JOHN W. GADSBY

WHITEHORSE COPPER MINE
YUKON TERRITORY

CONCEPTUAL DECOMMISSIONING PLAN

prepared for

HUDSON BAY MINING AND SMELTING CO. LTD.
FLIN FLON, MANITOBA

prepared by

GADSBY CONSULTANTS LTD.
903-580 Hornby Street
Vancouver, B.C. Canada V6C 3B6

in association with

STEFFEN ROBERTSON & KIRSTEN (B.C.) INC.
800 - 903 Hornby Street
Vancouver, B.C. Canada V6C 3B6

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WHITEHORSE COPPER MINE
WHITEHORSE, YUKON

CONCEPTUAL DECOMMISSIONING PLAN

SUMMARY

The Whitehorse Copper Mine is located about six miles south of the city of Whitehorse, Yukon Territory on the western slopes of the Yukon River. The mine operated between 1967 until 1982. Whitehorse Copper Mines Ltd. is a wholly owned subsidiary of Hudson Bay Mining and Smelting Company Ltd. (HBM&S).

The mine site occupies a total area of about 800 acres, (320 Ha). The individual components from the mining activities, that will remain in this mine site area, after decommissioning activities are completed, will be:

- the Little Chief open pit and underground mine;
- the Little Chief rock pile; and
- the tailings impoundment system, including the water management structures.

All buildings in the millsite area will have been removed, and the materials in the underground rock pile will have been used for site rehabilitation work.

Gadsby Consultants Ltd. in association with Steffen Robertson and Kirsten have performed an evaluation of the factors affecting the long-term physical and chemical stability of the decommissioned mine site. The study has consisted of:

- a review of the investigations and studies carried out by Thompson Geotechnical Consultants Ltd;
- collecting samples of the mine tailings and rock for laboratory acid base accounting tests, and samples from surface water bodies and domestic supply wells, downstream of the site, to evaluate the chemical stability of the decommissioned site;
- performing engineering analyses to assess the long term stability of the earth and rock fill embankments, that contain the tailing impoundments; and
- evaluating the probable maximum flood and the routing of this flood through the tailings impoundment system.

The results from these studies indicate that:

- the tailings and rock materials are chemically stable and there is sufficient neutralizing capability to prevent the development of acid drainage;

- both surface and groundwater meet the CCREM drinking water guidelines, with the exception of seepage from the Little Chief rock pile. Although aquatic freshwater standards are not met in a few samples there are no streams in the drainage basin capable of supporting fish, and it is not anticipated that this water will pose a problem for wildlife preservation;

- surface drainage from the mine site will not have an impact on the Yukon River;

- the embankments that contain the tailings are considered to have acceptable factors of safety for long-term stability under both static and dynamic (earthquake) conditions; and

- the probable maximum flood can be routed through the tailings impoundment system without affecting the structural integrity of the embankments.

HBM&S propose to complete the decommissioning activities on the minesite in 1992. The decommissioning work will include:

- the construction of spillways in the tailings impoundments;

- backfilling and regrading the tailings surface in the Old Pond impoundment, and the placement of fine rock fill in some areas to resist wind erosion of the tailings;

- regrading on the north slope of the Little Chief rock pile;

- removal of all the structures on the mill site and placement of sand and gravel, or fine rock fill, to cover concrete foundation pads; and

- monitoring the extent of ongoing ground collapse in the Little Chief open pit area; where found necessary, additional barriers or fences will be constructed to prevent inadvertent access.

HBM&S propose to inspect the mine site area twice a year for a five year period, to monitor the effectiveness of the closure measures for the various components. As part of these inspections, water samples will taken for the first three years of the monitoring period. Results from site inspections and the water quality test data, together with an interpretation of the results will form the basis of an annual report, which will be submitted to interested agencies.

WHITEHORSE COPPER MINE
CONCEPTUAL DECOMMISSIONING PLAN

1.0 INTRODUCTION

At the request of Wayne W Fraser P.Eng, Hudson Bay Mining and Smelting Co.Ltd.,(HBMS), Gadsby Consultants Ltd. in association with Steffen Robertson & Kirsten have performed a review and evaluation of the proposed decommissioning plan for the abandoned Whitehorse Copper Minesite, near Whitehorse, Yukon. The purpose of the review has been to develop reclamation objectives and identify the work necessary to decommission the minesite in such a manner that will:

- protect public health and safety;
- alleviate or eliminate environmental damage; and
- wherever practicable, allow a productive use of the land to its original condition, or an acceptable alternative.

The review was carried out between the period July to September 1991. The work has consisted of:

- a review of the detailed studies carried out for the minesite by Thompson Geotechnical Consultants Ltd, (TGC);
- a field reconnaissance by John Gadsby, P.Eng. and Adrian Chantler, P.Eng. on 4 and 5 July 1991;
- a field reconnaissance by John Gadsby on 14 to 16 August 1991, and the collection of water samples from surface water bodies in the minesite area and domestic water supply wells downstream (east) of the mine site;
- photographs, taken from ground level and a helicopter to assist in preparing a record of the site conditions; and
- office engineering analyses and studies to assess the physical and chemical stability of the various structures that will remain on the site upon completion of the decommissioning plan.

This report summarizes the results of the studies. The project area was separated into five components, namely: the open pit and underground mine; the mill site and the infrastructure; the Little Chief rock pile; the underground rock pile; and the tailings impoundment system. The pertinent factors, and the proposed decommissioning work for each of the five components are discussed.

The report has been prepared in order that Hudson Bay Mining and Smelting can schedule and finalize the decommissioning activities.

1.1 Documentation

This report is presented in three documents. The text and Appendix A (project photographs) are included in Volume 1; Appendix B contains the 17 Drawings, (Volume 2), and Appendix C contains laboratory test data, (Volume 3).

2.0 PRE-MINING ENVIRONMENT

2.1 Topography and Surficial Geology

The Whitehorse Copper Minesite is located about six miles south of the city of Whitehorse, Yukon Territory. The study area is shown on Drawing 1, (Appendix B). A layout plan of the minesite facilities is shown on Drawing 2. Both the city and the minesite are in the Yukon River valley. The valley is about five miles wide. The Yukon River is at about elevation 2000 feet, and the mountains of the Coast Range, on either side of the valley, reach an elevation of 5000 feet. The valley has been glaciated, resulting in gently sloping valley sides.

Photographs 1 an 2, (Appendix A) are aerial views which show the minesite relative to the Yukon River and the Alaska Highway. Photograph 3 is an aerial view of the minesite.

The minesite is located at the foot of the east facing slope on the west side of the Yukon River valley, about 1.1 miles (1.5 km) west of the Yukon River. The relief within the minesite area, ranges from elevation 2700 feet, at the foot of the mountains, to about 2500 feet along the western boundary.

A map of the surficial geology, as inferred from a study of 1951 stereo air photographs, is shown on Drawing 3 together with the original topography for the area. The identity and nature of the surficial materials, as inferred from the air photographs, have been mapped using the Terrain Classification system for British Columbia (revised edition, 1988).

The surficial geology consists of a complex series of glacial and postglacial drift. Bedrock is exposed in areas of high relief, near the open pit and under the Old Pond tailings impoundment. Glacial and post glacial features obscure the bedrock elsewhere. Lava flows are found in Crater Lake area and in the Miles Canyon. Lava flows may be intercalated with glacial drift in some areas, as observed at the south end of Miles Canyon (Wheeler 1961).

A cobbly, silty relatively dense glacial till overlies bedrock in areas of high relief, adjacent to the open pit and north towards the tailings impoundment. This till mantles the bedrock and varies in thickness from a few inches to several feet. Kame terraces consisting of poorly sorted sands and gravels, in units up to 100 feet thick, adjoin the till slopes.

Overflow channels, formed during periods of high run-off immediately following glaciation, occur throughout the project area. The channels are mainly erosional; they have cut a series of fluvial terraces down towards the Yukon River. The original sediments along the Yukon River, NE of the minesite (Miles Canyon), consist of mainly glacial outwash sands and gravels deposited as the valley glaciers advanced; these deposits have been obscured but are exposed along the banks of the river. The deposits adjacent to the west bank of the Yukon River in the Miles Canyon are complex; they have been affected by ice collapse features and eskers.

Geological sections, developed by TGC, through the A, B and Crater Lake valleys are shown on Drawings 4 and 5.

2.2. Climate

Meteorological records are available for the period 1951 to 1980.

The mean annual temperature is 29.5° F (-1.2° C). In the summer period, the average daily high temperatures range from 65 to 75° F (18 to 24° C). In the winter period the average daily low temperature ranges from -6.7 to 13.0° F, (-12.0 to -25.0° C).

Precipitation is low, with an average of 5.7 inches (145.5 mm) of rain per year, and 5.38 inches (136.6 mm) of snow. The total mean precipitation is 10.2 inches, (261.22 mm).

2.3 Hydrology

The drainage boundaries for both surface and groundwater prior to the development of the mine, as developed by TGC, are shown on Drawing 6. In the mine project area both surface and groundwater drain eastwards through three main watersheds, The Crater Lake, A Valley and B Valley from the foot of the mountains to the Yukon River. The groundwater boundaries closely follow the surface water boundaries. There are no well defined drainage courses west of the Alaska Highway and the Yukon River; surface water enters the Yukon River through the fluvial and glaciofluvial sand and gravel deposits.

The A and B valley watersheds combine, at about the location of the Alaska Highway, and drain into the Yukon River in the Miles Canyon, over a distance of about 3000 feet. The Crater Lake

watershed drains into the Yukon River over a distance of about 2000 feet.

2.4 Geochemistry

No information is readily available on the geochemistry of the minesite area, prior to mining operations.

2.5 Water Quality

No information is readily available on the water quality of the project area, prior to mining operations

2.6 Seismic Exposure

The National Building Code for Canada, 1985 Seismic Zoning Maps places the site in Zone 2, with a peak acceleration of 0.10 G.

A seismic hazard assessment for the minesite has been carried out by the Pacific Geoscience Centre; results from this study indicate the following values:

Probability of Exceedance	1:475 year	1:1000 year
Probability of Exceedance (50 years)	10%	5%
Peak Horizontal Acceleration	0.099 G	0.125 G

Based upon the remoteness of the minesite and the low risk in terms of loss of life, the National Building Code recommend using the 10 percent probability of exceedance in 50 years, (1:475 year event).

2.7 Pre-mine Land and Water Use

Prior to mining, the area is presumed to have been forested, similar to that of the adjacent areas. There were no commercial logging operations in the area.

No permanent streams capable of supporting fish occur within the drainage basin of the minesite area. As noted in section 2.3, surface water from the minesite appears to enter the Yukon through the fluvial and glaciofluvial sand and gravel deposits. Domestic water supply for the homes located in the lower valley, to the north and north east of the minesite, is obtained from wells installed at depths ranging typically from 40 to 65 feet, and at depths of 165 and 400 feet at the Pioneer R.V. park.

There are no records of wildlife in the area prior to mine startup; wildlife density is presumed to have been low due to the proximity to Whitehorse.

3.0 HISTORY OF MINE DEVELOPMENT

New Imperial Mines, (formerly Imperial Mines and Metals, 1954) commenced construction of the 2000 ton concentrator and support facilities in the early 1960's. Production started from the Little Chief ore body in May 1967, followed by the open pit sites at War Eagle, Black Cub and Keenewaw. Milling was suspended in mid 1971 due to a shortage of ore.

The company was reformed, in the spring of 1972, as Whitehorse Copper Mines. Development of the Little Chief underground mine commenced in early 1973. The mine was eventually closed in December 1982.

4.0 DEVELOPMENT OF THE DECOMMISSIONING PLAN

4.1 General

The decommissioning plan for a mine must consider all components of the site, and for each component it must address chemical and physical stability, environmental impact and land use.

For the Whitehorse Copper Mine, the area has been divided into five components, namely:

- The Little Chief Open Pit and Underground Mine;
- Millsite and Infrastructure;
- Little Chief rock pile;
- Underground rock pile; and
- Tailings Impoundment System.

Each of these components is described in sections 5.2 to 5.6. The long term aspects of the physical and chemical stability issues are described for each component, together with a description of the decommissioning activities that have been carried out, from 1982 to 1991, and the proposed future work.

4.2 Chemical Stability

Chemical stability issues include the potential for acid rock drainage, leaching of metals and flushing of mill reagents, or other chemicals, into the environment.

The following samples were obtained from the Whitehorse Copper Minesite in August 1991 to assess the chemical stability of the tailings and mined rock piles and the migration of both surface water and groundwater from the minesite site into the downstream environments:

- tailings from the Old Pond and A Valley impoundments and rock from the Little Chief and Underground rock piles for acid base accounting tests;
- surface water from the lake and seepage water from the left (west) abutment above the B Valley impoundments for background water quality;
- surface water from the Old Pond and the B Valley pond, and from lakes and ponds downstream of the tailings and rock piles in the Crater Lake and A & B valley watersheds;
- groundwater from domestic water supply wells in residences and the Pioneer R.V. park to the east and downstream of the minesite; and
- samples from the Yukon River both upstream and downstream from where minesite drainage enters the river.

Locations of the water sampling sites are shown on Drawing 7. The laboratory test results are included in Appendix B together with laboratory test results from earlier work carried out by TGC and HBM&S. The results are summarized and discussed below.

4.2.1 Tailings and Mine Rock Characteristics

Results from the laboratory tests to evaluate the acid generation and neutralization potentials are shown on Table 4.1.

Three samples of tailings have been tested, one in 1983 by HBM&S and two in 1991. The tailings exhibit an acid potential between 4 to 6 kg $CaCO_3$ equivalent/ton. The neutralization potential is in excess of 200 kg $CaCO_3$/ton, which will provide sufficient neutralization of any acid that may be produced.

SAMPLE	DATE	PASTE pH	SO_4 (%)	S^{2-} (%)	S(T) (%)	AP kgCaCO$_3$ per ton	NP kgCaCO$_3$ per ton	NNP kgCaCO$_3$ per ton	NP/AP
Tailings	Mar 83				0.2	5.3	80	74.7	15
Old Pond Tailings	Jul 91	9.3	0.19	<0.01	0.18	6	209	203	34
'A' Valley Tailings	Jul 91	9.1	0.13	<0.01	0.13	4	283	279	70
L/C Rock Pile	Jul 91	9.0	0.02	0.02	0.05	1	25	24	25
U/G Rock Pile	Jul 91 Aug 91	9.1 9.0	0.12 0.06	0.35 0.21	0.58 0.27	18 8	52 68	34 60	2.9 8.5

(U/G = underground; L/C = Little Chief)

Table 4.1 Tailing and Rock Sample Characteristics

Leach extraction tests, performed by HBM&S in 1983, indicated that although a fraction of the copper was solubilized under highly acidic conditions (pH 1.1), the copper did not dissolve at a pH less than 4.0, the conditions that were expected (in 1983) to occur in the impoundment. Currently the paste pH of the tailings is in the range of 9.1 to 9.3.

The mineralogical analysis indicate that the tailings are comprised mainly of quartz, garnet and magnetite. These minerals are common to the Whitehorse area and they are benign.

The three samples from the Little Chief and Underground mined rock piles produced neutralization potentials (NP) of 25, 52 and 68 kg $CaCO_3$/ton. It is considered that sufficient alkalinity is provided to prevent the generation of acid drainage from the two mined rock piles.

4.2.2 Water Quality

The results from the water quality tests are presented on Tables 4.2, 4.3 and 4.4 for samples taken in 1989, A/B watershed (1991), and the Crater Lake watershed (1991) respectively. The results from water samples taken in July 1991 are included in Appendix B; these samples were not correctly prepared, and consequently the results are questionable.

4.2.2.1 1989 Water Quality Data

The results from the six water samples taken in 1989 (Table 4.2) indicate that the water largely complies with the Canadian Drinking Water Guidelines (CCREM 1987), with the following few exceptions:

- total dissolved solids for Copper Lake (675 mg/l) and Lower Crater Lake (568 mg/l;-CCREM 500 mg/l);
- manganese in Copper Lake (1.24 mg/l; CCREM 0.05 mg/l), (manganese is not a toxic element; the limit is set for aesthetic reasons only); and
- pH 8.6 in the B Pond and pH 8.56 in the background water sample from the lake at elevation 2465; these data suggest that natural runoff in the area is alkaline.

4.2.2.2 A and B Valley Surface Water Quality

The results from 5 surface water samples taken in the A/B Valley watershed (Table 4.3) indicate that the water complies with the CCREM guidelines, with the exception of the Copper Lake sample (91-11), which marginally exceeded total dissolved solids, (566 mg/l) and manganese, (0.47 mg/l; CCREM 0.05 mg/l). These two parameters are primarily set for aesthetic reasons. Copper Lake receives local run-off and seepage from the A Valley impoundment. A comparison between the 1989 and 1991 water quality data in Copper Lake indicates a significant decrease in the manganese concentration from 1.24 to 0.47 mg/l. Manganese was not detected in the B Valley pond (sample 91-8) which receives water from the A Valley. Furthermore, the background water, (sample 91-9) above the B Valley shows an appreciable manganese concentration of 0.012 mg/l. This data suggests that the high manganese concentration in Copper Lake may be a result of the local mineralogy.

The quality of the water in the B pond (sample 91-8) compares favourably with the background lake water (sample 91-9) and the seepage water, (sample 91-10).

4.2.2.3 Crater Lake Surface Water Quality

The results from 6 surface water samples taken in the Crater Lake watershed, (Table 4.4), indicate that water meets the CCREM drinking water guidelines with the following exceptions:

- total dissolved solids and sulphate concentrations in the sample off the Old Pond, (91-7); and

Table 4.2 1989 Water Quality Data (Thompson Geotechnical)

SAMPLE DESCRIPTION		Guidelines (CCREM)*		Copper Lake	'B' Pond	Bii Springs	Pond 2403	Pond 2465	Lower Crater L.
		Drinking Water	Aquatic Fresh water						
Sample Location				91-11	91-8				91-21
Date				Aug17	Aug17	Aug17	Aug16	Aug16	Aug16
Time									
Physical Tests									
Conductivity mhos/cm		-	-	675	589	321	383	325	600
Total Dissolved Solids		500	-	675	454	313	366	321	568
pH		6.5 - 8.5	6.5 - 9.0	8.33	8.6	8.43	8.26	8.56	8.61
Total Suspended Solids		-	-						
Dissolved Anions									
Alkalinity	CaCO3	-	-	389	188	220	254	237	349
Chloride	Cl	250	-	19.5	1.6	0.25	1.5	1.47	13.3
Fluoride	F	1.5	-	0.12	0.36	0.10	0.1	0.20	<0.05
Sulphate	SO4	500	-	87.3	153	9.63	13.4	3.15	53.2
Total Metals									
Aluminum	T-Al	-	0.1	-	-	-	-	-	-
Antimony	T-Sb	-	-	-	-	-	-	-	-
Arsenic	T-As	0.05	0.05	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Barium	T-Ba	1.0	-	-	-	-	-	-	-
Beryllium	T-Be	-	-	-	-	-	-	-	-
Bismuth	T-Bi	-	-	-	-	-	-	-	-
Boron	T-B	5.0	-	-	-	-	-	-	-
Cadmium	T-Cd	0.005	0.0018	-	-	-	-	-	-
Calcium	T-Ca	-	-	-	-	-	-	-	-
Chromium	T-Cr	0.05	0.02	-	-	-	-	-	-
Cobalt	T-Co	-	-	-	-	-	-	-	-
Copper	T-Cu	1.0	0.004	0.008	0.020	0.003	0.003	0.003	0.003
Iron	T-Fe	0.3	0.3	0.11	0.037	0.048	<0.030	0.099	<0.030
Lead	T-Pb	0.05	0.007	-	-	-	-	-	-
Lithium	T-Li	-	-	-	-	-	-	-	-
Magnesium	T-Mg	-	-	27.7	51.1	10	12.2	27.6	25.4
Manganese	T-Mn	0.05	-	1.24	<0.003	<0.003	<0.003	0.024	0.045
Molybdenum	T-Mo	0.25**	0.05**	-	-	-	-	-	-
Nickel	T-Ni	-	0.11	-	-	-	-	-	-
Phosphorus	T-P	-	-	-	-	-	-	-	-
Potassium	T-K	-	-	-	-	-	-	-	-
Selenium	T-Se	0.01	0.001	-	-	-	-	-	-
Silicon	T-Si	-	-	-	-	-	-	-	-
Silver	T-Ag	0.05	0.0001	-	-	-	-	-	-
Sodium	T-Na	-	-	-	-	-	-	-	-
Strontium	T-Sr	-	-	-	-	-	-	-	-
Thallium	T-Tl	-	-	-	-	-	-	-	-
Tin	T-Sn	-	-	-	-	-	-	-	-
Titanium	T-Ti	-	-	-	-	-	-	-	-
Tungsten	T-W	-	-	-	-	-	-	-	-
Vanadium	T-V	-	-	-	-	-	-	-	-
Zinc	T-Zn	5.0	0.03	-	-	-	-	-	-

Results expressed in milligrams per litre except for pH and conductivity.
* Extracted from CCREM (1987) Guidelines
** Swain (1986)

Table 4.3 A and B Valley Surface and Ground Water Quality Data - 1991

SAMPLE DESCRIPTION		Guidelines (CCREM)*		Copper Lake	B/G Lake'B' Valley	Seepage W.Abut B dam	"B" Dam Pond	BelowB Dam	Richards Well	Boyd Well	McKinnon Well
		Drinking Water	Aquatic Fresh water								
Sample Number				91-11	91-9	91-10	91-8	91-14	91-2	91-1	91-3
Date				Aug15	Aug15	Aug15	Aug15	Sep03	Aug14	Aug14	Aug14
Time								10:45			
Physical Tests											
Conductivity umhos/cm		-	-	708	310	327	358	362	383	401	411
Total Dissolved Solids		500	-	566	248	260	287	286	306	320	320
pH		6.5 - 8.5	6.5 - 9.0	8.10	7.80	7.91	8.16	7.60	7.68	7.71	7.42
Total Suspended Solids		-	-	3	13	<1	3	<1	<1	<1	<1
Dissolved Anions											
Alkalinity	CaCO3	-	-	317	169	187	157	195	222	217	235
Chloride	Cl	250	-	18	1.7	<0.5	<0.5	<0.5	0.6	1.7	1.2
Fluoride	F	1.5	-	0.28	0.15	0.1	0.28	0.09	0.09	0.08	0.1
Sulphate	SO4	500	-	94	16.7	10.6	47.4	12.3	9.7	15.9	10.7
Total Metals											
Aluminum	T-Al	-	0.1	<0.20	<0.20	<0.20	<0.20	~<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	0.05	0.05	0.0033	0.0001	0.0011	0.0011	0.0009	0.0007	00005	0.0007
Barium	T-Ba	1.0	-	0.055	0.034	0.055	0.055	0.053	0.057	0.065	0.086
Beryllium	T-Be	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	T-B	5.0	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	T-Cd	0.005	0.0018	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.0003	0.0003
Calcium	T-Ca	-	-	101	41.1	59.1	38.5	66.2	67.1	67.6	70.8
Chromium	T-Cr	0.05	0.02	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	T-Co	-	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	T-Cu	1.0	0.004	<0.010	<0.010	<0.010	0.019	<0.010	0.047	0.014	0.028
Iron	T-Fe	0.3	0.3	<0.030	0.114	<0.030	0.061	<0.030	<0.030	0.034	0.105
Lead	T-Pb	0.05	0.007	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Lithium	T-Li	-	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	T-Mg	-	-	27.8	14.9	8.87	23.5	10.9	12.1	12.5	11.6
Manganese	T-Mn	0.05	-	0.472	0.012	<0.005	<0.005	<0.005	<0.005	<0.005	0.061
Molybdenum	T-Mo	0.25**	0.05**	<0.030	<0.030	<0.030	0.043	<0.030	<0.030	<0.030	<0.030
Nickel	T-Ni	-	0.11	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	T-P	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	-	-	5.8	5.5	<2.0	5	<2.0	<2.0	<2.0	2.1
Selenium	T-Se	0.01	0.001	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	T-Si	-	-	8.45	1.51	5.19	4.32	7.1	5.9	5.66	7
Silver	T-Ag	0.05	0.0001	<0.015	<0.015	<0.015	<0.015	0.023	<0.015	<0.015	<0.015
Sodium	T-Na	-	-	24.8	9.6	3.3	7.4	4.3	3.9	4.2	5.7
Strontium	T-Sr	-	-	0.785	0.239	0.228	0.632	0.248	0.250	0.276	0.278
Thallium	T-Tl	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	T-Sn	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	T-W	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	T-V	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	T-Zn	5.0	0.03	<0.005	<0.005	<0.005	<0.005	<0.005	0.02	0.364	0.419

All results in milligrams per litre except for pH and conductivity
* Extracted from CCREM (1987) Guidelines
** Swain (1986)

Table 4.4 Crater Lake Surface Water Quality Data - 1991

SAMPLE DESCRIPTION		Guidelines (CCREM)*		Old Pond Pond	Little C. Seepage	Borrow Pit N.of Rd.	Borrow Pit S.E.ofRd	Crater Lake	Lower Crater	Old Pond (Piez.)
		Drinking Water	Aquatic Fresh water							
Location				91-7	91-12	91-6	91-5	91-4	91-21	91-13
Date				Aug15	Aug16	Aug15	Aug15	Aug15	Sep03	Aug15
Time									09:45	
Physical Tests										
Conductivity umhos/cm		-	-	1370	1010	791	381	667	425	1910
Total Dissolved Solids		500	-	1100	800	630	305	530	299	-
pH		6.5 - 8.5	6.5 - 9.0	7.91	7.58	7.45	8.33	8.04	8.55	7.94
Total Suspended Solids		-	-	4	15	<1	<1	3	12	-
Dissolved Anions										
Alkalinity	CaCO3	-	-	79.2	302	290	56.8	283	163	-
Chloride	Cl	250	-	3.4	7.4	12	10.9	11.8	8.4	-
Fluoride	F	1.5	-	1.21	0.15	0.17	0.12	0.15	0.16	-
Sulphate	SO4	500	-	762	327	165	136	109	38.2	1050
Total Metals										
Aluminum	T-Al	-	0.1	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
Antimony	T-Sb	-	-	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20	-
Arsenic	T-As	0.05	0.05	0.0005	0.0005	0.0006	0.0012	0.0009	0.0014	-
Barium	T-Ba	1.0	-	0.024	0.102	0.14	0.048	0.116	0.043	-
Beryllium	T-Be	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Bismuth	T-Bi	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-
Boron	T-B	5.0	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-
Cadmium	T-Cd	0.005	0.0018	0.0005	0.0002	<0.0002	0.0002	<0.0002	<0.0002	-
Calcium	T-Ca	-	-	128	158	133	36.7	99.3	54.4	-
Chromium	T-Cr	0.05	0.02	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-
Cobalt	T-Co	-	-	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-
Copper	T-Cu	1.0	0.004	0.07	0.026	<0.010	<0.010	<0.010	<0.010	-
Iron	T-Fe	0.3	0.3	0.072	0.372	<0.030	<0.030	0.039	<0.030	-
Lead	T-Pb	0.05	0.007	<0.001	0.001	<0.001	<0.001	<0.001	<0.001	-
Lithium	T-Li	-	-	<0.015	0.086	<0.015	<0.015	<0.015	<0.015	-
Magnesium	T-Mg	-	-	121	48.4	25.2	19.7	25.9	22.4	-
Manganese	T-Mn	0.05	-	0.015	0.909	0.007	0.007	0.033	0.01	-
Molybdenum	T-Mo	0.25**	0.05**	0.284	<0.030	<0.030	<0.030	<0.030	0.035	-
Nickel	T-Ni	-	0.11	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020	-
Phosphorus	T-P	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	-
Potassium	T-K	-	-	31	<2.0	4	2.2	3.4	2.7	-
Selenium	T-Se	0.01	0.001	0.0007	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-
Silicon	T-Si	-	-	1.84	5.13	6.31	1.85	6.95	4.39	-
Silver	T-Ag	0.05	0.0001	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015	-
Sodium	T-Na	-	-	16.6	8.9	14.9	15.8	16.9	18	-
Strontium	T-Sr	-	-	7.16	0.943	0.784	0.414	0.705	0.557	-
Thallium	T-Tl	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-
Tin	T-Sn	-	-	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	-
Titanium	T-Ti	-	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	-
Tungsten	T-W	-	-	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	-
Vanadium	T-V	-	-	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030	-
Zinc	T-Zn	5.0	0.03	<0.005	0.091	<0.005	<0.005	<0.005	<0.005	-

Results expressed in milligrams per litre except for pH and conductivity.
* Extracted from CCREM (1987) Guidelines
** Swain (1986)

Table 4.4 Crater Lake Ground Water Quality Data - 1991

SAMPLE DESCRIPTION		Lammers 65'Well	O. Boyd 40'Well	G. Boyd 50'Well	Dan Boyd 62'Well	Pioneer 165'Well	Pioneer 400'Well
Location		91-18	91-19	91-20	91-17	91-15	91-16
Date		Sep03	Sep03	Sep03	Sep03	Sep03	Sep03
Time		12:55	13:15	13:35	12:30	11:45	11:45
Physical Tests							
Conductivity umhos/cm		500	416	419	461	605	416
Total Dissolved Solids		388	326	323	353	437	322
pH		7.76	7.73	7.65	7.66	7.76	8.06
Total Suspended Solids		<1	<1	3	<1	3	<1
Dissolved Anions							
Alkalinity	CaCO3	258	220	210	237	250	196
Chloride	Cl	2	2.6	5.7	2.4	32	8.1
Fluoride	F	0.13	0.13	0.11	0.1	0.12	0.18
Sulphate	SO4	23.2	15.3	17.7	17.2	31.3	28.6
Total Metals							
Aluminum	T-Al	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	0.0016	0.0014	0.0016	0.0016	0.0008	0.0006
Barium	T-Ba	0.065	0.065	0.054	0.06	0.09	0.043
Beryllium	T-Be	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10	0.13	<0.10	<0.10
Cadmium	T-Cd	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	64.7	57.2	57.3	63.6	86.3	54.6
Chromium	T-Cr	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	T-Cu	0.143	<0.010	<0.010	0.082	0.605	0.023
Iron	T-Fe	<0.030	0.058	<0.030	<0.030	<0.030	<0.030
Lead	T-Pb	<0.001	0.001	<0.001	0.002	0.037	0.012
Lithium	T-Li	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	T-Mg	27.3	19.7	20.5	23.3	25	17.5
Manganese	T-Mn	<0.005	<0.005	<0.005	<0.005	0.101	0.235
Molybdenum	T-Mo	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	2.3	2.2	2.7	2.3	2.9	<2.0
Selenium	T-Se	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	T-Si	6.62	6.74	6.93	6.78	6.89	7.32
Silver	T-Ag	<0.015	<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	T-Na	10.8	8.9	9.6	9.8	14.5	18.6
Strontium	T-Sr	0.42	0.269	0.29	0.378	0.671	0.434
Thallium	T-Tl	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	T-Zn	0.07	0.177	0.012	0.051	0.106	0.587

Results expressed in milligrams per litre except for pH and conductivity.
* Extracted from CCREM (1987) Guidelines
** Swain (1986)

Table 4.5 Yukon River Water Quality Data - 1991

SAMPLE DESCRIPTION		Guidelines (CCREM)*		Pump House	Miles Canyon	Schwatka Lake
		Drinking Water	Aquatic Fresh water			
Location				91-22	91-23	91-24
Date				Oct 16	Oct 16	Oct 16
Time				12:45	13:30	14:00
Physical Tests						
Conductivity umhos/cm		-	-	96.0	94.0	94.0
Total Dissolved Solids		500	-	67	68	68
pH		6.5 - 8.5	6.5 - 9.0	7.86	7.91	8.02
Total Suspended Solids		-	-	<1	2	1
Dissolved Anions						
Alkalinity	CaCO3	-	-	44.7	44.4	44.5
Chloride	Cl	250	-	<0.5	<0.5	<0.5
Fluoride	F	1.5	-	0.08	0.08	0.08
Sulphate	SO4	500	-	5.2	5.9	5.9
Total Metals						
Aluminum	T-Al	-	0.1	<0.20	<0.20	<0.20
Antimony	T-Sb	-	-	<0.20	<0.20	<0.20
Arsenic	T-As	0.05	0.05	0.0003	0.0002	0.0002
Barium	T-Ba	1.0	-	0.026	0.026	0.026
Beryllium	T-Be	-	-	<0.005	<0.005	<0.005
Bismuth	T-Bi	-	-	<0.10	<0.10	<0.10
Boron	T-B	5.0	-	<0.10	<0.10	<0.10
Cadmium	T-Cd	0.005	0.0002	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	-	-	15.1	14.8	14.8
Chromium	T-Cr	0.05	0.02	<0.015	<0.015	<0.015
Cobalt	T-Co	-	-	<0.015	<0.015	<0.015
Copper	T-Cu	1.0	0.002	<0.010	<0.010	<0.010
Iron	T-Fe	0.3	0.3	0.048	0.044	0.036
Lead	T-Pb	0.05	0.001	<0.001	<0.001	<0.001
Lithium	T-Li	-	-	<0.015	<0.015	<0.015
Magnesium	T-Mg	-	-	2.95	2.89	2.89
Manganese	T-Mn	0.05	-	<0.005	<0.005	<0.005
Molybdenum	T-Mo	0.25**	0.05**	<0.030	<0.030	<0.030
Nickel	T-Ni	-	0.025	<0.020	<0.020	<0.020
Phosphorus	T-P	-	-	<0.30	<0.30	<0.30
Potassium	T-K	-	-	<2.0	<2.0	<2.0
Selenium	T-Se	0.01	0.001	<0.0005	<0.0005	<0.0005
Silicon	T-Si	-	-	1.48	1.43	1.44
Silver	T-Ag	0.05	0.0001	<0.0001	<0.0001	<0.0001
Sodium	T-Na	-	-	<2.0	<2.0	<2.0
Strontium	T-Sr	-	-	0.076	0.073	0.075
Thallium	T-Tl	-	-	<0.10	<0.10	<0.10
Tin	T-Sn	-	-	<0.30	<0.30	<0.30
Titanium	T-Ti	-	-	<0.010	<0.010	<0.010
Tungsten	T-W	-	-	<0.10	<0.10	<0.10
Vanadium	T-V	-	-	<0.030	<0.030	<0.030
Zinc	T-Zn	5.0	0.03	<0.005	<0.005	<0.005

Results are expressed in milligrams per litre except for pH and conductivity
* Extracted from CCREM (1987) Guidelines
** Swain (1986)

- total dissolved solids, (800 ppm), iron (0.372 mg/l) and manganese (0.909 mg/l) in the seepage water from the Little Chief rock pile, (sample 91-12).

Aquatic water standards were not met in all parameters tested in the water off the Old Pond (sample 91-7). Seepage from the Little Chief rock pile, (sample 91-12) did not meet CCREM drinking water guidelines for total dissolved solids (800 ppm), iron (0.372 mg/l) and manganese (0.909 mg/l), and aquatic freshwater guidelines for copper (0.026 mg/l), iron (0.372 mg/l) and zinc (0.091 mg/l).

4.2.2.4 Groundwater Quality

The results from a total of 9 domestic water supply wells, 3 from the A/B Valley and 6 from the Crater Lake watershed are shown on Tables 4.3 and 4.4. The wells in the A/B Valley are located at a distance of about 3200 feet "downstream" from the tailings impoundments; the wells in the Crater Lake watershed are about 6000 feet "downstream" of the Old Pond tailing impoundment, (Drawing 8). There is no readily available data on the quality of the groundwater prior to the development of the tailing impoundments. The 1991 test results indicates that water from the wells all meet the CCREM drinking water guidelines with the sole exception of manganese in the two wells in Pioneer R.V. Park, (0.101 and 0.235 mg/l: CCREM 0.05 mg/l), which may be a result of the localized mineralogy.

4.2.2.5 Yukon River

Three samples were taken from the Yukon River in October 1991, (samples 91-22, 23 and 24). Sample 91-22 was taken upstream of where the Crater Lake and A/B Valley watersheds drain into the river, 91-23 was taken in the "drainage zone" from the mine site, and 91-24 downstream of the "drainage zone". Locations of these samples are shown on Drawing No. 8. The laboratory test results, shown on Table 4.5, indicate that the water meets CRREM aquatic freshwater guidelines for the parameters tested; there is no apparent evidence that seepage from the minesite has affected the quality of the water in the Yukon River.

4.2.2.6 Impact on the Yukon River

Surface drainage off the site, from the A/B Valley and the Crater Lake watersheds, have been measured during the period 1980 to 1987, by TGC (Appendix C). Field measurements indicate that the maximum flows occur in May, and the combined flow from the two watersheds is of the order of 1×10^{-2} m^3/sec. A typical flow in the Yukon River in May is 140 m^3/sec, which provides a dilution ratio of about 2000. Since the site surface water quality closely approximates the freshwater aquatic life guidelines, the

high dilution ratio will ensure that surface drainage will not impact on the Yukon River.

4.2.3 Chemical Stability of the Whitehorse Copper Minesite

The results from the tailing, mined rock piles surface and groundwater samples, discussed above in sections 4.2.1 and 2, indicate that:

- the tailing impoundments and the mined rock materials on the site are chemically stable and there is sufficient neutralizing capability in the materials to prevent the development of acid drainage; and

- both surface and groundwater meet CCREM drinking water guidelines, with the exception of seepage from the Little Chief rock pile, (Sample 91-12 iron and manganese); trends observed from the available data indicate improvement in the water quality from 1987 to 1991.

- although aquatic freshwater standards are not met in a few samples, there are no streams in the drainage basin capable of supporting fish; seepage from the Little Chief rock pile, (sample 91-12) did not meet the aquatic guidelines for copper, iron and zinc, however, it is not anticipated that this water will pose a problem for wildlife preservation; and

- surface drainage will not have an impact on the Yukon River.

5.0 MINE COMPONENTS FOR DECOMMISSIONING

5.1 General

A general layout plan of the project area is shown on Drawing 2. Photographs Nos 4 to 47 inclusive, illustrate the separate aspects of the project area, (Appendix A).

The long term aspects of physical and chemical stability, decommissioning work, and proposed activities to close down the various components of the minesite are described in sections 5.2 to 5.6. Section 5.7 reviews and comments on the landslides that occurred in the Miles Canyon in 1968.

5.2 Little Chief Open Pit and Underground Mine

This component is located at the southern end of the mine site area. The component includes: the Little Chief open pit; the Little Chief and Middle Chief A and B zones in the underground Mine; the Portal and Decline to the underground operations; and

the Mine Shaft and Vent Raise. A plan and section through the Open Pit and Underground mine are shown on Drawing 8. Photographs 4 to 12 inclusive illustrate the present conditions in the area.

The open pit has a plan area of approximately 14 acres. The pit is approximately 1000 feet long and 600 feet wide, and a maximum depth of about 300 feet. The rim of the pit is generally at elevation 2700 feet.

Underground mining in the Little Chief ore zone was extended below the open pit down to elevation 1400 feet. The Middle Chief A and B zones were taken down to about elevation 1800 feet. The underground crusher, was located at elevation 1300 feet. The Middle Chief ore zones were approximately 350 feet long, 50 feet wide and 350 feet deep. The underground ore bodies were mined by sub-level blast hole and vertical-crater-retreat mining systems. The underground workings were not backfilled, other than the materials that collapsed into the openings.

5.2.1 Mine and Ventilation Shafts and Portal

The shaft is located at the northern end of the orebodies. The shaft is a 14 foot diameter circular structure, that extends down from ground surface, at elevation 2708 feet to elevation 1450 feet, a total depth of 1250 feet. The shaft is lined with concrete from the ground surface down to the 1700 foot level.

The ventilation shaft was located about 600 feet north of the open pit and connected to the main decline at the 2300 foot level.

The portal to the decline is located about 2500 feet north of the open pit. The elevation at the portal is 2640 feet. The decline was relatively straight to the 2130 foot level, then traversed north and south through the ore bodies.

The walls of the open pit and the underground mining have collapsed since the cessation of mining. The approximate extent of ground movement is shown on Drawing 8. Ground subsidence has occurred over an area of approximately 50 acres. Fissures have occurred at the ground surface, adjacent to the open pit and a sinkhole has developed about 100 feet south of the south wall, (photographs 7,8,9 and 10). HBM&S have fenced off, and have maintained the fencing around the areas affected by the collapse of the open pit and underground mining operations, (photographs 6 and 11).

There is (August 1991) a small body of water at the bottom of the open pit; the depth of the water and its quality are not known. There was no readily apparent evidence of seepage of water from the walls of the pit, and there was no evidence of seepage from the portal to the decline.

5.2.2 Decommissioning Activities

The following decommissioning work has been carried out by HBM&S in the Little Chief open pit and underground mine area.

5.2.2.1 Physical Stability

The area in which ground collapse and slope instability have, and are taking place has been fenced off to prevent inadvertent access by the public. The fencing has been kept a minimum distance of generally 50 feet from any indications of unstable slopes or collapsing ground. The security fence is shown on photographs 4,5,6 and 11.

Detailed engineering studies to predict the possible extent of the land that may be subjected to ground collapse, using readily available mine records, have not been carried out at present.

HBM&S propose that for the long-term decommissioning plan an engineering assessment will be made of the possible extent of the ground area that may be subject to collapse, fencing will where found necessary and practicable be placed a minimum of fifty feet beyond that boundary, and stakes and hubs installed to monitor any ground movements for a period of 5 years. A survey will be carried out annually. The fencing will be maintained during the monitoring period.

5.2.2.2 Portal to the Decline

The portal was located about 2500 feet north west of the open pit, (Drawing 8). The portal was approximately 17 feet wide x 13 feet high. The decline was 13 feet wide by 11 feet high and it was unlined. We understand that in 1983 the portal was plugged with sand and gravel for a 200 foot distance from the entrance, followed by a facing of waste rock to prevent inadvertent access. A view of the closed off portal site is shown on photograph 12.

5.2.2.3 Mine Shaft

Access to the underground mine was provided by a 14 ft. diameter concrete-lined circular shaft divided into two compartments. The shaft is located about 800 feet northwest of the Little Chief Pit open pit. The collar elevation was at 2708 feet. We understand that the shaft was sealed in 1983 by installing a reinforced concrete plug about 8 feet thick, approximately 6 feet below the ground surface. The 6 foot void above the plug was backfilled to the ground surface with sand and gravel.

5.2.3 Chemical Stability

There are, at present, no available records to indicate if groundwater was encountered in the open pit or underground operations. The topography of the site is such that any water from the mine will not enter into the surface or near surface groundwater system. There is no evidence that any groundwater from the mining operations is presently entering the environment.

5.3 Mill Site Area and Infrastructure

The mill site area is located at the southern end of the project area and west of the open pit. A plan of the mill site area is shown on Drawing 8. General views of the mill site area, taken in August 1991, are shown on photographs 5, 13, 14 and 15. The millsite area occupied a total area of about 50 acres, and generally at elevation 2650 feet.

There were originally 13 main buildings on the site plus the ancillary buildings. Since 1988 HBM&S have been steadily arranging for the buildings to be demolished by private organizations. Where practicable, all the structural components have been salvaged and materials removed from the site.

A list of the buildings, the main construction materials and the present status is shown on Drawing 8. As of September 1991, there are 3 main buildings and their associated structures to be removed from the site, namely: the fine ore bin; the crusher building and the head frame. The former powder magazine, a wooden framed structure, is located on the Keeniwaw haul road about 4000 feet east of the open pit. This building has been sold to Titan explosives of Calgary; there are no explosives or chemicals stored in the building.

It is planned that all the structures will be removed by the Fall of 1992.

5.3.1 Decommissioning Activities

All buildings will be disassembled and removed from the site. Concrete foundation walls, presently protruding above the ground level, will be knocked down and the areas covered with chemically stable waste rock and or sand and gravel. Near surface culverts under the roads in the millsite area will be removed and the natural drainage channels restored.

Power lines owned by Whitehorse Copper will be disconnected and the poles and cables destroyed, and or removed from the site.

At present, a quantity of PCB electrical equipment is stored in the approved manner on the concrete base pad of the former assay laboratory building, (building #6). It is intended that the

materials will be removed from the site and shipped to a licensed waste disposal facility.

There is no record, or readily apparent evidence of any residual products from any chemical spills in the millsite area. Contamination of the soils in the area is, therefore, not expected.

The final stage of decommissioning work in the millsite area will be to contour the soils and rock waste materials, used to cover the building foundations, so that they blend in with the natural topography and direct surface drainage into natural channels downstream of the site.

5.4 Little Chief Rock Pile

The Little Chief rock pile is located at the southern end of the mine project area, immediately east of the open pit. A plan and sections through the rock pile are shown on Drawing 9. Photographs 16, 17 and 18 illustrate the rock pile. The rock pile was formed by end-dumping the rock directly from the mine trucks.

The rock pile contains about 8 million tonnes of material, consisting predominantly of barren rock.

The rock pile occupies an area of approximately 17 acres. The top of the rock pile is at about elevation 2690 feet. The surface of the pile was graded in 1989 to provide a top level area, generally at elevation 2690 feet, which covers about 14 acres. The rock pile has a maximum height of about 90 feet.

The rock pile is founded upon a mantle of till, generally less than 3 feet thick, overlying bedrock and or bedrock, (Drawing 3). From a study of the original site topography, it is apparent that the rock pile is not located upon any streams or drainage channels.

The grading of the rock pile has resulted in side slopes over the southern and eastern faces of about 3.5 to 4.0 horizontal to 1 vertical in the upper 50 feet, steepening to about 1.2 horizontal to 1 vertical over the lower 25 to 40 feet. The northern face of the rock pile was not graded in 1989 and presently slopes at about 1.1 horizontal to 1 vertical over the 85 foot high face. The northern face constitutes about 20% of the total side face of the rock pile.

There are no readily apparent signs of instability within the rock pile, or in its foundation material, (August 1991). There are no tension cracks or indications of seepage or a high water Table within the pile.

The top surface of the pile, and the upper graded slopes, consist mainly of materials ranging from 6 inches down to sand sizes. The lower steeper slopes contain rocks up to about 6 feet in size; the rocks are angular and there is no apparent indication of weathering or breakdown of the materials.

The catchment area for the rock pile is essentially the plan area of the pile, and water does not pond on the surface. A small pond, located at the toe of the east face (Drawing 9), receives seepage water from the rock pile. At the time of the inspection in August 1991, there were no other indications of seepage from the pile.

Inspection of the Little Chief rock pile shows that in the 2 years since surface regrading activities, grasses and small shrubs are developing on the top surface and upper slopes, see photograph 18.

5.4.1 Decommissioning Activities

HBM&S propose to grade the northern face of the rock piles to generally the same slopes as the eastern and southern faces. The small pit excavated at the top of the pile for miscellaneous metal waste will be covered over, and the site graded to blend in with the surface topography. It is proposed that site grading activities to flatten the northwest slope be continued in 1992.

5.4.1.1 Physical Stability

The rock pile is stable. The lower steeper portion of the rock pile is judged to have a factor greater than 1.4 under static conditions. This value has been obtained from consideration of the rock material and the appearance of the slopes. Detailed evaluations of stability under seismic loading have not been carried out. Based upon the results of studies carried out for other projects, gross instability of the relatively flat slopes of the Little Chief rock pile will not occur. It is likely that some displacement of the lower steep (1.2 h to 1.0 v) 25 foot high slope may occur and that isolated blocks of rock may roll down to the toe. These occurrences are not considered to constitute a hazard to public health and safety.

5.4.1.2 Chemical Stability

The results from an acid base accounting test on a rock sample and seepage water from the rock pile are discussed in section 4.0. The result indicates there is sufficient alkalinity in the rock material to prevent acidic drainage.

5.4.1.3 Land Use

Based upon the field observations that natural grasses and shrubs are self propagating on the surface and flatter slopes of the rock pile, it is not considered necessary to attempt to establish a vegetative cover.

5.5 Underground Rock Pile

The underground rock pile is located northwest of the Little Chief rock pile and east of the open pit. The location of the rock pile is shown on Drawing 8 and on photograph 5.

The underground rock pile contains several hundred thousand yards of waste rock from the underground workings. The pile is a sidehill dump, and presently lies at slopes as steep as 1.1 horizontal to 1 vertical. Based upon the results from samples taken from the surface of the dump, the material consists primarily of rock particles smaller than 3 inches, and less than 5% passing the #200 sieve size. Results from a laboratory gradation test are included in Appendix C.

Two samples of the underground waste rock were subjected to acid base accounting analyses. One sample consisted of a piece of rock taken from the surface of the pile. The second sample was a portion of the material used for the gradation test. The results from these tests are included in Appendix C.

The results from the acid base account analyses indicate that the waste rock from the underground operations is highly alkaline with a neutralization potential of at least 52 kg $CaCO_3$ per ton of rock. The results from the testing program indicate that the underground waste rock pile consists primarily of material in the "sand and gravel" size range; it is also considered to be chemically stable and may be used on the site for rehabilitation activities.

5.5.1 Decommissioning Activities

It is intended to use the underground waste rock for site rehabilitation material for reclamation activities at the mill site area, (see section 5.3) and on the tailings pond, (see section 5.5). The material will be taken from the pile and the remaining slopes of the pile will be graded so that they are no steeper than 3 horizontal to 1 vertical.

Based upon observations at the Little Chief rock pile, it is expected that natural grasses and shrubs will, with time, develop on the final slopes of the underground rock pile. Seeding of the slopes is, therefore, not considered to be necessary.

5.6 Tailings Impoundment System

5.6.1 General

The tailings impoundment system consists of three storage areas, The Old Pond, and the A and B Valleys. The locations of these storage areas are shown on Drawings 1 and 2. and on the photographs 3 and 4. The three impoundments were developed in stages over the life of the mine.

The three impoundments occupy an area of approximately 185 acres, and store about 10 million cubic yards of tailings. The plan area and volume of tailings stored for each of the three impoundments are summarized below.

Impoundment	**Area (Acres)**	**Volume (cubic yards)**
Old Pond	135	6.5 million
A Valley	30	2.5 million
B Valley	20	1.0 million
Total	**185**	**10.0 million**

5.6.2 Old Pond

The plan for the Old Pond impoundment is shown on Drawing 10; sections through the perimeter embankment are shown on Drawing 11. Photographs 19 to 26 illustrate various features of the Old Pond impoundment.

The Old Pond impoundment is approximately elliptical in plan, with a maximum dimension of 3000 feet (north-south), and about 2400 feet, east-west. The surface elevation of the tailings is generally between 2600 and 2575 feet, (Drawing 10). The tailing deposits are between 30 to 65 feet thick.

The tailings are contained by constructed sand and gravel embankments on the south, east and north boundaries and by the natural topography on the west boundary. The embankments range in height from about 20 to 68 feet. The tailings are generally about 2 feet or less below the crest of the perimeter embankments.

Foundation deposits in the Old Pond area consist primarily of till, or a till mantle (less than 3 feet thick) overlying bedrock, (Drawing 3).

The results from the 1982 drill hole program indicate that the perimeter embankments have been developed utilizing the "downstream" construction technique. The embankments are constructed almost entirely from sand and gravel borrow materials; waste rock has been used in some locations near to the "downstream" toe, (photographs 19, 20, 22, and 23. The results from standard penetration tests indicate that the granular materials are in medium to dense state, with occasional lenses or layers of loose material. The "downstream" slopes of the perimeter embankment range from 1.4 to 1.8 horizontal to 1 vertical; the average slope is about 1.5 horizontal to 1 vertical.

The southern areas of the tailings surface have a fairly uniform slope. The eastern areas, near to the perimeter dyke, are undulating with a height range of about 5 feet. A small pond has formed in the south east area; the pond is approximately 100 feet wide by 200 feet long, and about 3 feet deep (photographs 19 and 26).

Within the tailings impoundment there is a system of internal dykes that have been constructed upon the tailings; the dykes divide the impoundment into 4 separate surface drainage areas. Channels have been cut in the dykes to allow surface water to drain off the old pond, (Drawing 10 noted as spillways 1 to 7 inclusive and photographs 19,20 and 21).

A total of 11 standpipe piezometers were installed around the perimeter of the Old Pond in 1982 (Drawing 8). Readings taken from 1983 through to August 1991 indicate that the tailings are drained; the water level within the tailings is at, or within 1 foot above the base of the tailings and the perimeter embankments.

There are no indications of instability to the perimeter embankments. The toe of the embankment above the A Valley is damp, suggesting seepage; the toe of the embankment in this area is composed of rockfill and there are no signs of piping or instability of the toe, (photographs 23 and 25).

The remnants of a 12 inch diameter steel decant line occurs in the south east corner of the impoundment, (photograph 24). It is understood that the decant line runs through the base of the embankment into the Crater Lake drainage.

5.6.3 A and B Valleys

The A and B Valley impoundments lie north of the Old Pond; the surface elevation of the tailings in both impoundments is generally at about elevation 2500 feet. The tailing deposits are contained by earth and rockfill embankments at the northern end of the impoundments and by the till and or sand and gravel

terraces that form the valleys. A layout plan of the A and B Valley impoundments is shown on Drawing 12.

5.6.4 A Embankment Dam

The plan and section of the A embankment are shown on Drawing No. 13. General views of the A embankment are shown on photographs 27 to 33 inclusive.

The embankment dam in the A valley has a maximum height of about 115 feet, and a crest length of about 600 feet, at elevation +/- 2515 feet; the tailings have a maximum depth of about 90 feet upstream of the embankment. The tailings are about 17 feet lower than the crest of the embankment, (photograph 32).

The embankment consists of an impervious till core with a nominally 30 feet thick downstream shell of sand and gravel. The embankment is placed upon a gravel and waste rock blanket underdrain, which is about 240 feet wide and extends across the full width, and up each abutment of the valley. It is understood that the embankment was placed and compacted as an engineered fill.

The embankment is founded upon sand and gravel and a mantle of till overlying bedrock, (Drawings 3 and 13).

The embankment has downstream slopes of 1.5 horizontal to 1 vertical in the upper 20 feet, flattening to 2 horizontal to 1 vertical over the lower 80 feet of height.

The embankment consisted originally, (mid 1970's to 1980) of only the till section and the underdrain. A surficial failure of the downstream slope occurred in the spring of 1980 caused primarily by uncontrolled seepage; stabilization consisted of placement of the downstream sand and gravel shell.

Piezometers were placed in the downstream zone of the embankment in 1980 and 1981, see section A-A, Drawing 12. Piezometers 81-1, at the downstream toe, is a standpipe; the remaining piezometers, 80-3 and 81-2 to 81-8 are pneumatic diaphragm type and they have been damaged since 1985.

The remnants of the decant system, upstream of the A embankment, consist of two 12 inch diameter vertical steel pipes which connect to 2- 15 inch diameter corrugated galvanized culverts that lie at the base of the dam, and are exposed at the downstream toe, (photograph 33). In August 1991, there was no ponding of water upstream of the A Dam. Since closure of mining in 1982, water has not been discharged through the decant system into Copper Lake.

There is no evidence of seepage or instability on the downstream slope of the embankment or through the abutments. The water

table at the downstream toe is about 5 feet below the ground surface. Any seepage from the tailings is probably draining through the blanket underdrain and the near surface granular deposits into Copper Lake.

5.6.5. Copper Lake

Copper Lake is located about 400 feet downstream of the toe of the A embankment, see Drawing 13 and photographs 29 and 31. Copper Lake was constructed to perform as the reclaim pond for the A valley impoundment. The lake is presently about 150 feet wide by 300 feet long and approximately 6 feet deep. Water is discharged from the north end of the lake through a "v" notched weir, through a drainage channel and into the downstream alluvial deposits.

5.6.6. B Embankment Dam

Plan and sections through the B embankment are shown on Drawings 14, 15 and 16. General views of the B embankment are shown on photographs 34 to 42 inclusive.

The embankment in the B valley has a maximum height of about 90 feet, and a crest length of about 600 feet; the tailings have a maximum depth of about 115 feet upstream of the embankment; it appears that some of the materials used to construct the embankment were excavated from the valley floor, within the impoundment area and about 15 to 20 feet below the embankment foundation level.

The embankment consists of an upstream low permeability facing (sloping core), an upstream zone of till, a downstream zone of sand gravel and cobbles and a downstream toe berm of cobbles and boulders. The upstream low permeability material extends downward to the underlying till strata and laterally to the till on the abutments.

The embankment is founded upon deposits of sand, gravel and cobbles.

The embankment has a downstream slope of 2 horizontal to 1 vertical. The downstream berm is about 15 feet wide and incorporates the access road from the valley to the crest of the embankment.

Standpipe piezometers were placed in the embankment and downstream of the abutments in 1979 and 1982. In August 1991, water levels in the embankment were measured in standpipes 79-3 (downstream mid-height), and 82-16 and 82-11 (crest). Water levels in the abutments, downstream of the embankment, were measured in standpipes 82-12,13 and 14 (right abutment) and 82-19,20,21 and 23 (left abutment). The results from these readings

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indicate that the B Embankment Dam is well drained; the water levels at the standpipes are plotted on the sections, (Drawings 14 and 15).

During August 1991 water was seeping from the left abutment downstream and above the level of the embankment crest. The seepage water was draining both into the B pond and over the slope downstream of the dam. The seepage was causing gully erosion of the slopes downstream of the embankment, (photographs 38, 40 and 41.).

The remnants of the decant system in the B pond consist of 2-24 inch diameter vertical pipes which connect to two pipes that pass through the base of the embankment. In August 1991 the level of the B pond was 2491.6 feet; water was flowing through the decant pipes and being discharged onto the access road downstream of the dam, (photograph 42). The water flow, during the period 29 August to 3 September 1991, ranged between 1.3 to 2.0 l/sec.

There is no evidence of seepage or instability of the B Embankment Dam. Piezometer readings indicate that the water Table is in the alluvial deposits below the base of the dam. As discussed above, the only evidence of water seepage and gully erosion occurs in the natural deposits on the left abutment downstream of the dam.

5.6.7 Surface Water Management

A general layout plan of the surface water and groundwater drainage of the mine site, since development of the mine is shown on Drawing 17. Photographs 43 to 47 inclusive illustrate various aspects of the surface water management.

Surface drainage in the tailing impoundment system consists of three catchment areas, namely the Crater Lake, A Valley and B Valley watersheds.

A series of berms were placed on the surface of the Old Pond for tailing deposition purposes, (Drawing 10). These berms have been breached and surface water in the southern portion of the impoundment drains through spillway #7 into the Crater Lake watershed, (photograph 43), and the northern portion through spillway #6 into the A Valley watershed, (photograph 45). Inspection of photographs 44 and 46 indicate that when water is discharged from the Old Pond into Crater Lake or the A Valley, tailings are being carried and deposited downstream in the drainage channels.

Surface water runoff passes through the A Valley into the B valley, via a channel cut into the sand and gravel terrace that separates the A and B valleys, (photograph 47). In August 1991 no water was ponding in the A Valley, although it appears that a small pond had been in existence upstream of the embankment dam

until 1988, see photographs 28 and 32). A pond has formed upstream of the B Valley dam, see photographs 27, 34 and 36. Records show that this pond has been in existence since closure of mining. In August 1991 the pond was at elevation 2491.6, and covered an area about 550 feet long by 350 feet wide. The depth of the pond is judged to be about 10 feet. The water discharged through the decant pipes, (August 1991) was the first occasion since 1985.

5.6.8 Wind Erosion

Dust storms have been known to occur on the tailings on the Whitehorse Copper impoundments since the closure of mining activities and the end of tailings deposition in 1982. These storms generally occur during June to August. A detailed record of the occurrence of the dust storms has not been made, however, the dust storms have not occurred on a daily basis for extended periods of time.

Examination of photographs 19, 20 and 21 indicate that wind erosion of the tailings surface has occurred on the Old Pond impoundment. Environment Canada records for the Whitehorse airport, (period 1951 to 1980), approximately 4 km north of the minesites, indicate that the prevailing winds in the Yukon River valley are primarily from the south east. The mean wind speeds during May to October range from 14 to 18 km per hour. The maximum values can be as high as 63 km per hour, and gusts of 101 km per hour have been recorded.

A laboratory mineralogical analysis was made to establish the free silicate content of the respirable portion of the dust, (i.e. that fraction of the dust finer than 10 microns). The results indicate that the 10 micron portion accounted for 6.7% of the total weight of the sample. Of this portion, 8% of the particles are present as free silica; i.e. less than 1% of the total tailings is respirable free silica. The laboratory test data are included in Appendix C.

These data indicate that wind erosion has liberated some respirable dust into the atmosphere on some occasions since 1982. It is generally recognized that for any dust to cause physiological damage it must be present in excessive quantities and inhaled for a sufficiently long time. Factors which determine the harmfulness of any dust are its composition, particle size, concentration in the air, exposure and susceptibility of the exposed individual, (Sengupta 1990). Furthermore, the average time for the development of silicosis has been found to be 20 to 30 years.

Silicosis has not developed in any of the personnel who worked on the Whitehorse Copper property over the 15 year period of operation. Since the cessation of tailings deposition, the dust storms off the tailings impoundment in the 9 year period have not

been of sufficient duration, or continuity, to be considered a high health hazard. Dr. A.E Hall, of the University of B.C. department of mining and a specialist in mine ventilation, has reviewed the above data. Dr Hall has stated:

> *"There is a possibility that persons spending prolonged periods of time (several months) in dust clouds generated by wind erosion from the tailings could be exposed to dust levels above those recommended by the American Conference of Government Industrial Hygienists. It would therefore be prudent to adopt remedial action to reduce wind erosion for the long term decommissioning of the mine site until natural vegetation has moved in to stabilize the material. A cover of larger granular material would be adequate to reduce the wind erosion to obviate any risk or nuisance to adjacent sites".*

5.6.9 Decommissioning Objectives for the Tailings Impoundment System

From a review of the field reconnaissance in August 1991, and standpipe piezometer readings the following conclusions can be made for considering the decommissioning plan for the tailing impoundment system:

- in the Old Pond, the tailings have drained and water is not stored within the impoundment; the embankments do not act as water storage structures;

- both the A and B embankment dams act as water retaining structures. Upon closure of the minesite, provisions are required to pass runoff water through and downstream of the impoundment system in a manner that will require the minimum of care and maintenance, not to affect the long-term integrity of the dams, human health and the environment.

Consequently, the following studies and investigations have been carried out to evaluate the long-term physical and chemical stability of the tailings impoundment system:

- evaluation of the probable maximum flood, (PMF), the routing of the PMF and lesser floods through the impoundment system and the probable consequences downstream of the project area;

- stability analyses of the embankments under both static and pseudo-static (earthquake) conditions;

- collecting both surface and groundwater samples from within and beyond the project area, in order to establish the possible consequences of surface and near surface drainage from the minesite into the environment; and

- collecting two samples of the tailings for acid base accounting tests.

The results from the flood routing and stability for the tailings impoundment system are summarized in sections 5.6.10 and 5.6.11. The chemical stability and water quality of the project area have been discussed in section 4.0.

5.6.10 Flood Hydrology and Routing

For small catchments, such as the Whitehorse Copper Minesite, peak discharges are generally caused by intense rainfall rather than by snowmelt. The spring snowmelt produces greater volumes of water than the rainstorms but it is spread over several weeks.

To develop the decommissioning plan it is generally considered appropriate to obtain the flood discharge resulting from the probable maximum flood, (PMF), which is developed from the probable maximum precipitation, (PMP).

For the Whitehorse Copper Minesite analyses were carried out, using the U.S. Corps of Engineers HEC-1 computer model, to determine the peak rate of runoff from the combined effects of the PMP and snowmelt on the Crater Lake and A and B valley catchments. The runoff was routed through the various storage areas (A and B impoundments), over the spillways from the Old Pond (#6 and #7), from the A into the B Impoundment, and over a new spillway at the B Dam. It was assumed that decant lines from the three impoundments would be sealed with concrete. The catchment areas and the spillways are shown on Drawing 17.

The probable maximum flood was based upon a combination of the 1 in 200 year snowpack (April) water equivalent of 8 inches (200 mm), and the probable maximum precipitation in a 24 hour period of 5.16 inches (131 mm). It was assumed that the snowmelt would fill the storage area to the spillway invert level, followed by the runoff resulting from the PMP.

Table 5.1 summarizes the results from the computer analyses. The Table provides elevations of the tailings, dam crests, spillway characteristics, and freeboard at the embankment dams.

CATCHMENT	CATCHMENT AREA (acres)	ASSUMED PONDING AREA (acres)	TAILINGS ELEVATION (ft)	DAM CREST ELEVATION (ft)	SPILLWAY CHARACTERISTICS		
					Crest Elevation (ft)	Crest Length (ft)	Side Slope (H:V)
Old Pond (Crater Lake drainage)	43	0	2577	2577	2572	18	8:1
Old Pond (A Valley drainage)	347	0	2577	2577	2569	18	8:1
A Valley	107	32	2500	2516	2503	8	1:1
B Valley	449	19	2495	2516	2501	100*	1:1

* Side channel spillway at B Dam on right abutment

Table 5.1 Tailing Impoundments Water Management Characteristics

Table 5.2 summarizes the maximum outflows, water levels and freeboards at the various spillways for flood return periods of 200, 500, and 1000 years and the PMF. The data in Tables 5.1 and 5.2 will be utilized for the final design of rock-lined spillways and erosion protection in the spillway channels.

Upon closure of the minesite, water will be discharged from the impoundment system through spillway #6 from the Old Pond into Crater Lake watershed and from a new spillway at the B Dam into the lower portion of the B Valley watershed. Prior to the development of the mine the A and B valleys were separate, (Drawing 6); upon closure of mining, both catchments discharge into the B valley downstream of the B embankment dam, (Drawing 17).

A comparison of the PMF, both prior to and after mine development, indicates that the flood flows downstream of the B dam would have been greater prior to development of the mine. The storage areas in the A and B impoundments more than compensate for deforestation of the tailings areas and the A Valley drainage. The relative magnitudes of the PMF for a spillway in the B Valley, with a crest elevation at 2503 feet, (18 feet wide) are:

CATCHMENT	24 HOUR DESIGN STORM (in)	MAXIMUM INFLOW (ft^3/s)	MAXIMUM OUTFLOW (ft^3/s)	MAXIMUM WATER ELEV. (ft)	MAXIMUM HEAD (ft)	MINIMUM FREEBOARD (ft)
200 YEAR FLOOD						
Old Pond (Crater Lake drainage)	2.0	N/A	N/A	N/A	N/A	N/A
Old Pond (A Valley drainage)	2.0	176	176	2569.9	0.9	7.1
A Valley	2.0	226	74	2504.4	1.4	11.6
B Valley	2.0	281	231	2501.8	0.8	14.2
500 YEAR FLOOD						
Old Pond (Crater Lake drainage)	2.5	N/A	N/A	N/A	N/A	N/A
Old Pond (A Valley drainage)	2.5	215	215	2570.2	1.2	6.8
A Valley	2.5	275	91	2504.6	1.6	11.4
B Valley	2.5	344	285	2502.0	1.0	14.0
1000 YEAR FLOOD						
Old Pond (Crater Lake drainage)	2.8	N/A	N/A	N/A	N/A	N/A
Old Pond (A Valley drainage)	2.8	258	258	2570.2	1.2	6.8
A Valley	2.8	329	107	2504.8	1.8	11.2
B Valley	2.8	408	338	2502.1	1.1	13.9
PROBABLE MAXIMUM FLOOD						
Old Pond (Crater Lake drainage)	5.2	161	161	2572.8	0.8	4.2
Old Pond (A Valley drainage)	5.2	724	724	2571.9	2.9	5.1
A Valley	5.2	908	271	2506.4	3.4	9.6
B Valley	5.2	1096	928	2503.2	2.2	12.8

Table 5.2 Flood Hydrology Data

B Valley pre-mine	920 ft3/s, (26m3/s)
A + B Valleys post-mine	635 ft3/s, (18m3/s)

The Crater Lake catchment is small and has not been significantly altered by the mine, (Drawings 6 and 17), consequently there is no change between the pre-mining and post mining drainage.

5.6.11 Embankment Stability

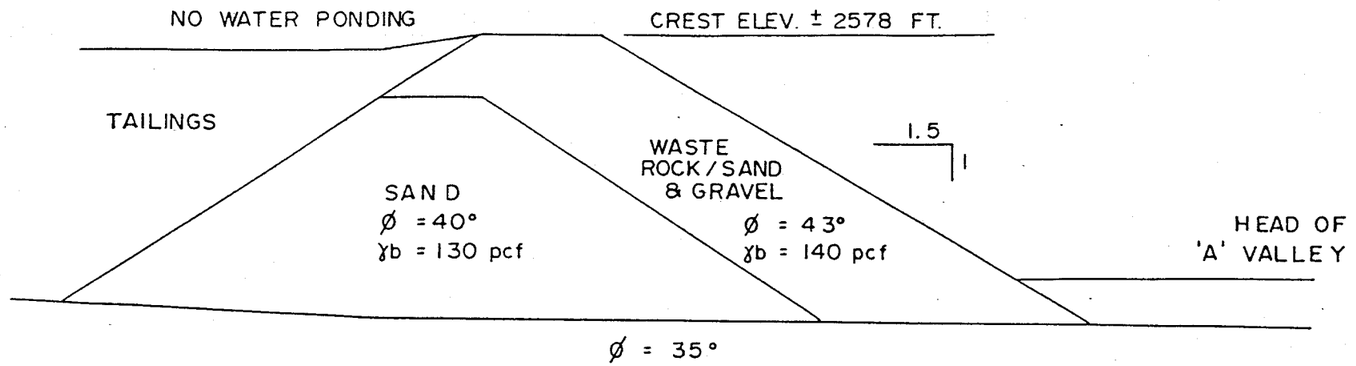
The stability of the tailing embankments, under both static and pseudo-static conditions have been assessed using the CLARA computer program. This program incorporates the Bishop circular and Janbu simplified methods of analyses. The program will analyze specified surfaces or search various circular surfaces for the minimum factor of safety.

Engineering properties for the various material types and the geometry conditions for the embankments in the Old Pond, A and B Valleys are summarized and illustrated on Table 5.3. Laboratory tests have not been performed on materials used in the embankments for the Whitehorse Copper project. The material strength parameters shown in Figure 5.3 have been selected from other projects and from the literature.

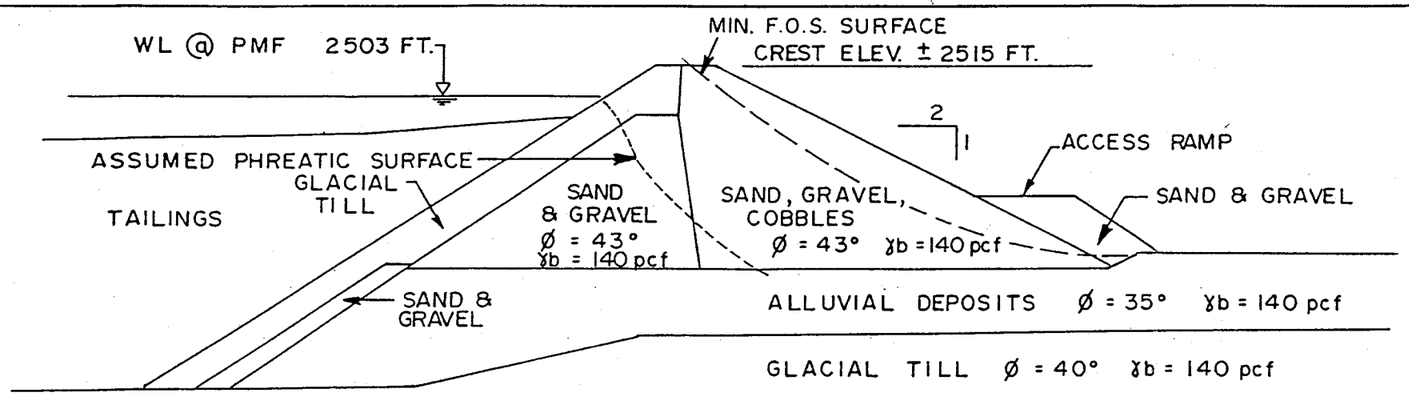
The computed factors of safety against sliding on the downstream slope for the three embankments, for the static condition and pseudo-static condition for ground accelerations of 0.1g (1:475 year event) and 0.2g (1:10,000 year event), are shown Figure 5.3.

The embankments are constructed from natural glacial or fluvioglacial materials that are not subject to weathering with time. Recommended minimum values for the factor of safety on the downstream slope are provided on Table 5.4, (CANMET 1977)

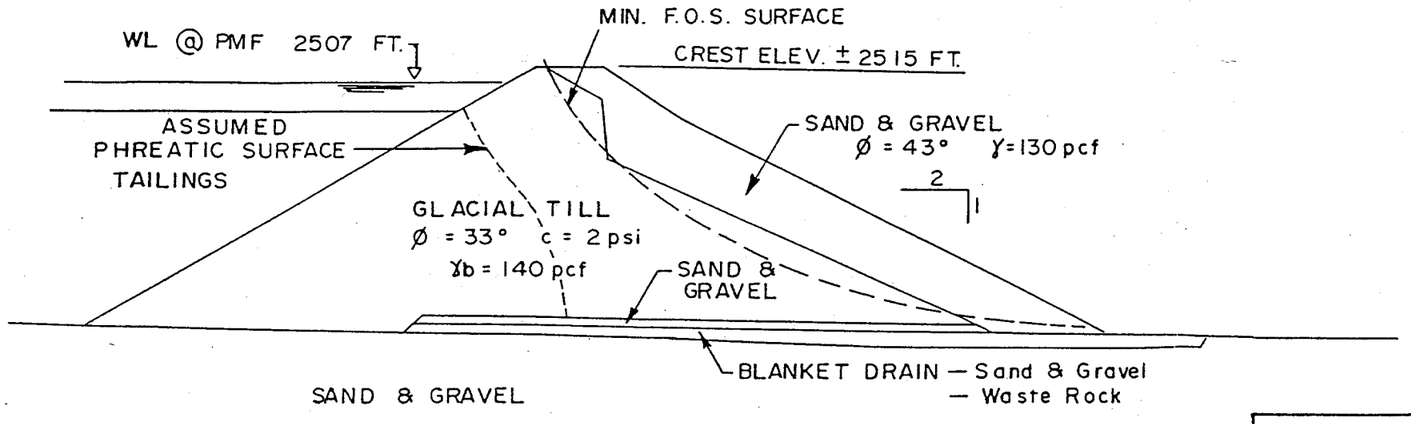
Results of the analytical studies for the embankments on the Whitehorse Copper project indicate that the computed factors of safety are greater than the minimum values recommended by CANMET. Consequently, the existing embankments are considered to have acceptable values for long-term stability.



OLD POND PERIMETER EMBANKMENT



'B' EMBANKMENT DAM



'A' EMBANKMENT DAM

EMBANKMENT	HEIGHT (FEET)	CREST ELEV. (FEET)	MAX. W.L. ELEV.	FACTORS OF SAFETY		
				STATIC	PSUEDO STATIC Acc. 0.1g ①	0.2g ②
OLD POND	64	2578	N.A.	1.9	1.5	1.3
B DAM	85	± 2515	2503	2.0	1.5	1.2
A DAM	115	± 2515	2507 (PMF)	1.6	1.3	1.1

① acceleration for 1:475 year seismic event

② acceleration for 1:10000 year seismic event

Stability analyses performed using CLARA computer program and Bishop Circular Analysis

HUDSON BAY MINING & SMELTING CO. LTD.

SUMMARY OF STABILITY ANALYSES

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH S R K Eng.

DATE OCT. 1991

PROJ. NO. 90-149

APPROVED

FIG. 5.3

Assumptions	I*	II*
Using peak shear strength parameters	1.5	1.3
Using residual shear strength parameters	1.3	1.2
Including the loading for a 100-year** earthquake	1.2	1.1
For horizontal sliding on the base of embankment retaining tailings in earthquake areas of assuming shear strength of tailings behind the dam reduced to zero	1.3	1.3
I* Where it is anticipated that severe damage would occur as a result of embankment failure. II* Where it is anticipated that severe damage would not occur as a result of embankment failure. *** Appropriate return periods for extreme events are discussed in Section 5.2.4.		
from CANMET (1977)		

Table 5.4 Minimum Factors of Safety for the Downstream slopes of Dams

5.6.12 Perpetual Disruptive Forces

Perpetual disruptive forces include wind erosion, water erosion, precipitation of salts in permanent internal drainage systems, frost action, ice accumulation, and decomposition and breakdown of rock particles. Biological activities include root penetration, borrowing intrusion and actions by animals and man.

From the above list, the only perpetual forces that need to be considered, which may affect the long-term integrity of the Whitehorse Copper site, are:

- wind erosion of tailings on the Old Pond;
- water erosion on natural soil slopes immediately downstream of the B Dam; and
- water erosion of the tailings from the Old Pond into the downstream watersheds
- the potential for the accumulation of ice in the final spillway channel from the B impoundment.

Proposed control technology for the above case are discussed in section 5.6.14.

5.6.13 Chemical Stability of the Tailings Impoundment System

The chemical stability of the tailings impoundment system is discussed in section 4.0. Two samples of the tailings were taken for laboratory acid base accounting tests; and samples of surface water were obtained for water quality testing.

The test results indicate that acid drainage will not occur from the tailings and that the material is benign.

5.6.14 Decommissioning Work for the Tailings impoundment system

From the above discussion, the following work is proposed to decommission the tailings impoundment system.

5.6.14.1 Decant Towers and Lines

All structures will be removed from the surface of the three tailing impoundments. Both vertical and horizontal pipes will be plugged with concrete over the full length.

5.6.14.2 Water Management and Control Structures

Old Pond: the channels (spillways 1 to 6, Drawing 10) in the interior dykes will be widened and the side slopes flattened to ensure that the flood flows pass freely across the impoundment. Both spillways #6 (into the A Valley) and #7 (into the Crater Lake drainage) will be widened, the side slopes flattened and the channels lined with rock to resist erosion. Where considered necessary, the surface of the tailings will be graded to ensure that water is not ponded and that surface runoff is directed into the Crater Lake and A Valley drainages. This work will include backfilling the existing pond on the Old Pond impoundment.

A and B Valley Impoundments: the channel between the A and B Valleys will be widened to pass the PMF event; the slopes will be flattened and the natural soil deposits protected with rock to resist erosion.

A new spillway will be constructed on the right (east) abutment of the B Dam, to discharge surface runoff downstream in the lower B Valley drainage. Both the left and right abutments to the B Dam are in fluvioglacial deposits; the spillway through the right abutment is preferred as it will direct flood flows further downstream, which will not affect the long-term integrity of the embankment. Preliminary engineering studies indicate that the

spillway would be set at elevation 2501 feet, and at the PMF the calculated freeboard on the B embankment dam will be 12.8 feet. A side channel concrete spillway is considered which would provide a long overflow crest, followed by a concrete lined section through the granular deposits and into a rip-rap lined channel which would discharge into the old granular borrow pit area, (see Drawing 12).

A water pond has existed behind the B embankment since the closure of mining activities. The available records show that the elevation of the pond has ranged from elevation 2490 feet to 2498 feet. Only in August 1991 has water discharged through the decant pipes. When the decant pipes have been plugged, as part of the decommissioning activities, it is expected that the pond will increase in size. The pond could rise to the maximum elevation of the spillway, 2501 feet, and occupy about half of the area of the B impoundment, (Drawing 12). Water would not be discharged from the impoundment until the water elevation was greater than 2501 feet. A detailed water balance, allowing for seepage, evaporation and monthly variations in precipitation has not been attempted. The results from the water quality analyses, (section 4.2.2), indicate that any water accumulating in the B valley impoundment would meet CCREM drinking water guidelines, and that with time, as the pond stabilizes, the water would meet the freshwater aquatic guidelines.

5.6.15 Water Erosion and Gullying

Seepage emanating from the left abutment area, above and downstream of the B Dam, has and is causing gullying of the natural materials. It is proposed to protect the areas from further erosion by placing rip-rap with an inverted filter to guard against potential piping failures.

5.6.16 Wind Erosion

Areas on the Old Pond impoundment, subject to wind erosion, will be covered with a thin layer (nominally 3 inches thick) of coarse granular rock from the underground rock pile. Windscreens, about 5 feet high, which would reduce windspeed across the tailings surface, will also be considered.

5.6.17 Vegetation

Inspection of the site indicates that local species of vegetation are developing naturally over the tailings impoundments and the rock piles. It is proposed, therefore, that development of vegetative covers not be carried out in the minesite area.

6.0 MILES CANYON

A landslide occurred in the Miles Canyon area, on the west bank of the Yukon River, in late May early June 1968. The location of the slide areas are shown on Drawing 3. Investigations and studies to evaluate the probable cause(s) of the slide and necessary remedial measures were carried out in 1968 by R.M. Hardy, the P.F.R.A and Golder Brawner & Associates.

The slide occurred following a very wet period in May; in fact the precipitation on 22 May (0.49 ins; 12 mm) was the highest on record for a 24 hour period.

The slide occurred in a larger area of prehistoric landslide activity. It was recognized in all three of the studies that water discharge from the tailings impoundments was of the order of 2 cu.ft/sec, and that this water was entering the surficial soil deposits about 3000 feet west and 60 feet above the slide area.

There have been no other occurrences of land sliding in the Miles Canyon since 1968. Furthermore, tailings deposition finished in 1981 and water has not been discharged downstream of the impoundment, apart for August 1991.

Monitoring of the water level in the tailings impoundment, since the closure of the mining operations, indicates that the water Table in the Old Pond area has dropped to practically the original ground levels.

A review of the original studies, and readily available data, has been made by N.A. Skermer P.Eng, (SRK), who specializes in landslide work. Mr Skermer is of the opinion that the water discharged from the mine in 1968 had little effect upon the stability of the banks of the Yukon River in the Miles Canyon. He believes that above average precipitation in May of 1968 was likely to have been the contributing factor to reactivating an old marginally stable landslide mass.

Drainage from the minesite, since the closure of mining, has steadily reduced and the drainage today, (1991), is practically the same as the pre-mining conditions.

The 1968 landslides are attributed to natural groundwater seepage below the minesite. Hence, it can be concluded that any seepage from the decommissioned minesite will not contribute to further instability in the west bank of the Yukon River. Movements may occur, but the triggering mechanism is likely to be excessive natural precipitation, perhaps rainfall following snowmelt, or intense summer precipitation following prolonged steady rain. Excessive precipitation, leading to an increase in groundwater levels and high induced pore water pressures, may reactivate the ancient landslide; undercutting of the toe of the bank by the

river would contribute to instability of the slopes in the Miles Canyon.

7.0 SCHEDULING FOR DECOMMISSIONING AND CLOSEOUT OF THE MINESITE

The decommissioning activities for the various components of the minesite are discussed in sections 5.2 to 5.6. Following review by the government agencies on the basic concepts of the decommissioning plan, HBM&S propose to complete all the decommissioning work by the end of 1993. Consequently, detailed designs for the spillways, surface contouring and protection against wind erosion in the Old Pond would be completed by April 1992.

8.0 MONITORING AND MANAGEMENT PROGRAMS

HBM&S propose to carry out an annual inspection of the site. In addition, the following monitoring programs will be instituted to monitor the effectiveness of the closure measures for the various mine component.

8.1 Open Pit and Underground Mine

Decommissioning activities are discussed in section 5.2.2. HBM&S propose to instal surface monuments to monitor the extent of any ongoing ground collapse for a period of 5 years. The surface monuments will be surveyed annually, together with an inspection of the site and a photographic record taken.

8.2 Millsite Area and Infrastructure

The area will be inspected; particular attention will be paid to ensure that surface drainage is taking place off the site. Any necessary maintenance work will be carried out to ensure that surface drainage is effective. A photographic record will be made.

8.3 Little Chief Rock pile

In addition to the visual inspection, HBM&S propose to take water samples twice a year, for a period of three years from seepage off the rock pile. If found necessary additional water quality monitoring would be carried out after this period.

8.4 Underground Rock pile

Apart from the visual inspection, no additional monitoring is believed necessary for either physical or chemical stability.

8.5 Tailings Impoundment System

The decommissioning work will consist of:

- backfilling the pond on the Old Pond impoundments, and where necessary contouring the tailings surface and the placement of fine rock fill materials to resist wind erosion;
- sealing the decant pipes with concrete, in all three impoundments;
- construction of the spillways; and
- placement of an inverted filter and slope protection on the left abutment downstream of the B Embankment Dam.

Site inspections will be made twice a year for a three year period; both after the spring run-off and before the winter period, to review the performance of the water management structures. If found necessary the spillways will be cleaned and any repair work carried out. The visual inspection will include evaluating the development of vegetative cover and the performance of the wind-erosion protective cover material.

During the above inspections, water samples will be taken from the pond in the B impoundment, and any other surface water body that may have developed in the impoundment system.

Site photographs will be taken for record purposes.

8.6 Water Quality

In addition to the water samples taken for the mine components described above, HBM&S will take samples of the surface water from Crater Lake (site 4), Lower Crater Lake (site 21), Sites 5 and 6 in the Crater Lake watershed, Copper Lake (site 11) and sites 9 and 14 in the A/B Valley watershed.

HBM&S propose to take water samples twice a year from the above locations for a three year period from the time of closure of the minesite. If found necessary, this period may be extended.

8.7 Reporting

Results from the site inspections and the water quality test data, together with an interpretation of the results, will form

the basis of an annual report which will be submitted to interested agencies. The report will include photographs, and the extent and nature of any necessary remedial work.

HBM&S envisaged that the site inspections and monitoring, by HBM&S personnel or their representative, will continue for the periods outlined above, following which their interest in the land would be surrendered to the Yukon Territorial Government.

9.0 REFERENCES

CANMET Pit Slope Manual, Chapter 9 Waste Embankments, 1977, Energy, Mines and Resources, Canada.

Howes, D.E. and E. Kenk, *Terrain Classification system for British Columbia (Revised Edition).* MOE Manul 10, Recreational Fisheries Branch Ministry of Environment and Surveys and Resource Mapping Branch Ministry of Crown Lands Province of British Columbia, Victoria, B.C., 1988.

Wheeler, J.O., *Whitehorse Map-Area, Yukon Territory 105D.* Geological Survey of Canada, Memoir 312, 1961.

10.0 PERSONNEL

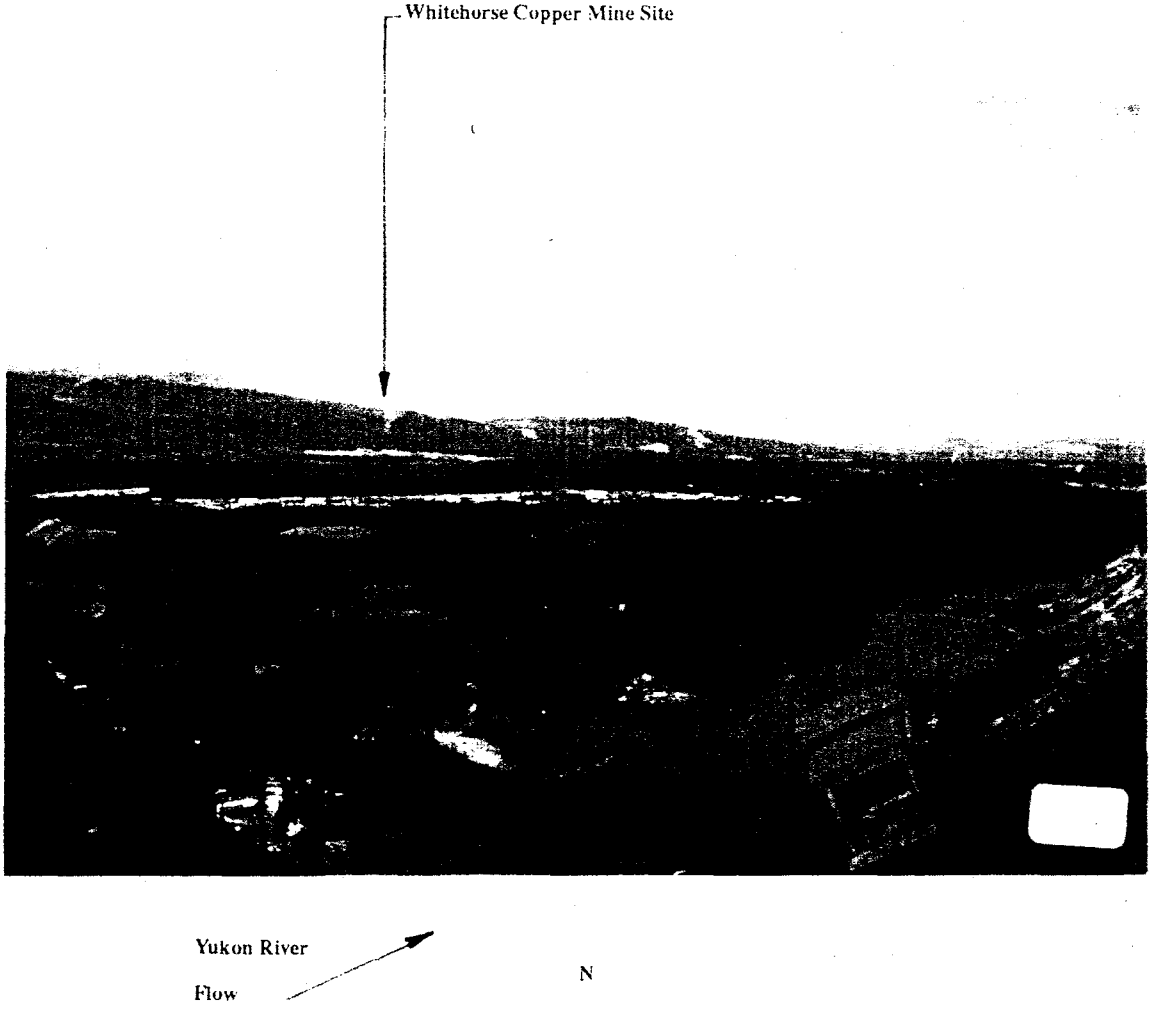
The following staff members contributed to this study: R.W. Chambers, M.Eng., P.Eng., A.G. Chantler, Ph.D., P.Eng., J.T. Chapman, M.Sc., P.Eng., J.W. Gadsby, M.S., P.Eng., N.A. Skermer, M.Sc., P.Eng.

Respectfully submitted by:

J.W. Gadsby, M.S., P.Eng.

A.G. Chantler, Ph.D., P.Eng.

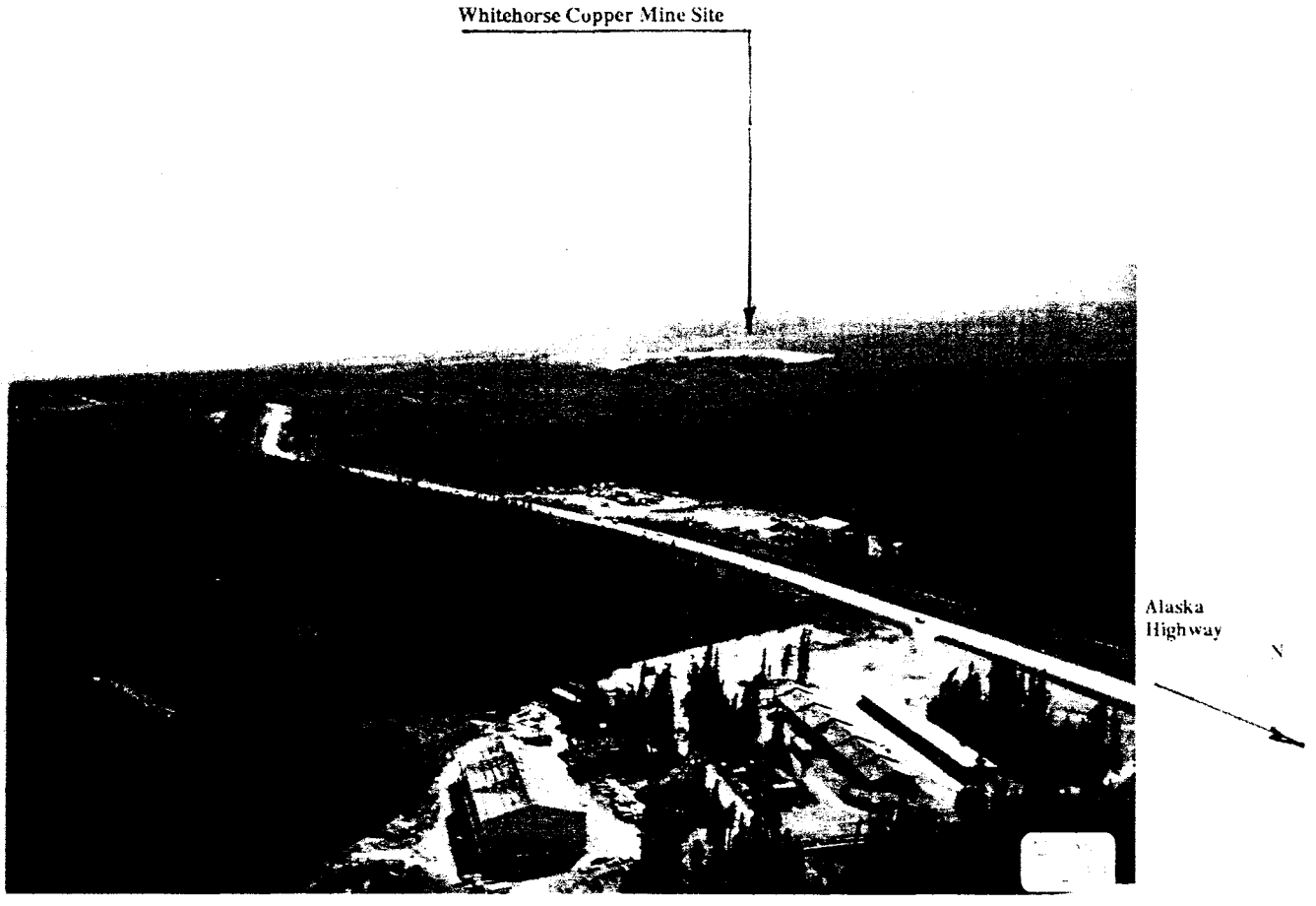
APPENDIX A
SITE PHOTOGRAPHS
Nos. 1 to 47 inclusive



Aerial view N.W from the Yukon River

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

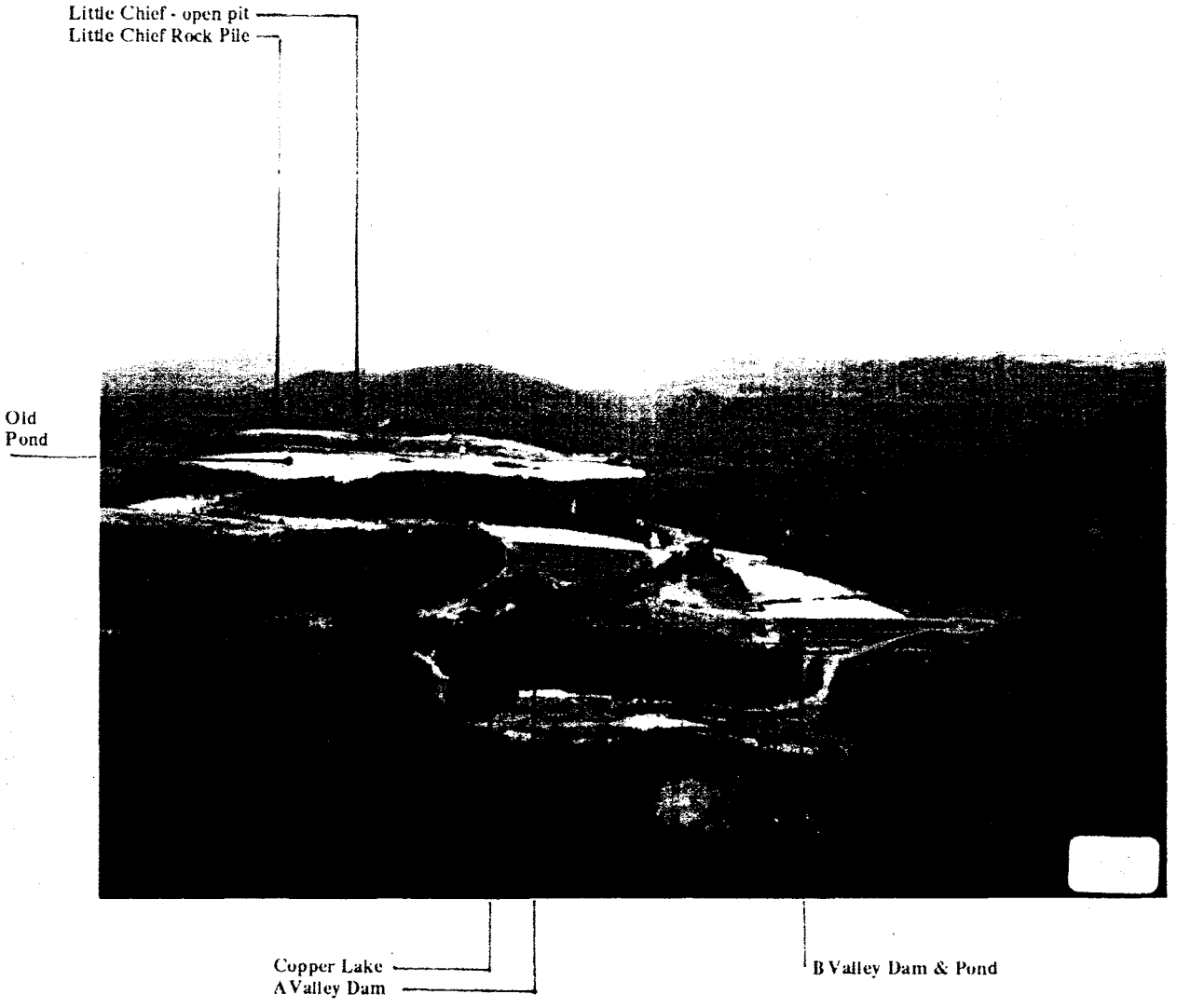
PHOTOGRAPH #1



Aerial view south from the southern outskirts of Whitehorse

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

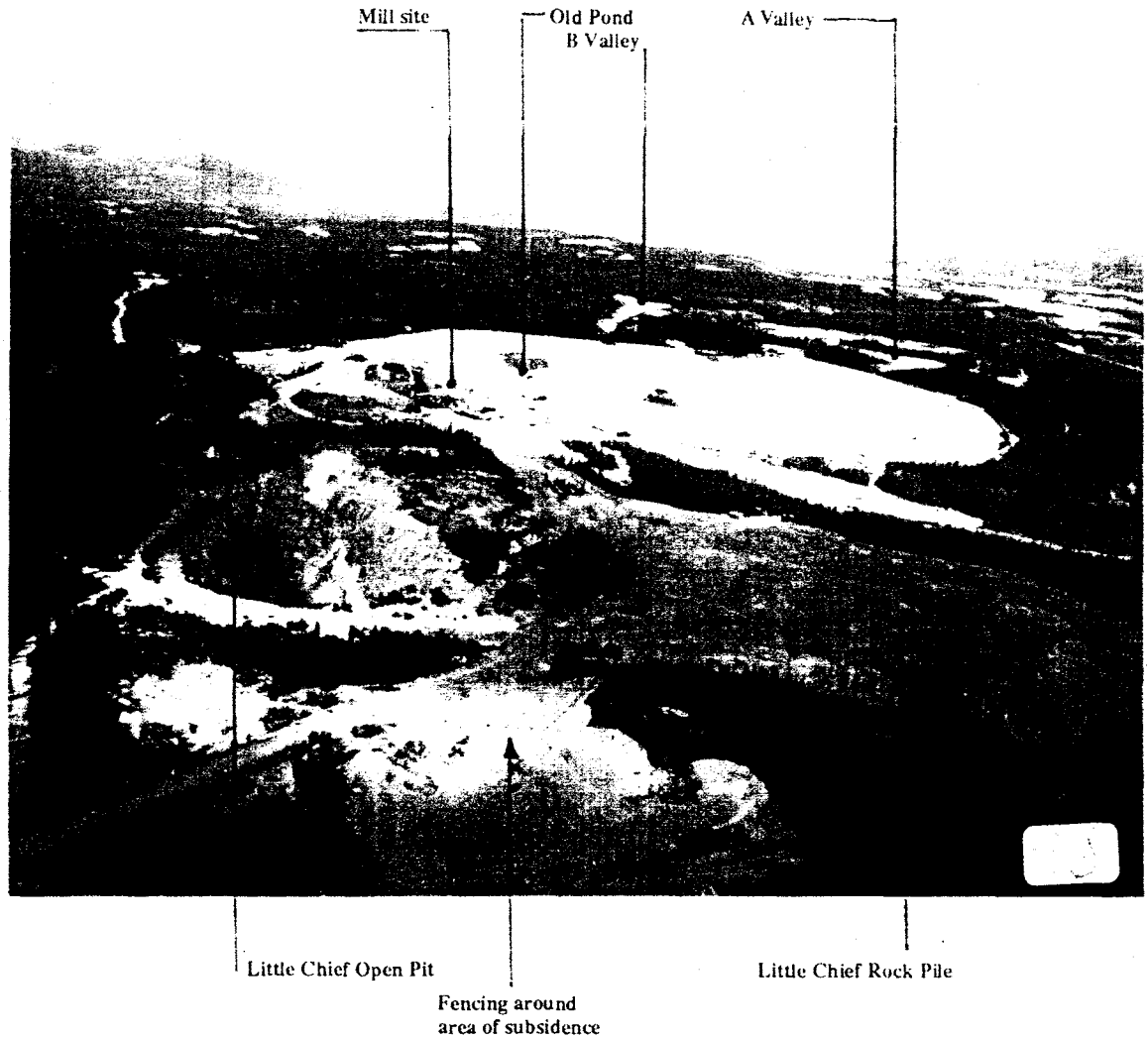
PHOTOGRAPH #2



Aerial view south over Minesite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

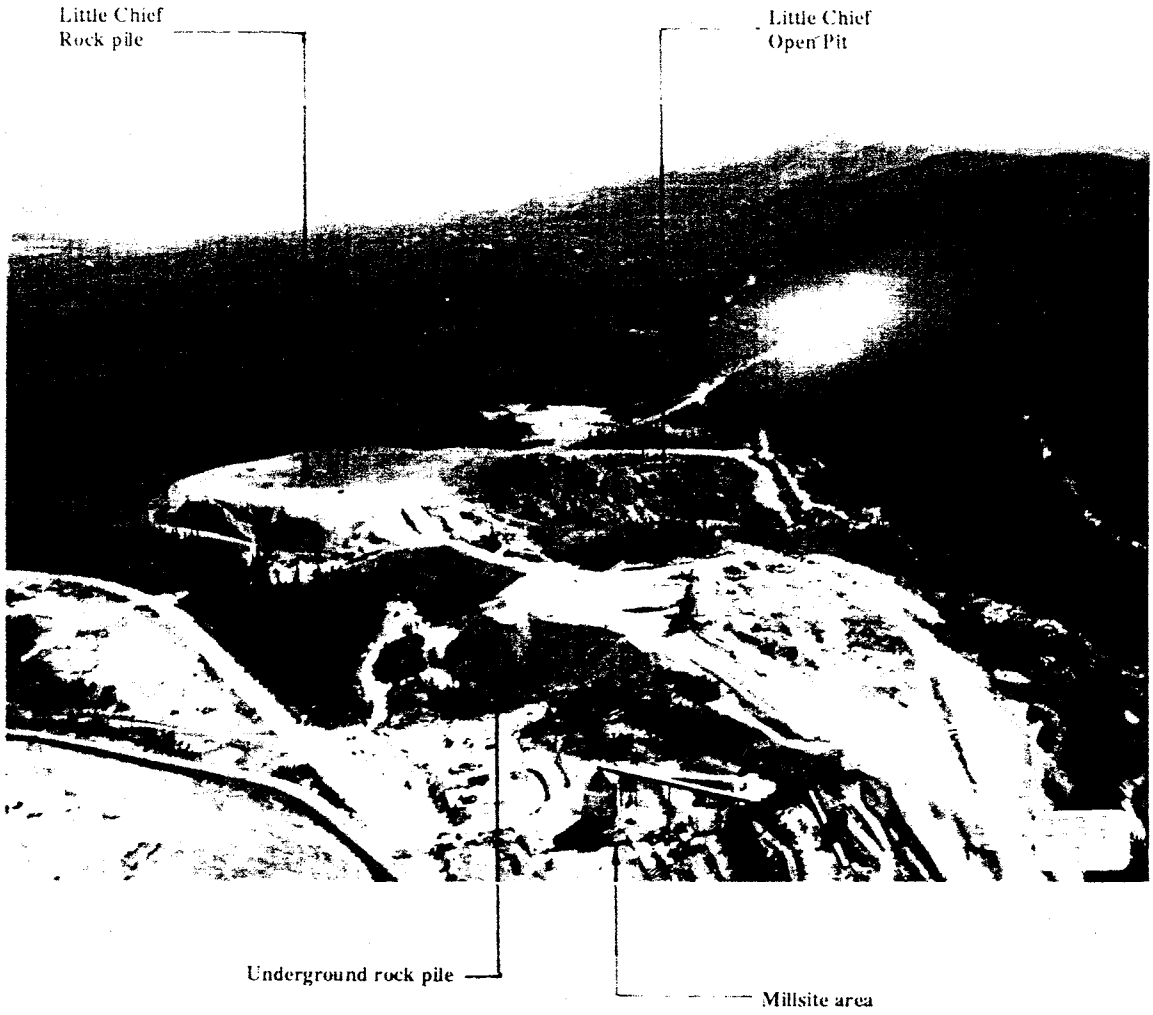
PHOTOGRAPH #3



Aerial view north from the south end of Minesite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

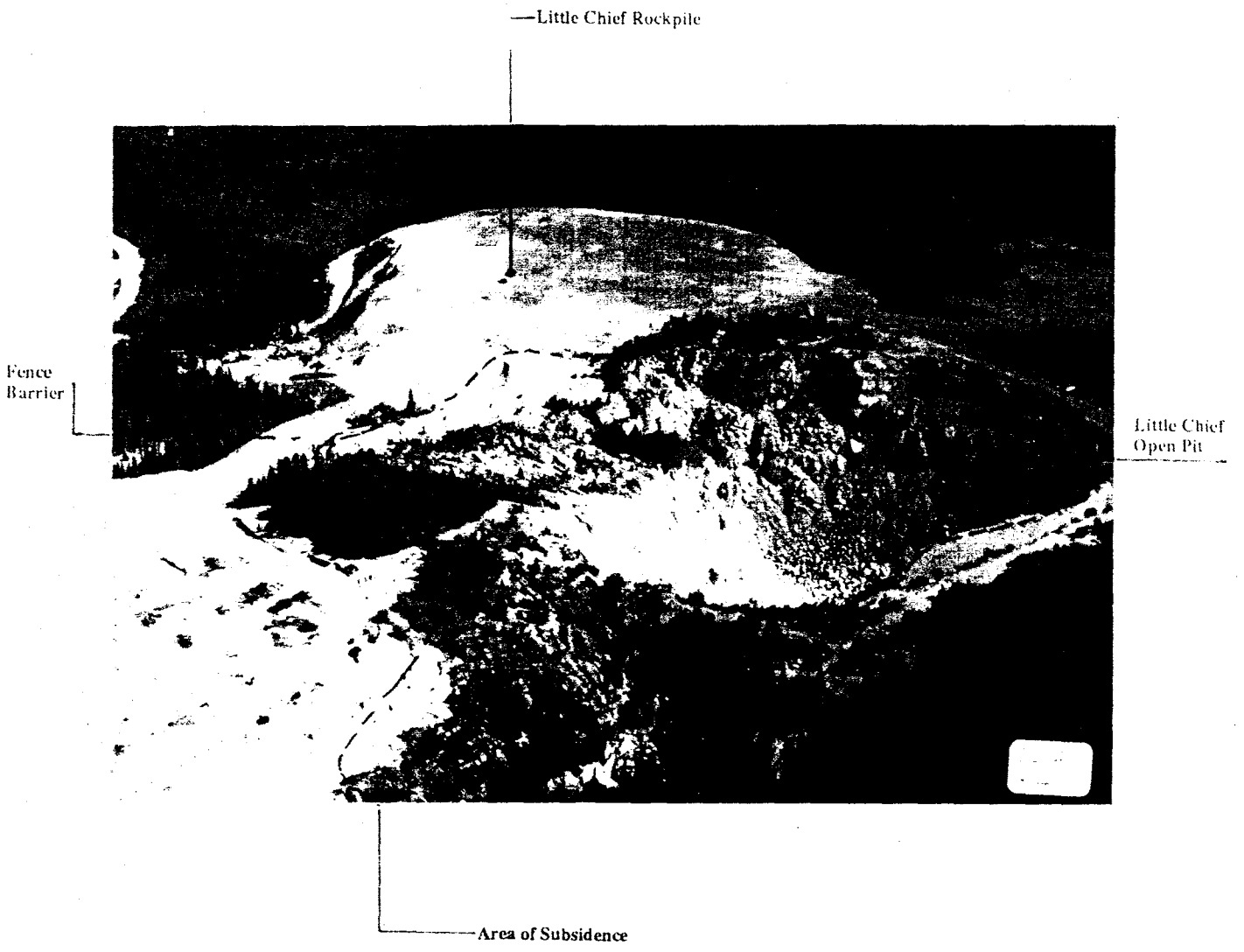
PHOTOGRAPH #4



Aerial view south over the S.W. area of the Minesite

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #5



Aerial view east over the Little Chief Open Pit and Rockpile

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #6



View south showing ground subsidence to the east of Little Chief Open Pit

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #7



View north of south end of
Little Chief Pit - Ground subsidence
on the east side - within fenced off area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #8



**Tension cracks @ ground surface
100 to 200 feet from south and
west walls of Little Chief Pit
(cracks within fenced off area).**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #9



"Sink hole" about 100 feet south of south wall of Little Chief Pit - (hole within fenced off area).

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #10



Security fence on the west side of the road to the Little Chief Rockpile (adjacent to portal yard)

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #11



View East in Portal Yard

Entrance to Portal - covered
with rockfill

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #12



General view of the southern area of the project - Millsite area in the foreground

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #13



View south showing foundation slab to the former warehouse and storage yard

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #14



View N.W. over the Millsite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #15



View south regraded (1989)
slope of Little Chief Rockpile

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

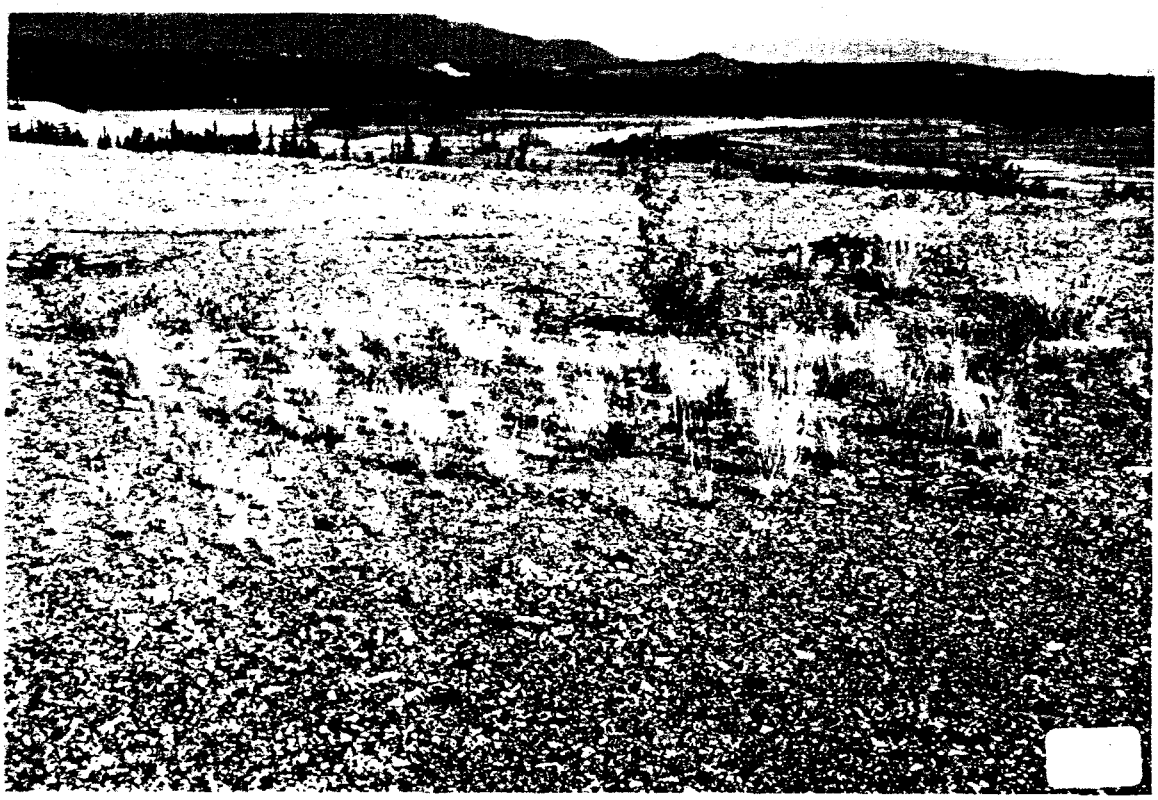
PHOTOGRAPH #16



View south on north slope
of Little Chief Rockpile - steepest portion
of slope approx 1.2 horizontal to 1 vertical

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

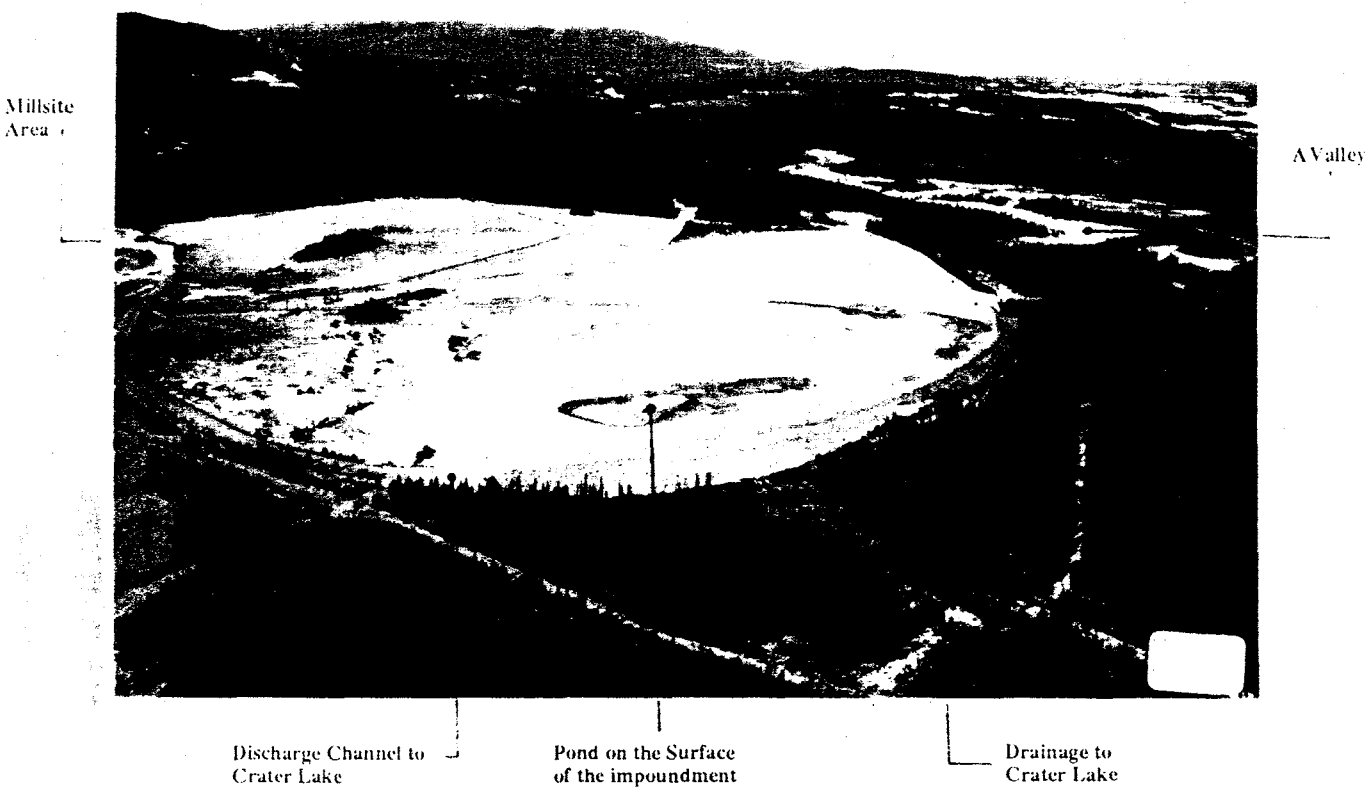
PHOTOGRAPH #17



View north - development of natural vegetation following regrading activities on the Rockpile in 1989

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

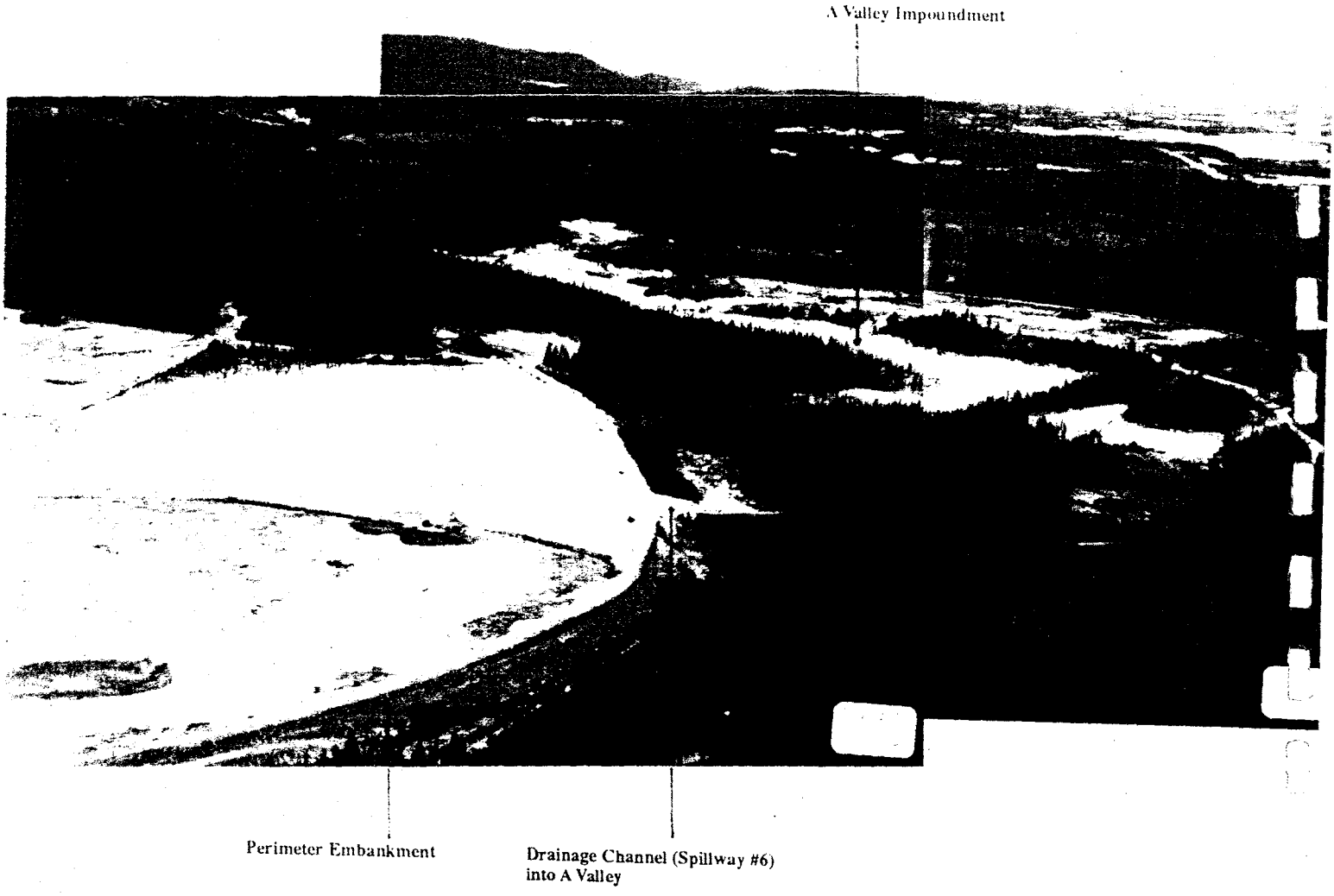
PHOTOGRAPH #18



Aerial view north over the Old Pond tailings impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #19



Aerial view north along east side of the Old Pond impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #20



Aerial view south over the "Old Pond" tailings impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #21



View north on the "downstream" side of the Old Pond perimeter embankment - "S.E. side"

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #22



View N.W. on the downstream slope of "Old Pond" embankment at the head of the A Valley - average slope 1.8 h to 1 vertical Embankment approximately 60 feet high.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #23

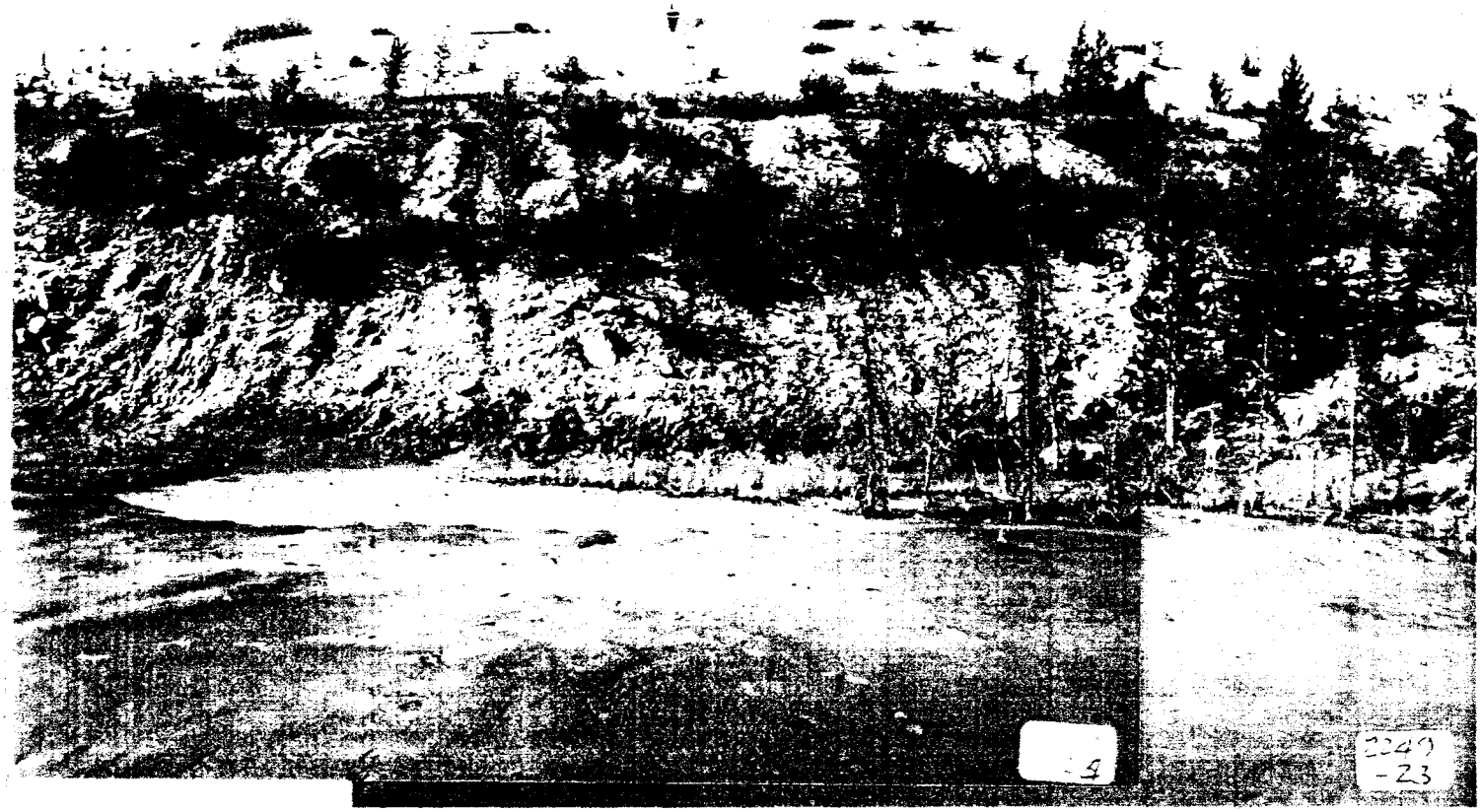


**View east drainage channel
into Crater Lake drainage - remnants
of the decant tower**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #24

Crest ±2578 feet



A Valley Tails @ elevation ±2520 feet

View S.W. on the downstream face of Old Pond embankment at the head of the A Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

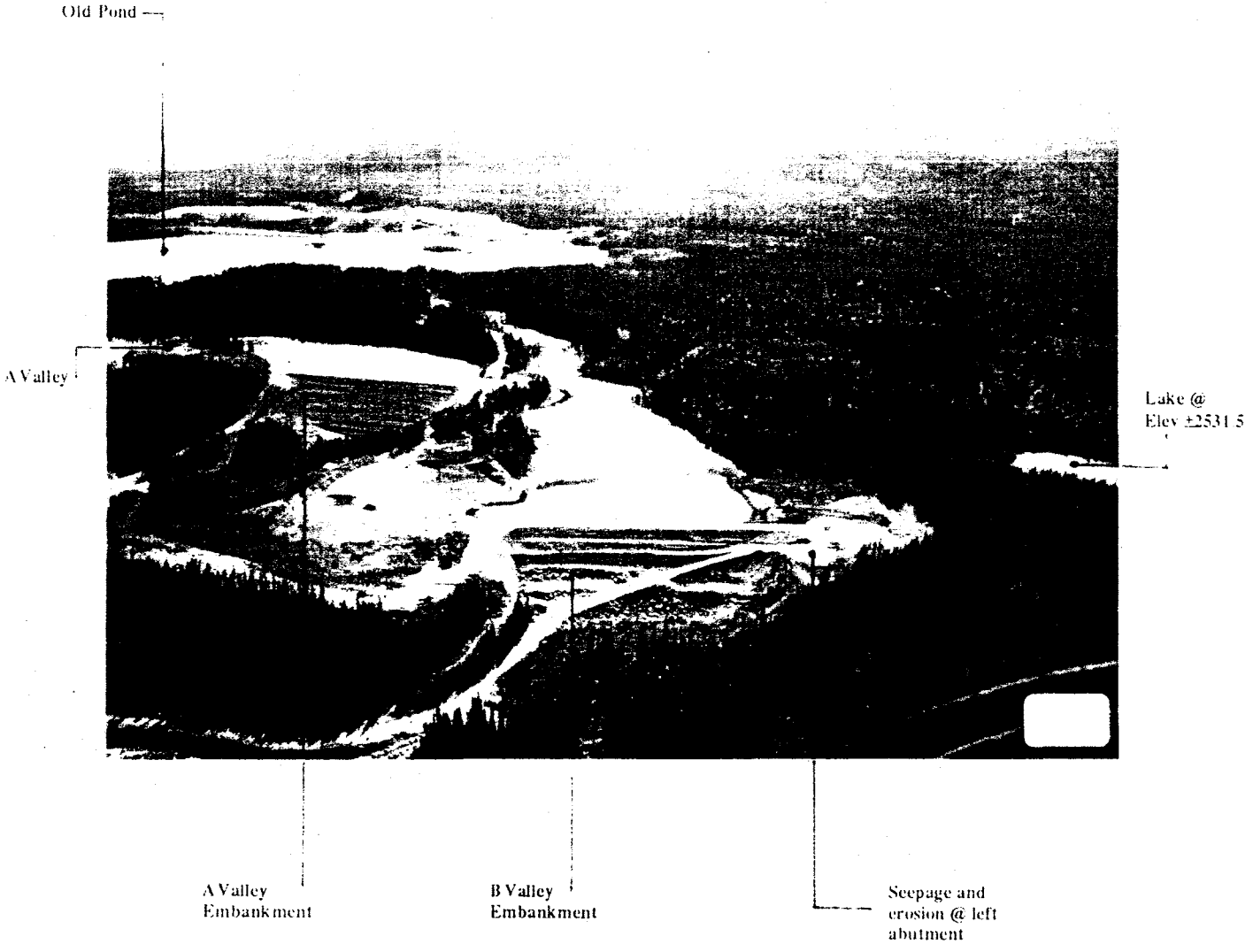
PHOTOGRAPH #25



View north onto pond on the "Old Pond" impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

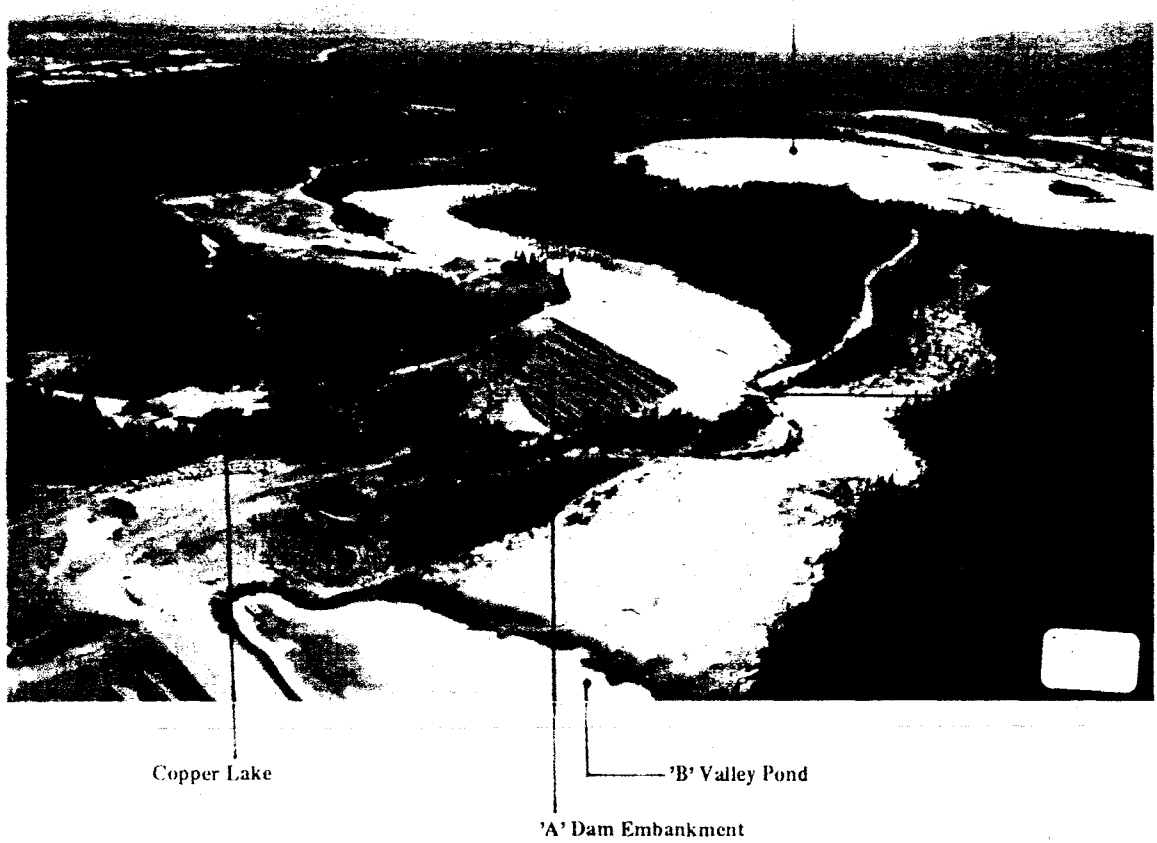
PHOTOGRAPH #26



View south onto A & B Valley impoundments

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

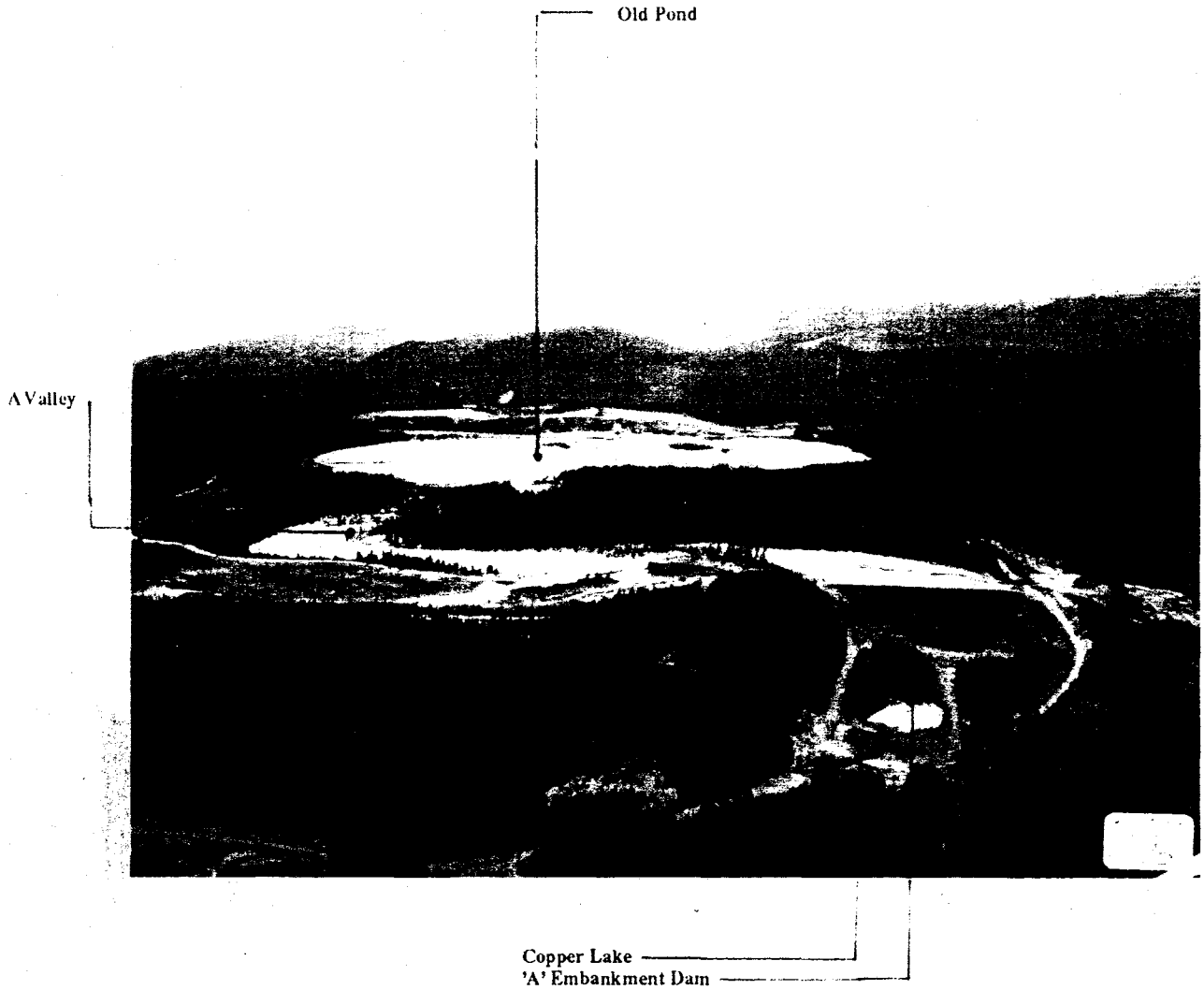
PHOTOGRAPH #27



Aerial view southeast onto the A & B Valleys

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

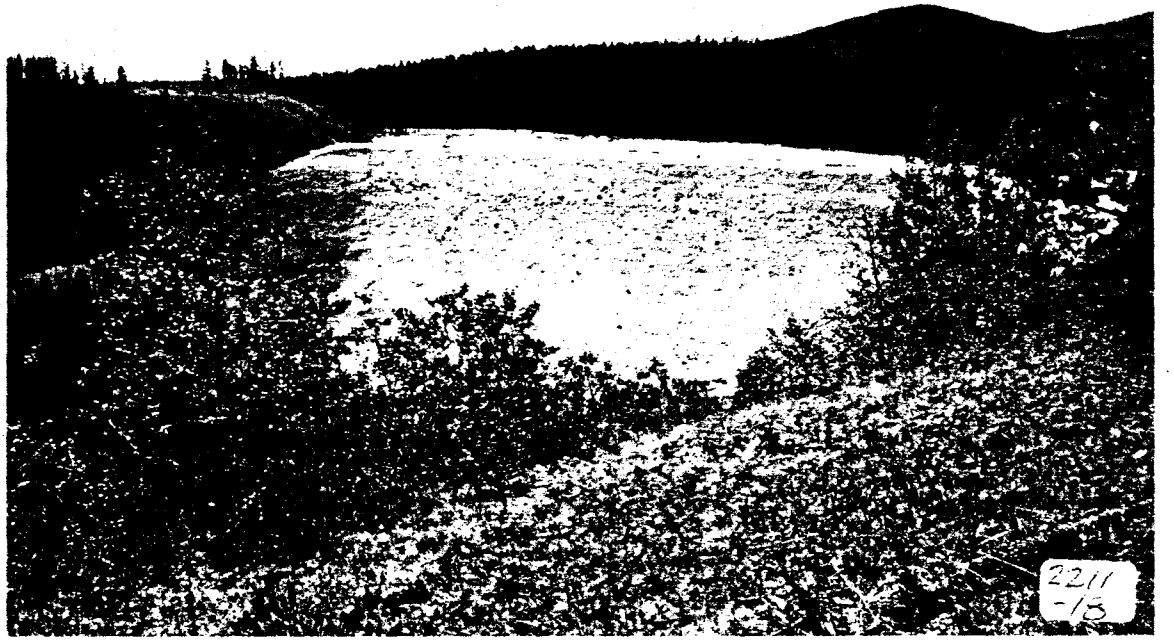
PHOTOGRAPH #28



Aerial view south over the A Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

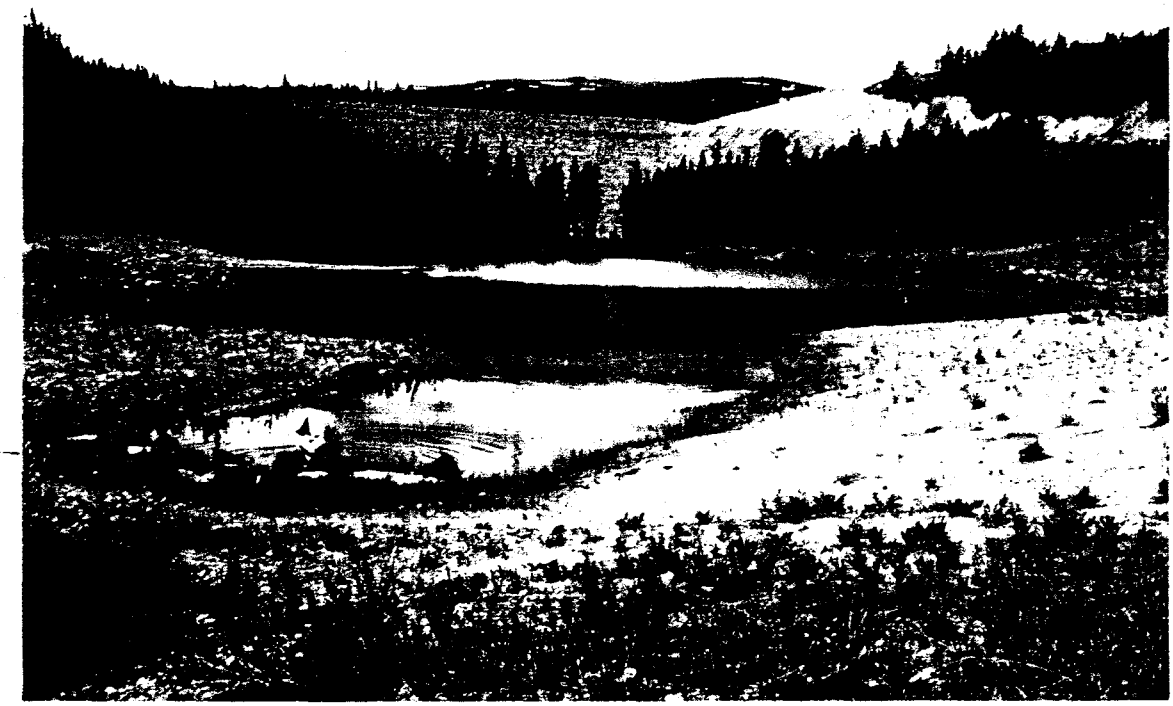
PHOTOGRAPH #29



View southeast on the downstream face of the A embankment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #30



View south - Copper Lake
A embankment in the background

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #31



**View east from left abutment
of A embankment
crest @ elev ±2515.5 feet tailings
@ elevation ±2498 feet.**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

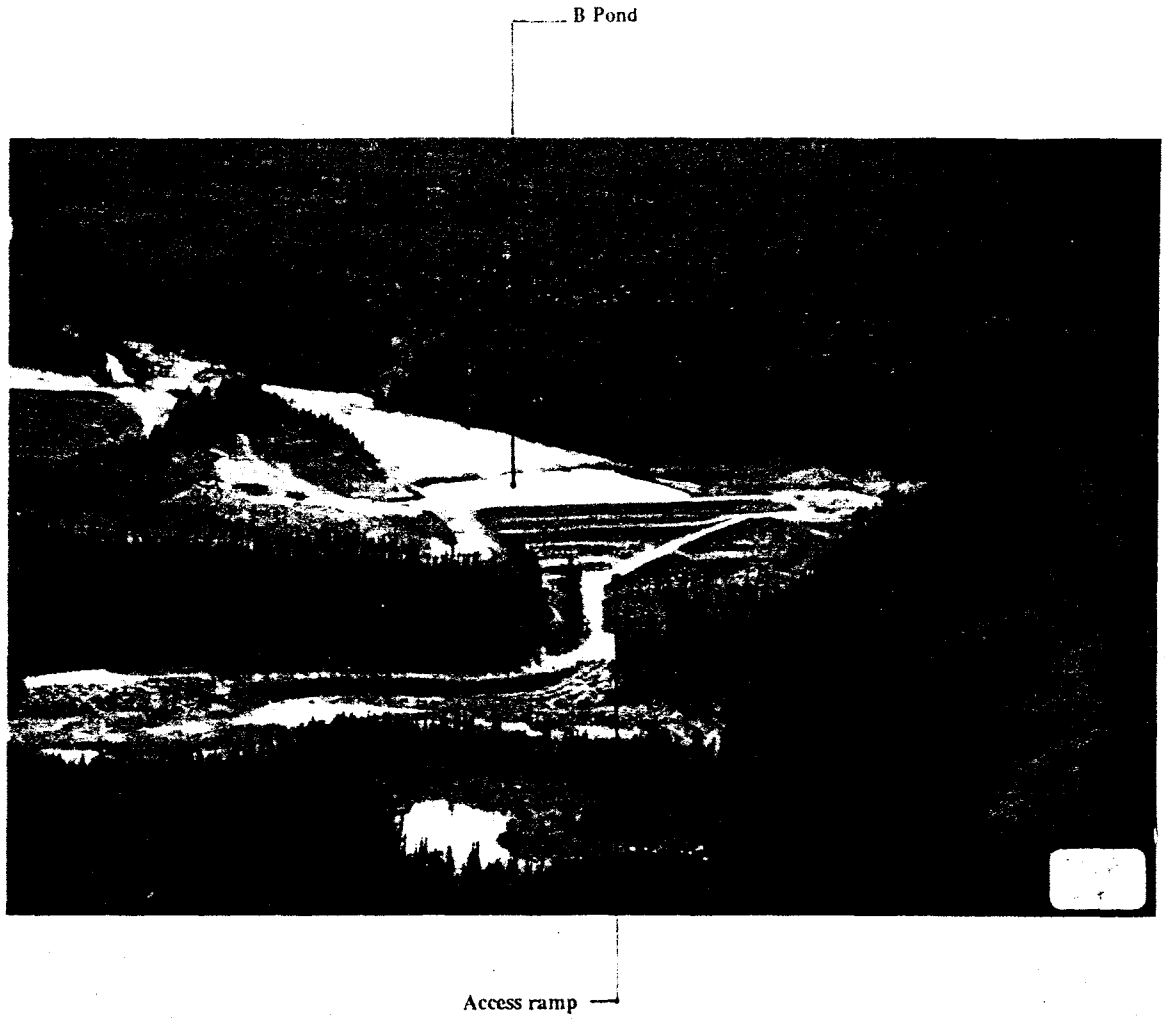
PHOTOGRAPH #32



2 - 15" O/D corrugated galvanized steel pipe decant lines @ downstream toe right abutment of the embankment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

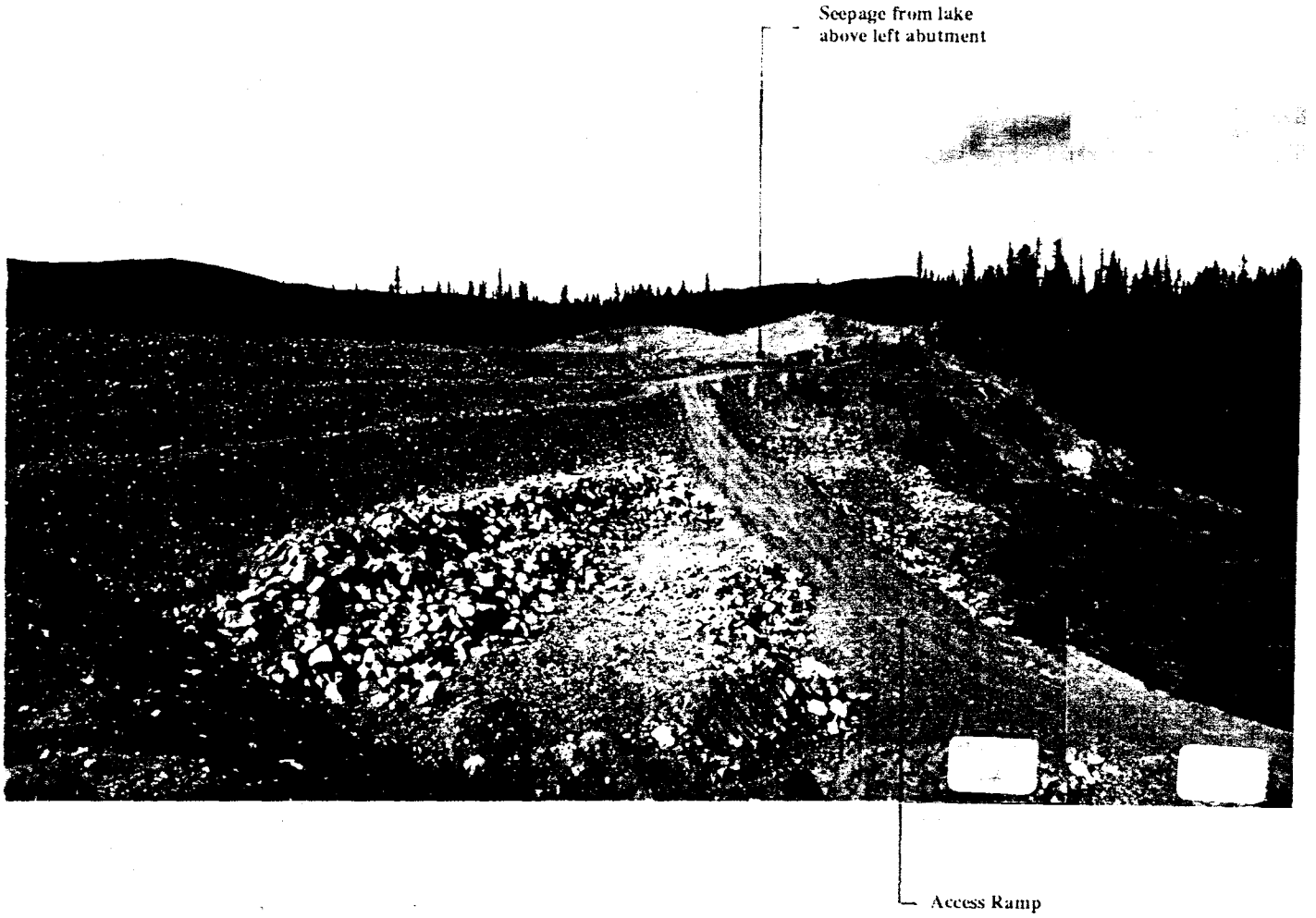
PHOTOGRAPH #33



Aerial view of the B Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #34



View west on downstream slope of 'B' Dam embankment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #35



View west - onto the 'B' Pond.
Crest elevation of B Embankment ±2515.5 feet,
Pond Elev. (July 91) ±2490 feet.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

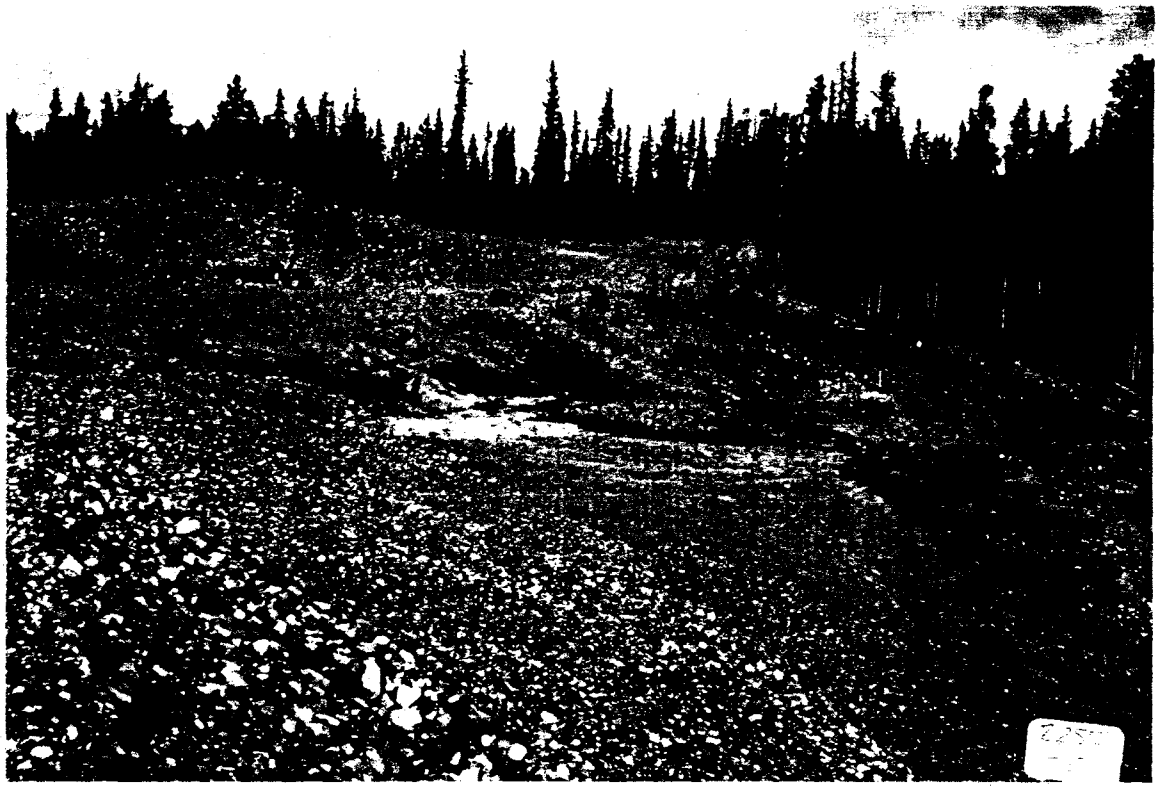
PHOTOGRAPH #36



View North - drainage ditch
on left abutment above B Dam.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #37



View West - downstream of left abutment to the B embankment. Seepage from the left abutment @ about elevation 2512 feet (B Pond elev. 2491.6 feet August 91).

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #38



Shallow Lake about 800 feet west of the left abutment to the B Dam embankment - Lake elevation ±2531.5. Believed to be water source for seepage in the left abutment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #39

B Dam
Embankment



View southwest - gully erosion downstream of embankment in the left (west) abutment.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #40

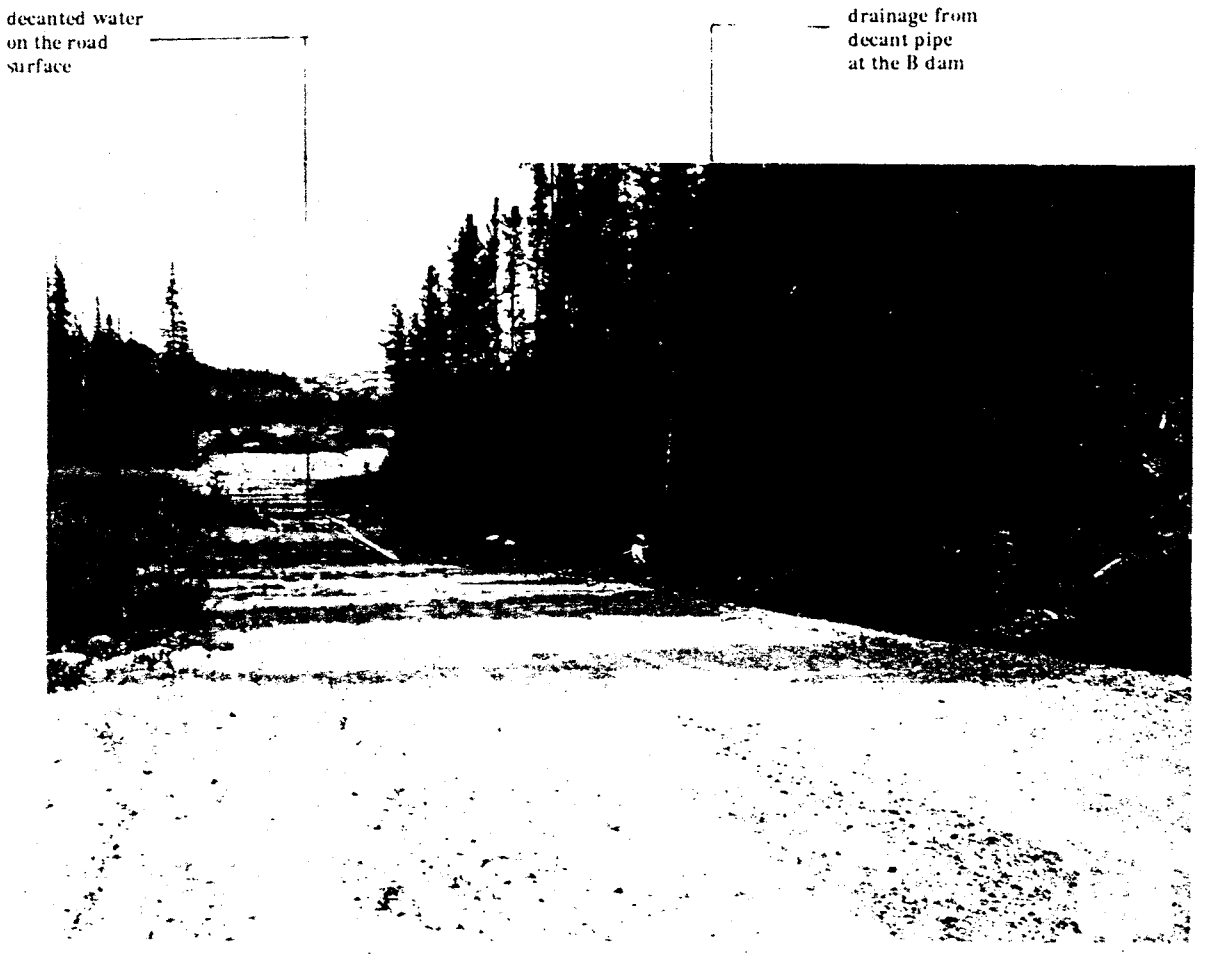
Elev
±2507.0 ft.



Gully erosion downstream of left abutment, caused by seepage out of left abutment above the B Pond level

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #41



View north - access road from the B Dam - water discharged onto the road from the B Pond 29 August to 3rd. September 1991, @ approximately 1.3 to 2 .0 l/sec

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #42



**View south at drainage channel
(Spillway #7) across Old Pond embankment**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #43



View north of the Old Pond
embankment @ downstream side drainage
channel (spillway #7) into
Crater Lake watershed

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #44



View east - upstream of drainage channel (Spillway #6) from the Old Pond into the A Valley impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #45



View N.W. - downstream side of drainage channel (Spillway #6) from the Old Pond into the A Valley impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #46

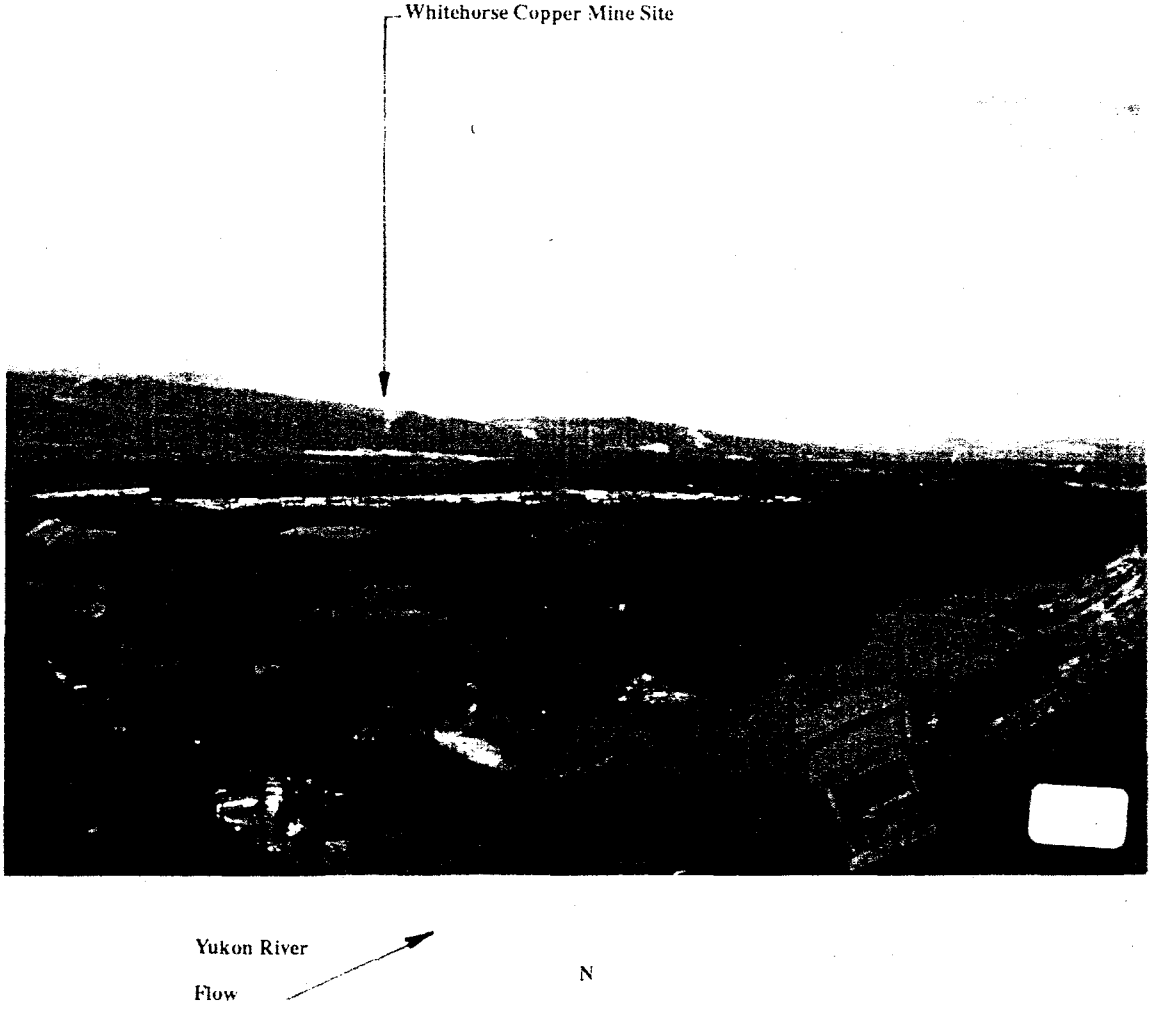


View west through saddle spillway from the A Valley to the B Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #47

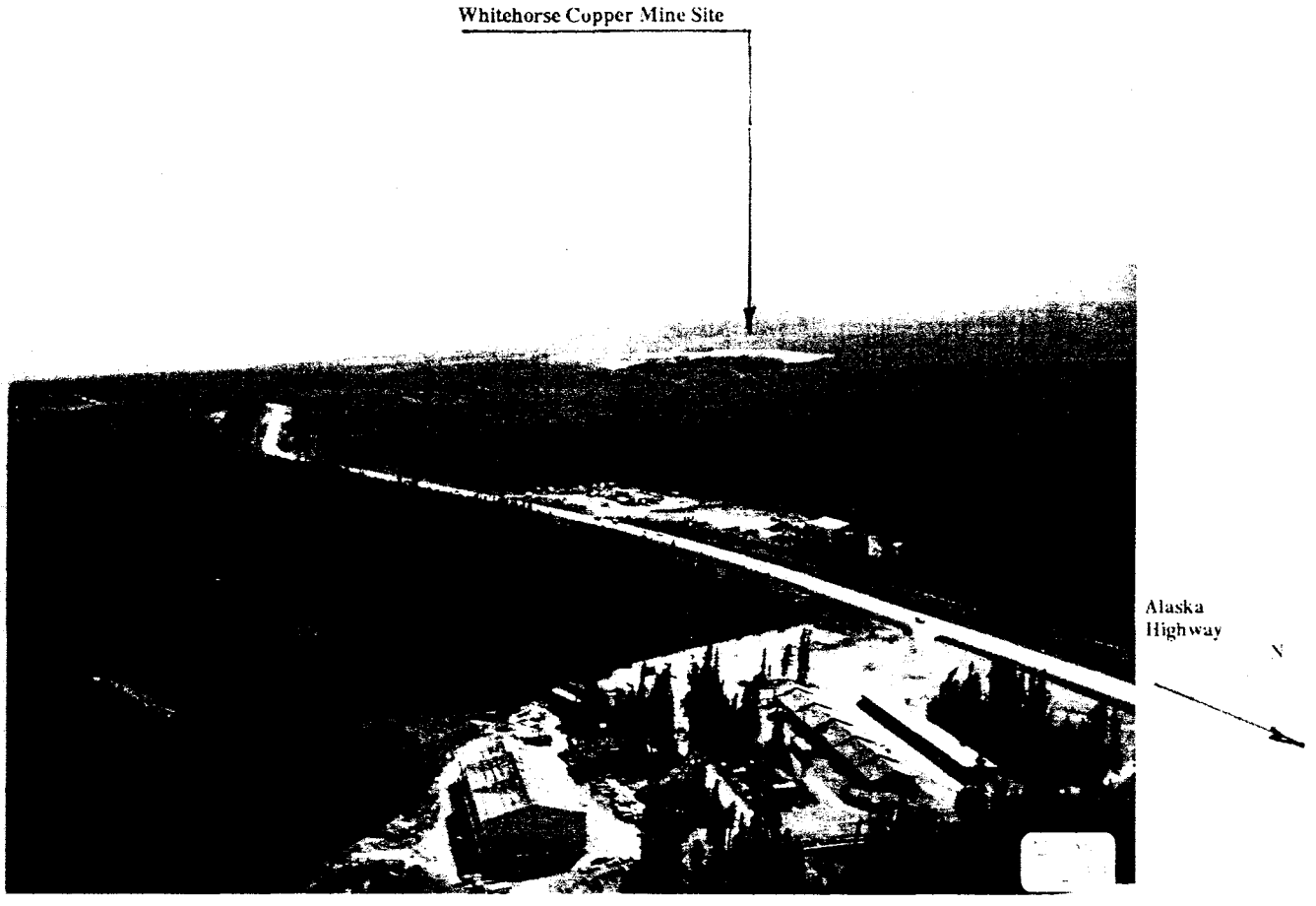
APPENDIX A
SITE PHOTOGRAPHS
Nos. 1 to 47 inclusive



Aerial view N.W from the Yukon River

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

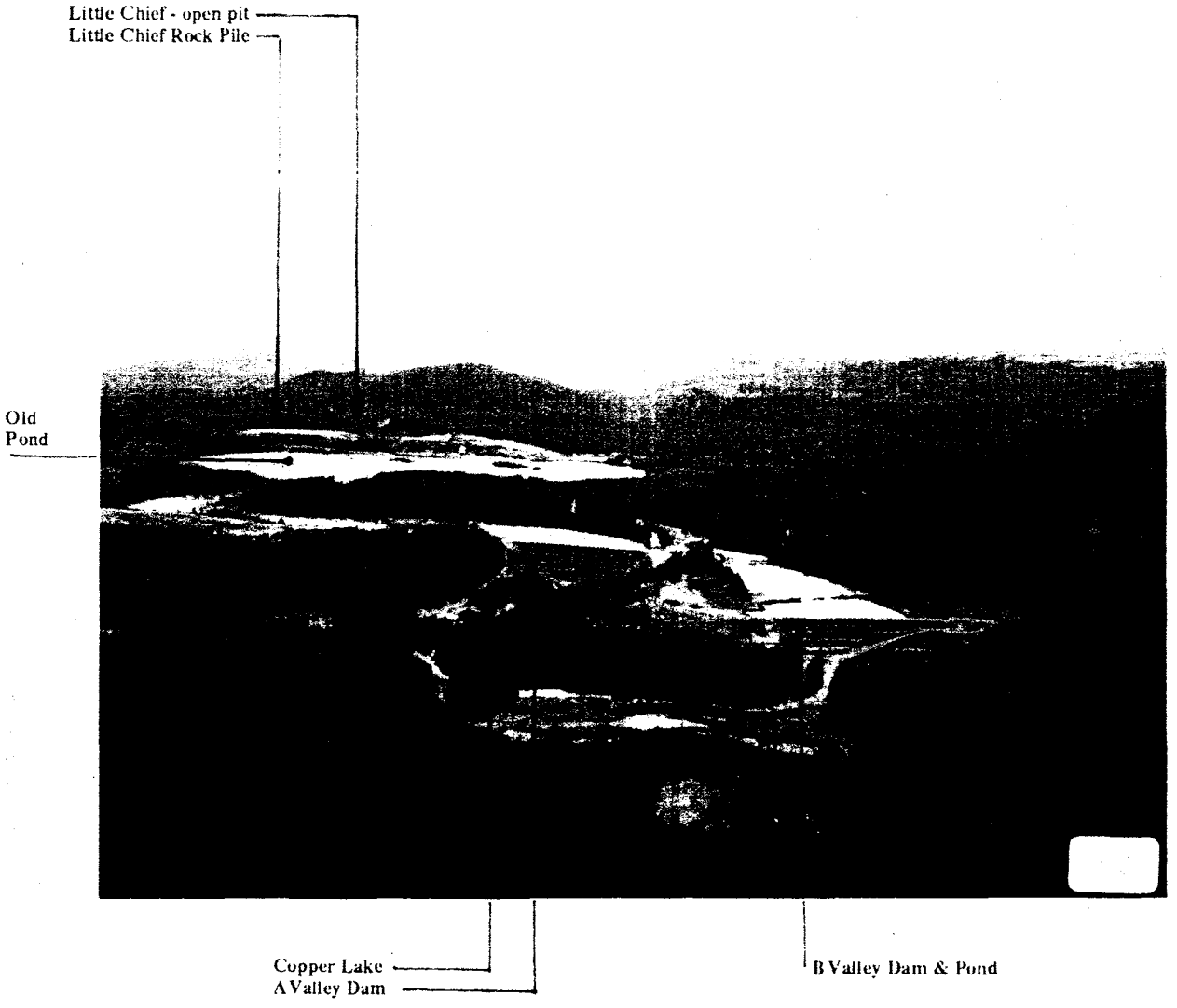
PHOTOGRAPH #1



Aerial view south from the southern outskirts of Whitehorse

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

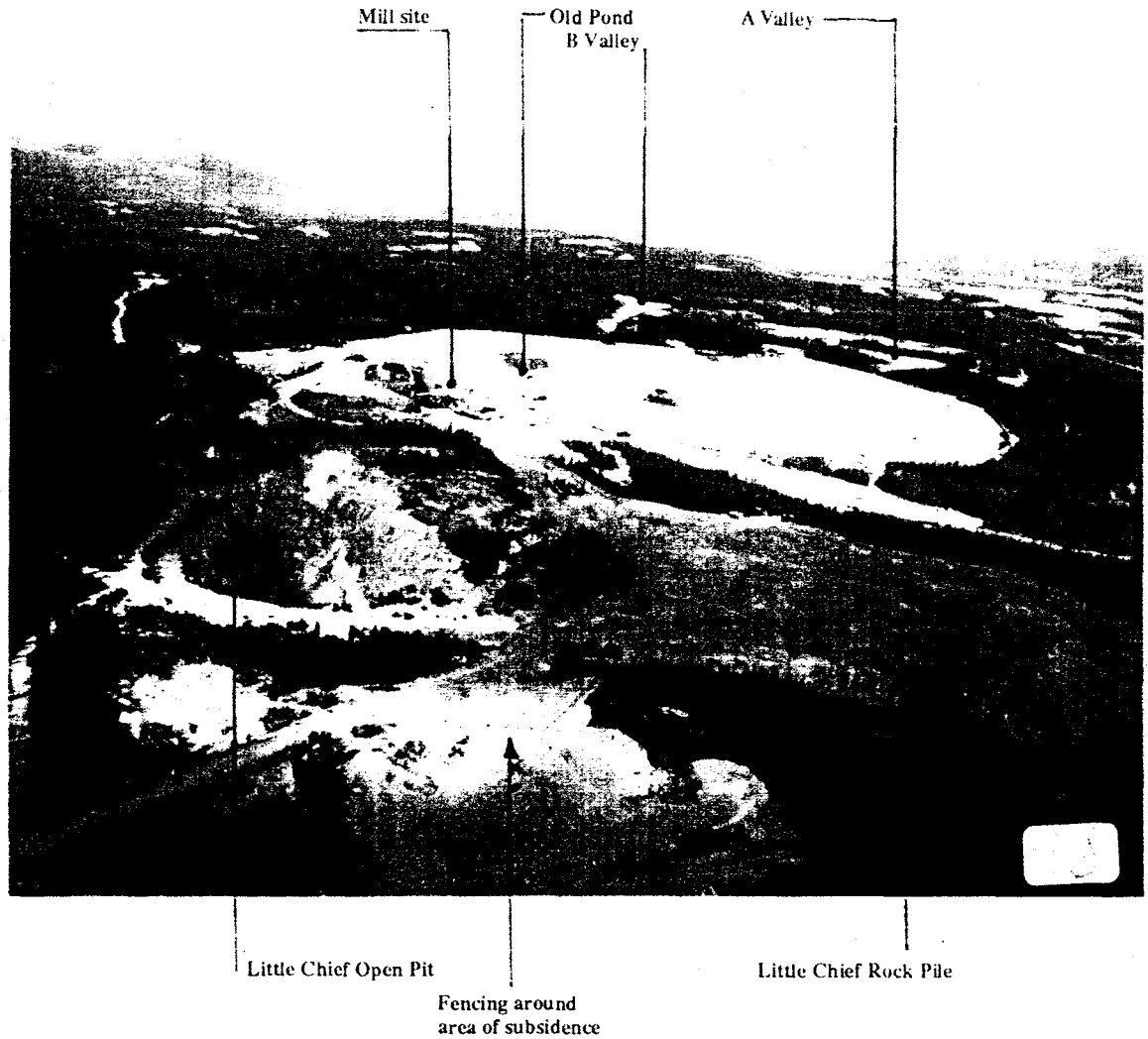
PHOTOGRAPH #2



Aerial view south over Minesite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

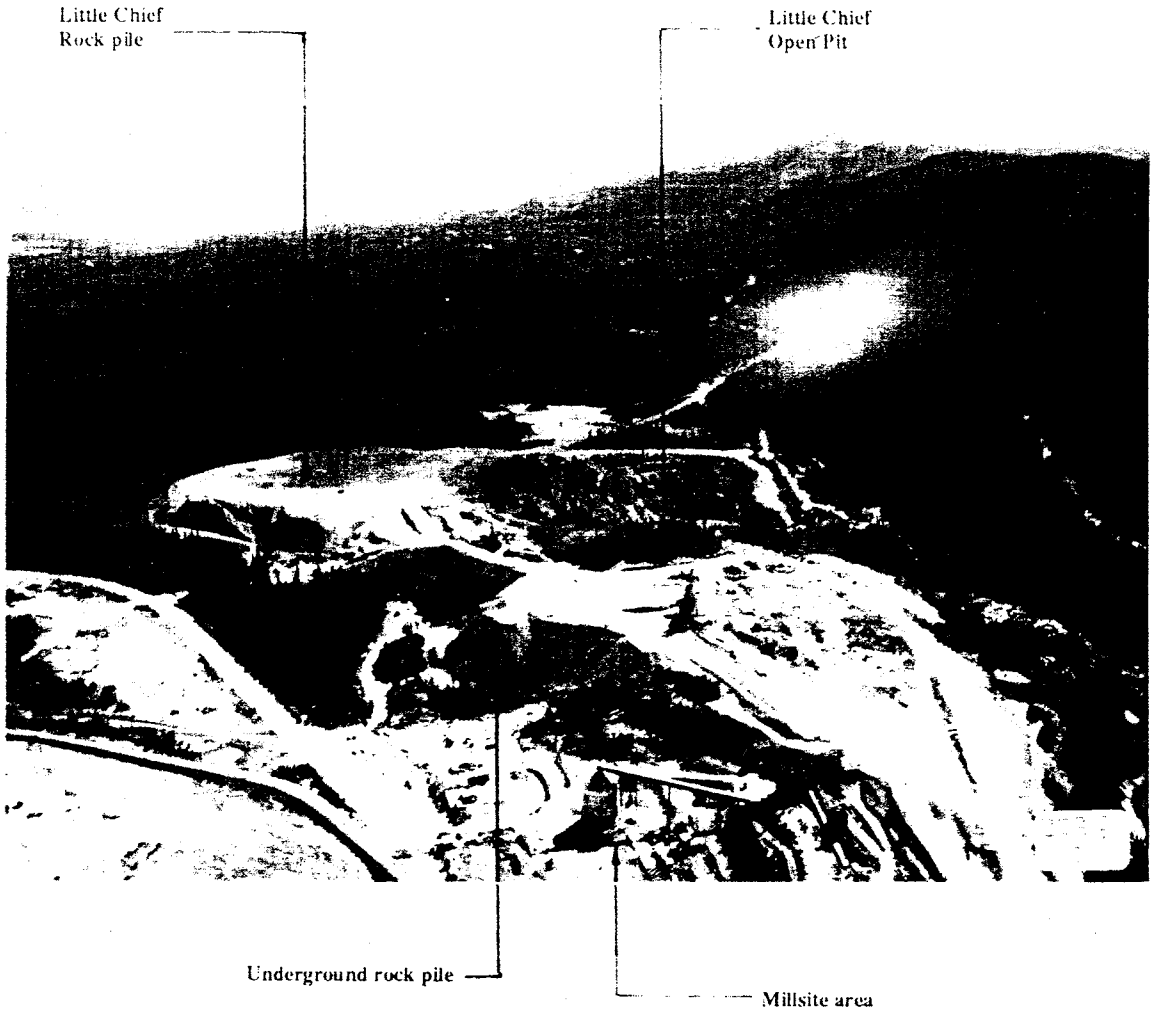
PHOTOGRAPH #3



Aerial view north from the south end of Minesite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

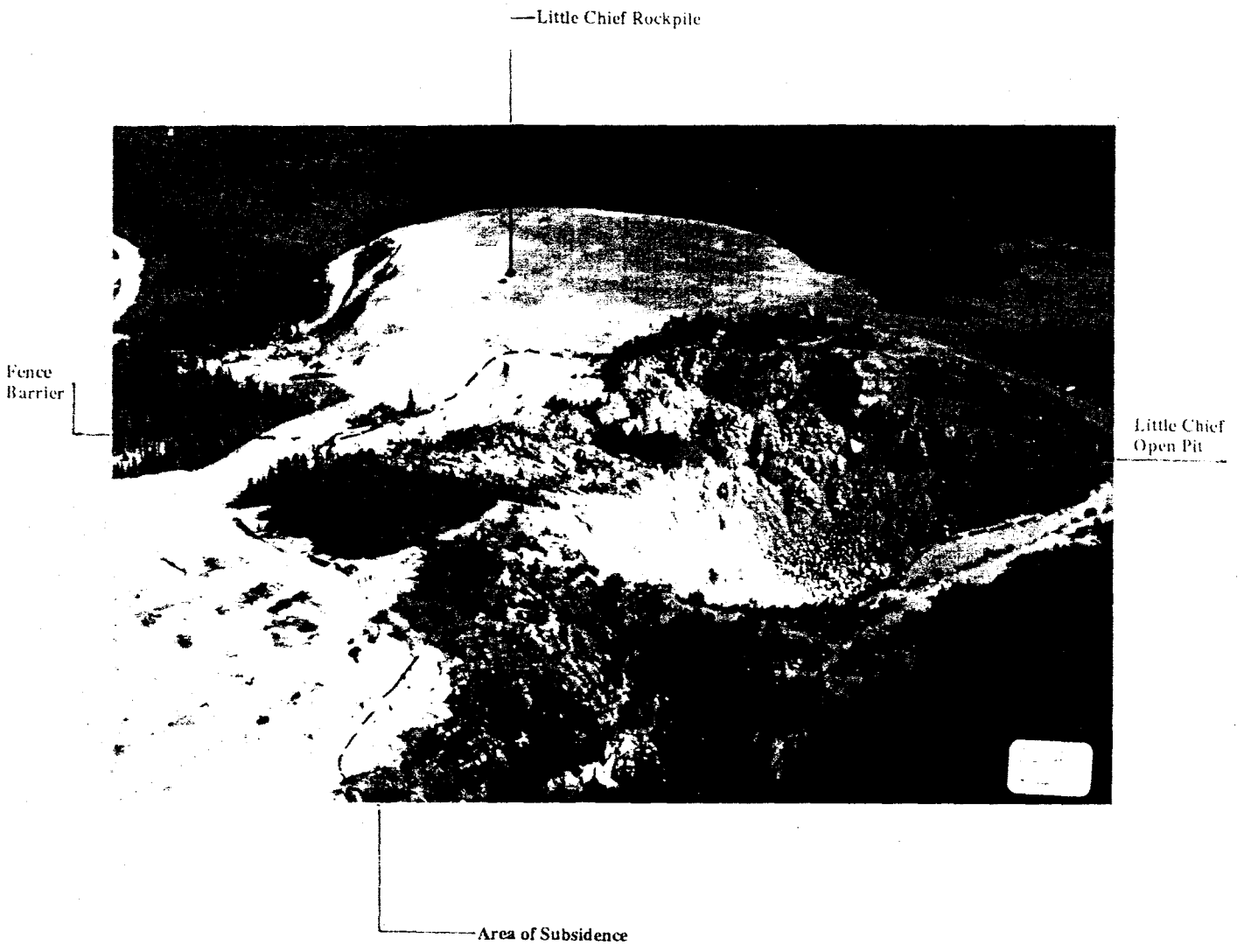
PHOTOGRAPH #4



Aerial view south over the S.W. area of the Minesite

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #5



Aerial view east over the Little Chief Open Pit and Rockpile

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #6



View south showing ground subsidence to the east of Little Chief Open Pit

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #7



View north of south end of
Little Chief Pit - Ground subsidence
on the east side - within fenced off area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #8



**Tension cracks @ ground surface
100 to 200 feet from south and
west walls of Little Chief Pit
(cracks within fenced off area).**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #9



"Sink hole" about 100 feet south of south wall of Little Chief Pit - (hole within fenced off area).

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #10



Security fence on the west side of the road to the Little Chief Rockpile (adjacent to portal yard)

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #11



View East in Portal Yard

Entrance to Portal - covered
with rockfill

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #12



General view of the southern area of the project - Millsite area in the foreground

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #13



View south showing foundation slab to the former warehouse and storage yard

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #14



View N.W. over the Millsite area

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #15



View south regraded (1989)
slope of Little Chief Rockpile

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

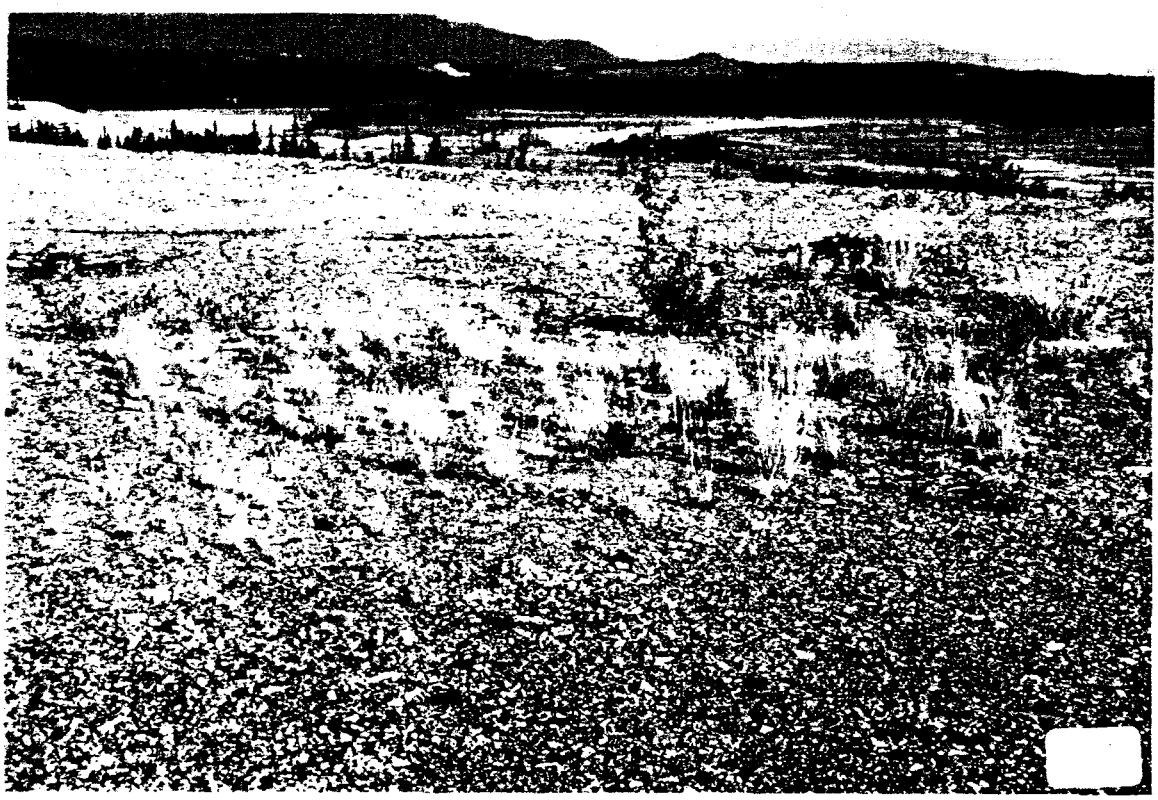
PHOTOGRAPH #16



View south on north slope
of Little Chief Rockpile - steepest portion
of slope approx 1.2 horizontal to 1 vertical

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

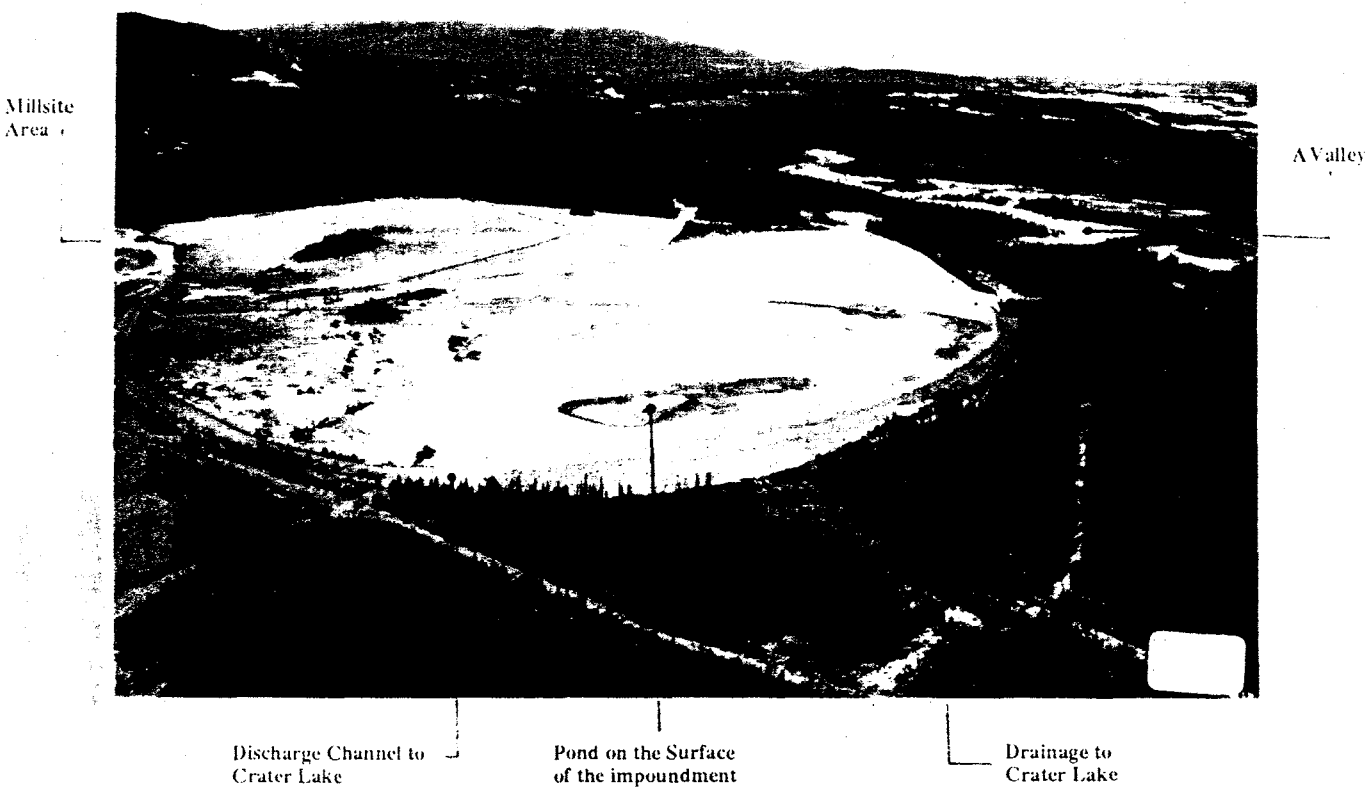
PHOTOGRAPH #17



View north - development of natural vegetation following regrading activities on the Rockpile in 1989

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

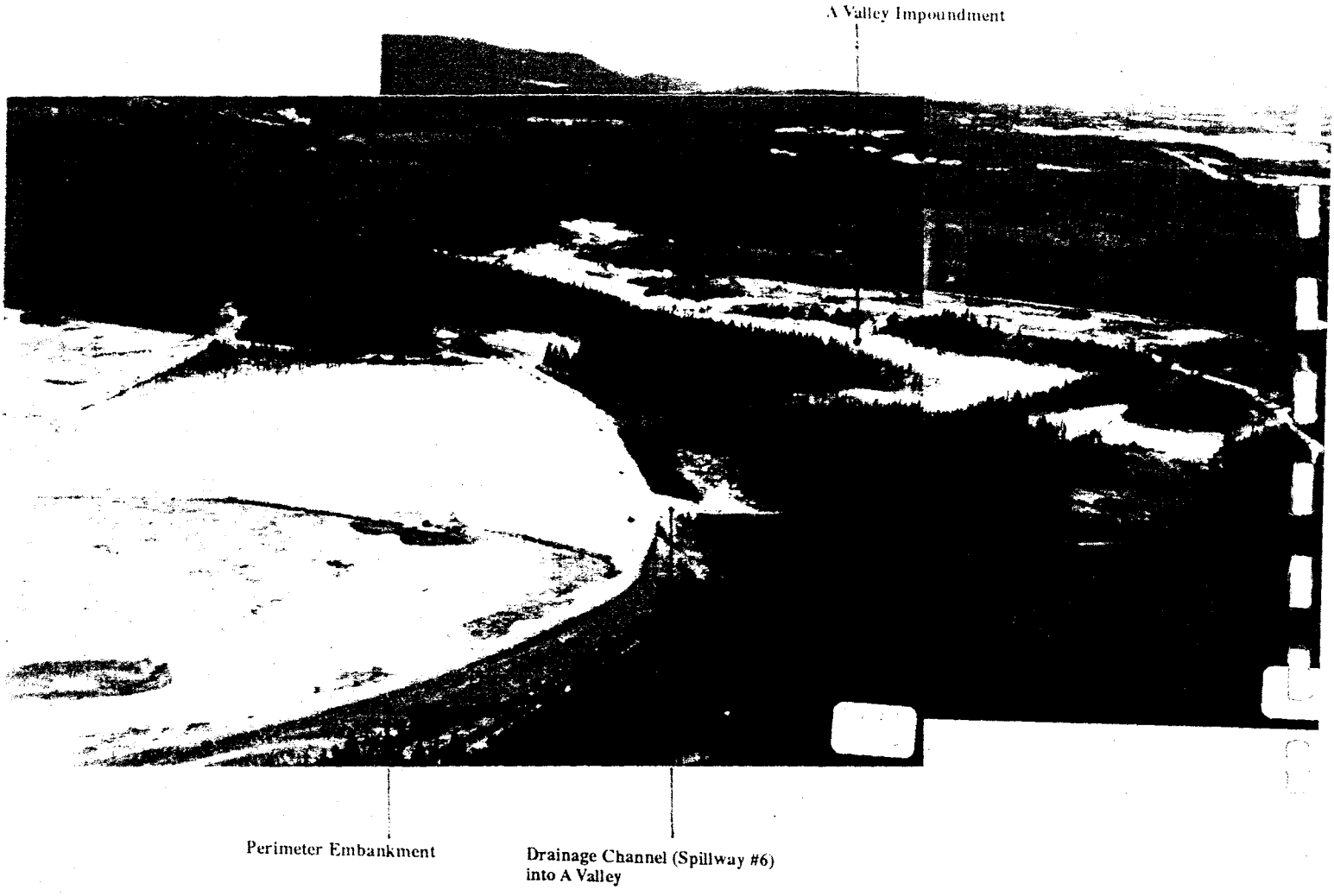
PHOTOGRAPH #18



Aerial view north over the Old Pond tailings impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #19



Aerial view north along east side of the Old Pond impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #20



Aerial view south over the "Old Pond" tailings impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #21



View north on the "downstream" side of the Old Pond perimeter embankment - "S.E. side"

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #22



View N.W. on the downstream slope of "Old Pond" embankment at the head of the A Valley - average slope 1.8 h to 1 vertical Embankment approximately 60 feet high.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #23

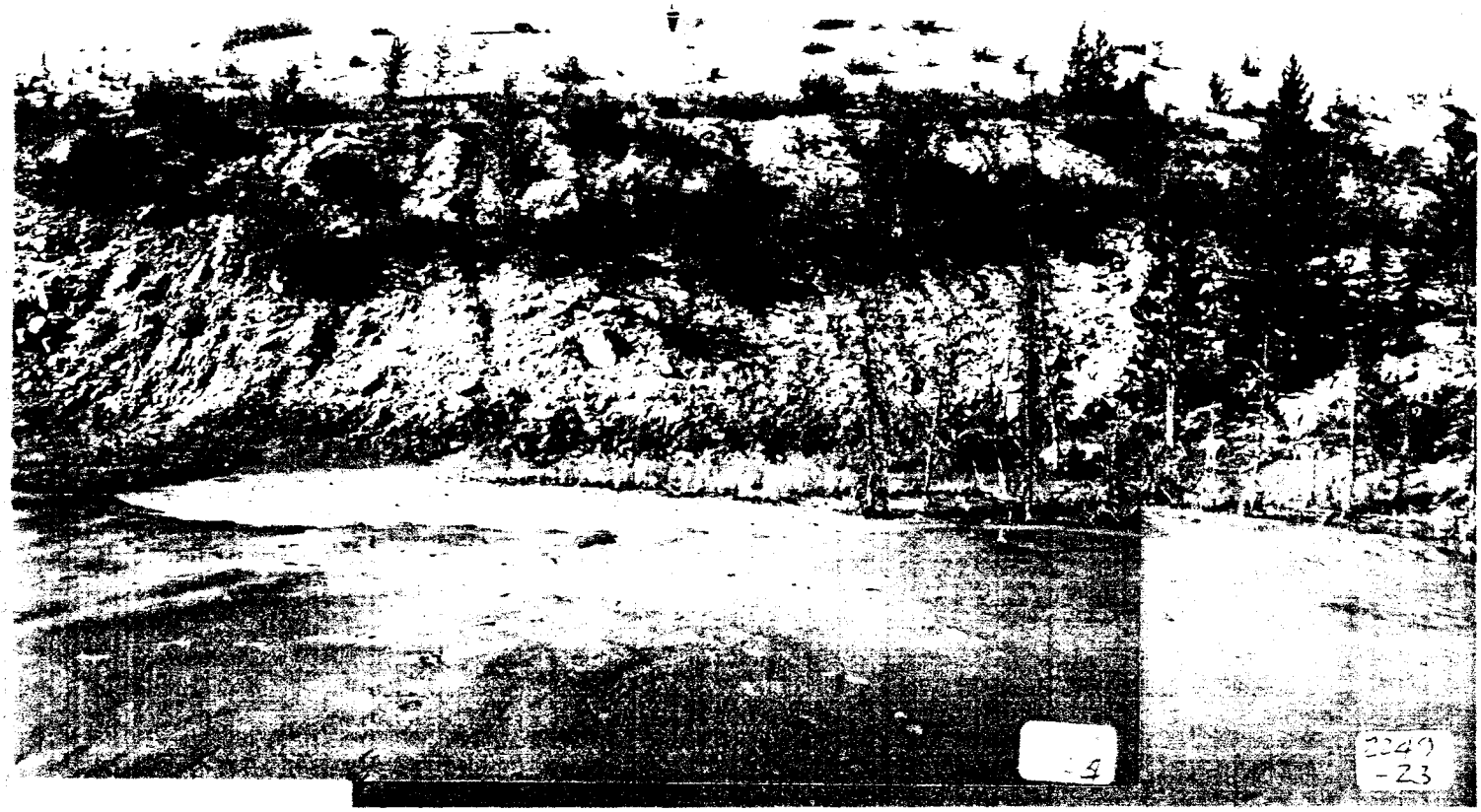


**View east drainage channel
into Crater Lake drainage - remnants
of the decant tower**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #24

Crest ±2578 feet



A Valley Tails @ elevation ±2520 feet

View S.W. on the downstream face of Old Pond embankment at the head of the A Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

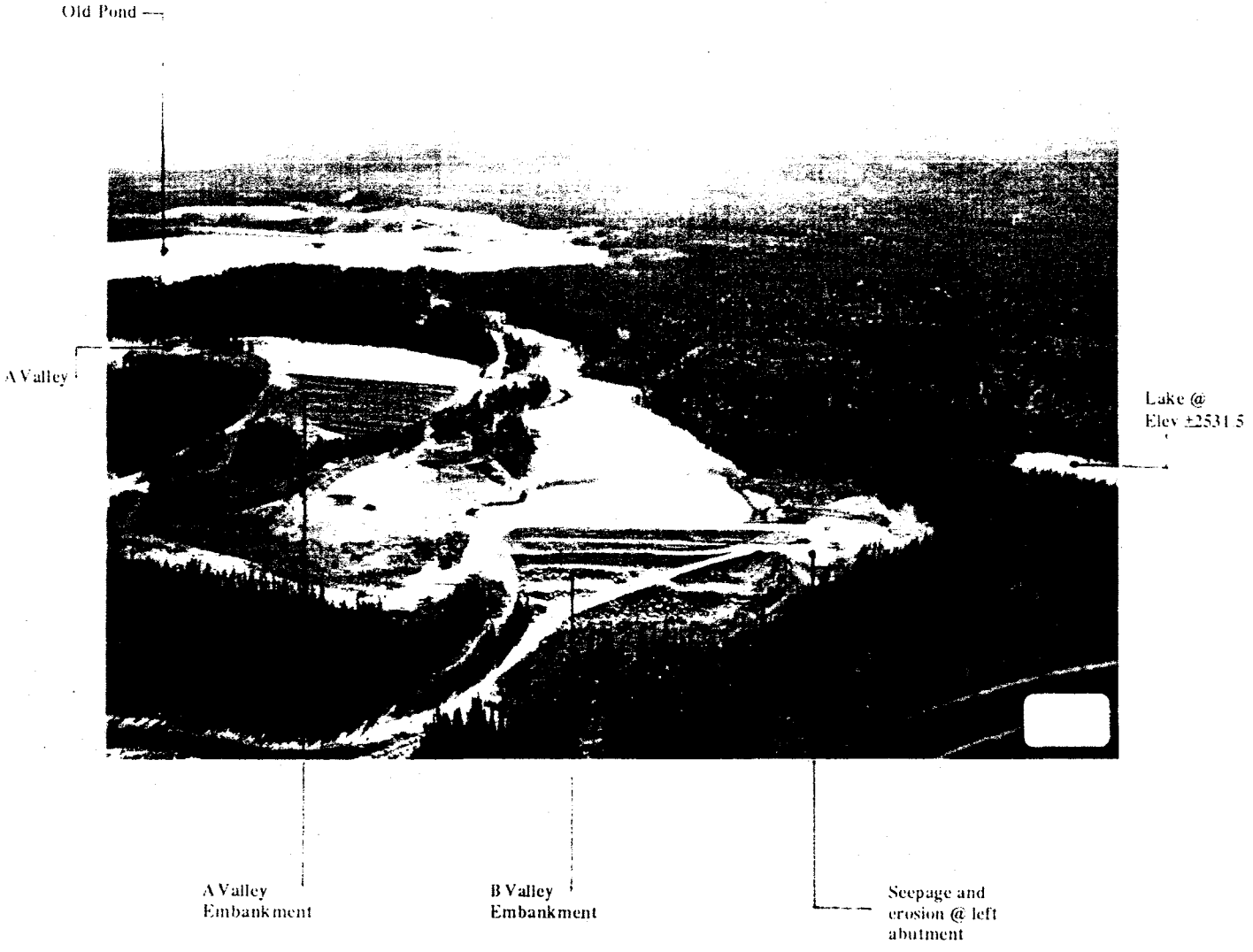
PHOTOGRAPH #25



View north onto pond on the "Old Pond" impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

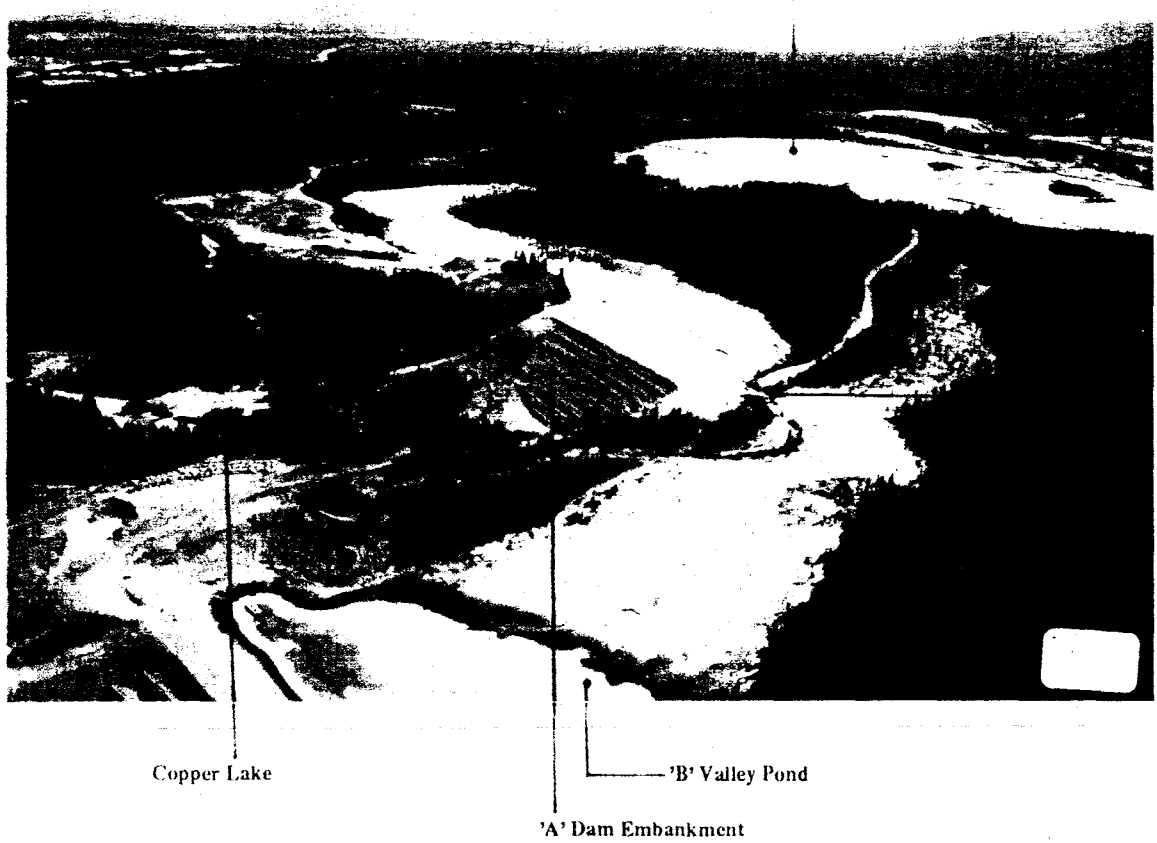
PHOTOGRAPH #26



View south onto A & B Valley impoundments

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

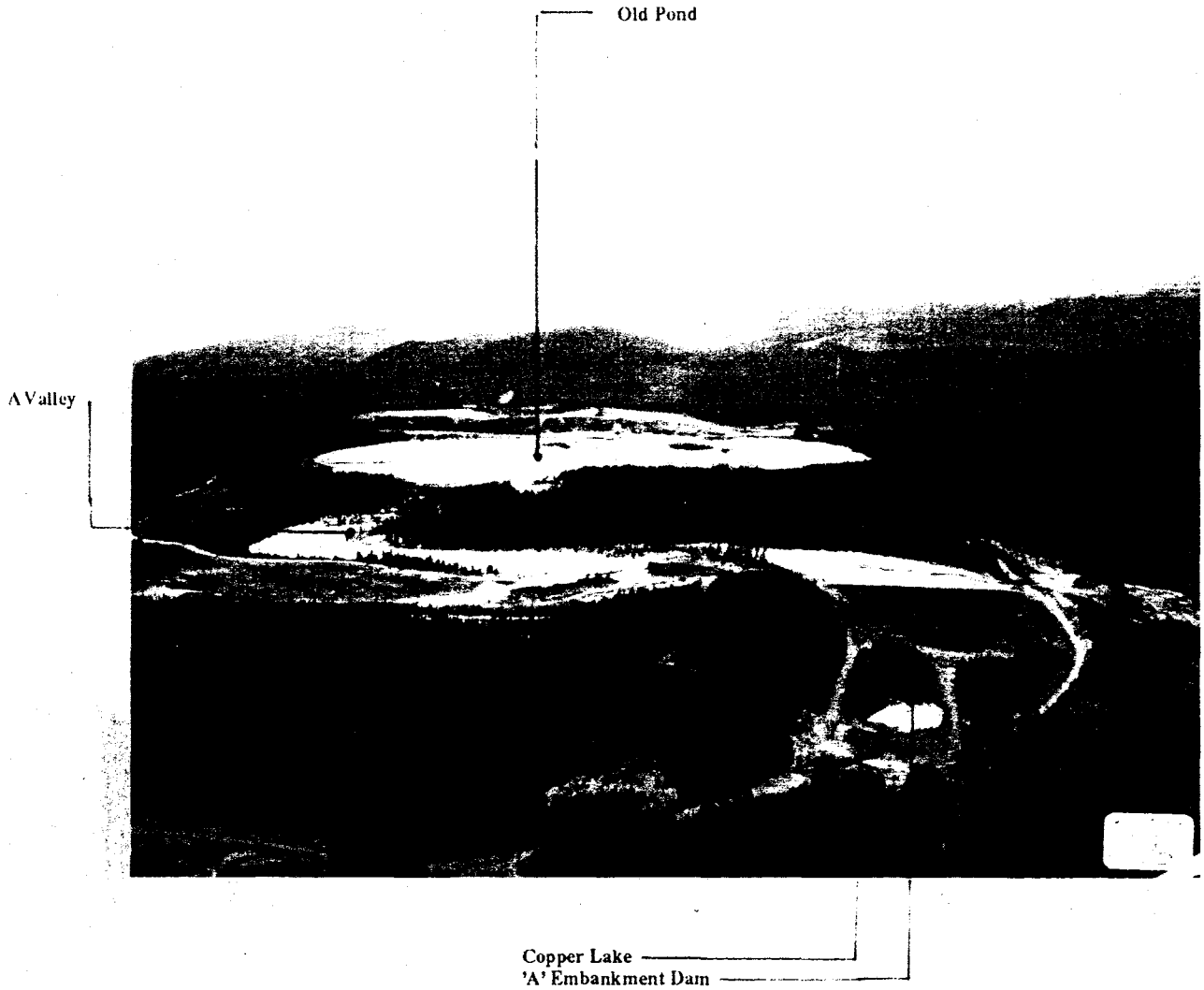
PHOTOGRAPH #27



Aerial view southeast onto the A & B Valleys

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

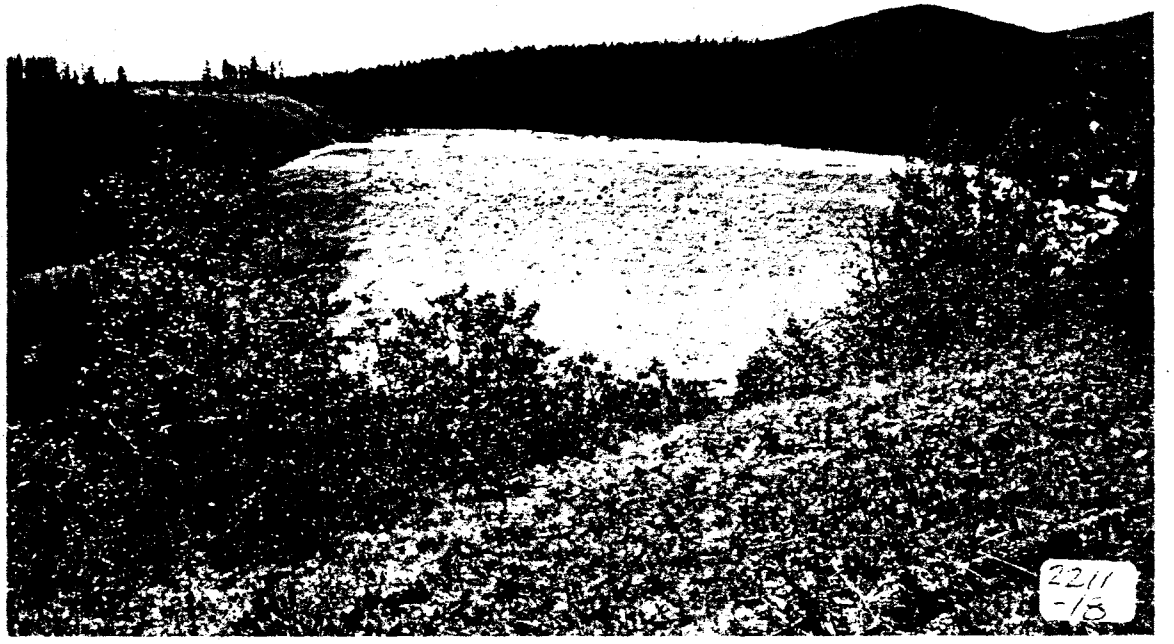
PHOTOGRAPH #28



Aerial view south over the A Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

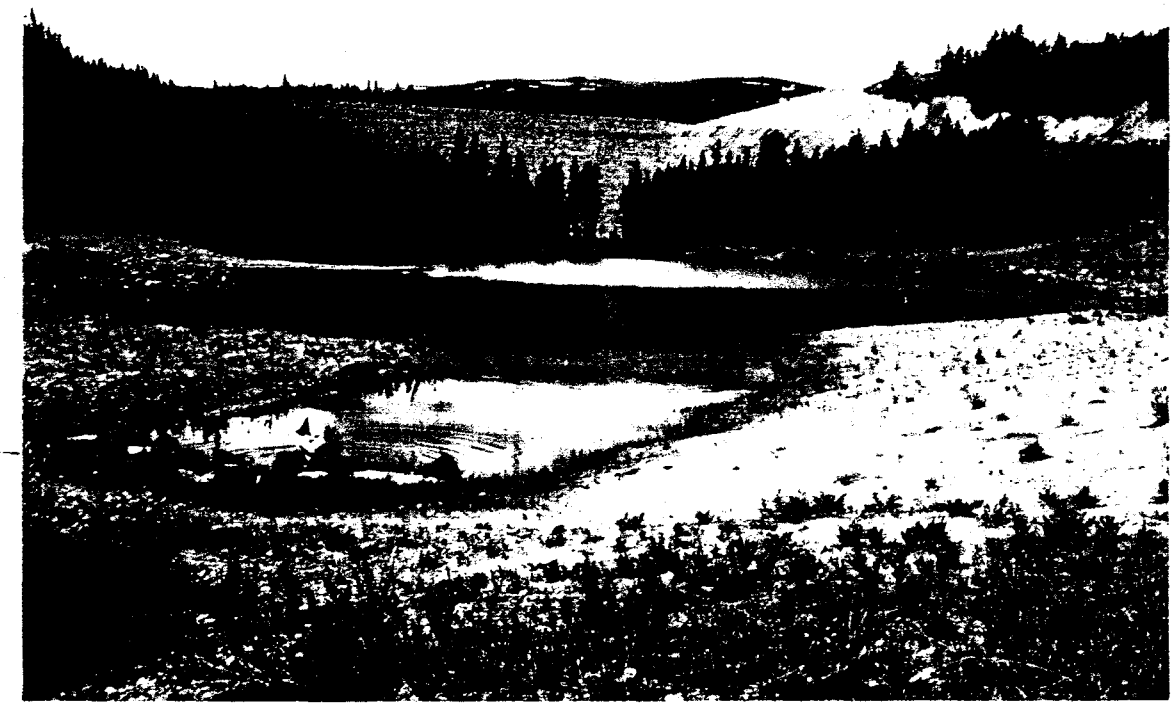
PHOTOGRAPH #29



View southeast on the downstream face of the A embankment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #30



View south - Copper Lake
A embankment in the background

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #31



**View east from left abutment
of A embankment
crest @ elev ±2515.5 feet tailings
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Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

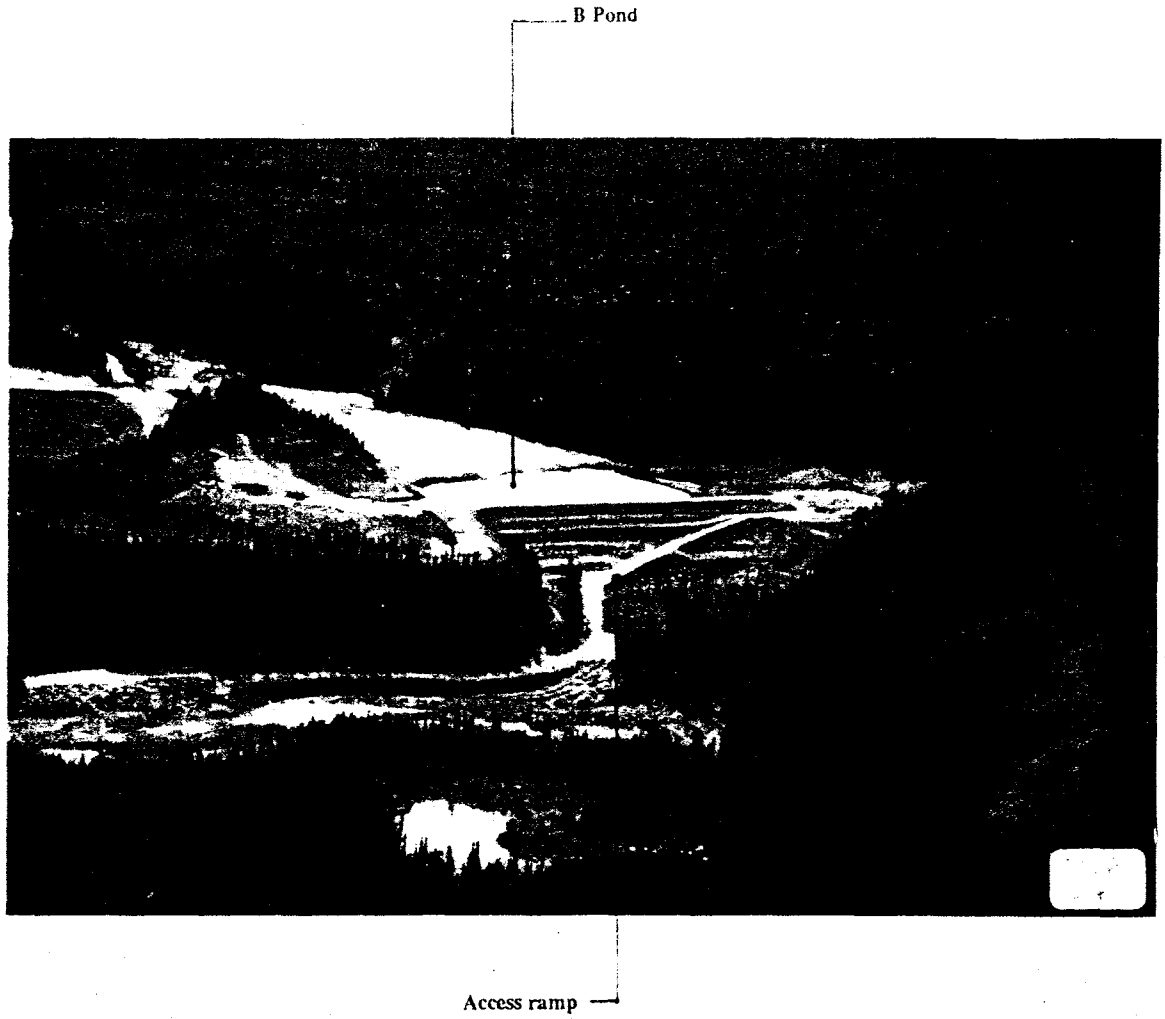
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2 - 15" O/D corrugated galvanized steel pipe decant lines @ downstream toe right abutment of the embankment

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Whitehorse Copper Mine Yukon
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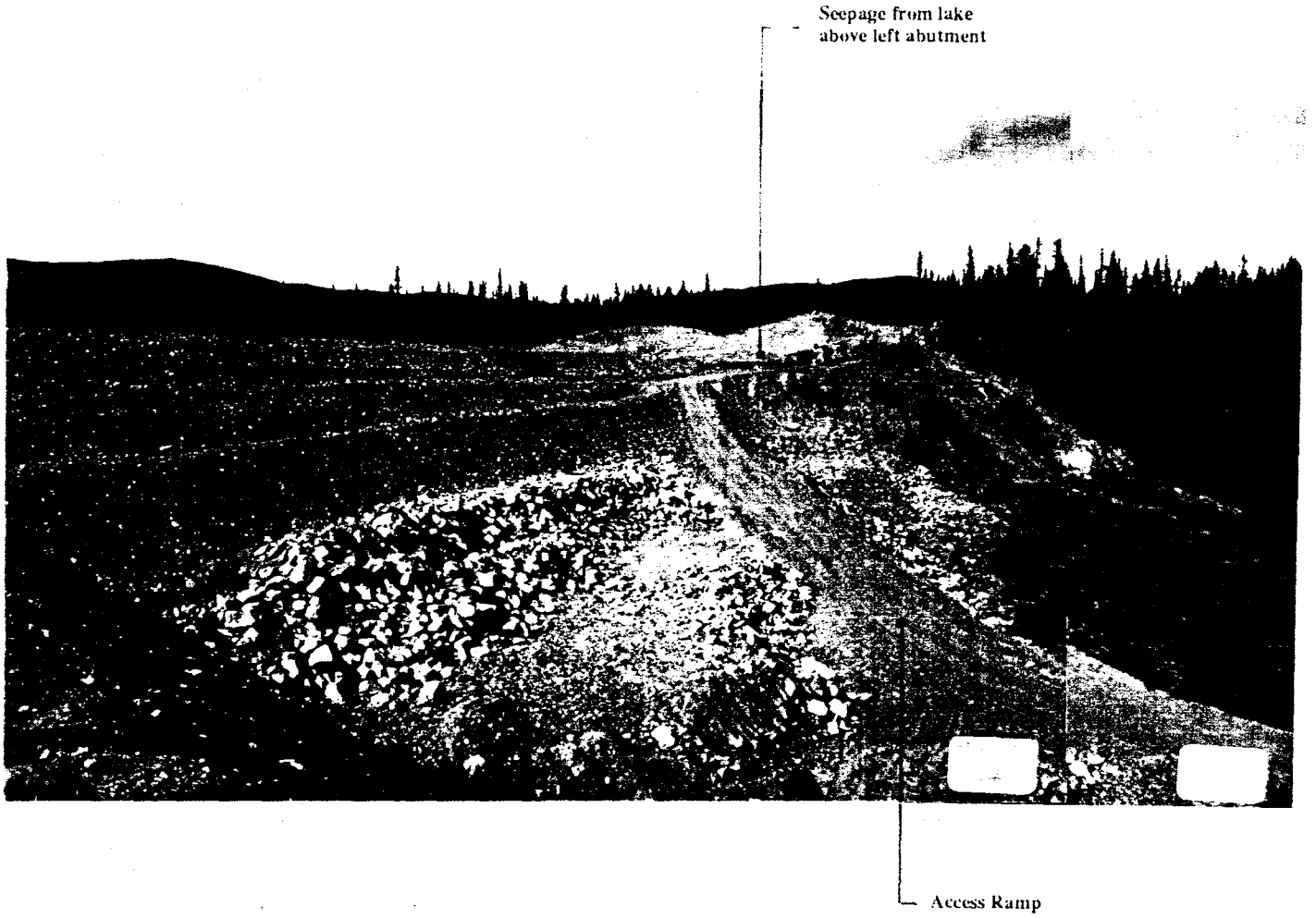
PHOTOGRAPH #33



Aerial view of the B Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #34



View west on downstream slope of 'B' Dam embankment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #35



View west - onto the 'B' Pond.
Crest elevation of B Embankment ±2515.5 feet,
Pond Elev. (July 91) ±2490 feet.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
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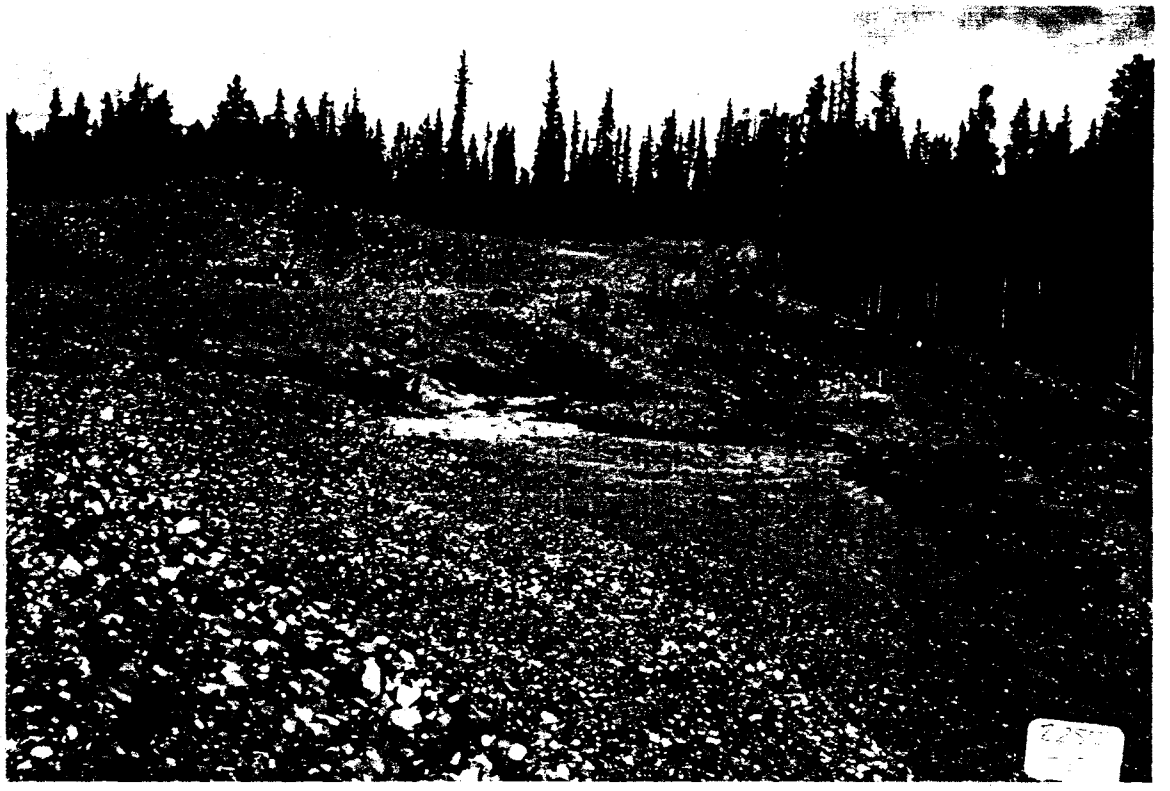
PHOTOGRAPH #36



View North - drainage ditch
on left abutment above B Dam.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #37



View West - downstream of left abutment to the B embankment. Seepage from the left abutment @ about elevation 2512 feet (B Pond elev. 2491.6 feet August 91).

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #38



Shallow Lake about 800 feet west of the left abutment to the B Dam embankment - Lake elevation ±2531.5. Believed to be water source for seepage in the left abutment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #39

B Dam
Embankment



View southwest - gully erosion downstream of embankment in the left (west) abutment.

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
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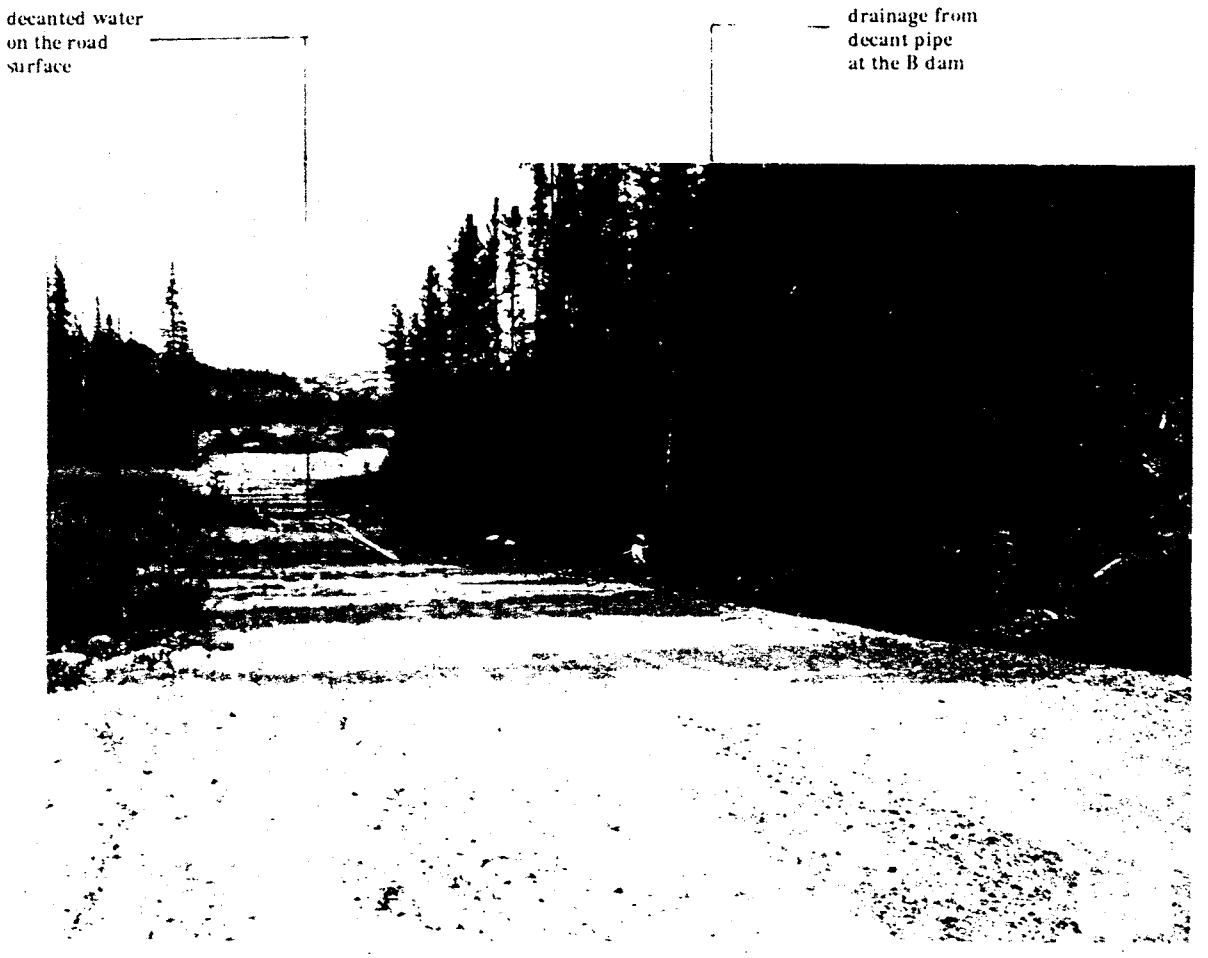
Elev
±2507.0 ft.



Gully erosion downstream of left abutment, caused by seepage out of left abutment above the B Pond level

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #41



View north - access road from the B Dam - water discharged onto the road from the B Pond 29 August to 3rd. September 1991, @ approximately 1.3 to 2 .0 l/sec

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #42



**View south at drainage channel
(Spillway #7) across Old Pond embankment**

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #43



View north of the Old Pond
embankment @ downstream side drainage
channel (spillway #7) into
Crater Lake watershed

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #44



View east - upstream of drainage channel (Spillway #6) from the Old Pond into the A Valley impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #45



View N.W. - downstream side of drainage channel (Spillway #6) from the Old Pond into the A Valley impoundment

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #46



View west through saddle spillway from the A Valley to the B Valley

Hudson Bay Mining & Smelting Co.
Whitehorse Copper Mine Yukon
Photographs by J.W. Gadsby
90-149 August 1991

PHOTOGRAPH #47

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DECOMMISSIONING PLAN

FOR

WHITEHORSE COPPER MINE WHITEHORSE, YUKON TERRITORY

APPENDIX B

LIST OF DRAWINGS

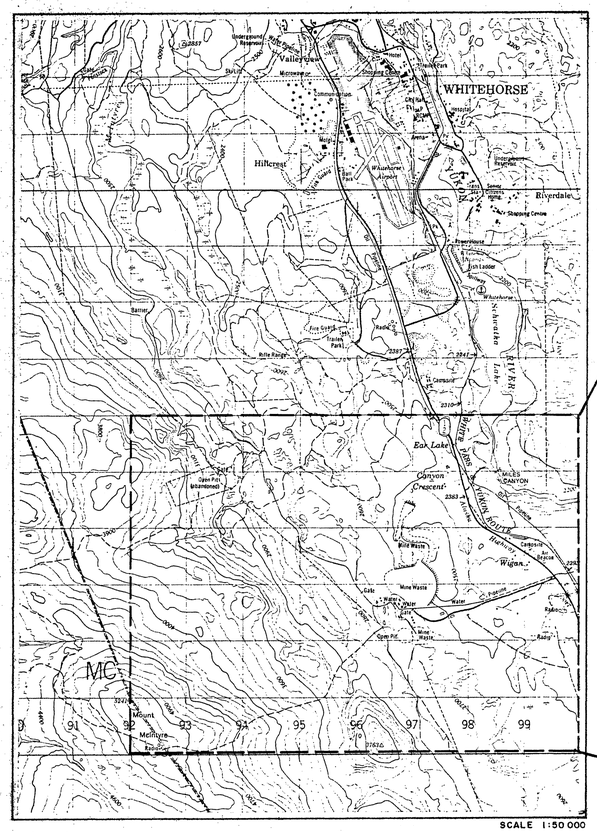
DRAWING NO.	TITLE
1	STUDY AREA
2	SITE PLAN
3	TERRAIN ANALYSIS – PRE–MINING SURFICIAL GEOLOGY (1952)
4	SURFICIAL SOIL DEPOSITS SECTIONS A–A & B–B
5	SURFICIAL SOIL DEPOSITS SECTION C–C
6	PRE–MINING DRAINAGE BOUNDARIES
7	WATER SAMPLING LOCATIONS 1989 & 1991
8	PLAN & SECTIONS – MILL SITE AREA & LITTLE CHIEF OPEN PIT & U/G MINE
9	LITTLE CHIEF ROCK PILE
10	"OLD POND" IMPOUNDMENT AREA
11	OLD POND SECTIONS A–A TO E–E
12	PLAN OF 'A' & 'B' VALLEY IMPOUNDMENTS
13	'A' DAM EMBANKMENT PLAN & SECTION
14	'B' DAM EMBANKMENT PLAN & SECTIONS B–B & C–C
15	'B' DAM EMBANKMENT SECTIONS B–B & C–C
16	'B' DAM EMBANKMENT SECTIONS D–D & E–E
17	POST MINING DRAINAGE BOUNDARIES
18 to 22	DECOMMISSIONING EARTHWORKS

PREPARED FOR:

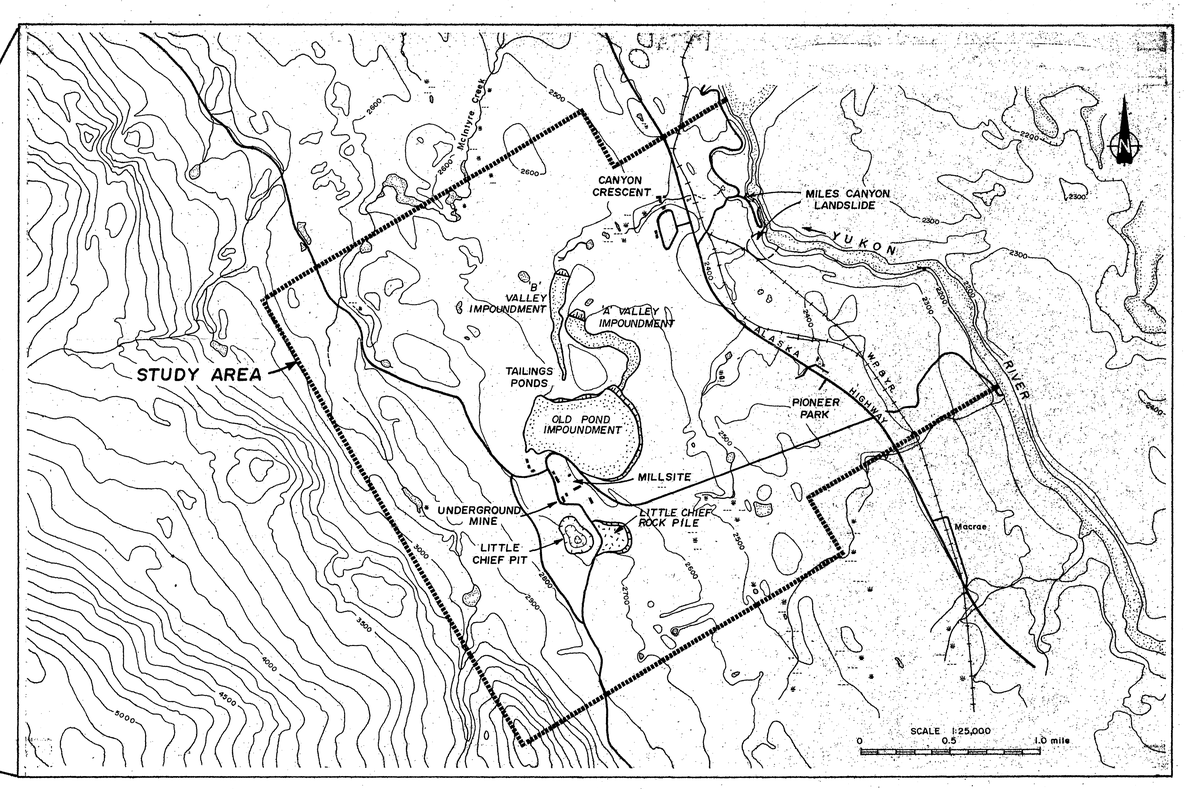
HUDSON BAY MINING & SMELTING CO. LTD.

PREPARED BY:

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN



LOCATION MAP



SITE PLAN

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WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN STUDY AREA	PROJ. NO.: 90-149 APPROVED NO.: 1
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	



LEGEND:

GENERAL FEATURES

- Permanent Stream
- Intermittent Stream
- Open Channel
- Spring or Seepage
- W.L. 2612 — Permanent Lake or Pond
- Fen or Muskeg
- Areas Subject to Seasonal and/or Ephemeral Flooding
- House and Well
- Access Road
- Crest of Slope
- Edge of Clearing

REFERENCE DRAWINGS:

- N.T.S. Topography - Whitehorse (1:25,000) Part of 105 D/11h, 11g & 10e (1968)
- "Valerie - Arctic Chief - Topography" - New Imperial Mines Ltd. Drwg. No. D-11-1 (Undated)
- "Plan of Tailings Area" - Whitehorse Copper Mines (1973)
- Airphotos 24074 (Sept. '67) and 127955 (June '80) - Pacific Survey Corporation.

NOTES:

1) Topographic information has been compiled from various sources. Contours in northern and eastern areas are approximate only.
2) Planimetric detail has been compiled from uncontrolled airphoto enlargements. Various features have been omitted for clarity.
3) Drawing depicts conditions as of June 1987. Various abandonment work has already been completed.

SITE PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

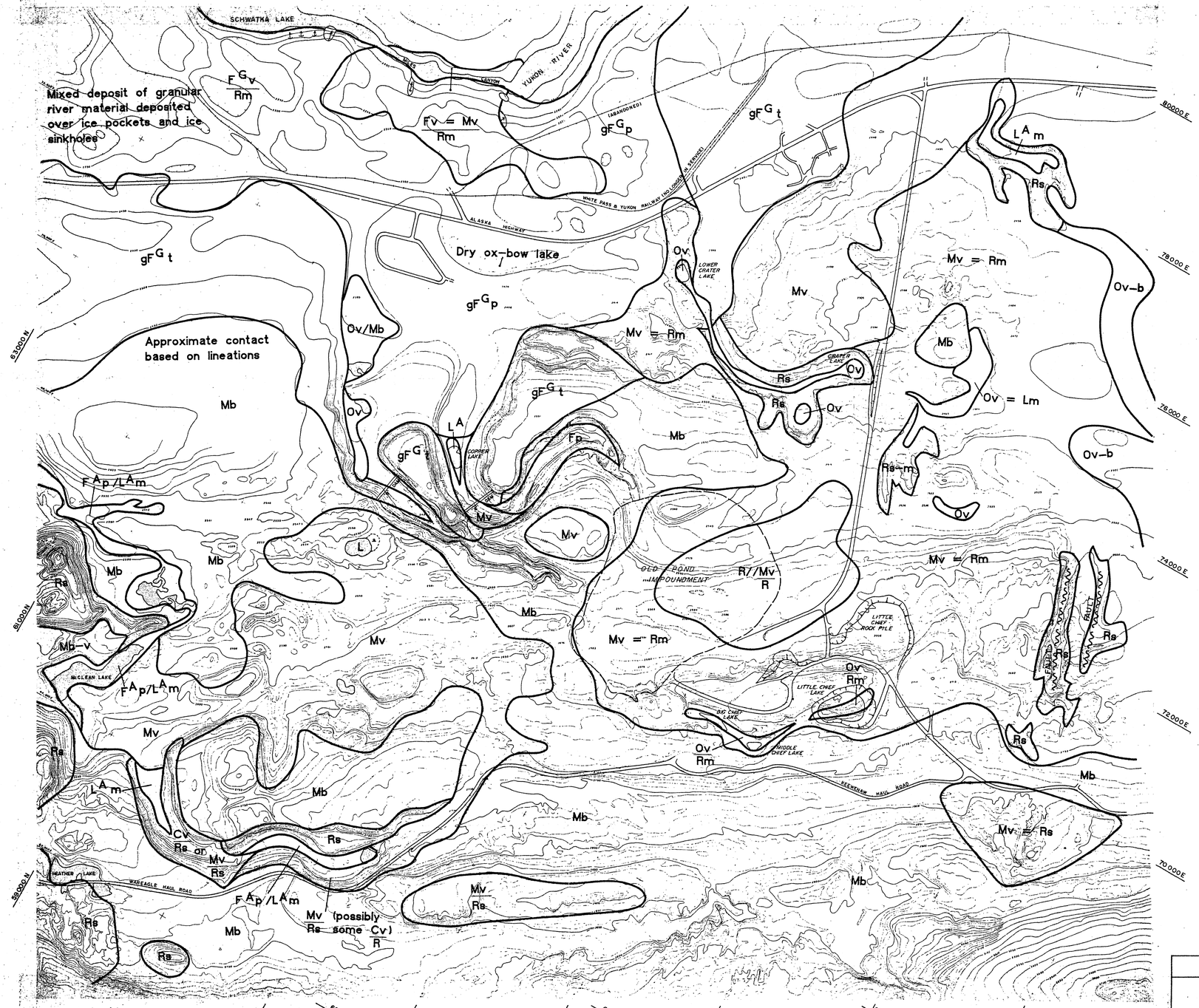
SCALE— 1" = 800'

0 800 1600 2400 3200 4000 FT.

CONTOUR INTERVAL = 10 FT.

HUDSON BAY MINING & SMELTING CO. LTD.	DATE SEPT. 1991
WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN	PROJ. NO. 90-149
SITE PLAN	APPROVED
	NO. 2
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Legend

Fp = F^{G}t Complex unit comprised of fluvial and glaciofluvial sands and gravels, generally poorly sorted, with ice contact features. Channel and point bar features are noted in several locations. Ice collapse or thermokarstic features are found along existing river course. Esker complexes to the north of Miles Canyon were first noted in this area by Wheeler (1962). Some of the irregularity in the terrain can be explained by the presence of quaternary volcanic activity. The Miles Canyon Basalt, exposed in Miles canyon and at Crater lake, mantles topography. Flows are masked by shallow fluvial and glaciofluvial drift in this area. Irregular ridges and depressions could by caused by erosionally resistant lava flows. Lava flows at the south end of Miles canyon are intercalated with sediments of pleistocene age, indicating that Volcanic activity took place during glaciation.

F^{G}p River channel, includes ancient terraces directly adjacent to the existing river course. The river is fast flowing and is eroding, rather than depositing sediments. Slopes adjacent to the river course show signs of instability: slump features, active sloughing of sediments, and side cast movement along roadways were observed. These locations are noted on the map in blue with scarp and arrow symbols.

agF^{G}t Kame terrace; sandy gravelly outwash terrace formed in contact with valley glaciation. Contact with fluvial and glaciofluvial sediments is not always distinct. (Classic exposures in location of "A" and "B" Dams).

skMb Glacial till, rounded cobbles with a silty matrix, high cohesion. Mantles underlying material and is greater than 1 metre thick. Areas at north end of map sheet show distinct flutted lineations, (see symbols).

skMv Glacial till, as above, closely mantles bedrock, and is between 0.1 and 1.0 metres. Generally assumed to overlie bedrock.

saCv Colluvium, (weathered rock that has not been transported by wind, water or ice), probable texture is sandy with angular rock fragments.

Rs Steep rock slopes: generally along water courses, although south of the map sheet these form steep canyons running roughly E-W.

Rm Subdued rock exposures, often covered with thin veneer of glacial till or colluvium. In the area near Crater lake, and along Miles canyon, the rock type is probably a recent basaltic lava. This is furthur discussed in the text.

L^{A}m/Ov Small lakes or wetlands, with shallow organic soils over till or bedrock. Characterized by slow rates of deposition, as they are not fed by any glaciers or rapidly flowing streams.

References:

Wheeler, J.O., *Whitehorse Map-Area, Yukon Territory 105D*. Geological Survey of Canada, Memoir 312, 1961.

Howes, D.E. and E. Kenk, *Terrain Classification system for British Columbia (Revised Edition)*. MOE Manual 10, Recreational Fisheries Branch Ministry of Environment and Surveys and Resource Mapping Branch Ministry of Crown Lands Province of British Columbia, Victoria, B.C., 1988.

NOTE: TERRAIN ANALYSIS INTERPRETED FROM STEREO AIR PHOTOS INDEX MAP 1050/11 ROLL A 13476 FRAMES 196-200; 231-234; AND 243-244-245 FLOWN ON JULY 1952 AT ALTITUDE OF 10,300 FEET (SCALE- 1:20600)

0 800 1600 2400 3200 4000 FEET

SCALE - 1" = 800'

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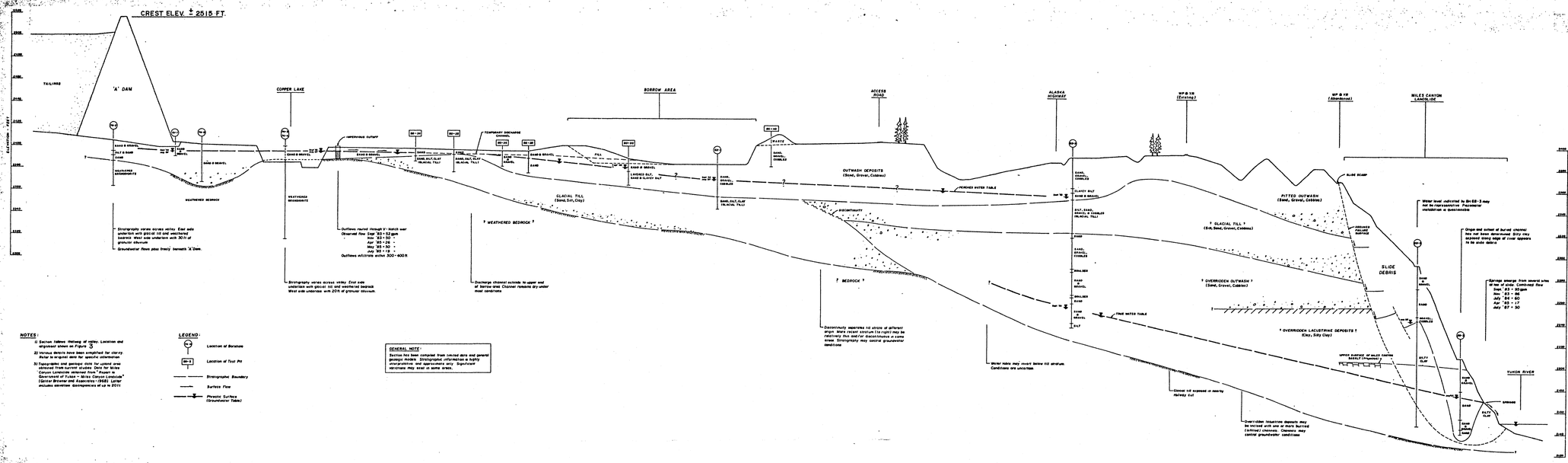
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WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

TERRAIN ANALYSIS
PRE-MINING SURFICIAL GEOLOGY (1952)

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 3

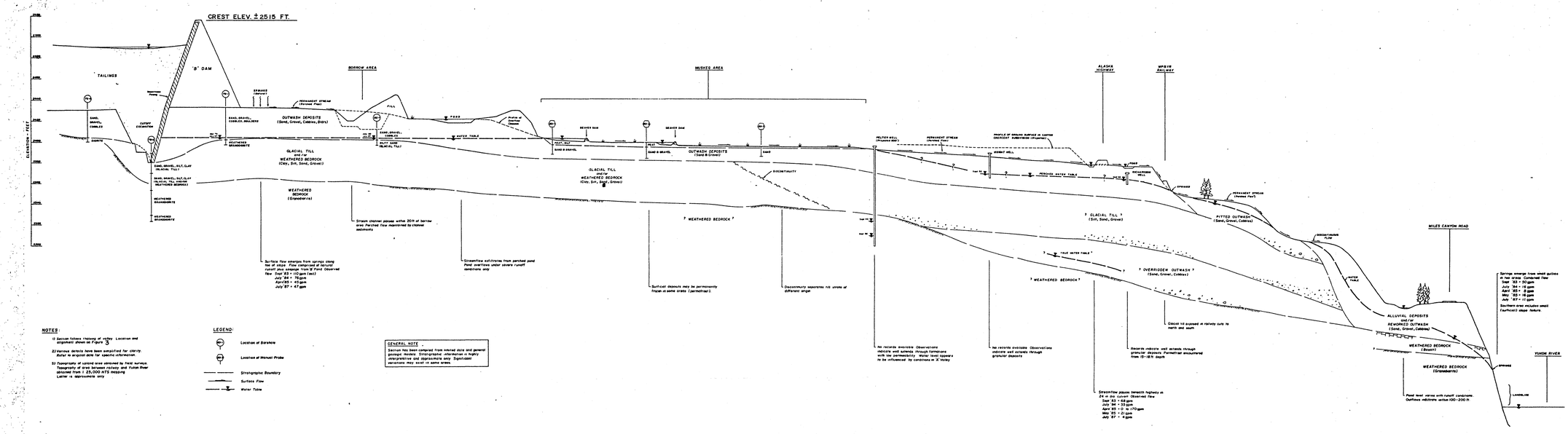


NOTES:
1) Section follows thalweg of valley. Location and alignment shown on Figure 3.
2) Various details have been simplified for clarity. Refer to original data for specific information.
3) Topographic and geologic data for upland area obtained from current studies. Data for Miles Canyon Landslide obtained from "Report to Government of Yukon - Miles Canyon Landslide" (Golder Brawner and Associates - 1968). Latter includes elevation discrepancies of up to 20 ft.

LEGEND:
- Location of Borehole
- Location of Test Pit
- Stratigraphic Boundary
- Surface Flow
- Phreatic Surface (Groundwater Table)

GENERAL NOTE:
Section has been compiled from limited data and general geologic models. Stratigraphic information is highly interpretative and approximate only. Significant variations may exist in some areas.

SECTION A-A
LOWER 'A' VALLEY
(DISTORTED SCALE)



NOTES:
1) Section follows thalweg of valley. Location and alignment shown on Figure 3.
2) Various details have been simplified for clarity. Refer to original data for specific information.
3) Topography of upland area obtained by field surveys. Topography of area between railway and Yukon River obtained from 1:25,000 NTS mapping. Latter is approximate only.

LEGEND:
- Location of Borehole
- Location of Monoil Probe
- Stratigraphic Boundary
- Surface Flow
- Water Table

GENERAL NOTE:
Section has been compiled from limited data and general geologic models. Stratigraphic information is highly interpretative and approximate only. Significant variations may exist in some areas.

SECTION B-B
LOWER 'B' VALLEY
(DISTORTED SCALE)

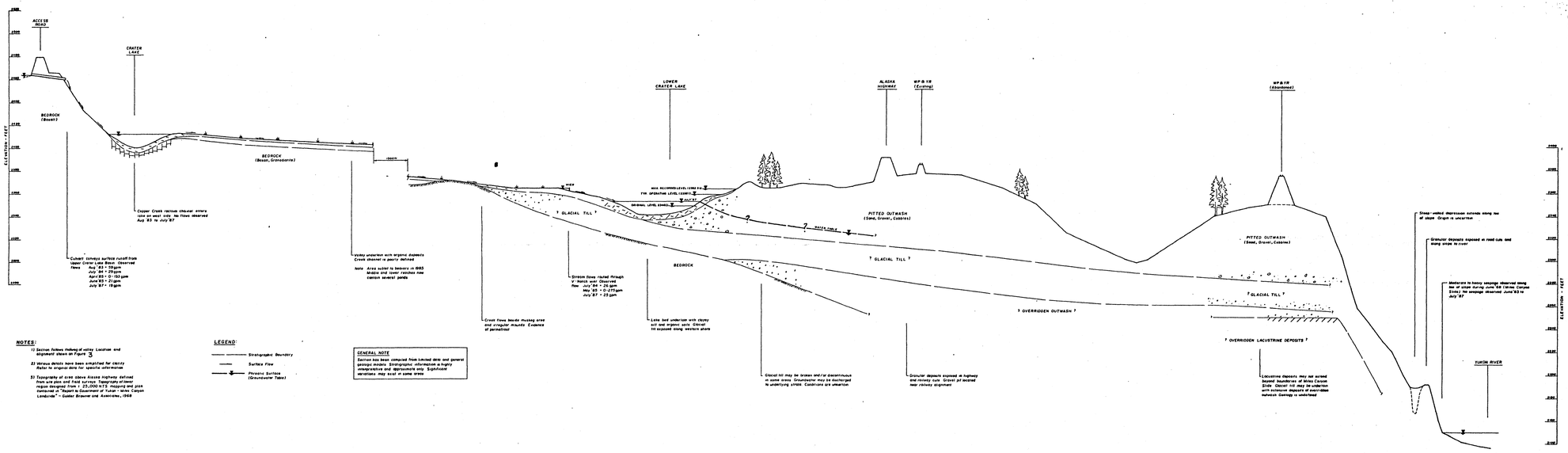
SECTIONS ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

Vertical Scale: 0 50 100 150 200 FEET

Horizontal Scale: 0 250 500 750 1000 FEET

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SURFICIAL SOIL DEPOSITS SECTIONS A-A & B-B	APPROVED
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NOTES:

1) Section follows thalweg of valley Location and alignment shown on Figure 3.

2) Various details have been simplified for clarity Refer to engineering data for specific information

3) Topography of area above Alaska Highway defined from aire photo and field surveys Topography of lower region digitized from 1 : 25,000 NTS mapping and plan contained in "Report to Government of Yukon - Miles Canyon Landslide" - Golder Brawner and Associates, 1968

LEGEND:

Stratigraphic Boundary

Surface Flow

Phreatic Surface (Groundwater Table)

GENERAL NOTE

Section has been compiled from limited data and general geologic models Stratigraphic information is highly unappropriative and approximate only Significant variations may exist in some areas

SECTION C-C
LOWER 'C' VALLEY
(DISTORTED SCALE)

Vertical Scale 0 50 100 150 200 FEET

Horizontal Scale 0 250 500 750 1000 FEET

SECTION ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

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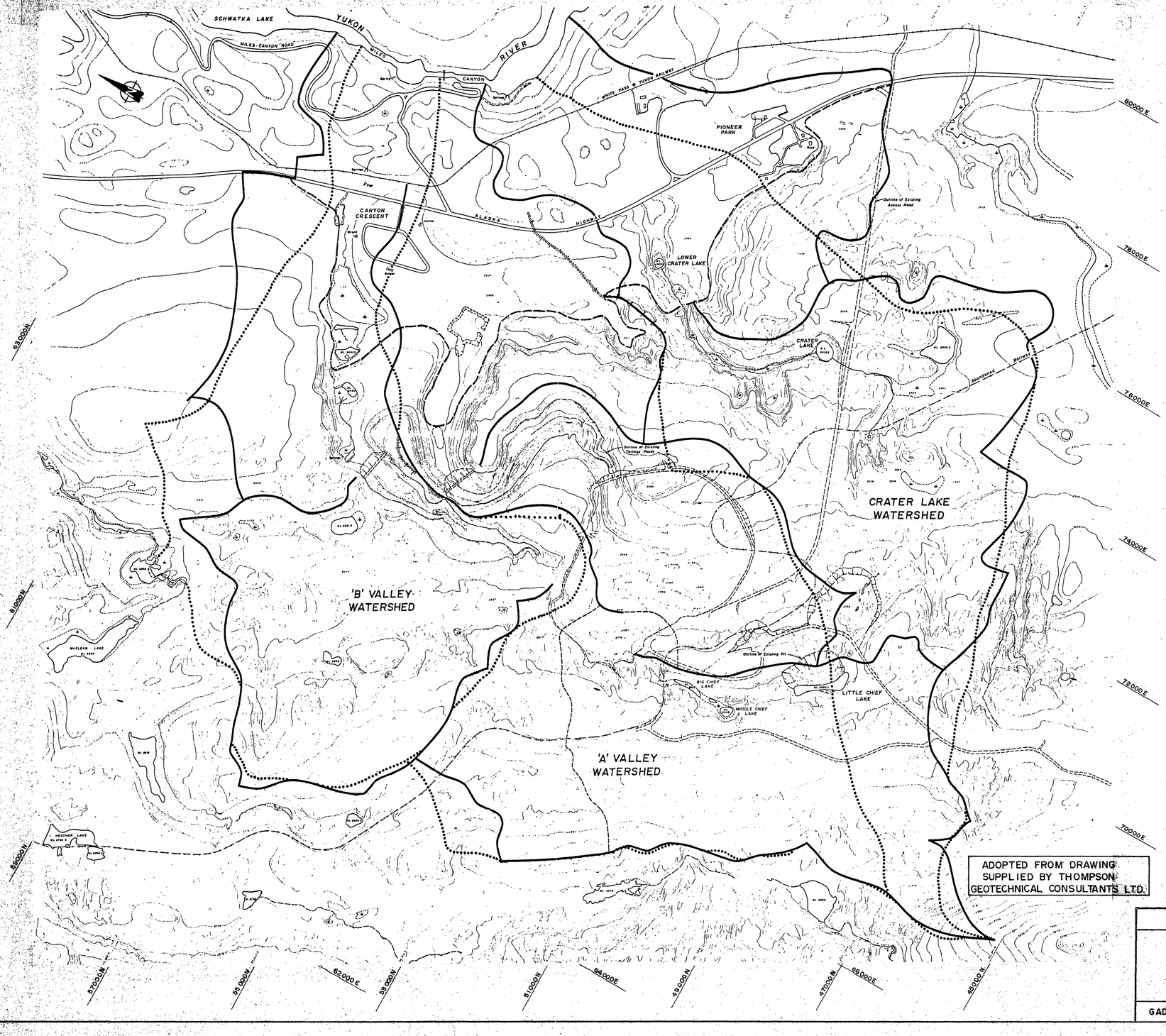
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WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

SURFICIAL SOIL DEPOSITS
SECTION C-C

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: OCT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 5



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LEGEND:

GENERAL FEATURES

- Permanent Stream
- Intermittent Stream
- Open Channel
- Spring or Seepage
- Permanent Lake or Pond
- Fen or Muskeg
- Areas Subject to Seasonal and/or Ephemeral Flooding
- House and Well
- Access Road
- Crest of Slope

DRAINAGE BOUNDARIES

- Major Surface Divide
- Lesser Surface Divide
- Major Groundwater Divide
- Lesser Groundwater Divide
- Partial (Leaky) Groundwater Divide (Arrows indicate direction of minor flow)
- Reference Boundary

REFERENCE DRAWINGS:

- N.T.S. Topography - Whitehorse (1:25,000) Part of 105D/11h, 11g & 10e (1968)
- "Valerie - Arctic Chief - Topography" - New Imperial Mines Ltd. Drwg. No. D-11-1 (Undated)
- "Plan of Tailings Area" - Whitehorse Copper Mines (1973)
- Airphotos 24074 (Sept.'67) and 127955 (June'80) - Pacific Survey Corporation

NOTES:

1) Topographic and planimetric information is approximate only.

2) Surface divides have been inferred from topographic data and field observations. Some boundaries are approximate only. Local variations may exist on account of limited data and/or complex conditions.

3) Groundwater divides have been inferred from groundwater models. All boundaries are approximate only. Significant variations may exist on account of complex geological conditions.

SCALE - 1" = 800'

0 800 1600 2400 3200 4000 FT.

CONTOUR INTERVAL = 10 FT.

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PRE-MINING DRAINAGE BOUNDARIES	APPROVED
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LEGEND:

TGC-1989 △	THOMPSON GEOTECHNICAL CONSULTANTS LTD. WATER SAMPLING LOCATIONS AUG. 1989
91-1 to 21 ▲	WATER SAMPLING LOCATIONS AUG. & SEPT. 1991
91-22 to 24 □	WATER SAMPLING LOCATIONS OCT. 1991
92-5A	SAMPLE TAKEN ON 19 MAY 1992

NOTES:

1) *Topographic information has been compiled from various sources. Contours in northern and eastern areas are approximate only.*

2) *Planimetric detail has been compiled from uncontrolled airphoto enlargements. Various features have been omitted for clarity.*

3) *Drawing depicts conditions as of June 1987.*

SITE PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

SCALE- 1" = 800'

0 800 1600 2400 3200 4000 FT.

CONTOUR INTERVAL = 10 FT.

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E	28 Feb 1995	"Spring & Fall" Surface water sampling locations
D	31 Dec. 1993	"Fall 93" Surface water & ground water sampling locations
C	17 June 1993	"Spring 93" Surface Water Sampling Locations added.
B	21 Sept 1992	"Fall 92" Surface Water Sampling Locations added.
A	15 June 1992	1992 Surface Water Sampling Locations Added

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DATE: SEPT. 1991

WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

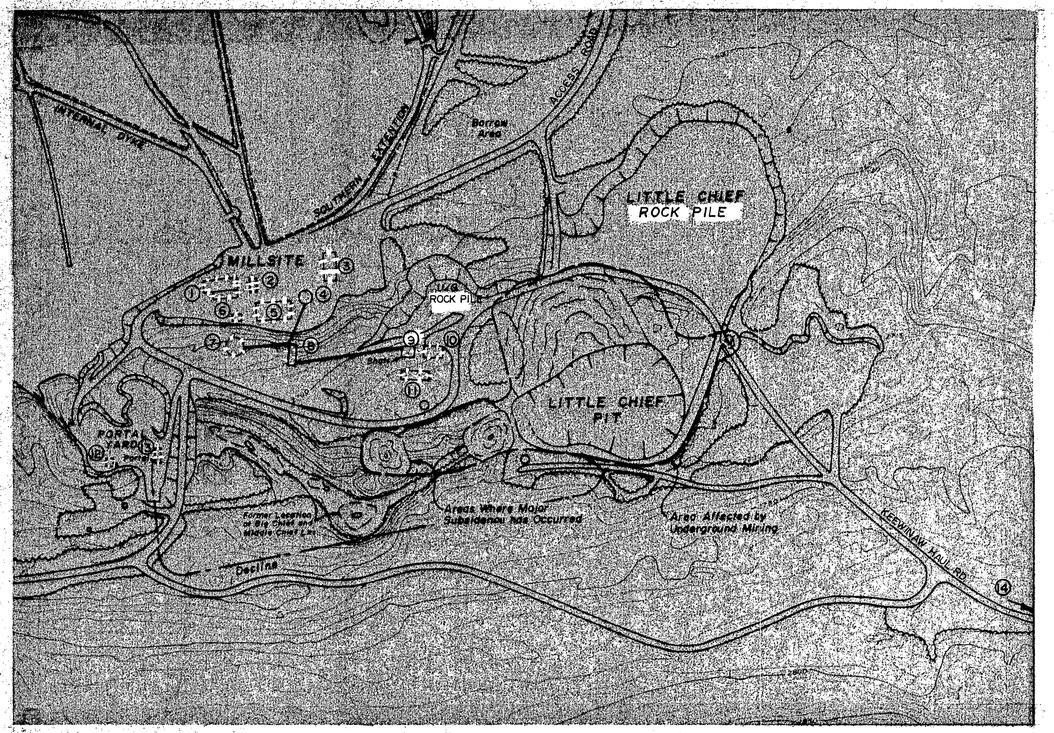
PROJ. NO. 90-149

APPROVED

WATER SAMPLING LOCATIONS
1989, 1990, 1991, 1992, 1993 & 1994

NO. 7E

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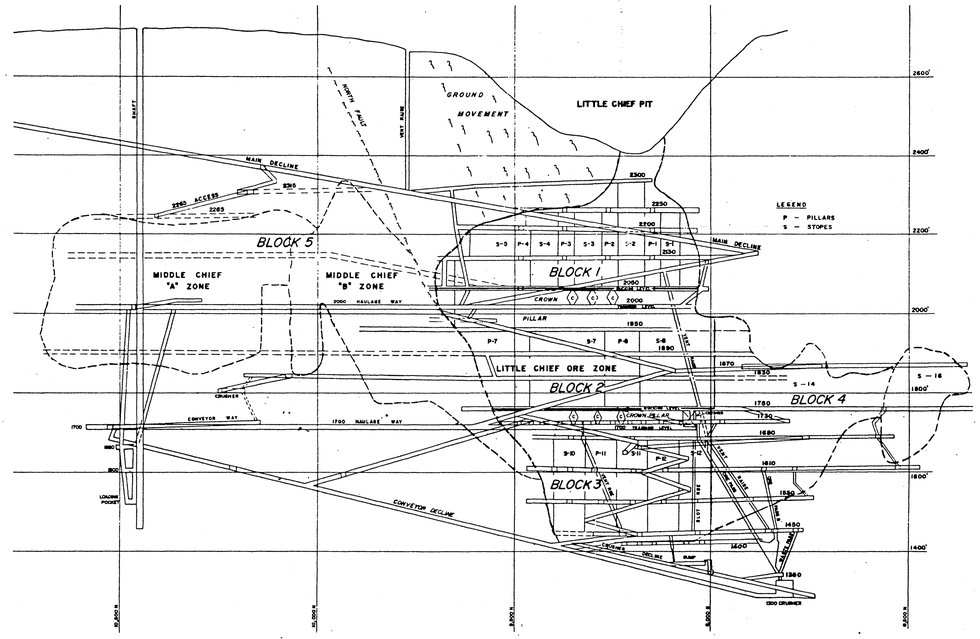
LOCATION PLAN - MILLSITE BUILDINGS & LITTLE CHIEF OPEN PIT

0 200 400 600 800 1000 FT.

PROJECT BUILDINGS

BUILDING	NO.	AREA	TYPE OF BUILDING	STATUS
Maintenance Shop	1	Mill Site	Steel and wood construction on concrete pad	Torn down 1991
Admin. Bldg.	2	Mill Site	Wood construction on concrete pad	Torn down 1989
Warehouse Bldg.	3	Mill Site	Steel building on concrete pad	Torn down 1989
Fine Ore Bin	4	Mill Site	Steel bin sitting on concrete pillars and pad	Still standing in place
Mill Bldg.	5	Mill Site	Steel and wood construction on concrete pad	Torn down 1990
Assay Lab. Bldg.	6	Mill Site	Wood construction on concrete pad *	Torn down 1988
Coarse Ore Tee Pee	7	Mill Site	Steel-wood-metal sheeting-cable construction	Torn down 1989
Crusher Bldg.	8	Mill Site	Steel building on concrete pad	Just started to be torn down 1991
Head Frame	9	Shaft Site	Steel-wood-metal sheeting construction on cement pad	Two-thirds down started in 1989
Mine Dry	10	Shaft Site	ATCO trailer units on cement pony walls	Moved - Year ?
Hoist & Compressor Buildings	11	Shaft Site	Steel construction on concrete pads	Torn down 1988
Maintenance U/G Shop	12	Portal Yard	Wood construction	Torn down 1989
Carpenter Shop	13	Portal Yard	Wood construction on concrete pad	Torn down 1989
Powder Mag.	14	Keewinaw Haul Road	Wood-sand-steel sheet const. on wooden blocks	Sold to Titan Explosives, Calgary

NOTE: Pad is being used to store P.C.B. - oil and transformers and ballast in Sea container.

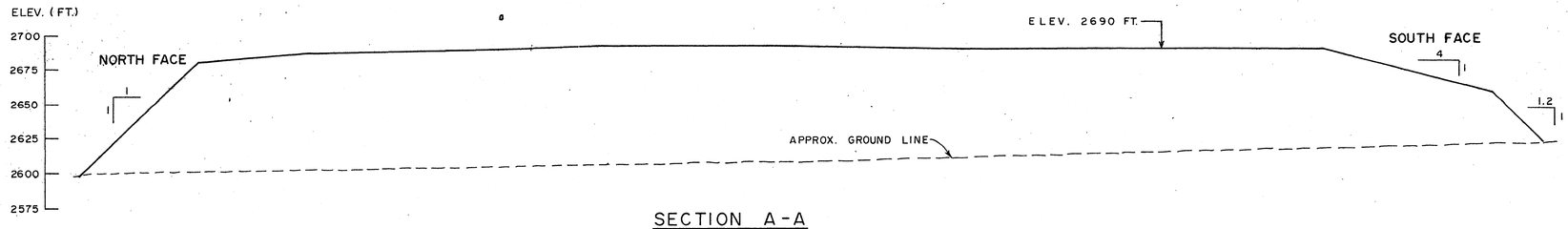


SECTION OF MIDDLE CHIEF & LITTLE CHIEF ORE ZONES

0 100 200 300 400 500 FT.

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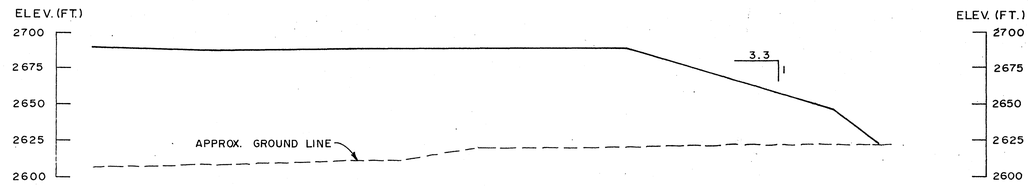
HUDSON BAY MINING & SMELTING CO. LTD.	DATE OCT. 1991
WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN	PROJ. NO. 90-149
PLAN & SECTIONS - MILLSITE AREA & LITTLE CHIEF OPEN PIT & U/G MINE	APPROVED
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SECTION A-A

0 50 100 150 FT.

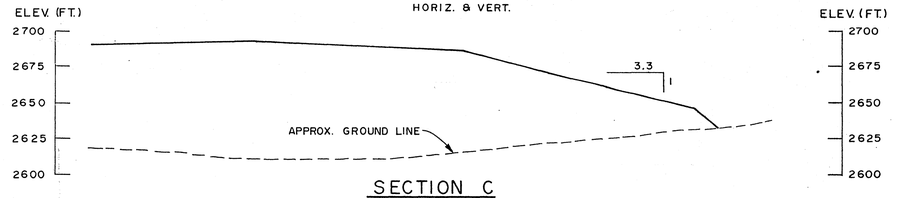
HORIZ. & VERT.



SECTION B

0 50 100 150 FT.

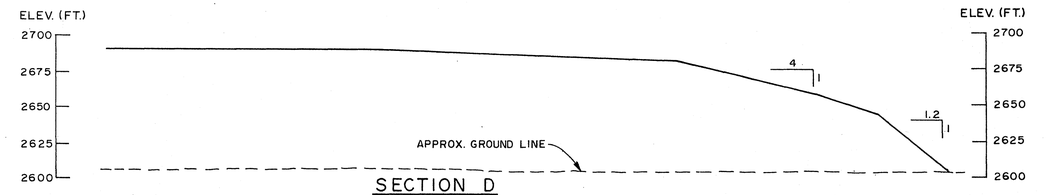
HORIZ. & VERT.



SECTION C

0 50 100 150 FT.

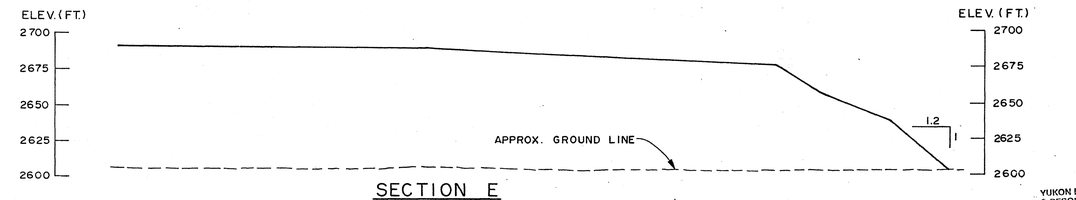
HORIZ. & VERT.



SECTION D

0 50 100 150 FT.

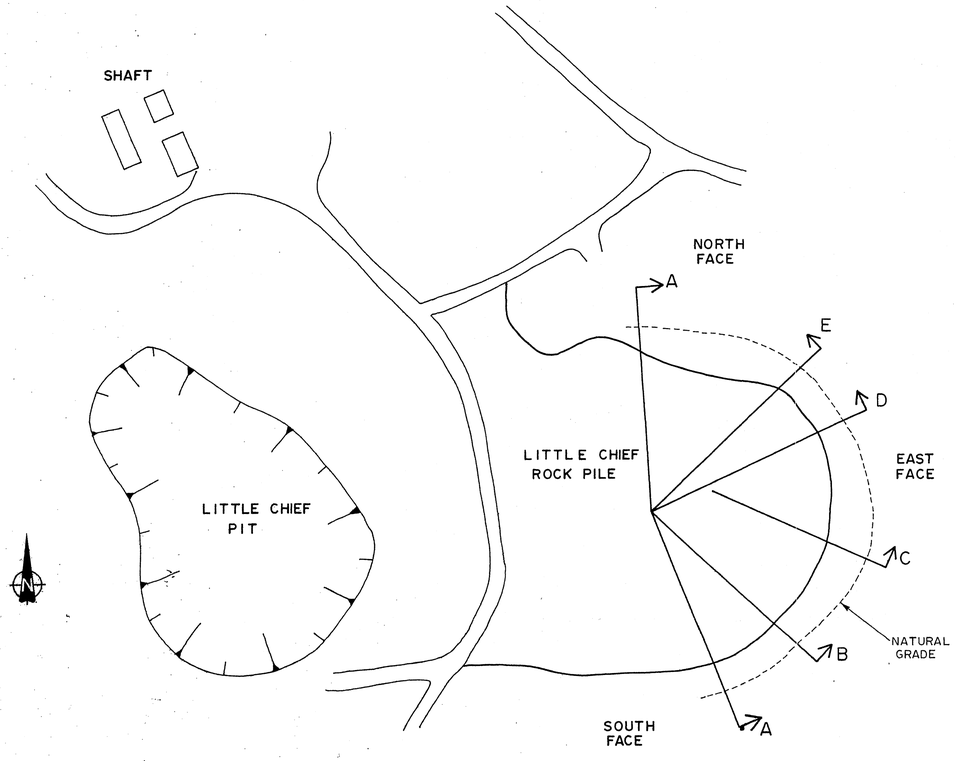
HORIZ. & VERT.



SECTION E

0 50 100 150 FT.

HORIZ. & VERT.

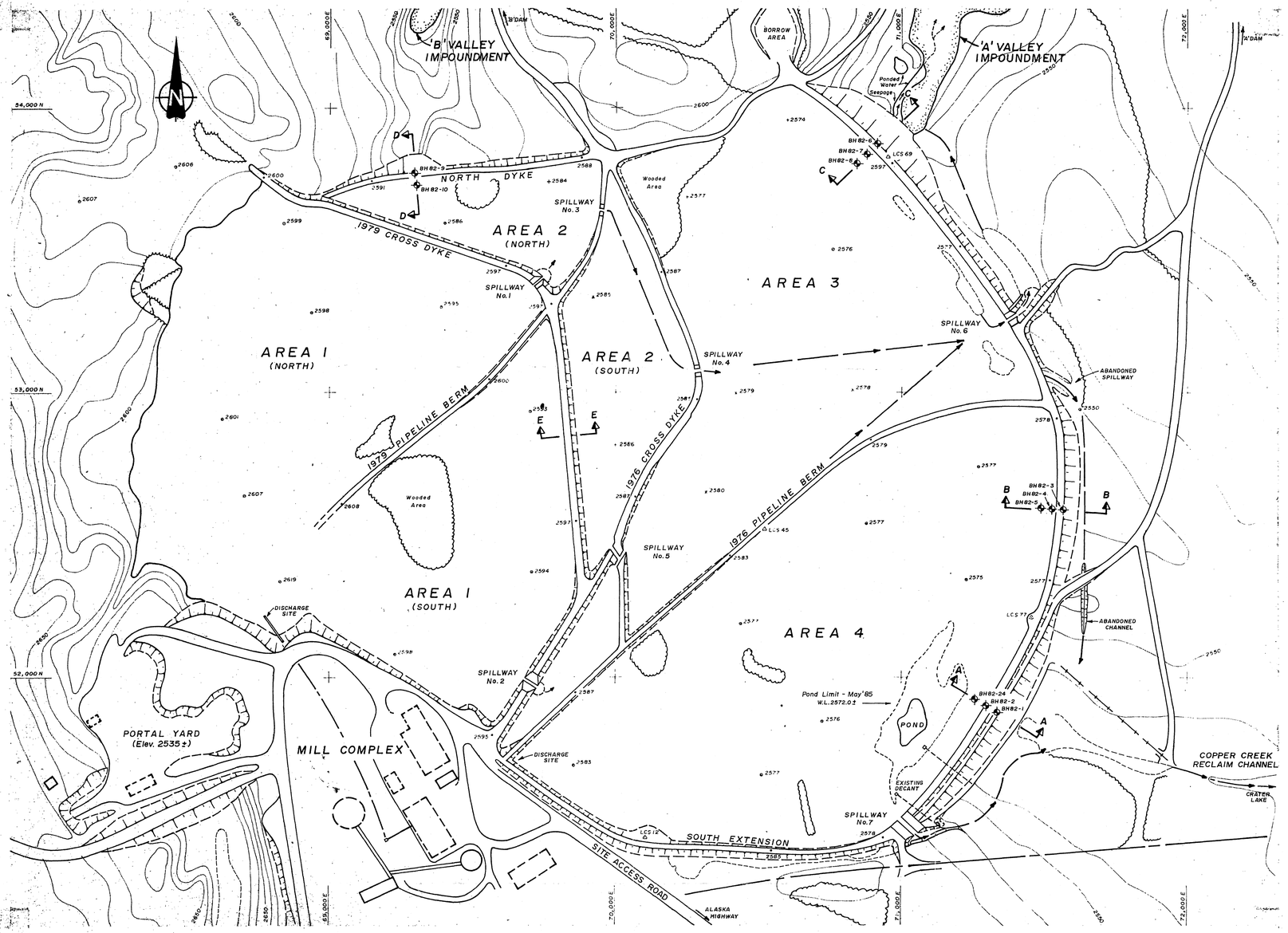


PLAN OF LITTLE CHIEF ROCK PILE

0 100 200 300 400 500 FT.

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LITTLE CHIEF ROCK PILE	APPROVED
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LEGEND:

- Crest of Slope / Toe of Slope
- Open Channel – Drainage Swale
- Areas Subject to Seasonal and/or Ephemeral Flooding
- Edge of Clearing
- BH82-3 — Location of Borehole/Instrumentation
- 2520 — Spot Elevations – Oct.'81
- 2530 — Spot Elevations – May'82
- 2540 — Spot Elevations – Aug.'82

REFERENCE DRWG'S:

- Old Pond Storage Area – Thompson Geotechnical – Aug.'82
- Valerie – Arctic Chief Topography – New Imperial Mines Drwg No. D-11-1 (undated).
- Airphotos 129754 & 129755 – Pacific Survey Corp. – June'80.

NOTES:

1) Drawing has been compiled from various data. Topographic and planimetric detail is approximate only.

2) Spot elevations have been defined from surface surveys as noted in legend. Minor deposition and/or settlement has occurred in various areas since surveys were completed.

3) Sections A-A to E-E shown on Figure 11.

PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

SCALE – 1" = 200'

0 200 400 600 800 1000 FEET

CONTOUR INTERVAL = 10 FT.

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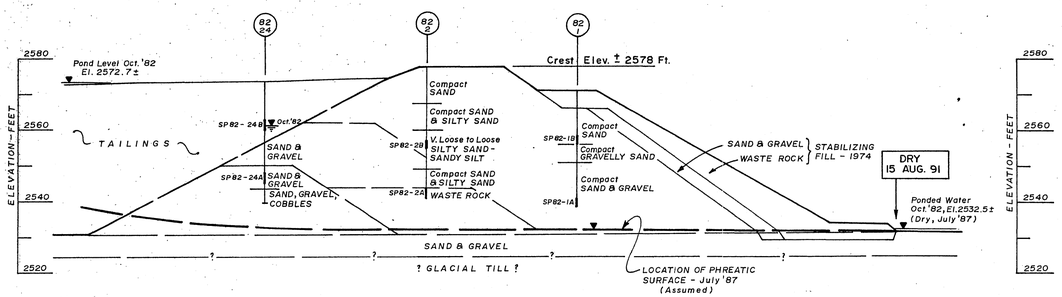
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WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

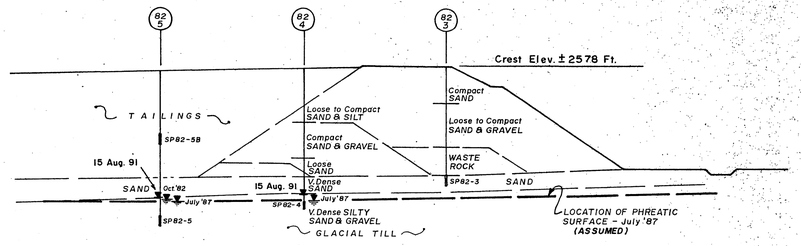
"OLD POND" IMPOUNDMENT AREA

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

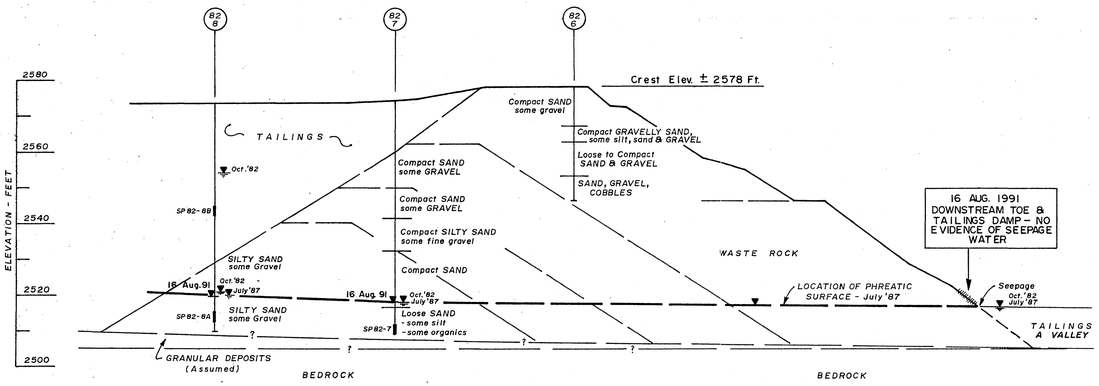
DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 10



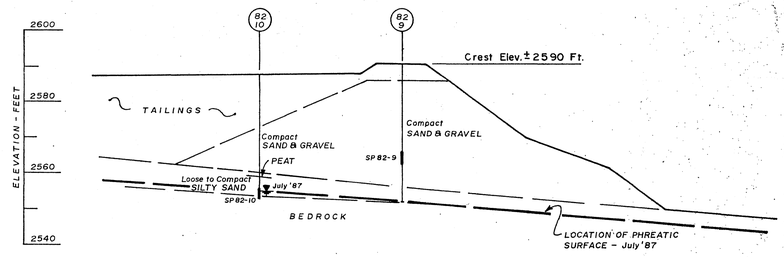
SECTION A - A



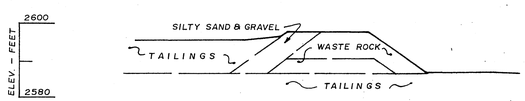
SECTION B-B



SECTION C - C

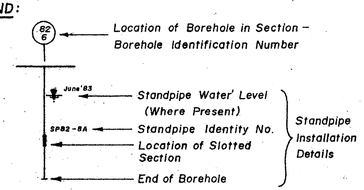


SECTION D - D



SECTION E - E

LEGEND:



NOTES:

1) See Figure 10 for location of sections and location of boreholes in plan.

2) Fill boundaries and internal zoning have been inferred from limited data. Actual configuration may vary. See Text and Record of Boreholes for additional details.

3) Each borehole contains one standpipe only. Additional standpipes (where indicated) are located in offset holes and have been projected onto section shown. See Record of Boreholes for specific details of each installation.

SECTIONS ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

0 20 40 60 80 100 FEET

SCALE - 1" = 20'

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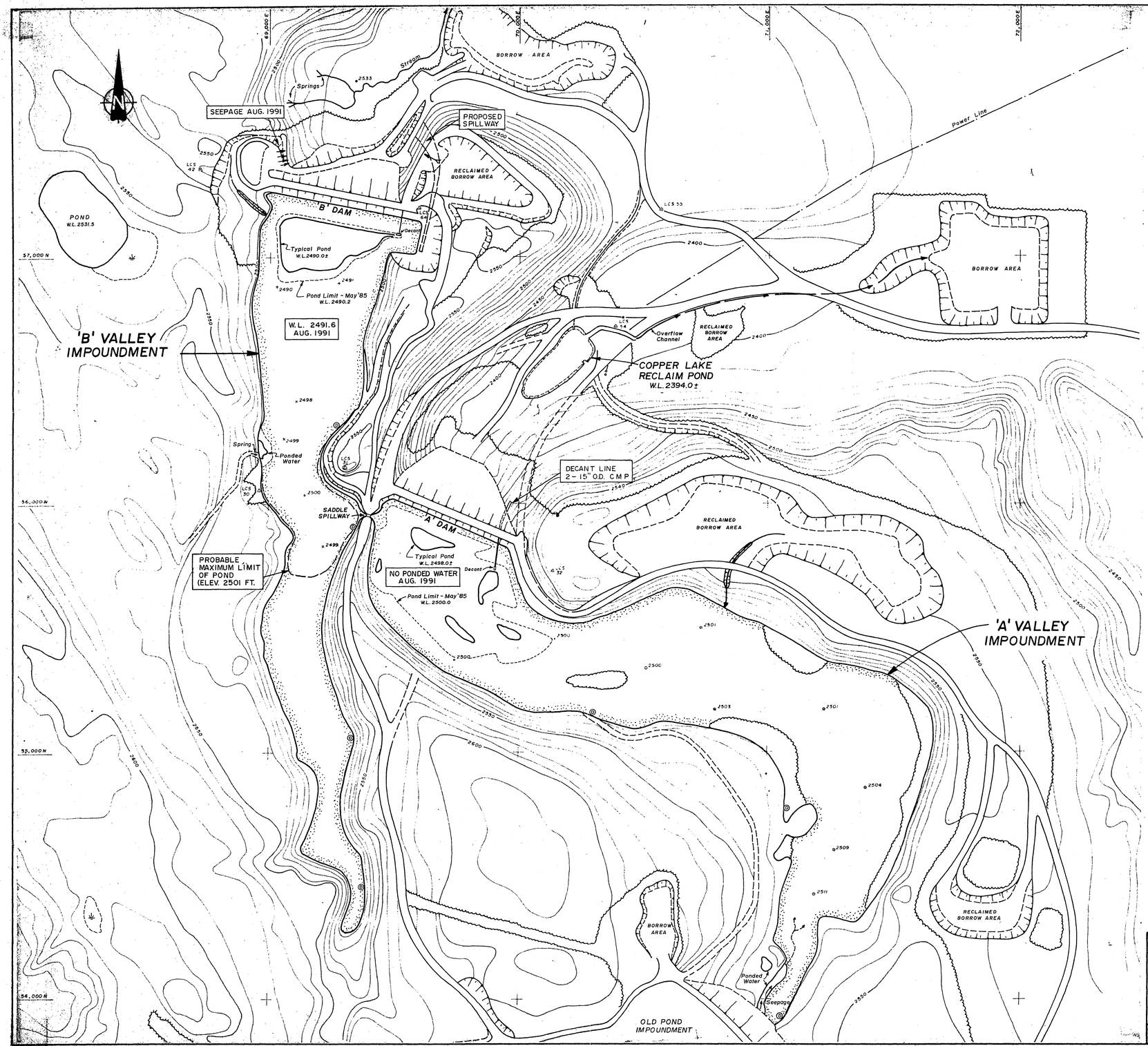
HUDSON BAY MINING & SMELTING CO. LTD.

WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

OLD POND SECTIONS A-A TO E-E

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED
NO.: 11



LEGEND:

- Crest of Slope / Toe of Slope
- Edge of Clearing
- Areas Subject to Seasonal and/or Ephemeral Flooding
- Open Channel / Ditch
- •2520 Spot Elevations – Aug. '82
- ×2530 Spot Elevations – July '82
- +2530 Spot Elevations – May '85
- D Tailings Discharge Site

REFERENCE DRWG'S:

- 'A' Dam and Abutment Areas - Thompson Geotechnical - Jan. '88 (Revised).
- 'B' Dam and Abutment Areas - Thompson Geotechnical - Jan. '88 (Revised).
- Topography of Tailings Dams and Adjacent Areas - Whitehorse Copper Mines - Selected Surveys to November 1982.
- Old Pond Storage Area - Thompson Geotechnical - Aug. '82.
- Valerie - Arctic Chief Topography - New Imperial Mines - Drwg No. D-11-1 (undated).
- Airphotos 129 755 & 129 756 - Pacific Survey Corp. - June '80.

NOTES:

1) Drawing has been compiled from various data. Topographic and planimetric detail is approximate only.

2) Spot elevations have been defined from surface surveys as noted in legend. Minor deposition and/or settlement has occurred in various areas since surveys were completed.

3) Details of 'A' and 'B' Dams and adjacent areas shown on Figures 13 and 14

PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

SCALE - 1" = 200'
0 200 400 600 800 1000 FEET
CONTOUR INTERVAL = 10 FT.

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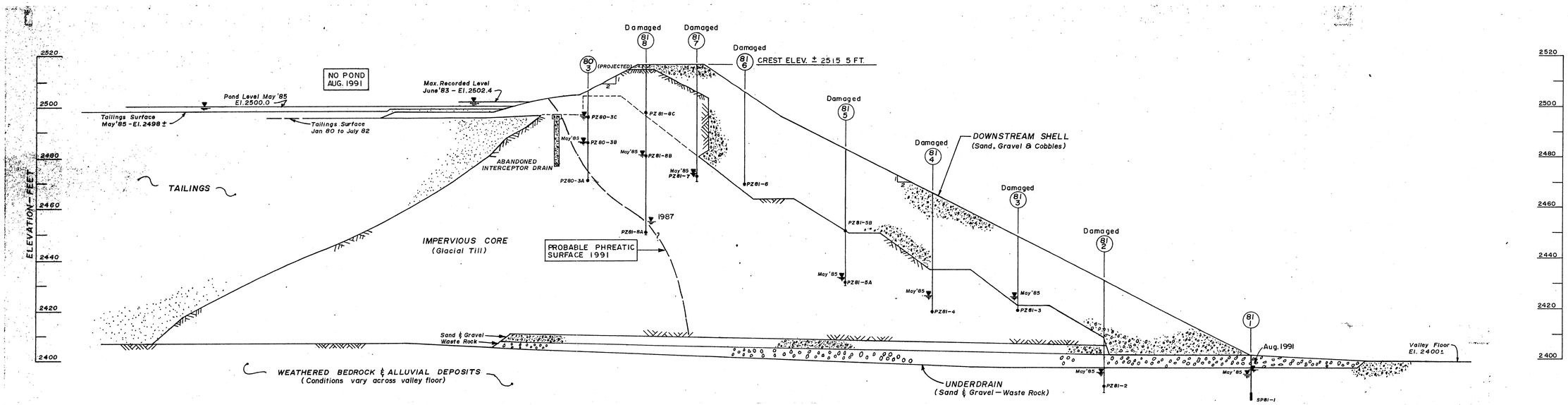
HUDSON BAY MINING & SMELTING CO. LTD.

WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

PLAN OF 'A' & 'B' VALLEY IMPOUNDMENTS

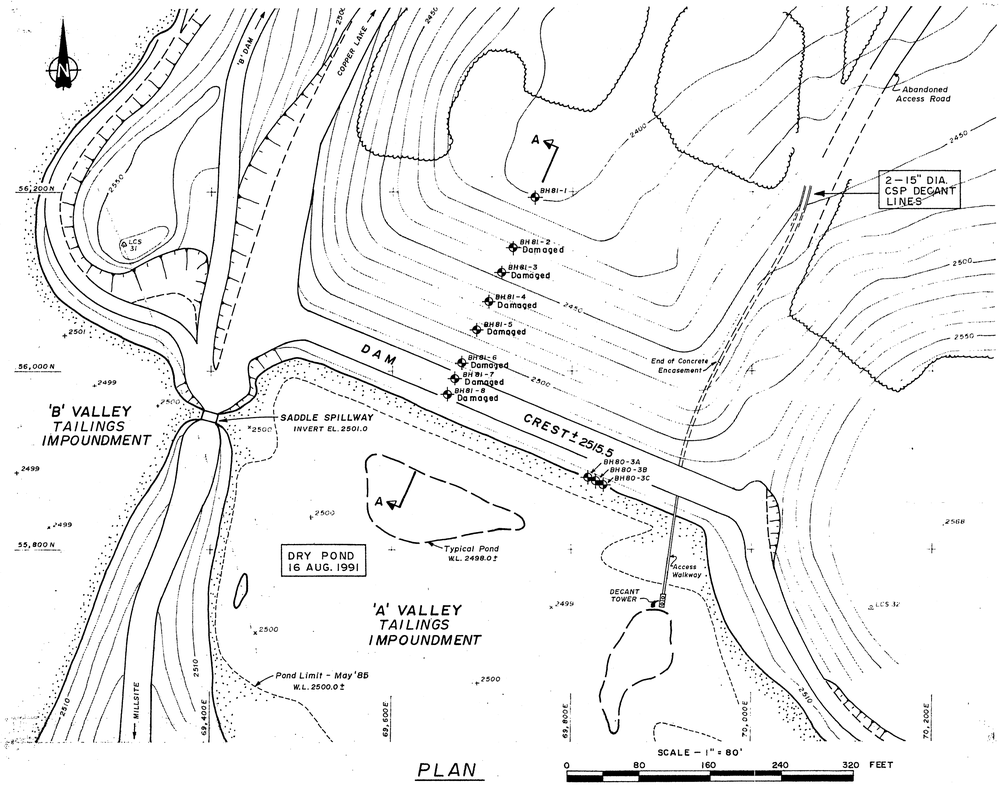
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 12



SECTION A-A

0 20 40 60 FEET
SCALE - 1" = 20'



PLAN

0 80 160 240 320 FEET
SCALE - 1" = 80'

LEGEND:

- Crest of Slope
- Toe of Slope
- Edge of Clearing
- Areas Subject to Seasonal and/or Ephemeral Flooding
- BH81-3 — Location of Borehole / Instrumentation
- 2520 — Spot Elevations - July '84
- 2530 — Spot Elevations - May '85

NOTES:

1) Drawing has been compiled from various data. Topographic and planimetric detail is approximate only.

2) Spot elevations have been defined as noted in legend. Minor settlement has occurred since surveys were completed.

LEGEND:

- 81/8 — Location of Borehole in Section - Borehole Identification Number
- May '85 — Piezometric Head (Where Present)
- PZ81-5 — Piezometer Identity Number
- Location of Pneumatic Piezometer
- End of Borehole

(Piezometer Installation Details)

- Phreatic Surface (Inferred)

NOTES:

1) See Figure for location of section and location of boreholes in plan.

2) Piezometers 81-2 to 81-10 installed during construction of downstream shell. Boreholes shown are schematic only and do not extend to surface.

3) See text for details of pond history and seepage conditions.

PLAN & SECTION ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

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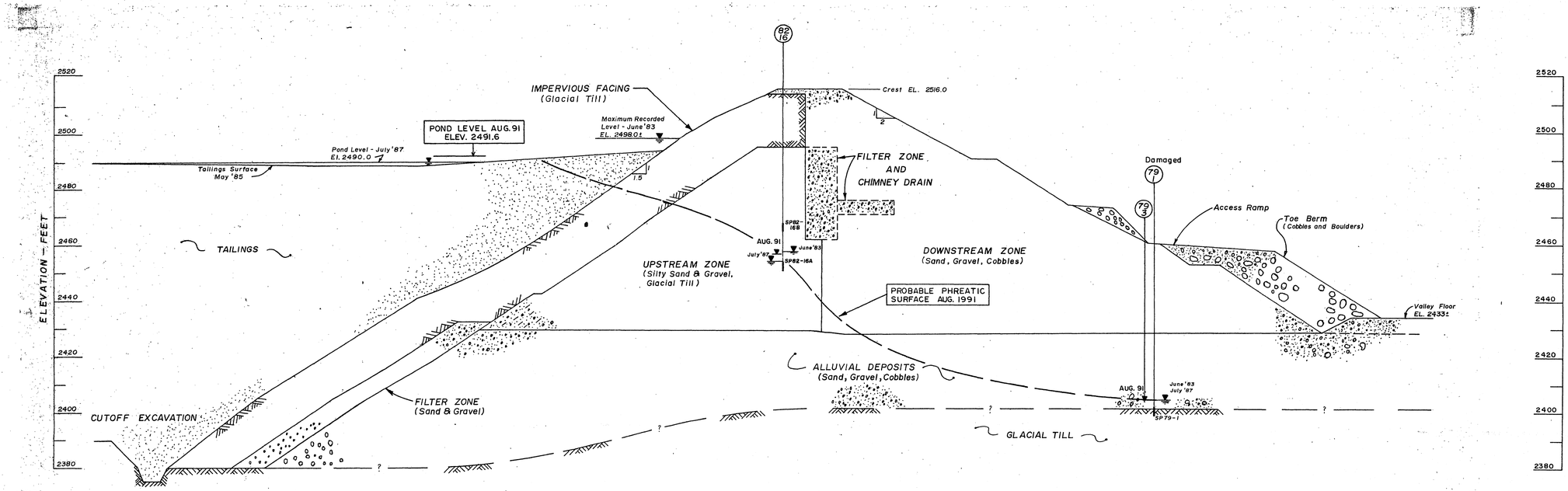
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WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

'A' DAM EMBANKMENT PLAN & SECTION

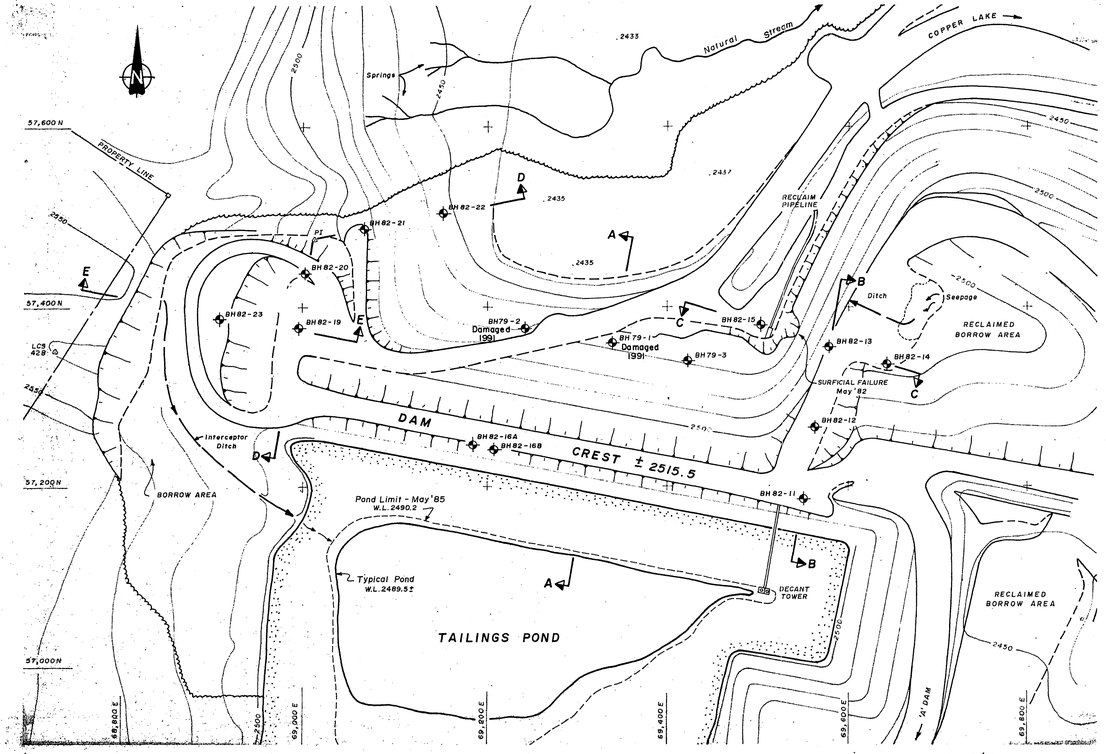
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DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 13



SECTION A-A

0 20 40 60 FEET
SCALE - 1" = 20'



PLAN

0 80 160 240 320 FEET

LEGEND:

- Crest of Slope
- Toe of Slope
- Edge of Clearing
- Areas Subject to Seasonal and/or Ephemeral Flooding.
- Open Channel / Ditch
- BH82-19 — Location of Borehole / Instrumentation

NOTES:

1) Drawing has been compiled from various data. Topographic and planimetric detail is approximate only.

LEGEND:

- 82/16 — Location of Borehole in Section — Borehole Identification Number
- Oct., 82 — Standpipe Water Level (Where Present)
- SP79-1 — Standpipe Identity No.
- Location of Slotted Section
- End of Borehole
- (Standpipe Installation Details)
- Stratigraphic Boundary (Inferred)
- Phreatic Surface (Inferred)

NOTES:

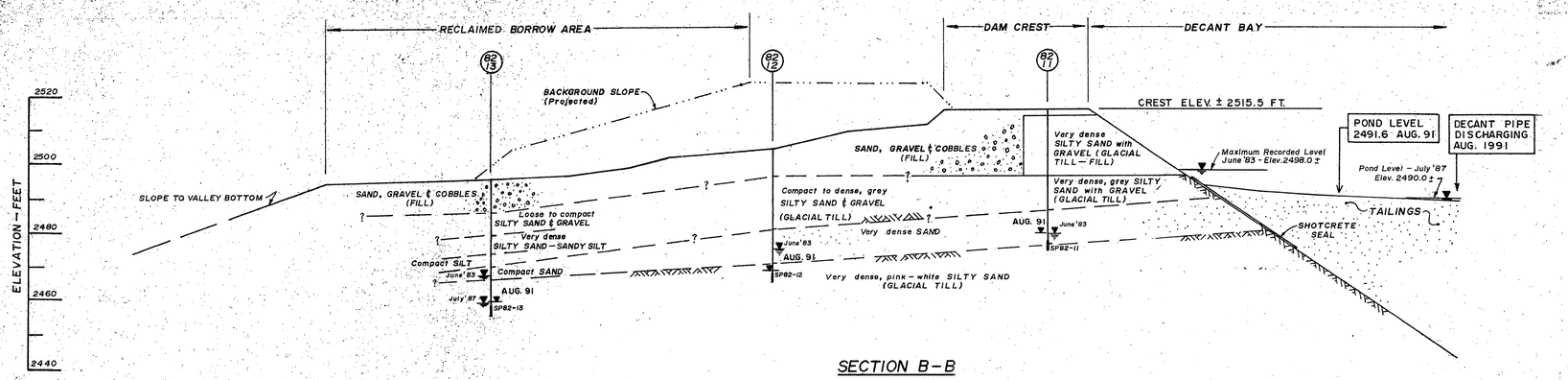
1) See Figure for location of section and location of boreholes in plan.
2) Each borehole contains one standpipe only. Additional standpipes (where indicated) are located in offset holes and have been projected to section shown. See Record of Boreholes for additional details.
3) See text for details of pond history and seepage conditions.

PLAN & SECTION ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

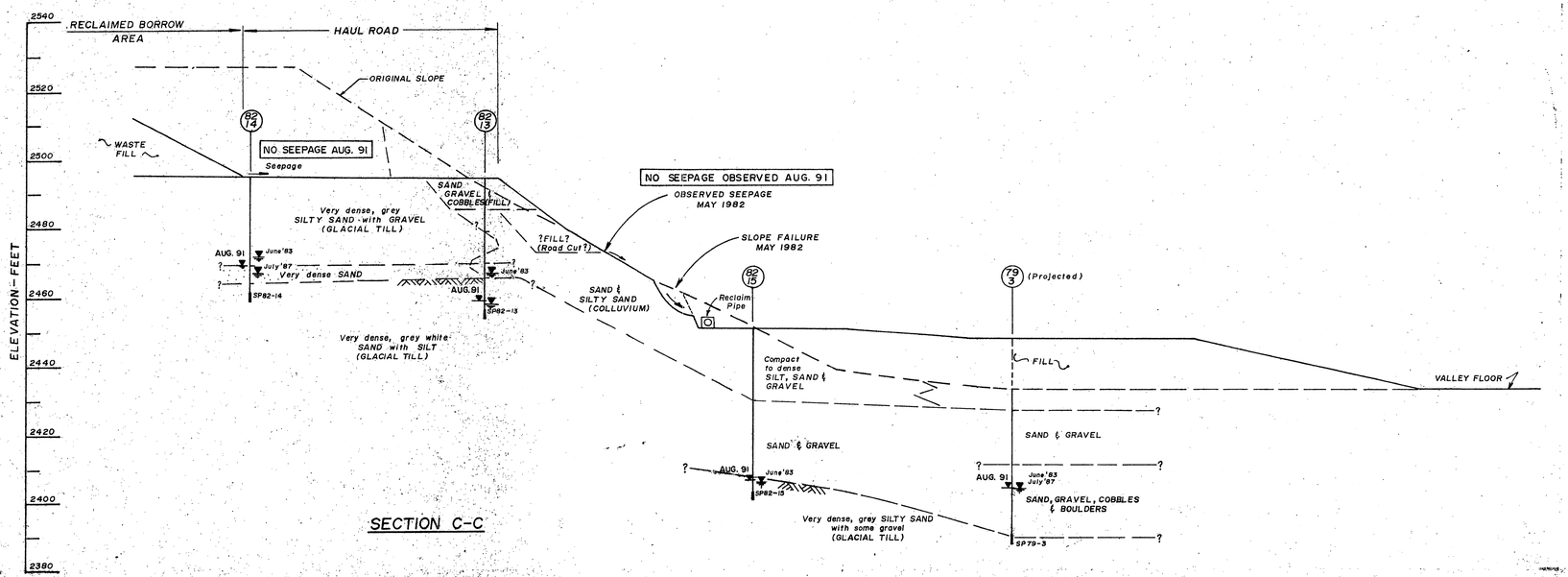
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HUDSON BAY MINING & SMELTING CO. LTD.	DATE SEPT. 1991
WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN 'B' DAM EMBANKMENT PLAN & SECTION A-A	PROJ. NO. 90-149 APPROVED NO. 14
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	

#15



SECTION B–B



SECTION C–C

LEGEND:

- 82/14 — Location of Borehole in Section – Borehole Identification Number
- Oct.,82 — Standpipe Water Level (Where Present)
- SP82-12 — Standpipe Identity No.
- Location of Slotted Section
- End of Borehole
- (Standpipe Installation Details)
- ? ——— ? Stratigraphic Boundary (Inferred)
- Phreatic Surface (Inferred)

NOTES:

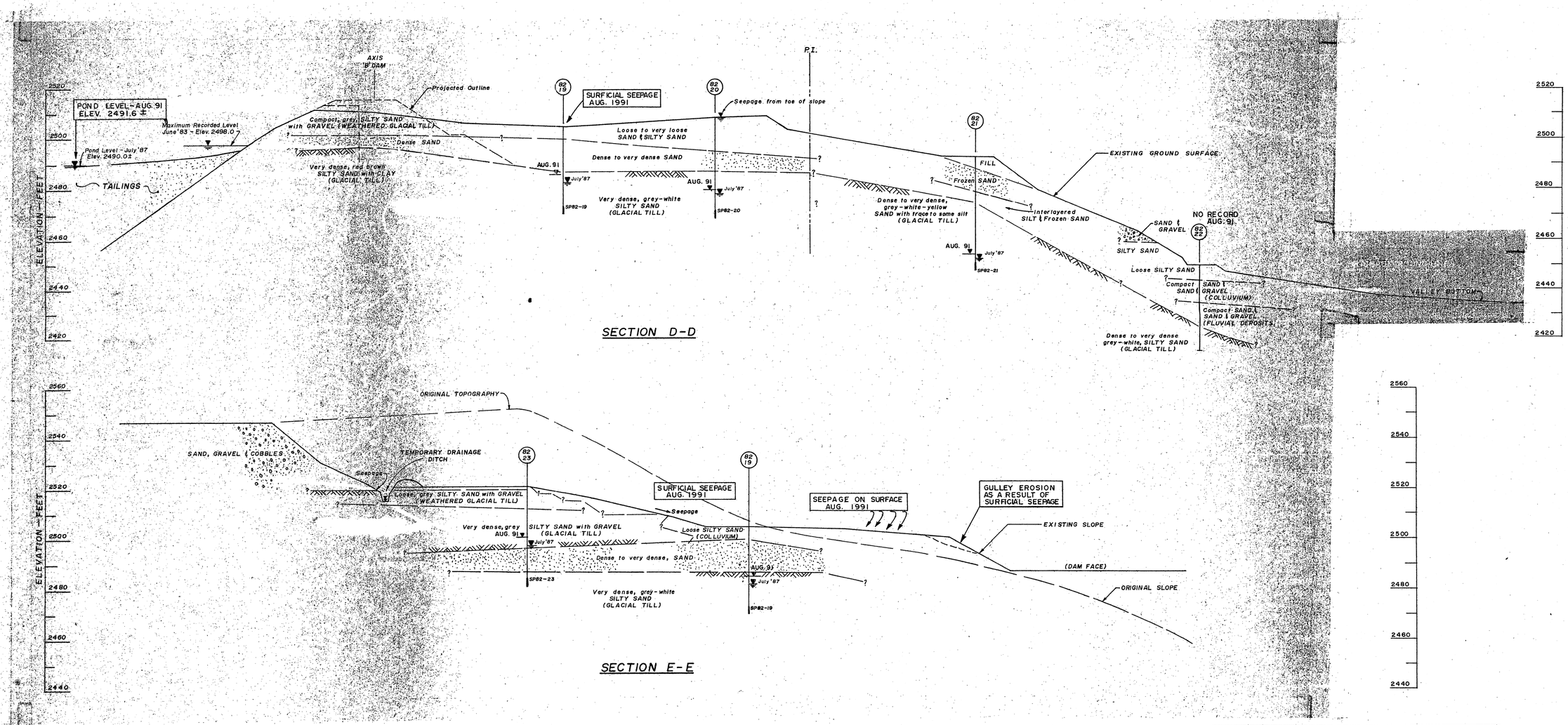
1) See Figure 14 for location of sections and location of boreholes in plan.
2) Stratigraphic boundaries and seepage conditions have been inferred from borehole data. Actual conditions may vary. See Record of Boreholes for specific details.

SECTIONS ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

0 20 40 60 80 100 FEET
SCALE – 1" = 20'

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HUDSON BAY MINING & SMELTING CO. LTD.	DATE SEPT. 1991
WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN 'B' DAM EMBANKMENT SECTIONS B-B & C-C	PROJ. NO. 90-149 APPROVED
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	NO. 15



SECTION D-D

SECTION E-E

SECTIONS ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

LEGEND

- 82-6 — Location of Borehole in Section — Borehole identification Number
- Oct. '82 — Standpipe Water Level (Where Present)
- SP82-19 — Standpipe Identity No.
- Location of Slotted Section
- End of Borehole
- (Standpipe Installation Details)
- ? — Stratigraphic Boundary (Inferred)
- Phreatic Surface (Inferred)

NOTES:

1) See Figure 14 for location of sections and location of boreholes in plan.
2) Stratigraphic boundaries and seepage conditions have been inferred from borehole data. Actual conditions may vary. See Record of Boreholes for specific details.

0 20 40 60 80 100 FEET
SCALE - 1" = 20'

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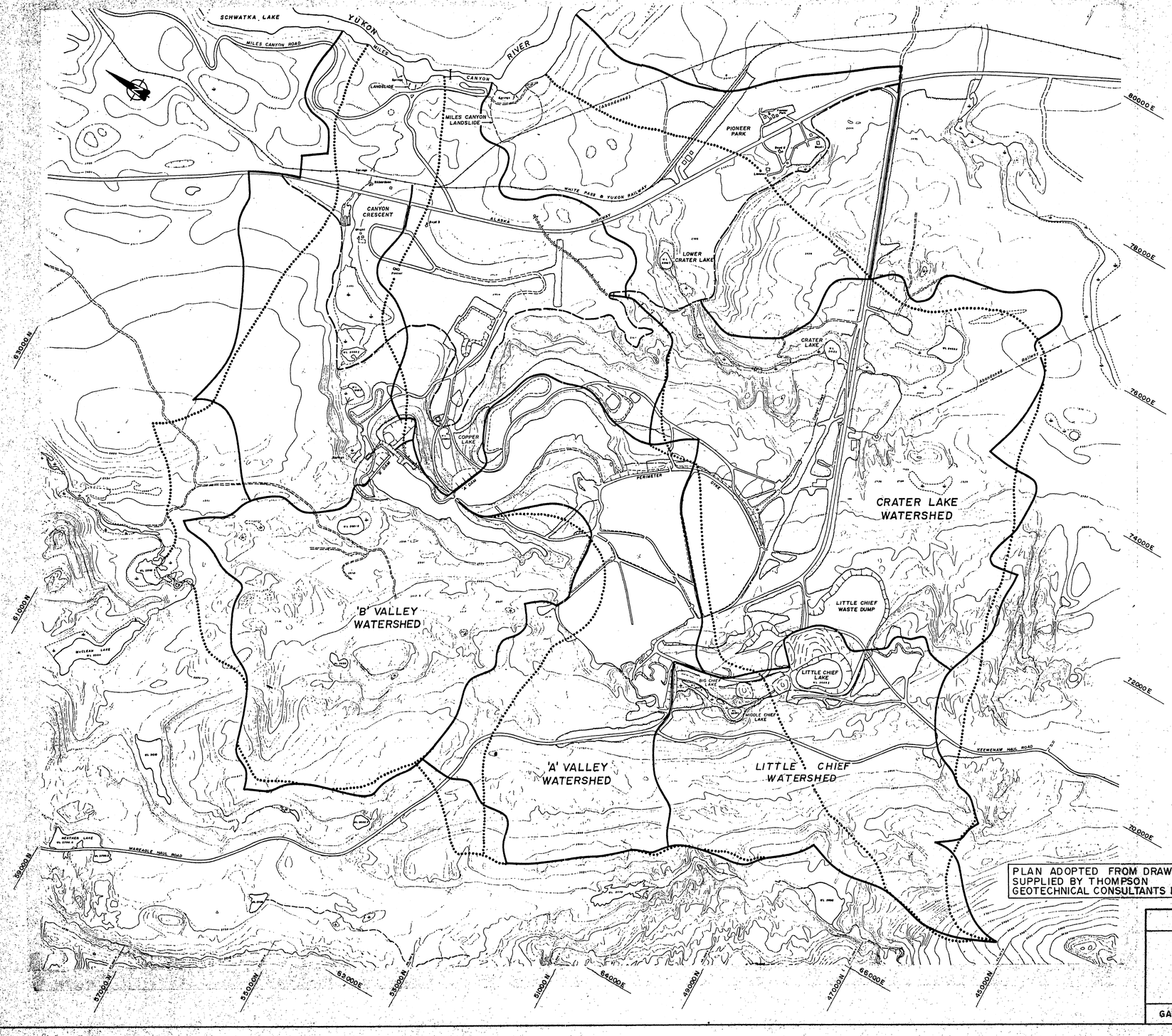
HUDSON BAY MINING & SMELTING CO. LTD.

WHITEHORSE COPPER MINE SITE
DECOMMISSIONING PLAN

'B' DAM EMBANKMENT
SECTIONS D-D & E-E

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: SEPT. 1991
PROJ. NO.: 90-149
APPROVED:
NO.: 16



PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

LEGEND

GENERAL FEATURES

- Permanent Stream
- Intermittent Stream
- Open Channel
- Spring or Seepage
- Permanent Lake or Pond
- Fen or Muskeg
- Areas Subject to Seasonal and/or Ephemeral Flooding
- House and Well
- Access Road
- Crest of Slope

DRAINAGE BOUNDARIES

- Major Surface Divide
- Lesser Surface Divide
- Major Groundwater Divide
- Lesser Groundwater Divide
- Partial (Leaky) Groundwater Divide (Arrows indicate direction of minor flow)
- Reference Boundary

REFERENCE DRAWINGS:

- N.T.S. Topography - Whitehorse (1:25,000) Part of 105D/11h, 11g & 10e (1969)
- "Valerie - Arctic Chief - Topography" - New Imperial Mines Ltd. Drwg. No. D - 11 - 1 (Undated)
- "Plan of Tailings Area" - Whitehorse Copper Mines (1973).
- Airphotos 24074 (Sept. '67) and 127955 (June '80) - Pacific Survey Corporation.

NOTES:

1) Topographic and planimetric information is approximate only.

2) Surface divides have been inferred from topographic data and field observations. Some boundaries are approximate only. Local variations may exist on account of limited data and/or complex conditions.

3) Groundwater divides have been inferred from groundwater models. All boundaries are approximate only. Significant variations may exist on account of complex geological conditions.

SCALE - 1" = 800'

0 800 1600 2400 3200 4000 FT.

CONTOUR INTERVAL = 10 FT.

HUDSON BAY MINING & SMELTING CO. LTD.

WHITEHORSE COPPER MINE SITE DECOMMISSIONING PLAN

POST MINING DRAINAGE BOUNDARIES

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

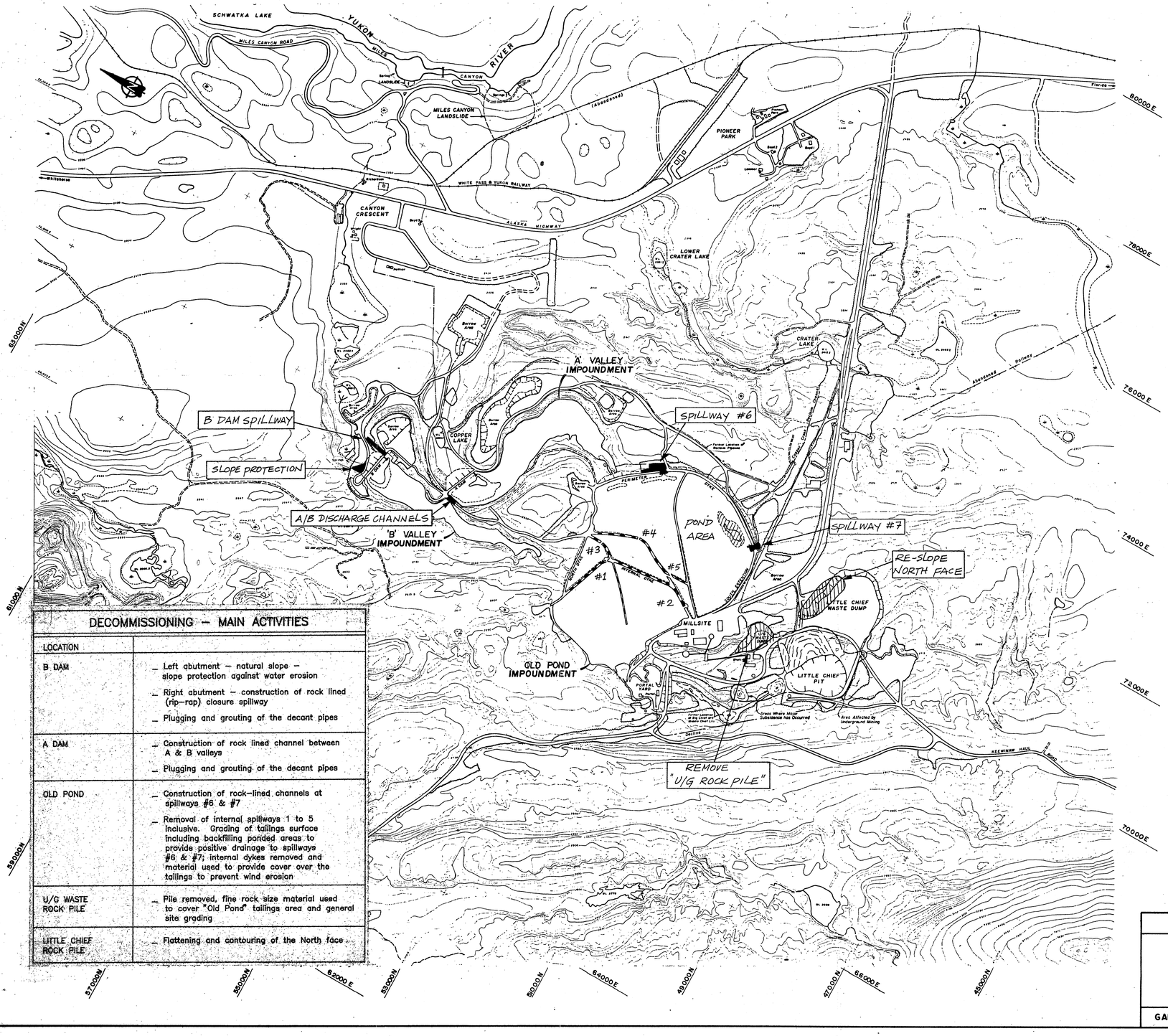
DATE: SEPT. 1991

PROJ. NO.: 90-149

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NO.: 17

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DECOMMISSIONING — MAIN ACTIVITIES

LOCATION	
B DAM	– Left abutment — natural slope — slope protection against water erosion – Right abutment — construction of rock lined (rip–rap) closure spillway – Plugging and grouting of the decant pipes
A DAM	– Construction of rock lined channel between A & B valleys – Plugging and grouting of the decant pipes
OLD POND	– Construction of rock–lined channels at spillways #6 & #7 – Removal of internal spillways 1 to 5 inclusive. Grading of tailings surface including backfilling ponded areas to provide positive drainage to spillways #6 & #7; internal dykes removed and material used to provide cover over the tailings to prevent wind erosion
U/G WASTE ROCK PILE	– Pile removed, fine rock size material used to cover "Old Pond" tailings area and general site grading
LITTLE CHIEF ROCK PILE	– Flattening and contouring of the North face

LEGEND:

GENERAL FEATURES

- Permanent Stream
- Intermittent Stream
- Open Channel
- Spring or Seepage
- W.L. 2612 — Permanent Lake or Pond
- Fen or Muskeg
- Areas Subject to Seasonal and/or Ephemeral Flooding
- House and Well
- Access Road
- Crest of Slope
- Edge of Clearing

REFERENCE DRAWINGS:

- N.T.S. Topography – Whitehorse (1:25,000) Part of 105 D/11h, 11g & 10e (1968)
- "Valerie – Arctic Chief – Topography" – New Imperial Mines Ltd. Drwg. No. D-11-1 (Undated)
- "Plan of Tailings Area" – Whitehorse Copper Mines (1973)
- Airphotos 24074 (Sept. '67) and 127955 (June '80) – Pacific Survey Corporation.

NOTES:

1) Topographic information has been compiled from various sources. Contours in northern and eastern areas are approximate only.
2) Planimetric detail has been compiled from uncontrolled airphoto enlargements. Various features have been omitted for clarity.
3) Drawing depicts conditions as of June 1987. Various abandonment work has already been completed.

SITE PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

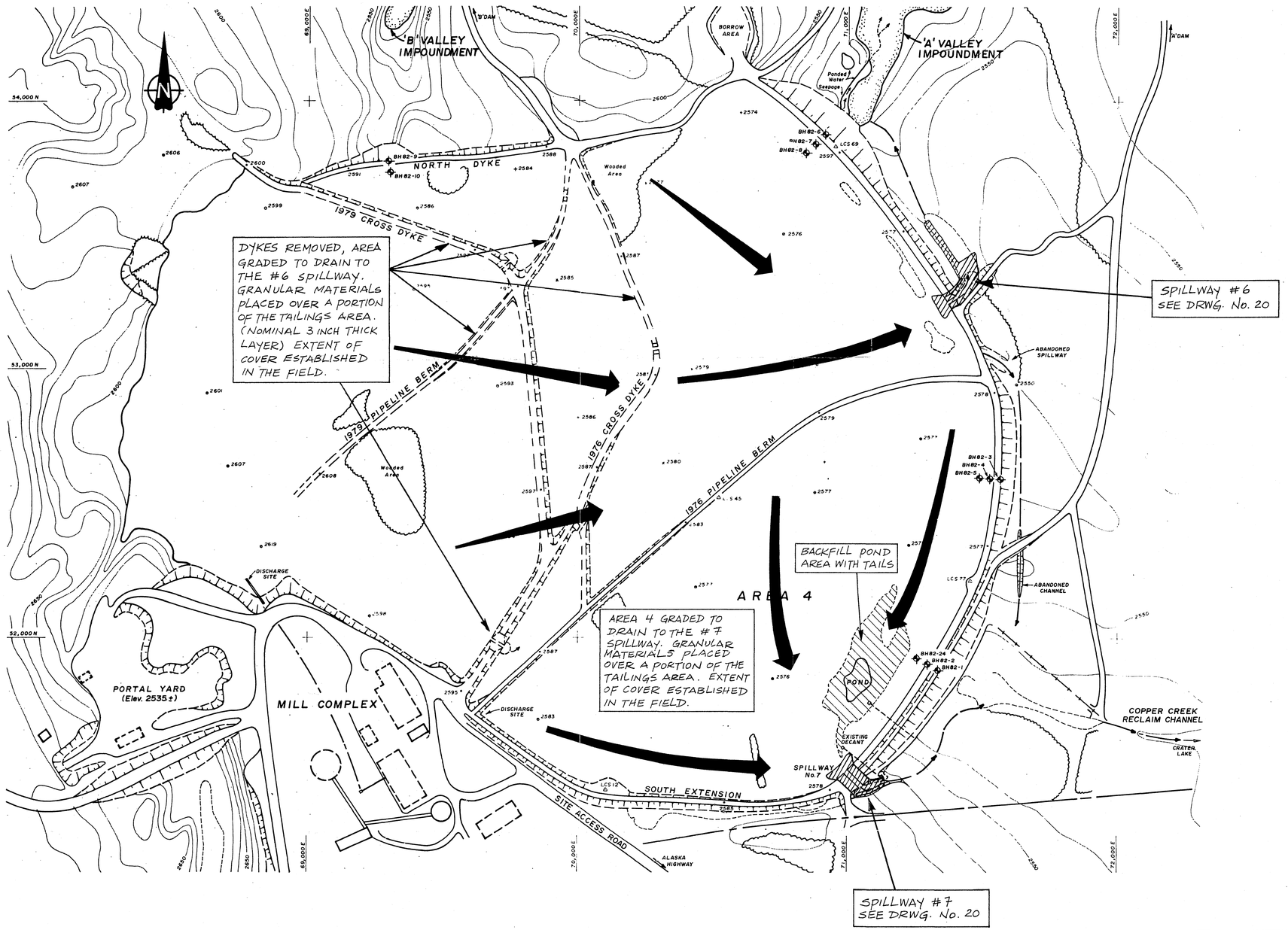
SCALE— 1" = 800'

0 800 1600 2400 3200 4000 FT.

CONTOUR INTERVAL = 10 FT.

HUDSON BAY MINING & SMELTING CO. LTD.	DATE: JULY 1992
WHITEHORSE COPPER MINE SITE	PROJ. NO.: 90-149
SITE PLAN DECOMMISSIONING EARTHWORKS	APPROVED:
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	NO.: 18

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LEGEND:

- Crest of Slope / Toe of Slope
- Open Channel – Drainage Swale
- Areas Subject to Seasonal and/or Ephemeral Flooding
- Edge of Clearing
- BH82-3 — Location of Borehole/Instrumentation
- 2320 — Spot Elevations – Oct.'81
- 2330 — Spot Elevations – May '82
- 2340 — Spot Elevations – Aug.'82

REFERENCE DRWG'S:

- Old Pond Storage Area – Thompson Geotechnical – Aug.'82
- Valerie – Arctic Chief Topography – New Imperial Mines Drwg No. D-11-1 (undated).
- Airphotos 129754 & 129755 – Pacific Survey Corp. – June'80.

NOTES:

1) Drawing has been compiled from various data. Topographic and planimetric detail is approximate only.

2) Spot elevations have been defined from surface surveys as noted in legend. Minor deposition and/or settlement has occurred in various areas since surveys were completed.

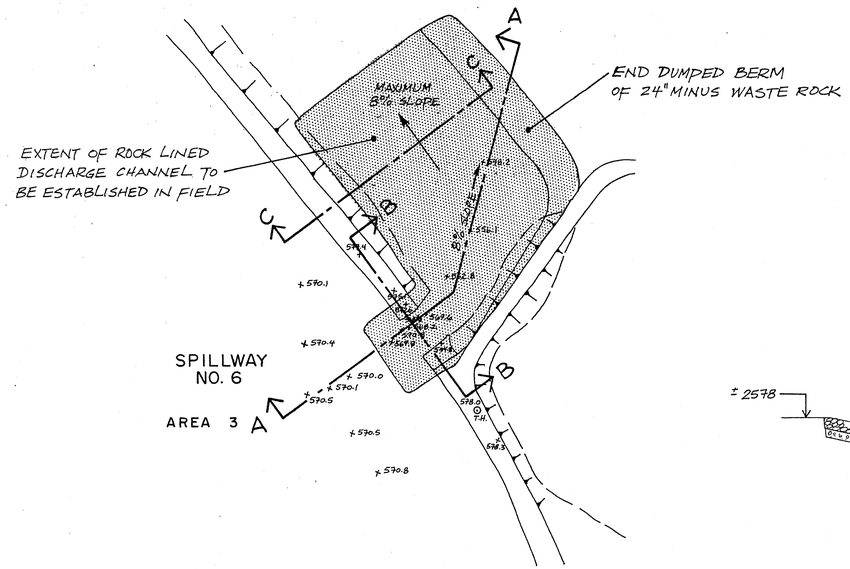
3) Sections A-A to E-E shown on Figure 11.

PLAN ADOPTED FROM DRAWINGS SUPPLIED BY THOMPSON GEOTECHNICAL CONSULTANTS LTD.

SCALE – 1" = 200'
0 200 400 600 800 1000 FEET
CONTOUR INTERVAL = 10 FT.

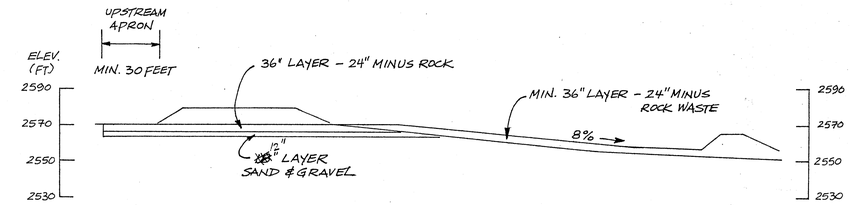
HUDSON BAY MINING & SMELTING CO. LTD.	DATE: JULY 1992
WHITEHORSE COPPER MINE SITE "OLD POND" IMPOUNDMENT AREA DECOMMISSIONING EARTHWORKS	PROJ. NO.: 90-149 APPROVED: NO.: 19
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	

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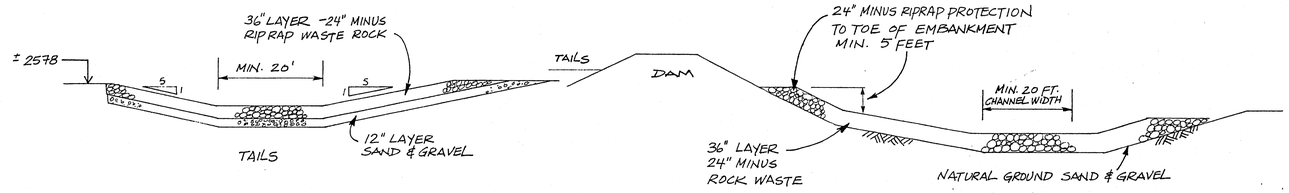
PLAN OF SPILLWAY NO. 6

SCALE - 1"=80'



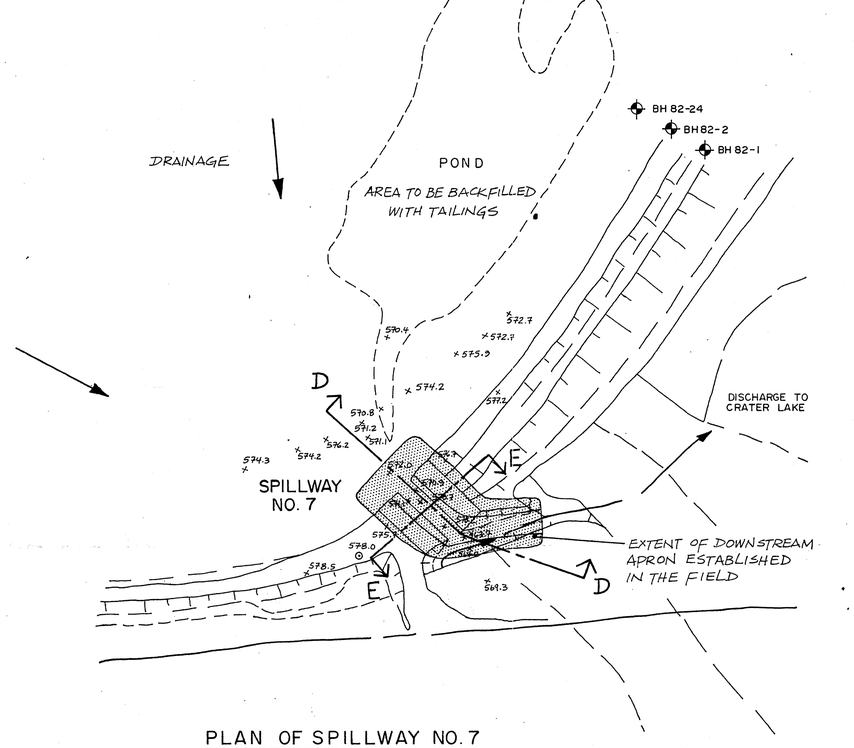
SECTION A-A

SCALE - 1"=40'

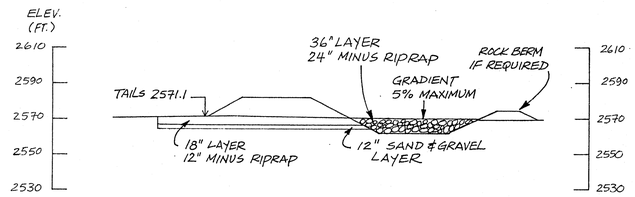


SECTION B-B

SECTION C-C

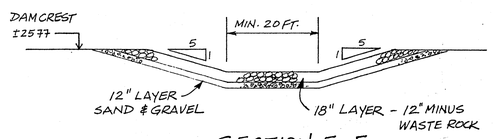


PLAN OF SPILLWAY NO. 7



SECTION D-D

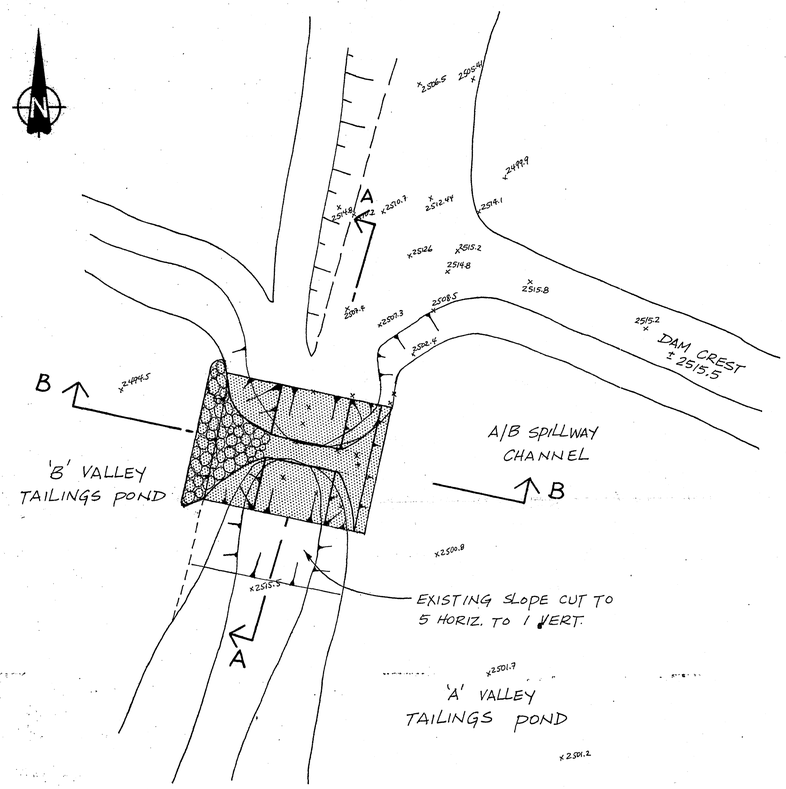
SCALE - 1" = 40'



SECTION E-E

HUDSON BAY MINING & SMELTING CO. LTD.	DATE JULY 1992
WHITEHORSE COPPER MINE SITE	PROJ. NO. 90-149
"OLD POND" - SPILLWAYS 6 & 7 DECOMMISSIONING EARTHWORKS	APPROVED
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	NO. 20

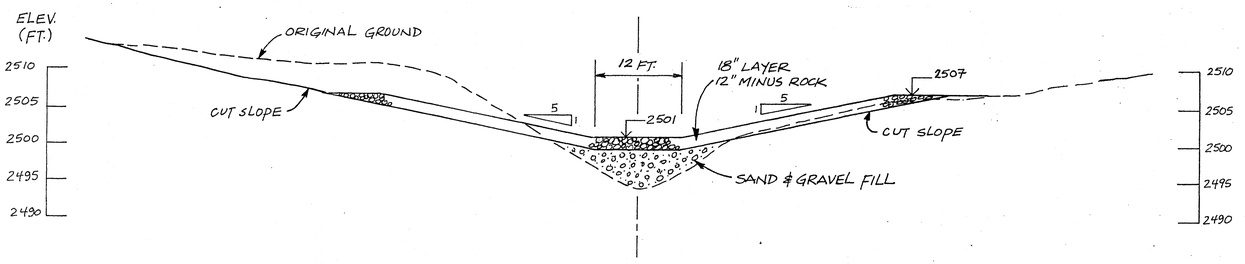
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PLAN OF A/B SPILLWAY CHANNEL

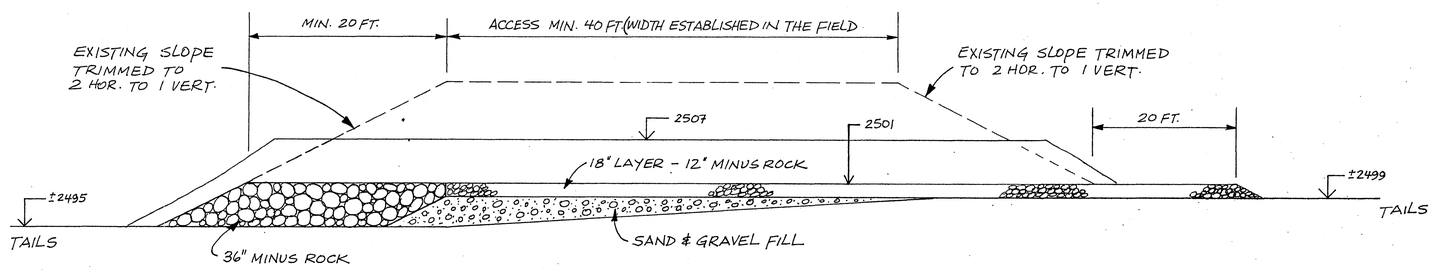
SCALE - 1" = 40'

FIELD SURVEY BY UNDERHILL & UNDERHILL



SECTION A-A

SCALE - 1" = 10'

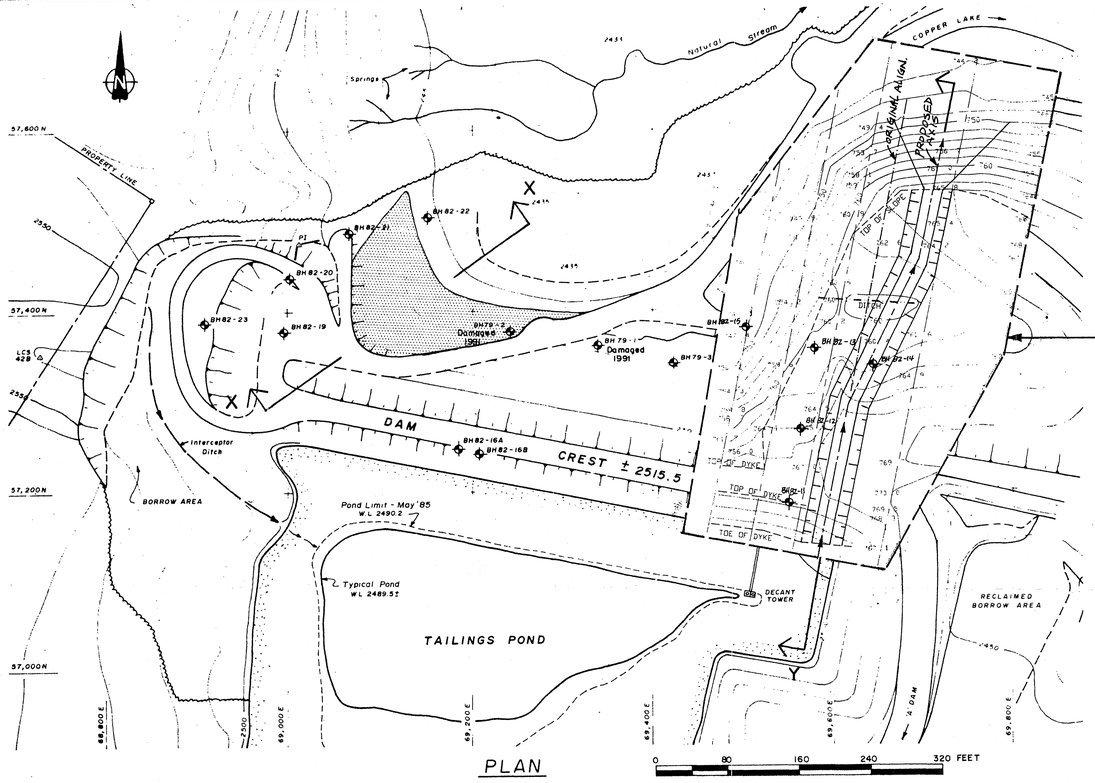


SECTION B-B

SCALE - 1" = 10'

HUDSON BAY MINING & SMELTING CO. LTD.	DATE - JULY 1992
WHITEHORSE COPPER MINE SITE	PROJ. NO. 90-149
A/B SPILLWAY CHANNEL DECOMMISSIONING EARTHWORKS	APPROVED
GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN	NO. 21

YUKON ENERGY, MINES & RESOURCES LIBRARY
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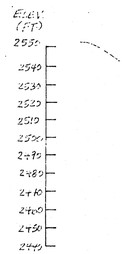


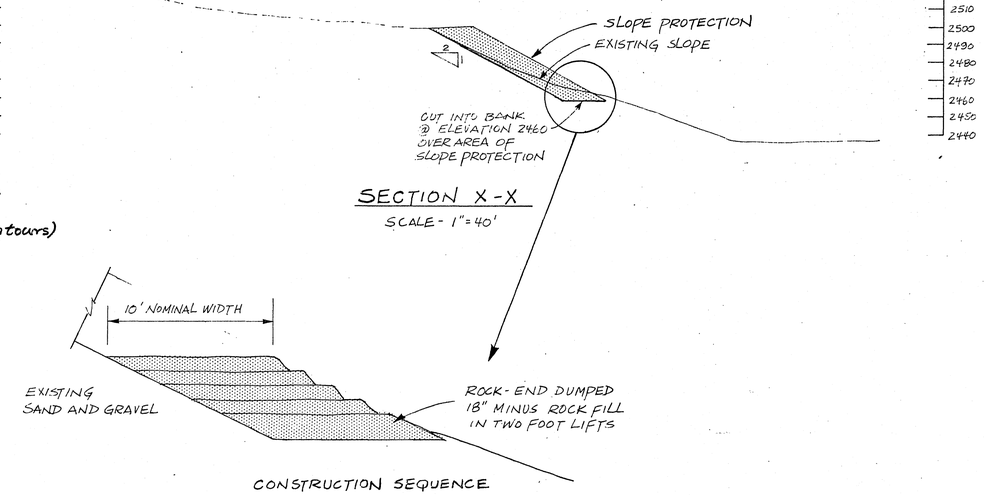
PLAN

SCALE - 1"=80'

0 80 160 240 320 FEET

CONTOURS IN BOXED AREA SURVEYED JUNE '1994 (Metric contours)

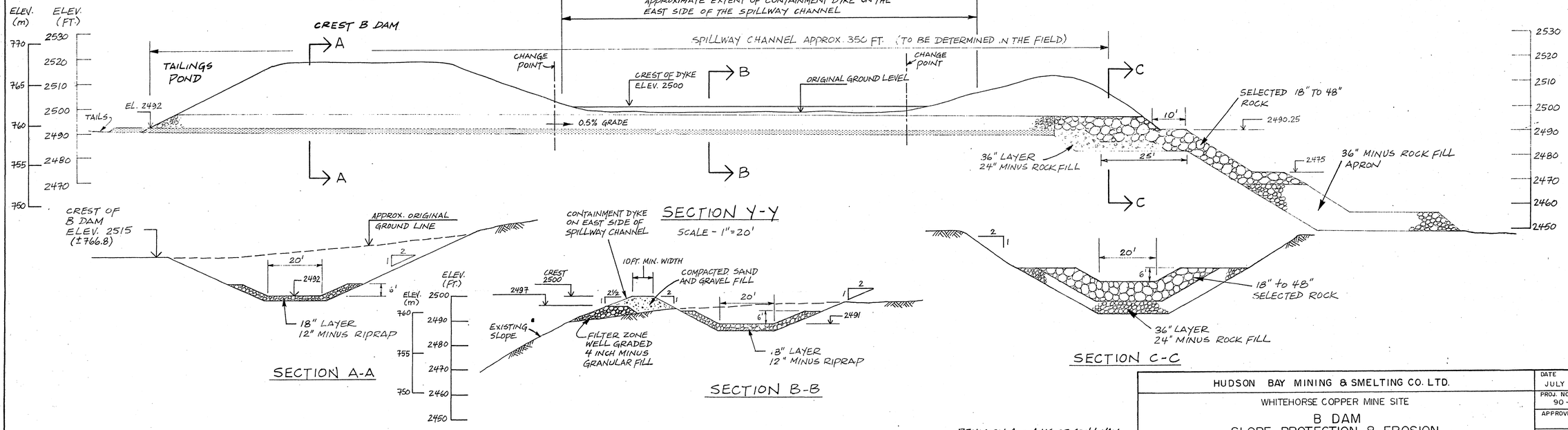




SECTION X-X

SCALE - 1"=40'

CONSTRUCTION SEQUENCE



SECTION A-A

SECTION Y-Y

SCALE - 1"=20'

SECTION B-B

SECTION C-C

REVISION A - AXIS OF SPILLWAY CHANNEL RELOCATED

HUDSON BAY MINING & SMELTING CO. LTD.

WHITEHORSE COPPER MINE SITE

B DAM
SLOPE PROTECTION & EROSION DECOMMISSIONING EARTHWORKS

GADSBY CONSULTANTS LTD. IN ASSOCIATION WITH STEFFEN ROBERTSON & KIRSTEN

DATE: JULY 1992

PROJ. NO.: 90 - 149

APPROVED:

NO.: 22A

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P.O. Box 2703
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TN443
.C3
W54
APPENDIX
C
c.1

APPENDIX C
HUDSON BAY MINING & SMELTING COMPANY LTD.
WHITEHORSE COPPER MINE

LABORATORY AND FIELD DATA

Tailings and Rock Characteristics

HBM&S Leach Tests 1983.....C1
Chemex Labs ABA Tests 1991.....C2
Coastech Research Inc. ABA Test 191.....C3

Water Sample Analyses

Cantest (Thompson Geotechnical) 1989.....C4
Analytical Service Laboratories July 1991.....C5
Analytical Service Laboratories August 1991.....C6
Analytical Service Laboratories September 1991.....C7
Analytical Service Laboratories October 1991.....C8

Tailings Subject to Wind Erosion

SRK - Gradation Tests September 1991.....C9
Bacon & Donaldson - Sub-sieve size September 1991.....C10
Chemex Labs Ltd. - Mineralogy of 10 micron size
September 1991.....C11
Bacon & Donaldson S.E.M. point count of Free Silica
October 1991.....C12
A.E. Hall - Letter October 1991.....C13

Bore Hole Logs

Thompson Geotechnical Ltd.....C14
Lower B Valley: 80-1
Old Pond: 82-1; 82-2; 82-24; 82-3; 82-4; 82-5; 82-6; 82-7; 82-8; 82-9; 82-10;
B. Embankment Dam: 82-11; 82-12; 82-13; 82-14; 82-15;82-16; 82-19; 82-20; 82-21; 82-22; 82-23;
A Valley: 83-1; 83-2.

Piezometer Readings

Thompson Geotechnical Ltd.....C15
Stand pipe piezometers.
Old Pond
Section A-A: 82-1A; 82-1B; 82-2A; 82-2B; 82-24A; 82-24b;
Old Pond
Section B-B: 82-3A; 82-4; 82-5A; 82-5B;
Old Pond
Section C-C: 82-7; 82-8A; 82-8B;
Old Pond: 82-9; 82-10.
A Dam: 81-1;
A Valley: 83-1; 83-2;
B Dam: 79-1; 79-2; 79-3; 82-11; 82-12; 82-13; 82-14; 82-15; 82-16A; 82-16B; 82-19; 82-20; 82-21; 82-23;
B Valley: 80-1
Pnuematic Piezometers.....C16

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A Dam: 80-3A; 80-3B; 80-3C; 81-2; 81-3; 81-4; 81-5A; 81-5B; 81-6; 81-7; 81-8A; 81-8B; 81-8C.

Streamflow Observations
Thompson Geotechnical Ltd.....C17
Stations: A1; A2; A3; A4; B1; B2; B3; B4; B5-a; B5-b; C1a; C3; C4.

Seismic Hazard Calculation
Pacific Geoscience Centre.....C18

Tailings and Rock Characteristics
Appendices C1 to C3 inclusive

Form No. 153

C-1 K

INTER-OFFICE CORRESPONDENCE

HUDSON BAY MINING AND SMELTING CO., LIMITED

Date MARCH 16, 1983

To P. PERCIVAL/W.H. COPPER At

From W.W. FRASER At

Subject WHITEHORSE COPPER TAILINGS

ATTACHED ARE SEVERAL REPORTS AND MEMOS COVERING WORK CONDUCTED ON SAMPLES OF WHC TAILINGS RESPECTING POSSIBLE POST-ABANDONMENT ENVIRONMENTAL IMPACT.

THE PRINCIPLE AND SIGNIFICANT CONCLUSIONS ARE AS FOLLOWS:

(1) SULFUR IN THE TAILINGS APPEARS LOCKED WITH THE COPPER, NOT WITH THE IRON, AND THEREFORE SHOULD BE RELATIVELY STABLE.

(2) IF THE SULFUR IS CONVERTED TO ACID, THE TAILINGS HAVE SUFFICIENT ALKALINITY TO PROVIDE IN-SITU NEUTRALIZATION. THE MAXIMUM ACID THAT COULD BE GENERATED IS LESS THAN 12 POUNDS PER TON OF TAILINGS, WHILE THE NEUTRALIZING ABILITY IS 176 POUNDS PER TON.

(3) THE COPPER, THOUGH SOLUABLE UNDER CERTAIN CONDITIONS, SHOULD NOT DISSOLVE UNDER THOSE CONDITIONS WHICH CAN BE PREDICTED TO OCCUR IN THE TAILINGS POND.

WE ARE PREPARED TO DO ANY ADDITIONAL WORK YOU FEEL IS NEEDED, OR TO PROVIDE EXPERT TESTIMONY ON OUR STUDIES.

W.W. FRASER

:JM

CC: J.W. SENKA
FILE

Originals Also to Terry Rept.

Form No. 163

C1

INTER-OFFICE CORRESPONDENCE

HUDSON BAY MINING AND SMELTING CO., LIMITED

Date MARCH 16, 1983

To W.W. FRASER At

From J.W. SENKA At

Subject WHITEHORSE COPPER TAILINGS - LEACH TESTS

(THE FOLLOWING WORK WAS DONE IN CONSULTATION WITH OUR DR. BATRIC PESIC.)

INTRODUCTION

ADVERSE EFFECTS FROM TAILINGS PONDS ON THE ENVIRONMENT CAN OCCUR DUE TO THE GENERATION OF H_2SO_4 AND $Fe(SO_4)_3$. THE ACIDIC NATURE OF THESE CHEMICALS, AS WELL AS BEING OF DIRECT CONCERN, CAN POTENTIALLY LEACH STABLE COMPOUNDS FROM THE TAILINGS AND ADD METAL VALUES TO ANY RUN-OFF WATER.

SULFUR COMPOUNDS IN THE TAILINGS ARE THE SOURCE OF SULFATE COMPOUNDS. ALTHOUGH THERE ARE MANY INTERMEDIATE STAGES, THE REACTION INITIATED BY WEATHERING CAN BE SUMMARIZED AS FOLLOWS:

$$FeS_2 + \underset{(RAIN)}{H_2O} + \underset{(AIR)}{7O} \rightarrow FeSO_4 + H_2SO_4$$

$FeSO_4$ CAN BE FURTHER OXIDIZED BY AIR:

$$2FeSO_4 + H_2SO_4 + \tfrac{1}{2}O_2 \rightarrow Fe_2(SO_4)_3 + H_2O$$

$Fe_2(SO_4)_3$ IS SOLUBLE BELOW PH = 3.5 AND IS A POWERFUL OXIDANT. IT WILL DISSOLVE MINERALS AS FOLLOWS:

$$MeS + Fe^{+3} \rightarrow Me^{+2} + Fe^{+2} + S^{\circ} + 4e^{-}$$

(WHERE MeS = Cu_2S, CuS, $CuFeS_2$, Cu_2FeS_4)

H_2SO_4 CAN ALSO PARTICIPATE IN DISSOLUTION OF METAL-BEARING MINERALS IN THE PRESENCE OF OXYGEN:

$$MeS + H_2SO_4 + \underset{(AIR)}{O_2} \rightarrow Me^{+2} + H_2O + 2e$$

THUS, WHEN SULFIDE MINERALS (IE. PYRITES) ARE EXPOSED TO ATMOSPHERIC CONDITIONS, THE DISSOLUTION OF METALS INEVITABLY OCCURS.

THIS WAS PROVEN IN THE LABORATORY TRIALS SHOWN BELOW. THE IMPORTANT FACT, HOWEVER IS THAT IT ONLY OCCURRED WHEN H_2SO_4 AND $Fe_2(SO_4)_3$ WERE ARTIFICIALLY INTRODUCED TO THE TAILINGS AT PH = 1.1. IN A MODERATELY ACID SOLUTION (PH = 4.0), THE BASIC NATURE OF THE TAILINGS WAS SHOWN TO BE MORE THAN CAPABLE OF NEUTRALIZING THE ACID. FURTHER MORE, THE

EFFECTS DESCRIBED ABOVE WOULD BE MINIMAL DUE TO THE EXTREMELY LOW SULFUR CONTENT OF THE TAILINGS.

THIS STUDY WAS CONDUCTED TO DETERMINE WHAT PERCENTAGE OF CU AND MG WOULD DISSOLVE FROM THE TAILINGS AT PH = 1, 4 AND 8 AS WELL AS $Fe_2(SO_4)_3$ SOLUTION AT PH = 1.

CONCLUSIONS

CU

- 100% OF THE CU LEACHED OUT AFTER 72 HOURS OF MECHANICAL STIRRING IN $Fe_2(SO_4)_3$ SOLUTION AT PH = 1.1.
- 24% OF THE CU LEACHED WITH AN H_2SO_4 SOLUTION AT PH = 1.1.
- THE DIFFERENCE IN THE ABOVE TWO VALUES CAN BE ATTRIBUTED TO THE OXIDIZING CHARACTER OF THE FERRIC IONS.
- LESS THAN 1% OF THE CU DISSOLVED AT PH = 4.0 AND PH = 8.0.
- THE ACID-CONSUMING CAPACITY OF THE TAILINGS WAS DEMONSTRATED IN TRIAL #2 WHERE THE PH OF THE SOLUTION IMMEDIATELY ROSE FROM 4.0 TO 9.4.
- SINCE ALL THE CU DISSOLVED IN THE $Fe_2(SO_4)_3$ SOLUTION, IT CAN BE STATED THAT MOST OF THE CU IS IN THE FORM OF BORNITE, CAVELLITE AND CALCOCITE RATHER THAN THE MORE STABLE CHALCOPYRITE.
- CU CONCENTRATION IN THE PH 4.0 + 8.0 LEACHATE RANGED FROM 0.03 TO 0.12 MG/L, WHILE VALUES OF 0.31 AND 0.14 WERE ATTRIBUTED TO ANALYTICAL ERROR. THESE DEPEND ON RATIO OF SOLIDS TO LIQUID CHOSEN FOR TESTS AND CANNOT BE DIRECTLY USED FOR PREDICTING FIELD LEVELS.

MG

- LESS THAN 9% OF THE MG WAS LEACHED IN ALL CASES. ALTHOUGH CONCENTRATION OF THIS METAL WENT AS HIGH AS 870 MG/L (IN $Fe_2(SO_4)_3$), THIS METAL IS OF NO MAJOR ENVIRONMENTAL CONCERN.

EXPERIMENTAL

- 10% SLURRY WAS EMPLOYED, USING 800 ML OF SAMPLE IN EACH OF 4 TRIALS.

- PH OF LEACH WATER WAS:

  TRIAL 1 PH = 1.1 (WITH H_2SO_4)
  TRIAL 2 PH = 4.0 (WITH H_2SO_4)
  TRIAL 3 PH = 8.3 (WITH NACH)
  TRIAL 4 PH = 1.1 (WITH 0.1 M $Fe_2(SO_4)_3$)

- TRIALS 1-3 WERE MIXED BY AERATION, IE. TO CAUSE OXIDATION BY OXYGEN.

  TRIAL 4 WAS MIXED MECHANICALLY WITH A MAGNETIC STIRRER (OXIDATION BY Fe^{+3})

- MIXING TOOK PLACE OVER A PERIOD OF 72 HOURS AT ROOM TEMPERATURE.

- PH'S WERE RECORDED INTERMITTENTLY, AND 10 ML SAMPLE DRAWN OFF FOR CU AND MG ANALYSES BY THE ATOMIC ABSORPTION METHOD. (NOTE: SOME HIGH METAL VALUES WERE OBTAINED WHERE SAMPLES WERE CLOUDY DUE TO INADEQUATE SETTLING AND FILTRATION. THIS WAS ESPECIALLY THE CASE IN TRIAL #1. DURING ANALYSES, METAL VALUES WERE FOUND TO INCREASE AFTER SHAKING THE SAMPLE VIAL).

RESULTS

SAMPLE	MIX TIME (HR)	PH	VOLUME SLURRY (ML)	VIAL #	CU MG/L	(∝) % LEACHED	MG MG/L	(∝) % LEACHED
TRIAL #1 - PH = 1.1								
	0	1.40						
1	2.0	1.50	800	1	38.0	13.6	96.0	1.03
2	9.0	1.60	794	5	53.0	18.8	180.0	1.9
3	23.5	1.60	785	9	62.0	22.0	320.0	3.4
4	33.25	1.95	775	13	65.0	22.4	360.0	3.8
5	47.75	2.10	765	17	69.0	23.6	430.0	4.4
6	57.25	2.30	755	21	70.0	23.6	440.0	4.5
7	71.5	2.70	745	25	70.0	23.3	480.0	4.8
TRIAL #2 - PH = 4.00								
	0	9.40						
1	2.25	7.20	795	2	0.14	0.05	7.3	0.08
2	9.0	8.25	790	6	0.07	0.02	9.3	0.10
3	23.5	8.30	780	10	0.04	0.015	12.3	0.13
4	33.25	8.32	770	14	0.04	0.014	11.7	0.12
5	47.75	8.30	760	18	0.04	0.014	14.5	0.15
6	57.25	8.25	740	22	0.04	0.013	15.5	0.15
7	71.5	8.60	730	26	0.03	0.010	13.7	0.14
TRIAL #3 - PH = 8.30								
	0	9.60						
1	2.5	8.20	800	3	0.07	0.03	6.6	0.07
2	9.0	8.40	795	7	0.31	0.11	10.3	0.11
3	23.5	8.30	785	11	0.08	0.03	10.7	0.11
4	33.25	8.32	775	15	0.06	0.02	11.7	0.12
5	47.75	8.25	765	19	0.03	0.01	13.0	0.13
6	57.25	8.45	755	23	0.12	0.04	14.0	0.14
7	71.5	N/A	745	27	0.06	0.02	14.3	0.14
TRIAL #4 - $FE_2(SO_4)_3$ AT PH = 1.1								
	1.40							
1	2.75	1.30	800	4	176	62.9	310	3.33
2	9.0	1.35	795	8	203	72.0	440	4.70
3	23.5	1.40	785	12	227	79.6	580	6.12
4	33.25	1.45	775	16	248	85.8	650	6.81
5	47.75	1.50	765	20	275	95.6	740	7.61
6	57.25	1.80	755	24	284	95.7	800	8.12
7	71.5	1.90	745	28	303	100.0	870	8.71

CALCULATIONS WERE BASED ON THE FOLLOWING DATA:

ORIGINAL VOLUME OF SAMPLE - 800 ML
AMOUNT OF TAILINGS - 80 G

CU ASSAY - 0.28%
CU CONTENT IN EACH SAMPLE - 0.224 G
MG ASSAY - 9.3%
MG CONTENT IN EACH SAMPLE - 7.44 G

α FACTOR REPRESENTING % OF ORIGINAL METAL LEACHED IS CALCULATED AS FOLLOWS:

$$\frac{(ME)}{1000} \times \frac{V}{1000} \times \frac{1}{\text{ORIGINAL ME CONTENT}} \times 100$$

WHERE (ME) = CONCENTRATION OF DISSOLVED METAL
V = VOLUME OF LEACH WATER

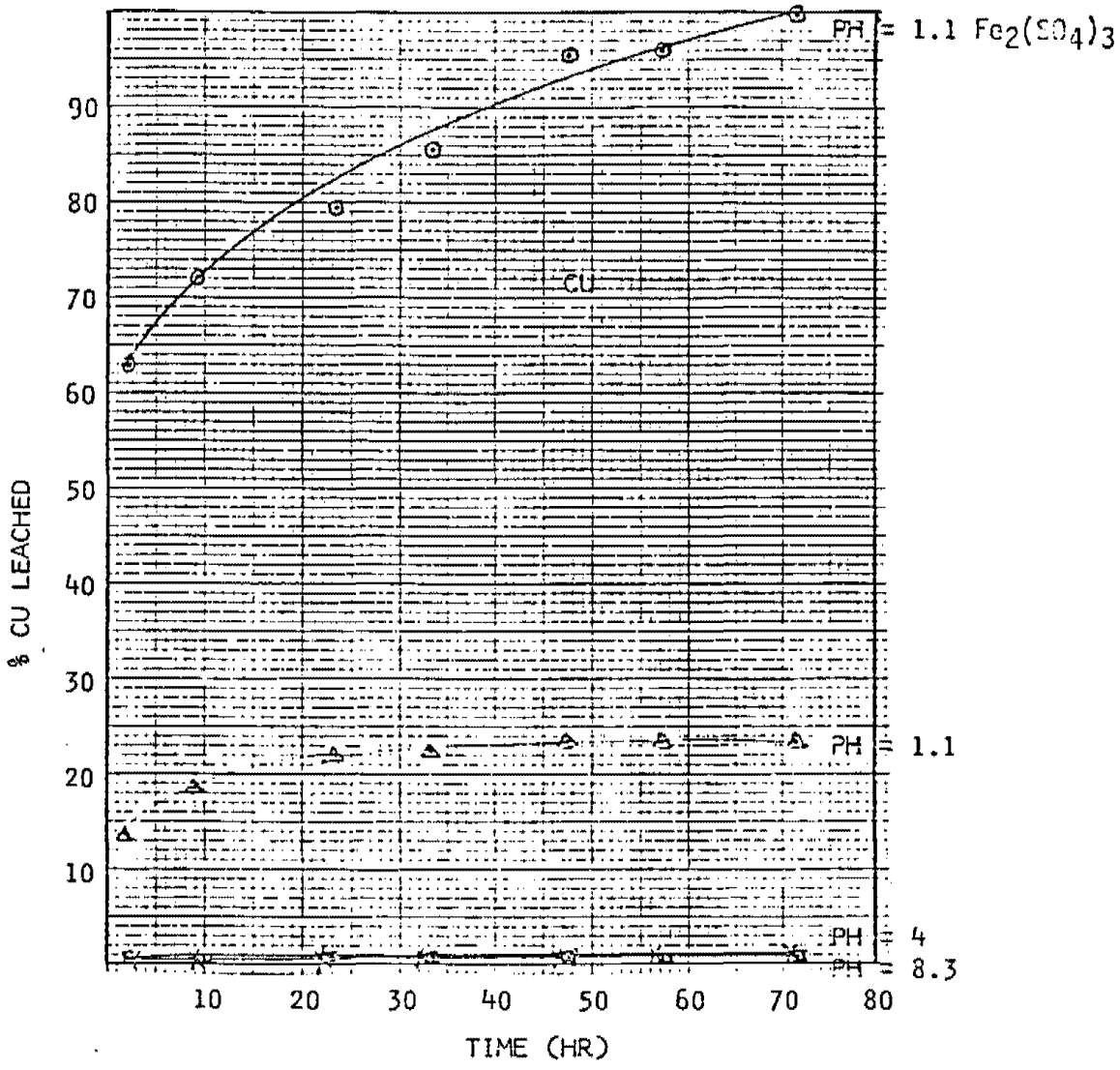
J.W. SENKA

:JM

CC: R.V. TYPLISKI
S.P. WEST
B. PESIC
J.W. SENKA

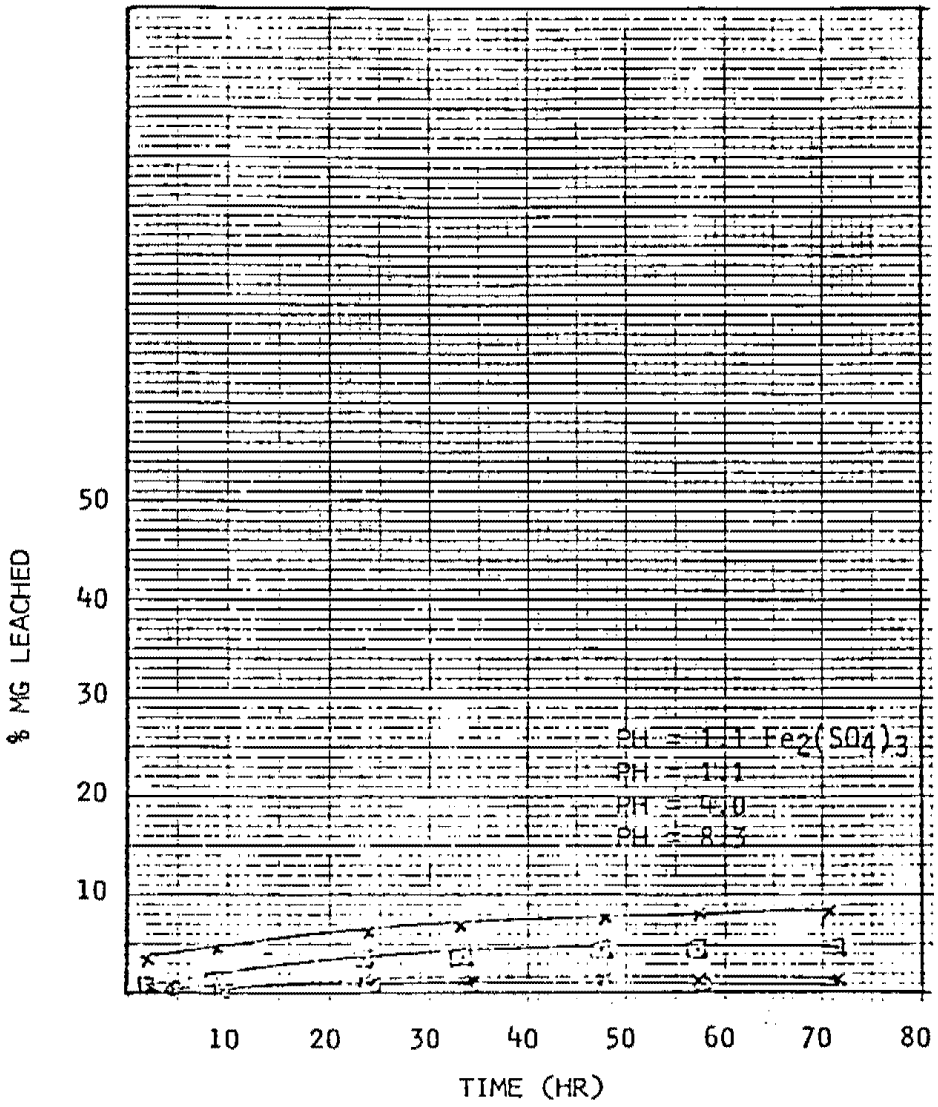
% CU LEACHED VS TIME

ROOM TEMPERATURE
800 ML SAMPLE
10% SLURRY
CU = 0.28%



% MG LEACHED VS TIME

ROOM TEMPERATURE
800 ML SAMPLE
10% SLURRY
MG = 9.3%



C1

WHITEHORSE COPPER TAILINGS

REF. (D.W. DUNCAN) GROUP LEADER
MINERAL BIOLOGY
AND
C.C. WALDEN, HEAD
DIVISION OF APPLIED BIOLOGY
B.C. RESEARCH

ACID PRODUCING POTENTIAL

SINCE SULFUR CONTENT IS 0.2%, THE TOTAL WEIGHT OF ACID THAT COULD BE GENERATED (EXPRESSED AS H_2SO_4) IS:

$0.002 \times 2000 \times 98/32 = 11.64$ LB H_2SO_4/TON OF TAILINGS

ACID CONSUMPTION VALUE

DETERMINED BY TITRATION OF 10 G SOLID, SLURRIED WITH 100 ML DISTILLED WATER, AND TITRATED TO A PH = 3.5 WITH 1.0 NH_2SO_4:

IN THIS CASE, THE AMOUNT OF ACID ABSORBED WAS 18 ML (A DUPLICATE TITRATION WITH 0.1 N H_2SO_4 WAS 180 ML).

∴ ACID CONSUMPTION VALUE IS:

$18 \times 98/2 \times 1/1000 \times 200/10 = 176.4$ LB H_2SO_4/TON OF TAILINGS

Form No. 163

C-1

INTER-OFFICE CORRESPONDENCE

HUDSON BAY MINING AND SMELTING CO., LIMITED

Date MARCH 16, 1983

To W.W. FRASER At

From J.W. SENKA At

Subject MINERALOGICAL ANALYSES OF WHC TAILINGS

THE FOLLOWING IS A MINERALOGICAL BREAKDOWN OF THE MAJOR CONSTITUENTS OF WHITEHORSE COPPER TAILINGS. THIS ANALYSIS WAS CONDUCTED JOINTLY BY D. MACNAMARA (MILL METALLURGIST) AND KELLY GILMORE (EXPLORATION GEOLOGIST) WITH REFERENCE TO DANA'S MANUAL ON MINERALOGY.

THE MINERALS ARE LISTED IN ORDER OF AMOUNTS, THE TOTAL COMPROMISING APPROXIMATELY 95-99% OF THE PARTICLES. (A FEW PARTICLES COULD NOT BE CLEARLY IDENTIFIED, AND COULD, IN FACT HAVE BEEN FORMS OF GLOSSULARITE.)

James W Senka

J.W. SENKA

:JM

STEREOSCOPIC EXAMINATION OF WHITEHORSE COPPER TAILINGS

Minerals Observed (approx. in order of amounts)

1.) Quartz - SiO_2 (clear, glasslike fracture)

2.) Garnet - probably Grossularite $Ca_3Al_2(SiO_4)_3$ (yellowish color, irregular fracture, translucent.

3.) Magnetite - Fe_3O_4 (dark, metallic black color, magnetic)

4.) Dropside $CaMgSi_2O_6$ clear, colorless, marked striations
Tremolite $Ca_2Mg_5Si_8O_{22}(OH)_2$ bladed or columnar
Wallastenite $CaSiO_3$

5.) Talc - $Mg_3Si_4O_{10}(OH_2)$ - micaceous, silvery white, translucent

6.) Calcite - $CaCO_3$ - white, effervesces in HCl acid

7.) Serpentine - $Mg_3Si_2O_5(OH)_4$ - striations, columnar, greenish color

8.) Chlorite - $(MgFe)_5$ (Al Fe $)_2$ $Si_3O_{10}(OH)_8$ - green color, micaceous

9.) Cu minerals (very minor) - bornite Cu_5FeS_4 - purple, blue to black
total assay only .28% Cu cavellite CuS - blue
.19% S calcocite Cu_2S - lead gray
chalcopyrite $CuFeS_2$ - brass yellow

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC.

SUITE 800 - 580 HORNBY ST.
VANCOUVER, BC
V6C 3B6

A9117931

Comments: ATTN: JOHN CHAPMAN

CERTIFICATE A9117931

STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC.

Project: 90149 (JWG)
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 24-JUL-91.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
208	4	Assay ring to approx 150 mesh
294	2	Crush and split (0-10 pounds)

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
1119	4	Paste pH	POTENTIOMETER	N/A	N/A
466	4	SO4 %: Acid or H2O leach	GRAVIMETRIC	0.01	100.00
1066	4	S %: HNO3-bromide digestion	GRAVIMETRIC	0.01	100.00
380	4	S %: Leco induction furnace	LECO-IR DETECTOR	0.001	100.0
1117	4	Maximum potential acidity	CALCULATION	N/A	N/A
1118	4	Neutralization potential	TITRATION	N/A	N/A
1970	4	Net neutralization potential	CALCULATION	N/A	N/A
1971	4	Neutraliz. pot. acidity ratio	CALCULATION	N/A	N/A

C2

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC. **

SUITE 800 - 580 HORNBY ST.
VANCOUVER, BC
V6C 3B6

Project : 90149 (JWG)
Comments: ATTN: JOHN CHAPMAN

Page Number :1
Total Pages :1
Certificate Date: 24-JUL-91
Invoice No. :I9117931
P.O. Number :

CERTIFICATE OF ANALYSIS A9117931

SAMPLE DESCRIPTION	PREP CODE		PASTE pH	SO4 % *	Sulfide S% ***	S % (Leco)	MAX POT ACID **	Neutral Poten**	Net Neu Poten**	RATIO NP/MPA		
90149/1	208	294	9.1	0.12	0.35	0.583	18	52	34	2.89	U/G Rock pile	
90149/2	208	294	9.0	0.02	0.02	0.045	1	25	24	25.00	L.C. Rock pile	
90149/3	208	--	9.3	0.19	< 0.01	0.181	6	209	203	34.80	old pond tails	
90149/4	208	--	9.1	0.13	< 0.01	0.132	4	283	279	70.80	A Valley tails.	

NOTE: * HYDROCHLORIC ACID SOLUBLE SULFATE
NOTE: ** UNITS = KILOGRAMS CaCO3 EQUIVALENT PER METRIC TONNE (Kg/MT)
NOTE: *** NITRIC ACID SOLUBLE SULFIDE

CERTIFICATION: [signature]

C2

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC.

SUITE 800 - 580 HORNBY ST.
VANCOUVER, BC
V6C 3B6

A9117932

Comments: ATTN: JOHN CHAPMAN

CERTIFICATE A9117932

STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC.

Project: 90149 (JWG)
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 23-JUL-91.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
299	4	Sample split from other certif
233	4	Assay AQ ICP digestion charge
* NOTE	1:	

The 32 element ICP package is suitable for trace metals in soil and rock samples. Elements for which the nitric-aqua regia digestion is possibly incomplete are: Al, Ba, Be, Ca, Cr, Ga, K, La, Mg, Na, Sr, Ti, Tl, W.

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
922	4	Ag ppm: 32 element, soil & rock	ICP-AES	0.2	200
921	4	Al %: 32 element, soil & rock	ICP-AES	0.01	15.00
923	4	As ppm: 32 element, soil & rock	ICP-AES	5	10000
924	4	Ba ppm: 32 element, soil & rock	ICP-AES	10	10000
925	4	Be ppm: 32 element, soil & rock	ICP-AES	0.5	100.0
926	4	Bi ppm: 32 element, soil & rock	ICP-AES	2	10000
927	4	Ca %: 32 element, soil & rock	ICP-AES	0.01	15.00
928	4	Cd ppm: 32 element, soil & rock	ICP-AES	0.5	100.0
929	4	Co ppm: 32 element, soil & rock	ICP-AES	1	10000
930	4	Cr ppm: 32 element, soil & rock	ICP-AES	1	10000
931	4	Cu ppm: 32 element, soil & rock	ICP-AES	1	10000
932	4	Fe %: 32 element, soil & rock	ICP-AES	0.01	15.00
933	4	Ga ppm: 32 element, soil & rock	ICP-AES	10	10000
951	4	Hg ppm: 32 element, soil & rock	ICP-AES	1	10000
934	4	K %: 32 element, soil & rock	ICP-AES	0.01	10.00
935	4	La ppm: 32 element, soil & rock	ICP-AES	10	10000
936	4	Mg %: 32 element, soil & rock	ICP-AES	0.01	15.00
937	4	Mn ppm: 32 element, soil & rock	ICP-AES	5	10000
938	4	Mo ppm: 32 element, soil & rock	ICP-AES	1	10000
939	4	Na %: 32 element, soil & rock	ICP-AES	0.01	5.00
940	4	Ni ppm: 32 element, soil & rock	ICP-AES	1	10000
941	4	P ppm: 32 element, soil & rock	ICP-AES	10	10000
942	4	Pb ppm: 32 element, soil & rock	ICP-AES	2	10000
943	4	Sb ppm: 32 element, soil & rock	ICP-AES	5	10000
958	4	Sc ppm: 32 elements, soil & rock	ICP-AES	1	10000
944	4	Sr ppm: 32 element, soil & rock	ICP-AES	1	10000
945	4	Ti %: 32 element, soil & rock	ICP-AES	0.01	5.00
946	4	Tl ppm: 32 element, soil & rock	ICP-AES	10	10000
947	4	U ppm: 32 element, soil & rock	ICP-AES	10	10000
948	4	V ppm: 32 element, soil & rock	ICP-AES	1	10000
949	4	W ppm: 32 element, soil & rock	ICP-AES	10	10000
950	4	Zn ppm: 32 element, soil & rock	ICP-AES	2	10000

C2

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC. **

SUITE 800 - 580 HORNBY ST.
VANCOUVER, BC
V6C 3B6

Project : 90149 (JWG)
Comments: ATTN: JOHN CHAPMAN

Page Number :1-A
Total Pages :1
Certificate Date: 23-JUL-91
Invoice No. :I9117932
P.O. Number :

CERTIFICATE OF ANALYSIS A9117932

SAMPLE DESCRIPTION	PREP CODE		Ag ppm	Al %	As ppm	Ba ppm	Be ppm	Bi ppm	Ca %	Cd ppm	Co ppm	Cr ppm	Cu ppm	Fe %	Ga ppm	Hg ppm	K %	La ppm	Mg %	Mn ppm	Mo ppm
90149/1	299	233	2.2	0.97	< 5	1520	< 0.5	4	2.23	0.5	11	48	674	2.20	20	< 1	0.15	20	1.17	345	74
90149/2	299	233	1.8	2.19	5	60	< 0.5	< 2	3.71	2.0	9	14	310	1.44	20	1	0.16	60	1.28	170	< 1
90149/3	299	233	< 0.2	1.63	< 5	130	1.5	< 2	6.12	< 0.5	47	42	2080	>15.00	10	< 1	0.22	< 10	6.30	780	8
90149/4	299	233	< 0.2	2.34	5	170	1.0	< 2	9.21	< 0.5	23	51	2260	6.08	10	< 1	0.23	< 10	7.95	625	28

CERTIFICATION: B. Caplan

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

To: STEFFEN ROBERTSON AND KIRSTEN (B.C.) INC. **

SUITE 800 - 580 HORNBY ST.
VANCOUVER, BC
V6C 3B6

Project : 90149 (JWG)
Comments: ATTN: JOHN CHAPMAN

Certificate Date: 23-JUL-91
Invoice No. :19117932
P.O. Number :

CERTIFICATE OF ANALYSIS A9117932

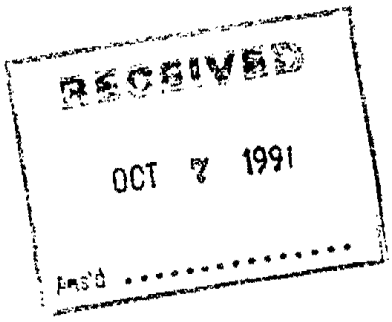
SAMPLE DESCRIPTION	PREP CODE		Na %	Ni ppm	P ppm	Pb ppm	Sb ppm	Sc ppm	Sr ppm	Ti %	Tl ppm	U ppm	V ppm	W ppm	Zn ppm
90149/1	299	233	0.06	12	560	36	5	3	374	0.03	< 10	130	31	< 10	168
90149/2	299	233	0.08	8	3890	36	< 5	2	65	0.06	< 10	100	37	< 10	90
90149/3	299	233	0.04	20	550	6	10	4	185	0.08	< 10	10	36	< 50	120
90149/4	299	233	0.04	23	590	8	10	5	325	0.10	< 10	60	41	< 10	94

C2

CERTIFICATION: B. Campbell

C 3

COASTECH RESEARCH INC.



Via Fax & Mail : 687 5532
No. of pages : 02

Steffen, Robertson & Kirsten
#800 - 580 Hornby Street
Vancouver, B.C.
V6C 3B6

September 30, 1991

Attn: Mr. John Chapman, P. Eng.

Dear John,

Please find enclosed the acid base account test result for the JWG sample (SRK Job # : 90-149). The test was conducted on a representative sample which was obtained by multiple riffling of the entire screened sample (approx. 15 kg). Due to an error in sample labelling, please disregard the set of results I faxed to you on September 6, 1991.

We sincerely regret the error in the initial test and apologise for any inconvenience this matter might have caused.

Yours very truly,

COASTECH RESEARCH INC.

Tony Y. Chong
Senior Project Metallurgist

Approved by :

Peter Bosse
President

Enclosure.

88 Niche Street, North Vancouver, B.C., Canada, V7L 2C9 Telephone (604) 980-5992 FAX (604) 980-2737

September 30, 1991.

Steffen, Robertson & Kirsten
SRK Job # : 90 - 149 (JWG)
Coastech Project No. M181

ACID-BASE ACCOUNT

SAMPLE	PASTE pH	S(T) (%)	S(SO4) (%)	S(S) (%)	ACID * POTENTIAL	NEUT. * POTENTIAL	NET * NP
Composite Sample	8.97	0.27	0.06	0.21	6.5	68.5	61.9

* Acid potential, neutralization potential and net neutralization potential are given in kg CaCO3 equivalent per tonne.

Note : A negative Net Neutralisation Potential (Net NP) indicates that the sample is a potential source of acid mine drainage.

Water Sample Analyses
Appendices C4 to C8 inclusive

C4

CANTEST

CanTest Ltd

Professional
Analytical
Services

Suite 200
1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

EPORT ON: Analysis of Water Samples

EPORTED TO: Thompson Geotechnical Consultants
225 - 18th Gostick Place
North Vancouver, B.C.
V7M 3G3

Att'n: Brian Thompson

ILE NO: 8096H

DATE: September 7, 1989 **(Amended September 12, 1989)**

We have tested the samples submitted by you and report as follows:

AMPLE IDENTIFICATION:

he samples were identified as:

PROJECT NAME: WHC-80001
ATE SAMPLED: August 16 & 17, 1989
ATE SUBMITTED: August 18, 1989
YPE OF CONTAINER: Plastic

or further identification, see "Results of Testing".

SUMMARY:

or the chemical parameters tested, some of the samples did not meet the limits set by the "British Columbia Drinking Water Quality Standards, 1982", Province of B.C., Ministry of Health and "Guidelines for Canadian Drinking Water Quality, 1978", published by authority of Health and Welfare anada, as indicated in the "Results of Testing".

Parameters are limited for health or aesthetic reasons. The parameters that did not meet the limits ere pH, color, manganese and total dissolved solids, which are limited primarily for aesthetic onsiderations.

he water represented by the samples submitted may be characterized as high in dissolved ineralization and hard with respect to hardness.

ESULTS OF TESTING

(on the following pages)

AN TEST LTD.

on M. Enns, B.Sc., M.B.A.
Assistant Manager

ME/csd
C:WATER

20
Years of
Analytical
Excellence
since 1969

CANTEST

iompson Geotechnical Consultants
ile No: 8096H
'age No: 2

SAMPLE IDENTIFICATION AND RESULTS OF TESTING:

AMPLE # / CLIENT SAMPLE I.D.		8096-1 COPPER LAKE AUG. 17	8096-2 POND 2403 AUG. 16	8096-3 LOWER CRATER LAKE - AUG.16	MAXIMUM ACCEPTABLE CONC.***
HYSICAL TESTS					
H (pH units)		8.33	8.26	8.61x	6.5-8.5
onductivity (us/cm)		675.	383.	600.	-
ue Color (CU)		5.	<5.	20.x	15.
Turbidity (NTU)		3.3	0.23	2.0	5.
Hardness as CaCO3		381.	215.	323.	-
otal Dissolved Solids (mg/L)		675.x	366.	568.x	500.*
SSOLVED ANIONS (mg/L)					
kalinity:					
Bicarbonate	HCO3	389.	254.	349.	-
Carbonate	CO3	Nil	Nil	Nil	-
Hydroxide	OH	Nil	Nil	Nil	-
Chloride	Cl	19.5	1.5	13.3	250.
Sulfates	SO4	87.3	13.4	53.2	500.
trates/Nitrites	N	<0.03	<0.05	<.05	10.**
uorides	F	0.12	0.10	<0.05	1.5
SSOLVED METALS (mg/L)					
alcium ✓	Ca	106.	65.8	87.2	-
Magnesium ✓	Mg	27.7	11.9	24.9	-
odium ✓	Na	23.0	4.20	16.3	-
otassium ✓	K	6.63	1.51	3.23	-
ron ✓	Fe	<0.030	<0.030	<0.030	0.30
anganese ✓	Mn	1.04x	<0.003	<0.003	0.05
ilicon ✓	Si02	14.9	13.3	20.6	-
OTAL METALS (mg/L)					
agnesium ✓	Mg	27.7	12.2	25.4	-
Iron ✓	Fe	0.11	<0.030	<0.030	0.30
anganese ✓	Mn	1.24x	<0.003	0.045	0.05
Copper ✓	Cu	0.008	0.003	0.003	1.0
Arsenic ✓	As	<0.001	<0.001	<0.001	0.05

= filtered on a 0.45 micron membrane
** = total nitrate and nitrite nitrogen
* = maximum acceptable concentration as set by "B.C. Drinking Water Quality Standards, 1982" and "Guidelines for Canadian Drinking Water Quality, 1978"
< = less than; mg/L = milligrams per litre
= exceeded the "guidelines"

C4

CANTEST

ıompson Geotechnical Consultants
ile No: 8096H
ıge No: 3

SAMPLE IDENTIFICATION AND RESULTS OF TESTING:

AMPLE # / LIENT SAMPLE I.D.		8096-4 'B' POND AUG. 17	8096-5 Bii SPRINGS AUG. 17	8096-6 POND 2465 AUG. 16	MAXIMUM ACCEPTABLE CONC.***
HYSICAL TESTS					
H (pH units)		8.60x	8.43	8.56x	6.5-8.5
onductivity (us/cm)		589.	321.	325.	-
ue Color (CU)		<5.	<5.	15.	15.
urbidity (NTU)		0.65	0.21	4.1	5.
lardness as CaCO3		275.	184.	170.	-
otal Dissolved Solids (mg/L)		454.	313.	321.	500.*
SSOLVED ANIONS (mg/L)					
kalinity:					
Bicarbonate	HCO3	188.	220.	237.	-
Carbonate	CO3	Nil	Nil	Nil	-
lydroxide	OH	Nil	Nil	Nil	-
Chloride	Cl	1.60	0.25	1.47	250.
Sulfates	SO4	153.	9.63	3.15	500.
trates/Nitrites	N	<0.05	<0.05	0.21	10.**
uorides	F	0.36	0.10	0.20	1.5
SSOLVED METALS (mg/L)					
alcium	Ca	29.0	56.7	20.5	-
Magnesium	Mg	48.1	9.92	28.3	-
odium	Na	14.5	2.78	12.1	-
otassium	K	10.6	1.18	3.93	-
Iron	Fe	<0.030	<0.030	<0.030	0.30
anganese	Mn	<0.003	<0.003	<0.003	0.05
licon	Si02	8.68	12.6	14.4	-
OTAL METALS (mg/L)					
agnesium	Mg	51.1	10.0	27.6	-
Iron	Fe	0.037	0.048	0.099	0.30
Manganese	Mn	<0.003	<0.003	0.024	0.05
Copper	Cu	0.020	0.003	0.003	1.0
Arsenic	As	<0.001	<0.001	<0.001	0.05

= filtered on a 0.45 micron membrane
** = total nitrate and nitrite nitrogen
* = maximum acceptable concentration as set by "B.C. Drinking Water Quality Standards, 1982" and "Guidelines for Canadian Drinking Water Quality, 1978"
< = less than; mg/L = milligrams per litre
ᵛ = exceeded the "guidelines"

C5

ASL

CHEMICAL ANALYSIS REPORT

Date: Jul. 29, 1991

ASL File No. 7203B

Report On: Water Analysis (90149)

Report To: SRK Robinson Inc.
801 - 500 Hornby Street
Vancouver, BC
V6C 3B6

Attention: Mr. John Chapman

Date Received: Jul. 12, 1991

METHODOLOGY

Conventional Parameters

These analyses are carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Ed. published by the American Public Health Association, 1989. Further details are available on request.

Metals

These analyses were carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Edition published by the American Public Health Association, 1989. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element. Specific details are available on request.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

Frederick Chen B.Sc.
Project Chemist

James R. Downie
Supervisor, Trace Metals Lab

ASL

RESULTS OF ANALYSIS - Water

Parameter		Copper Lake Jul05/91	Crater Lake Jul05/91	Tailings Pond Jul05/91
Physical Tests				
Conductivity	umhos/cm	721	673	2050
Total Dissolved Solids		577	540	1660
pH		8.24	8.20	7.70
Total Suspended Solids		5	1	50
Dissolved Anions				
Alkalinity	CaCO3	329	279	59.5
Chloride	Cl	16.5	11.2	8.8
Fluoride	F	0.29	0.19	0.98
Sulphate	SO4	90.5	115	765

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = less than detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

Parameter		Copper Lake Jul05/91	Crater Lake Jul05/91	Tailings Pond Jul05/91
Total Metals				
Aluminum	T-Al	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20
Arsenic	T-As	0.0026	0.0006	<0.20
Barium	T-Ba	0.025	0.112	0.023
Beryllium	T-Be	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10
Cadmium	T-Cd	<0.0002	<0.0002	<0.010
Calcium	T-Ca	101	99.1	108
Chromium	T-Cr	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015
Copper	T-Cu	<0.010	<0.010	0.055
Iron	T-Fe	<0.030	<0.030	0.077
Lead	T-Pb	<0.001	<0.001	<0.050
Lithium	T-Li	<0.015	<0.015	<0.015
Magnesium	T-Mg	26.6	24.8	91.3
Manganese	T-Mn	0.131	<0.005	0.028
Molybdenum	T-Mo	<0.030	<0.030	0.224
Nickel	T-Ni	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30
Potassium	T-K	5.7	3.3	23.8
Selenium	T-Se	<0.0005	<0.0005	<0.20
Silicon	T-Si	7.84	6.07	1.64
Silver	T-Ag	<0.015	<0.015	<0.015
Sodium	T-Na	22.8	16.3	34.3
Strontium	T-Sr	0.754	0.700	5.72
Thallium	T-Tl	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030
Zinc	T-Zn	<0.005	0.033	0.236

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = less than detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

File No. 7203B
Page 4

Parameter		Copper Lake Jul05/91	Crater Lake Jul05/91	Tailings Pond Jul05/91
Dissolved Metals				
Aluminum	D-Al	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20	<0.20
Arsenic	D-As	0.0025	0.0006	<0.20
Barium	D-Ba	0.025	0.112	0.022
Beryllium	D-Be	<0.005	<0.005	<0.005
Bismuth	D-Bi	<0.10	<0.10	<0.10
Boron	D-B	<0.10	<0.10	<0.10
Cadmium	D-Cd	<0.0002	<0.0002	<0.010
Calcium	D-Ca	85.5	92.2	108
Chromium	D-Cr	<0.015	<0.015	<0.015
Cobalt	D-Co	<0.015	<0.015	<0.015
Copper	D-Cu	<0.010	<0.010	0.048
Iron	D-Fe	<0.030	0.040	<0.030
Lead	D-Pb	<0.001	<0.001	<0.050
Lithium	D-Li	<0.015	<0.015	<0.015
Magnesium	D-Mg	22.6	23.2	91.3
Manganese	D-Mn	<0.005	0.016	0.025
Molybdenum	D-Mo	<0.030	<0.030	0.221
Nickel	D-Ni	<0.020	<0.020	<0.020
Phosphorus	D-P	<0.30	<0.30	<0.30
Potassium	D-K	4.4	3.4	23.7
Selenium	D-Se	<0.0005	<0.0005	<0.20
Silicon	D-Si	7.83	5.74	1.59
Silver	D-Ag	<0.015	<0.015	<0.015
Sodium	D-Na	19.7	16.2	33.8
Strontium	D-Sr	0.660	0.682	5.56
Thallium	D-Tl	<0.10	<0.10	<0.10
Tin	D-Sn	<0.30	<0.30	<0.30
Titanium	D-Ti	<0.010	<0.010	<0.010
Tungsten	D-W	<0.10	<0.10	<0.10
Vanadium	D-V	<0.030	<0.030	<0.030
Zinc	D-Zn	<0.005	<0.005	0.230
Inorganic Parameters				
Dissolved Inorganic Carbon	C	149	164	123

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = less than detection limit indicated.

End of Report

WHITEHORSE COPPER WATER SAMPLING July (1991)

LOCATION		Guidelines (CCREM)*		Copper Lake	Tailings Pond	Crater Lake
Sample Number		Drinking Water	Aquatic Freshwater			
Date				Jul05/91	Jul05/91	Jul05/91
Time				09:45	09:45	09:45
Physical Tests						
Conductivity	umhos/cm	-	-	673	2050	721
Total Dissolved Solids		500	-	540	1660	577
pH		6.5 - 8.5	6.5 - 9.0	8.20	7.70	8.24
Total Suspended Solids		-	-	1	50	5
Dissolved Anions						
Alkalinity	CaCO3	-	-	279	59.5	329
Chloride	Cl	250	-	11.2	8.8	16.5
Fluoride	F	1.5	-	0.19	0.98	0.29
Sulphate	SO4	500	-	115	765	90.5
Total Metals						
Aluminum	T-Al	-	0.1	<0.20	<0.20	<0.20
Antimony	T-Sb	-	-	<0.20	<0.20	<0.20
Arsenic	T-As	0.05	0.05	0.0006	<0.20	0.0026
Barium	T-Ba	1.0	-	0.112	0.023	0.025
Beryllium	T-Be	-	-	<0.005	<0.005	<0.005
Bismuth	T-Bi	-	-	<0.10	<0.10	<0.10
Boron	T-B	5.0		<0.10	<0.10	<0.10
Cadmium	T-Cd	0.005	0.0018	<0.0002	<0.010	<0.0002
Calcium	T-Ca	-	-	99.1	108	101
Chromium	T-Cr	0.05	0.02	<0.015	<0.015	<0.015
Cobalt	T-Co	-	-	<0.015	<0.015	<0.015
Copper	T-Cu	1.0	0.004	<0.010	0.055	<0.010
Iron	T-Fe	0.3	0.3	<0.030	0.077	<0.030
Lead	T-Pb	0.05	0.007	<0.001	<0.050	<0.001
Lithium	T-Li	-	-	<0.015	<0.015	<0.015
Magnesium	T-Mg	-	-	24.8	91.3	26.6
Manganese	T-Mn	0.05	-	<0.005	0.028	0.131
Molybdenum	T-Mo	0.25**	0.05**	<0.030	0.224	<0.030
Nickel	T-Ni	-	0.11	<0.020	<0.020	<0.020
Phosphorus	T-P	-	-	<0.30	<0.30	<0.30
Potassium	T-K	-	-	3.3	23.8	5.7
Selenium	T-Se	0.01	0.001	<0.0005	<0.20	<0.0005
Silicon	T-Si	-	-	6.07	1.64	7.84
Silver	T-Ag	0.05	0.0001	<0.015	<0.015	<0.015
Sodium	T-Na	-	-	16.3	34.3	22.8
Strontium	T-Sr	-	-	0.700	5.720	0.754
Thallium	T-Tl	-	-	<0.10	<0.10	<0.10
Tin	T-Sn	-	-	<0.30	<0.30	<0.30
Titanium	T-Ti	-	-	<0.010	<0.010	<0.010
Tungsten	T-W	-	-	<0.10	<0.10	<0.10
Vanadium	T-V	-	-	<0.030	<0.030	<0.030
Zinc	T-Zn	5.0	0.03	0.033	0.236	<0.005

* Extracted from CCREM (1987) Guidelines

** Swain (1986)

Note: this water samples not considered in evaluation not correctly prepared in the field

C6

ASL

CHEMICAL ANALYSIS REPORT

RECEIVED
SEP 18 1991
Ans'd .....

Date: Sep. 04, 1991

ASL File No. 7751B

Report On: Water Analysis (90149)

Report To: SRK Robinson Inc.
800 - 580 Hornby Street
Vancouver, BC
V6C 3B6

Attention: Mr. John Chapman

Date Received: Aug. 16, 1991

METHODOLOGY

Conventional Parameters

This analysis is carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Ed. published by the American Public Health Association, 1989. Further details are available on request.

Metals

This analysis is carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Edition published by the American Public Health Association, 1989. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element. Specific details are available on request.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

Frederick Chen B.Sc.
Project Chemist

James R. Downie
Supervisor, Trace Metals Lab

C6

ASL

CONVENTIONAL
PARAMETER DATA

CG

ASL

RESULTS OF ANALYSIS - Water

File No. 7751B
Page 2

Parameter		Boyd well #1 Aug14/91	Richardson well #2 Aug14/91	McKinnon well #3 Aug14/91	Crater Lake #4 Aug15/91	Pit S.E. of Road #5 Aug15/91
Physical Tests						
Conductivity	umhos/cm	401	383	411	667	381
Total Dissolved Solids		320	306	320	530	305
pH		7.71	7.68	7.42	8.04	8.33
Total Suspended Solids		<1	<1	<1	3	<1
Dissolved Anions						
Alkalinity	CaCO3	217	222	235	283	56.8
Chloride	Cl	1.7	0.6	1.2	11.8	10.9
Fluoride	F	0.08	0.09	0.10	0.15	0.12
Sulphate	SO4	15.9	9.7	10.7	109	136

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 3

Parameter		Borrow Pit N of Road #6 Aug15/91	Old Pond #7 Aug15/91	'B' Pond #8 Aug15/91	Lake above B Valley #9 Aug15/91	Seepage W. about B. Dam #10 Aug15/91
Physical Tests						
Conductivity	umhos/cm	791	1370	358	310	327
Total Dissolved Solids		630	1100	287	248	260
pH		7.45	7.91	8.16	7.80	7.91
Total Suspended Solids		<1	4	3	13	<1
Dissolved Anions						
Alkalinity	CaCO3	290	79.2	157	169	187
Chloride	Cl	12.0	3.4	<0.5	1.7	<0.5
Fluoride	F	0.17	1.21	0.28	0.15	0.10
Sulphate	SO4	165	762	47.4	16.7	10.6

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 4

Copper Lake

Parameter		#11 Aug15/91
Physical Tests		
Conductivity	umhos/cm	708
Total Dissolved Solids		566
pH		8.10
Total Suspended Solids		3
Dissolved Anions		
Alkalinity	CaCO3	317
Chloride	Cl	18.0
Fluoride	F	0.28
Sulphate	SO4	94.0

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

C6

ASL

TOTAL METALS

DATA

ASL

RESULTS OF ANALYSIS - Water

Parameter		#1 Aug14/91	#2 Aug14/91	#3 Aug14/91	#4 Aug15/91	#5 Aug15/91
Total Metals						
Aluminum	T-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	0.0005	0.0007	0.0007	0.0009	0.0012
Barium	T-Ba	0.065	0.057	0.086	0.116	0.048
Beryllium	T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	T-Cd	0.0003	<0.0002	0.0003	<0.0002	0.0002
Calcium	T-Ca	67.6	67.1	70.8	99.3	36.7
Chromium	T-Cr	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	T-Cu	0.014	0.047	0.028	<0.010	<0.010
Iron	T-Fe	0.034	<0.030	0.105	0.039	<0.030
Lead	T-Pb	<0.001	<0.001	0.001	<0.001	<0.001
Lithium	T-Li	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	T-Mg	12.5	12.1	11.6	25.9	19.7
Manganese	T-Mn	<0.005	<0.005	0.061	0.033	0.007
Molybdenum	T-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	<2.0	<2.0	2.1	3.4	2.2
Selenium	T-Se	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	T-Si	5.66	5.90	7.00	6.95	1.85
Silver	T-Ag	<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	T-Na	4.2	3.9	5.7	16.9	15.8
Strontium	T-Sr	0.276	0.250	0.278	0.705	0.414
Thallium	T-Tl	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	T-Zn	0.364	0.020	0.419	<0.005	<0.005

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

Parameter		#6 Aug15/91	#7 Aug15/91	#8 Aug15/91	#9 Aug15/91	#10 Aug15/91
Total Metals						
Aluminum	T-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	0.0006	0.0005	0.0011	0.0001	0.0011
Barium	T-Ba	0.140	0.024	0.055	0.034	0.055
Beryllium	T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	T-Cd	<0.0002	0.0005	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	133	128	38.5	41.1	59.1
Chromium	T-Cr	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	T-Cu	<0.010	0.070	0.019	<0.010	<0.010
Iron	T-Fe	<0.030	0.072	0.061	0.114	<0.030
Lead	T-Pb	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	T-Li	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	T-Mg	25.2	121	23.5	14.9	8.87
Manganese	T-Mn	0.007	0.015	<0.005	0.012	<0.005
Molybdenum	T-Mo	<0.030	0.284	0.043	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	4.0	31.0	5.0	5.5	<2.0
Selenium	T-Se	<0.0005	0.0007	<0.0005	<0.0005	<0.0005
Silicon	T-Si	6.31	1.84	4.32	1.51	5.19
Silver	T-Ag	<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	T-Na	14.9	16.6	7.4	9.6	3.3
Strontium	T-Sr	0.784	7.16	0.632	0.239	0.228
Thallium	T-Tl	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	T-Zn	<0.005	<0.005	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 7

Parameter		#11 Aug15/91
Total Metals		
Aluminum	T-Al	<0.20
Antimony	T-Sb	<0.20
Arsenic	T-As	0.0033
Barium	T-Ba	0.055
Beryllium	T-Be	<0.005
Bismuth	T-Bi	<0.10
Boron	T-B	<0.10
Cadmium	T-Cd	<0.0002
Calcium	T-Ca	101
Chromium	T-Cr	<0.015
Cobalt	T-Co	<0.015
Copper	T-Cu	<0.010
Iron	T-Fe	<0.030
Lead	T-Pb	<0.001
Lithium	T-Li	<0.015
Magnesium	T-Mg	27.8
Manganese	T-Mn	0.472
Molybdenum	T-Mo	<0.030
Nickel	T-Ni	<0.020
Phosphorus	T-P	<0.30
Potassium	T-K	5.8
Selenium	T-Se	<0.0005
Silicon	T-Si	8.45
Silver	T-Ag	<0.015
Sodium	T-Na	24.8
Strontium	T-Sr	0.785
Thallium	T-Tl	<0.10
Tin	T-Sn	<0.30
Titanium	T-Ti	<0.010
Tungsten	T-W	<0.10
Vanadium	T-V	<0.030
Zinc	T-Zn	<0.005

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

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DISSOLVED METALS DATA
AND
DISSOLVED INORGANIC CARBON
DATA

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 8

Parameter		#1 Aug14/91	#2 Aug14/91	#3 Aug84/91	#4 Aug15/91	#5 Aug15/91
Dissolved Metals						
Aluminum	D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	D-As	0.0005	0.0007	0.0006	0.0009	0.0012
Barium	D-Ba	0.062	0.055	0.085	0.116	0.048
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	D-Bi	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	D-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	D-Cd	0.0003	<0.0002	0.0003	<0.0002	0.0002
Calcium	D-Ca	67.2	65.3	70.8	95.8	36.7
Chromium	D-Cr	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	D-Co	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	D-Cu	0.014	0.047	0.028	<0.010	<0.010
Iron	D-Fe	<0.030	<0.030	0.059	<0.030	<0.030
Lead	D-Pb	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	D-Li	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	D-Mg	12.3	11.8	11.6	25.4	19.1
Manganese	D-Mn	<0.005	<0.005	0.061	0.019	<0.005
Molybdenum	D-Mo	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	D-K	<2.0	<2.0	2.1	3.4	2.2
Selenium	D-Se	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	D-Si	5.66	5.90	7.00	6.95	1.85
Silver	D-Ag	<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	D-Na	4.2	3.9	5.7	16.9	15.8
Strontium	D-Sr	0.276	0.250	0.278	0.697	0.414
Thallium	D-Tl	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	D-Sn	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	D-W	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	D-Zn	0.364	0.020	0.416	<0.005	<0.005
Inorganic Parameters						
Dissolved Inorganic Carbon	C	44.6	45.6	46.4	58.5	13.0

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 9

Parameter		#6 Aug15/91	#7 Aug15/91	#8 Aug15/91	#9 Aug15/91	#10 Aug15/91
Dissolved Metals						
Aluminum	D-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	D-As	0.0005	0.0005	0.0011	0.0001	0.0011
Barium	D-Ba	0.140	0.024	0.051	0.026	0.055
Beryllium	D-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	D-Bi	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	D-B	<0.10	<0.10	<0.10	<0.10	<0.10
Cadmium	D-Cd	<0.0002	0.0005	<0.0002	<0.0002	<0.0002
Calcium	D-Ca	133	127	37.9	40.2	58.6
Chromium	D-Cr	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	D-Co	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	D-Cu	<0.010	0.039	<0.010	0.016	<0.010
Iron	D-Fe	<0.030	<0.030	<0.030	0.045	<0.030
Lead	D-Pb	<0.001	<0.001	<0.001	<0.001	<0.001
Lithium	D-Li	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	D-Mg	25.2	120	23.3	14.8	8.87
Manganese	D-Mn	0.007	0.014	<0.005	0.011	<0.005
Molybdenum	D-Mo	<0.030	0.284	0.043	<0.030	<0.030
Nickel	D-Ni	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	D-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	D-K	4.1	31.0	5.0	5.3	<2.0
Selenium	D-Se	<0.0005	0.0006	<0.0005	<0.0005	<0.0005
Silicon	D-Si	6.31	1.65	4.23	1.49	5.19
Silver	D-Ag	<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	D-Na	14.9	16.6	7.4	9.5	3.3
Strontium	D-Sr	0.784	7.15	0.362	0.232	0.228
Thallium	D-Tl	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	D-Sn	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	D-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	D-W	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	D-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	D-Zn	<0.005	<0.005	<0.005	<0.005	<0.005
Inorganic Parameters						
Dissolved Inorganic Carbon	C	57.4	15.8	32.1	34.3	37.8

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 7751B
Page 10

Parameter		#11 Aug15/91
Dissolved Metals		
Aluminum	D-Al	<0.20
Antimony	D-Sb	<0.20
Arsenic	D-As	0.0033
Barium	D-Ba	0.055
Beryllium	D-Be	<0.005
Bismuth	D-Bi	<0.10
Boron	D-B	<0.10
Cadmium	D-Cd	<0.0002
Calcium	D-Ca	100
Chromium	D-Cr	<0.015
Cobalt	D-Co	<0.015
Copper	D-Cu	<0.010
Iron	D-Fe	<0.030
Lead	D-Pb	<0.001
Lithium	D-Li	<0.015
Magnesium	D-Mg	27.7
Manganese	D-Mn	0.357
Molybdenum	D-Mo	<0.030
Nickel	D-Ni	<0.020
Phosphorus	D-P	<0.30
Potassium	D-K	5.8
Selenium	D-Se	<0.0005
Silicon	D-Si	8.45
Silver	D-Ag	<0.015
Sodium	D-Na	24.8
Strontium	D-Sr	0.783
Thallium	D-Tl	<0.10
Tin	D-Sn	<0.30
Titanium	D-Ti	<0.010
Tungsten	D-W	<0.10
Vanadium	D-V	<0.030
Zinc	D-Zn	<0.005
Inorganic Parameters		
Dissolved Inorganic Carbon	C	62.7

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

CG

ASL

CHEMICAL ANALYSIS REPORT

Date: Sep. 04, 1991

ASL File No. 7775B

Report On: Water Analysis

Report To: SRK Robinson Inc.
801 - 500 Hornby Street
Vancouver, BC
V6C 3B6

RECEIVED
SEP 11 1991
AnM .....

Attention: Mr. John Chapman

Date Received: Aug. 19, 1991

METHODOLOGY

Conventional Parameters

This analysis is carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Ed. published by the American Public Health Association, 1989. Further details are available on request.

Metals

This analysis is carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Edition published by the American Public Health Association, 1989. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element. Specific details are available on request.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

Frederick Chen B.Sc.
Project Chemist

James R. Downie
Supervisor, Trace Metals Lab

CG

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RESULTS OF ANALYSIS - Water

File No. 7775B
Page 2

Parameter		91-12 L.C. Dump Aug16/91	91-13 Old Pond (Piez.) Aug15/91
Physical Tests			
Conductivity	umhos/cm	1010	1910
Total Dissolved Solids		800	-
pH		7.58	7.94
Total Suspended Solids		15	-
Dissolved Anions			
Alkalinity	CaCO3	302	-
Chloride	Cl	7.4	-
Fluoride	F	0.15	-
Sulphate	SO4	327	1050

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

File No. 7775B
Page 3

Parameter		L.C. Dump Aug16/91
Total Metals		
Aluminum	T-Al	<0.20
Antimony	T-Sb	<0.20
Arsenic	T-As	0.0005
Barium	T-Ba	0.102
Beryllium	T-Be	<0.005
Bismuth	T-Bi	<0.10
Boron	T-B	<0.10
Cadmium	T-Cd	0.0002
Calcium	T-Ca	158
Chromium	T-Cr	<0.015
Cobalt	T-Co	<0.015
Copper	T-Cu	0.026
Iron	T-Fe	0.372
Lead	T-Pb	0.001
Lithium	T-Li	0.086
Magnesium	T-Mg	48.4
Manganese	T-Mn	0.909
Molybdenum	T-Mo	<0.030
Nickel	T-Ni	<0.020
Phosphorus	T-P	<0.30
Potassium	T-K	<2.0
Selenium	T-Se	<0.0005
Silicon	T-Si	5.13
Silver	T-Ag	<0.015
Sodium	T-Na	8.9
Strontium	T-Sr	0.943
Thallium	T-Tl	<0.10
Tin	T-Sn	<0.30
Titanium	T-Ti	<0.010
Tungsten	T-W	<0.10
Vanadium	T-V	<0.030
Zinc	T-Zn	0.091

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

File No. 7775B
Page 4

Parameter		L.C. Dump Aug16/91
Dissolved Metals		
Aluminum	D-Al	<0.20
Antimony	D-Sb	<0.20
Arsenic	D-As	0.0003
Barium	D-Ba	0.101
Beryllium	D-Be	<0.005
Bismuth	D-Bi	<0.10
Boron	D-B	<0.10
Cadmium	D-Cd	<0.0002
Calcium	D-Ca	158
Chromium	D-Cr	<0.015
Cobalt	D-Co	<0.015
Copper	D-Cu	0.021
Iron	D-Fe	0.229
Lead	D-Pb	<0.001
Lithium	D-Li	0.086
Magnesium	D-Mg	48.0
Manganese	D-Mn	0.714
Molybdenum	D-Mo	<0.030
Nickel	D-Ni	<0.020
Phosphorus	D-P	<0.30
Potassium	D-K	<2.0
Selenium	D-Se	<0.0005
Silicon	D-Si	5.00
Silver	D-Ag	<0.015
Sodium	D-Na	8.9
Strontium	D-Sr	0.940
Thallium	D-Tl	<0.10
Tin	D-Sn	<0.30
Titanium	D-Ti	<0.010
Tungsten	D-W	<0.10
Vanadium	D-V	<0.030
Zinc	D-Zn	<0.005
Inorganic Parameters		
Dissolved Inorganic Carbon	C	56.5

Results are expressed as milligrams per litre.
< = Less than the detection limit indicated.

End of Report

C7

ASL

CHEMICAL ANALYSIS REPORT

Date: Sep. 17, 1991

ASL File No. 8084B

Report On: Water Analysis (90149)

Report To: SRK Robinson Inc.
800 - 580 Hornby Street
Vancouver, BC
V6C 3B6

Attention: Mr. John Chapman

Date Received: Sep. 05, 1991

METHODOLOGY

Conventional Parameters

These analyses are carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Ed. published by the American Public Health Association, 1989. Further details are available on request.

Metals

These analyses are carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Edition published by the American Public Health Association, 1989. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element. Specific details are available on request.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

Frederick Chen B.Sc.
Project Chemist

James R. Downie
Supervisor, Trace Metals Lab

C7

ASL

CONVENTIONAL PARAMETERS DATA

C7

ASL

RESULTS OF ANALYSIS - Water

File No. 8084B
Page 2

Parameter		91-21 Lower Crater Lake Sep03/91 09:45	91-14 Below B Dam Sep03/91 10:45	91-15 Pioneer R.V. 165'Well Sep03/91 11:45	91-16 Pioneer R.V. 400'Well Sep03/91 11:45	91-17 Dan Boyd 62'Well Sep03/91 12:30
Physical Tests						
Conductivity	umhos/cm	425	362	605	416	461
Total Dissolved Solids		299	286	437	322	353
pH		8.55	7.60	7.76	8.06	7.66
Total Suspended Solids		12	<1	3	<1	<1
Dissolved Anions						
Alkalinity	CaCO3	163	195	250	196	237
Chloride	Cl	8.4	<0.5	32.0	8.1	2.4
Fluoride	F	0.16	0.09	0.12	0.18	0.10
Sulphate	SO4	38.2	12.3	31.3	28.6	17.2

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

C7

ASL

RESULTS OF ANALYSIS - Water

File No. 8084B
Page 3

Parameter		91-18 Lammers 65'Well Sep03/91 12:55	91-19 O. Boyd 40'Well Sep03/91 13:15	91-20 G. Boyd 50'Well Sep03/91 13:35
Physical Tests				
Conductivity	umhos/cm	500	416	419
Total Dissolved Solids		388	326	323
pH		7.76	7.73	7.65
Total Suspended Solids		<1	<1	3
Dissolved Anions				
Alkalinity	CaCO3	258	220	210
Chloride	Cl	2.0	2.6	5.7
Fluoride	F	0.13	0.13	0.11
Sulphate	SO4	23.2	15.3	17.7

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

C7

ASL

TOTAL METALS

DATA

C7

ASL

RESULTS OF ANALYSIS - Water

File No. 8084B
Page 4

Parameter		Lower Crater Lake Sep03/91 09:45	Below B Dam Sep03/91 10:45	Pioneer R.V. 165'Well Sep03/91 11:45	Pioneer R.V. 400'Well Sep03/91 11:45	Dan Boyd 62'Well Sep03/91 12:30
Total Metals						
Aluminum	T-Al	<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	T-As	0.0014	0.0009	0.0008	0.0006	0.0016
Barium	T-Ba	0.043	0.053	0.090	0.043	0.060
Beryllium	T-Be	<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10	<0.10	0.13
Cadmium	T-Cd	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	54.4	66.2	86.3	54.6	63.6
Chromium	T-Cr	<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015	<0.015	<0.015
Copper	T-Cu	<0.010	<0.010	0.605	0.023	0.082
Iron	T-Fe	<0.030	<0.030	<0.030	<0.030	<0.030
Lead	T-Pb	<0.001	<0.001	0.037	0.012	0.002
Lithium	T-Li	<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	T-Mg	22.4	10.9	25.0	17.5	23.3
Manganese	T-Mn	0.010	<0.005	0.101	0.235	<0.005
Molybdenum	T-Mo	0.035	<0.030	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	T-K	2.7	<2.0	2.9	<2.0	2.3
Selenium	T-Se	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	T-Si	4.39	7.10	6.89	7.32	6.78
Silver	T-Ag	<0.015	0.023	<0.015	<0.015	<0.015
Sodium	T-Na	18.0	4.3	14.5	18.6	9.8
Strontium	T-Sr	0.557	0.248	0.671	0.434	0.378
Thallium	T-Tl	<0.10	<0.10	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	T-Zn	<0.005	<0.005	0.106	0.587	0.051

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

Parameter		Lammers 65'Well Sep03/91 12:55	O. Boyd 40'Well Sep03/91 13:15	G. Boyd 50'Well Sep03/91 13:35
Total Metals				
Aluminum	T-Al	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20
Arsenic	T-As	0.0016	0.0014	0.0016
Barium	T-Ba	0.065	0.065	0.054
Beryllium	T-Be	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10
Cadmium	T-Cd	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	64.7	57.2	57.3
Chromium	T-Cr	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015
Copper	T-Cu	0.143	<0.010	<0.010
Iron	T-Fe	<0.030	0.058	<0.030
Lead	T-Pb	<0.001	0.001	<0.001
Lithium	T-Li	<0.015	<0.015	<0.015
Magnesium	T-Mg	27.3	19.7	20.5
Manganese	T-Mn	<0.005	<0.005	<0.005
Molybdenum	T-Mo	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30
Potassium	T-K	2.3	2.2	2.7
Selenium	T-Se	<0.0005	<0.0005	<0.0005
Silicon	T-Si	6.62	6.74	6.93
Silver	T-Ag	<0.015	<0.015	<0.015
Sodium	T-Na	10.8	8.9	9.6
Strontium	T-Sr	0.420	0.269	0.290
Thallium	T-Tl	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030
Zinc	T-Zn	0.070	0.177	0.012

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

C7

ASL

DISSOLVED METALS
AND
DISSOLVED INORGANIC CARBON
DATA

ASL

RESULTS OF ANALYSIS - Water

Parameter			Lower Crater Lake Sep03/91 09:45	Below B Dam Sep03/91 10:45	Pioneer R.V. 165'Well Sep03/91 11:45	Pioneer R.V. 400'Well Sep03/91 11:45	Dan Boyd 62'Well Sep03/91 12:30
Dissolved Metals							
Aluminum	D-Al		<0.20	<0.20	<0.20	<0.20	<0.20
Antimony	D-Sb		<0.20	<0.20	<0.20	<0.20	<0.20
Arsenic	D-As		0.0014	0.0008	0.0007	0.0004	0.0015
Barium	D-Ba		0.039	0.053	0.087	0.042	0.060
Beryllium	D-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	D-Bi		<0.10	<0.10	<0.10	<0.10	<0.10
Boron	D-B		<0.10	<0.10	<0.10	<0.10	0.13
Cadmium	D-Cd		<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Calcium	D-Ca		52.2	64.0	82.7	53.2	61.3
Chromium	D-Cr		<0.015	<0.015	<0.015	<0.015	<0.015
Cobalt	D-Co		<0.015	<0.015	<0.015	<0.015	<0.015
Copper	D-Cu		<0.010	<0.010	0.209	0.021	0.068
Iron	D-Fe		<0.030	<0.030	<0.030	<0.030	<0.030
Lead	D-Pb		<0.001	<0.001	0.005	0.008	0.001
Lithium	D-Li		<0.015	<0.015	<0.015	<0.015	<0.015
Magnesium	D-Mg		21.0	10.6	24.2	17.5	23.3
Manganese	D-Mn		0.006	<0.005	0.082	0.229	<0.005
Molybdenum	D-Mo		0.030	<0.030	<0.030	<0.030	<0.030
Nickel	D-Ni		<0.020	<0.020	<0.020	<0.020	<0.020
Phosphorus	D-P		<0.30	<0.30	<0.30	<0.30	<0.30
Potassium	D-K		2.1	<2.0	2.8	<2.0	2.3
Selenium	D-Se		<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Silicon	D-Si		3.96	6.98	6.83	7.32	6.78
Silver	D-Ag		<0.015	<0.015	<0.015	<0.015	<0.015
Sodium	D-Na		14.5	4.3	14.1	18.6	9.8
Strontium	D-Sr		0.549	0.248	0.665	0.434	0.378
Thallium	D-Tl		<0.10	<0.10	<0.10	<0.10	<0.10
Tin	D-Sn		<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	D-Ti		<0.010	<0.010	<0.010	<0.010	<0.010
Tungsten	D-W		<0.10	<0.10	<0.10	<0.10	<0.10
Vanadium	D-V		<0.030	<0.030	<0.030	<0.030	<0.030
Zinc	D-Zn		<0.005	<0.005	0.079	0.556	0.051
Inorganic Parameters							
Dissolved Inorganic Carbon		C	37.5	50.6	64.8	47.7	63.8

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

ASL

RESULTS OF ANALYSIS - Water

Parameter		Lammers 65'Well Sep03/91 12:55	O. Boyd 40'Well Sep03/91 13:15	G. Boyd 50'Well Sep03/91 13:35
Dissolved Metals				
Aluminum	D-Al	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20	<0.20
Arsenic	D-As	0.0015	0.0014	0.0016
Barium	D-Ba	0.065	0.065	0.054
Beryllium	D-Be	<0.005	<0.005	<0.005
Bismuth	D-Bi	<0.10	<0.10	<0.10
Boron	D-B	<0.10	<0.10	<0.10
Cadmium	D-Cd	<0.0002	<0.0002	<0.0002
Calcium	D-Ca	64.3	56.9	56.4
Chromium	D-Cr	<0.015	<0.015	<0.015
Cobalt	D-Co	<0.015	<0.015	<0.015
Copper	D-Cu	0.139	<0.010	<0.010
Iron	D-Fe	<0.030	0.034	<0.030
Lead	D-Pb	<0.001	<0.001	<0.001
Lithium	D-Li	<0.015	<0.015	<0.015
Magnesium	D-Mg	27.3	19.7	20.5
Manganese	D-Mn	<0.005	<0.005	<0.005
Molybdenum	D-Mo	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.020	<0.020	<0.020
Phosphorus	D-P	<0.30	<0.30	<0.30
Potassium	D-K	2.3	2.2	2.7
Selenium	D-Se	<0.0005	<0.0005	<0.0005
Silicon	D-Si	6.62	6.74	6.93
Silver	D-Ag	<0.015	<0.015	<0.015
Sodium	D-Na	10.8	8.9	9.6
Strontium	D-Sr	0.420	0.269	0.290
Thallium	D-Tl	<0.10	<0.10	<0.10
Tin	D-Sn	<0.30	<0.30	<0.30
Titanium	D-Ti	<0.010	<0.010	<0.010
Tungsten	D-W	<0.10	<0.10	<0.10
Vanadium	D-V	<0.030	<0.030	<0.030
Zinc	D-Zn	0.070	0.177	0.012
Inorganic Parameters				
Dissolved Inorganic Carbon	C	64.5	55.3	51.5

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

C8

CHEMICAL ANALYSIS REPORT

ASL

Date: Oct. 30, 1991

ASL File No. 8845B

Report On: Water Analysis (Whitehorse Copper)

Report To: SRK Robinson Inc.
800 - 580 Hornby Street
Vancouver, BC
V6C 3B6

Attention: Mr. John Chapman

Date Received: Oct. 18, 1991

METHODOLOGY

Conventional Parameters

These analyses are carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Ed. published by the American Public Health Association, 1989. Further details are available on request.

Metals

These analyses are carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 17th Edition published by the American Public Health Association, 1989. The procedures involve a variety of instrumental analyses including atomic emission spectrophotometry (ICP) and atomic absorption spectrophotometry (AA) to obtain the required detection limit for each element. Specific details are available on request.

ASL ANALYTICAL SERVICE LABORATORIES LTD.

Frederick Chen B.Sc.
Project Chemist

James R. Downie
Supervisor, Trace Metals Lab

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ASL

RESULTS OF ANALYSIS - Water

File No. 8845B
Page 2

Parameter		#1 Schwatka Lake Oct16/91 12:45	#2 Miles Canyon Oct16/91 13:30	#3 Pump House Oct16/91 14:00
Physical Tests				
Conductivity	umhos/cm	94.0	94.0	96.0
Total Dissolved Solids		68	68	67
pH		8.02	7.91	7.86
Total Suspended Solids		1	2	<1
Dissolved Anions				
Alkalinity	CaCO3	44.5	44.4	44.7
Chloride	Cl	<0.5	<0.5	<0.5
Fluoride	F	0.08	0.08	0.08
Sulphate	SO4	5.9	5.9	5.2
Inorganic Parameters				
Dissolved Inorganic Carbon	C	10.0	10.0	10.2

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

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RESULTS OF ANALYSIS - Water

File No. 8845B
Page 3

Parameter		#1 Schwatka Lake Oct16/91 12:45	#2 Miles Canyon Oct16/91 13:30	#3 Pump House Oct16/91 14:00
Total Metals				
Aluminum	T-Al	<0.20	<0.20	<0.20
Antimony	T-Sb	<0.20	<0.20	<0.20
Arsenic	T-As	0.0002	0.0002	0.0003
Barium	T-Ba	0.026	0.026	0.026
Beryllium	T-Be	<0.005	<0.005	<0.005
Bismuth	T-Bi	<0.10	<0.10	<0.10
Boron	T-B	<0.10	<0.10	<0.10
Cadmium	T-Cd	<0.0002	<0.0002	<0.0002
Calcium	T-Ca	14.8	14.8	15.1
Chromium	T-Cr	<0.015	<0.015	<0.015
Cobalt	T-Co	<0.015	<0.015	<0.015
Copper	T-Cu	<0.010	<0.010	<0.010
Iron	T-Fe	0.036	0.044	0.048
Lead	T-Pb	<0.001	<0.001	<0.001
Lithium	T-Li	<0.015	<0.015	<0.015
Magnesium	T-Mg	2.89	2.89	2.95
Manganese	T-Mn	<0.005	<0.005	<0.005
Molybdenum	T-Mo	<0.030	<0.030	<0.030
Nickel	T-Ni	<0.020	<0.020	<0.020
Phosphorus	T-P	<0.30	<0.30	<0.30
Potassium	T-K	<2.0	<2.0	<2.0
Selenium	T-Se	<0.0005	<0.0005	<0.0005
Silicon	T-Si	1.44	1.43	1.48
Silver	T-Ag	<0.0001	<0.0001	<0.0001
Sodium	T-Na	<2.0	<2.0	<2.0
Strontium	T-Sr	0.075	0.073	0.076
Thallium	T-Tl	<0.10	<0.10	<0.10
Tin	T-Sn	<0.30	<0.30	<0.30
Titanium	T-Ti	<0.010	<0.010	<0.010
Tungsten	T-W	<0.10	<0.10	<0.10
Vanadium	T-V	<0.030	<0.030	<0.030
Zinc	T-Zn	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

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ASL

RESULTS OF ANALYSIS - Water

File No. 8845B
Page 4

Parameter		#1 Schwatka Lake Oct16/91 12:45	#2 Miles Canyon Oct16/91 13:30	#3 Pump House Oct16/91 14:00
Dissolved Metals				
Aluminum	D-Al	<0.20	<0.20	<0.20
Antimony	D-Sb	<0.20	<0.20	<0.20
Arsenic	D-As	<0.0001	<0.0001	<0.0001
Barium	D-Ba	0.024	0.023	0.025
Beryllium	D-Be	<0.005	<0.005	<0.005
Bismuth	D-Bi	<0.10	<0.10	<0.10
Boron	D-B	<0.10	<0.10	<0.10
Cadmium	D-Cd	<0.0002	<0.0002	<0.0002
Calcium	D-Ca	14.6	14.4	14.3
Chromium	D-Cr	<0.015	<0.015	<0.015
Cobalt	D-Co	<0.015	<0.015	<0.015
Copper	D-Cu	<0.010	<0.010	<0.010
Iron	D-Fe	<0.030	<0.030	<0.030
Lead	D-Pb	<0.001	<0.001	<0.001
Lithium	D-Li	<0.015	<0.015	<0.015
Magnesium	D-Mg	2.89	2.83	2.81
Manganese	D-Mn	<0.005	<0.005	<0.005
Molybdenum	D-Mo	<0.030	<0.030	<0.030
Nickel	D-Ni	<0.020	<0.020	<0.020
Phosphorus	D-P	<0.30	<0.30	<0.30
Potassium	D-K	<2.0	<2.0	<2.0
Selenium	D-Se	<0.0005	<0.0005	<0.0005
Silicon	D-Si	1.44	1.43	1.39
Silver	D-Ag	<0.0001	<0.0001	<0.0001
Sodium	D-Na	<2.0	<2.0	<2.0
Strontium	D-Sr	0.073	0.073	0.073
Thallium	D-Tl	<0.10	<0.10	<0.10
Tin	D-Sn	<0.30	<0.30	<0.30
Titanium	D-Ti	<0.010	<0.010	<0.010
Tungsten	D-W	<0.10	<0.10	<0.10
Vanadium	D-V	<0.030	<0.030	<0.030
Zinc	D-Zn	<0.005	<0.005	<0.005

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
< = Less than the detection limit indicated.

Tailings Subject to Wind Erosion
Appendices C9 to C13 inclusive

MECHANICAL SIEVE ANALYSIS

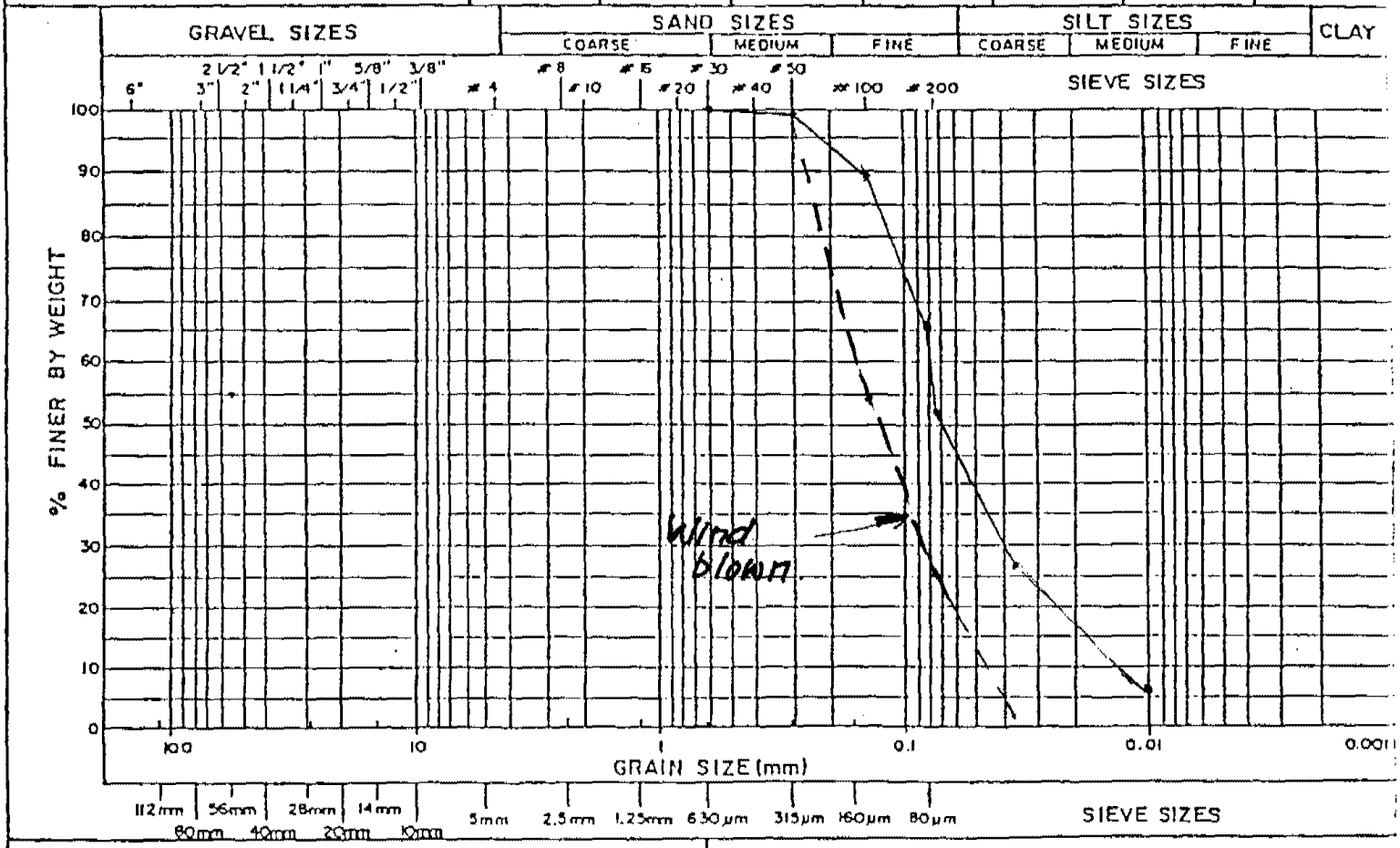
TECHNICIAN B. BOLOT DATE SAMPLED _____ BY _____ OF _____ DATE TESTED SEPT. 18/91

TH _____ SAMPLE NO 2 SAMPLE TYPE _____ SAMPLE DEPTH _____ TO _____

SAMPLE DESCRIPTION DARK GREY TAILINGS SAMPLE LOCATION TAILINGS

Wt. of Pan 28 = 15.1g
Wt. of Wet Sample + Pan = 345.5
Wt of Dry Sample and Pan
Before Washing = 317.9
400 SIEVE After Washing = 239.5
Wt of Dry Sample
Before Washing = 302.8
400 SIEVE After Washing = 224.4
Moisture Content = 9.1%
$C_u = D_{60}/D_{10}$ =
$C_c = (D_{30})^2/D_{10} \times D_{60}$ =
% Gravel = 0
% Sand = 21.9
% Silt + Clay = 78.1
Unified Soil Class. SANDY SILT

SIEVE SIZE	Cumm. Wt. Retained + Pan	Cumm Wt. Retained	Cumm Wt. Passing	% FINER THAN	% FINER THAN BASIS ORIG. SAMPLE	SPEC.
30	0	0	302.8	100		
50	15.4	0.3	302.5	99.9		
100	47.5	32.4	270.4	89.3		
170	119.9	104.8	198.0	65.9		
200	160.9	145.8	157.0	51.8		
400	238.2	223.1	79.7	26.3		
PAN	239.5	224.4	0	0		
	+ 78.4	302.8				



STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers

CLIENT _____
PROJECT TAILINGS
LOCATION WHITE HORSE COPPER MINE
PROJECT NO. 23-[illegible]

MECHANICAL SIEVE ANALYSIS

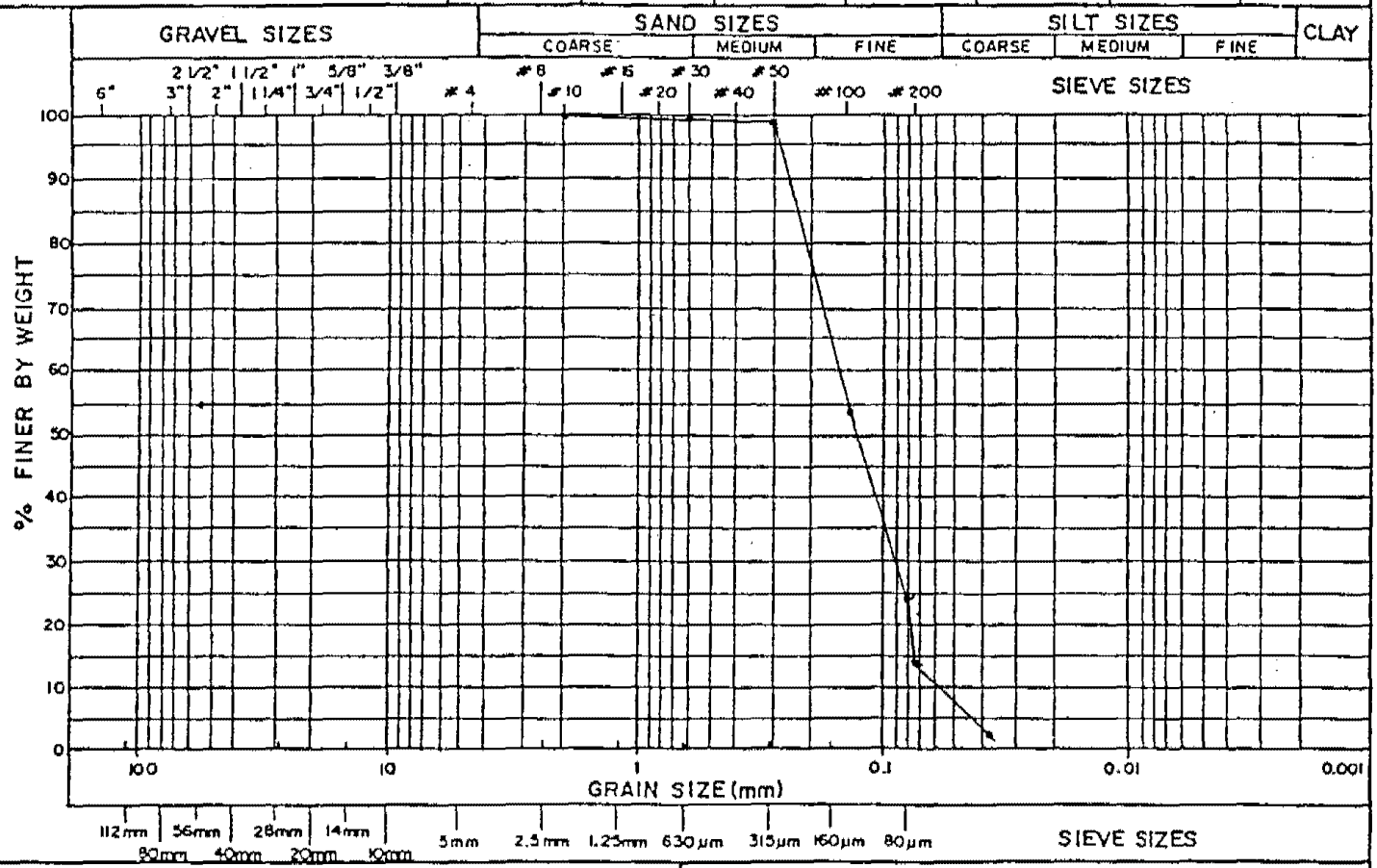
TECHNICIAN R. BOLDT DATE SAMPLED _____ BY _____ OF _____ DATE TESTED SEPT. 18/91

TH _____ SAMPLE NO. 1 SAMPLE TYPE _____ SAMPLE DEPTH _____ TO _____

SAMPLE DESCRIPTION BROWNISH GREY TAILINGS SAMPLE LOCATION WINDBLOWN 'A' VALLEY

Wt. of Pan 3B = 155.9 g
Wt. of Wet Sample & Pan = 558.8 g
Wt of Dry Sample and Pan Before Washing = 529.4
400 SIEVE After Washing = 517.5
Wt of Dry Sample Before Washing = 513.9
400 SIEVE After Washing = 502.0
Moisture Content = 5.7%
$C_u = D_{60}/D_{10}$ =
$C_c = (D_{30})^2/D_{10} \times D_{60}$ =
% gravel = 0
% Sand = 83.1
% Silt + Clay = 16.9
Unified Soil Class. SAND SOME SILT

SIEVE SIZE	Cumm. wt Retained + Pan	Cumm Wt. Retained	Cumm wt Passing	% FINER THAN	% FINER THAN BASIS ORIG. SAMPLE	SPEC.
10	0	0	513.9	100		
30	15.7	0.2	513.7	99.9		
50	20.8	5.3	508.6	99.0		
100	247.5	232.0	281.9	54.9		
170	404.2	388.7	125.2	24.4		
200	455.5	440.0	73.9	14.4		
400	516.7	501.2	12.7	2.5		
PAN	517.5	502.0	.0	0		
	+ 11.9	513.9				



STEFFEN ROBERTSON & KIRSTEN
Consulting Engineers

CLIENT _____
PROJECT TAILINGS
LOCATION WHITE HORSE COPPER MINE
PROJECT NO. 90-149 (SWG)

BACON
DONALDSON
& ASSOCIATES LTD.

12271 HORSESHOE WAY
RICHMOND, B.C.
CANADA V7A 4Z1
TELEPHONE: (604) 277-2322
FACSIMILE : (604) 274-7235

RECEIVED
OCT 9 1991
Ans'd .....

September 30, 1991

File Number: MN1208

STEFFEN, ROBERTSON & KIRSTEN, INC.
#800-580 Hornby Street
Vancouver, B.C.
V6C 3B6

Attention: John Chapman

Dear John:

As discussed, we have performed a sub sieve size analysis on the sample of tailings material which you sent to us. In addition, the fine fraction was analyzed to determine its SiO_2 content. The results of the test work have been tabulated and are attached. The -10µm particles accounted for 6.7% by weight of the sample and this -10µm material contained 40.53% SiO_2.

The size analysis was performed by using a cyclosizer on a representative sample. As you requested, the I.C.P. analyses, for the determination of the SiO_2 content, was performed on the cyclosizer fines which is the -10µm fraction. It should be noted that the SiO_2 content reported is the total silicate content and not the quartz content that is typically reported in dust. X-ray diffraction can be used to determine the dust quartz content.

If you have any questions concerning these results, please feel free to contact me at any time.

Yours truly,

BACON, DONALDSON & ASSOCIATES LTD.

Bernhard Klein

Bernhard Klein, B.A.Sc.
Senior Process Metallurgist

BK/mg

SIZE DISTRIBUTION

SAMPLE NO: MN1-208 Head

Size Fraction (um)		Individual Percentage Retained	Cumulative Percentage Passing
	+ 38	29.3	70.7
- 38	+ 29	37.2	33.5
- 29	+ 20	21.8	11.7
- 20	+ 13	3.0	8.7
- 13	+ 10	2.0	6.7
- 10		6.7	

Chemex Labs Ltd.
Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221

T: ACOI NALL & AS ATES
12271 HORSESHOE WAY
RICHMOND, BC
V7A 4Z1

Project : MNI-208
Comments: ATTN: RON WILLIAMS

Pag ber
Total ages :
Certificate Date: 02-OCT-91
Invoice No. : I9122333
P.O. Number : 58792

CERTIFICATE OF ANALYSIS A9122333

SAMPLE DESCRIPTION	PREP CODE		Al2O3 %	BaO %	CaO %	Fe2O3 %	K2O %	MgO %	MnO %	Na2O %	P2O5 %	SiO2 %	TiO2 %	LOI %	TOTAL %
MNI-208 10um	214	200	7.61	0.01	4.13	37.52	0.48	6.77	0.19	0.60	0.11	40.53	0.32	3.63	104.10

CERTIFICATION: B. Caglioni

0/08/91 14:02 ☎604 984 0218 CHEMEX LABS 002/002

BACON
DONALDSON
& ASSOCIATES LTD.

12271 HORSESHOE WAY
RICHMOND, B.C.
CANADA V7A 4Z1
TELEPHONE: (604) 277-2322
FACSIMILE : (604) 274-7235

October 29, 1991 File Number: MN1208

STEFFEN, ROBERTSON & KIRSTEN INC.
#800 - 580 Hornby Street
Vancouver, B.C.
V6C 3B6

Attention: John Chapman

Dear: John

Re: SEM Point Counting of Free Silica

As was requested, a Scanning Electron Microscope with an Energy Dispersive X-ray Analyzer (SEM and EDX) was used to determine the amount of free silica particles in -10 µm fraction of tailings material. From 150 particles counted, 12 were free silica particles which is 8% of all particles analyzed.

The sample was prepared by dispersing the particles in distilled water (Victa Wet added) and using a dropper to place a sample of the dispersed particles on a polystyrene dish. Once the water had evaporated, the particles were gold coated and analyzed.

The point counting procedure involved traversing the prepared sample of particles. Every particle that crossed the centre of the monitor was analyzed using the EDX analyzer. If the EDX spectrum showed only a silica peak, the particle was counted as free silica. If other elemental peaks were produced, the particle was counted as not free silica.

Most silicate minerals were found to contain aluminum, magnesium, iron, and calcium. These silicate minerals were either aluminum silicates, aluminum magnesium silicates, aluminum calcium silicates, magnesium silicate, iron magnesium silicates, or calcium silicates. The main source of iron was an iron oxide mineral (i.e. magnetite or hematite).

If you have any questions concerning these results, please feel free to contact me at any time.

Yours truly,

BACON, DONALDSON & ASSOCIATES LTD.

Bernhard Klein

Bernhard Klein, B.A.Sc.
Senior Process Metallurgist

BK:kc

A.E. Hall P.Eng.
22720 Gilley Road
Richmond, B.C.
V6V 1E4
Tel: 604-521-9207

October 11, 1991

Hudson Bay Mining and Smelting Co. Ltd.
Toronto Dominion Centre
Toronto, Ontario
M5K 1B8

Re: Whitehorse Copper Tailing Site

At the request of Gadsby Consultants, I have reviewed the plans of this site, relative to the town of Whitehorse and the surrounding area. (Included as Figure 1 in the report on this site.) I have also reviewed the site photographs and weather data for the area. These indicate that some wind erosion of the site is occurring.

The Chemex lab report indicates that the tailings material has a silica content of 40.53% and the size distribution data shows 6.7% of the insitu tailings being less than 10 microns. This material is the respirable portion of the tailings and it is significant that the analysis of windblown tailings done by Steffen, Robertson & Kirsten on September 18,1991 indicates a much lower content of this fine material. It can be concluded that the wind erosion is therefore liberating some respirable dust into the atmosphere.

Determination of the extent and amount of respirable dust propogation from the site would require an extensive field test program to be conducted around the site. There is a possibility that persons spending prolonged periods of time (several months) in dust clouds generated by wind erosion from these tailings could be exposed to dust levels above those recommended by the American Conference of Government Industrial Hygienists. It would therefore be prudent to adopt remedial action to reduce wind erosion for the long term decommissioning of the mine site until natural vegetation has moved in to stabilise the material. A cover of larger granular material would be adequate to reduce the wind erosion to obviate any risk or nuisance to adjacent sites.

Yours truly

A E Hall

Allan Hall P.Eng.

Borehole Logs
Appendix C14

RECORD OF BOREHOLE NO. 80-1

LOCATION: Lower 'B' Valley – Gravel Borrow Area

COORDINATES: 58,000 N – 69,770 E

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: July 7, 1980

DRILLING METHOD: Rotary–Tricone

BOREHOLE DIAMETER: 4.5 in.

LOGGED BY: B.T.

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2412.0	Ground Surface					SP80-1
0.0	Compact brown SAND and GRAVEL. Tr. to some silt. Coarse lenses.					3 in. dia. slotted steel casing
2404.5						
7.5	Coarse SAND and GRAVEL.					July 7, 80
2402.0						
10.0	Compact grey SILTY SAND and GRAVEL (TILL)					
2397.0						
15.0	End of Borehole					

NOTE: Borehole drilled for standpipe installation only. Stratigraphy inferred from drill cuttings and drill behavior.

VERTICAL SCALE: 1 in. = 10 ft.

BOREHOLE NO: 80-1

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 80-1

LOCATION: Lower 'B' Valley – Gravel Borrow Area

COORDINATES: 58,000 N – 69,770 E

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: July 7, 1980

DRILLING METHOD: Rotary–Tricone

BOREHOLE DIAMETER: 4.5 in.

LOGGED BY: B.T.

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2412.0	Ground Surface					SP80-1
0.0	Compact brown SAND and GRAVEL. Tr. to some silt. Coarse lenses.					3 in. dia. slotted steel casing
2404.5						
7.5	Coarse SAND and GRAVEL.					
2402.0						July 7, 80
10.0	Compact grey SILTY SAND and GRAVEL (TILL)					
2397.0						
15.0	End of Borehole					

NOTE: Borehole drilled for standpipe installation only. Stratigraphy inferred from drill cuttings and drill behavior.

VERTICAL SCALE: 1 in. = 10 ft.

BOREHOLE NO: 80-1

RECORD OF BOREHOLE NO. 82-1

LOCATION: *Old Pond - Perimeter Dyke - Section A-A*
Outside edge of downstream berm.

COORDINATES:

GRID SYSTEM - DATUM: *Whitehorse Copper*

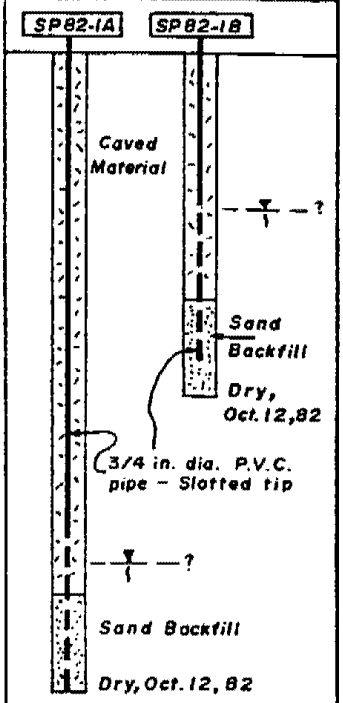
DRILLING DATE: *Sept. 28, 1982*

DRILLING METHOD: *H.S. Auger*

BOREHOLE DIAMETER: *8 in.*

LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2571.0 0.0	*Ground Surface*					
	Waste Rock					
2566.0 5.0±	*Compact, brown fine and medium SAND with some gravel. Tr. to some silt. Lenses of clean sand. Wet.*	1	2" O.D.	25		
		2	"	25		
2556.0 15.0±	*Compact, grey and brown GRAVELLY SAND with some silt. Wet*	3	"	26		
2551.0 20.0±	*Compact, grey and brown interlayered SAND and GRAVEL and SILTY SAND and GRAVEL. Damp becomming wet below 25 ft. depth.*	4	"	42		
		5	"	23		
2538.5 32.5	*End of Borehole (Boulder)*					



NOTE:
Possible perched seepage zones at 8 ft. and 26 ft. depth.

VERTICAL SCALE: *1 in. = 10 ft.*

BOREHOLE NO: *82-1*

THOMPSON GEOTECHNICAL

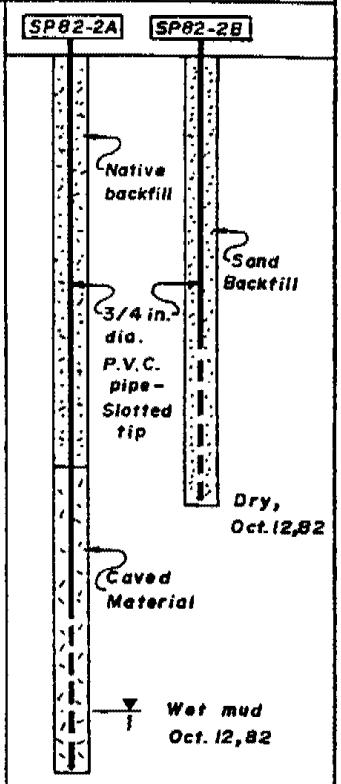
RECORD OF BOREHOLE NO. 82-2

LOCATION: *Old Pond - Perimeter Dyke - Section A-A*
Inside edge of dyke crest.
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept. 28,82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING
2577.5	*Ground Surface*				
0.0	*Compact, brown, fine and medium SAND with some gravel.*	1	2"O.D.	26	
2567.5					
10.0±	*Compact, interlayered, brown SAND and grey white SILTY SAND with some fine gravel. Damp to moist.*	2	"	23	
2560.0					
17.0	*Very loose to loose, grey and white-grey and black SANDY SILT - SILTY SAND with some fine gravel. (Weathered till mixed with topsoil) Wet to very wet, very cold.*	3	"	4	
		4	"	11	
2549.5					
28.0 ±	*Compact, brown, interlayered, med. and crs. SILTY SAND and fine GRAVEL and med. to crs. SAND with some fine gravel.*	5	"	30	
2544.0		6	"	30	
33.5	*? Waste Rock ?*				
2541.0					
36.5	*End of Borehole*				

PIEZOMETER INSTALLATIONS



NOTE
- *Possible perched seepage zone at 17 ft. depth.*
- *Water level indicated by SP 82-2A is suspect.*

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-2*

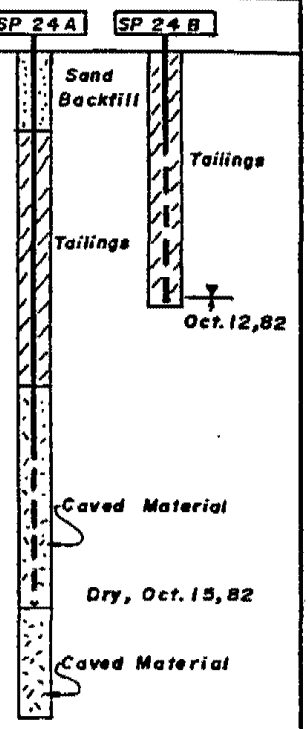
THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-24

LOCATION: *Old Pond - Perimeter Dyke - Section A-A Tailings.*
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Oct. 11, 82*
DRILLING METHOD: *S.S. Auger*
BOREHOLE DIAMETER: *4 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2573.5	*Ground Surface*					
0.0	*Soft, moist, dark grey CLAYEY SILT with sand. (TAILINGS)*					
2556.5						
17.0	*Loose to compact, SAND and fine GRAVEL with a trace to some silt.*					
2543.5						
30.0	*SAND, GRAVEL, COBBLES*					
2539.5						
34.0	*End of Borehole*					



NOTE
Conditions inferred from drill behavior and auger cuttings.

NOTE
- Holes squeezed before backfill could be placed.
- Water level indicated by SP 82-24B is suspect.

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-24*

RECORD OF BOREHOLE NO. 82-3

LOCATION: *Old Pond – Perimeter Dyke – Section B-B*
Outside edge of dyke crest.
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept. 29, 82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2576.6 0.0	*Ground Surface*					SP 82-3
	Loose, brown, fine SAND with some fine gravel.					
2571.6 5.0±	*Compact, interlayered, brown fine SAND with some fine gravel and grey and white SILTY SAND with some fine gravel.*	1	2"O.D.	18		
2566.6 10.0±						
	Loose to compact, brown SAND and GRAVEL with occ. cobbles.	2	"	20		Sand Backfill
		3	"	8		
2554.6 22.0±						3/4 in. dia. P.V.C. pipe – Slotted tip
	Waste Rock	4	"	16		
		5	"	50		
2543.6 33.0	*End of Borehole*					Dry, Oct. 12, 82

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-3*

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-4

LOCATION: *Old Pond – Perimeter Dyke – Section B-B*
Tailings/Inside edge of dyke.
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept. 29, 82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2576.5	*Ground Surface*					SP 82-4
0.0	*Soft, moist, dark grey CLAYEY SILT with sand. (TAILINGS)*					
2566.0						
10.5	*Loose to compact, interlayered, brown SAND with tr. silt and some fine gravel and white and grey SILT with fine gravel. Silt layers are wet.*	1	2" D.O.	10		Sand Backfill
2561.5						
15.0±	*Compact, brown SAND and GRAVEL*	2	"	28		3/4 in. dia. P.V.C. pipe – Slotted tip
		3	"	34		
2551.5						
25.0	*Loose, brown, fine SAND with some gravel*	4	"	10		
2546.5						
30.0±	*Very dense, brown, fine SAND with occ. fine gravel.*	5	"	59		
2541.5						
35.0±	*Very dense, tan SILTY SAND and GRAVEL (TILL).*	6	"	>65		Oct. 12, 82
2537.0						
39.5	*End of Borehole*					

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-4*

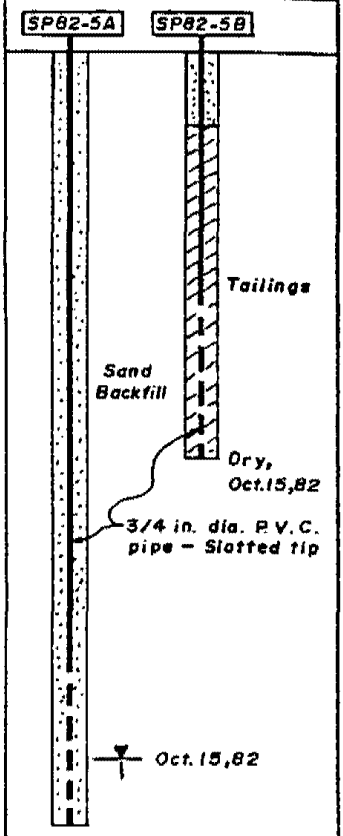
THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-5

LOCATION: *Old Pond - Perimeter Dyke - Section B-B Tailings*
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept. 30, 82*
DRILLING METHOD: *S.S. Auger*
BOREHOLE DIAMETER:
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2575.8	*Ground Surface*					
0.0	*Firm, moist, dark grey SANDY SILT (TAILINGS)*					
2570.8						
5.0	*Very soft, moist to wet, grey CLAYEY SILT. (TAILINGS)*					
2546.3						
29.5	*Coarse Layer*					
31.5	*SAND*					
2532.8						
43.0	*End of Borehole*					



NOTE
- *Borehole 82-5B squeezed before backfill could be placed.*

NOTE
Conditions inferred from drill behavior and auger cuttings.

VERTICAL SCALE: *1 in.=10 ft.*
BOREHOLE NO: *82-5*

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-6

LOCATION: *Old Pond — Perimeter Dyke — Section C–C*
Outside edge of dyke crest.
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept 30, 82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2578.0	*Ground Surface*					
0.0	*Compact, brown, fine and medium SAND with some gravel.*	1	2" O.D.	35		
2567.0		2	"	23		
11.0±	*Compact, intermixed, brown, GRAVELLY fine SAND with a trace to some silt and grey SILTY SAND and GRAVEL.*					
2563.0		3	"	10		
15.0±	*Loose to compact, brown, med. and crs. SAND and GRAVEL*	4	"	15		
2553.0						
25.0±	*COARSE GRANULAR STRATUM (no sample recovery)*	5	"	>60		
2545.5						
32.5	*END OF BOREHOLE.*					
	NOTE: Augers broke at 32.5' depth. Hole abandoned.					

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-6*

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-7

LOCATION: *Old Pond Perimeter Dyke — Section C-C*
Tailings / Inside edge of dyke

COORDINATES:

GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Sept 30, 82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2573.9 / 0.0	*Ground Surface*					SP82-7
	TAILINGS					*3/4 in. dia. P.V.C. Pipe — Slotted Tip*
2558.9 / 15.0	*Compact, brown, fine SAND with some fine gravel.*	1	2" O.D.	15		
		2	"	22		
		3	"	>50#		
2540.9 / 33.0	*Compact, grey and brown SANDY SILT — SILTY SAND with some fine gravel. Becoming wet below 38ft. ±*	4	"	14		? — ▽ — ? *Sand Backfill*
		5	"	21		
2531.9 / 42.0±	*Compact, brown, fine SAND. Damp becoming wet below 54 ft. depth.*	6	"	26		
		7	"	16		
		8	"	19		*Oct. 12/ 82* ▽
2516.4 / 57.5±	*Very loose to compact, brown fine SAND with tr. to some silt. Trace to some black organic material. Very wet.*	9	"	W.O.H.		
2508.4 / 65.5	*End of Borehole*	10	"	14		

Note: Possible perched seepage zone at 38.0' depth.

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-7*

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-8

LOCATION: *Old Pond – Perimeter Dyke – Section C-C Tailings.*
COORDINATES:
GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Oct. 1, 82*
DRILLING METHOD: *S.S. Auger*
BOREHOLE DIAMETER: *4 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2573.2 / 0.0	*Ground Surface*					SP82-8A, SP82-8B
	Soft, moist, dark grey CLAYEY SILT with sand. (TAILINGS)					Sand Backfill; 3/4 in. dia. P.V.C. Pipe – slotted tip
2553.2 / 20.0±						Oct. 15/82
	Very soft, very wet, light grey, CLAYEY SILT. (TAILINGS)					Sand Backfill
2529.2 / 44.0	*Grey SILTY SAND with gravel. (Till Like – Fill)*					Oct. 12/82
2509.2 / 64.0	*End of Borehole* *Note: Conditions inferred from drill behavior and auger cuttings.*					

VERTICAL SCALE: *1 in = 10 ft.*
BOREHOLE NO: *82-8*

RECORD OF BOREHOLE NO. 82-9

LOCATION: *Old Pond – Perimeter Dyke – Section D–D*
North Dyke – Center of Crest

COORDINATES:

GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Oct. 1, 82*

DRILLING METHOD: *H.S./S.S. Auger*

BOREHOLE DIAMETER: *8 in./4 in.*

LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2590.7 0.0	*Ground Surface*					SP82-9
	Compact, brown SAND and GRAVEL with COBBLES. Trace of silt. Dry.	1	2"O.D.	34		*3/4 in. dia. P.V.C. Pipe – Slotted tip* *Sand Backfill* *Dry, Oct 12, 82* *Caved Material*
2552.2 38.5	*End of Borehole – Bedrock?* *Note: Could not advance H.S. Auger beyond 12 ft. depth. Drilled from 12 ft. to 38.5 ft. with S.S. Auger. Conditions infered from drill behavior and auger cuttings.*					

VERTICAL SCALE: *1 in = 10 ft*

BOREHOLE NO: *82-9*

RECORD OF BOREHOLE NO. 82-10

LOCATION: *Old Pond - Perimeter Dyke - Section D-D*
Tailings / Upstream Edge of Dyke

COORDINATES:

GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Oct. 1, 82*
DRILLING METHOD: *H.S. Auger*
BOREHOLE DIAMETER: *8 in.*
LOGGED BY: *B.T.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2587.5 0.0	*Ground Surface*					SP82-10
	Soft to firm, dry to damp, dark grey SANDY SILT (TAILINGS). Becoming soft and moist at 10 ft.±					*3/4 dia. P.V.C. Pipe - Slotted Tip*
2573.5 14.0	*Compact, brown SAND and GRAVEL. Occ. lens of silty sand and gravel.*	1	2"O.D.	59		*Sand Backfill*
		2	"	18		
2560.5 27.0±	*Brown fiberous PEAT. Moist.*					
28.0	*Compact, grey and grey brown SILTY fine SAND. Moist.*	3	"	13		
2554.5 33.0	*Weathered BEDROCK.*	4	"	>>50		
34.5	*End of Borehole*					*Dry, Oct 12, 82*

VERTICAL SCALE: *1 in. = 10 ft.*
BOREHOLE NO: *82-10*

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-11

LOCATION: 'B' Dam - East Abutment - Section B-B
Dam crest
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 4, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2515.5 / 0.0	Ground Surface SAND, GRAVEL and COBBLES					SP 82-11
2.0	very dense, grey SILTY SAND with GRAVEL, trace to some clay (GLACIAL TILL-FILL)					3/4" ϕ P.V.C. Pipe - Slotted Tip
2486.5 / 29.0	very dense, brown and white, fine, medium and coarse SAND, damp becoming wet below 32 ft. depth	1	SPT	70/5		Sand Backfill
		2	"	>80		Oct. 12, 1982
2476.5 / 39.0		3	"	>90		
39.5	very dense, red brown SILTY SAND (GLACIAL TILL) End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-11

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-12

LOCATION: 'B' Dam - East Abutment - Section B-B Mid Section
DRILLING DATE: Oct. 4, 1982
DRILLING METHOD: H.S. Auger
COORDINATES:
BOREHOLE DIAMETER: 8 in
GRID SYSTEM - DATUM: Whitehorse Copper
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2503.0	Ground Surface					SP 82-12
0.0	SAND, GRAVEL and COBBLES (FILL)					3/4" ϕ P.V.C. Pipe - Slotted Tip
2495.0						
8.0	compact to dense, grey SILTY SAND and GRAVEL (WEATHERED TILL?)	1	S.S.	28		Sand Backfill
2479.5						
23.5	very dense, brown and white, medium and coarse SAND, damp, becoming wet below 27 ft. depth	2	"	33		
		3	"	52		Oct. 12, 1982
2469.5		4	"	780		
33.5	very dense, pink white SILTY SAND with some clay (GLACIAL TILL)					
2465.0						
38.0	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-12

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-13

LOCATION: 'B' Dam - East Abutment - Section B-B Crest of Slope
DRILLING DATE: Oct. 1, 1982
DRILLING METHOD: H.S. Auger
COORDINATES:
BOREHOLE DIAMETER: 8 in
GRID SYSTEM - DATUM: Whitehorse Copper
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	TYPE	'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2494.9	Ground Surface					SP82-13
0.0	compact, brown SAND and GRAVEL, with some cobbles FILL					
2485.4		1	2" O.D.	30		3/4" ϕ P.V.C. Pipe - Slotted Tip
9.5	loose to compact, damp to moist, grey SILTY SAND and GRAVEL, some rootlets (WEATHERED TILL or FILL)	2	"	10		
2478.9						
16.0±	very dense, damp SILTY SAND - SANDY SILT with GRAVEL; trace clay (GLACIAL TILL)	3	"	53		Sand Backfill
2473.4						
21.5	compact, grey SILT with some sand, some fine gravel, and a trace to some clay	4	"	18		
2469.9						
25.0±	compact, brown & white, medium & coarse SAND; stratum underlain w/lens brown sandy silt	5	"	27		Oct 12, 1982
2465.9						
29.0	very dense, pink white and grey white, fine, medium and coarse SAND with SILT and trace clay, occasional fine gravel (GLACIAL TILL)	6	"	55		
2454.4		7	"	>90		
40.5	End of Borehole (Bedrock?)					

VERTICAL SCALE: 1in = 10ft
BOREHOLE NO: 82-13

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-14

LOCATION: 'B' Dam - East Abutment - Section C-C Borrow Pit
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 4, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in.
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	TYPE	'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2495.5 0.0	Ground Surface					SP82-14
	very dense, grey SILTY SAND with GRAVEL, trace clay (GLACIAL TILL)	1	2" O.D.	760	a	3/4" ϕ P.V.C. Pipe. Slotted tip
		2	"	>70	14	Sand Backfill
		3	"	>50	19	
?469.5						Oct. 12, 1982
26.0? 2463.5	very dense, brown and white fine and medium SAND	4	"	>90	30	
32.0± 2459.5	very dense, white and grey SAND with SILT, trace clay (GLACIAL TILL)	5	"	780	35	
36.0	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-14

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-15

LOCATION: 'B' Dam - East Abutment - Section C-C
Toe of slope near reclaim line

COORDINATES:

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 5, 1982

DRILLING METHOD: S.S. Auger

BOREHOLE DIAMETER: 4 in.

LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2450.2	Ground Surface					SP 82-15
0.0	compact to dense, grey SILT, SAND and GRAVEL with some clay. Till like composition	1	2"O.D.	17	9	
		2	"	37	14	
		3	"	29	19	3/4" ϕ P.V.C. Pipe. Slotted tip
2429.2						
21.0±	compact, brown and white, and grey and white SAND and GRAVEL	4	"	22	24	
		5	"	19	29	Sand Backfill
2416.2						
34.0±	compact, brown and white SAND and GRAVEL, with lenses of grey till like silty sand	6	"	31	39	
2406.7		7	"	27	44	Oct 12, 1982
43.5	very dense, light grey SILTY SAND with some gravel, trace clay (GLACIAL TILL)	8	"	>60	49	
2400.7						
49.5	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft

BOREHOLE NO: 82-15

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-16

LOCATION: 'B' Dam - Upstream Crest

COORDINATES:

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 7 & 11, 1982

DRILLING METHOD: S.S. Auger

BOREHOLE DIAMETER: 4 in.

LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
	Ground Surface					SP82-16A SP82-16B
0.0	Note Holes drilled for stand-pipe installations only. Both holes located in fine grained mixed fills in upstream zone of dam					3/4" ϕ P.V.C pipe slotted tip Sand Backfill Dry Oct. 15, 1982 Oct. 15, 1982

VERTICAL SCALE: 1 in = 10 ft.

BOREHOLE NO: 82-16

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-19

LOCATION: 'B' Dam - West Abutment Section D-D Spillway Centerline
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper
DRILLING DATE: Oct. 7, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	TYPE	'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2505.4	Ground Surface					SPBZ-19
0.0 / 2500.4	loose, grey brown SILTY fine SAND, moist	1	2"OD	8		3/4" ϕ P.V.C. pipe, slotted tip
5.0±	dense to very dense, brown and white, fine, medium and coarse SAND	2	"	42		Sand Backfill
2487.4		3	"	53		
18.0?	very dense, light grey-white SILTY SAND, with trace to some clay (GLACIAL TILL)	4	"	>70		Oct. 12, 1982
		5	"	760		
		6	"	63		
2470.9		7	"	64		
34.5	End of Borehole					

VERTICAL SCALE: 1 in = 10 Ft
BOREHOLE NO: 82-19

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-20

LOCATION: 'B' Dam - West Abutment - Section D-D Spillway Centerline - P.I.
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 7, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in.
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2508.5 / 0.0	Ground Surface					SP82-20
	very loose, brown, Fine SAND, with lenses of silty fine sand, wet	1	2" D.O.	5	4	
		2	"	3	9	3/4" ϕ P.V.C. Pipe - Slotted Tip
2495.0 / 13.5		3	"	43	14	
2491.5 / 17.0±	dense, brown and white, fine medium and coarse SAND	4	"	47	19	
2487.5 / 21.0±	dense, brown fine SAND	5	"	760	24	Sand Backfill
	very dense, light grey-white SILTY SAND with a trace of clay (GLACIAL TILL)	6	"	750	29	Oct. 12, 1982
2469.0		7	"	760	39	
39.5	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-20

RECORD OF BOREHOLE NO. 82-21

LOCATION: 'B' Dam - West Abutment. Section O-O Spillway Centerline - Crest of Slope
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 8, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2493.0	Ground Surface					SP82-21
0.0	silty sand, gravel and cobbles (FILL)					
2488.0						
5.0	frozen, grey, fine and medium SAND with some gravel, low ice content, some crystals, no lenses	1	2" DO	48	9	
2479.0		2	"	40/8"	14	3/4 in ϕ P.V.C. pipe - Slotted tip
14.0	interlayered, soft to firm, khaki SILT (unfrozen) and frozen fine SAND					
2475.0		3	"	21	19	
18.0	dense, becoming very dense, light grey-white-yellow, fine medium and coarse SAND, trace to some silt and trace clay (GLACIAL TILL). Cold but not frozen. Breaks down with handling	4	"	36	24	Sand Backfill
		5	"	56	34	
2452.0		6	"	79	39	Oct. 12, 1982
41.0±	very dense, light grey-yellow SILTY fine and medium SAND, with trace to some clay (GLACIAL TILL)	7	"	>90	44	
2448.5						
44.5'	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-21

THOMSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-22

LOCATION: 'B' Dam - West abutment - Section D-D Spillway Centerline - Toe of Slope
COORDINATES:
GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct. 11, 1982
DRILLING METHOD: H.S. Auger
BOREHOLE DIAMETER: 8 in
LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2450.2	Ground Surface					
0.0	loose, grey and grey white SILTY SAND with some fine gravel (COLLUVIUM)	1	2"OD	8		
2444.2						
6.0	compact, interlayered, grey white and brown SAND, SAND and GRAVEL, and SAND with some silt and some gravel (COLLUVIUM)	2	"	17		
2435.2		3	"	21		
15.0±	compact, interlayered, grey and white, fine and medium SAND, and SAND and GRAVEL	4	"	19		No standpipe installed - Hole dry to >25 ft depth.
2425.2		5	"	17		
25.0±	dense, becomming very dense, light grey-white SILTY SAND, with trace clay (GLACIAL TIL'L)	6	"	34		
2415.7		7	"	74		
34.5	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft
BOREHOLE NO: 82-22

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 82-23

LOCATION: 'B' Dam - West Abutment _ Section F-F
Gravel Borrow Area

COORDINATES:

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Oct: 8, 1982

DRILLING METHOD: H.S. Auger

BOREHOLE DIAMETER: 8 in

LOGGED BY: BT

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2521.4	Ground Surface					SP 82-23
0.0	Loose, grey and tan SILTY SAND with GRAVEL, wet (WEATHERED GLACIAL TILL)	1	2" DD	7		
2512.4		2	"	51		
9.0	very dense, grey SILTY SAND with GRAVEL (GLACIAL TILL) Cold, damp, may be frozen in local zones	3	"	56		3/4" ϕ P.V.C. Pipe slotted tip
		4	"	780		
2496.9		5	"	65		Sand Backfill
24.5	dense to very dense, grey and brown, fine and medium SAND, wet	6	"	740		
2487.9		7	"	>80		Oct 12, 1982
33.5	very dense, light grey - white SILTY fine and medium SAND, trace clay (GLACIAL TILL)	8	"	N.A.		
2481.9						
39.5	End of Borehole					

VERTICAL SCALE: 1 in = 10 ft

BOREHOLE NO: 82-23

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 83-1

LOCATION: Lower 'A' Valley – Gravel Borrow Area

COORDINATES: 57,015 N – 71,970 E

GRID SYSTEM - DATUM: Whitehorse Copper

DRILLING DATE: Aug. 25, 83

DRILLING METHOD: Schram Air Rotary

BOREHOLE DIAMETER: 6 in.

LOGGED BY: D.C.

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2381.8 / 0.0	Ground Surface					SP83-1
	Clean, grey SAND, GRAVEL & COBBLES. Dry					3/4 in. dia. P.V.C. pipe – slotted tip
2370.8 / 11.0	Clean, grey SAND & GRAVEL with occ. cobbles. Becomming slightly silty with depth.					Granular Backfill
2365.8 / 15.0±	Clean well graded SAND & GRAVEL					Aug 30, 83
2357.8 / 24.0±	Crs. SAND & fine GRAVEL. Tr. Silt					
2352.8 / 29.0	Tan, SAND, SILT & CLAY (GLACIAL TILL)					
2341.8 / 40.0	End of Borehole					
	NOTE: No samples taken. Stratigraphy inferred from drill cuttings and drill behavior.					

VERTICAL SCALE: 1 in. = 10 ft.

BOREHOLE NO: 83-1

THOMPSON GEOTECHNICAL

RECORD OF BOREHOLE NO. 83-2

LOCATION: *Lower 'A' Valley – Alaska Highway*

COORDINATES: *57,450 N – 73,520 E*

GRID SYSTEM - DATUM: *Whitehorse Copper*

DRILLING DATE: *Aug 25-26, '83*

DRILLING METHOD: *Schram Air Rotary*

BOREHOLE DIAMETER: *6 in.*

LOGGED BY: *B.T. / D.C.*

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2389.8 0.0	*Ground Surface*					SP83-2
	Grey SAND, GRAVEL & COBBLES. Dry					*3/4 in. dia. P.V.C. pipe – slotted tip*
2361.8 28.0	*Stiff, brown CLAYEY SILT. Damp*					
2357.8 32.0	*Brown SAND & GRAVEL Damp to moist*					
2353.8 36.0	*Light brown fine, med. & crs. SAND. Damp*					
2350.3 39.5±	*Light brown SILT, SAND, GRAVEL & COBBLES. Dry. (GLACIAL TILL ?)*					
2324.8 65.0						

Continued next page

VERTICAL SCALE: *1 in. = 10 ft.*

BOREHOLE NO: *83 – 2*

RECORD OF BOREHOLE NO. 83-2 Cont'd

LOCATION:

COORDINATES:

GRID SYSTEM - DATUM:

DRILLING DATE:

DRILLING METHOD:

BOREHOLE DIAMETER:

LOGGED BY:

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
	Continued from previous page					SP83-2
2288.3	*Light grey & brown SAND, GRAVEL & COBBLES, Tr. to some silt. Dry*					3/4 in. dia. P.V.C. pipe — Slotted tip; Caved Material
101.5 / 2265.8	*BOULDER*					
104	*SAND & GRAVEL.*					
2264.8						
125 / 2262.8	*BOULDER*					
127	*SAND with some GRAVEL. Dry.*					
2257.8						
132 / 2255.8	*SAND & GRAVEL. Moist.*					
134	*SAND & GRAVEL. Some silt*					Aug 30, '85

Continued next page

VERTICAL SCALE: 1 in = 10 ft

BOREHOLE NO: 83-2

RECORD OF BOREHOLE NO. 83-2 Cont'd

LOCATION:

COORDINATES:

GRID SYSTEM - DATUM:

DRILLING DATE:

DRILLING METHOD:

BOREHOLE DIAMETER:

LOGGED BY:

ELEV. / DEPTH	INFERRED STRATIGRAPHY	SAMPLES NO.	SAMPLES TYPE	SAMPLES 'N'	LABORATORY TESTING	PIEZOMETER INSTALLATIONS
2249.8	*Continued from previous page*					SP83-2
140.0	SAND & GRAVEL					Backfill
2239.8						
150.0	*Firm brown SILT with some clay and tr. to some sand. (GLACIAL TILL?)*					
2235.8						
154.0	*End of Borehole*					

VERTICAL SCALE: 1 in = 10 ft

BOREHOLE NO: 83-2

Piezometer Readings
Appendices C15 & C16

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-1A

- C15

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	-		
LOCATION: BH 82-1	Oct. 12/82	Dry		
Section A-A - Old Pond D/S of Crest.	Oct. 19/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	Dry		
	Nov. 24/83	-		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	Dry		
INSTALLED: Sept./82				
TOTAL LENGTH: 34.4'	July 6/87	-		(Destroyed)
COLLAR ELEV: 2573.2'				
GENERAL NOTES				
i) Conditions indicate standpipe may be located within zone of partially saturated flow. See also Record of Borehole No. 82-1.				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - IB

INSTALLATION DETAILS

LOCATION: BH 82-1
Section A-A, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE / MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Sept. /82

TOTAL LENGTH: 17.3'

COLLAR ELEV: 2572.7'

GENERAL NOTES

i) Conditions indicate standpipe may be located within zone of partially saturated flow. See also Record of Borehole No. 82-1.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	–		
Oct. 12/82	Dry		
Oct. 19/82	–		
June 20/83	Dry		
Nov. 24/83	–		
July 11/84	Dry		
July 6/87	Dry		Sounded to 17.2'

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 2A

INSTALLATION DETAILS

LOCATION: BH 82-2
Section A-A, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE / MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Sept. / 82

TOTAL LENGTH: 36.7'

COLLAR ELEV: 2578.9'

GENERAL NOTES

i) Conditions indicate standpipe may be located within zone of partially flow. See also Record of Borehole No. 82-2.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4 / 82	-		
Oct. 12 / 82	→		Mud at 35.0' (El. 2543.9')
Oct. 19 / 82	-		
June 20 / 83	→		" " " "
Nov. 24 / 83	-		
July 11 / 84	→		Mud at 35.3' (El. 2543.6')
July 6 / 87	Dry		Sounded to 35.1'
15 Aug 91	Dry		

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-2B

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	-		
LOCATION: BH 82-2	Oct. 12/82	Dry		
Section A-A, Old Pond	Oct. 19/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	Dry		
	Nov. 24/83	-		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	→		Mud at 24.3'
INSTALLED: Sept./82				
TOTAL LENGTH: 24.6'	July 6/87	Dry		Sounded to 24.0'
COLLAR ELEV: 2579.7'	16 Aug 91	Dry.		
GENERAL NOTES				
i) Conditions indicate standpipe may be located within zone of partially saturated flow. See also Record of Borehole No. 82-2.				

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-24A

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	-		
LOCATION: BH 82-24	Oct. 12/82	Dry	≤2545.3	
Section A-A, Old Pond	Oct. 19/82			
COORDINATES:				
REF. DRWGS: Figures	June 20/83	Dry		
	Nov. 24/83	Dry		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	28.7	2546.6	Bottom undefined
INSTALLED: Oct./82				
TOTAL LENGTH: 30.0' ±	July 6/87	Dry		Bottom at 28.2'.
COLLAR ELEV: 2575.3'	16 Aug 31	Dry		
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-24B

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	13.9	2561.4	
LOCATION: BH 82-24	Oct. 12/82	14.5	2560.8	
Section A-A, Old Pond	Oct. 19/82	–		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	11.6	2563.7	
	Nov. 24/83	13.6		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Piezometer	July 11/84	13.5	2561.8	
INSTALLED: Oct. /82				
TOTAL LENGTH: 15.0'	July 6/87	Dry	≤2562.1	Sounded to 13.2'
COLLAR ELEV: 2575.3'	16. Aug 9	Dry.		Sounded to 4m.
GENERAL NOTES				
i) Collar elevation subject to change with settlement of tailings.				

OLD POND - SECTION B-B'

- C/S

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 3A

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	Dry		
LOCATION: BH 82-3	Oct. 12/82	Dry		
Section B-B, Old Pond	Oct. 19/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	Dry		
	Nov. 24/83	-		Blocked by ice.
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	Dry		
INSTALLED: Sept. /82				
TOTAL LENGTH: 35.0'	July 6/87	Dry		Sounded to 34.1'.
COLLAR ELEV: 2578.8'	15 Aug.			Destroyed?
GENERAL NOTES				
				Sheet 1 of 1

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 4

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	38.8	2539.2	
LOCATION: BH 82-4	Oct. 12/82	38.8		
Section B-B, Old Pond	Oct. 19/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	38.7	2539.2	
	Nov. 24/83	39.3	2538.7	
TYPE / MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	39.4	2538.6	
INSTALLED: Sept. /82				
TOTAL LENGTH: 41.5'	July 6/87	38.5	2539.5	Bottom at 39.0'
COLLAR ELEV: 2578.0'	15 Aug 91	36.6	2541.0	S.U. 43 cm 11.6 m Water @ 36.6 ft
GENERAL NOTES				

C15

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-5A

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	-		
LOCATION: BH 82-5	Oct. 12/82	45.3	2532.7	Level rising
Section B-B, Old Pond	Oct. 19/82	39.2	2538.8	
COORDINATES:				
REF. DRWGS: Figures	June 20/83	39.2	2538.8	
	Nov. 24/83	39.7	2538.3	
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	40.0	2538.0	
INSTALLED: Oct. /82				
TOTAL LENGTH: 46.0'	July 6/87	39.1	2538.9	Bottom at 45.5'
COLLAR ELEV: 2578.0'	15 Aug 91	36.3	2541.7	w.l. @ 11.8 m − 0.73 = 11.07 = 36.3 ft
				took a small water sample
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 5B

INSTALLATION DETAILS

LOCATION: BH 82-5
Section B-B, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE / MODEL: Slotted Tube

CONFIGURATION: Partial Piez.

INSTALLED: Oct. 1982

TOTAL LENGTH: 22.6'

COLLAR ELEV: 2578.1'

GENERAL NOTES

i) Collar elevation subject to change with settlement of tailings.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	-		
Oct. 12/82	Dry		Sounded to 22.5'
Oct. 19/82	-		
June 20/83	Dry		
Nov. 24/83	Dry		
July 11/84	Dry		
July 6/87	Dry		Sounded to 22.5'

OLD POND - SECTION C-C - C/

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 – 7

INSTALLATION DETAILS

LOCATION: BH 82-7 Section C-C, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. /82

TOTAL LENGTH: 67.4'

COLLAR ELEV: 2576.4'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	58.2	2518.2	
Oct. 12/82	58.3		
Oct. 19/82	–		
June 20/83	58.1	2518.3	
Nov. 24/83	58.3		
July 11/84	–		Blocked ?
July 6/87	58.7	2517.7	
16 Aug 91	57.4	2519.0	18.1m S.U. 0.6m 17.5m 57.4ft

THOMPSON GEOTECHNICAL

C15

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-8A

INSTALLATION DETAILS

LOCATION: BH 82-8
Section C-C, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. 182

TOTAL LENGTH: 63.0'

COLLAR ELEV: 2575.8'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	55.4	2520.4	
Oct. 12/82	55.2		
Oct. 19/82	-		
June 20/83	55.1	2520.7	
Nov. 24/83	55.2		
July 11/84	55.7	2520.1	
July 6/87	56.1	2519.7	
16 Aug	~~56.5~~	2519.2	17.25m ~~bf.~~ 56.5, 20.20 m bef. of hole

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-8B

INSTALLATION DETAILS

LOCATION: BH 82-8
Section C-C, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. /82

TOTAL LENGTH: 32.5'

COLLAR ELEV: 2575.4'

GENERAL NOTES

i) Collar elevation subject to change with settlement of tailings.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	-		
Oct. 12/82	21.5	2553.9	
Oct. 19/82	20.9	2554.5	
June 20/83	19.8	2555.6	
Nov. 24/83	20.0		
July 11/84	Dry		Unconfirmed
July 6/87	-		Damaged

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-9

INSTALLATION DETAILS

LOCATION: BH 82-9
Section D-D, Old Pond

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. 182

TOTAL LENGTH: 30.0'

COLLAR ELEV: 2592.7'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 4/82	Dry		
Oct. 12/82	Dry		
Oct. 19/82	-		
June 20/83	Dry		
Nov. 24/83	-		
July 11/84	Dry		
July 6/87	29.5	-	Bottom at 29.55'
11 Sept 91	Dry	-	10.5m s.u. 0.4m

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-10

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 4/82	Dry		
LOCATION: BH 82-10	Oct. 12/82	Dry		
Section O-O, Old Pond	Oct. 19/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	Dry		
	Nov. 24/83	-		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe	July 11/84	34.7	2554.6	
INSTALLED: Oct. 182				
TOTAL LENGTH: 35.7'	July 6/87	34.3	2555.0	Bottom at 34.8'
COLLAR ELEV: 2589.3'	11 Sept 91	"Dry"		9.0 m S.U. 0.5m
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 81 - 1

INSTALLATION DETAILS

LOCATION: BH 81-1
Section A-A 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE / MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: July / 81

TOTAL LENGTH: 14.0'

COLLAR ELEV: 2403.3'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	9.0	2394.3	
Sept. 2/81			
Oct. 20/81			
July 25/82	9.8	2393.5	
Oct. 12/82	9.6		
Oct. 29/82	10.0		
June 17/83	6.4	2396.9	
Sept. 3/83	9.0		
Nov. 24/83	9.4		
July 14/84	9.3		
May 23/85	8.9	2394.4	
July 7/87	8.8		
16 Aug 91	7.9	2395.4	(2.7 fm 0.3) = 7.9
			(4.1 m x 3.28) = 13.4 ft.

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 83 - 1

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Aug. 29/83	14.9	2368.1	
LOCATION: BH 83-1 Lower 'A' Valley	Nov. 25/83	15.4		
COORDINATES:	July 14/84	15.6	2367.4	
REF. DRWGS: Figures				
	July 6/87	15.0	2368.0	
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe				
INSTALLED: Aug./83				
TOTAL LENGTH: 30.0 ±				
COLLAR ELEV: 2483.0'				
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 83-2

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Aug. 29/83	136.2	2254.2	
LOCATION: BH 83-2 Lower 'A' Valley				
COORDINATES:				
REF. DRWGS: Figures				
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe				
INSTALLED: Aug./83				
TOTAL LENGTH: 143.5' ±				
COLLAR ELEV: 2390.4'				
GENERAL NOTES				

THOMPSON GEOTECHNICAL

Sheet 1 of 1

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 79 - 1

INSTALLATION DETAILS

LOCATION: BH 79-1 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: March/79

TOTAL LENGTH: See Note i)

COLLAR ELEV: " "

GENERAL NOTES

i) Tube extended during dam construction (1979/80)
- original length 35.1'
- original elev. 2434.1'
- extended length 66.0'
- present elev. 2465.0'

ii) Elevations prior to Oct/82 are approximate only.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Mar. 22/79		2403.2	
June 13/79		2403.1	
July 22/79		2404.8	Approximate only.
Sept. 14/79		2405.6	" "
Oct. 27/79		2399.3	Pumping
July 2/80	Dry	-	Pumping
Oct. 5/82	61.1	2403.9	
Oct. 12/82	-	-	
Oct. 29/82	-	-	
June 20/83	-	-	
Sept. 4/83	-	-	
Nov. 25/83	60.9	2401.1	
July 14/84	60.7	2404.3	
July 7/87	61.3	2403.7	
16 July 91	—?	—?	Damaged.

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 79-2

INSTALLATION DETAILS

LOCATION: BH 79-2 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: March/79

TOTAL LENGTH: See Note i)

COLLAR ELEV: " "

GENERAL NOTES

i) Tube extended during dam construction (1979/80)
- original length 49.0'
- original elev. 2438.0'
- extended length 86.4'
- present elev. 2475.4'

ii) Elevations prior to Oct./82 are approximate only.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Mar. 22/79		2402.2	
June 13/79		2403.0	
July 27/79		2404.5	Approximate Only
Sept. 14/79		-	Blocked
Oct. 27/79		-	"
July 2/80		2399.5	Pumping
Oct. 5/82	72.2	2403.2	
Oct. 12/82	-	-	
Oct. 29/82	-	-	
June 20/83	-	-	
Sept. 4/83	-	-	
Nov. 25/83	-	-	Blocked at 5' depth
July 14/84	71.9	2403.5	
July 7/87	-	-	
16 Aug 91	-	-	damaged.

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 79 - 3

INSTALLATION DETAILS

LOCATION: BH 79-3 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: March/79

TOTAL LENGTH: See Note i)

COLLAR ELEV: " "

GENERAL NOTES

i) Tube extended during dam construction (1979/80)
- original length 46.5'
- original elev. 2334.0'
- extended length 79.2'
- present elev. 2466.7'

ii) Elevations prior to Oct./82 are approximate only.

(iii) Casing pipe cut off to S.L. Sept 91 Elev. 2460.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Mar. 22/79		2403.5	
June 13/79		2403.5	
July 22/79		2404.8	Approximate only.
Sept. 14/79		2403.3	" "
Oct. 27/79		2401.0	Pumping
July 2/80		2399.9	Pumping
Oct. 5/82	62.7	2403.9	
Oct. 12/82	-	-	
Oct. 29/82	-	-	
June 20/83	-	-	
Sept. 4/83	-	-	
Nov. 25/83	62.6	2404.1	
July 14/84	62.4	2404.3	
July 7/87	-	-	15.9 24.2 m
16 Aug 91	61.9	2404.7	(15.9 - 2.0 s.u) 79.3 ft.
3 Sept 91	55.4	2404.6	upper pipe cut-off to S.L. 91 - 17.0 m

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-11

INSTALLATION DETAILS

LOCATION: BH 82-11
Section B-B, 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. /82

TOTAL LENGTH: 40.0'

COLLAR ELEV: 2516.4'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 5/82	36.7	2479.7	
Oct. 12/82	37.0	2479.4	
Oct. 29/82	37.7		
June 20/83	37.0	2479.4	
Sept. 4/83	–		
Nov. 25/83	–		
July 14/84	39.1	2477.3	
July 7/87	Dry	–	Sounded to 39.2'
16 Aug 91	Dry	<2476	

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-12

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	38.9	2468.3	
LOCATION: BH 82-12	Oct. 12/82	33.5	2473.7	
Section B-B, 'B' Dam	Oct. 29/82	33.7		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	33.9	2473.3	
	Sept. 4/83	-		
TYPE/MODEL: Slotted Tube	Nov. 25/83	-		
CONFIGURATION: Standpipe				
INSTALLED: Oct. 182	July 14/84	Dry		
TOTAL LENGTH: 43.5'				
COLLAR ELEV: 2507.2'	July 7/87	Dry		Sounded to 42.1'
	16 Aug 91	41.9.	2465.2?	12.8 - 1m S.u
				41.9 ft
GENERAL NOTES				

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-13

INSTALLATION DETAILS

LOCATION: BH 82-13
Section B-B, 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. 1/82

TOTAL LENGTH: 42.0'

COLLAR ELEV: 2497.2'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 5/82	-		
Oct. 12/82	32.1	2465.1	
Oct. 29/82	32.8		
June 20/83	30.5	2466.7	
Sept. 4/83	-		
Nov. 25/83	-		
July 14/84	39.9	2457.3	
July 7/87	39.1	2458.1	
16 Aug 91	40.5	2456.7	12.35 m / m S.U.
			40.5 ft

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 14

INSTALLATION DETAILS

LOCATION: BH 82-14
Section C-C, 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE / MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. / 82

TOTAL LENGTH: 37.1'

COLLAR ELEV: 2497.5'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 5/82	24.7	2472.8	
Oct. 12/82	24.9		
Oct. 29/82	25.2		
June 20/83	24.9	2472.6	
Sept. 4/83	-		
Nov. 25/83	-		
July 14/84	29.7	2467.8	
July 7/87	29.1	2468.4	
16 Aug 91	29.7	2468.6	8.8 m (S.U. 0.45)

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-15

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	-		
LOCATION: BH 82-15	Oct. 12/82	48.0	2405.0	
Section C-C, 'B' Dam	Oct. 29/82	-		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	48.0	2405.0	
	Sept. 4/83	-		
TYPE/MODEL: Slotted Tube	Nov. 25/83	-		
CONFIGURATION: Standpipe				
INSTALLED: Oct. 182	July 14/84	48.9	2404.1	
TOTAL LENGTH: 52.6'				
COLLAR ELEV: 2453.0'	July 7/87	49.1	2403.9	
	16 Aug. 91	46.2	2406.75	14.1 m S.U 0.1 m
GENERAL NOTES				
				Sheet 1 of 1

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-16A

INSTALLATION DETAILS

LOCATION: BH 82-16
Crest of 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. /82

TOTAL LENGTH: 67.0'

COLLAR ELEV: 2517.8'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 5/82	-		
Oct. 12/82	60.7	2457.1	
Oct. 29/82	61.1	2456.7	
June 20/83	60.4	2457.4	
Sept. 4/83	63.0		
Nov. 25/83	64.4		
July 14/84	64.9	2452.9	
July 7/87	63.9	2453.9	
16 Aug 91	59.3	2458.4	18.1 m I.U. ?

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-16B

INSTALLATION DETAILS

LOCATION: BH 82-16 Crest of 'B' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Slotted Tube

CONFIGURATION: Standpipe

INSTALLED: Oct. /82

TOTAL LENGTH: 53.0'

COLLAR ELEV: 2517.5'

GENERAL NOTES

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Oct. 5/82	–		
Oct. 12/82	Dry		
Oct. 29/82	Dry		
June 20/83	Dry		
Sept. 4/83	Dry		
Nov. 25/83	Dry		
July 14/84	Dry		
July 7/87	Dry		Sounded to 52.8'
16 Aug 91	52.4	2465.1	16 m. 52.4 ft

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-19

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	-		
LOCATION: BH 82-19	Oct. 12/82	24.7	2482.9	
Section D-D, 'B' Dam	Oct. 29/82	24.9		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	25.8	2482.8	
	Sept. 4/83	-		
TYPE/ MODEL: Slotted Tube	Nov. 15/83	-		
CONFIGURATION: Standpipe				
INSTALLED: Oct./82	July 14/84	24.8	2482.8	
TOTAL LENGTH: 37.8'				
COLLAR ELEV: 2507.6'	July 7/87	24.8	2482.8	
	16 Aug 91	21.8	2485.8	6.65 m
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82-20

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	-		
LOCATION: BH 82-20	Oct. 12/82	32.8	2478.3	
Section D-D, 'B' Dam	Oct. 29/82	32.8		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	32.9	2478.2	
	Sept. 4/83	-		
TYPE/MODEL: Slotted Tube	Nov. 25/83	-		
CONFIGURATION: Standpipe				
INSTALLED: Oct. 182	July 14/84	32.8	2478.3	
TOTAL LENGTH: 43.0'				
COLLAR ELEV: 2511.1'	July 7/87	33.1	2478.0	
	16 Aug 91	32.1'	2479.0	9.8 m
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 21

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	–		
LOCATION: BH 82-21	Oct. 12/82	41.1	2452.8	
Section D-D, 'B' Dam	Oct. 29/82	-		
COORDINATES:	June 20/83	41.4	2452.5	
REF. DRWGS: Figures	Sept. 4/83	–		
	Nov. 25/83	–		
TYPE/MODEL: Slotted Tube				
CONFIGURATION: Standpipe				
	July 14/84	41.4	2452.5	
INSTALLED: Oct./82				
TOTAL LENGTH: 50.0'	July 7/87	41.2	2452.7	
COLLAR ELEV: 2493.9'	16 Aug 91	40.8	2453.1	12.45 m
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 82 - 23

INSTALLATION DETAILS	DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Oct. 5/82	-		
LOCATION: BH 82-23	Oct. 12/82	24.2	2498.2	
Section F-F, 'B' Dam	Oct. 29/82	24.2		
COORDINATES:				
REF. DRWGS: Figures	June 20/83	24.2		
	Sept. 4/83	—		
TYPE/MODEL: Slotted Tube	Nov. 25/83	—		
CONFIGURATION: Standpipe				
INSTALLED: Oct. / 82	July 14/84	23.8	2498.6	
TOTAL LENGTH: 41.0'				
COLLAR ELEV: 2522.4	July 7/87	24.1	2498.3	
	16 Aug 91	21.3	2501.1	6.5 m
GENERAL NOTES				

PIEZOMETRIC OBSERVATIONS (STANDPIPE PIEZOMETERS)

STANDPIPE No: 80 - 1

INSTALLATION DETAILS

LOCATION: BH 80-1 Lower 'B' Valley

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: Open Casing

CONFIGURATION: Standpipe

INSTALLED: July/80

TOTAL LENGTH: See Note i)

COLLAR ELEV: " "

GENERAL NOTES

i) Casing extended in Nov./83
- original length 15.0'
- original elev. 2412.2'
- extended length 18.6'
- present elev. 2414.8'

ii) Collar elevations based on Corley survey, July/80.

DATE	DEPTH TO S.W. (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
July 8/80	10.2	2402.0	Pumping from cutoff exc.
"	10.2	2402.0	" " " "
Aug. 5/80		2403.2	Pumping with d/s discharge
Aug 10/81		2403.0	
Oct. 5/82	-		
Oct. 12/82	8.8	2403.4	
Oct. 29/82	-		
June 20/83	-		
Sept. 4/83	-		
Nov. 25/83	11.1	2403.7	Casing extended
July 14/84	10.9	2403.9	Level prior to disch. test
July 7/87	12.6	2402.2	

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 80-3A

INSTALLATION DETAILS

LOCATION: BH 80-3
Section B-B, 'A' Dam
COORDINATES:
REF. DRWGS: Figures

TYPE/MODEL: P-100
CONFIGURATION: Piezometer
INSTALLED: July / 80
ZERO READING: N/A (0.6)
TIP ELEVATION: 2570.0'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft)	NOTES
Aug. 14/80	5.95	12.31	2482.3	
Aug. 29/80	5.81			
Sept. 11/80	5.50			
Oct. 4/80	5.70			
Nov. 4/80	5.55			
Mar. 9/81	3.45	6.56	2476.6	
Aug. 10/81	2.75	4.95	2474.9	
Sept. 21/81	2.95	5.41	2475.4	
Oct. 20/81	2.70	4.83	2474.8	
July 25/82	1.70	2.50	2472.5	
Oct. 12/82	2.00			
Oct. 29/82	2.60			
June 17/83	4.20	8.28	2478.3	
Sept. 3/83	4.35			
Nov. 24/83	–			Damaged
July 14/84	3.50	6.67	2476.7	
May 23/85	–			Damaged
July 7/87	–			Damaged

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 80 - 3B

INSTALLATION DETAILS

LOCATION: BH 80-3
Section B-B, 'A' Dam
COORDINATES:
REF. DRWGS: Figures

TYPE/MODEL: P-100
CONFIGURATION: Piezometer
INSTALLED: July /80
ZERO READING: N/A (0.6)
TIP ELEVATION: 2485.0'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft)	NOTES
Aug. 14/80	2.05	3.34	2488.3	
Aug. 29/80	1.81			
Sept. 11/80	1.50			
Oct. 4/80	1.75			
Nov. 4/80	1.20			
Mar. 9/81	1.25±	0	~	Erratic Response
Aug. 10/81	0.50	0	~	
Sept. 21/81	0.60	0	~	
Oct. 20/81	0.45	0	~	
July 25/82	0.60	0	~	
Oct. 12/82	0.50			
Oct. 29/82	0.60			
June 17/83	1.10	1.15	2486.0	
Sept. 3/83	1.10			
Nov. 24/83	–			Damaged
July 14/84	0.60	0	~	
May 23/85	0.70	0.23	2485.2	
July 7/87	–			Damaged

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 80-3C

INSTALLATION DETAILS

LOCATION: BH 80-3
Section B-B, 'A' Dam
COORDINATES:
REF. DRWGS: Figures

TYPE/MODEL: P-100
CONFIGURATION: Piezometer
INSTALLED: July 1/80
ZERO READING: N/A (0.6)
TIP ELEVATION: 2495.0'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 14/80	1.00	0.92	2495.9	
Aug. 29/80	0.18			
Sept. 11/80	0.18			
Oct. 4/80	0.18			
Nov. 4/80	–			
Mar. 9/81	–			
Aug. 10/81	–			
Sept. 21/81	0.60	0	~	
Oct. 20/81	–			
July 25/82	0.60	0	~	
Oct. 12/82	1.00			
Oct. 29/82	1.10			
June 17/83	1.00	0.92	2495.9	
Sept. 3/83	1.00			
Nov. 24/83	–			
July 14/84	0.90	0.69	2595.6	
May 23/85	1.00	0.92	2495.9	
July 7/87	–			Damaged

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81 - 2

INSTALLATION DETAILS	DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Aug. 10/81	2.70	4.83	2394.3	
LOCATION: BH 81-2	Sept. 21/81	2.55			
Section A-A, 'A' Dam	Oct. 20/81	2.40			
COORDINATES:	July 25/82	2.60	4.6	2394.1	
REF. DRWGS: Figures	Oct. 12/82	2.70			
	Oct. 29/82	2.50			
TYPE/MODEL: P-100					
CONFIGURATION: Piezometer	June 17/83	4.00	7.82	2397.3	
INSTALLED: July/81	Sept. 3/83	2.95			
ZERO READING: N/A (0.6)	Nov. 24/83	2.80			
TIP ELEVATION: 2389.5					
	July 14/84	2.90			
GENERAL NOTES	May 23/85	3.10	5.75	2395.2	
	July 7/87	3.00			

THOMPSON GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-3

INSTALLATION DETAILS

LOCATION: BH 81-3
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: July 181

ZERO READING: N/A (0.6)

TIP ELEVATION: 2419.7'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	0.65	0	~	
Sept. 21/81	0.70			
Oct. 20/81	0.70			
July 12/82	0.85	0	~	
Oct. 12/82	0.80			
Oct. 29/82	0.90			
June 17/83	2.10	3.45	2423.1	
Sept. 3/83	2.30			
Nov. 24/83	2.40			
July 14/84	2.50			
May 23/85	2.80	5.06	2424.8	
July 7/87	2.35			

THURBER GEOTECHNICAL

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-4

INSTALLATION DETAILS

LOCATION: BH 81-4
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: Aug. '81

ZERO READING: N/A (0.6)

TIP ELEVATION: 2419.0

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	0.30	0	~	
Sept. 21/81	0.40			
Oct. 20/81	0.03			
July 25/82	0.30	0	~	
Oct. 12/82	0.40			
Oct. 29/82	0.50			
June 17/83	2.30	3.91	2422.9	
Sept. 3/83	3.20			
Nov. 24/83	3.20			
July 14/84	3.50			
May 23/85	3.45	6.56	2425.6	
July 7/87	–			Damaged

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-5A

INSTALLATION DETAILS

LOCATION: BH 81-5
Section A-A, 'A' Dam
COORDINATES:
REF. DRWGS: Figures
TYPE/MODEL: P-100
CONFIGURATION: Piezometer
INSTALLED: Aug. /81
ZERO READING: N/A (0.6)
TIP ELEVATION: 2430.2'

GENERAL NOTES

DATE	FIELD READING (p.s.i)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft)	NOTES
Aug. 10/81	0.45	0	~	
Sept. 21/81	0.60			
Oct. 20/81	0.05			
July 25/82	0.60	0	~	
Oct. 12/82	0.60			
Oct. 29/82	0.50			
June 17/83	1.10	1.15	2431.3	
Sept. 3/83	1.00			
Nov. 24/83	1.00			
July 14/84	0.95			
May 23/85	1.40	1.84	2432.4	
July 7/87	—			Damaged

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-5B

INSTALLATION DETAILS

LOCATION: BH 81-5
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: Aug. 181

ZERO READING: N/A (0.6)

TIP ELEVATION: 2450.2

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	0.20	0	~	
Sept. 2/81	0.30			
Oct. 20/81	0.02			
July 25/82	0.30	0	~	
Oct. 12/82	0.35			
Oct. 29/82	0.40			
June 17/83	0.50	0	~	
Sept. 3/83	0.50			
Nov. 24/83	0.50			
July 14/84	0.80			
May 23/85	0.90	0	~	
July 7/87	0.90			

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-6

INSTALLATION DETAILS

LOCATION: BH 81-6
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: Sept. /81

ZERO READING: 0.4 D/0.6 W

TIP ELEVATION: 2468.8'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	-			
Sept. 21/81	0.60			
Oct. 20/81	>30			Frozen
July 25/82	0.60	0	~	
Oct. 12/82	0.60			
Oct. 29/82	0.60			
June 17/83	0.65	0	~	
Sept. 3/83	0.70			
Nov. 24/83	>30			Frozen
July 14/84	0.85			
May 23/85	0.85	0	~	
July 7/87	0.60			

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-7

INSTALLATION DETAILS

LOCATION: BH 81-7
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Standpipe

INSTALLED: Sept. /81

ZERO READING: 0.3D/0.4W

TIP ELEVATION: 2472.3'

GENERAL NOTES

i) Borehole backfilled with granular material. Piezometer behaves as open standpipe.

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	-			
Sept. 21/81	0.50			
Oct. 20/81	0.04			
July 25/82	0.50	0	~	
Oct. 12/82	0.60			
Oct. 29/82	0.70			
June 17/83	1.30	2.07	2474.4	
Sept. 3/83	1.35			
Nov. 24/83	1.40			
July 14/84	1.05			
May 23/85	1.00	1.38	2473.7	
July 7/87	0.90			

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81 - 8A

INSTALLATION DETAILS

LOCATION: BH 81-8
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: Sept. /81

ZERO READING: 0.30

TIP ELEVATION: 2450.0'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	-			
Sept. 21/81	2.60	5.29	2455.3	
Oct. 20/81	2.25	4.49	2454.5	
July 25/82	1.30	2.30	2453.0	
Oct. 12/82	1.75			
Oct. 29/82	2.30	2.00	2454.6	
June 17/83	3.60	2.59	2457.6	
Sept. 3/83	3.85			
Nov. 24/83	3.85			
July 14/84	3.05			
May 23/85	2.00	3.90	2453.9	
July 7/87	1.85	3.56	2453.6	

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-8B

INSTALLATION DETAILS

LOCATION: BH 81-8
Section A-A, 'A' Dam

COORDINATES:

REF. DRWGS: Figures

TYPE/MODEL: P-100

CONFIGURATION: Piezometer

INSTALLED: Sept. /81

ZERO READING: 0.30

TIP ELEVATION: 2480.0'

GENERAL NOTES

DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
Aug. 10/81	-			
Sept. 21/81	0.10			
Oct. 20/81	0.25			
July 25/82	0.10	0	~	
Oct. 12/82	0.30			
Oct. 29/82	0.50			
June 17/83	1.60	2.99	2483.0	
Sept. 3/83	2.00			
Nov. 24/83	1.80			
July 14/84	1.00			
May 23/85	0.60	0.69	2480.7	
July 7/87	0			Damaged ?

PIEZOMETRIC OBSERVATIONS (PNEUMATIC PIEZOMETERS)

PIEZOMETER No: 81-8C

INSTALLATION DETAILS	DATE	FIELD READING (psi)	ADJ. HEAD (ft.)	PIEZOM. ELEVATION (ft.)	NOTES
	Aug. 10/81	—			
LOCATION: BH 81-8	Sept. 21/81	2.90			
Section A-A, 'A' Dam	Oct. 20/81	9.90			
COORDINATES:					
REF. DRWGS: Figures	July 25/82	1.40	2.53	2499.0	
	Oct. 12/82	1.10			
TYPE/MODEL: P-100	Oct. 29/82	1.20			
CONFIGURATION: Piezometer					
INSTALLED: Sept. 181	June 17/83	0.60	0	~	
ZERO READING: 0.5 D/0.7 W	Sept. 3/83	0.75			
TIP ELEVATION: 2496.5'	Nov. 24/83	0.75			
	July 14/84	0.55			
GENERAL NOTES					
	May 23/85	0.70	0	~	
	July 7/87	0.60			

Stream Flow Observations
Appendix C17

APPENDIX ' '

STREAMFLOW OBSERVATIONS

STREAMFLOW OBSERVATIONS

STATION A1
SPILLWAY No.6

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	May 4/85			8	Snowmelt
LOCATION: See Figure	May 5/85			17	"
COORDINATES:	May 6/85	AM		21	"
	May 6/85	PM		167	" (*)
METHOD OF OBS: V-Notch Wier	May 7/85			21	
SENSIVITY: Minor Head Pond	May 8/85			8	
	May 9/85			17	
DRAINAGE AREA:	May 10/85			0	End of melt
·SURFACE RUNOFF:					
·GROUNDWATER RUNOFF:					
					* Major discharge occured during night of May 6-7. Peak flow estimated at 3000 gpm approximately. (Discharge caused by failure of u/s ice dam).

GENERAL NOTES

i) Station installed for 1985 snowmelt study.

STREAMFLOW OBSERVATIONS

STATION A2
SADDLE SPILLWAY

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS ( )	NOTES
LOCATION: See Figure					No flows observed-
COORDINATES:					Runoff stored in
					'A' Pond.
METHOD OF OBS: Rectangular Wier					
SENSIVITY: 4-6 Ac Headpond					
DRAINAGE AREA:					
·SURFACE RUNOFF:					
·GROUNDWATER RUNOFF:					
GENERAL NOTES					
i) Station installed for 1985 snowmelt study.					
					Sheet 1 of 1

THOMPSON GEOTECHNICAL

STREAMFLOW OBSERVATIONS

STATION A 3
COPPER LAKE

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	May 6/83			120	Groundwater Only
LOCATION: See Figure	Sept. 19/83			52	"
COORDINATES:	Nov. 25/83			~50	"
METHOD OF OBS: V-Notch Wier	April 17/85			24	Incl. minor snowmelt
SENSIVITY: O.S. Ac Head Pond	April 18/85			21	"
	April 19/85			24	"
DRAINAGE AREA:	April 20/85			21	"
·SURFACE RUNOFF:	April 21/85			24	"
·GROUNDWATER RUNOFF:	April 22/85			26	
	April 23/85			23	
	April 24/85			23	
GENERAL NOTES	April 25/85			26	
	April 26/85			26	
i) Discharge comprised of groundwater only unless otherwise noted.	April 27/85			23	
	April 28/85			23	
	April 29/85			26	
	April 30/85			26	
	May 1/85			26	
	May 2/85			26	
	May 3/85			28	
	May 4/85			28	
	May 5/85			28	
	May 6/85			-	Wier flooded
	May 7/85			-	
	May 8/85			-	
	May 9/85			-	
					Sheet 1 of 2

THOMPSON GEOTECHNICAL

STREAMFLOW OBSERVATIONS

STATION A3
COPPER LAKE

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	May 10/85			-	Wier flooded
LOCATION: (cont'd)	May 11/85			-	"
COORDINATES:	May 12/85			-	"
	May 23/85			30	Groundwater only
METHOD OF OBS:					
SENSIVITY:	July 6/87			19	Groundwater only
DRAINAGE AREA:					
-SURFACE RUNOFF:					
-GROUNDWATER RUNOFF:					
GENERAL NOTES					
					Sheet 2 of 2

STREAMFLOW OBSERVATIONS

STATION A4
RIVER SPRINGS

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: See Note i)

SENSIVITY: Direct discharge

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Springs emerge from several sites at toe of slide. Northern flows channeled to common drain - Southern flow directed to U-notch wier. Record shows combined (total) flow from both areas.

ii) Discharge comprised of groundwater only.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
Aug. 23/83			94	Combined flow
Aug. 29/83			95	"
Sept. 19/83			94	"
Nov. 25/83			86	"
July 14/84			60	"
April 19/85			24	Flow obs. at wier
April 20/85			24	only - No discharge
April 21/85			21	from northern
April 22/85			21	sites.
April 23/85			17	"
April 24/85			19	"
April 25/85			17	"
April 26/85			17	"
April 27/85			17	"
April 28/85			17	"
April 29/85			17	"
April 30/85			17	"
May 1/85			19	"
May 2/85			17	"
May 3/85			17	"
May 4/85			17	"
May 6/85			17	"
May 8/85			17	"
May 12/85			17	"
May 23/85			17	Minor flow from north
				Sheet 1 of 2

STREAMFLOW OBSERVATIONS

STATION A4
RIVER SPRINGS

STATION DATA

LOCATION: (Cont'd)

COORDINATES:

METHOD OF OBS:

SENSIVITY:

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
July 6/87			50	Combined flow

STREAMFLOW OBSERVATIONS

STATION B2
B2 SPRINGS

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	July 13/84	17:30		76	
LOCATION: See Figure	July 14/84	09:30		77	
COORDINATES:					
	April 18/85			43	
METHOD OF OBS: V-Notch Wier	April 19/85			43	
SENSIVITY: Minor Head Pond	April 20/85			43	
	April 21/85			47	
DRAINAGE AREA:	April 22/85			47	
·SURFACE RUNOFF:	April 23/85			43	
·GROUNDWATER RUNOFF:	April 24/85			43	
	April 25/85			43	
	April 26/85			43	
GENERAL NOTES	April 27/85			43	
	April 28/85			43	
i) Springs emerge from several sites near toe of slope. Flows converge to common stream.	April 29/85			43	
	April 30/85			43	
	May 1/85			43	
ii) Discharge comprised of groundwater only unless otherwise noted.	May 2/85			43	
	May 3/85			43	
	May 4/85			47	Incl. minor snowmelt
	May 5/85			47	"
	May 6/85			43	"
	May 7/85			47	"
	May 8/85			43	"
	May 9/85			47	"
	May 24/85			51	Groundwater only
					Sheet 1 of 2

STREAMFLOW OBSERVATIONS

STATION B3
BEAVER POND

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: V-Notch Wier

SENSIVITY: 0.5. Ac Head Pond

DRAINAGE AREA:

- SURFACE RUNOFF: N/A
- GROUNDWATER RUNOFF: N/A

GENERAL NOTES

i) Station installed for 1984 discharge test.

ii) Discharge comprised of groundwater only unless otherwise noted. Total runoff is larger than indicated.

iii) Data for July 12-16/84 has been abbreviated. Field records include up to 4 observations per day. See record of discharge test for additional details.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
July 12/84	08:00		41	Base flow
July 13/84	12:00		39	Discharge test
July 14/84	11:30		45.5	"
July 15/84	14:45		55	"
July 16/84	10:15		57	"
April 18/85			30	Base flow
April 19/85			30	"
April 20/85			27	"
April 21/85			30	"
April 22/85			27	"
April 23/85			27	"
April 24/85			27	"
April 25/85			30	"
April 26/85			30	"
April 27/85			30	"
April 28/85			33	"
April 29/85			33	"
April 30/85			30	"
May 1/85			30	"
May 2/85			30	"
May 3/85			27	"
May 4/85			30	"
May 5/85			64	Snowmelt - Rain
May 6/85			55	Snowmelt
May 7/85			69	"
May 8/85			69	"
				Sheet 1 of 2

STREAMFLOW OBSERVATIONS

STATION B3
BEAVER POND

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
LOCATION: (Cont'd)	May 9/85			74	Snowmelt
	May 10/85			64	"
COORDINATES:	May 11/85			–	"
	May 12/85			55	"
METHOD OF OBS:	May 24/85			39	Groundwater only
SENSIVITY:					
DRAINAGE AREA:					
• SURFACE RUNOFF:					
• GROUNDWATER RUNOFF:					
GENERAL NOTES					

STREAMFLOW OBSERVATIONS

STATION B4
HIGHWAY WIER

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: V-Notch Wier

SENSIVITY: See Note ii)

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Station installed during construction of 'B' Dam.

ii) Upstream area includes several ponds and extensive muskeg.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
Aug. 6/80	AM		32.0	
Aug. 13/80	PM		27.0	
Aug. 19/80	PM		29.5	
Aug. 20/80	–		–	'B' Dam closed –
Aug. 21/80	AM		27.0	Pumping required
Aug. 22/80	AM		19.0	on Aug. 20 & 21
Aug. 22/80	PM		12.5	
Aug. 23/80	AM		6.5	
Aug. 23/80	PM		8.0	
Aug. 24/80	AM		9.5	
Aug. 24/80	PM		12.5	
Aug. 25/80	AM		11.0	
Aug. 26/80	"		9.5	
Aug. 29/80	"		21.0	
Sept. 3/80	PM		27.0	
Sept. 4/80	"		33.0	Rain
Sept. 5/80	"		38.0	Heavy rain
Sept. 7/80	"		36.0	
Sept. 22/80	"		29.5	
Sept. 30/80	"		32.0	
July 18/81			36.0	
July 20/81			34.0	
July 24/81			32.5	
July 29/81			37.5	
July 31/81			46.5	
				Sheet 1 of 5

STREAMFLOW OBSERVATIONS

STATION B4
HIGHWAY WIER

STATION DATA

LOCATION: (Cont'd)

COORDINATES:

METHOD OF OBS:

SENSIVITY:

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Data for April 22-June 21/1983 may be in error. Check survey on Aug. 30/83 indicates wier reference pin may have been up to 0.42 in low.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
Aug. 6/81			46.5	'B' Pond at 2475.0'
Aug. 9/81			41.0	
Aug. 10/81			37.5	
Aug. 11/81			37.5	
Aug. 12/81			–	
Aug. 19/81			43.0	
Aug. 20/81			43.0	
Aug. 22/81			43.0	
Aug. 27/81			43.0	
Aug. 28/81			47.0	
Aug. 30/81			47.0	'B' Pond at 2485.0'
Sept. 11/81	PM		59.0	Heavy rain
Sept. 17/81	AM		53.0	Rain on 16th
Sept. 29/81			55.0	Snow on 28th
Oct. 19/81			59.0	'B' Pond at 2490.0'
April 22/83	PM		29.5	Base flow
April 26/83	16:30		361.0	Snowmelt
April 27/83	10:00		222.0	"
April 27/83	16:30		347.0	"
April 28/83	08:00		264.0	"
April 28/83	16:30		322.0	"
May 2/83	08:00		222.0	Groundwater
May 2/83	16:30		212.0	"
May 3/83	08:00		203.0	"
May 3/83	16:30		222.0	"
May 4/83	08:00		203.0	"
				Sheet 2 of 5

STREAMFLOW OBSERVATIONS

STATION B4
HIGHWAY WIER

STATION DATA

LOCATION: (Cont'd)

COORDINATES:

METHOD OF OBS:

SENSIVITY:

DRAINAGE AREA:

·SURFACE RUNOFF:

·GROUNDWATER RUNOFF:

GENERAL NOTES

i) Data for April 22 - June 21/1983 may be in error. See note on sheet 2.

ii) Data for May 5-12, 1983 and July 12-16/1984 has been abbreviated. Field records include up to 4 observations per day. See records of discharge tests for additional details.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
May 5/83	08:00		203.0	Discharge test
May 6/83	"		203.0	"
May 6/83	17:00		347.0	"
May 7/83	12:00		492.0	"
May 7/83	17:00		677.0	"
May 8/83	12:00		677.0	"
May 9/83	"		525.0	"
May 10/83	08:00		461.0	"
May 11/83	"		402.0	"
May 12/83	"		347.0	"
May 12/83	16:30		298.0	"
May 13/83	08:00		264.0	"
May 16/83	"		203.0	"
May 18/83	"		167.0	"
May 27/83	"		115.0	End of Test
June 20/83			90.0	
June 21/83			90.0	
Aug. 24/83			68.0	
Aug. 25/83			68.0	
Aug. 30/83			68.0	
July 12/84	18:45		48.0	Discharge test
July 13/84	17:30		50.0	"
July 14/84	09:15		58.0	"
July 14/84	18:00		52.0	"
July 15/84	10:45		57.0	"
July 16/84	11:00		64.0	"
				Sheet 3 of 5

STREAMFLOW OBSERVATIONS

STATION B4
HIGHWAY WIER

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
LOCATION: (Cont'd)	May 11/85	AM		102.0	
	May 12/85	"		84.0	
COORDINATES:	May 13/85	"		96.0	
	May 17/85	"		51.0	
METHOD OF OBS:	May 24/85	"		21.0	Rain/Snow on 20-22
SENSIVITY:					
	July 7/87			4.0	
DRAINAGE AREA:					
· SURFACE RUNOFF:					
· GROUNDWATER RUNOFF:					
GENERAL NOTES					

THOMPSON GEOTECHNICAL

STREAMFLOW OBSERVATIONS

STATION B5 - a
RIVER SPRINGS - NORTH

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	Aug. 30/83			34	
LOCATION: See Figure					
COORDINATES:	July 14/84			15	
METHOD OF OBS: Timed Volume	April 25/85			9	
SENSIVITY: Direct Discharge	April 26/85			8	
	April 27/85			8	
DRAINAGE AREA:	April 29/85			8	
·SURFACE RUNOFF:	April 30/85			8	
·GROUNDWATER RUNOFF:	May 1/85			8	
	May 2/85			8	
	May 4/85			8	
GENERAL NOTES	May 6/85			8	
	May 8/85			9	
i) Discharge comprised of groundwater only unless otherwise noted.	May 10/85			10	
	May 24/85			16	
	July 7/87			11	
					Sheet 1 of 1

THOMPSON GEOTECHNICAL

STREAMFLOW OBSERVATIONS

STATION B5 - b
RIVER SPRINGS - SOUTH

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: Timed Volume

SENSIVITY: Direct Discharge

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Flows emerge from several sites. Discharge comprised of groundwater only.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
Aug. 30/83			15	
July 14/84			Est. 1	Minor seepage only
April 25/85			-	Glaciated
May 1/85			-	"
May 10/85			-	"
May 24/85			Est. 8	Ice melt
July 7/87			Est. 1	Minor seepage only

STREAMFLOW OBSERVATIONS

STATION C1a
COPPER CREEK

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: V-Notch Wier

SENSIVITY: 0.5Ac Head Pond

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Station installed for 1985 snowmelt study.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
May 5/85			0	See below - *
May 6/85			1	"
May 7/85			0	"
May 8/85			0	"
May 9/85			3	"
May 10/85			3	"
July 7/87			0	
				* Little or no flow observed - Runoff stored in upstream area.

STREAMFLOW OBSERVATIONS

STATION C3
CRATER LAKE

STATION DATA

LOCATION: See Figure

COORDINATES:

METHOD OF OBS: See Note i)

SENSIVITY: See Note ii)

DRAINAGE AREA:

- SURFACE RUNOFF:
- GROUNDWATER RUNOFF:

GENERAL NOTES

i) Flows to May 5/85 measured by timed volume. Flows from May 8 to June 1/85 measured by U-Notch wier.

ii) Upstream area includes several ponds and extensive muskeg.

DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
June 14/83			50.0	
Aug. 30/83			59.0	
July 13/84			28.5	
April 27/85	09:30 12:30		10.0	Base flow
April 30/85			17.5	Snowmelt
May 1/85			20.5	"
May 2/85			17.0	"
May 3/85			18.5	"
May 4/85			94.0	"
May 5/85			115.0	"
May 6/85			-	Flows ≥ 120 gpm
May 7/85			-	"
May 8/85			96.0	Snowmelt
May 9/85			193.0	"
May 10/85			136.0	"
May 11/85			96.0	"
May 12/85			102.0	"
May 23/85			90.0	Groundwater
June 1/85			21.0	"
July 7/87			18.5	"

STREAMFLOW OBSERVATIONS

STATION C4
LOWER CRATER LAKE

STATION DATA	DATE	TIME	MEASURED FLOWS ( )	MEASURED FLOWS (gpm)	NOTES
	July 11/84			25.5	
LOCATION: See Figure	July 14/84			26.0	
COORDINATES:					
	May 7/85			-	Glaciated: Est. 250
METHOD OF OBS: V-Notch wier	May 8/85			-	" " 275
SENSIVITY: Minor Head Pond	May 9/85			248.0	
	May 10/85			222.0	
DRAINAGE AREA:	May 12/85			151.0	
·SURFACE RUNOFF:	May 23/85			185.0	
·GROUNDWATER RUNOFF:					
	July 7/87			27.0	Beavers U/S
	July 23/87			24.5	" "
GENERAL NOTES					

Seismic Hazard Calculation
Appendix C18

666-8350
356-6433 Alt 363-6433 -6500

C 18

ENERGY, MINES AND RESOURCES CANADA
GEOLOGICAL SURVEY OF CANADA

ENERGIE, MINES ET RESSOURCES CANADA
COMMISSION GEOLOGIQUE DU CANADA

SEISMIC HAZARD CALCULATION *

CALCUL DE PERIL SEISMIQUE *

REQUESTED BY/ DEMANDE PAR: Steffen Robertson & Kirsten/ Chambers

SITE: Whitehorse Copper Mine

LOCATED AT/ SITUE AU: 60.63 NORTH/NORD 135.05 WEST/OUEST

PROBABILITY OF EXCEEDENCE PER ANNUM/ PROBABILITE DE DEPASSEMENT PAR ANNEE	0.010	0.005	0.0021 (1:475)	0.001 (1:1000 year)
PROBABILITY OF EXCEEDENCE IN 50 YEARS/ PROBABILITE DE DEPASSEMENT EN 50 ANS	40 %	22 %	10 %	5 %
PEAK HORIZONTAL GROUND ACCELERATION (G) / ACCELERATION HORIZONTALE MAXIMALE DU SOL (G)	0.057	0.076	0.099	0.125
PEAK HORIZONTAL GROUND VELOCITY (M/SEC) / VITESSE HORIZONTALE MAXIMALE DU SOL (M/SEC)	0.119	0.157	0.215	0.265

* REFERENCES

1. NEW PROBABILISTIC STRONG SEISMIC GROUND MOTION MAPS OF CANADA: A COMPILATION OF EARTHQUAKE SOURCE ZONES, METHODS AND RESULTS. P.W. BASHAM, D.H. WEICHERT, F.M. ANGLIN, AND M.J. BERRY EARTH PHYSICS BRANCH OPEN FILE NUMBER 82-33, OTTAWA, CANADA 1982.

ENGINEERING APPLICATIONS OF NEW PROBABILISTIC SEISMIC GROUND-MOTION MAPS OF CANADA. A.C. HEIDEBRECHT, P.W. BASHAM, J.H. RAINER, AND M.J. BERRY CANADIAN JOURNAL OF CIVIL ENGINEERING, VOL. 10, NO. 4, P. 670-680, 1983.

3. NEW PROBABILISTIC STRONG GROUND MOTION MAPS OF CANADA. P.W. BASHAM, D.H. WEICHERT, F.M. ANGLIN, AND M.J. BERRY, BULLETIN OF THE SEISMOLOGICAL SOCIETY OF AMERICA, VOL. 75, NO. 2, P. 563-595, 1985.

4a. SUPPLEMENT TO THE NATIONAL BUILDING CODE OF CANADA 1985, NRCC NO. 23178. CHAPTER 1: CLIMATIC INFORMATION FOR BUILDING DESIGN IN CANADA. CHAPTER 4: COMMENTARY J: EFFECTS OF EARTHQUAKES.

SITE Whitehorse Copper Mine

ZONING FOR ABOVE SITE/ ZONAGE DU SITE CI-DESSUS

** 1985 NBCC/CNBC: Za = 2; Zv = 4

ACCELERATION ZONE/ ZONE D'ACCELERATION Za = 2
ZONAL ACCELERATION/ ACCELERATION ZONALE a = 0.10 G

** VELOCITY ZONE/ ZONE DE VITESSE Zv = 4
** ZONAL VELOCITY/ VITESSE ZONALE v = 0.20 M/S

1985 NBCC/CNBC
SEISMIC ZONING MAPS/ CARTES DU ZONAGE SEISMIQUE

PROBABILITY LEVEL: 10% IN 50 YEARS
NIVEAU DE PROBABILITE: 10% EN 50 ANNEES

G OR M/S	ZONE	ZONAL VALUE/ VALEUR ZONALE
0.00	0	0.00
0.04	1	0.05
0.08	2	0.10
0.11	3	0.15
0.16	4	0.20
0.23	5	0.30
0.32	6*	0.40

* ZONE 6: NOMINAL VALUE/ VALEUR NOMINALE 0.40;
SITE-SPECIFIC STUDIES SUGGESTED FOR IMPORTANT PROJECTS/
ETUDES COMPLEMENTAIRES SUGGEREES POUR DES PROJETS D'IMPORTANCE.

** For NBCC applications, when Zv=0 and Za>0, the values of Zv and v should be taken as 1 and 0.05, respectively. See NBCC 1985, Sentence 4.1.9.1 (4).

Pour applications selon le CNBC, lorsque Zv=0 et Za>0, les valeurs Zv et v deviendraient 1 et 0.05, respectivement. Voir CNBC 1985, paragraphe 4.1.9.1 4).

29-JUL-91 08:35:28