Phase III ENVIRONMENTAL ASSESSMENT

PESO MINE SITE

Interim Report

Prepared for:

Action on Waste Program
Indian and Northern Affairs Canada

Prepared by:

Environmental Services
Public Works and Government Services Canada

March 1998

Executive Summary

The Peso exploration site is located at 64° 00' 38" N, 135° 57' 56" W, approximately 48 km north of Mayo. Phase III assessment was carried out by Environmental Services for Indian and Northern Affairs Canada to a) identify the potential for waste rock slope failure; b) identify appropriate stabilization options for prevention or mitigation of ARD from the waste rock disposal area, and c) identify seasonal variations in contaminant loadings in Secret Creek upstream and downstream of the waste rock disposal area. Major findings of this assessment are summarised in the following Table:

Summary of Concerns at Peso Mine Site

Site Assessment Component	Concern
Waste rock dump slope stability	Waste rock dump is not considered unstable and future failures are unlikely.
Acid rock drainage	Stressed vegetation downslope of Peso site indicates impact from waste rock runoff. Elevated aluminum, chromium, copper, nickel, and zinc concentrations downstream of the site in August 1997 may indicate that drainage from Peso is also affecting Secret Creek water quality.

Recommendation 1. Prevent further leaching and transport of metals from waste rock by constructing a containment and isolation or migration control system. If a geomembrane cover with rock anchor is planned, conduct a geological assessment to identify a suitable source and volume of non-acid generating anchor rock.

Recommendation 2. Site drainage (i.e. seasonal snowmelt) and Secret Creek water quality should be sampled at the onset of spring melt in 1998. Monitor upstream and downstream water quality in Secret Creek every five years to identify significant trends or changes, or for one year after construction of a containment and isolation or migration control system.

Final recommendations will be based on a spring freshet sampling event proposed for April 1998.

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1. INTRODUCTION AND BACKGROUND

In 1993, initial assessments of 49 abandoned Yukon mine exploration and development sites were completed under the Arctic Environmental Strategy - Action on Waste program by DIAND Technical Services. These assessments provided a) a general overview of historical activities, b) described site infrastructure, workings and wastes, c) summarized existing environmental or safety concerns on each site, and d) provided general recommendations for remediation or mitigation work. No rock, soil or water samples were collected for these assessments.

GeoViro Engineering Limited conducted a Phase II environmental assessment of the abandoned Peso mine site to a) identify specific environmental and human safety risks, describe aesthetic concerns, and recommend remediation or mitigation measures. The Peso mine site was inspected by Geoviro on 12 September, 1996.

GeoViro identified a high potential for acid rock drainage emanating from waste rock located on a hillside above Secret Creek. Low paste pH results and signs of phytotoxicity on the slope below the waste rock pile indicated acid drainage conditions.

Background aluminum and copper concentrations exceeded the CCME criterion for protection of freshwater aquatic life. However, surface water from Secret Creek (a water body below the waste rock disposal area potentially affected by ARD) was not sampled.

In light of these findings, a Phase III assessment of the lower Peso site was completed to definitively characterize the environmental risk associated with the waste rock disposal area. The assessment involved site visits by Environmental Services on 20 August and 18 October, 1997.

1.1 Location

The Peso exploration site is located at 64° 00' 38" N, 135° 57' 56" W, approximately 48 km north of the village of Mayo. The site is located approximately 5 km west of Dublin Gulch at an elevation of about 1300 m.

2. PURPOSE AND SCOPE OF WORK

This Phase III assessment was carried out by Environmental Services for Indian and Northern

Affairs Canada to a) identify the potential for waste rock slope failure; b) identify appropriate stabilization options for prevention or mitigation of ARD from the waste rock disposal area, and c) identify seasonal variations in contaminant loadings in Secret Creek upstream and downstream of the waste rock disposal area. Accordingly, the following assessment activities were completed:

- Geotechnical inspection of the waste rock disposal area
- Photo documentation of relevant site features
- Sampling of waste rock disposal area and surface water (including waste rock seeps and receiving waters)
- Identification of environmental pathways and receptors for site contaminants
- Assessment of contaminant loadings caused by acid rock drainage at the waste rock disposal area

Recommendations and preliminary cost estimates were then generated to meet the following remediation/mitigation requirements:

- Physical stabilization of waste rock disposal areas
- Chemical stabilization of waste rock disposal areas, taking into account onsite resources and accessibility

3. SITE ASSESSMENT METHODOLOGY

3.1 Assumptions

At the Peso mine site, the assessment was limited to the area specifically developed or occupied for mine exploration or mining purposes and off-site environmental resources potentially affected by mine exploration or development activities.

3.2 Assessment Criteria

<u>CCME Criteria</u>

The Canadian Council of Ministers of the Environment (CCME) Interim Canadian Environmental Quality Criteria for Contaminated Sites are numerical limits for contaminants in soil and water intended to protect, maintain or improve environmental quality and human health at contaminated sites in general. For this Phase III mine assessment, Freshwater Aquatic Life criteria were used to assess surface water quality.

Mine Reclamation in Northwest Territories and Yukon (INAC, 1992)

This report defines factors which are to be considered in reclamation of abandoned mine sites operating in northern climates. Factors include:

- open pit and underground mines
- waste rock and tailings disposal
- acid generation and leaching, and
- estimating cleanup costs.

3.3 Methods

3.3.1 Site Assessment Components

The Phase III assessment included the following components:

A professional geologist assessed the acid rock drainage and metal leaching potential of the waste rock disposal area by:

- Confirming variations in rock type, mineralization and alteration noted in the Phase II assessment;
- Laboratory leach testing of selected archived waste rock samples (originally collected during the 1996 site visit).

A professional geotechnical engineer was retained to inspect the lower/eastern waste rock disposal area to identify:

- Site-specific factor(s) involved in past and possible future slumping of the waste rock disposal area;
- Methods and preliminary costs for physical stabilization of the waste rock disposal area;
- Location, accessibility, and approximate quantity of suitable borrow materials in the vicinity of the Peso site. Borrow materials would be used for future stabilization/reclamation of the waste rock disposal area, should that work be deemed necessary.

3.3.2 Sampling Methods and Quality Assurance

Water Sampling

Samples were collected from Secret Creek upstream and downstream of the waste rock disposal area. Field pH and conductivity measurements were recorded during the summer sampling period. Samples were collected on 20 August and 18 October, 1997 to measure contaminant concentrations during the summer and fall seasons respectively. A spring freshet sampling event is scheduled for April 1998.

250 ml water samples were collected by hand, facing upstream, ensuring that the sample was not contaminated by disturbed sediment, debris and other floating materials. Sample bottles were rinsed three times with water from the sample stream prior to collecting the sample. 2 ml of HNO_3 were immediately added to water samples intended for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled to minimise head space, placed in a cooler, and maintained at 4° C until delivery to the laboratory.

Quality Assurance

Quality Assurance (QA) is a set of procedures for ensuring that the results of chemical analyses are (and can be shown to be) accurately representative of field conditions. A complete QA program includes both a field component and a laboratory component.

In addition to the standard sample collection methods outlined above, the field QA measures that were implemented for this assessment study include:

- chain of custody procedures and forms;
- a sample labelling and sample location identification scheme;
- laboratory preparation of all sampling containers;
- laboratory defined sample preservation and shipping procedures; and
- regular maintenance (including re-calibration) and cleaning of field equipment.

4. ENVIRONMENTAL SETTING

4.1 Mineralization

The commodities of interest at the Peso site on Galena Hill are silver, gold, lead and zinc. The Keno Hill-Galena Hill silver-lead ores occur in erratic shoots and lenses lying in vein faults that cut fine-bedded to massive quartzite, intercalated with greenstone sills and lenses, and various schistose rocks.

The Peso veins are composed of siderite ($FeCO_3$) with variable, but small, amounts of quartz, sphalerite ((Zn,Fe)S), galena (PbS) and freiberigite (silver-bearing tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$)). The cubiform galena occurs as dots and clusters rarely more than a few centimetres in size. The vein has been affected by post-mineralization fault movement, as well as intense weathering. Siderite ($FeCO_3$) and galena are commonly weathered to limonite and anglesite. The footwall is greenstone and the hangingwall is graphite schist which is highly brecciated within a few metres of the vein.

4.2 Hydrology

Drainage from the waste rock disposal area flows toward Secret Creek, a third-order stream which joins Haggert Creek and ultimately the South McQueston River. The waste rock disposal area is approximately 1 km in distance and 400m in elevation above Secret Creek. No surface water bodies cross the Peso mine site.

Hydrological/water quality records were not available for Secret Creek. During the 20 August site visit, Secret Creek discharge was measured at 0.117 m^3/second below the waste rock disposal area.

4.3 Climate

Temperature and precipitation data for Mayo, provided by Environment Canada Climatic Data Services, have been used for the Peso Site. The climate of the area is characterised by moderate rainfall and seasonal temperature extremes. Average monthly temperatures vary from -26.9° C in January to 15.6° C in July. Since the site is at a higher elevation than Mayo, the mean temperatures at the site may be slightly different, i.e. slightly lower average in the summer. The average annual precipitation for Mayo is 318 mm. Based on our experience at other sites in this area, precipitation will vary with elevation. The Peso site will likely experience 500 to 600 mm of precipitation. Over 50% falls during the months of June, July, August and September. The four driest months are January to April.

4.4 Fisheries Resources

No fisheries data for Secret Creek were available from Yukon Renewable Resources. However, Secret Creek flows into Haggert Creek, which is known to contain arctic grayling and northern pike.

4.5 Site Topography and Soils

The main portion of the site lies within the watershed of Secret Creek and its tributaries. Secret Creek is located approximately 1 km west of the site and approximately 400 m lower in elevation. The main mine area is located along the top and west flank of a north south ridge. The site slopes moderately to steeply to the west towards Secret Creek.

The general area was extensively glaciated during the Pleistocene period. Thus, the majority of the site is mantled with till or till-like material comprised of silt to gravel and rock. The depth of the unconsolidated material is unknown and likely varies from a few metres to several metres as evident in many of the trenches. A small exploration excavation was completed at the northeast portion of the exploration area at a lower elevation and in the immediate vicinity of a creek tributary. This area is infilled with unconsolidated glacial and alluvial deposits.

5. SITE ASSESSMENT RESULTS

5.1 Surface Water Quality

During the 1996 visit, much of the waste rock outside the main adit at the Peso site was found to be acidic. Runoff from the waste had impacted vegetation immediately below the waste rock. The main concern at this site was determining what impact the acidic waste was having on the Secret Creek.

Water quality samples collected in August 1996 were collected on the drainage to the north of Secret Creek. However, since the waste located in the Secret Creek drainage is generating acid, samples were collected from this creek in 1997. No sample was collected from the northern drainage in 1997. Therefore, no comparison of water quality is made between the two sampling programs.

The distance between the base of the waste dumps and the stream is approximately a kilometre. No adit drainage or seeps were seen on the exploration site. It appears that the most water at the site is discharged as runoff. Two water samples were collected from Secret Creek during the sampling 20 August and 18 October, 1997 events. Sample Peso-WQ-St1-1 was collected about 200 m downstream of the drainage path from the waste rock disposal area. Sample Peso-WQ-St1-2 was collected from Secret Creek approximately 900 m upstream from Peso-WQ-St1-1, at a point unaffected by drainage from the Peso mine site. The flow in Secret Creek in August 1997 was 0.1 m3/s.

Complete analytical results are provided in Appendix B; significant results are summarized in Table

5.1. The samples all had near neutral pH values and low conductivities (range=149 µS/cm to 163 µS/cm). In August, metals concentrations generally increased past the site, with aluminum (0.125 mg/L), chromium (0.00216 mg/L), copper (0.0223 mg/L), and zinc (0.0235 mg/L) above the CCME FAL criteria. In October, there was little change in metals concentrations downstream of the site, and concentrations of all constituents were below the FAL criteria. The reason for the high metal values in August is unclear but could be attributed to the period of high rainfall that preceded that field program. A high precipitation event could have washed unusually high amounts of soluble metals from the waste rock piles.

Table 5.1 Significant Results - Peso Surface Water Samples

Sample ID	Sample Location	Sample Date	pH	Conductivity (µS/cm)	Parameters > CCME FAL Criteria
PESO-WQ-ST1-1	Secret Creek 200 m downstream from waste rock dump drainage path	20 Aug 1997	7.4 (6.7)	151 (151)	
		18 Oct 1997	7.4	163	Se
PESO-WQ-ST1-2	Secret Creek 700 m upstream from waste rock dump drainage path	20 Aug 1997	7.1 (6.7)	149 (132)	Al, Cr, Cu, Zn
		18 Oct 1997	7.1	161	

Note: pH and conductivity readings in brackets are field measurements; unbracketed values are lab measurements. Field conductivity results reported as microsiemens. FAL = Freshwater Aquatic Life.

5.2 Waste Rock Geochemical Assessment

None of the waste rock samples collected in 1996 had been analzyed for metals concentrations. Therefore, samples GV206PADI-3 (shown as sample location 3 on Figure 4, Appendix A) and GV206PAD-16 (shown as sample location 16 on Figure 4, Appendix A) collected in 1996 from the waste rock piles outside of the portal were analyzed.

Metals concentrations were high in both samples. Sample GV206PADI-3 contained greater than 6900 ppm arsenic, 253 ppm copper, 2690 ppm lead, 1790 ppm antimony, and 719 ppm zinc. Concentrations of these elements in Sample GV206PAD-16 were less than a quarter of those measured in Sample GV206PADI-3.

Bottle roll tests were conducted on samples GV206PADI-3 and GV206PAD-16. The laboratory paste pH values of Sample 3 and Sample 16 were 3.0 and 4.0, respectively. The NP/AP ratios were less than 0.1 for both samples.

pH values of the slurry samples were similar to the paste pH values throughout 72 hours of testing. The final conductivities were 1560 µS/cm and 420 µS/cm for GV206PADI-3 and GV206PAD-16, respectively. The presence of some alkalinity in the filtered leachate of GV206PAD-16 indicates that this sample is being buffered. Sulphate concentrations in both samples were similar to their conductivities.

Soluble metals concentrations were high in the leachates from both samples, but particularly high in the GV206PADI-3 leachate which contained 67 mg/L aluminum, 2.6 mg/L copper, 431 mg/L iron, 0.32 mg/L nickel, and 58 mg/L zinc. This sample also contained high concentrations of arsenic and cadmium. Many of these metals were found in elevated concentrations in Secret Creek, including aluminum, copper, nickel, and zinc, suggesting that the waste rock could be the source of the metals.

Table 5.2 Waste Rock Sample Locations and Summarized ABA Test Results - Peso Mine Site

Sample ID	Sample Location	Summary of ABA Test Results
GV206PADI-3	South edge of waste rock near portal	Potentially acid generating (NP:AP= <0.1), with high metal concentrations: 6900 ppm As, 253 ppm Cu, 2690 ppm Pb, 719 ppm Zn.
GV206PAD-16	South edge, easternmost lobe of waste rock below portal	Potentially acid generating (NP:AP=<0.1)

5.3 Waste Rock Geotechnical Assessment

The waste rock pile encompassed a 50 m by 70 m area, and existed as 3 lifts ranging in thickness from 2 - 6 m. Each lift consisted of a flat bench area ranging in width between 2 m and 15 m and having a side slope angle of approximately 30° to 32°. Natural ground surrounding the waste rock pile consisted of a west facing slope an angle of approximately 22° to 23°. This area was well vegetated with semi-mature to mature spruce trees. Near-surface soils were of a thin veneer (0.05-0.08 m) of organics underlain by dense glacial till and a heterogeneous mix of silt, sand and gravel.

Waste rock consisted primarily of a platy schist material with grain sizes ranging from silt sizes (<0.08 mm) up to cobbles in size (>75 mm diameter). Since the waste material is composed primarily of sand and gravel, it is considered relatively stable due to the high internal angle of friction and the low pore water pressure which is common for these materials.

The waste rock has been in its current state for over 30 years, and signs of slope instability (due to significant changes in the moisture regime) would likely have become apparent by now. However, there was no evidence of slope failures throughout the waste rock mass with the exception of some minor slumping at the south edge of the waste rock pile. It does not appear that the existing positional structure of the waste rock pile will lead to slope failures within the waste rock mass.

6. CONCLUSIONS

Existing or potential environmental concerns associated with the Peso mine site are summarized in Table 6.1, and are examined more fully in the following sections.

Table 6.0 Summary of Concerns at Peso Mine Site

Site Assessment Component	Concern
Waste rock dump slope stability	Waste rock dump is not considered unstable and future failures are unlikely.
Acid rock drainage	Stressed vegetation downslope of Peso site indicates impact from waste rock runoff. Elevated aluminum, chromium, copper, nickel, and zinc concentrations downstream of the site in August 1997 may indicate that drainage from Peso is also affecting Secret Creek water quality.

6.1 Peso Waste Rock Dump Slope Stability

The Peso waste rock dump is not considered unstable and future failures are unlikely. Because of the low probability of slope failure, the costs of further stabilization work are probably not justified.

6.2 Acid Rock Drainage

The stressed vegetation down slope of the Peso Mine site indicates that runoff from the waste rock piles is affecting the area around the waste. Increases in aluminum, chromium, copper, nickel, and zinc concentrations downstream of the site in August 1997 may indicate that drainage from the site is also impacting the quality of Secret Creek. During the dryer period of October 1997 no increase in metals concentrations were seen, suggesting that the impact on the creek may be seasonal or may occur only in periods of high rainfall.

To prevent further transport of ARD from the waste rock would require a containment and isolation or migration control system. A low-permeability cover would limit mobilization of oxidation products by reducing infiltration of precipitation and surface runoff into the waste rock.

There is no suitable borrow source within an economical distance from the Peso site which could be used for construction of a low-permeability soil cover. The containment remediation system could instead use a high density polyethylene (HDPE) geomembrane liner as a low permeability cover. Construction of the cover system would require grading the waste rock dump to reduce the existing surface area and prepare an acceptable surface for placement of the liner. After grading, the waste rock would be allowed to settle; the liner could then be installed and covered with rock obtained from the vicinity of the waste rock dump.

7. RECOMMENDATIONS

Recommended remediation and management actions are compliant with applicable federal or territorial regulations and criteria, rely upon available technology, and intended to be appropriate for local conditions and sensitivities.

Recommendation 1. Prevent further leaching and transport of metals from waste rock by constructing a containment and isolation or migration control system. If a geomembrane cover with rock anchor is planned, conduct a geological assessment to identify a suitable source and volume of non-acid generating anchor rock.

Recommendation 2. Site drainage (i.e. seasonal snowmelt) and Secret Creek water quality should be sampled in the spring, summer and fall for a period of five years or for one year after construction of a containment and isolation or migration control system.

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Appendix A

Detailed Geochemical Assessment of Waste Rock and Surface Water

Peso Mine Site

Extracts from:

Yukon Abandoned Mine Sites Assessment

Report on 1997 Followup

Prepared by SRK Steffen Robertson & Kirsten

(1998)

PESO

1. BACKGROUND

During the 1996 visit, much of the waste rock outside the main adit at the Peso site was found to be acidic. Runoff from the waste had impacted vegetation immediately below the waste rock. The main concern at this site was determining what impact the acidic waste was having on the Secret Creek.

Water quality samples collected in August 1996 were collected on the drainage to the north of Secret Creek. However, since the waste located in the Secret Creek drainage is generating acid, samples were collected from this creek in 1997. No sample was collected from the northern drainage in 1997. Therefore, no comparison of water quality is made between the two sampling programs.

2. OBSERVATIONS

At the Peso site, additional mapping was conducted around Adit 1 (Figure 4). The most significant observation was that the vegetation stress that was noted below the waste rock piles at Adit 1 during the 1996 visit, continues down slope for at least 200 m, and possibly to the stream below.

3. WATER QUALITY

The flow in Secret Creek in August 1997 was 0.1 m3/s. Two water quality samples were collected in the creek in August and October 1997. Samples PESO-WQ-ST1-2 and PESO-WQ-ST1-1 were collected upstream and downstream, respectively, of the approximate location of any discharge from the Peso site. The distance between the base of the waste dumps and the stream is approximately 1 kilometre. No adit drainage or seeps were seen on the exploration site. It appears that the most water at the site is discharged as runoff.

Results of analysis of the creek water samples are listed in Table 7. The samples all had near neutral pH values and low conductivities (range=149 µS/cm to 163 µS/cm). In August, metals concentrations generally increased past the site, with aluminum (0.125 mg/L), chromium (0.00216 mg/L), copper (0.0223 mg/L), and zinc (0.0235 mg/L) above the CCME guidelines. In October, there was little change in metals concentrations downstream of the site, and concentrations of all constituents were below the guidelines. The reason for the high metal values in August is unclear but could be attributed to the period of high rainfall that preceded that field program, swelling many of the local rivers. A high precipitation event could have washed unusually high amounts of soluble metals from the waste rock piles.

4. METALS CONCENTRATIONS

None of the waste rock samples collected in 1996 were analzyed for metals concentrations during the 1996 program. Therefore, samples GV206PADI-3 (Sample 3) and GV206PAD-16 (Sample 16) collected in 1996 from the waste rock piles outside of the main adit (Figure 4) were analyzed. The results are presented in Table 4.

Metals concentrations were high in both samples. Sample 3 contained greater than 6900 ppm arsenic, 253 ppm copper, 2690 ppm lead, 1790 ppm antimony, and 719 ppm zinc. Concentrations of these elements in Sample 16 were less than a quarter of those measured in Sample 3.

5. SOLUBLE METALS CONCENTRATIONS

Bottle roll tests were conducted on samples GV206PADI-3 (Sample 3) and GV206PAD-16 (Sample 16). The laboratory paste pH values of Sample 3 and Sample 16 were 3.0 and 4.0, respectively. The NP/AP ratios were less than 0.1 for both samples.

Results of bottle roll tests are shown in Tables 1 and 2. The pH values of the slurry samples were similar to the paste pH values throughout 72 hours of testing. The final conductivities were 1560 µS/cm and 420 µS/cm for Sample 3 and Sample 16, respectively. The presence of some alkalinity in the filtered leachate of Sample 16 indicates that this sample is being buffered. Sulphate concentrations in both samples were similar to their conductivities.

Soluble metals concentrations were high in the leachates from both samples, but particularly high in the Sample 3 leachate which contained 67 mg/L aluminum, 2.6 mg/L copper, 431 mg/L iron, 0.32 mg/L nickel, and 58 mg/L zinc. This sample also contained high concentrations of arsenic and cadmium. Many of these metals were found in elevated concentrations in Secret Creek, including aluminum, copper, nickel, and zinc, suggesting that the waste rock could be the source of the metals.

6. DISCUSSION

The stressed vegetation down slope of the Peso Mine site indicates that runoff from the waste rock piles is affecting the area around the waste. Increases in aluminum, chromium, copper, nickel, and zinc concentrations downstream of the site in August 1997 may indicate that drainage from the site is also impacting the quality of Secret Creek. During the dryer period of October 1997 no increase in metals concentrations were seen, suggesting that the impact on the creek may be seasonal or may occur only in periods of high rainfall.

7. RECOMMENDATIONS

Secret Creek should be monitored during the spring freshet, but because of the remoteness of the site, no other action is recommended.

Appendix B

Site Photographs

Photo 1. Peso mine waste rock dump. Note trail of distressed vegetation leading from waste rock.

Photo 2. Aerial view of distressed vegetation seen as a greyish line between the waste rock and Secret Creek channel.

Appendix C

Analytical Results

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WATER ANALYSIS REPORT

SAMPLE		1 FORMA FO-WQ-ST1-1	2 FORMA FO-WQ-ST1-2	3 FORMA FO-WQ-ST1-3
TOTAL METALS				
SELENIUM	mg/L	0.0005	0.0005	0.0006
ROUTINE WATER				
pH		7.97	7.88	7.98
ELECTRICAL COND	uS/cm	484	486	485
CALCIUM	mg/L	91.7	91.3	91.6
MAGNESIUM	mg/L	17.1	17.0	17.1
SODIUM	mg/L	1.3	1.3	1.2
POTASSIUM	mg/L	1.05	0.79	0.86
IRON	mg/L	0.06	0.05	0.06
MANGANESE	mg/L	0.094	0.124	0.118
SULPHATE	mg/L	162	162	163
CHLORIDE	mg/L	0.6	1.0	<0.5
BICARBONATE	mg/L	145	145	145
T ALKALINITY	mg/L	119	119	119
HARDNESS	mg/L	299	298	299
T DIS SOLIDS	mg/L	345	345	346
IONIC BALANCE	%	-105	-105	-105
WATER NUTRIENTS				
NO2&NO3-N	mg/L	<0.05	<0.05	<0.05
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	0.119	0.050	0.062
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.0457	0.0430	0.0425
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	<0.0004	<0.0004	<0.0004
BORON	mg/L	<0.002	<0.002	<0.002
CADMIUM	mg/L	0.00068	0.00222	0.00188
CALCIUM	mg/L	87.2	84.9	84.8
CHROMIUM	mg/L	0.00132	0.00063	0.00038
COBALT	mg/L	0.00017	0.00011	0.00016

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YUKON PH3

WATER ANALYSIS REPORT

SAMPLE		1 FORMA FO-WQ-ST1-1	2 FORMA FO-WQ-ST1-2	3 FORMA FO-WQ-ST1-3
TRACE ICP,TOTAL				
COPPER	mg/L	0.00339	0.00386	0.00388
IRON	mg/L	0.195	0.126	0.135
LEAD	mg/L	0.0004	<0.0003	<0.0003
LITHIUM	mg/L	0.00560	0.00592	0.00681
MANGANESE	mg/L	0.129	0.132	0.125
MAGNESIUM	mg/L	15.9	15.5	15.5
MOLYBDENUM	mg/L	0.00049	0.00057	0.00052
NICKEL	mg/L	0.0018	0.0014	0.0013
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	2.34	0.87	2.84
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	0.003	0.003	0.004
SILICON	mg/L	2.89	2.70	2.70
STRONTIUM	mg/L	0.185	0.181	0.180
SODIUM	mg/L	1.21	1.16	1.16
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	53.5	50.9	51.1
TITANIUM	mg/L	0.00352	0.00154	0.00151
TIN	mg/L	0.0007	0.0021	<0.0002
VANADIUM	mg/L	0.00027	<0.00003	0.00013
ZINC	mg/L	0.0973	0.288	0.257

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YUKON PH3

WATER ANALYSIS REPORT

SAMPLE		4 FORMA FO-WQ-SE-1	5 FORMA FO-WQ-SE2-1	6 PADDY MINE PAD-WQ-ST1-1
TOTAL METALS				
SELENIUM	mg/L	0.0004	<0.0001	<0.0001
ROUTINE WATER				
pH			2.75	7.87
ELECTRICAL COND	uS/cm		6700	506
CALCIUM	mg/L		429	90.1
MAGNESIUM	mg/L		298	16.9
SODIUM	mg/L		3.4	1.2
POTASSIUM	mg/L		0.61	1.05
IRON	mg/L		980	0.06
MANGANESE	mg/L		53.7	0.109
SULPHATE	mg/L		7820	161
CHLORIDE	mg/L		<0.5	0.6
BICARBONATE	mg/L		<5	145
T ALKALINITY	mg/L		<1	118
HARDNESS	mg/L		2300	294
T DIS SOLIDS	mg/L		8550	342
IONIC BALANCE	%		-39.2	-104
WATER NUTRIENTS				
NO2&NO3-N	mg/L		<0.05	<0.05
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	1.55	21.2	0.179
ANTIMONY	mg/L	<0.005	0.024	<0.005
ARSENIC	mg/L	0.05	0.50	<0.01
BARIUM	mg/L	0.0221	0.00666	0.0454
BERYLLIUM	mg/L	0.00011	0.00164	<0.00001
BISMUTH	mg/L	<0.0004	0.0076	<0.0004
BORON	mg/L	0.006	<0.002	<0.002
CADMIUM	mg/L	2.19	1.63	0.00396
CALCIUM	mg/L	411	374	84.0
CHROMIUM	mg/L	<0.00006	0.00993	<0.00006

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YUKON PH3

WATER ANALYSIS REPORT

SAMPLE		4 FORMA FO-WQ-SE-1	5 FORMA FO-WQ-SE2-1	6 PADDY MINE PAD-WQ-ST1-1
TRACE ICP,TOTAL				
COBALT	mg/L	0.136	0.184	0.00023
COPPER	mg/L	0.0597	0.304	0.00344
IRON	mg/L	6.06	1010	0.603
LEAD	mg/L	0.195	0.681	0.0030
LITHIUM	mg/L	0.161	0.176	0.00611
MANGANESE	mg/L	6.99	4.45	0.128
MAGNESIUM	mg/L	333	251	15.3
MOLYBDENUM	mg/L	0.00041	<0.00007	0.00048
NICKEL	mg/L	0.389	0.396	0.0016
PHOSPHORUS	mg/L	0.188	0.262	<0.006
POTASSIUM	mg/L	5.67	3.86	4.40
SILVER	mg/L	0.00219	0.0112	<0.00005
SELENIUM	mg/L	0.025	0.302	0.005
SILICON	mg/L	8.97	25.8	2.86
STRONTIUM	mg/L	0.823	0.487	0.179
SODIUM	mg/L	4.38	3.98	1.15
THALLIUM	mg/L	0.028	<0.001	<0.001
SULPHUR	mg/L	1290	2440	50.6
TITANIUM	mg/L	0.0142	0.00277	0.00561
TIN	mg/L	0.0041	0.0093	0.0005
VANADIUM	mg/L	0.00151	0.0211	0.00043
ZINC	mg/L	49.9	49.0	0.444

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YUKON PH3

WATER ANALYSIS REPORT

SAMPLE		7 PADDY MINE PAD-WQ-ST1-2	8 PADDY MINE PAD-WQ-ST1-3	9 PADDY MINE PAD-WQ-SE1-1
TOTAL METALS				
SELENIUM	mg/L	<0.0001	<0.0001	<0.0001
ROUTINE WATER				
pH		8.01	8.07	7.65
ELECTRICAL COND	uS/cm	499	499	1060
CALCIUM	mg/L	90.0	90.7	204
MAGNESIUM	mg/L	16.8	17.0	61.0
SODIUM	mg/L	1.2	1.2	3.0
POTASSIUM	mg/L	0.73	1.14	1.29
IRON	mg/L	0.06	0.06	<0.04
MANGANESE	mg/L	0.090	0.087	0.009
SULPHATE	mg/L	161	161	459
CHLORIDE	mg/L	0.7	8.9	<0.5
BICARBONATE	mg/L	143	145	301
T ALKALINITY	mg/L	117	119	247
HARDNESS	mg/L	294	297	761
T DIS SOLIDS	mg/L	341	352	878
IONIC BALANCE	%	~104	99.8	~106
WATER NUTRIENTS				
NO2&NO3-N	mg/L	<0.05	0.61	<0.05
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	0.127	0.059	0.069
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	0.02
BARIUM	mg/L	0.0430	0.0410	0.0275
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	<0.0004	<0.0004	<0.0004
BORON	mg/L	0.010	<0.002	0.009
CADMIUM	mg/L	0.00187	0.00176	0.00187
CALCIUM	mg/L	85.2	86.0	192
CHROMIUM	mg/L	<0.00006	<0.00006	<0.00006

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WATER ANALYSIS REPORT

SAMPLE		7 PADDY MINE PAD-WQ-ST1-2	8 PADDY MINE PAD-WQ-ST1-3	9 PADDY MINE PAD-WQ-SE1-1
TRACE ICP,TOTAL				
COBALT	mg/L	0.00013	0.00011	0.00018
COPPER	mg/L	0.00312	0.00300	0.00552
IRON	mg/L	0.157	0.118	0.020
LEAD	mg/L	0.0006	0.0004	0.0064
LITHIUM	mg/L	0.0115	0.00720	0.00449
MANGANESE	mg/L	0.105	0.0974	0.0115
MAGNESIUM	mg/L	15.4	15.7	56.2
MOLYBDENUM	mg/L	0.00053	0.00057	0.00052
NICKEL	mg/L	0.0011	0.0016	0.0033
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	7.09	3.31	4.52
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	0.006	<0.003	0.006
SILICON	mg/L	2.75	2.70	2.41
STRONTIUM	mg/L	0.180	0.179	0.340
SODIUM	mg/L	1.15	1.16	3.36
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	51.2	53.5	144
TITANIUM	mg/L	0.00206	0.00131	0.00064
TIN	mg/L	<0.0002	<0.0002	<0.0002
VANADIUM	mg/L	0.00016	<0.00003	<0.00003
ZINC	mg/L	0.250	0.244	0.159

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WATER ANALYSIS REPORT

SAMPLE		13 STUMP MINE STU-WQ-AT1-1	14 PESO PESO-WQ-ST1-1	15 PESO PESO-WQ-ST1-2
TOTAL METALS				
SELENIUM	mg/L	0.0002	<0.0001	0.0002
ROUTINE WATER				
pH		7.91	7.36	7.14
ELECTRICAL COND	uS/cm	762	151	149
CALCIUM	mg/L	78.8	16.0	16.1
MAGNESIUM	mg/L	72.8	7.2	6.9
SODIUM	mg/L	11.3	1.6	1.6
POTASSIUM	mg/L	5.11	1.40	1.40
IRON	mg/L	0.08	0.04	0.05
MANGANESE	mg/L	<0.003	0.041	0.072
SULPHATE	mg/L	111	49.0	49.5
CHLORIDE	mg/L	<0.5	<0.5	0.8
BICARBONATE	mg/L	468	30	28
T ALKALINITY	mg/L	384	24	23
HARDNESS	mg/L	497	69.8	68.4
T DIS SOLIDS	mg/L	510	90	90
IONIC BALANCE	%	-106	-98.7	94.7
WATER NUTRIENTS				
NO2&NO3-N	mg/L	<0.05	<0.05	0.64
TOTAL, COLD VAPO				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,TOTAL				
ALUMINUM	mg/L	0.068	0.053	0.125
ANTIMONY	mg/L	0.107	<0.005	<0.005
ARSENIC	mg/L	0.05	<0.01	<0.01
BARIUM	mg/L	0.0254	0.0307	0.0692
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	<0.0004	<0.0004	<0.0004
BORON	mg/L	0.075	<0.002	0.017
CADMIUM	mg/L	<0.00006	0.00011	0.00048
CALCIUM	mg/L	79.6	15.8	25.3
CHROMIUM	mg/L	<0.00006	<0.00006	0.00216

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WATER ANALYSIS REPORT

AMPLE		13 STUMP MINE STU-WQ-AT1-1	14 PESO PESO-WQ-ST1-1	15 PESO PESO-WQ-ST1-2
TRACE ICP,TOTAL				
COBALT	mg/L	0.00044	0.00068	0.00163
COPPER	mg/L	0.00776	0.00178	0.0223
IRON	mg/L	0.413	0.125	0.205
LEAD	mg/L	0.0456	<0.0003	0.0068
LITHIUM	mg/L	0.0361	0.00718	0.0129
MANGANESE	mg/L	0.0350	0.0730	0.138
MAGNESIUM	mg/L	67.2	6.63	10.1
MOLYBDENUM	mg/L	0.00048	0.00020	0.00108
NICKEL	mg/L	0.0027	0.0056	0.0196
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	7.79	<0.60	0.72
SILVER	mg/L	0.00039	<0.00005	<0.00005
SELENIUM	mg/L	0.005	<0.003	<0.003
SILICON	mg/L	2.71	6.50	9.98
STRONTIUM	mg/L	1.18	0.0645	0.108
SODIUM	mg/L	11.8	1.41	2.44
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	37.8	16.0	25.0
TITANIUM	mg/L	0.00043	0.00042	0.00277
TIN	mg/L	0.0003	<0.0002	0.0010
VANADIUM	mg/L	<0.00003	<0.00003	0.00013
ZINC	mg/L	0.0131	0.0091	0.235

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WATER ANALYSIS REPORT

note pH — pH REPORTED AT ROOM TEMP

note ELECTRICAL COND — 'ELECTRICAL COND' (EC) is in microsiemens/cm and is a measure of solids in solution
E.C. CORRECTED TO 25C

note T ALKALINITY — 'ALKALINITY' is CARBONATE/BICARBONATE expressed as CALCIUM CARBONATE

note HARDNESS — 'HARDNESS' is calcium and magnesium expressed as CALCIUM CARBONATE

note NO2&NO3-N — is expressed as nitrogen

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WATER ANALYSIS REPORT

-PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------	---PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------
LENIUM	27Aug97	LANG QUE TRAN	pH	26Aug97	DARREN CRICHTON
ECTRICAL COND	26Aug97	DARREN CRICHTON	CALCIUM	27Aug97	LANG QUE TRAN
MAGNESIUM	27Aug97	LANG QUE TRAN	SODIUM	27Aug97	LANG QUE TRAN
POTASSIUM	27Aug97	LANG QUE TRAN	IRON	27Aug97	LANG QUE TRAN
NGANESE	27Aug97	LANG QUE TRAN	SULPHATE	27Aug97	LANG QUE TRAN
LORIDE	27Aug97	THERESA LIEU	BICARBONATE	26Aug97	DARREN CRICHTON
I ALKALINITY	26Aug97	DARREN CRICHTON	HARDNESS	0	LANG QUE TRAN
DIS SOLIDS	0	LANG QUE TRAN	IONIC BALANCE	0	LANG QUE TRAN
2&NO3-N	27Aug97	THERESA LIEU	MERCURY	26Aug97	LANG QUE TRAN
ALUMINUM	27Aug97	LANG QUE TRAN	ANTIMONY	26Aug97	LANG QUE TRAN
ARSENIC	26Aug97	LANG QUE TRAN	BARIUM	27Aug97	LANG QUE TRAN
RYLLIUM	27Aug97	LANG QUE TRAN	BISMUTH	27Aug97	LANG QUE TRAN
RON	26Aug97	LANG QUE TRAN	CADMIUM	27Aug97	LANG QUE TRAN
CALCIUM	26Aug97	LANG QUE TRAN	CHROMIUM	27Aug97	LANG QUE TRAN
BALT	27Aug97	LANG QUE TRAN	COPPER	27Aug97	LANG QUE TRAN
RON	26Aug97	LANG QUE TRAN	LEAD	27Aug97	LANG QUE TRAN
LITHIUM	26Aug97	LANG QUE TRAN	MANGANESE	27Aug97	LANG QUE TRAN
GNESIUM	26Aug97	LANG QUE TRAN	MOLYBDENUM	27Aug97	LANG QUE TRAN
CKEL	27Aug97	LANG QUE TRAN	PHOSPHORUS	26Aug97	LANG QUE TRAN
POTASSIUM	26Aug97	LANG QUE TRAN	SILVER	27Aug97	LANG QUE TRAN
SELENIUM	26Aug97	LANG QUE TRAN	SILICON	26Aug97	LANG QUE TRAN
RONTIUM	27Aug97	LANG QUE TRAN	SODIUM	26Aug97	LANG QUE TRAN
HALLIUM	27Aug97	LANG QUE TRAN	SULPHUR	26Aug97	LANG QUE TRAN
TITANIUM	27Aug97	LANG QUE TRAN	TIN	27Aug97	LANG QUE TRAN
ANADIUM	27Aug97	LANG QUE TRAN	ZINC	27Aug97	LANG QUE TRAN

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WATER ANALYSIS REPORT

The following published METHODS OF ANALYSIS were used:

3 11 SELENIUM
Total, perchloric acid digest, automated
hydride atomic absorption spectroscopy.
Ref. APHA 3114 C

1 01L pH
Electrometric (pH meter)
Ref. APHA 4500-H+

41L ELECTRICAL COND
Conductance meter
Ref. APHA 2510 B

03 CALCIUM
ICP spectroscopy @ 317.9 nm
Ref. APHA 3120 B

12102L MAGNESIUM
ICP spectroscopy @ 285.2 nm
Ref. APHA 3120 B

11102L SODIUM

11 POTASSIUM
Diss.,ICP Spectroscopy, Ref. APHA 3120 B

26304L IRON

1 06L SULPHATE
ICP spectroscopy @ 180.7 nm
Ref. APHA 3120 B

17203L CHLORIDE
Automated colorimetry, Thiocyanate
Ref. APHA 4500 Cl-,E

06201L BICARBONATE
Potentiometric titration with standard
acid to pH 8.3 and pH 4.5
Ref. APHA 2320 B

10101 T ALKALINITY
Potentiometric titration with standard
acid to pH 4.5 & pH 8.3. Report as CaCO3
Ref. APHA 2320 B

10602 HARDNESS
Calculation from 2.5*Ca + 4.1*Mg
Reported as CaCO3
Ref. APHA 2340 B

00203 T DIS SOLIDS
SUM OF IONS CALCULATION
Ca + Mg + K + Na + SO4 + Cl + 0.6*T Alk
Ref. APHA 1030 F

NWL4994 IONIC BALANCE

00100 IONIC BALANCE 2
%Diff=(Sum Cations-Sum Anions)/
(Sum Cations+Sum Anions)*100
Ref. APHA 1030 F

07105L NO2&NO3-N
Automated colorimetry Cadmium reduction
Ref. APHA 4500-NO3-,F

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
b. Methods for Chemical Analysis of Water and Wastewater, US EPA, 1983
MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

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WATER ANALYSIS REPORT

SAMPLE		1 BT-WQ-STR102 97/10	2 BT-WQ-STR208 97/10	3 FO-WQ-ST1-1
ROUTINE WATER				
pH		7.11	7.04	8.01
ELECTRICAL COND	uS/cm	35.0	49.0	566
CALCIUM	mg/L	3.6	5.7	113
MAGNESIUM	mg/L	0.9	1.2	23.1
SODIUM	mg/L	1.6	1.7	2.5
POTASSIUM	mg/L	1.22	1.11	<0.60
SULPHATE	mg/L	6.6	12.7	216
CHLORIDE	mg/L	<0.5	<0.5	<0.5
BICARBONATE	mg/L	26	25	174
T ALKALINITY	mg/L	21	21	142
HARDNESS	mg/L	12.8	19.0	377
T DIS SOLIDS	mg/L	27	35	441
IONIC BALANCE	%	-59.0	-67.9	-104
WATER NUTRIENTS				
NO2&NO3-N	mg/L	0.30	0.33	0.10
ICP METALS,EXTR				
IRON	mg/L	0.02	<0.02	0.05
MANGANESE	mg/L	<0.003	<0.003	0.140
DISS, COLD VAPOR				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
METALS,DISS,AAS				
SELENIUM	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,DISS				
IRON	mg/L	0.0150	0.0064	0.0395
ALUMINUM	mg/L	0.0284	0.0131	0.00172
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	0.02	0.03	<0.01
BARIUM	mg/L	0.00099	0.00148	0.0524
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	<0.0004	<0.0004	<0.0004
BORON	mg/L	<0.002	<0.002	<0.002

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MIKE NAHIR

WATER ANALYSIS REPORT

SAMPLE		1 BT-WQ-STR102 97/10	2 BT-WQ-STR208 97/10	3 FO-WQ-ST1-1
TRACE ICP,DISS				
CADMIUM	mg/L	<0.00006	<0.00006	0.00047
CALCIUM	mg/L	3.62	5.72	106
CHROMIUM	mg/L	<0.00006	<0.00006	<0.00006
COBALT	mg/L	<0.00003	<0.00003	<0.00003
COPPER	mg/L	<0.00003	<0.00003	<0.00003
LEAD	mg/L	<0.0003	<0.0003	<0.0003
LITHIUM	mg/L	0.00095	0.00078	0.00833
MANGANESE	mg/L	0.00034	0.00022	0.137
MAGNESIUM	mg/L	0.828	1.07	20.0
MOLYBDENUM	mg/L	0.00030	0.00025	0.00029
NICKEL	mg/L	<0.0001	<0.0001	0.0009
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	1.22	1.11	<0.60
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	<0.003	<0.003	<0.003
SILICON	mg/L	2.03	2.20	3.33
STRONTIUM	mg/L	0.0170	0.0247	0.226
SODIUM	mg/L	0.765	0.885	1.41
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	2.16	4.16	66.5
TITANIUM	mg/L	0.00037	0.00015	<0.00002
TIN	mg/L	0.0003	0.0002	0.0009
URANIUM	mg/L	0.0034	0.0018	0.0057
VANADIUM	mg/L	<0.00003	<0.00003	<0.00003
ZINC	mg/L	0.0008	0.0013	0.0507
ZIRCONIUM	mg/L	<0.00004	<0.00004	<0.00004

Lab Manager: ____

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MIKE NAHIR

WATER ANALYSIS REPORT

SAMPLE		4 FO-WQ-ST1-2	5 FO-WQ-ST1-3	6 PESO-WQ-ST1-1
ROUTINE WATER				
pH		8.02	8.05	7.43
ELECTRICAL COND	uS/cm	560	564	163
CALCIUM	mg/L	113	113	19.4
MAGNESIUM	mg/L	23.0	23.1	8.5
SODIUM	mg/L	2.3	2.3	2.8
POTASSIUM	mg/L	0.81	<0.60	2.13
SULPHATE	mg/L	216	216	60.6
CHLORIDE	mg/L	<0.5	<0.5	<0.5
BICARBONATE	mg/L	175	175	33
T ALKALINITY	mg/L	143	144	27
HARDNESS	mg/L	378	376	83.5
T DIS SOLIDS	mg/L	442	442	110
IONIC BALANCE	%	-104	-103	-101
WATER NUTRIENTS				
NO2&NO3-N	mg/L	0.10	0.10	0.08
ICP METALS,EXTR				
IRON	mg/L	0.09	0.07	0.12
MANGANESE	mg/L	0.148	0.137	0.063
DISS, COLD VAPOR				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
METALS,DISS,AAS				
SELENIUM	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP,DISS				
IRON	mg/L	0.0700	0.0632	0.1100
ALUMINUM	mg/L	0.00694	0.00365	0.0382
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.0523	0.0519	0.0304
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	<0.0004	<0.0004	<0.0004
BORON	mg/L	<0.002	<0.002	<0.002

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MIKE NAHIR

WATER ANALYSIS REPORT

SAMPLE		4 FO-WQ-ST1-2	5 FO-WQ-ST1-3	6 PESO-WQ-ST1-1
TRACE ICP,DISS				
CADMIUM	mg/L	0.00152	0.00140	0.00010
CALCIUM	mg/L	105	104	17.8
CHROMIUM	mg/L	0.00019	0.00018	0.00018
COBALT	mg/L	0.00014	0.00014	0.00056
COPPER	mg/L	0.00041	0.00028	0.00051
LEAD	mg/L	0.0006	0.0003	<0.0003
LITHIUM	mg/L	0.00798	0.00788	0.00894
MANGANESE	mg/L	0.140	0.132	0.0580
MAGNESIUM	mg/L	19.7	19.5	7.38
MOLYBDENUM	mg/L	0.00021	0.00021	<0.00007
NICKEL	mg/L	0.0010	0.0011	0.0054
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	0.81	<0.60	2.13
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	<0.003	<0.003	0.004
SILICON	mg/L	3.32	3.31	6.77
STRONTIUM	mg/L	0.218	0.220	0.0654
SODIUM	mg/L	1.41	1.39	1.41
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	67.1	67.1	19.2
TITANIUM	mg/L	<0.00002	<0.00002	<0.00002
TIN	mg/L	0.0017	0.0015	0.0003
URANIUM	mg/L	0.0037	0.0063	<0.0009
VANADIUM	mg/L	<0.00003	<0.00003	<0.00003
ZINC	mg/L	0.199	0.201	0.0176
ZIRCONIUM	mg/L	0.00013	<0.00004	<0.00004

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MIKE NAHIR

WATER ANALYSIS REPORT

AMPLE		7 PESO-WQ-ST1-2	8 PAD-WA-ST1-1	9 PAD-WQ-ST1-2
UTINE WATER				
pH		7.13	7.99	8.05
ELECTRICAL COND	uS/cm	161	561	560
CALCIUM	mg/L	18.6	114	113
AGNESIUM	mg/L	8.4	23.4	23.4
SODIUM	mg/L	2.5	2.3	2.0
POTASSIUM	mg/L	0.94	1.04	0.90
SULPHATE	mg/L	59.2	220	218
CHLORIDE	mg/L	<0.5	0.5	<0.5
BICARBONATE	mg/L	30	170	174
T ALKALINITY	mg/L	24	140	142
HARDNESS	mg/L	81.2	381	379
T DIS SOLIDS	mg/L	105	445	443
IONIC BALANCE	%	-101	105	-104
WATER NUTRIENTS				
O2&NO3-N	mg/L	0.07	0.10	0.10
ICP METALS,EXTR				
IRON	mg/L	0.06	0.06	0.06
MANGANESE	mg/L	0.070	0.128	0.122
ISS, COLD VAPOR				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
ETALS,DISS,AAS				
SELENIUM	mg/L	<0.0001	<0.0001	<0.0001
RACE ICP,DISS				
IRON	mg/L	0.0581	0.0540	0.0529
ALUMINUM	mg/L	0.0289	0.00408	0.00394
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	<0.01	<0.01
BARIUM	mg/L	0.0297	0.0495	0.0489
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001
BISMUTH	mg/L	0.0005	<0.0004	<0.0004
BORON	mg/L	<0.002	<0.002	<0.002

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MIKE NAHIR

WATER ANALYSIS REPORT

SAMPLE		7 PESO-WQ-ST1-2	8 PAD-WA-ST1-1	9 PAD-WQ-ST1-2
TRACE ICP,DISS				
CADMIUM	mg/L	0.00010	0.00212	0.00209
CALCIUM	mg/L	17.3	103	104
CHROMIUM	mg/L	0.00011	0.00014	0.00019
COBALT	mg/L	0.00067	<0.00003	0.00011
COPPER	mg/L	0.00033	0.00027	0.00033
LEAD	mg/L	<0.0003	0.0009	0.0009
LITHIUM	mg/L	0.00883	0.00787	0.00800
MANGANESE	mg/L	0.0641	0.122	0.116
MAGNESIUM	mg/L	7.11	19.2	19.3
MOLYBDENUM	mg/L	<0.00007	0.00022	0.00023
NICKEL	mg/L	0.0054	0.0011	0.0011
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	0.94	1.04	0.90
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	<0.003	<0.003	<0.003
SILICON	mg/L	6.79	3.28	3.27
STRONTIUM	mg/L	0.0635	0.213	0.213
SODIUM	mg/L	1.38	1.37	1.38
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	19.5	68.4	67.4
TITANIUM	mg/L	<0.00002	<0.00002	<0.00002
TIN	mg/L	0.0005	0.0014	0.0014
URANIUM	mg/L	0.0013	0.0020	0.0037
VANADIUM	mg/L	<0.00003	<0.00003	<0.00003
ZINC	mg/L	0.0182	0.258	0.258
ZIRCONIUM	mg/L	<0.00004	<0.00004	<0.00004

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MIKE NAHIR

WATER ANALYSIS REPORT

AMPLE		10 PAD-WQ-ST1-3	11 VE-WA, A101	12 VE-WQ-A102
OUTINE WATER				
pH		8.15	8.36	8.42
ELECTRICAL COND	uS/cm	562	285	352
CALCIUM	mg/L	114	51.3	52.0
MAGNESIUM	mg/L	23.6	13.2	28.5
SODIUM	mg/L	2.3	4.3	6.8
POTASSIUM	mg/L	0.89	0.60	<0.60
SULPHATE	mg/L	220	59.8	77.3
CHLORIDE	mg/L	<0.5	<0.5	<0.5
CARBONATE	mg/L			4.64
BICARBONATE	mg/L	189	148	192
P ALKALINITY	mg/L			4
T ALKALINITY	mg/L	155	122	165
HARDNESS	mg/L	381	182	247
T DIS SOLIDS	mg/L	454	203	265
IONIC BALANCE	%	-101	-104	-107
ATER NUTRIENTS				
NO2&NO3-N	mg/L	0.10	0.16	0.17
CP METALS, EXTR				
IRON	mg/L	0.06	1.63	0.03
MANGANESE	mg/L	0.107	0.013	<0.003
DISS, COLD VAPOR				
MERCURY	mg/L	<0.0001	<0.0001	<0.0001
METALS, DISS, AAS				
SELENIUM	mg/L	<0.0001	<0.0001	<0.0001
TRACE ICP, DISS				
IRON	mg/L	0.0508	1.554	0.0254
ALUMINUM	mg/L	0.00447	0.0215	0.00394
ANTIMONY	mg/L	<0.005	<0.005	<0.005
ARSENIC	mg/L	<0.01	1.27	0.23
BARIUM	mg/L	0.0488	0.0333	0.0280
BERYLLIUM	mg/L	<0.00001	<0.00001	<0.00001

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MIKE NAHIR

WATER ANALYSIS REPORT

SAMPLE		10 PAD-WQ-ST1-3	11 VE-WA, A101	12 VE-WQ-A102
TRACE ICP,DISS				
BISMUTH	mg/L	<0.0004	0.0006	<0.0004
BORON	mg/L	<0.002	<0.002	<0.002
CADMIUM	mg/L	0.00205	0.0229	0.00111
CALCIUM	mg/L	105	49.3	48.8
CHROMIUM	mg/L	0.00016	0.00023	0.00027
COBALT	mg/L	<0.00003	0.00014	<0.00003
COPPER	mg/L	0.00041	0.00597	0.00016
LEAD	mg/L	0.0008	0.0500	0.0017
LITHIUM	mg/L	0.00809	0.00937	0.0174
MANGANESE	mg/L	0.104	0.0133	0.00207
MAGNESIUM	mg/L	19.6	11.2	23.5
MOLYBDENUM	mg/L	0.00020	0.00849	0.00830
NICKEL	mg/L	0.0012	0.0002	0.0001
PHOSPHORUS	mg/L	<0.006	<0.006	<0.006
POTASSIUM	mg/L	0.89	0.60	<0.60
SILVER	mg/L	<0.00005	<0.00005	<0.00005
SELENIUM	mg/L	<0.003	<0.003	<0.003
SILICON	mg/L	3.25	3.79	3.83
STRONTIUM	mg/L	0.218	0.716	1.10
SODIUM	mg/L	1.39	3.28	5.11
THALLIUM	mg/L	<0.001	<0.001	<0.001
SULPHUR	mg/L	67.1	18.1	23.1
TITANIUM	mg/L	<0.00002	<0.00002	<0.00002
TIN	mg/L	0.0014	0.0013	0.0016
URANIUM	mg/L	0.0029	0.0144	0.0063
VANADIUM	mg/L	<0.00003	<0.00003	<0.00003
ZINC	mg/L	0.256	0.376	0.0379
ZIRCONIUM	mg/L	<0.00004	<0.00004	<0.00004

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MIKE NAHIR

WATER ANALYSIS REPORT

ote*	pH	pH REPORTED AT ROOM TEMP
ote*	ELECTRICAL COND	'ELECTRICAL COND' (EC) is in microsiemens/cm and is a measure of solids in solution E.C. CORRECTED TO 25C
ote*	T ALKALINITY	'ALKALINITY' is CARBONATE/BICARBONATE expressed as CALCIUM CARBONATE
note	HARDNESS	'HARDNESS' is calcium and magnesium expressed as CALCIUM CARBONATE
note	NO2&NO3-N	is expressed as nitrogen

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MIKE NAHIR

WATER ANALYSIS REPORT

-PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------	---PARAMETER----	DATE OF-ANALYSIS	------ANALYZED BY-------
E	21Oct97	DARREN CRICHTON	ELECTRICAL COND	21Oct97	DARREN CRICHTON
LCIUM	22Oct97	LANG QUE TRAN	MAGNESIUM	22Oct97	LANG QUE TRAN
SODIUM	22Oct97	LANG QUE TRAN	POTASSIUM	22Oct97	LANG QUE TRAN
SULPHATE	22Oct97	LANG QUE TRAN	CHLORIDE	21Oct97	THERESA LIEU
RBONATE	21Oct97	DARREN CRICHTON	BICARBONATE	21Oct97	DARREN CRICHTON
ALKALINITY	21Oct97	DARREN CRICHTON	T ALKALINITY	21Oct97	DARREN CRICHTON
HARDNESS	0	LANG QUE TRAN	T DIS SOLIDS	0	LANG QUE TRAN
NIC BALANCE	0	LANG QUE TRAN	NO2&NO3-N	21Oct97	THERESA LIEU
ON	21Oct97	LANG QUE TRAN	MANGANESE	21Oct97	LANG QUE TRAN
MERCURY	23Oct97	LANG QUE TRAN	SELENIUM	22Oct97	LANG QUE TRAN
RON	22Oct97	LANG QUE TRAN	ALUMINUM	22Oct97	LANG QUE TRAN
TIMONY	22Oct97	LANG QUE TRAN	ARSENIC	22Oct97	LANG QUE TRAN
BARIUM	22Oct97	LANG QUE TRAN	BERYLLIUM	22Oct97	LANG QUE TRAN
BISMUTH	22Oct97	LANG QUE TRAN	BORON	22Oct97	LANG QUE TRAN
DMIUM	22Oct97	LANG QUE TRAN	CALCIUM	22Oct97	LANG QUE TRAN
ROMIUM	22Oct97	LANG QUE TRAN	COBALT	22Oct97	LANG QUE TRAN
COPPER	22Oct97	LANG QUE TRAN	LEAD	22Oct97	LANG QUE TRAN
THIUM	22Oct97	LANG QUE TRAN	MANGANESE	22Oct97	LANG QUE TRAN
GNESIUM	22Oct97	LANG QUE TRAN	MOLYBDENUM	22Oct97	LANG QUE TRAN
NICKEL	22Oct97	LANG QUE TRAN	PHOSPHORUS	22Oct97	LANG QUE TRAN
POTASSIUM	22Oct97	LANG QUE TRAN	SILVER	22Oct97	LANG QUE TRAN
LENIUM	22Oct97	LANG QUE TRAN	SILICON	22Oct97	LANG QUE TRAN
RONTIUM	22Oct97	LANG QUE TRAN	SODIUM	22Oct97	LANG QUE TRAN
THALLIUM	22Oct97	LANG QUE TRAN	SULPHUR	22Oct97	LANG QUE TRAN
TANIUM	22Oct97	LANG QUE TRAN	TIN	22Oct97	LANG QUE TRAN
RANIUM	22Oct97	LANG QUE TRAN	VANADIUM	22Oct97	LANG QUE TRAN
ZINC	22Oct97	LANG QUE TRAN	ZIRCONIUM	22Oct97	LANG QUE TRAN

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MIKE NAHIR

WATER ANALYSIS REPORT

e following published METHODS OF ANALYSIS were used:

10301L pH
Electrometric (pH meter)
Ref. APHA 4500-H+

2041L ELECTRICAL COND
Conductance meter
Ref. APHA 2510 B

0103 CALCIUM
ICP spectroscopy @ 317.9 nm
Ref. APHA 3120 B

2102L MAGNESIUM
ICP spectroscopy @ 285.2 nm
Ref. APHA 3120 B

1102L SODIUM

9111 POTASSIUM
Diss.,ICP Spectroscopy, Ref. APHA 3120 B

16306L SULPHATE
ICP spectroscopy @ 180.7 nm
Ref. APHA 3120 B

17203L CHLORIDE
Automated colorimetry, Thiocyanate
Ref. APHA 4500 Cl-,E

06301L CARBONATE
Potentiometric titration with standard
acid to pH 8.3 and pH 4.5
Ref. APHA 2320 B

06201L BICARBONATE
Potentiometric titration with standard
acid to pH 8.3 and pH 4.5
Ref. APHA 2320 B

0151 P ALKALINITY
Potentiometric titration with standard
acid to pH 8.3. Report as CaCO3
Ref. APHA 2320 B

10101 T ALKALINITY
Potentiometric titration with standard
acid to pH 4.5 & pH 8.3. Report as CaCO3
Ref. APHA 2320 B

10602 HARDNESS
Calculation from 2.5*Ca + 4.1*Mg
Reported as CaCO3
Ref. APHA 2340 B

00203 T DIS SOLIDS
SUM OF IONS CALCULATION
Ca + Mg + K + Na + SO4 + Cl + 0.6*T Alk
Ref. APHA 1030 F

NWL4994 IONIC BALANCE

00100 IONIC BALANCE 2
%Diff=(Sum Cations-Sum Anions)/
(Sum Cations+Sum Anions)*100
Ref. APHA 1030 F

07105L NO2&NO3-N
Automated colorimetry Cadmium reduction
Ref. APHA 4500-NO3-,F

26321 IRON
Acid extr.,ICP Spectro. Ref. APHA 3120 B

25321 MANGANESE
Acid extr.,ICP Spectro. Ref. APHA 3120 B

80016 MERCURY
Dissolved, cold vapor atomic absorption
spectroscopy, with H2SO4/K2S208 digest
Ref. EPA 245.2

34102 SELENIUM
Dissolved, perchloric acid digest, auto.
hydride atomic absorption spectroscopy

Method References:

1. APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.
2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
   b. Methods for Chemical Analysis of Water and Wastewater, US EPA, 1983
3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

* NORWEST SOIL RESEARCH LTD has been accredited by the STANDARDS COUNCIL of CANADA for specific tests registered with the COUNCIL.

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P.O. NO.

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MIKE NAHIR

WATER ANALYSIS REPORT

Ref. APHA 3114 C

thod References:

APHA Standard Methods for the Examination of Water and Wastewater, American Public Health Assoc., 17th ed.

2. EPA a. Test Methods for Evaluating Solid Waste, Physical/Chemical Methods SW-846, 3rd ed., US EPA, 1986
b. Methods for Chemical Analysis of Water and Wastewater, US EPA, 1983

3. MSS Manual on Soil Sampling and Methods of Analysis, Cdn. Soc. of Soil Science, J. A. McKeague, 2nd ed.

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Lab Manager: ____________________

Appendix D

Geotechnical Services

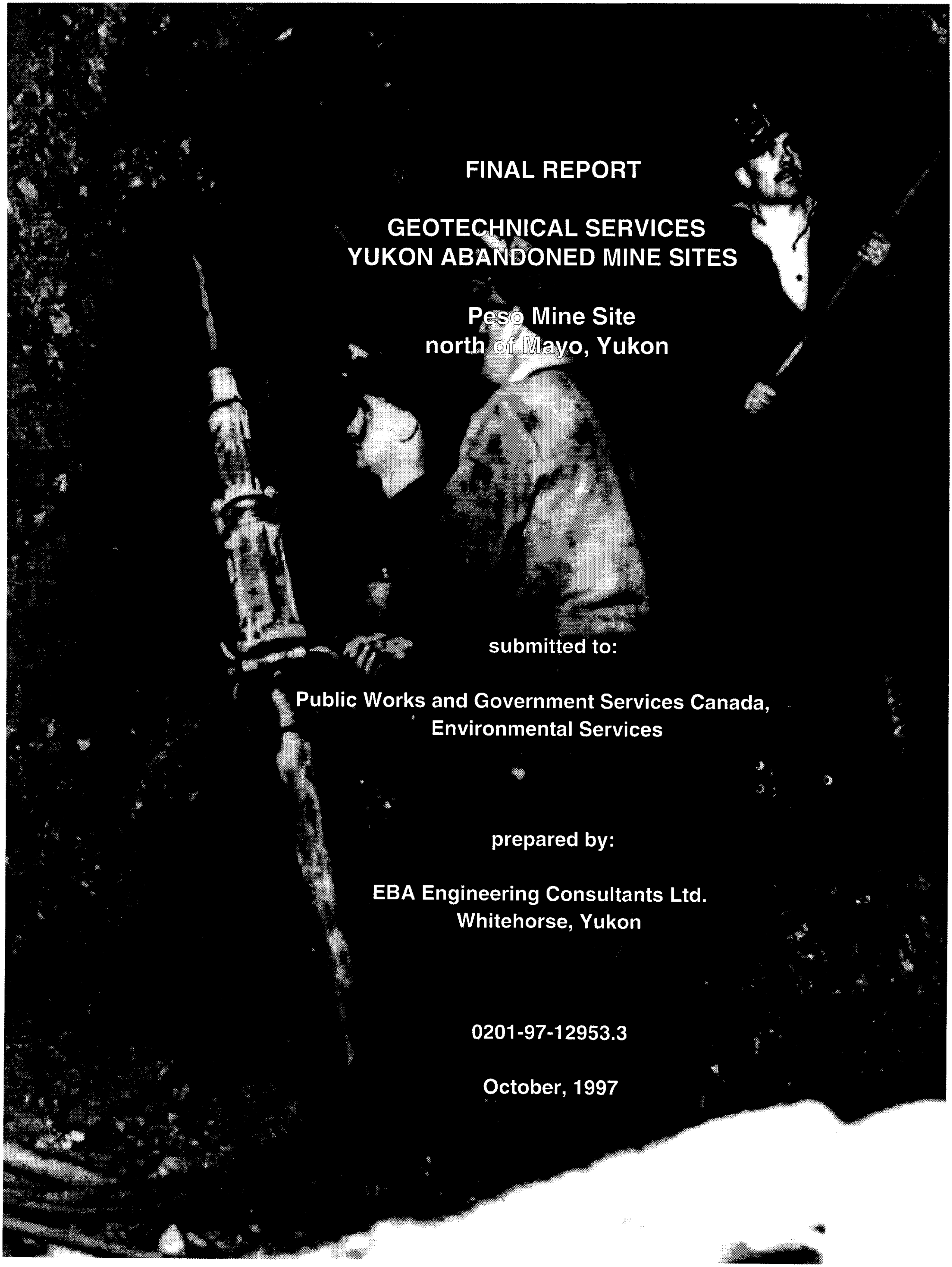
Yukon Abandoned Mine Site

Peso Mine Site

north of Mayo, Yukon

prepared by EBA Engineering Consultants Ltd.

(1997)



FINAL REPORT

GEOTECHNICAL SERVICES
YUKON ABANDONED MINE SITES

Peso Mine Site
north of Mayo, Yukon

submitted to:

Public Works and Government Services Canada,
Environmental Services

prepared by:

EBA Engineering Consultants Ltd.
Whitehorse, Yukon

0201-97-12953.3

October, 1997

EXECUTIVE SUMMARY

Public Works and Government Services Canada (PWGSC), Environmental Services retained EBA Engineering Consultants Ltd. (EBA) to perform geotechnical services in relation to a study focussed on the restoration of the Peso Mine Site which is approximately 48 km north of Mayo, YT. In brief, the geotechnical aspect of the restoration study involved a field work component and a terrain analysis component. The purpose of the field work program was to visually observe and assess slope conditions at the site and to provide information for site specific slope stabilization options. The purpose of the terrain analysis work was to identify potential sources of fine grained borrow material for potential use in site restoration work.

From the information obtained during the site visit, there is not an existing or a perceived threat of mass wasting within the waste rock pile at the site. In relation to slope failures occurring within the underlying till soil, this is not considered likely due to the dense and relatively coarse grained nature of this material, the shallow depth to bedrock, and the existing moderate slope. As such, it is not recommended to proceed with a restoration program aimed at reconfiguring the waste rock dump strictly for slope stability considerations. However, there was considerable visual evidence of potential acid rock drainage (ARD) affects from the waste rock pile. If it is the intention to remediate this site for ARD considerations, it is recommended to perform the necessary measures to develop a containment and isolation approach. This would include conducting a geological assessment to identify a suitable rock borrow source, performing the design of a containment system utilizing a high density polyethylene geomembrane liner with rock cover, and engaging in the actual construction. The Class "D" cost estimate for the proposed remediation system is presented under separate cover.

From the terrain analysis work, it appears that the surficial soils consist of a thin veneer (less than 1.0 m) of colluvium or till over shallow bedrock. There was no evidence of sizable morainic or glaciofluvial deposits within the study area of sufficient quantity for borrow source development purposes. From this, it does not appear that there is a suitable borrow source within an economical distance from the Peso site which could be used as a low permeability cover.

TABLE OF CONTENTS

Cover photo: *A photograph taken by flashlight of three underground miners in the Elsa Mine [1926-1930's]. Yukon Archives. Hare Collection #6957*

1.0 INTRODUCTION

Public Works and Government Services Canada (PWGSC), Environmental Services retained EBA Engineering Consultants Ltd. (EBA) to perform geotechnical services in relation to a study focussed on the restoration of five abandoned mines near the communities of Elsa and Carcross, Yukon. The property which is considered in this report is known as the Peso Mine Site and is located approximately 48 km north of the community of Mayo, YT. The site is in the general vicinity of the Dublin Gulch and Haggart Creek placer mines.

The terms and conditions of the agreement for the project, including the scope of work and the basis for payment, was outlined in the fax by Tim Sackmann of PWGSC dated August 11, 1997. In brief, the geotechnical aspect of the restoration study involved a field work component and a terrain analysis component. The purpose of the field work program was to visually observe and assess slope conditions at the site and to provide information for site specific slope stabilization options. The purpose of the terrain analysis work was to perform the necessary air photo interpretation and review of existing borehole data in order to identify potential sources of fine grained borrow material for site restoration purposes.

It is understood that this report was intended to cover strictly the geotechnical aspects of the restoration work and as such, that it would be appended to a comprehensive document describing the overall restoration study. Therefore, to avoid redundancies, the writer has not described in detail the location, site access, past mining activities, climate, or other extraneous details of each site. Rather, the report contains background information which is related to geotechnical considerations, the results of the field work program, the slope stabilization options with cost estimates, and the results of the terrain analysis. Brief conclusions and recommendations have also been prepared in consideration of the findings.

2.0 BACKGROUND INFORMATION

Various background information was provided by PWGSC for the Peso mine site. Prior to initiating the field work program, the information was reviewed in order to identify specific geotechnical concerns which were raised and to incorporate these concerns into the site inspection work. This section briefly describes the relevant geotechnical background information.

An evaluation of the Peso mine site was prepared by GeoViro Engineering Ltd. (Report No. GV206.01, February, 1997) for PWGSC. From this study, there was no evidence of slope failure or other geotechnical concerns associated with the waste rock pile near the adit. There was ravelling noted along the surface of the waste rock pile but this was not considered to compromise the stability of the mass.

Geotechnical considerations at the site were primarily related to the remediation recommendations to deal with acidic seepage deriving from the waste rock pile. This included providing cursory recommendations for either capping the waste rock pile with a synthetic liner or by slightly modifying the existing waste rock pile in order to reduce infiltration.

3.0 SITE CONDITIONS

The main development area where the adit and waste rock pile occur at the Peso Mine Site was inspected for slope stability considerations. The relevant site features noted at the time of the site visit were essentially as described on the site plan enclosed as Drawing 12953-9 and as seen in Photos PE1 and PE2. The waste rock pile encompassed a 50 m by 70 m area and occurred as 3 lifts ranging in thickness of between 2 m and 6 m. Each lift consisted of a flat bench area ranging in width between 2 m and 15 m and a side slope at an angle of approximately 30° to 32°. The waste rock consisted primarily of a platy schist material with grain sizes ranging from silt sizes (<0.08 mm) up to cobbles in size (>75 mm dia). Sample Peso 1 was retrieved from the waste rock pile at the location depicted in Drawing 12953-9 and analysed for moisture content and particle size distribution. As seen in the lab results in the Figures section of the report, the waste rock appears to resemble a silty, gravelly sand in particle size, with a moisture content of 11%. The waste material is composed primarily of sand and gravel sizes and therefore it is considered relatively stable due to the high internal angle of friction and the low pore water pressures which are common for this type of material. This is reinforced by the fact that the waste rock has been in its current state for over 30 years and that significant changes to the moisture regime which would impact the slope stability most likely would have occurred by this time.

There was no evidence of slope failures throughout the waste rock mass with the exception of some minor slumping at the south edge of the waste rock pile. It does not appear that the existing depositional structure of the waste rock pile is prone to slope failures within the waste rock mass itself. The natural ground surface surrounding the waste rock pile consisted of a west facing slope with an angle of approximately 22° to 23°. The area was well vegetated with semi-mature to mature spruce trees and the near surface soil profile consisted of a thin veneer (0.05-0.08 m) of organics underlain by dense glacial till soil, a heterogeneous mixture of silt, sand, and gravel. Sample Peso 4 was retrieved from the native soil material and analysed for grain size and moisture content. As seen in Appendix C, sample Peso 4 consisted of a silty sand, some gravel with a moisture content of 11%.

Photo #PE1: Looking east at waste rock pile near adit and stressed vegetation along slope. Note benched tailings.

Photo #PE2: Looking north at top of lower bench slope . Note schistose rock, relatively fine grained. Note stressed vegetation.

EBA Engineering Consultants Ltd.	PROJECT GEOTECHNICAL SERVICES, YUKON ABANDONED MINES PROJECT
CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA**	TITLE **PESO MINE PHOTO SHEET #1**

DATE 97 10 09	DWN. MEB	CHKD.	FILE NO. 0201-96-12953	DWNG. 12953-PHTO6	REVISION 0

With a noticeable presence of fractured schist rock within the near surface soil profile, it is anticipated that the till soil does not extend more than one metre before bedrock is encountered. This was apparent in the previous shallow trenching work completed to the south of the waste rock pile and in the hand dug excavations which exposed primarily fragmented rock.

From the information gained in the site visit, it appears that the waste rock resembles a gravelly silty sand in grain size distribution and that there is not an existing or a perceived threat of mass wasting within the waste rock pile itself. In relation to slope failures occurring within the underlying till soil, this is not considered likely due to the dense and relatively coarse grained nature of the till soil, the shallow depth to bedrock, and the existing moderate slope.

4.0 SITE SPECIFIC SLOPE STABILIZATION OPTIONS

4.1 Description of Proposed System

As described above, the existing waste rock dump is not considered unstable and future failures are unlikely. The cost associated with performing site restoration activities aimed strictly at stabilizing the waste rock dump is not worth the added certainty against the already improbable occurrence of slope failure.

However, it does appear that this site may require restoration work in consideration of the potential adverse impacts deriving from acid rock drainage (ARD) of the waste rock pile. Although it was not within the scope of services for EBA to conduct an ARD analysis at this site, there was considerable visual evidence of potential ARD affects. This includes extensive stressed vegetation down slope of the waste rock pile. As seen on Photo #PE1, the stressed vegetation continued approximately 500 m down slope of the waste rock pile to Secret Creek. Following discussions with Tim Sackmann, it was agreed that the Class "D"cost estimate should deal with the ARD concern as apposed to the slope stability concern.

The most suitable remediation approach would be a containment and isolation or migration control system. This involves limiting the mobility of oxidation products by reducing the infiltration into the waste rock pile through the use of a low permeability cover. As discussed in Section 5.0 of this report, there is no fine grained borrow source within the study area which could be used for this purpose. As such, the most suitable cover would be a manufactured geomembrane such as a high density polyethylene liner (HDPE). Due to the extreme temperature variations and anticipated long term design life which it would have to endure, a 100 mil HDPE liner would be required (information obtained from Layfield Plastics Inc.).

Prior to placement, some grading of the material would be necessary to prepare a suitable surface on which to place the liner. The waste dump would be configured with a 3H:1V grade along the majority of the area and then a 1.5H:1V grade along the side slopes. These side slopes are the maximum possible given the type of waste rock material (the side slopes are currently at a 1.5H:1V grade) and the restrictions from the liner manufacturer for site welding requirements. This type of configuration is considered the most efficient to minimize the surface area of the pile while maintaining stable conditions within the waste rock material. If the liner was placed immediately following grading activities, it is possible that movements within the waste rock pile such as settlement could cause the liner to fail. As such, it would be prudent to wait approximately 2 to 3 years for the disturbed material to stabilize and reach a new equilibrium so that any consolidation or creep within the waste rock pile occurs prior to placement of the geomembrane liner. In order to confirm that the waste rock dump was configured properly and to establish control points for monitoring purposes, a survey would be performed immediately following grading activities. This would involve establishing single point monuments such as settlement rods and control stakes for future monitoring of lateral and vertical movements throughout the waste rock pile. Once it is confident that an equilibrium has been established within the waste rock pile, the liner placement could proceed.

The liner would be site welded to cover a total estimated area of 4000 m^2. The majority of this surface area (70%-75%) would cover the 3H:1V side slopes. For the long term stability of the liner, a cover would be required to avoid decay from exposure to ultra-violet radiation. The most suitable cover would be rock material from the immediate area since it would be close to the site and could withstand the relatively steep side slopes without erosion or slumping. The rock material could be mechanically placed over the 3H:1V slope and hand placed over the 1.5H:1V side slopes. The section of liner along the side slopes would be manufactured with a textured surface so that the rock would not slide off.

In regards to a rock borrow source, there is extensive exposed bedrock at the top of the slope above the waste rock pile. This rock is either naturally outcropping or has been exposed from trenching, open pit mining, or other human disturbances. It would be necessary to engage in a geological assessment of the surrounding rock material to identify a source for the cover material. This source must be confirmed as being non-acid generating and as being of suitable quality and quantity for the intended purpose. It is envisioned that the rock could be ripped with a D9 dozer or equivalent and then hauled and placed on the HDPE liner using dump trucks along the existing access road.

In order to restrict migration of water from entering the waste rock pile, the up slope side would be designed with a trench to divert surface runoff around the pile. This diversion trench is considered particularly necessary due to the location of the waste rock pile within a natural drainage course (as observed during the air photo review) and the high capacity for direct runoff given the dense colluvial/till soils and shallow bedrock at the study area.

4.2 Class "D" Cost Estimate

The Class "D" cost estimate to implement the restoration program described above has been detailed under separate cover.

5.0 FINE GRAINED BORROW SOURCE

Aerial photography of the study area with an approximate scale of 1:40,000 was reviewed for terrain analysis considerations in order to determine the location of a fine grained borrow source. The immediate area of the Peso Mine site is characterized by extensive bedrock outcroppings as noted on Drawing 12953-8. The surficial soils consist of a thin veneer (less than 1.0 m) of colluvium or till over bedrock. The till material is a heterogeneous mixture of sand, silt, and gravel with bedrock detritus intermixed as a result of down slope movement. The topography appears to conform with the subjacent bedrock with relatively steep slopes terminating sharply at valley bottoms. The thin colluvium along the slope near the Peso Mine Site would not be suitable as fine grained borrow material. Further, there was no evidence of sizable morainic or glaciofluvial deposits within the valley of Secret Creek of sufficient quantity for borrow source development purposes.

The only potential borrow source which was identified within the study area was along the lower Haggart Creek valley where more sizable fluvial and alluvial deposits are located. As indicated on Drawing 12953-8, sand and gravel alluvial deposits are present near the confluence of Secret Creek and Haggart Creek which could be used for borrow purposes. Borehole data from a previous investigation[1] is available along the access road for the Haggart Creek and Dublin Gulch mines. The subsurface soil profile consists of a fine to medium sand, with some gravel and silt and is free of permafrost. The grainsize distribution for this sand material is enclosed in the figure section of the report. Although this could be used as borrow material, it would not be suitable as a low permeability cover for the waste rock pile due to the relatively high intrinsic permeability which could be expected from such an alluvial deposit. Further, this area is approximately a 7 km to 8 km distance along a rough trail and a difference in elevation of approximately 400 m from the Peso Mine Site. Hauling costs for this distance would be prohibitively expensive. For these reasons, it is not considered feasible to develop a fine grained borrow source for use in site restoration purposes at the Peso Mine.

[1] EBA Engineering Consultants Ltd. 1996. Dublin Gulch Access Road. Unpublished Contract Report 0201-96-12289 produced for Yukon Engineering Services Ltd.

6.0 CONCLUSIONS

The following conclusions are drawn from this study:

1. The existing waste rock dump is not considered unstable and future failures are unlikely. The cost associated with performing site restoration activities aimed strictly at stabilizing the waste rock dump is not worth the added certainty against the already improbable occurrence of slope failure.
2. This site may require restoration work in consideration of the potential adverse impacts deriving from acid rock drainage (ARD) of the waste rock pile. There was considerable evidence of stressed vegetation as a result of the waste rock pile.
3. The most suitable remediation approach would be a containment and isolation or migration control system which involves limiting the mobility of oxidation products by reducing the infiltration into the waste rock pile through the use of a low permeability cover.
4. The surficial soils consist of a thin veneer (less than 1.0 m) of colluvium or till over bedrock. The veneer of colluvium along the slope near the Peso Mine Site would not be suitable as fine grained borrow material. Further, there was no evidence of sizable morainic or glaciofluvial deposits within the valley of Secret Creek of sufficient quantity for borrow source development purposes. From this, it does not appear that there is a suitable borrow source within an economical distance from the Peso site which could be used as a low permeability cover.
5. The containment remediation system could involve the use of a high density polyethylene (HDPE) geomembrane liner as a low permeability cover. This would involve grading the waste rock dump to reduce the existing surface area and to prepare an acceptable surface on which the liner could be placed. Following a stabilization period for settlement considerations, the liner could be placed and subsequently covered with rock material deriving from the immediate area of the waste rock dump. A geological assessment would be required to identify a suitable rock source of appropriate quality (non-acid generating) and quantity for the intended purpose. The Class "D" cost estimate for the proposed restoration system is provided under separate cover.

7.0 RECOMMENDATIONS

The following recommendations have been formulated in consideration of the objectives and results of this study:

1. It is not recommended to proceed with a restoration program aimed at reconfiguring the waste rock dump strictly for slope stability considerations. This is due to the relatively stable conditions observed during the site visit and the low probability for failure in the future.
2. If it is the intention to remediate this site for ARD considerations, it is recommended to perform the necessary measures to develop a containment and isolation approach as previously discussed. This would include conducting an initial geological assessment to identify a suitable rock borrow source, performing the design and developing construction specifications for the remediation system, and engaging in the actual construction.
3. It is not recommended to proceed with a geotechnical investigation for borrow source development as there were no fine grained sources identified in the terrain analysis within an economical distance from the Peso site.

8.0 LIMITATIONS

Recommendations presented herein are based on a geotechnical evaluation following the scope of work described in Section 1.0 of this report. The conditions encountered during the field work are considered to be reasonably representative of the site. If, however, conditions other than those reported be noted during subsequent construction work, monitoring activities or otherwise, EBA should be notified and given the opportunity to review our current recommendations in light of new findings.

This report has been prepared for the exclusive use of Public Works and Government Services Canada, Environmental Services for the specific application described in Section 1.0 of this report. It has been prepared in accordance with generally accepted geotechnical engineering practices. Engineering judgement has been applied in developing the recommendations in this report, in an attempt to strike a reasonable balance between risk of failure and economic factors. No other warranty is made, either expressed or implied. For further limitations on the use of this report, reference should be made to the General Conditions enclosed immediately following the text of this report.

9.0 REPORT CLOSURE

We trust this report meets your present requirements. We would be pleased to provide any further services needed for the design and to advise on the geotechnical aspects of specifications for inclusion in contract documents. Should you require any additional information, please do not hesitate to contact our office.

Respectfully submitted,

EBA Engineering Consultants Ltd.

97/12/18

Michael E. Billowits, M.Sc., P.Eng.
Project Engineer

Dec 18/97

J. Richard Trimble, M.Sc., P.Eng.
Project Director, Yukon Region

MEB/meb

EBA ENGINEERING CONSULTANTS LTD.

GEOTECHNICAL REPORT GENERAL CONDITIONS

A.1 USE OF REPORT AND OWNERSHIP

This geotechnical report pertains to a specific site and development. It is not applicable to adjacent sites nor is it valid for types of development other than that to which it refers. Any variation from the site, or development, necessitates a geotechnical review in order to determine the validity of the design concepts evolved herein.

This report is not to be reproduced in part or in whole without consent in writing from EBA Engineering Consultants Ltd. (EBA). Additional copies of the report, if required, may be obtained upon request. Isolated information, logs of borings, or profiles are not to be reproduced, copied or transferred.

A.2 NATURE AND EXACTNESS OF SOIL DESCRIPTION

Classification and identification of soils are based upon commonly accepted methods employed in professional geotechnical practice. This report contains descriptions of the systems and methods used. Where deviations from the system prevail, they are specifically mentioned.

Classification and identification of soil and geologic units are judgmental in nature as to both type and condition. EBA does not warrant conditions represented herein as exact, but infers accuracy only to the extent that is common in practice.

A.3 LOGS OF BORINGS

The boring logs are a compilation of conditions and classification of soils as obtained from field observations and laboratory testing of selected samples. Soil zones have been interpreted. Change from one geologic zone to the other, indicated on the logs as a distinct line, is in fact, transitional. The extent of transition is interpretive. Any circumstance which requires precise definition of soil zone transition elevations may require special evaluation.

A.4 STRATIGRAPHIC AND GEOLOGIC SECTIONS

The stratigraphic and geologic sections indicated on drawings contained in this report are evolved from logs of borings. Stratigraphy is known precisely only at the locations of the borings. Actual geology and stratigraphy between borings may vary from that shown on these drawings. Natural variations in geologic conditions are inherent and a function of historic environment. EBA does not represent the conditions illustrated as exact but recognizes that variations will exist. Where knowledge of exact locations of geologic units is necessary, it is cautioned that such determination requires special attention.

A.5 GROUNDWATER CONDITIONS

Groundwater conditions represented in this report refer only to those observed at the times recorded on logs of borings, and/or within the text of this report. These conditions vary with geologic detail between borings; annual, seasonal and special meteorologic conditions; and with construction activity. Where instruments have been established to record groundwater variations on an ongoing basis, the records will be specifically referred to. Interpretation of groundwater conditions from observations and records is judgmental and constitutes an evaluation of circumstances as influenced by geology, meteorology and construction activity. Deviations from these observations, may occur. No other warranty, express, or implied, is made by EBA.

A.6 PROTECTION OF EXPOSED GROUND

Excavation and construction operations expose geologic materials to meteorological elements. Many geologic materials deteriorate rapidly upon exposure to climatic elements. Severe deterioration of materials may be caused by precipitation and/or the action of frost on exposures. Unless otherwise specifically indicated in this report, walls and floors of excavations must be protected from elements, particularly all forms of moisture, desiccation from arid conditions and frost action.

A.7 SUPPORT OF ADJACENT GROUND AND STRUCTURES

Unless otherwise advised, support of excavation walls, ground adjacent to anticipated construction activity and of structures adjacent to the construction, must be provided. The support of ground and structures adjacent to the anticipated construction, with preservation of adjacent ground and structures from the adverse impact of construction activity, is therefore required.

A.8 INFLUENCE OF CONSTRUCTION ACTIVITY

There is a direct correlation between construction activity and adjacent structural performance. The influence of all anticipated construction activities should by considered by the contractor, owner, architect and prime engineer in consultation with a geotechnical engineer when the final design and construction techniques are known. EBA provides no warranty in respect to adverse circumstances resulting from construction activity.

A.9 OBSERVATIONS DURING CONSTRUCTION

Because of the nature of geologic deposits, the judgmental character of the art of soil and foundation engineering, as well the potential of adverse circumstances arising from construction activity, observations during site preparation, excavation and construction should be carried out by a geotechnical engineer. These observations then may serve as the basis for confirmation and/or alteration of geotechnical recommendations or design guidelines presented herein to the benefit of the project.

A.10 DRAINAGE SYSTEMS

Where drainage systems are installed within or around a structure, the systems which will be installed must protect the structure from loss of ground due to internal erosion and must be designed so as to assure continued performance of the drains. Specific design detail of such systems should be developed or reviewed by the geotechnical engineer. Unless otherwised specified, it is a condition of this report that effective drainage systems are required and that they must be considered in relation to project purpose and function.

A.11 BEARING CAPACITY

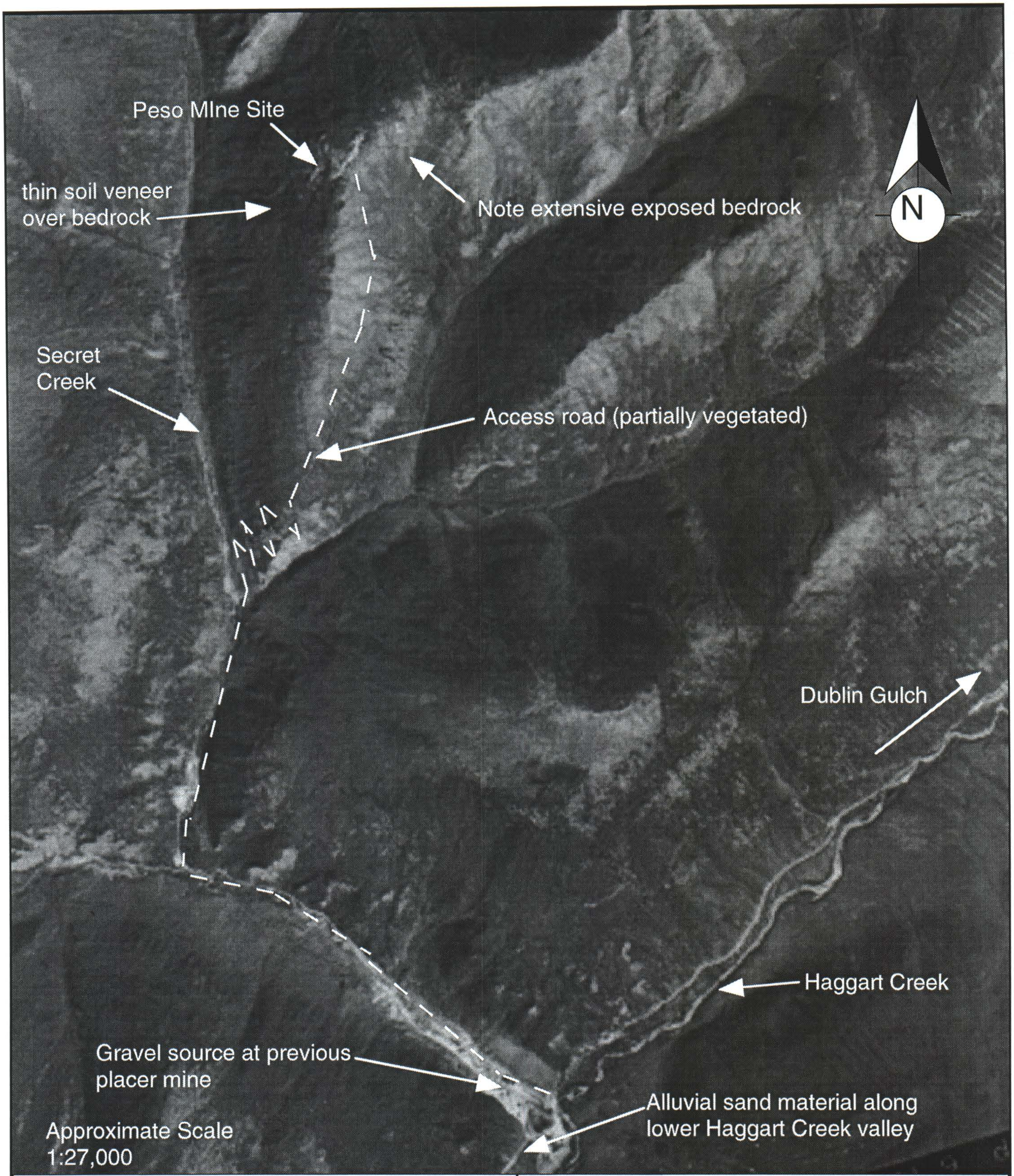
Design bearing capacities, loads and allowable stresses quoted in this report relate to a specific soil type and soil condition. Construction activity and environmental circumstances can materially change a soil condition. The elevation at which a soil type occurs is variable. It is a requirement of this report that structural elements be founded in and/or upon geologic materials of the type and in the condition assumed. Sufficient observations should be made by qualified geotechnical personnel during construction to assure that the soil conditions assumed in this report exist in fact.

A.12 SAMPLES

EBA will retain all soil and rock samples for 30 days. Further storage or transfer of samples can be made at owner expense upon written request.

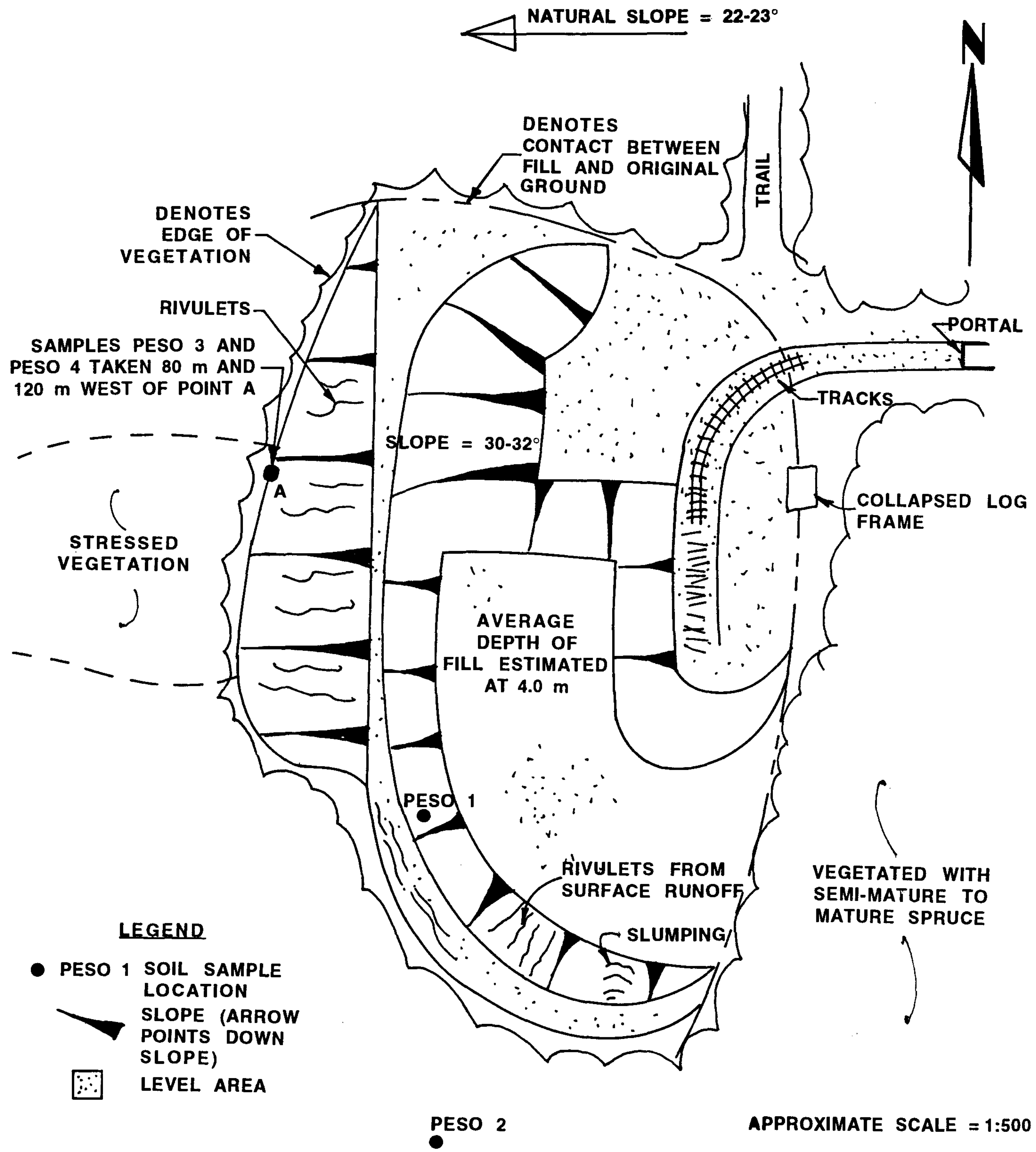
A.13 STANDARD OF CARE

Services performed by EBA for this report are conducted in a manner consistent with that level and skill ordinarily exercised by members of the profession currently practicing under similar conditions. No other warranty, express or implied, is made.



EBA Engineering Consultants Ltd.	PROJECT **GEOTECHNICAL SERVICES, YUKON ABANDONED MINE SITES**
CLIENT **PUBLIC WORKS AND GOVERNMENT SERVICES CANADA**	TITLE **Air Photo Depicting Features of Peso Mine Site**

DATE	97 10 20	DWN.	MEB	CHKD.		FILE NO.	0201-97-12953	DWNG.	12953-8	REVISION	0



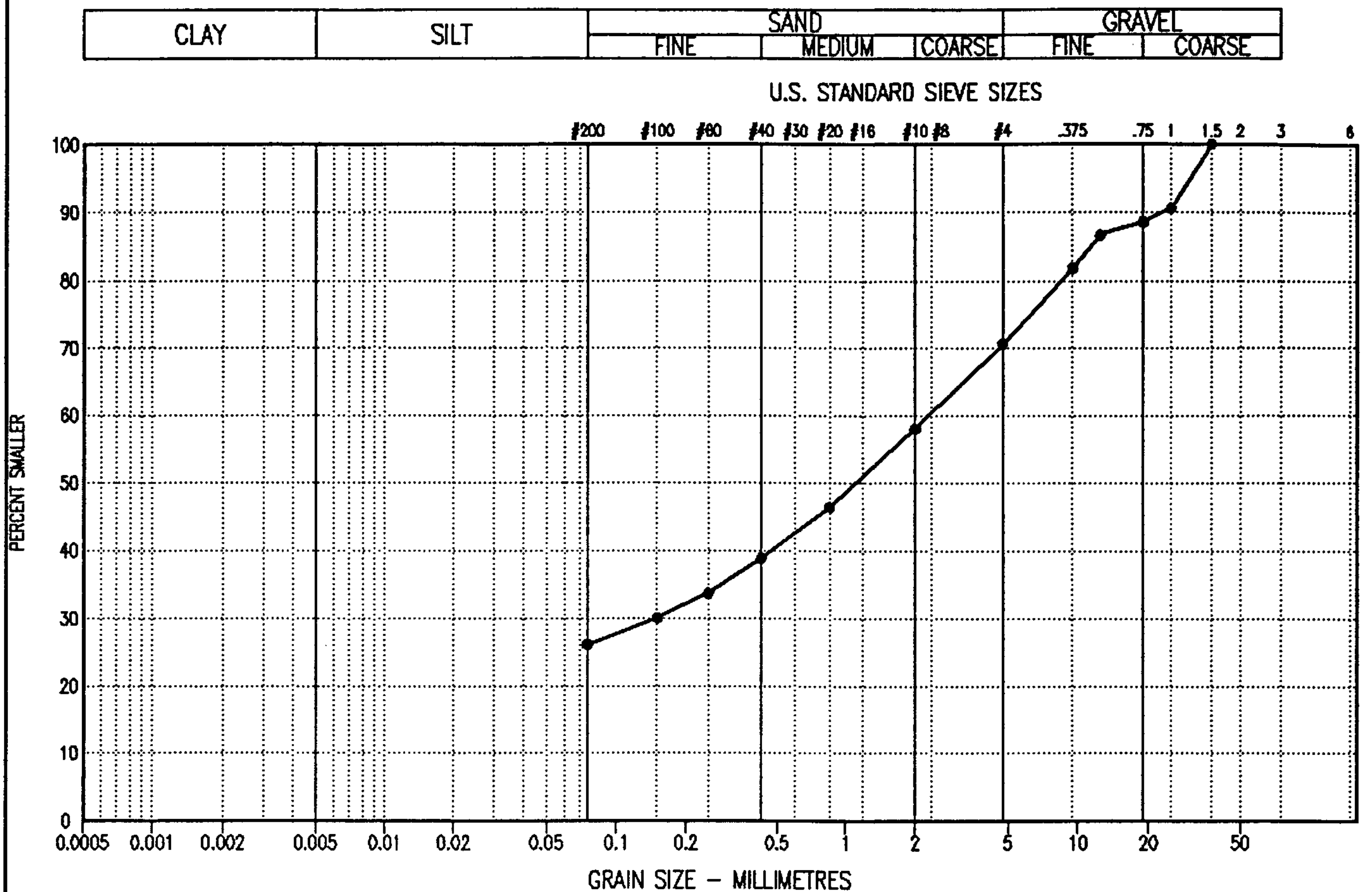
ADAPTED FROM FIGURE 5.2 - GEOVIRO REPORT GV206.01, SEPTEMBER, 1996

EBA Engineering Consultants Ltd.	PROJECT: GEOTECHNICAL SERVICES YUKON ABANDONED MINE SITES
CLIENT: PUBLIC WORKS & GOVERNMENT SERVICES CANADA	TITLE: PLAN DRAWING OF PESO MINE SITE, ADIT 1 WASTE ROCK PILE

DATE	DWN.	CHKD.	DRWG NO.	FILE NO.
97/10/08	MEB	MEB	12953-9	0201-97-12953

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS



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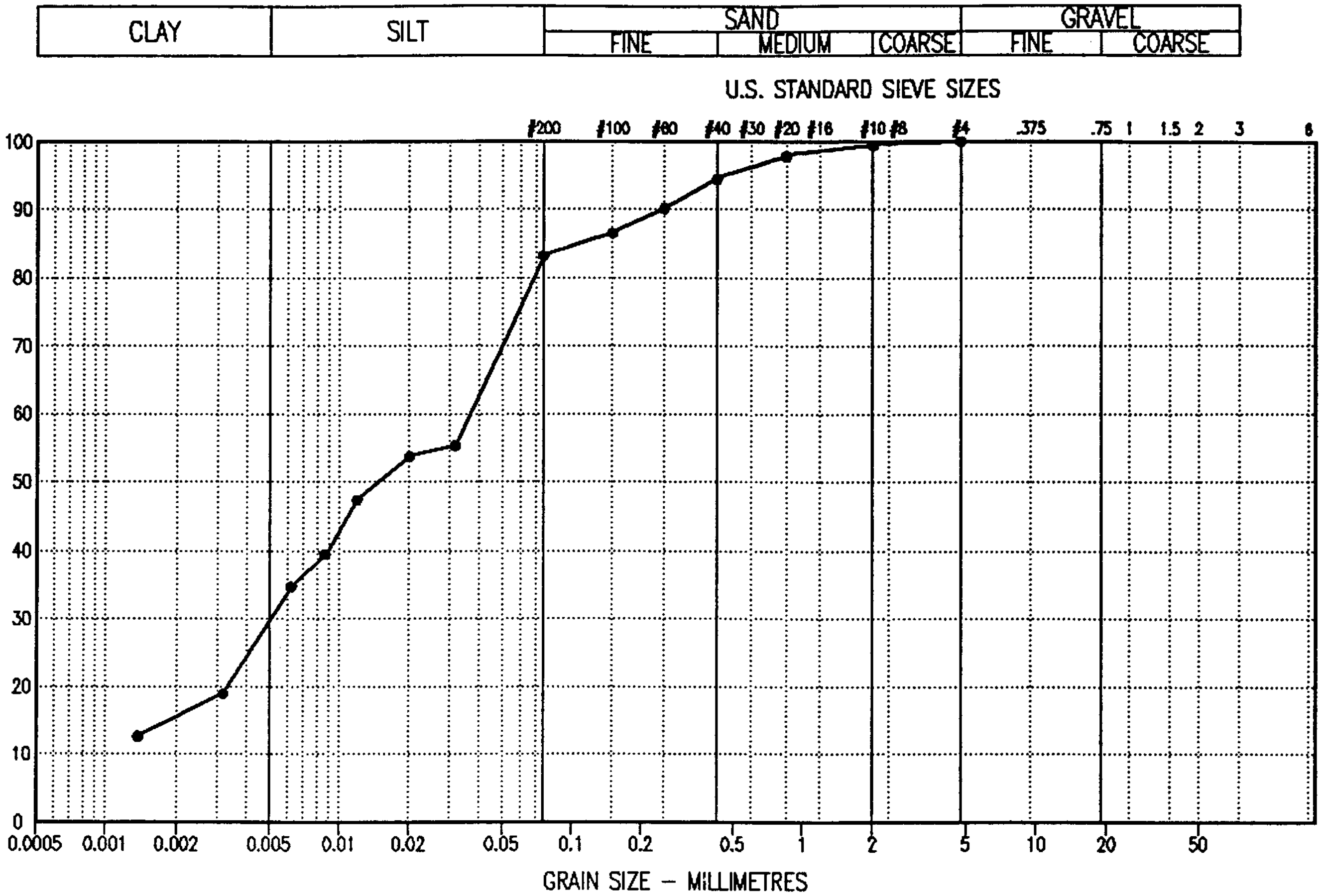
Project: 0201-97-12953   Date Tested: 97/10/15   BY: JSB

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS



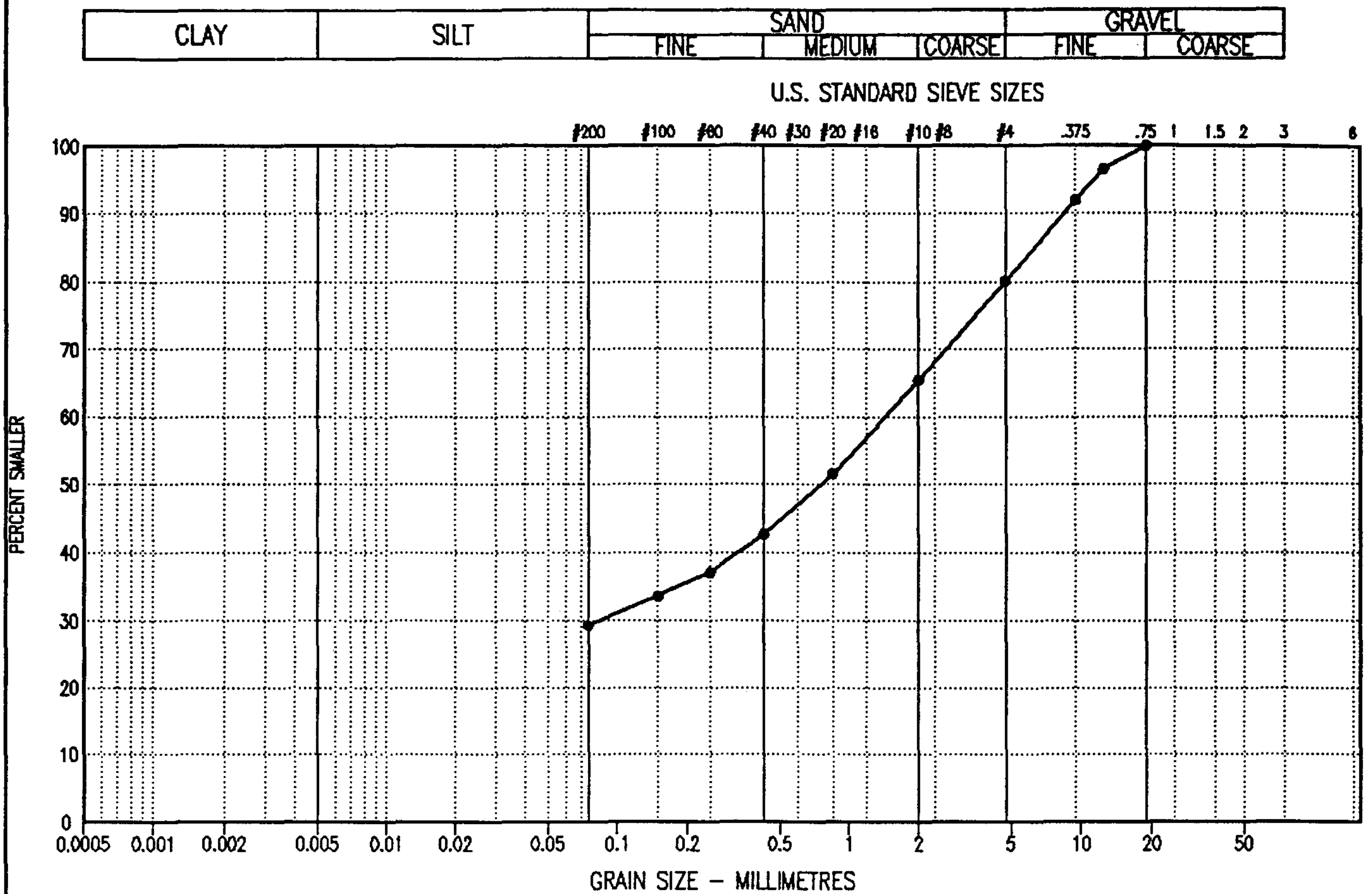
SYMBOL	BOREHOLE NUMBER	DEPTH (ft)	DESCRIPTION CLAY %	SILT %	SAND %	GRAVEL %	Cu	Cc	U.S.C
●——●	PES02	0.00	28.4	54.6	17.0	0.0	–	–	

Project: 0201-97-12953 Date Tested: 97/10/15 BY: JSB

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

PARTICLE SIZE – ANALYSIS OF SOILS



SYMBOL	BOREHOLE NUMBER	DEPTH (ft)	DESCRIPTION CLAY & SILT %	SAND %	GRAVEL %	Cu	Cc	U.S.C
•——•	PES04	0.00	29.3	50.8	19.9	60.5	0.2	SM

Project: 0201–97–12953 Date Tested: 97/10/15 BY: JSB

Tested in accordance with ASTM D422 unless otherwise noted.

EBA Engineering

AGGREGATE ANALYSIS REPORT

Project: DUBLIN GULCH ACCESS ROAD
Sample Number: 3702

Address: SOUTH McQUESTEN ROAD, YT
Sample Location: SECRET CREEK TAILINGS STOCKPILE

Project Number: 0201-96-12289

Date Sampled: / / By:
Time: Temp:

Client: YUKON ENGINEERING SERVICES
Date Tested: 96/11/08 By: RY

Natural Moisture Content: 0.1 %

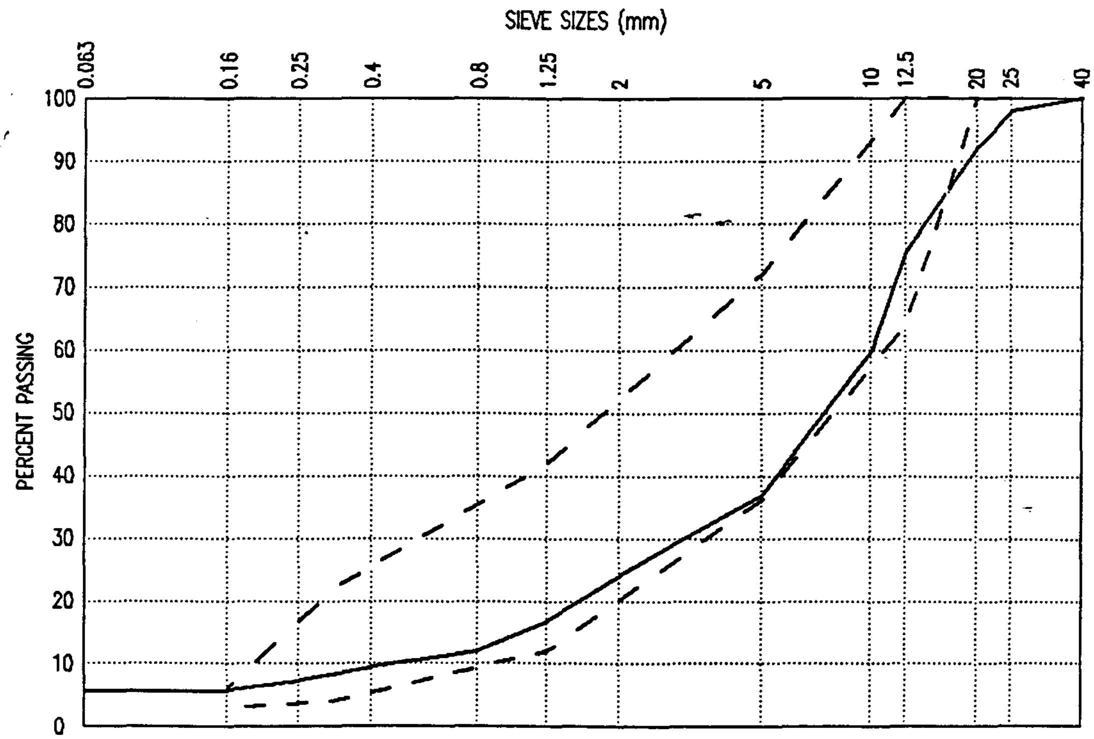
Crushed Faces: Faces:

Attention:

Soil Description: SAND & GRAVEL, 150mm MAX. TRACE CLAY LUMPS & ORGANIX FIBRES (SAMPLE WAS CRUSHED TO 20mm TOP SIZE FOR SIEVE ANALYSIS)

Remarks: LOS ANGELES ABRASION RESULT FOR TRIAL CRUSH MATERIALS IS 34.9% LOSS. (ASTM C131 - GRADING "B") - YTG GRANULAR A SPEC. BAND ALSO SHOWN

Sieve	% Passing
40	100.0
25	97.8
20	92.0
12.5	75.5
10	59.7
5	36.9
2	24.0
1.25	16.6
0.8	12.0
0.4	9.2
0.25	7.2
0.16	5.5
0.063	5.5



Reviewed By:

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