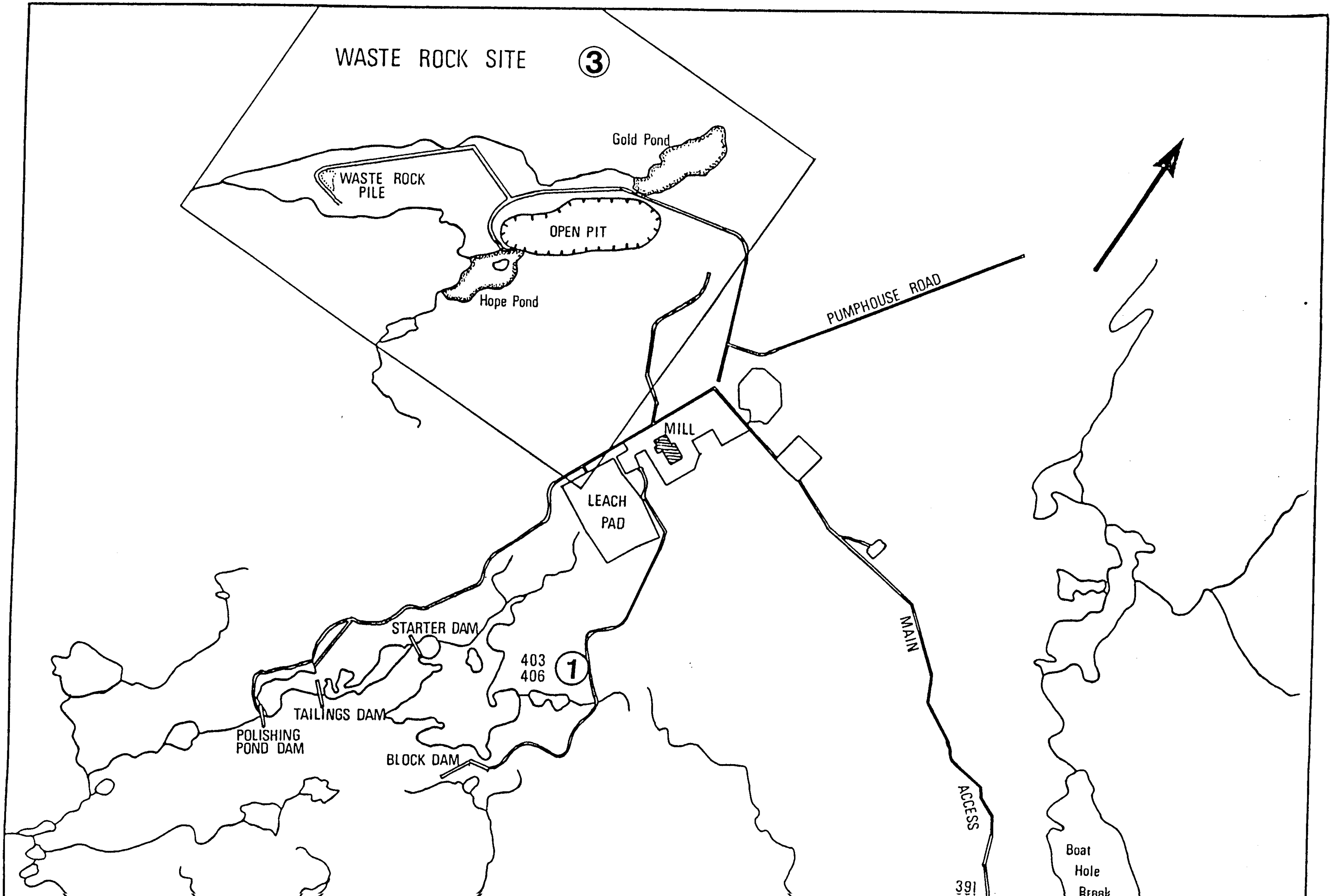
Area	WaterSite Sample Code	Description	FIELD, May 12 Temp. deg C	pH	Cond. uS/cm	LAB, May 27 Temp. deg C	pH	Cond. uS/cm
Hope Brook Site Samples								
DRAINAGE BASIN I:								
12		Upper part of Gold Pond diversion ditch	10	6.10	50			
5		Lower part of diversion beside polishing pond	10	6.20	60			
DRAINAGE BASIN II:								
7	(a) 394	Most easterly creek at S. end of water rock pile	5	5.40	40	10	5.70	48
	(b)	Very small seep creek just west of #7 (a)	6	5.20	50			
8	(c) 399	Brown creek at foot of waste rock pile	2	4.10	800	16	2.69	1250
9	(e) 400	Natural seep w/ iron ppte (tributary to #9 (d)?)	10	3.80	1750	13	2.45	1700
	(d) 393	Creek from waste rock pile	9	4.60	55	10	4.50	43
10	(f)	Most westerly creek at S. end of waste rock pile	9	4.50	50			
	(g) 405	Outflow from culvert at NW corner of ore pile	10	3.50	1400	18	2.85	1150
DRAINAGE BASIN III:								
13	(c) 397	Inflow to Hope Pond basin, east of sedimentation dam	9	4.60*	40	9	5.80	40
	(a) 404	West shores of Hope Pond	11	4.80	70	14.5	6.00	40
	(b)	Upper end of drainage ditch from Hope Pond	10	4.50	70			

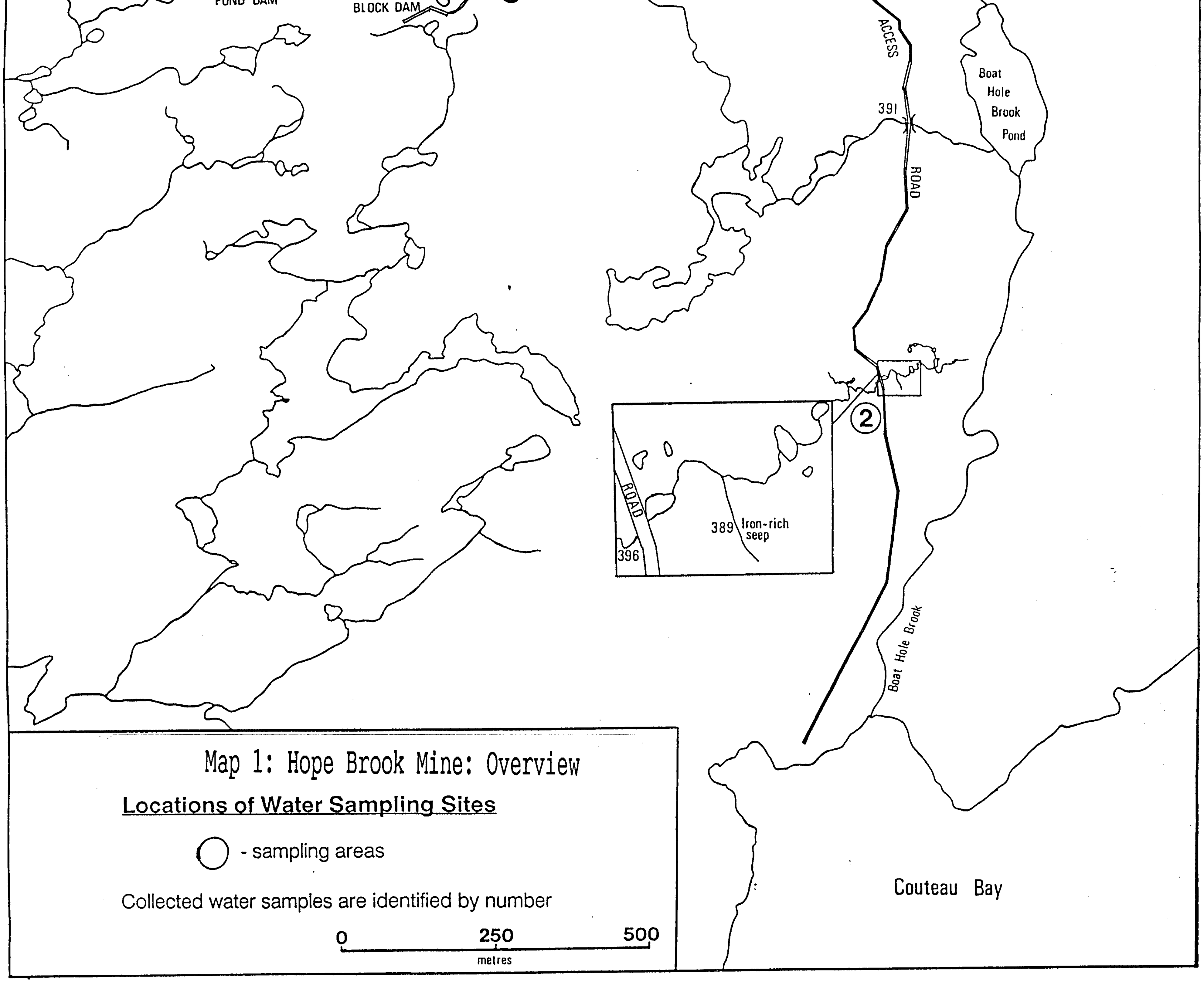
Table 3: Polishing Pond, Creeks and Seepages

Area	Water Sample Code	Site Description	FIELD, May 12 Temp. deg C	pH	Cond. uS/cm	LAB, May 27 Temp. deg C	pH	Cond. uS/cm
DRAINAGE BASIN IV:								
2		Polishing pond collecting from waste rock pile	14	3.60	600			
19		Drainage from area below polishing pond	8	7.00	80			
(a)		In peat below dam (disturbed)	8	4.60	100			
(b)		Peat water puddles	10	6.00	30			
(c)		Peat water puddles	10	6.00	30			
(d)	390	Back-hoe peat hole	6	5.30	30	12	5.40	40
(e)		Sedimentation dam below collection pond	9	5.10*	70			
18 (f)	398	Seep from polishing pond dam	7	4.90	340			
(d)	398	Continuation of seep from polishing pond	7	4.20	310	11	4.36	325
(c)	402	Stream from boggy area, joining stream #19 (d)	6	4.10	330	11	3.75	400
(b)		Brown bed stream above sump pump	6	4.30	340			
(e)	401	Diversion ditch from waste rock pile and Hope Pond drainage	7	5.00	150	15	5.06	200
(g)		East runoff into stream #19 (e)	9	5.40	50			
(a)		Below dam/sump pump	7	4.40	100			
21	392	Brown creek joining diversion ditch	8	4.90	60	11	4.69	70
20	395	W. side of diverson ditch, below confluence with brown creek	8	5.70*	50	10	6.78	58

Map 2 is a schematic representation of the sampling locations, numbered according to a survey previously carried out in December 1987 by Hope Brook Gold personnel. (This map was drawn based on Maps 2a included in the Appendix provided by G. McDonald.) The identification of the December 1987 sampling locations was made by proceeding along the toe of the waste-rock pile to the most southern creek, which ran along a steep ridge. This creek was considered to represent old sampling location 7 on Map 2. Then a northward route was taken along the toe of the pile, back to the road, following the numbering scheme shown on Map 2a). All sampling points were marked with red masking tape. By July, 1988 however, most of the sampling points were covered already by waste-rock. Stations 7, 9 and 18 were resampled.

A total of 7 seeps/creeks were measured directly at the toe of the pile and, from the field data alone, it is already clear that Creeks 8(c), 9(e) and 10(g) exhibit acid mine drainage characteristics (Table 2). Although the pH values in the field are close to the natural range, the conductivity is elevated. These samples, after transit, have all acidified to a lower pH, around 2.5. The electrical conductivity of these samples ranges from 800 to 1700 umhos/cm, compared to the other seeps in this drainage basin which have conductivities from around 40 to 70 umhos/cm.


WASTE ROCK SITE
3
Gold Pond
WASTE ROCK
PILE
OPEN PIT
Hope Pond
PUMPHOUSE ROAD
MILL
LEACH
PAD
MAIN
ACCESS
STARTER DAM
403
406
1
TAILINGS DAM
POLISHING
POND DAM
BLOCK DAM
Boat
Hole
391



Map 1: Hope Brook Mine: Overview

Locations of Water Sampling Sites

◯ - sampling areas

Collected water samples are identified by number

In Table 3, the seeps and creeks below the holding pond are identified. In Map 2, the approximate locations are given. The characteristics of these waters are distinctly different from the three acidic mine drainage creeks at the toe of the pile. The pH values are higher, the conductivity is only slightly elevated and, after transportation, the samples had not acidified significantly.

The peat and the wetland in the area are not affected by the seeps from the holding pond (note values for site 19). It is important to note that the values for sites 20 and 21 do not deviate from the background values presented in Table 1.

The field values of pH and electrical conductivity alone suggest that the acid mine drainage from the waste-rock pile is very confined. As the water seeps through the peat/fen below the pile and is collected in the holding pond, some amelioration/ dilution/neutralization has taken place. This is indicated by the values obtained in seeps below the holding pond.

3.2 Chemical Characteristics of the seeps

If the chemical analysis of the collected samples confirms that acid mine drainage is occurring in defined seeps rather than in all of the creeks, it may be possible that these can be confined in bog/fen areas immediately below the toe of the pile.

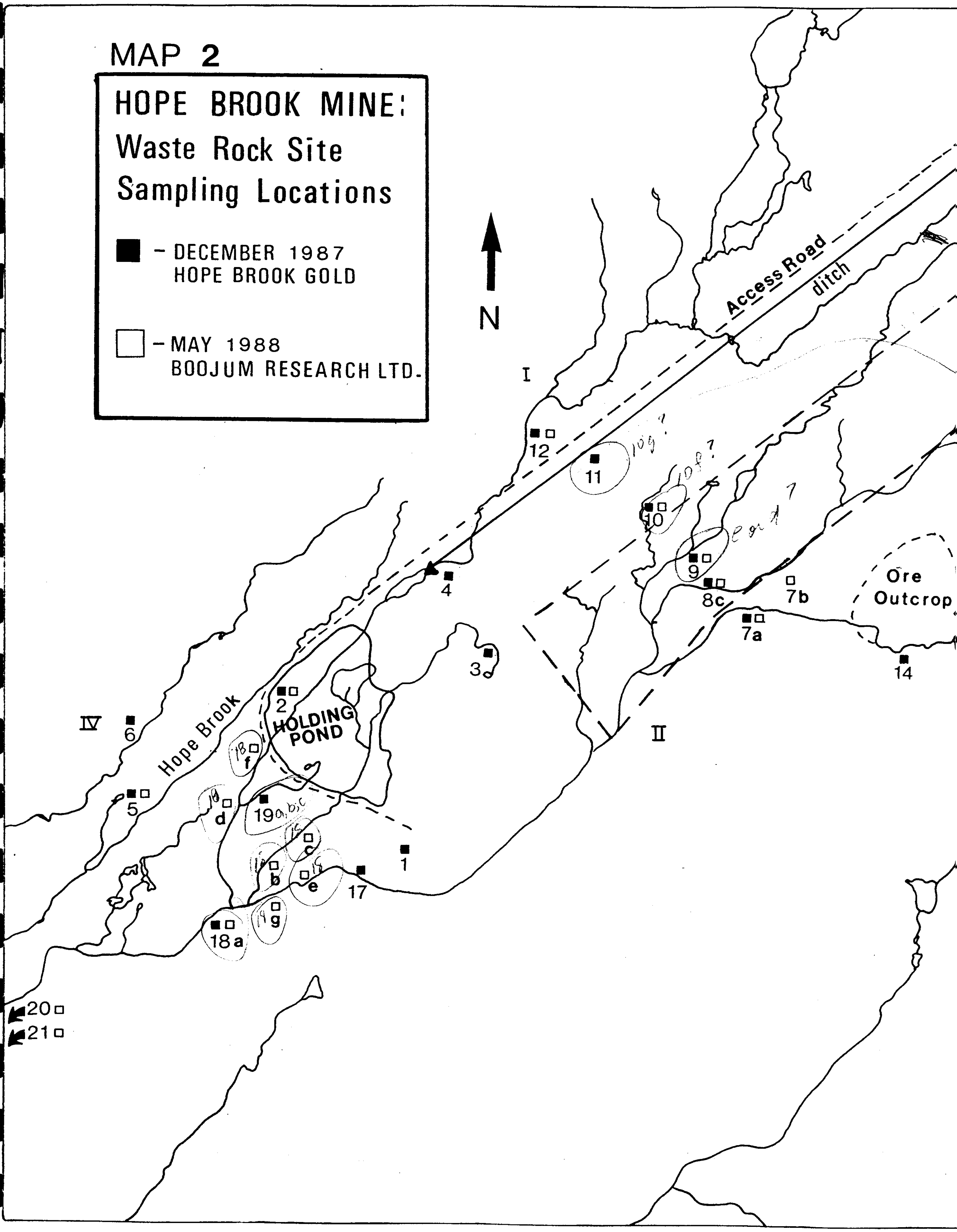
In Table 4, the elemental concentrations are presented for the inactive tailings areas and the non-disturbed background. The descriptions of the sample locations are those given in Table 1. Natural acidity and alkalinity values range between 11 to 43 mg calcium carbonate per litre, confirming that background waters have some buffering capacity as suggested by the small differences in pH values (Field and Laboratory) given in Table 1.

In Table 5 the analysis for samples from Drainage Basin II, the seeps and the toe of the pile and those coming from Hope Pond, are summarized. The descriptions of the locations correspond to those in Table 2. The three seepages previously identified from the field data as acid mine drainage seeps are indeed those which display acid mine drainage characteristics. The other seeps around the waste rock pile have alkalinities within the background range of 10 to 20, or natural acidity of 22 mg $CaCO_3$/L. The acid mine drainage seeps are presumably originating under the low-grade ore pile. The water leaving Hope Pond (7 and 13) represents background characteristics.

Table 4 : Elemental concentrations in water of Background locations

Area	1(2)	1(4)	2(7)	2(12)	2(13)
Assayer#	403	406	396	389	391
Al	0.20	0.30	0.03	0.02	<0.01
Bi	<0.01	<0.01	<0.01	0.02	<0.01
C	<0.01	<0.01	<0.01	94.00	<0.01
Ca	2.00	7.00	1.20	12.00	1.20
Co	<0.01	0.09	<0.01	<0.01	<0.01
Cr	<0.01	0.03	<0.01	<0.01	<0.01
Cu	0.01	0.02	<0.01	0.01	<0.01
Fe	0.01	<0.01	0.20	1.70	0.10
Hg	<0.10	<0.10	<0.10	<0.10	<0.10
K	3.00	5.00	1.00	<0.01	<1.00
Mg	0.30	0.90	0.40	1.00	0.09
Mn	0.02	0.03	<0.01	0.08	0.01
Na	2.00	3.00	3.00	4.00	2.00
Ni	0.01	0.02	<0.01	<0.01	<0.01
P	<0.01	0.40	<0.01	<0.01	<0.01
Pb	0.02	0.10	<0.01	<0.01	<0.01
S	1.00	3.90	<0.01	2.00	<0.01
Si	<0.01	<0.01	<0.01	2.60	<0.01
Sr	<0.01	<0.01	<0.01	0.02	<0.01
Th	0.03	0.08	<0.01	<0.01	<0.01
U	<0.10	0.50	0.08	<0.10	<.10
V	0.01	0.02	<0.01	<0.01	<0.01
W	<0.01	0.08	<0.01	<0.01	<0.01
Zn	<0.01	0.04	<0.01	<0.01	<0.01
Zr	0.01	0.01	<0.01	<0.01	<0.01
Alkalin.	33	16			
Acidity			11	43	13
mg/L ($CaCO_3$)					

mg./L Concentration of Ag, As, Ba, Cd, Ce, La, Mo, Nb, Sb, Se, Sn, Te, Ti, Y, all <0.01


MAP 2
HOPE BROOK MINE:
Waste Rock Site
Sampling Locations
– DECEMBER 1987
HOPE BROOK GOLD
– MAY 1988
BOOJUM RESEARCH LTD.
N
Access Road
ditch
I
II
IV
12
11
10
9
8c
7a
7b
Ore
Outcrop
14
4
3
2
HOLDING
POND
Hope Brook
6
5
f
d
19
c
b
e
1
17
g
18 a
20
21

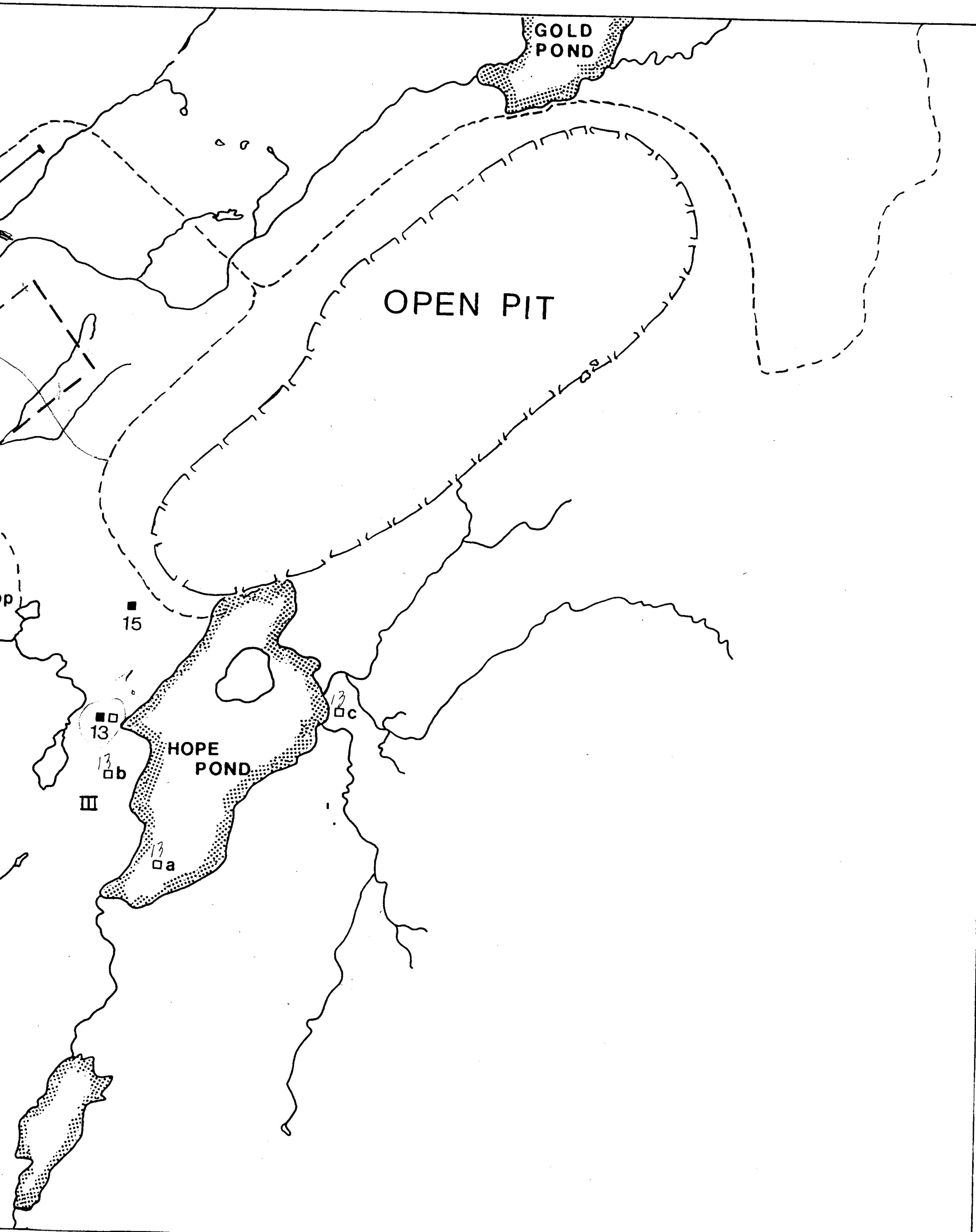

GOLD POND
OPEN PIT
15
13
HOPE POND
b
c
a
III

Table 5: Elemental concentrations in water from Waste Rock seeps.

DR.BASIN	II	II	II	II	II	III	III
AREA	#7(a)	#8(c)	#9(e)	#9(d)	#10(g)	#13(c)	#13(a)
ASSAYER#	394	399	400	393	405	397	404
Al	0.06	62.00	118.00	0.10	53.00	0.03	0.30
As	<0.01	0.10	<0.01	<0.01	<0.01	<0.01	<0.01
B	<0.01	0.07	0.20	<0.01	<0.01	<0.01	<0.01
Ba	<0.01	0.05	0.04	0.02	0.03	0.01	0.01
Be	<0.01	0.01	0.01	<0.01	<0.01	<0.01	<0.01
Bi	<0.01	0.10	<0.01	<0.01	0.10	<0.01	1.00
C	66.00	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Ca	8.70	107.00	299.00	3.90	444.00	6.90	5.50
Cd	<0.01	0.05	0.01	<0.01	0.01	<0.01	0.03
Ce	<0.01	<0.01	0.09	<0.01	0.03	<0.01	0.06
Co	0.05	0.40	0.60	0.04	0.50	<0.01	0.10
Cr	0.02	0.07	0.09	0.01	0.06	<0.01	0.03
Cu	<0.01	3.20	6.10	0.01	3.00	<0.01	0.03
Fe	0.10	70.00	175.00	0.08	20.00	0.03	0.20
Hg	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
K	<1.00	7.00	4.00	<1.00	8.00	<1.00	6.00
La	<0.01	0.08	0.07	<0.01	0.10	<0.01	<0.01
Mg	1.10	21.00	26.00	1.00	31.00	0.90	1.00
Mn	0.03	7.20	10.00	0.09	12.00	0.05	0.07
Mo	0.01	0.05	0.01	0.01	0.04	<0.01	<0.01
Na	4.00	21.00	17.00	3.00	18.00	4.00	3.00
Nb	<0.01	0.04	<0.01	<0.01	0.01	<0.01	<0.01
Ni	0.02	0.20	0.40	0.02	0.20	<0.01	0.03
P	0.30	0.90	1.30	0.20	0.80	<0.01	<0.01
Pb	0.10	0.30	0.60	0.10	0.70	0.01	0.10
S	6.20	438.00	807.00	5.50	686.00	4.20	6.50
Sb	<0.01	0.05	0.07	<0.01	0.03	<0.01	<0.01
Se	<0.01	0.05	0.05	<0.01	0.03	<0.01	<0.01
Si	0.70	15.00	39.00	<0.01	27.00	<0.01	<0.01
Sn	<0.01	0.09	0.01	<0.01	0.06	<0.01	0.01
Sr	0.01	0.30	0.50	0.01	0.40	0.02	0.01
Te	<0.01	0.02	<0.01	<0.01	0.02	<0.01	0.04
Th	<0.01	0.20	0.20	<0.01	0.30	<0.01	0.10
Ti	0.01	0.01	0.02	0.01	0.01	<0.01	0.01
U	<0.10	1.40	1.70	<0.10	1.80	<0.10	<0.10
V	0.01	0.03	0.03	0.01	0.03	<0.01	0.02
W	0.01	0.10	0.20	<0.01	0.30	<0.01	<0.01
Y	<0.01	0.10	0.10	<0.01	0.10	<0.01	<0.01
Zn	0.02	0.30	0.40	0.03	8.00	<0.01	0.02
Zr	0.01	0.04	0.04	0.01	0.05	<0.01	0.02
Alkalin.	21	—	—	10	—	12	—
Acidity ($CaCo_3$)	—	833	1455	—	545	—	22

mg/L Ag <0.01

In Table 6, the elemental composition of the seeps below the holding pond are summarized, together with the water leaving to Cinq Cerf Brook (·20 and 21). The seeps 18c, d and e exhibit slight increases in copper (0.01 to 0.03 mg/L) and acidity. These creeks should now be reduced in flow, since the dam grouting in June 1988.

Table 6: Elemental concentrations in seeps from Polishing pond

Dr.BASIN	IV	IV	IV	IV	IV	IV
AREA	#19(d)	#18(d)	#18(c)	#18(e)	#21	#20
ASSAYER#	390	398	402	401	392	395
Al	0.02	10.00	15.00	0.50	0.01	0.30
Ba	0.01	0.10	0.10	0.03	0.01	0.01
Bi	<0.01	<0.01	0.10	0.10	<0.01	0.07
C	65.00	<0.01	<0.01	<0.01	<0.01	<0.01
Ca	3.80	104.00	101.00	44.00	11.00	12.00
Cd	<0.01	0.03	0.03	0.03	<0.01	<0.01
Ce	<0.01	<0.01	0.10	0.08	<0.01	<0.01
Co	<0.01	0.10	0.10	0.10	<0.01	<0.01
Cr	<0.01	0.03	0.04	0.03	<0.01	<0.01
Cu	<0.01	0.30	0.50	0.05	0.01	0.03
Fe	0.10	<0.01	0.30	<0.01	0.08	0.03
Hg	<.10	<0.10	<.10	<0.10	<.10	<0.10
K	<1.00	5.00	7.00	6.00	<1.00	1.00
La	<0.01	<0.01	0.06	<0.01	<0.01	<0.01
Mg	1.30	10.00	8.70	3.20	2.00	1.50
Mn	0.70	1.90	2.80	0.30	0.10	0.02
Na	6.00	10.00	9.00	6.00	6.00	3.00
Nb	<0.01	<0.01	0.02	<0.01	<0.01	<0.01
Ni	<0.01	0.07	0.08	0.03	0.02	0.02
P	<0.01	0.20	0.10	<0.01	<0.01	0.50
Pb	<0.01	0.10	0.10	0.10	0.03	0.10
S	6.00	121.00	150.00	49.00	15.00	11.00
Sb	<0.01	0.02	0.04	<0.01	<0.01	<0.01
Se	<0.01	0.01	0.06	0.02	<0.01	<0.01
Sr	0.02	0.20	0.20	0.10	0.05	0.03
U	<.1	0.80	0.30	<0.1	0.01	<0.10
Zn	<0.01	0.10	0.10	0.04	0.02	0.02
Alkalin.	20	---	---	---	12	12
Acidity	---	105	126	97	---	---
($CaCO_3$)						

mg/L

Ag, As, B, Be, Mo, Sn, Th, Ti <0.01

3.3 Historical evaluations of the seeps

In Map 2, the December 1987 sampling locations below the waste rock pile and below the polishing pond are indicated. The results of this collection is summarized in Table 7 for pH values, Cu, Fe and sulphate determined in December 1987 and the May 1988 data for the same stations include acidity values. In December, two creeks number 7 and 18 showed sing of acid mine drainage, with increased iron and sulphate concentrations.

Table 7: Seep characteristics December 1987 to May 1988

Sampling Site (orig.map)*	pH 1	pH 2	pH 3	[Cu] 1	[Cu] 2	[Fe] 1	[SO4] 1	Acidity [CaCO3]
2	6.0	6.5	3.6	<0.02	0.07	<0.02	72	<2
5	6.3	6.7	6.2	<0.02	<0.02	0.05	33	<2
7	3.0	3.0	5.4	1.60	1.28	43.6	720	70.8
8	5.2	6.7	4.1	<0.02	0.03	<0.02	<10	<2
9	4.4	5.3	4.6	<0.02	0.03	0.31	<10	<2
10	4.7	5.4	4.5	<0.02	<0.02	0.21	67	<2
12	6.0	6.4	6.1	<0.02	0.03	0.09	30	<2
13	6.9	6.9	4.5	<0.02	<0.02	0.73	40	<2
18	n/a	3.6	3.6	n/a	0.35	1.66	320	13.9
19	4.3	6.4	7.0	<0.02	<0.02	0.04	13	<2
20	n/a	4.0	5.7	n/a	0.22	1.46	170	9.0
21	n/a	7.0	4.9	n/a	<0.02	0.42	37	—

NOTE: 1 = Dec. 5, 1987 (Hope Brook Data -- Mike Schmidt)
2 = Dec. 10, 1987 (Hope Brook Data -- Mike Schmidt)
3 = May 12, 1987 (Boojum Research Data)

(all concentrations given in mg/L)

* Reference Map 3

Note: Our 20 and 21 feeding their 20

Assuming that the allocation of seep numbers was reflecting that of the May 1988 investigation it is apparent, that the water quality at station 18 has improved since December 1987 and is certainly acceptable in May and July 1988 (Table 8). However seep number 9 below the waste rock pile has remained acid generating although the iron and sulphate concentrations were relatively low in December 1987.

Although it is possible, given the difficulty of assessing the terrain with many seeps, creeks and the fastly progressing waste rock pile which covers the terrain that the identification of the locations is erronous, there is no doubt, that acid generation is occuring in localized areas in the waste rock pile. To identify the low grade ore as the main location of this occurance is not possible.

Table 8: Seep Characteristics between May and July 1988

	Temp. C		pH		Cond.mmho/cm		Cu/ppm		Fe/ppm	
Station	July	May	July	May	July	May	July	May	July	May
7	13	5	5.63	5.40	0.21	0.04	0.05	<0.01	0.33	0.10
9D	16	9	2.50	4.60	2.98	0.05	7.34	0.01	375.00	0.08
9E	5	10	2.82	3.80	2.82	17.50	3.79	6.10	145.00	175.00
18C	12	6	3.95	4.10	0.69	0.33	0.68	0.50	0.81	0.30
18D	12	6	4.44	4.30	0.22	0.34	0.46	0.30	0.26	<0.01
18E	15	7	5.98	5.00	0.20	0.15	0.03	0.05	0.89	<0.01

The onset of AMD in the pile, however is not evenly distributed as can be derived by investigation of the precipitation processes which appear to take place directly in the pile.

The water characteristics for monitoring station 1 can be utilized in determining whether the limestone incorporated in the waste-rock pile is causing precipitation of iron. An analysis of the monitoring data from this site, i.e. the water entering the holding pond, displays a pattern similar to those for Section 18 below the pond and Station 20 (the water leaving to Cinq Cerf Brook). The relationship between the oxidation products from pyrite, namely dissolved iron and sulphur (sulfate), displays a different correlation at Station 1, where acid generation is occurring, compared to those for Stations 18 and 20. The concentrations of S and Fe in the water fall on neither the pyrite or pyrrhotite lines given in Figures 1, 2 and 3. With the exception of two points for Station 1, all monitoring data fall well below the pyrite line, suggesting that only one sample indicates oxidation products, possibly from some pyrrhotite. All monitoring data for Stations 18 and 20 fall well below the pyrite line (Figures 2 and 3). The sequence of Figures 1, 2 and 3 for Stations 1, 18 and 20, shows the result of (1) progressive dilution (decrease of dissolved S concentrations), and (2) progressive precipitation of Fe (decrease of Fe/S ratios).

Figure 1: Iron and sulphur ratios for station 1

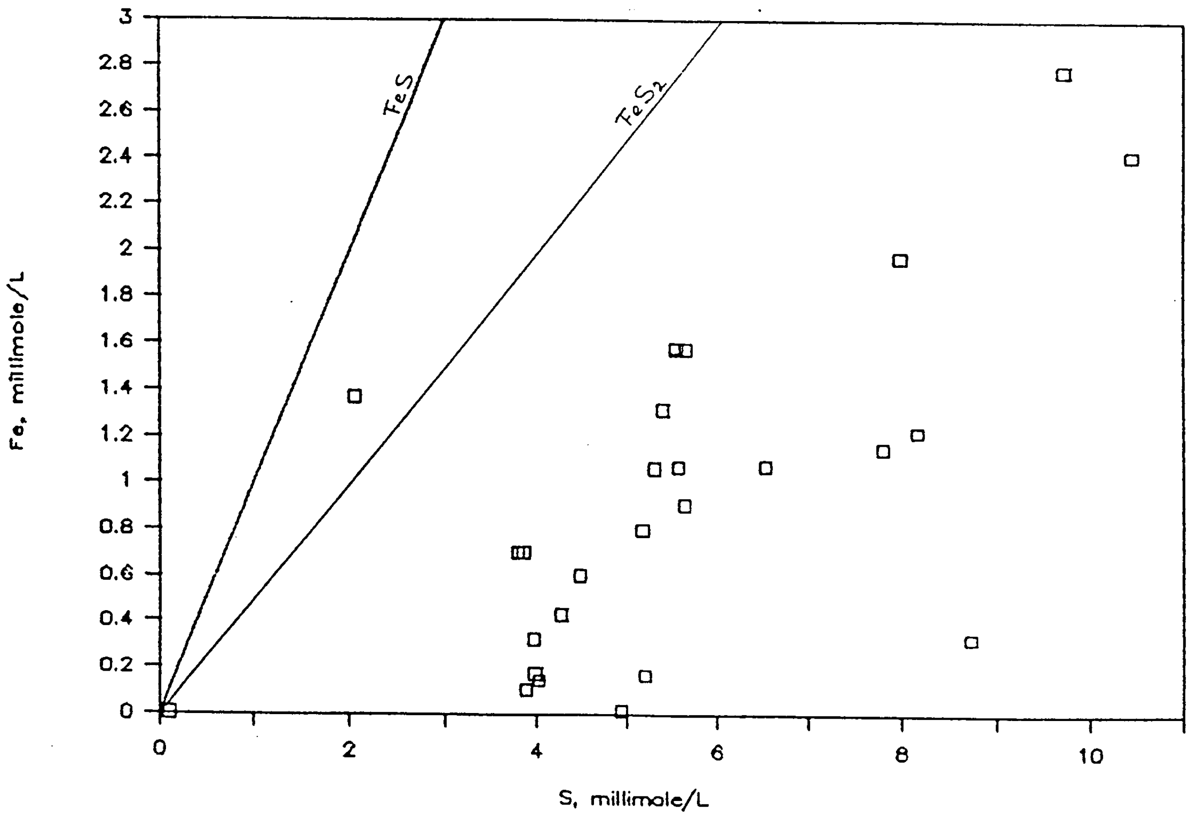


Figure 2: Iron and sulphur ratios for station 18

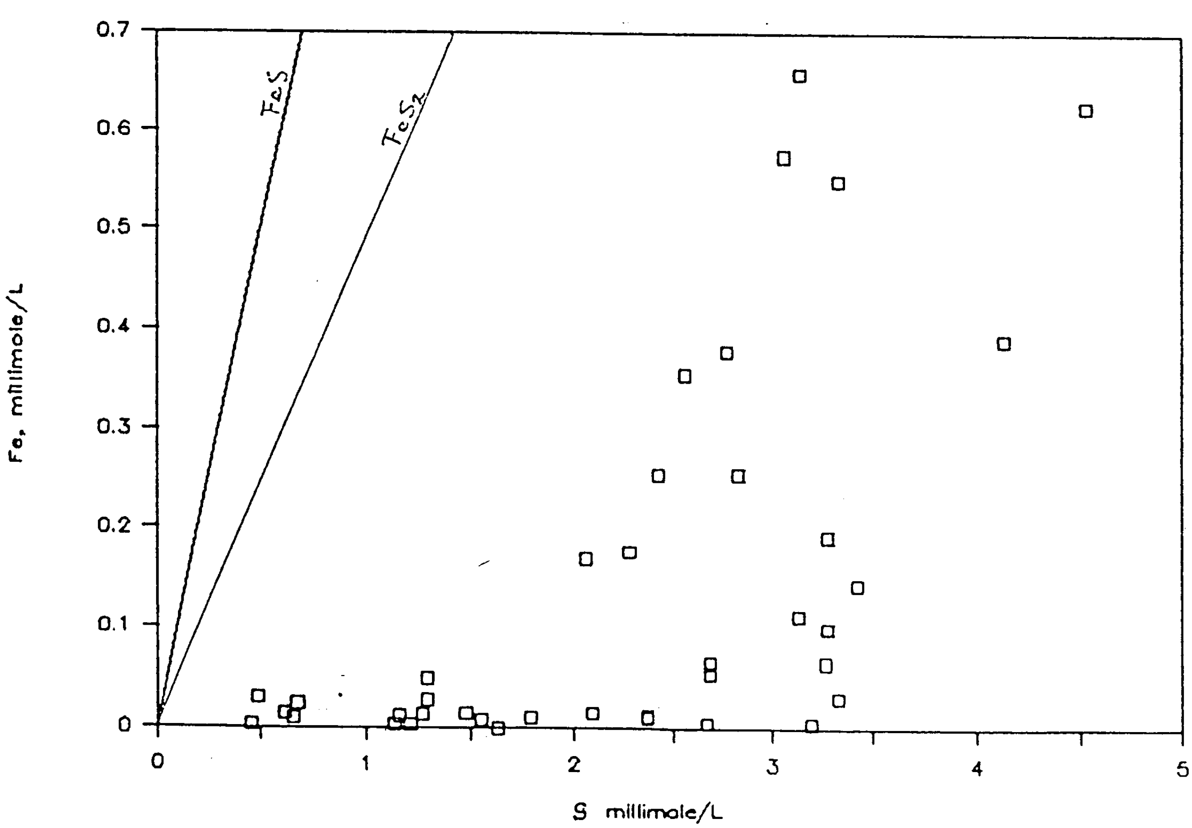
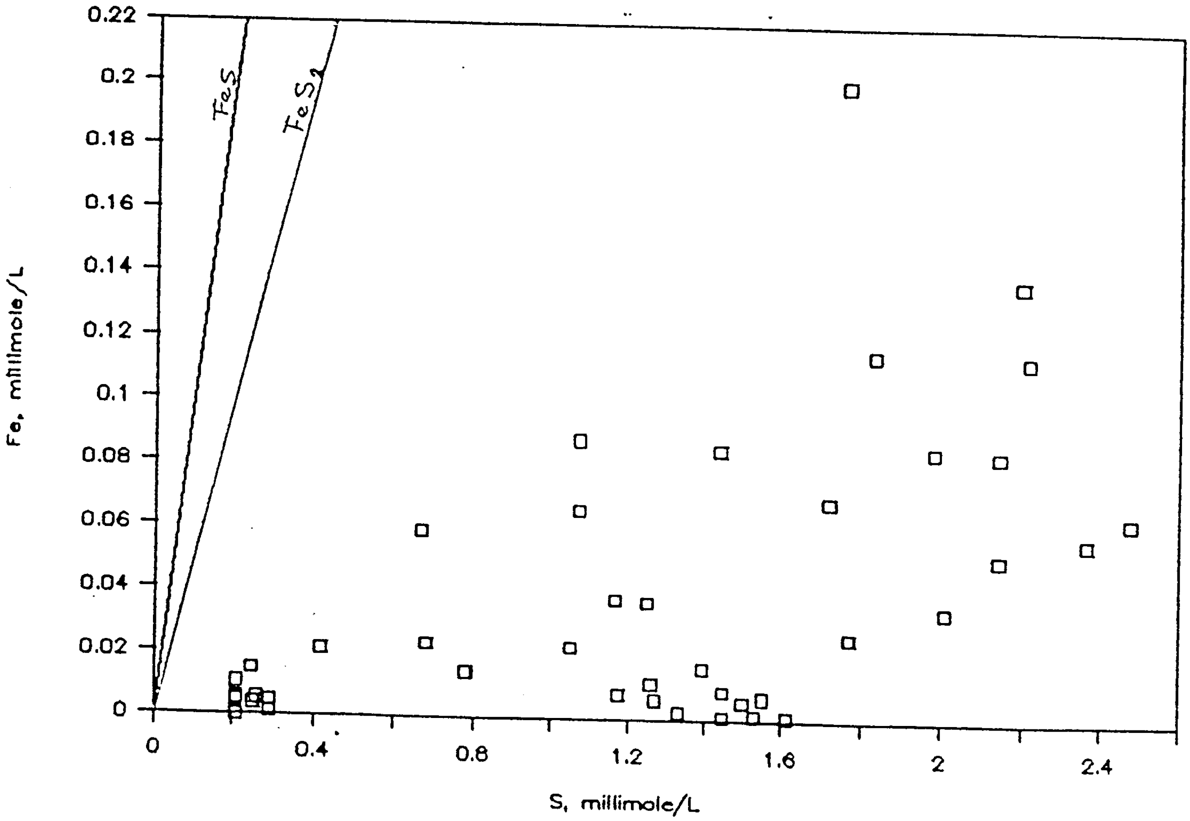


Figure 3: Iron and sulphur ratio for station 20



Thus, acid generation is occurring but the iron produced is apparently precipitating at least partly within the pile, as suggested by Figure 1. The water samples collected during Boojum Research's investigations showed iron and sulphur millimole ratios ranging from 0.0011 to 0.488, also indicating that iron produced by sulfide oxidation is being removed from solution by precipitation.

CONCLUSIONS

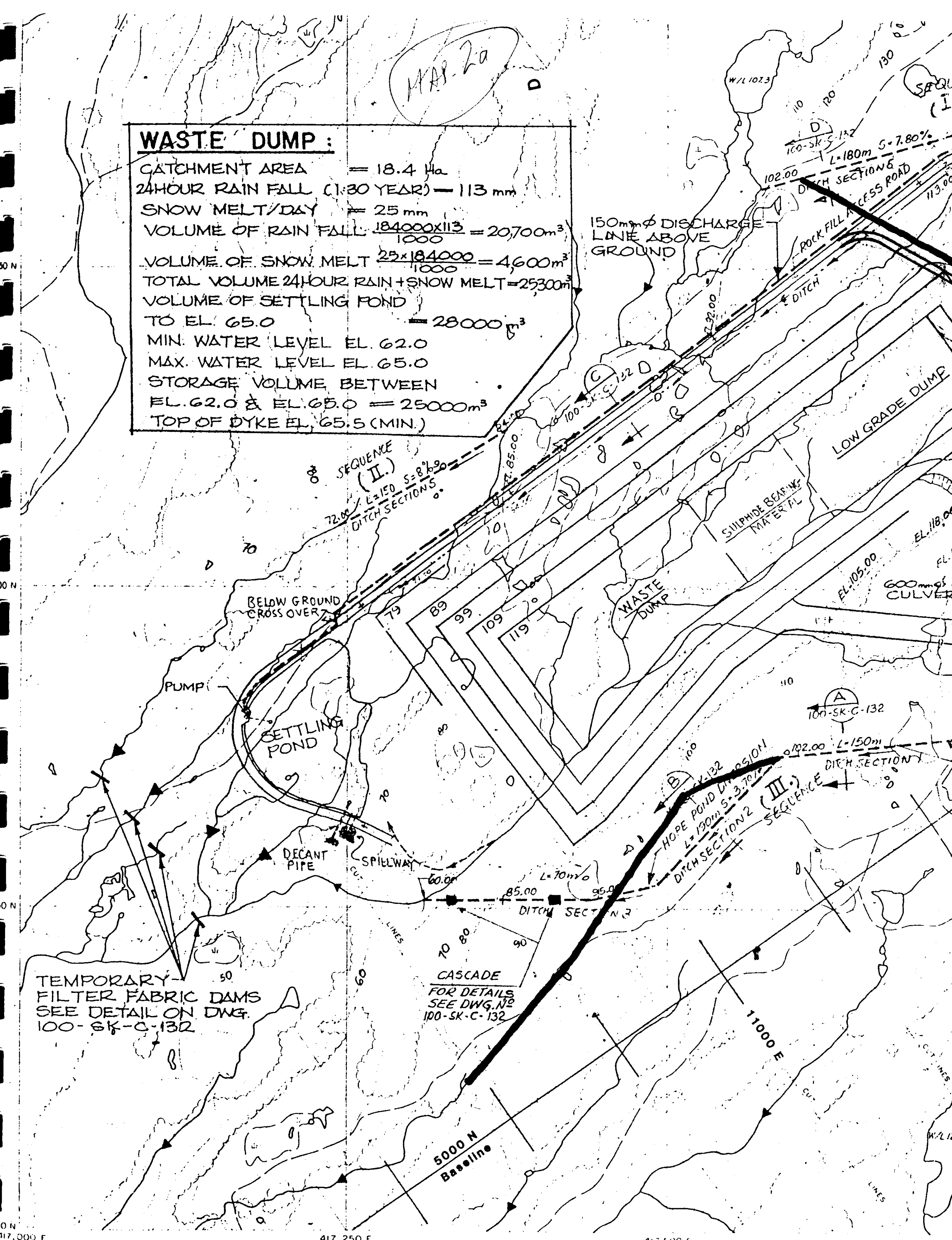
The water characteristics of the seeps located at the toe of the waste-rock pile clearly indicate that acid generation is occurring. At the present time, the quality of the water leaving to Cinq Cerf Brook is not affected, due to the buffering capacity of the natural background and the peat receiving the drainage. The present measures of pumping the water from the holding pond into the tailings basin appear to be reasonable, as the final dimensions of the pile are as yet indeterminable.

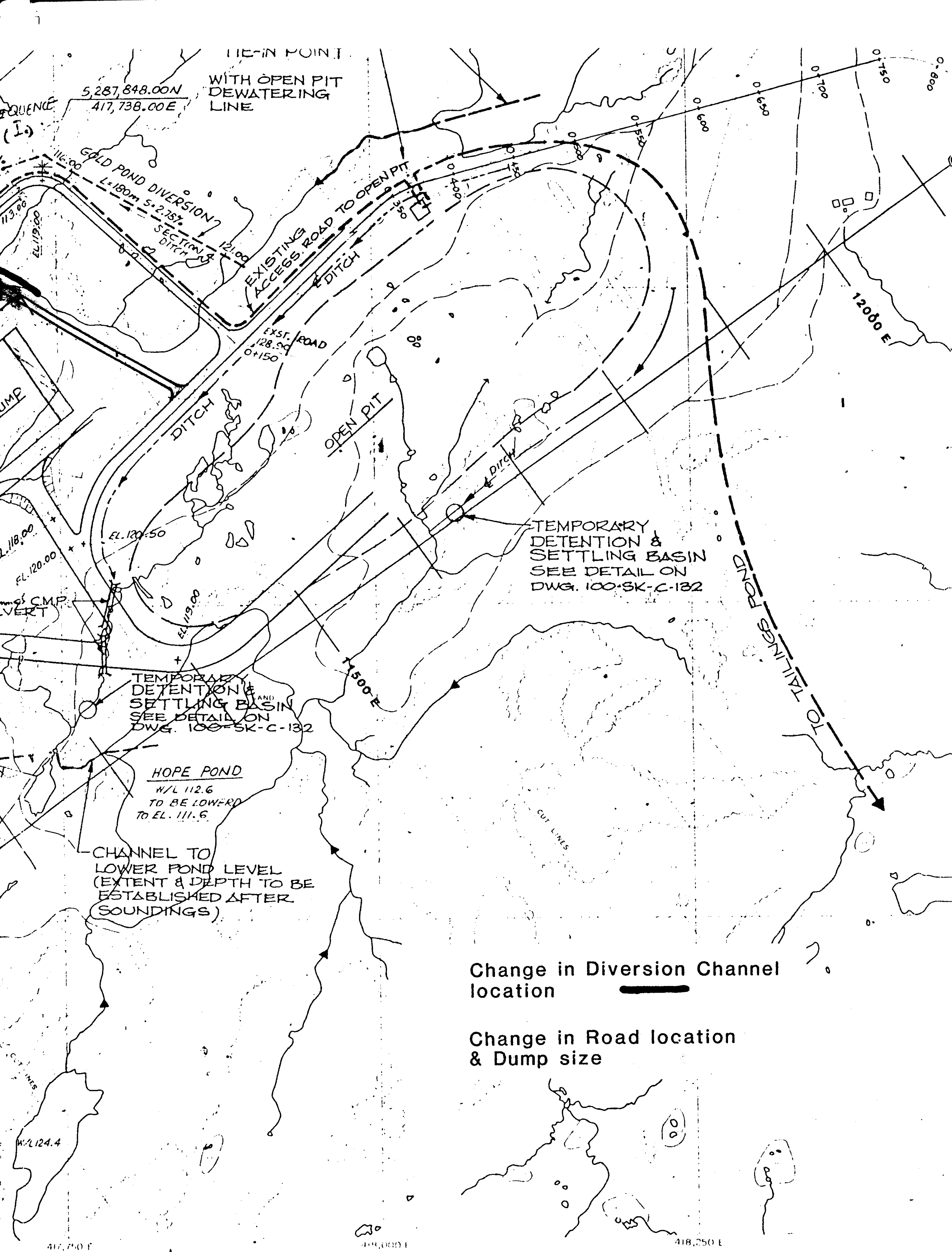
It is recommended that the rate at which acid generation is initiated in the different mining materials at the site (ore, waste-rock and low grade) be determined by exposing those materials to weathering for a known time. Based on these rate determinations, ameliorative measures can be taken at the time when the pile is completed (late 1988?). The drainage from the pile may then be contained possibly by ditching directly below the toe of the pile, but above the holding pond. If containment of the seepage above the holding pond can be achieved, then amelioration of the seepage water through the initiation of microbiological reducing conditions may be possible.

The rate at which acid might be generated, and the buffering capacity of the environment, are of utmost importance in protection of Cinq Cerf Brook. This is particularly significant since the drainage basin with the waste-rock pile also contains the open pit, which may have significant impact on the water quality of the system in the long term. A systematic approach is recommended to determine the rate at which acid generation is occurring.

Especially in light of its unexpected emergence at Hope Brook, the problem of acid mine drainage should be addressed and serious consideration should be given to the implementation of one of a number of treatment options to correct the situation and to provide the desired long-term protection.

A P P E N D I X


MAP 2a
WASTE DUMP :
CATCHMENT AREA = 18.4 Ha
24HOUR RAIN FALL (1:30 YEAR) — 113 mm
SNOW MELT/DAY = 25 mm
VOLUME OF RAIN FALL 184000x113 / 1000 = 20,700m³
VOLUME OF SNOW MELT 25x184000 / 1000 = 4,600m³
TOTAL VOLUME 24HOUR RAIN + SNOW MELT = 25300m³
VOLUME OF SETTLING POND
TO EL. 65.0 = 28000m³
MIN. WATER LEVEL EL. 62.0
MAX. WATER LEVEL EL. 65.0
STORAGE VOLUME BETWEEN
EL. 62.0 & EL. 65.0 = 25000m³
TOP OF DYKE EL. 65.5 (MIN.)
150mmφ DISCHARGE LINE ABOVE GROUND
ROCK FILL ACCESS ROAD
DITCH
DITCH SECTION 6
L=180m S=7.80%
100-SK-C-132
LOW GRADE DUMP
SULPHIDE BEARING MATERIAL
WASTE DUMP
SEQUENCE (II.)
L=150 S=8%
DITCH SECTION 5
BELOW GROUND CROSS OVER
PUMP
SETTLING POND
DECANT PIPE
SPILLWAY
EL. 105.00
EL. 118.00
600mmφ CULVERT
100-SK-C-132
L=150m
DITCH SECTION
HOPE POND DIVERSION
L=190m S=3.70%
DITCH SECTION 2
SEQUENCE (III.)
L=70m
DITCH SECTION 3
CASCADE
FOR DETAILS SEE DWG. No 100-SK-C-132
TEMPORARY FILTER FABRIC DAMS SEE DETAIL ON DWG. 100-SK-C-132
11000 E
5000 N Baseline
417,000 E
417,250 E



TIE-IN POINT
WITH OPEN PIT DEWATERING LINE
5,287,848.00N
417,738.00E
SEQUENCE (I.)
GOLD POND DIVERSION
L=180m S=2.75%
SECTION & DITCH
EXISTING ACCESS ROAD TO OPEN PIT
& DITCH
EXST. ROAD
128.90
0+150
DITCH
OPEN PIT
& DITCH
EL. 119.00
EL. 118.00
EL. 120.00
EL. 120.50
CMP CULVERT
TEMPORARY DETENTION & SETTLING BASIN SEE DETAIL ON DWG. 100-SK-C-132
TEMPORARY DETENTION AND SETTLING BASIN SEE DETAIL ON DWG. 100-SK-C-132
11500 E
12000 E
TO TAILINGS POND
HOPE POND
W/L 112.6
TO BE LOWERD TO EL. 111.6
CHANNEL TO LOWER POND LEVEL (EXTENT & DEPTH TO BE ESTABLISHED AFTER SOUNDINGS)
CUT LINES
W/L 124.4
Change in Diversion Channel location
Change in Road location & Dump size