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PHASE II ENVIRONMENTAL ASSESSMENT OF THE CLARK ABANDONED MINE SITE

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EXECUTIVE SUMMARY

The Clark abandoned mine site (64°07'31"N, 135°51'12"W) was first staked in 1967. Underground development took place between 1973 and 1974. The last reported work on the property was a 1988 drilling program.

DIAND Technical Services completed a Phase I environmental assessment on the property in 1993. The initial assessment (DIAND, 1994) identified safety concerns associated with an open adit and a low-level environmental risk from the abandoned hydrocarbon products. No rock, soil, water, or product samples were collected in the initial assessment.

A Phase II environmental assessment was conducted at the Clark abandoned mine site in September, 1996, by Steffen, Robertson and Kirsten. The following are the key conclusions and recommendations of this investigation:

- The underground workings at this remote site present a serious health and safety risk because of anticipated poor ground conditions from weak rock (i.e. the schist and phyllite that hosts the mineral occurrence). It is recommended that the adit be securely sealed.

- The waste rock does not represent a potential acid generating risk to the environment. A metal leaching potential was identified; however, no adverse impacts were observed.

- The small volume (<1500 litres) of abandoned petroleum products present an environmental risk. It is recommended that these products be incinerated.

- The debris and garbage remaining at the site presents an aesthetic concern. It is recommended that this material be incinerated and buried while other work is ongoing on the site.

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1.0 INTRODUCTION

1.1 Background

As part of the 1993 Arctic Environmental Strategy Action on Waste program, DIAND Technical Services completed Phase I environmental assessments of abandoned exploration and mine sites. The initial assessments provided a general overview of historical activities, described site infrastructure, mine workings and wastes, summarized environmental and/or safety concerns on each site, and provided general recommendations for remediation work. On the basis of the initial assessments, selected sites were chosen for further investigation.

The abandoned Clark mine was one of the sites chosen for further investigation. The initial assessment (DIAND, 1994) identified safety concerns associated with an open adit and a low-level environmental risk from the abandoned hydrocarbon products. No rock, soil, water, or product samples were collected in the initial assessment.

Environmental Services, Public Works and Government Services Canada, retained Steffen Robertson and Kirsten (SRK) to do further investigation. SRK staff were at the site September 19, 1996.

1.2 Location and Access

The Clark mine site is located 30 km northeast of the community of Keno Hill and approximately 2 km south of the Clark Lakes which are located on Scougale Creek at 1000 metres to 1300 metres (3300 to 4200 feet) above sea level (see Figures 1 and 2).

The site is accessible by helicopter (a one hour flight from the Mayo airport). It is also accessible by a 30 km long, unmaintained winter road which commences at the end of the McQuesten Lake Road (an 18 km unmaintained gravel road that branches off of Highway 2 between Elsa and Keno City).

1.3 Overview of Site Development

The property was first staked in 1967 on an anomaly which was outlined as a result of the Geological Survey of Canada's (GSC) "Operation Keno" in 1964. Road construction took place between 1968 and 1969. Bulldozer trenching and diamond drilling followed.

Underground development occurred on the property between 1973 and 1974. An adit, located on the side of the mountain, provides access to a reported 455 metres of crosscutting and drifting. 355 metres of underground drilling were completed during this period to evaluate the geological resource.

The last reported exploration work on the property was a 1988 drill program (Yukon Minfile 106D 011). It is not known if these holes were drilled from surface or from the underground workings.

The mining claims are currently held by Scott-Town Holdings Ltd. (8845 Ursus Crescent, Surrey, B.C. V3V 6L3) and Van Bibber Placer Development Ltd. (current address unknown).

2.0 OBJECTIVES AND SCOPE

2.1 Objectives

SRK personnel completed this investigated with the assistance of Yaanatun Consulting of Whitehorse, YT. The objectives of the investigation were to:

- Identify potential environmental and human safety risks and/or aesthetic concerns; and,

- Provide recommendations and preliminary cost estimates for mitigation of those risks and/or concerns.

The level of effort in the assessment was appropriate for identifying potential risks. The site investigation was limited to a single day. The objective of the sampling and testing was to identify potential chemical and stability issues associated with the site, to determine the nature of those issues, and to recommend what, if any, mitigation or further investigation is required.

2.2 Review of Available Information

The investigation was initiated with a review of available background information. Public information was consolidated from the Geological Survey of Canada, Yukon Assessment files, DIAND Exploration and Geological Services, and DIAND Mineral Resource Directorate. Indian and Northern Affairs Canada provided an overview of the Clark mine site titled Yukon Assessment Report 106D-01-1 Clark Abandoned Mines Assessment, (DIAND, 1994). Other published information sources were examined for site or regional information as applicable. A list of references examined are included in Section 8.0 of this report.

The Yukon Mining Recorder in Mayo was contacted to determine the status of the mining claims at the site to be visited and registered property holders were contacted by letter prior to the site visit.

2.3 Site Investigation

The site investigation followed a procedure that was designed to apply to all of the sites included in the 1996 program. The procedure included:

- Visual inspection of mine openings and workings, buildings and infrastructure, and waste disposal areas;
- Photo documentation and mapping of relevant site features;
- Sampling of waste rock disposal areas, stained soils, surface water (including waste rock seeps and receiving waters) and barrel contents;
- Identification and inventory of hazardous and non-hazardous materials on the site;
- Identification of pathways and receptors for site contaminants; and,
- Assessment of human safety hazards and access to hazardous areas.

2.4 Review and Cost Estimates

Samples taken in the field as part of the investigation were submitted for analysis. The results were compiled and reviewed by SRK staff. Preliminary cost estimates were then prepared for the following mitigation measures, as appropriate:

- Sealing of all mine openings;
- Physical stabilization of waste rock disposal areas;
- Chemical stabilization of the waste rock disposal areas, taking into account impact, on-site resources, and accessibility;
- Consolidation and landfill of all non-hazardous, non-combustible solid wastes;
- Remediation and/or removal and disposal of contaminated soils;
- Removal and disposal of hazardous solid wastes;

- Draining, cleaning, and disposal of drums, storage tanks, or other containers containing petroleum products or other liquid hazardous wastes;

- On-site flaring or removal and off-site disposal of petroleum products and other liquid hazardous wastes; and,

- Demolition of buildings and infrastructure to foundation level and burning of combustible non-hazardous materials in an approved location.

3.0 SITE INVESTIGATION METHODOLOGY

3.1 Area Investigated

The investigation was limited to the area specifically developed, or occupied during, exploration and mining purposes, immediately-adjacent areas, and the resources believed to be affected by these activities. The winter access road was not included in the investigation.

3.2 Assessment Criteria

The *Mine Reclamation in Northwest Territories and Yukon* (IANC, 1992) provides guidelines for the clean up and reclamation of mine sites operating in northern climates. These guidelines were applied in the assessment of the following mine features:

- open pit and underground workings;
- waste rock and tailings disposal areas; and,
- acid generation and metal leaching.

The *Interim Canadian Environmental Quality Criteria for Contaminated Sites* (CCME criteria, 1992) 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.

CCME criteria include two types of benchmarks for soil and water quality: assessment criteria and remediation criteria. Assessment criteria are approximate background concentrations, or approximate analytical detection limits, for contaminants in soil and water and remediation criteria are for specified uses of soil and water. Remediation criteria are for generic use and do not address site-specific conditions. They are considered generally protective of human and environmental health for specified uses of soil and water at contaminated sites.

The remediation criteria for soil are classified by land uses: agricultural, residential/parkland, and commercial/industrial. Remediation criteria for water are classified by four uses of water likely of concern at contaminated sites: freshwater aquatic life, irrigation, livestock watering, and drinking water.

For the Yukon mine assessments, commercial/industrial remediation criteria were used to assess soil contaminants (excluding waste rock and tailings) and the freshwater aquatic life remediation criteria were used to assess surface water quality.

3.3 Components Investigated

The following components were investigated to identify existing or potential safety and environmental risks on the mine site:

Water samples were to be collected from receiving water bodies upstream and downstream of potential sources on contamination. Observations of flow, flora, and fauna habitat, fisheries resources, and field pH and conductivity measurements were recorded. The field observations and a comparison of downstream water quality to the upstream were used to assess impact. Since water sampling was restricted to a single sampling event it does not necessarily reflect seasonal variations.

Waste Rock disposal areas were to be inspected and sampled by a professional geologist to assess acid rock drainage and metal leachate potential by:

- Identifying variations in rock type, mineralization and alteration;
- Mapping and logging waste rock, tailings, pit walls and rock faces; and,
- Collecting and field testing representative samples of mine wastes.
- Collecting and field testing (paste pH and paste conductivity) representative samples of mine wastes.
- Laboratory testing of selected samples, including whole rock analysis (solids assay) and acid base accounting (ABA). Laboratory leach tests (static or kinetic) were not included in the Phase II assessment.

Mine Openings and Excavations were to be visually inspected from surface and documented to identify safety concerns and closure requirements.

Non-Hazardous Site Debris was to be inventoried.

Potentially Contaminated Soil Areas were to be identified measured and sampled to determine the degree and type of contamination and estimate soil volumes for remediation. Samples collected were analysed for total organic halogens (TOX), polychlorinated biphenols (PCB's), and metals, as appropriate.

Hazardous Materials were to be inventoried and sampled for analyses of contaminant constituents, as necessary.

Barrels, Pails, and Storage Tanks containing petroleum products were to be sampled and analysed for total organic halogens (TOX), polychlorinated biphenols (PCB's), and metals to determine suitability for on-site incineration. Drums containing substances other than petroleum products were to be sampled to identify hazardous constituents.

Buildings and other Structures were to be inspected for hazardous materials and assessed for stability.

Borrow Sources were to be identified and assessed for accessibility and approximate quantity and type of granular material as applicable.

Site plans were prepared to identify the type, dimensions and locations of site structures, mine workings and adits, waste rock disposal areas, on-site sampling locations, the distribution and type of debris observed, and other pertinent information. The inventories made recorded the type, quantity, condition and general location of equipment and products found.

3.4 Sampling Methods and Quality Assurance

Mine Waste Sampling

Samples were collected from the mine wastes (waste rock piles, ore stockpiles and mill tailings). Sampling was restricted to hand methods; no drills or excavators were used. The samples were submitted to Cominco Engineering Services Ltd. (CESL) of Vancouver, BC, for acid base accounting and solids analysis.

Test pits were excavated to a depth of about 0.3 to 1.0 metres. Horizons in the test pit walls were logged, noting colour/weathering, rock composition, primary and secondary mineralization, particle size distribution, paste pH and paste conductivity, and moisture content. The test pit was photographed and its location was recorded on the field map.

Approximately 2 kg of rock was collected at each sample site. For test pits showing a homogeneous wall face, a plastic sheet was placed at the bottom of the test pit and the pit wall was cut vertically with a cleaned pick. All rock fragments larger than 75 mm in size were discarded. For test pit walls showing clearly separate horizons (distinguishable by the sulphide and carbonate contents) the horizons were sampled individually.

Water Sampling

Samples were collected from surface streams upstream and downstream of mine related flows and from representative seeps emanating from waste rock, tailings, pit walls, and adits. The samples were submitted to Analytical Service Laboratories Ltd. (ASL) of Vancouver, BC, for analysis of total metals, pH, conductivity, hardness, acidity, alkalinity and sulphate.

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 nitric acid (HNO_3) were immediately added to water samples destined for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled to minimise head space. The water samples were stored in a cooler, with freezer packs, to maintain a temperature of approximately 4° C until delivery to the laboratory.

Soil Sampling

Samples were collected from areas suspected of hazardous waste contamination based on appearance or location with respect to fuel storage areas or workshops.

Soil lithology was recorded from observations of the side walls of the test pit, and soil samples for both field and laboratory testing were collected. Observations were recorded for each soil sample site, including soil particle size, consistency, colour, moisture, discoloration, stratification, odour, and any other significant observations.

Samples were collected at depth intervals selected on the basis of stratigraphic observations and anticipated or apparent contamination. The lab samples were collected using disposable latex gloves and decontaminated stainless steel sampling utensils. All samples intended for organic analyses were stored in laboratory-cleaned 250 ml glass jars. Samples intended for metals analyses were placed in new, sealable, plastic bags. All samples were placed in a cooler for shipment to the laboratory.

Barrel and Pail Sampling

Barrels and pails containing hydrocarbons were sampled with 1.2 metre clean hollow glass tubes ("drum thieves") capable of extracting up to 25 ml of product. The rods were inserted into the drum or pail, and the uppermost open tip was sealed to maintain the sample within the rod as it was extracted from the drum or pail. The sampled hydrocarbon was then drained into a 40 ml laboratory-cleaned vial. The extractions were repeated until the vial was filled to form a meniscus above the rim. The vial was then sealed, making sure no air bubbles formed in the closed head space, and placed in a container for shipment to the laboratory. Each used sampling tube was subsequently destroyed to prevent accidental re-use.

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.

Laboratory QA measures included replicate analyses of selected soil and water samples. Replicate analytical results were submitted with each analytical report.

3.5 Analytical Methods

Water Quality methods of analysis are outlined in ASL's Chemical Analysis Report included in Appendix D of this study.

Field paste pH and paste conductivity measurements were taken to characterize the current state of the mine waste while on site. The testing methodology is described in the *Public Works and Government Services Canada ARD Reconnaissance Handbook* (SRK, 1996) prepared for the surveys of abandoned mine sites in the Yukon Territory.

Acid Base Accounting (ABA) is a set of analyses used to determine the balance between potentially acid generating (sulphide) minerals, expressed as the acid generating potential (AP), and potentially acid consuming minerals expressed as the neutralizing potential (NP). The modified acid base accounting procedure used in this study is based on the standard Environmental Protection Agency (EPA) test procedure and is described in *Guidelines for Acid Rock Drainage Prediction in the North* (INAC, 1992).

Solids Analysis was conducted on a fraction of the pulverized mine waste material. Inductively Coupled Plasma - Atomic Emission Spectrophotometry (ICP-AES) was used to determine total sulphur, sulphate sulphur and 31 additional elements (metals).

4.0 ENVIRONMENTAL SETTING

4.1 Mineralization

The commodities of interest at the Clark site are silver, lead and zinc. The mineral deposit occurs in a 45 to 170 metre wide bed of brecciated limestone in a sequence of schist, quartzite and phyllite. Bedding strikes east and dips moderately to the south. Mineralization forms a north-northeast trending, steeply east-dipping feeder vein and an irregular manto (stratabound vein) that has replaced a graphitic horizon within the limestone. The feeder vein is between 2.5 and 10 metres wide. The manto is only developed on the east side of the feeder vein and is up to 5 metres thick.

The mineralization are strongly oxidized and consist of galena (PbS) with rare sphalerite ((Zn,Fe)S), pyrite (FeS_2) and chalcopyrite ($CuFeS_2$) in a gangue of siderite ($FeCO_3$) with or without quartz (SiO_2) (Yukon Minfile # 106D 011).

4.2 Surface Hydrology

Regional drainage flows eastward along Scougale Creek (Figure 2), which joins up with Beaver River before entering the Stewart River system. Hydrological and water quality data are not available for Scougale Creek or Beaver River.

Surface runoff from the mine site, would flow northward to the Clark Lakes, which are located on Scougale Creek. No flowing streams or creeks were located in the vicinity of the mine site and camp. The source of fresh water for the main camp was not found during the site visit.

4.3 Climate

The area has a continental climate characterized by low precipitation and a wide temperature range. Winters are cold and long, but the short summer has almost continuous daylight during June and July (GSC Memoir 364, pp.3-4). The nearest climatological information, compiled in Environment Canada's Canadian Climate Normals, 1951 to 1980, is from the town of Elsa (Latitude 63°55', longitude 135°29', elevation 814 metres above mean sea level). Total annual precipitation is approximately 410 mm, with the highest snowfall period being October to December and the highest rainfall period in July and August. Elsa has on average 122 days with precipitation per year. Temperatures typically range from - 28°C in January and 20°C in July. The mean annual temperature is -4°C. Both Elsa and the Clark mine site are on the northern side of mountain ranges, however the Clark site is approximately 200 metres higher in elevation than Elsa.

4.4 Vegetation

The Clark mine site occurs within the Yukon Plateau North ecoregion. Vegetation on the slopes surrounding the adit and on the level areas above the adit is typical of warmer Western Boreal areas. The following trees and shrubs were identified during the site assessment: balsam fir, black and white spruce (stunted), white birch, poplar, willow thickets, alder, scrub birch, rose hips, labrador tea, grass, fireweed, low bush cranberries, moss with black berries, and other forms of moss and lichen.

4.5 Fish and Wildlife Resources

The Clark site is a prime wintering site for moose. The dense willow thickets on the roads and the clearings provide habitat for black bear, fox, wolf/coyote, ptarmigan, gopher/marmots, eagles and hawks.

The nearest likely fisheries resource is between 1 km and 1.5 km to the north in the lowlands surrounding the Clark Lakes along Scougale Creek. The Clark Lakes are classified as Type I habitat by the Yukon Placer Authorization. Type I streams and/or stream reaches are used for spawning by salmon, trout and char.

4.6 Site Topography and Soils

The site is found on the north side Mount Cameron in the Davidson Range of the Yukon Plateau, with relief up to 675 metres above sea level in the broad valley hosting the Clark Lakes to 2012 metres above sea level at the sharp peak of Mount Cameron. The Davidson Range is 22 km long and 16 km wide, having a general east-west trend. In general the southerly slopes of the range are gentle, being governed to some extent by the dip of the strata; the northerly slopes are steep, frequently precipitous (GSC Memoir 284, 1957). The area is dominated by well drained, coarse textured soils.

4.7 Permafrost

The Clark site is in an area of discontinuous permafrost on a north facing slope. No evidence of adverse impacts on the mine site components and the surrounding environment due to permafrost were observed during the site visit.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 Buildings, Infrastructure, and Equipment

The infrastructure at the Clark site is located in three separate areas on the property and consists of the main camp area, an upper camp (core logging/storage area, incinerator site, drill and helicopter pads), and the adit workings as illustrated on the site plan, Figure 3. Photographs of the buildings are included in Appendix B.

Main Camp

The main camp consists of seven (7) tent platforms with wooden walls and doors (Photo 1). All of the platforms are currently in fair condition, but the wood is starting to rot in the floors and will soon begin to fail. Some of the roof supports are also unstable and could collapse. A core storage area is located at the north end of the camp.

Upper Camp

A small log tent frame and the remains of a tent are located approximately 250 metres west of the main camp at the upper camp. A core storage and incinerator site is located approximately 100 metres south-southeast of the tent (Photo 2). No buildings are located near the incinerator site. Clearings suitable for a helicopter or drill are located approximately 40 metres north of the core storage and incinerator site and 300 metres west of the tent.

Mine Workings

The adit opening consists of heavy timber frame work, in good condition, extending approximately 3 metres out from the opening and 1 metre into the underground workings (Photo 3 and 4).

The remains of the compressor station and related material are located approximately 10 metres to the west of the adit opening. The compressor station has been demolished, but the building materials were left on site. The compressor has be removed from the site (Photo 5).

5.2 Non-Hazardous Waste Material

Main Camp

Minor debris (bottles, cans, etc.) is scattered around the camp area. One barrel, filled with drill core fragments, was found in the area.

The core beside the main camp is stacked in three rows of open boxes, 3 to 4 boxes high. Most of the core is in place, but is showing significant signs of weathering. Most of the core is unidentifiable as the plastic identification tags on the core boxes have fallen off or have been chewed by animals.

Upper Camp

The tent frame contains a freezer with a lid (no lock or latch on lid) and is half filled with water. Forty four (44) boxes of core (labelled) from a 1988 drilling program are stacked next to the tent. Minor debris and refuse is scattered around the tent frame.

Approximately 75 open core boxes, labelled '1987', are stored at the incinerator site. The burning barrels are filled with burnt tin cans.

Several lengths of compressor air hose and approximately 15 lengths of drill rod are located at the helicopter/drill pad area.

Mine Workings

Debris consisting of mining equipment and supplies (air hoses, ventilation tubing, drills, etc.) have been left near the mine opening (Photos 5 and 6). An assortment of debris was found scattered around the bottom of the waste pile. This consisted of torn lengths of ventilation tubing, pipes, oil cans, broken timbers, hydraulic hoses, and other mining debris.

A compressed air pipe consisting of a heavy gauge iron pipe (6" OD) with Victaulic™ clamps linking the compressor station to the adit opening is still in place. The pipe is suspended from by rusting, ductile wire (3 - 4 mm) and therefore is considered to be a potential physical hazard.

The debris at the demolished compressor station consists of both hazardous and non-hazardous material. The materials include the wall and roofing materials, as well as numerous air and fuel filters, miscellaneous tools (including two air drill/stopers), air hoses, a broken lead acid car size battery, diesel space heater, and fuel barrels.

TABLE 1
Non-Hazardous Waste Materials

Waste Material	Number / Volume	Location	Comments
drill rods and pipe	30+	adit area and helicopter pad	non-burnable, rusted
mining equipment and debris	4 to 5 m^3	adit area and compressor station	various types of debris, metals and plastics (non-burnable)
freezer	1	upper camp	non-burnable
drill core boxes	250+	main camp and upper camp	non-burnable
metal scrap, bottles, food cans	< 1 m^3	scattered in and around the main camp and upper camp	non-burnable, rusted

5.3 Hazardous Materials

Four 205 litre diesel barrels are located next to the tent in the upper camp. Two are empty and two contain $\leq$ 10 litres of fuel. All have bungs in place and no signs of soil contamination were observed.

Four unmarked, 205 litre fuel barrels were found standing upright in the main camp (Photo 1). The barrels were inspected and found to be approximately 1/4 full and containing diesel fuel. A sample of one of the barrels was collected (CL/B100) for laboratory analysis to test for organic halogens (solvents) and polychlorinated biphenols (PCBs). The analytical results confirm that this material does not contain significant organic halogens or PCBs. The analytical results are included in Appendix C. All of bungs on the barrels were tightened to prevent possible spillage if knocked over. No signs of soil contamination were observed near the barrels.

A further 205 litre diesel barrel (marked) was found standing upright approximately 50 metres northwest of the main camp. This barrel was still sealed and is full.

Four (4) 205 litre fuel barrels are located at the helicopter pad area. These consist of two (2) marked diesel barrels (1 full, 1 empty) and two marked JP4 barrels (1 ≤ ½ full, 1 empty). All of the barrels were on their sides, but have now been stood upright and the bungs tightened. These barrels may have leaked as the hydrocarbon levels were equal to the bung level of the overturned barrels. However, no significant signs of soil contamination or leakage were observed near the barrels.

A broken lead acid car size battery and three 205 litre diesel barrels (≤ 1/4 full - all with bungs in place) were observed at the compressor. No signs of soil contamination were observed near the barrels.

TABLE 2
Hazardous Waste Materials

Waste Material	Number / Volume	Location	Comments
fuel barrels, diesel	12	main camp, upper camp and adit	most ≤ ½ full, one full and sealed
fuel barrels, JP4	2	upper camp	1 < ½ full, 1 empty
lead acid battery	1	adit	broken and leaking

5.4 Water Quality

To identify potential environmental impact on the surrounding surface water, a samples was collected from the water seeping from the mine workings. No streams or significant drainage were encountered on the site. Therefore, no surface water samples were collected.

No seepage from the waste rock was observed within 200 metres of the toe of the pile during the site assessment. However, water was discharging from the adit at approximately 2 litres per second (visual estimate). The water flowed across the surface for less than 10 metres before disappearing into the ground and the waste rock. Surface runoff from above and around the adit is naturally directed around the waste rock pile.

A sample (CL/WQ/A001) of the discharge water was collected and submitted for chemical analysis. Field measurements and a summary of the laboratory analysis are provided in Table 3. Analytical results are presented in Appendix D.

TABLE 3
Surface Water Samples

Sample ID	Location	Flow L/sec	pH	Cond. µS/cm	Comments
CL/WQ/A001	2 metres from adit opening	2	7.34	10	Zn elevated above CCME freshwater aquatic life criteria

CCME = Canadian Council for the Ministers of the Environment
L/sec = litres per second
pH = field measurement
Cond. = Conductivity, field measurement

As there were no surface water sources to sample, it was not possible to compare "background" concentrations versus downstream or seepage samples. The adit seepage sample CL/WQ/A001 was found to exceed the CCME criteria for zinc (measured 0.319 mg/L, criteria is 0.03 mg/L), however, the flow from the mine is very low and does not appear to be a significant threat to receiving waters, several hundreds of metres downslope.

5.5 Waste Rock Disposal Areas

The volume of waste rock produced from the underground exploration program is in the order of 12,000 tonnes. The assumptions made to derive this estimate are:

- a specific gravity of 2.65;
- a total of 455 metres of lateral development; and,
- mine openings 2.5 metres by 3.7 metres.

No evidence of slumping or extension cracks was observed on the surface of the waste rock pile. The slope of the pile was measured to be approximately 30° to 35° (varied across waste pile) and is similar to the natural slope of the underlying hillside. The area downslope of the waste pile is medium growth forest, with waste material extending out into the treed area. The waste rock pile was constructed by end dumping using a diesel scoop tram. It is assumed that the trees immediately below the portal were buried by the material. No streams were observed to be located below the waste dump. Lichen and willow have been established on 5% of the waste rock.

Approximately 80% of the pile surface is covered with mineralized rock, 8% with chlorite altered limestone and 12% with unmineralized silicified limestone. The distribution of mineralization on the waste rock pile is shown on the site map, Figure 3. The proportion of mineralized material on the surface does not likely represent the total waste rock pile because mining of the mineralized horizon would have followed several feet of development through unmineralized limestone which is now buried under the mineralized material. The contact between the silicified limestone and the mineralized rock is visible in lower left corner of Photo 6.

Three samples were collected in the waste rock. Sample CL/WR/P201 was collected from the silicified limestone (Photo 6). Sample CL/WR/P202 was collected from the mineralized material and sample CL/WR/P203 was collected from the chlorite altered limestone. Results of the paste pH, ABA and ICP-AES analyses are presented in Appendix A. The sample locations are shown on the site map, Figure 3.

The waste rock samples descriptions and the analytical results are summarized in Table 4. The samples from the unmineralized waste rock (P201 and P203) contained less than 1% total sulphur and had alkaline paste pH values. Both samples had NP:AP ratios above 3 (7.8 and 4.0, respectively) indicating that the material has a low potential to generate acid. Metals concentrations of these samples were generally low.

The sample collected from the mineralized portion of the waste (P202) contained 1.40% total sulphur and 0.56% sulphate sulphur. The sample's paste pH was neutral and it has significantly more neutralizing potential than acid potential (NP:AP 14.1). Metals concentrations of manganese (8135 ppm), lead (>10000 ppm), and zinc (7922 ppm) are high, indicating a potential for metal leaching. However, no evidence was found to indicate that metal leaching was occurring.

TABLE 4

Waste Rock Sample Descriptions and Select ABA and ICP Results

Sample ID	Location and Description	Comments
CL/WR/P201	East side of waste rock pile. Unmineralized silicified limestone. Sample collected over a thickness of 30 cm. The surface was covered with moss and small trees. The material was sticky and consisted of 55% clay/silt, with angular fragments up to 15 cm in diameter.	The field paste pH was 9.0, alkaline. NP:AP ratio 7.8.
CL/WR/P202	Middle of waste rock pile, 5 m below crest. Mineralized waste. Sample collected over a thickness of 40 cm. Angular cobbles up to 30 cm x 15 cm of which 30% are mineralized and 20% are quartzite the remainder are phyllite and schist. The material is layered with black/brown bands of sand/silt.	The field paste pH was 8.4, neutral. NP:AP ratio 14.1. High concentrations of silver, manganese, lead, and zinc
CL/WR/P203	West side of waste rock pile. Unmineralized grey coloured chlorite altered limestone. Sample collected over a thickness of 30 cm. Material was sticky, matrix supported gravel with angular cobbles up to 20 cm x 5 cm. 1% quartzite. Sand/silt and clay made up 25% of the material.	The field paste pH was 8.5, neutral. NP:AP ratio 4.0 with 0.09% total sulphur and 0.05% sulphate as SO_4.

5.6 Mine Openings and Excavations

A portal, 3.7 metres wide and 2.5 metres high, exists at the Clark mine site (Photos 3 and 6). The portal is open and the ground conditions around the entrance appear stable, based on the lack of loose rock on the floor or rock spalling from the back or walls. A 6 inch diameter pipe is secured to the back of the underground workings. The opening is timbered for a distance of 4 metres. Approximately 1 metre of the timber is underground.

5.7 Tailings

No milling of ore was done on the site; therefore, no tailings are present.

6.0 RISKS AND CONCERNS

6.1 Health and Safety Risks

The underground workings at this remote site present a health and safety risk because access is not restricted. While no evidence of loose rock was observed in the first few metres of the adit, the ground near the ore zone is likely very unstable due to the presence of structurally weak rock types such as schist, quartzite and phyllite. Prospectors and geologists working in the area would, therefore, be exposed to a serious health and safety hazard.

The freezer at the upper camp is a safety concern because the lid is still attached.

6.2 Environmental Risks

The waste rock below the adit is net acid consuming and does not represent a potential acid generating risk to the environment. However, most of the surface of the waste rock is covered with a rock that is high in manganese, lead and zinc which does represent a risk to the environment. This risk is augmented by the fact that the waste rock is located on a steep slope which may fail in the future. The steepness of the slope precludes the use of typical remediation measures to physically and chemically stabilize the waste rock pile.

The small volume (<1500 litres) of abandoned petroleum products and batteries at the Clark site presents an environmental risk should the containers degrade and spill the contents onto the ground.

6.3 Aesthetic Concerns

There are few aesthetic concerns. The site is beginning to overgrow and blends in well to the surrounding environment. However, the tent frames in the main and upper camp areas and the compressor shack at the adit detract from the aesthetics of the site. The non-hazardous debris and garbage remaining at the site also presents an aesthetic concern and should be cleaned up and burned or buried in a trench.

The diamond drill core is an asset to the mining claim that does not represent a safety risk and should be left in place.

7.0 RECOMMENDATIONS

The following reclamation activities are recommended for the Clark mine site:

- Seal open adit by drilling and blasting the entrance. The rock used in the lower portion of the seal should be coarse enough to permit free draining of the adit discharge water;

- Collection of metal debris near the portal and moving them underground for burial. Non-metal debris at the bottom of the waste rock pile should be pulled back up. It is suggested that all metal objects below the waste pile be left where they are, owing to the effort required to retrieve them.

- Demolition of the main camp by incineration and burial;

- Collection of all other wood debris, abandoned fuel and dispose of by incineration; and,

- Collection and burial of metal debris at the camp.

Prior to undertaking any work on the Clark mine site, it is recommended that the Mining Inspector for the area be contacted and asked to help determine who is responsible for sealing the adit and cleaning up the waste and debris that remain on the site from the recent exploration program. It is suggested that all responsible parties and the current claim holders be contacted prior to commencing with any reclamation activities on the site. Unless directed by the current claim holder, all boxes of drill core should be left in place, undisturbed.

8.0 REFERENCES

Bostock, H.S., 1957. Yukon Territory, Selected Field Reports of the Geological Survey of Canada 1898 to 1933. Geological Survey of Canada Memoir 284.

Canadian Council of Ministers of the Environment, 1991. Interim Canadian Environmental Quality Criteria for Contaminated Sites. The National Contaminated Sites and Remediation Program.

DIAND Technical Services, 1994. Assessment Report 106D-02-1, Clark Abandoned Mines Assessment. Indian and Northern Affairs Canada.

DIAND Exploration and Geological Services Division, 1990. Yukon Minfield # 106D 011, Clark.

Environment Canada Atmospheric Environment Service. Canadian Climate Normals. 1951-1980.

Green L.H., 1968. Geology of Mayo Lake, Scougale Creek and McQuesten Lake Map-Areas, Yukon Territory (105M/15, 106D/2, 106D/3), Geological Survey of Canada Memoir 357.

Green L.H., 1968. Geology of Nash Creek, Larsen Creek, and Dawson Map-Areas, Yukon Territory (106D, 116A, 116B, 116C (E 1/2)), Operation Ogilvie, Geological Survey of Canada Memoir 364.

Steffen, Robertson and Kirsten (BC) Inc., 1992. Mine Reclamation in Northwest Territories and Yukon. Prepared for Northern Water Resources Studies, Northern Affairs Program, DIAND. Report No. QS-8476-000-EF-A1, Minister of Supply and Services Canada.

Steffen, Robertson and Kirsten (BC) Inc. in association with B.C. Research and Development, 1992. Guidelines for ARD Prediction in the North. Prepared for Northern Mine Environmental Neutral Drainage, Department of Indian and Northern Affairs Canada. Report No.QS-8480-000-EF-A1, Minister of Supply and Services Canada.

Steffen, Robertson and Kirsten (Canada) Inc., 1996. ARD Reconnaissance Handbook. Prepared for Public Works and Government Services Canada, Pacific Region.

This report, **P118401 - Phase II Environmental Assessment of the Clark Abandoned Mine Site**, has been prepared by:

STEFFEN, ROBERTSON AND KIRSTEN (CANADA) INC.

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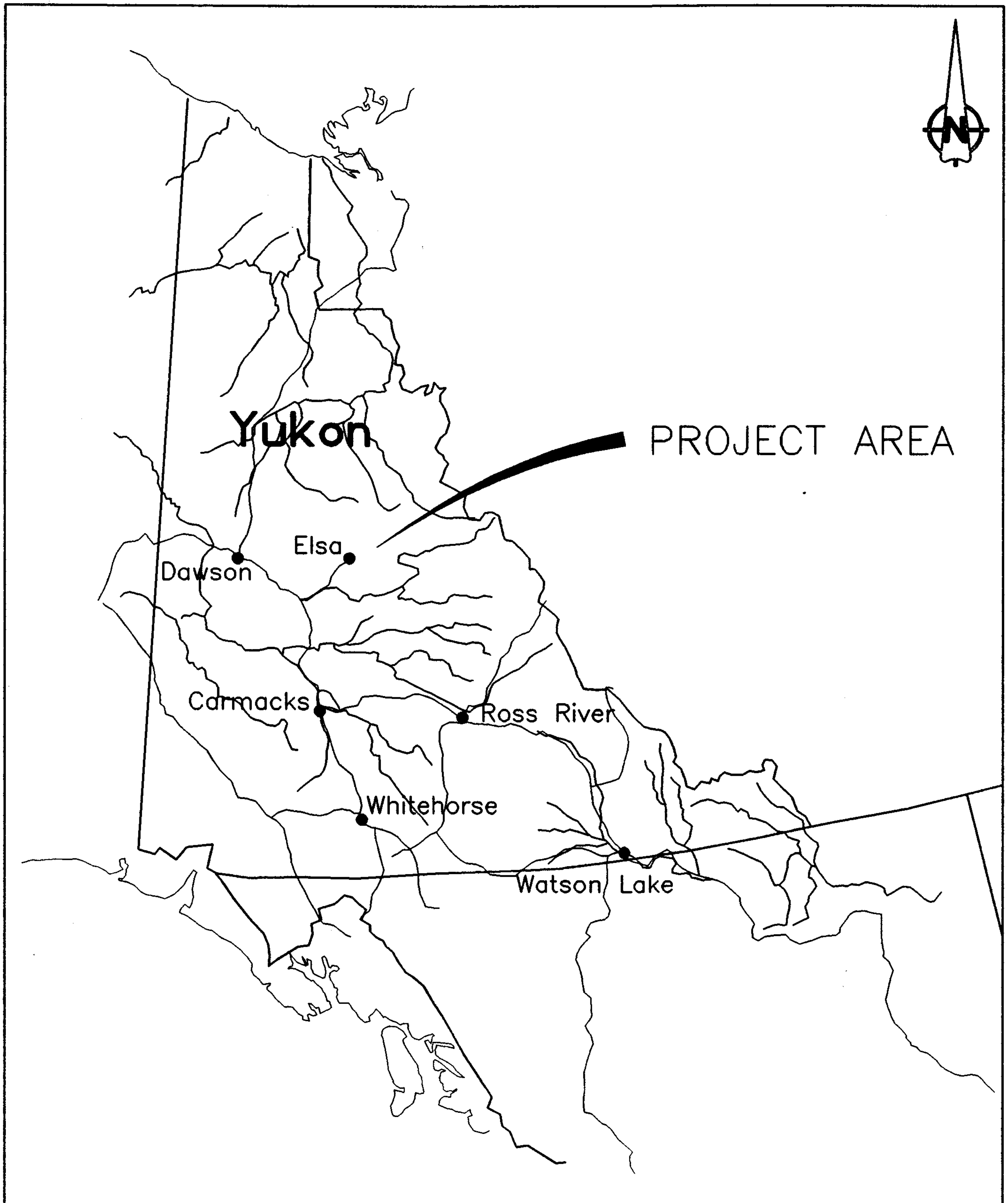
Geologist

Michael Royle, M.App.Sci.
Hydrogeologist

Daryl Hockley, P.Eng.
Senior Review

R-132/tg

FIGURES

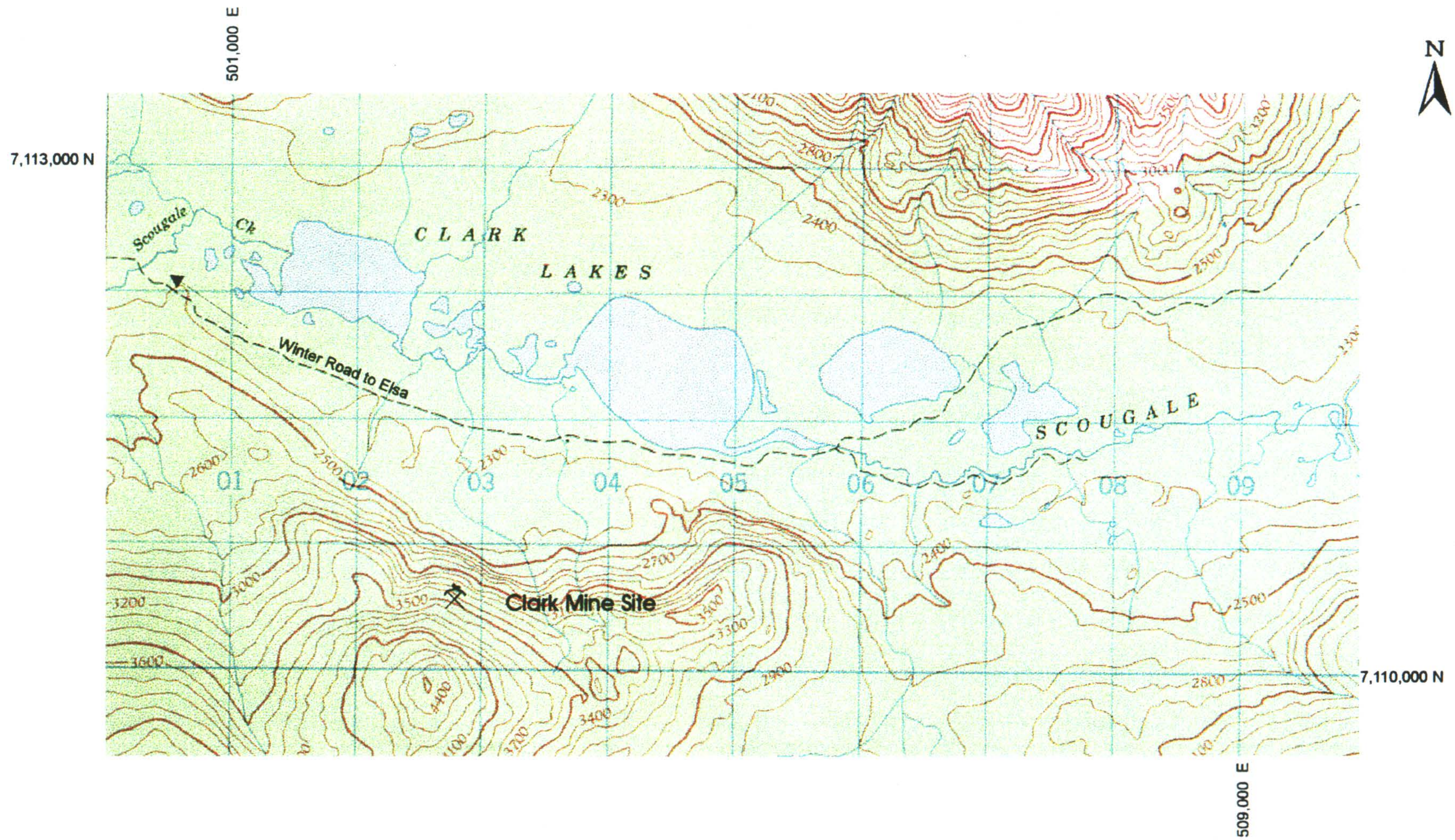


NOT TO SCALE

STEFFEN ROBERTSON AND KIRSTEN Consulting Engineers	Phase II Environmental Assessment
Public Works & Government Services	Vicinity Map

PROJECT NO.	DATE	APPROVED	FIGURE
P118401	Feb. 1997		1

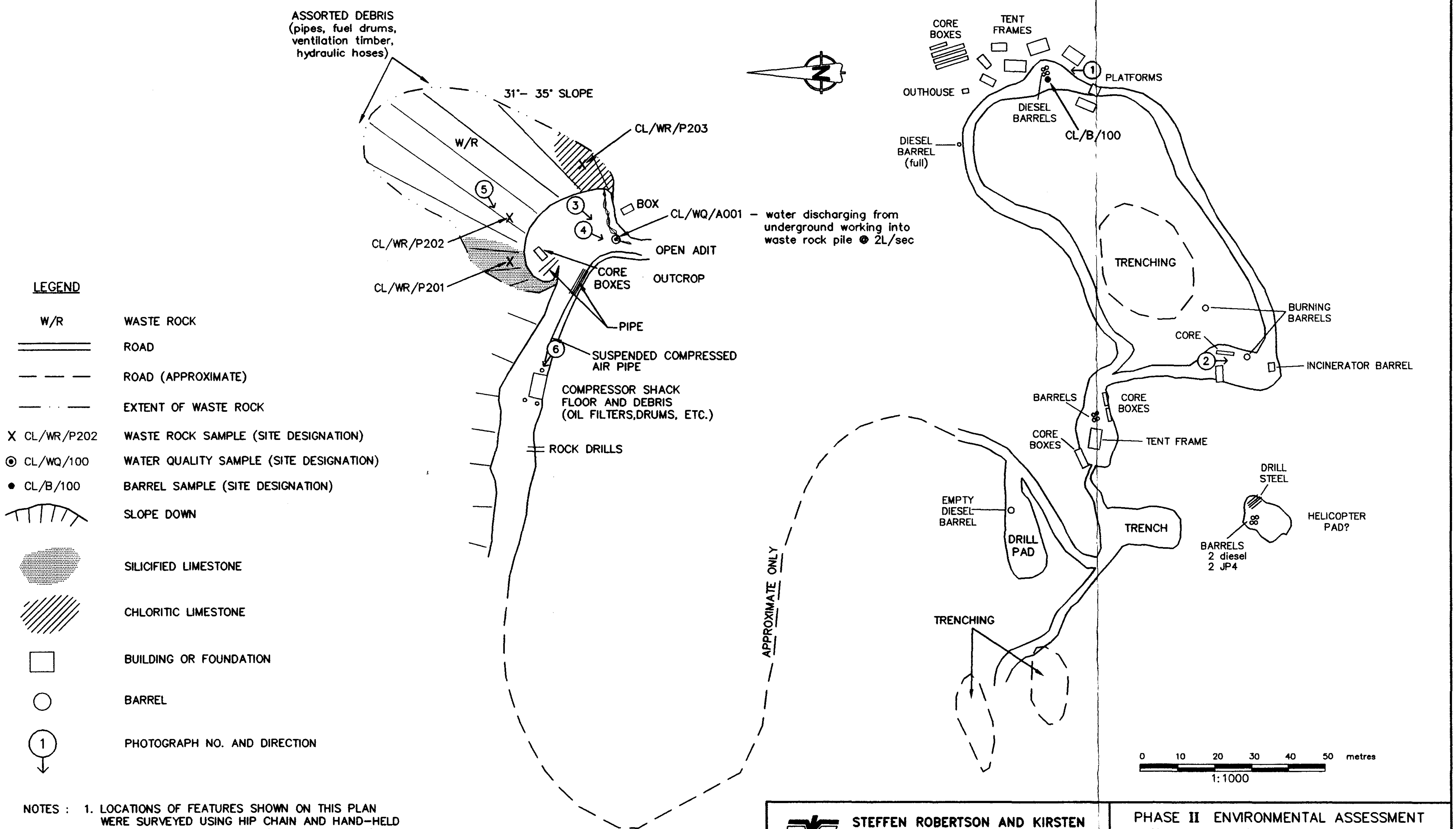
NAME: C:\PROJECTS\ENVPR\P118401\YUKON.DWG DATE: FEB 13, 1997 TIME: 4:56 AM



Scale: 1:50,000

Mapsheet: NTS 106D2

STEFFEN ROBERTSON AND KIRSTEN Consulting Engineers	**Phase II Environmental Assessment**		
Public Works and Government Services Canada	**Clark Mine Site Location Map**		
PROJECT NO. P118401	DATE Feb. 1997	APPROVED	FIGURE 2



NOTES : 1. LOCATIONS OF FEATURES SHOWN ON THIS PLAN WERE SURVEYED USING HIP CHAIN AND HAND-HELD COMPASS. ACTUAL LOCATIONS AND DIMENSIONS COULD DIFFER FROM THOSE SHOWN.

FILE REF: CLARK-1

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

PUBLIC WORKS AND GOVERNMENT SERVICES

PHASE II ENVIRONMENTAL ASSESSMENT

CLARK MINE SITE PLAN

PROJECT NO.	DATE	APPROVED	FIGURE
P118401	FEB. 1997		3

APPENDIX A

WASTE ROCK TEST RESULTS

Waste Rock Test Results

Parameter	Units	Sample Number CLWR/		
		P201	P202	P203
Field Paste pH		8.97	8.43	8.52
Field Cond	µS/cm	na	na	20
Lab Paste pH		8.79	7.90	9.39
Total Sulfur	%	0.20	1.40	0.09
Sulfate	%	0.05	0.56	0.05
AP		4.7	26.3	1.3
NP		36.5	495.6	4.9
NET NP		31.8	469.4	3.7
NP/AP		7.8	18.9	4.0
Aluminum	%	0.17	1.75	0.33
Antimony	ppm	4	125	6
Arsenic	ppm	18	38	20
Barium	ppm	31	36	14
Beryllium	ppm	<0.1	<0.1	<0.1
Bismuth	ppm	<1	<1	<1
Cadmium	ppm	<0.1	10.7	<0.1
Calcium	%	1.49	>15	0.15
Chromium	ppm	39	22	67
Cobalt	ppm	13	19	19
Copper	ppm	27	62	52
Gallium	ppm	<1	<1	<1
Iron	%	3.01	4.59	3.36
Lead	ppm	<1	>10000	<1
Lithium	ppm	24	2	53
Magnesium	%	0.90	0.95	1.02
Manganese	ppm	1278	8135	1055
Molybdenum	ppm	10	15	11
Nickel	ppm	32	56	44
Potassium	%	0.09	0.05	0.06
Phosphate	ppm	360	390	400
Silver	ppm	0.2	52.9	<0.1
Sodium	%	<0.01	<0.01	0.02
Strontium	ppm	27	595	19
Thorium	ppm	<1	<1	<1
Tin	ppm	4	8	4
Titanium	%	<0.01	<0.01	<0.01
Tungsten	ppm	<1	17	<1
Uranium	ppm	<1	<1	<1
Vanadium	ppm	12.2	6.8	12.3
Zinc	ppm	94	7922	119

AP = Acid Potential in tonnes $CaCO_3$ equivalent per 100 tonnes of material
NP = Neutralization Potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material
Net NP = Net Neutralization Potential = tonnes $CaCO_3$ equivalent per 1000 tonnes of material
na = no assay / analysis
< = lower detection limit
> = upper detection limit

CLIENT : ASL LTD.
PROJECT : PWGSC
PROJECT # : P118041
TEST : MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING

SAMPLE #	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
CL/WR/P201	8.79	0.20	0.05	4.7	36.5	31.8	7.8
CL/WR/P202	7.90	1.40	0.56	26.3	370.6	344.4	14.1
CL/WR/P203	9.39	0.09	0.05	1.3	4.9	3.7	4.0
GA/WR/P201	7.62	0.07	0.05	0.6	-1.6	-2.2	<0.1
GA/WR/P202	5.71	3.75	0.24	109.7	7.8	-101.9	<0.1
GA/WR/P203/1	5.74	1.37	0.28	34.1	9.1	-24.9	0.3
GA/WR/P203/2	4.30	1.11	0.17	29.4	2.0	-27.4	<0.1
GA/WR/P204	6.68	0.11	0.05	1.9	3.4	1.6	1.8
GA/WR/P205	7.83	0.71	0.18	16.6	111.3	94.7	6.7
GA/WR/P206	8.47	0.30	0.17	4.1	103.9	99.8	25.6
GA/WR/P207	8.46	0.70	0.16	16.9	109.0	92.1	6.5
TI/WR/P1-1	8.65	0.82	0.57	7.8	669.5	661.7	85.7

AP = ACID POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

NP = NEUTRALIZATION POTENTIAL IN TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

NET NP = NET NEUTRALIZATION POTENTIAL = TONNES CaCO3 EQUIVALENT PER 1000 TONNES OF MATERIAL.

CLIENT : ASL LTD.
PROJECT : PWGSC
PROJECT # : P118041
TEST : HEAD ICP

		CL/WR/P201	CL/WR/P202	CL/WR/P203	GA/WR/P201	GA/WR/P202	GA/WR/P203/1	GA/WR/P203/2	GA/WR/P204	GA/WR/P205	GA/WR/P206	GA/WR/P207
Ag	ppm	0.2	52.9	0.1	2.7	>200.0	108.3	17.3	>200.0	6.7	4.7	3.3
Al	%	0.17	1.75	0.33	0.22	0.23	0.16	0.46	0.7	0.7	1.7	0.9
As	ppm	18	38	20	1357	905	1135	1836	1	87	165	101
Ba	ppm	31	36	14	60	36	39	45	123	37	53	51
Be	ppm	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Bi	ppm	1	1	1	1	8	1	1	13	1	1	1
Ca	%	1.49	>15.00	0.15	0.09	0.3	0.54	0.26	0.24	2.99	3.69	3.62
Cd	ppm	0.1	10.7	0.1	0.1	>100.0	33.9	27.6	39.7	0.1	0.1	0.1
Co	ppm	13	19	19	6	9	6	3	25	27	23	20
Cr	ppm	39	22	67	142	84	92	114	52	45	95	50
Cu	ppm	27	62	52	16	635	101	20	980	39	137	56
Fe	%	3.01	4.59	3.36	1.82	4.84	3.95	2	3.13	6.66	3.56	3.93
Ga	ppm	1	1	1	1	1	1	1	1	1	1	1
K	%	0.09	0.05	0.06	0.05	0.05	0.06	0.07	0.11	0.11	0.06	0.11
Li	ppm	24	2	53	2	1	1	1	3	10	25	15
Mg	%	0.9	0.95	1.02	0.04	0.19	0.1	0.04	0.21	1.55	2.06	1.31
Mn	ppm	1278	8135	1055	372	9792	4399	940	6730	>10000	1816	3675
Mo	ppm	10	15	11	6	21	11	6	13	21	11	14
Na	%	0.01	0.01	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Ni	ppm	32	56	44	18	57	33	12	52	119	62	60
P	ppm	360	390	400	420	450	650	500	970	570	350	950
Pb	ppm	1	>10000	1	547	>10000	>10000	1142	572	633	398	122
Sb	ppm	4	125	6	9	614	127	28	715	14	1	7
Sn	ppm	4	8	4	2	8	5	2	4	10	6	5
Sr	ppm	27	595	19	17	14	13	11	14	12	20	31
Th	ppm	1	1	1	1	1	1	1	1	1	1	1
Ti	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
U	ppm	1	1	1	1	1	1	1	1	1	1	1
V	ppm	12.2	6.8	12.3	6.4	5.8	6.2	3.6	15.9	24.5	52	26.4
W	ppm	1	17	1	8	97	14	10	12	1	3	1
Zn	ppm	94	7922	119	214	>10000	5383	2088	4545	1465	1760	459

Engineering

APPENDIX B

PHOTOS

Photo 1: Main Camp, tent frames, partially filled barrels - sampled CL/B/B100, looking north. September 19, 1996.

Photo 2: Uppercamp: Core storage area and incinerator site, looking south September 19, 1996

Photo 3: Open adit, looking southwest. September 19, 1996

Photo 4: Open adit, suspended compressed air pipe, vent tubing in foreground, looking southwest. September 19, 1996.

Photo 5: Foundation of compressor station/mine services shed, air pipe and assorted debris, looking northwest. September 19, 1996

Photo 6: CLWR/P201 sample site 30 metres north of adit in silicified limestone, mineralize rock at lower left, stacked pipe, looking south-southwest. September 19, 1996

APPENDIX C

HYDROCARBON SAMPLE RESULTS
Total Organic Halogens (TOX)
and
Poly Chlorinated Biphenols (PCBs)

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : CL/B/100
Sample Date & Time : 17-09-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-1
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : October 25, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	RESULTS	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	3.0	2.

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : CL/B/100
Sample Date & Time : 17-09-96
Sampled By :
Sample Type : GRAB
Sample Station Code :

Chemex Worksheet Number : 96-07805-1
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15. 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

PARAMETER	DATE ANALYZED (DD-MM-YY)	QA/QC BATCH NUM ANAL	DUP Rr	MATRIX SPIKES RECOV %	MATRIX SPIKES CONTROL LIMITS LOWER	MATRIX SPIKES CONTROL LIMITS UPPER	CALIBRATION CHECK RECOV %	CALIBRATION CHECK CONTROL LIMITS LOWER	CALIBRATION CHECK CONTROL LIMITS UPPER
Total Organic Halogens (TOX)	25-10-96	1 RAV	N.A.	NOT APPLICABLE			103.0	80.0	120.0

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

TOX SAMPLES

Sample Description : CL/B/100
Sample Date & Time : 17-09-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-1
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 11, 1996

AROCLORS (PCBS) BY MODIFIED EPA METHOD 8081

COMPONENT	CONCENTRATION	UNIT	MDL
Aroclor 1016	< 0.3	mg/Kg	0.3
Aroclor 1221	< 0.3	mg/Kg	0.3
Aroclor 1232	< 0.3	mg/Kg	0.3
Aroclor 1242	< 0.3	mg/Kg	0.3
Aroclor 1248	< 0.3	mg/Kg	0.3
Aroclor 1254	< 0.3	mg/Kg	0.3
Aroclor 1260	< 0.3	mg/Kg	0.3
Aroclor 1262	< 0.3	mg/Kg	0.3
Aroclor 1268	< 0.3	mg/Kg	0.3

NOTES :

Results are reported in accordance with CCME guidelines, "Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites, Volume I". All results are corrected for blank levels.

MDL - Method detection level. - Calculated on the basis of the instrument detection level, the dilution used, and the weight of the sample.

( ) - Bracketed results are values below the reliable detection level, and are subject to reduced levels of confidence. The reliable detection level is twice the method detection level.

QA/QC SUMMARY

All samples were spiked with a component whose recovery was monitored to maintain analysis accuracy. Guidelines from SW846 for suggested surrogate recoveries for each matrix are shown below.

Surrogate Recovery : 76% LIQUID surrogate limits : 63% - 134%.

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468
Edmonton : 9331 - 48th Street, T6B 2R4, Telephone (403) 465-9877, FAX (403) 466-3332

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : CL/B/100
Sample Date & Time : 17-09-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-1
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 11, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

BATCH : 11	BLANK	DUPLICATE			MATRIX SPIKE			CALIBRATION CHECK		
DATE : November 11, 1996	CONC.	CONC.1	CONC.2	RPD	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMITS	
ANALYST:AAM	mg/Kg	mg/Kg	mg/Kg	%	%	LOWER	UPPER	%	LOWER	UPPER
Aroclor 1016	< 0.2	< 0.3	< 0.3	0						
Aroclor 1221	< 0.2	< 0.3	< 0.3	0						
Aroclor 1232	< 0.2	< 0.3	< 0.3	0						
Aroclor 1242	< 0.2	< 0.3	< 0.3	0						
Aroclor 1248	< 0.2	< 0.3	< 0.3	0						
Aroclor 1254	< 0.2	< 0.3	< 0.3	0	100	64.	130.	94	80.	130.
Aroclor 1260	< 0.2	< 0.3	< 0.3	0				70	61.	120.
Aroclor 1262	< 0.2	< 0.3	< 0.3	0						
Aroclor 1268	< 0.2	< 0.3	< 0.3	0						

APPENDIX D

WATER QUALITY ANALYTICAL RESULTS

Water Quality Results - Clark Site

Sample ID. / Sample Date	CL/WQ/A001 / 18-Sep-96	CCME Freshwater Aquatic Life
Physical Tests		
Conductivity (umhos/cm)	317	NA
Hardness (as $CaCO_3$)	157	NA
pH	8.08	6.5 - 9.0
Dissolved Anions		
Acidity (as $CaCO_3$)	1.0	NA
Alkalinity - Total (as $CaCO_3$)	116	NA
Sulphate (as SO_4)	52.7	NA
Total Metals		
Aluminum T-Al	0.023	0.005 to 0.1 *
Arsenic T-As	0.0002	0.05
Barium T-Ba	0.01	NA
Beryllium T-Be	<0.005	NA
Boron T-B	<0.1	NA
Cadmium T-Cd	0.0024	0.002 to 0.018 *
Calcium T-Ca	49.6	NA
Chromium T-Cr	<0.001	NA
Cobalt T-Co	<0.02	NA
Copper T-Cu	0.002	0.002 to 0.004 *
Iron T-Fe	<0.03	0.3
Lead T-Pb	0.004	0.001 to 0.007
Lithium T-Li	<0.02	NA
Magnesium T-Mg	8.09	NA
Manganese T-Mn	0.011	NA
Mercury T-Hg	<0.00005	0.0001
Molybdenum T-Mo	<0.03	NA
Nickel T-Ni	<0.02	0.025 to 0.150
Selenium T-Se	0.0006	0.001
Silver T-Ag	<0.0001	0.0001
Sodium T-NA	<2	NA
Vanadium T-V	<0.03	NA
Zinc T-Zn	**0.319**	0.03

NOTES:

CCME = Canadian Council of Resource and Environmental Ministers
All concentrations are in mg/L unless stated otherwise.
0.004 = number in bold exceeds CCME criteria for parameter listed

str = stream sample
S = seep sample
A = adit sample

Aluminum: 0.1 mg/L if pH >6.5, Ca^{2+} >4.0 mg/L, and DOC >2.0 mg/L
Cadmium: 0.013 mg/L if hardness is 120 - 180 mg/L $CaCO_3$
Chromium: 0.02 mg/L to protect fish and 0.002 mg/L to protect aquatic life, including zooplankton and phytoplankton
Copper: 0.003 mg/L if hardness is 120 - 180 mg/L $CaCO_3$
Lead: 0.004 mg/L if hardness is 120 - 180 mg/L $CaCO_3$
Nickel: 0.110 mg/L if hardness is 120 - 180 mg/L $CaCO_3$

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5
analytical service laboratories ltd.
FAX: (604) 253-6700 TEL: (604) 253-4188

CHEMICAL ANALYSIS REPORT

Date:	October 9, 1996
ASL File No.	G5281
Report On:	P118401 Water Analysis
Report To:	**Public Works & Gov't Services** Environmental Services 204-1166 Alberni Street Vancouver, BC V6E 3W5
Attention:	**Mr. Tim Sackmann**, Manager, Contaminated Sites
Received:	September 23, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc.
Project Chemist

Frederick Chen, B.Sc.
Supervisor, Trace Metals Lab

cc: Mr. Michael Royle - SRK Vancouver

Canada's 50 Best Managed Private Companies

RESULTS OF ANALYSIS - Water File No. G5281

			GA/WQ/ Str001	GA/WQ/ Str002	GA/WQ/ Str003	GA/WQ/ Str004	GA/WQ/ Str005
			96 09 18	96 09 18	96 09 18	96 09 18	96 09 18
Physical Tests							
Conductivity (umhos/cm)			371	456	792	36.0	186
Hardness		CaCO3	166	228	396	13.1	85.3
pH			7.69	7.95	6.99	6.52	7.53
Dissolved Anions							
Acidity		CaCO3	2.0	2.0	7.1	6.1	1.0
Alkalinity - Total		CaCO3	42.5	73.2	12.7	7.1	49.4
Sulphate	SO4		131	143	403	8.3	42.4
Total Metals							
Aluminum	T-Al		0.111	0.337	0.138	0.008	0.246
Arsenic	T-As		0.0048	0.0009	0.0113	0.0001	0.0002
Barium	T-Ba		0.03	0.05	0.02	0.02	0.02
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		0.0040	<0.0002	0.0238	<0.0002	<0.0002
Calcium	T-Ca		46.5	70.9	88.6	3.52	25.9
Chromium	T-Cr		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	T-Co		<0.02	<0.02	<0.02	<0.02	<0.02
Copper	T-Cu		0.003	<0.001	0.003	<0.001	<0.001
Iron	T-Fe		0.32	0.04	0.23	<0.03	<0.03
Lead	T-Pb		0.091	<0.001	0.074	<0.001	<0.001
Lithium	T-Li		<0.02	0.05	<0.02	<0.02	0.03
Magnesium	T-Mg		12.0	12.3	42.6	1.06	4.97
Manganese	T-Mn		0.142	<0.005	1.43	<0.005	<0.005
Mercury	T-Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	0.03	<0.02	<0.02
Selenium	T-Se		0.0012	0.0014	0.0020	0.0006	0.0006
Silver	T-Ag		0.0005	<0.0001	0.0008	<0.0001	<0.0001
Sodium	T-Na		<2	<2	<2	<2	<2
Vanadium	T-V		<0.03	<0.03	<0.03	<0.03	<0.03
Zinc	T-Zn		0.350	0.008	3.58	0.009	<0.005

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

RESULTS OF ANALYSIS - Water

File No. G5281

			GA/WQ/ S100	GA/WQ/ S101	CL/WQ/ A001
			96 09 18	96 09 18	96 09 18
Physical Tests					
Conductivity (umhos/cm)			79.2	282	317
Hardness		CaCO3	26.0	135	157
pH			6.99	7.79	8.08
Dissolved Anions					
Acidity		CaCO3	3.1	1.0	1.0
Alkalinity - Total		CaCO3	4.9	94.4	116
Sulphate	SO4		22.4	52.2	52.7
Total Metals					
Aluminum	T-Al		0.140	0.044	0.023
Arsenic	T-As		0.0738	0.0018	0.0002
Barium	T-Ba		<0.01	<0.01	0.01
Beryllium	T-Be		<0.005	<0.005	<0.005
Boron	T-B		<0.1	<0.1	<0.1
Cadmium	T-Cd		0.0114	<0.0002	0.0024
Calcium	T-Ca		7.94	39.0	49.6
Chromium	T-Cr		<0.001	<0.001	<0.001
Cobalt	T-Co		<0.02	<0.02	<0.02
Copper	T-Cu		0.014	0.001	0.002
Iron	T-Fe		1.07	0.15	<0.03
Lead	T-Pb		0.805	0.003	0.004
Lithium	T-Li		<0.02	<0.02	<0.02
Magnesium	T-Mg		1.50	9.12	8.09
Manganese	T-Mn		0.275	0.012	0.011
Mercury	T-Hg		<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	<0.02
Selenium	T-Se		0.0006	0.0008	0.0006
Silver	T-Ag		0.0040	<0.0001	<0.0001
Sodium	T-Na		<2	<2	<2
Vanadium	T-V		<0.03	<0.03	<0.03
Zinc	T-Zn		1.05	0.006	0.319

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

Appendix 1 - QUALITY CONTROL - Replicates

File No. G5281

Water			GA/WQ/ Str003	GA/WQ/ Str003
			96 09 18	QC # 73596
Physical Tests				
Conductivity (umhos/cm)			792	792
Hardness		CaCO3	396	407
pH			6.99	6.99
Dissolved Anions				
Acidity		CaCO3	7.1	6.1
Alkalinity - Total		CaCO3	12.7	12.5
Sulphate	SO4		403	411
Total Metals				
Aluminum	T-Al		0.138	0.136
Arsenic	T-As		0.0113	0.0113
Barium	T-Ba		0.02	0.02
Beryllium	T-Be		<0.005	<0.005
Boron	T-B		<0.1	<0.1
Cadmium	T-Cd		0.0238	0.0233
Calcium	T-Ca		88.6	91.0
Chromium	T-Cr		<0.001	<0.001
Cobalt	T-Co		<0.02	<0.02
Copper	T-Cu		0.003	0.003
Iron	T-Fe		0.23	0.24
Lead	T-Pb		0.074	0.073
Lithium	T-Li		<0.02	<0.02
Magnesium	T-Mg		42.6	43.5
Manganese	T-Mn		1.43	1.47
Mercury	T-Hg		<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03
Nickel	T-Ni		0.03	0.03
Selenium	T-Se		0.0020	0.0019
Silver	T-Ag		0.0008	0.0008
Sodium	T-Na		<2	<2
Vanadium	T-V		<0.03	<0.03
Zinc	T-Zn		3.58	3.67

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

Appendix 2 - METHODOLOGY | File No. G5281

Outlines of the methodologies utilized for the analysis of the samples submitted are as follows:

Conventional Parameters in Water

These analyses are carried out in accordance with procedures described in "Methods for Chemical Analysis of Water and Wastes" (USEPA), "Manual for the Chemical Analysis of Water, Wastewaters, Sediments and Biological Tissues" (BCMOE), and/or "Standard Methods for the Examination of Water and Wastewater" (APHA). Further details are available on request.

Metals in Water

This analysis is carried out in accordance with procedures described in "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 published by the United States Environmental Protection Agency (EPA). The procedures may involve preliminary sample treatment by acid digestion or filtration (EPA Method 3005), followed by instrumental analysis by atomic absorption spectrophotometry (EPA Method 7000), inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010), and/or inductively coupled plasma - mass spectrometry (EPA Method 6020).

Mercury in Water

This analysis is carried out using procedures adapted from "Standard Methods for the Examination of Water and Wastewater" 19th Edition 1995 published by the American Public Health Association. A cold-oxidation procedure involving bromine monochloride is used, followed by instrumental analysis by cold-vapour atomic absorption spectrophotometry (CVAAS).

End of Report