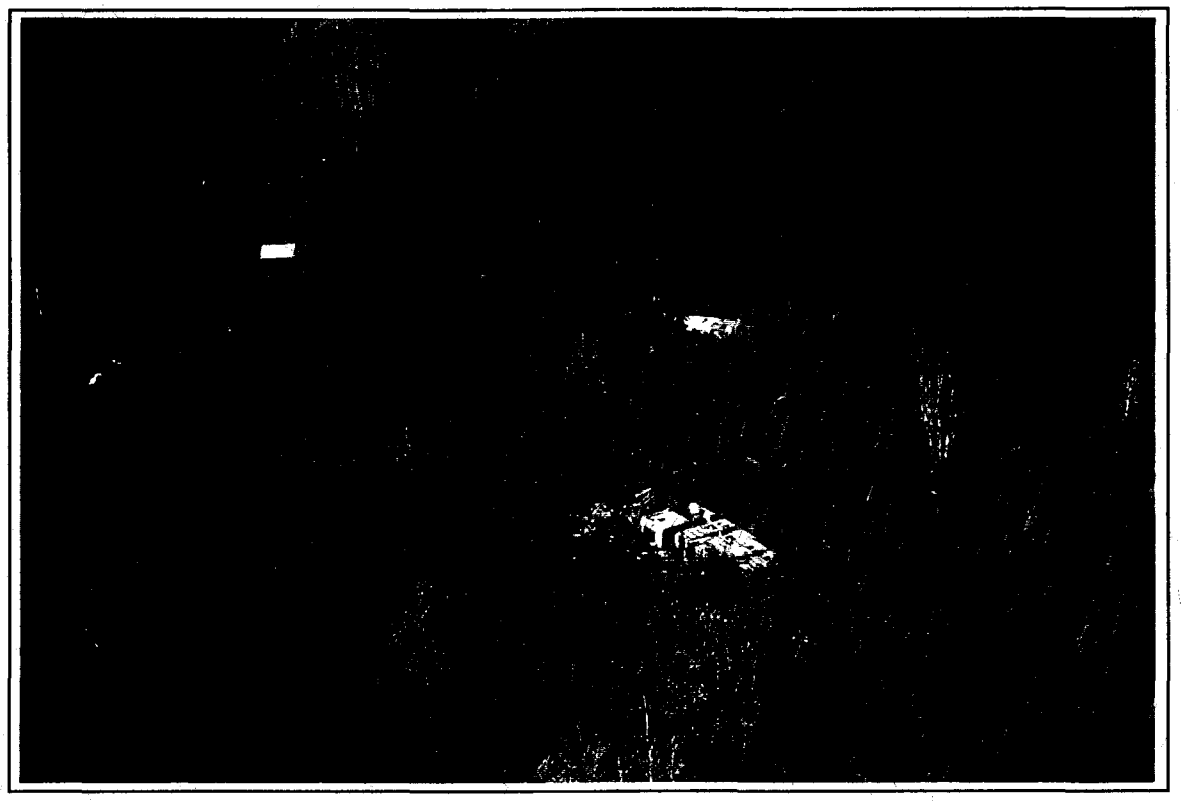
MN-075

PWGSC

Quality in Environmental Services

PHASE II ENVIRONMENTAL ASSESSMENT OF THE SOURDOUGH (COAL CREEK) ABANDONED MINE SITE



prepared for:

Action on Waste Program
Indian and Northern Affairs Canada

prepared by:

Environmental Services
Public Works and Government Services Canada

March 1997

Public Works and Government Services Canada
Travaux publics et Services gouvernementaux Canada

Canada

Printed on recycled paper

PHASE II ENVIRONMENTAL ASSESSMENT OF THE SOURDOUGH (COAL CREEK)

ABANDONED MINE SITE

prepared for:

Action on Waste Program
Indian and Northern Affairs Canada

prepared by:

Environmental Services
Public Works and Government Services Canada

March, 1997

EXECUTIVE SUMMARY

A phase II environmental assessment was conducted at the Sourdough abandoned mine site (64° 27'27" N, 140° 06'59" W) in August, 1996 by Environmental Services, Public Works and Government Services Canada for the Action on Waste Program, Indian and Northern Affairs Canada. Based on the findings of the Phase I investigation performed in 1993 by DIAND Technical Services, a phase II assessment was conducted to a) identify potential environmental and human health risks associated with the present condition of the mine site, and b) provide recommendations and preliminary cost estimates for remediation of those risks.

A field investigation of the abandoned mine site was conducted to evaluate environmental and human safety concerns with respect to: mine openings and workings; buildings and infrastructure; waste disposal areas; waste rock disposal areas; surface water (including adit and waste rock seepage, and receiving waters); and hazardous and non-hazardous materials on the site.

The results of the investigation concluded that two buildings pose potential health and safety hazards and are not adequately secured from public and wildlife access. An assessment of the acid rock drainage potential shows that the risk to the environment due to the presence of waste rock and adits are currently insignificant. Aesthetic concerns arise from two steel boiler units, collected timbers from collapsed buildings, and miscellaneous metal debris scattered primarily near former buildings.

Using applicable federal and territorial criteria as well as northern mine reclamation guidelines, the recommendation is to restrict access to the two potentially dangerous structures, by erecting fencing around the powerhouse facility and by placing warning signs on the log residence. Due to the isolated location of the site and the heavy vegetative cover, mobilizing equipment to remove or dispose of the remainder of the site debris is not economically feasible. No further test work is recommended on the waste rock.

Table 1: Summary of Potential Hazards at the Sourdough Mine Site

Assessment Component	Risk	Recommendation
1. Building, Infrastructure, Equipment		
Powerhouse, foundations and sumps	Health and Safety Concern	Fenced off and signed to alert of possible danger
Log residence (unstable)	Health and Safety Concern	Signed to alert of possible danger
4 - Collapsed buildings and misc. sheds	Aesthetic Concern	None
2. Non-Hazardous Waste Material		
2 - Boiler units	Aesthetic Concern	None
Rail ore cars (wooden)	Aesthetic Concern	None
Timbers	Aesthetic Concern	None
Misc. Metal Debris	Aesthetic Concern	None
3. Hazardous Materials		
None		
4. Water Quality		
Mine Seepage	None	
Site Drainage	None	
Receiving Waters	Minor environmental risk	None
5. Waste Rock Disposal Areas		
4 - small piles	Minor environmental risk	No action
6. Mine Openings		
None	None	
7. Tailings		
None	None	

TABLE OF CONTENTS

TABLE OF CONTENTS (Cont.)

1.0 INTRODUCTION AND BACKGROUND

In 1993, 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 were intended to provide a general overview of historical activities, describe site infrastructure, workings and wastes, describe existing environmental or safety concerns on each site, and provide general recommendations for remediation or mitigation work, as appropriate.

The 1993 report for the Sourdough abandoned mine site identified the potential safety hazards due to site debris and unstable infrastructure as the only issue requiring further investigation. No rock, soil or water samples were collected in this assessment.

In light of these preliminary findings, Indian and Northern Affairs Canada determined that further investigation was warranted. Environmental Services, Public Works and Government Services Canada was retained to conduct an environmental assessment of the Sourdough abandoned mine site to a) identify specific environmental and human safety risks; b) provide clean-up recommendations; and c) provide a Class "D" cost estimate for remediation or mitigation of those risks.

1.1 LOCATION

The Sourdough abandoned mine site is located at 64^0 27'27" N latitude and 140^0 06'59" W longitude approximately 56 km northwest of the community of Dawson. The site is in a low lying area of the Tintina Trench, south of Coal Creek and north of Fifteenmile River. The site is approximately 450 m above sea level.

1.2 OVERVIEW OF SITE DEVELOPMENT

The property was discovered in 1888. The coal mine consisted of a 19.3 km railway from the Yukon River and a 149 m decline (DIAND, 1994). The mine operated from 1903 to 1913.

1.3 SITE ACCESS

The site is only accessible by helicopter.

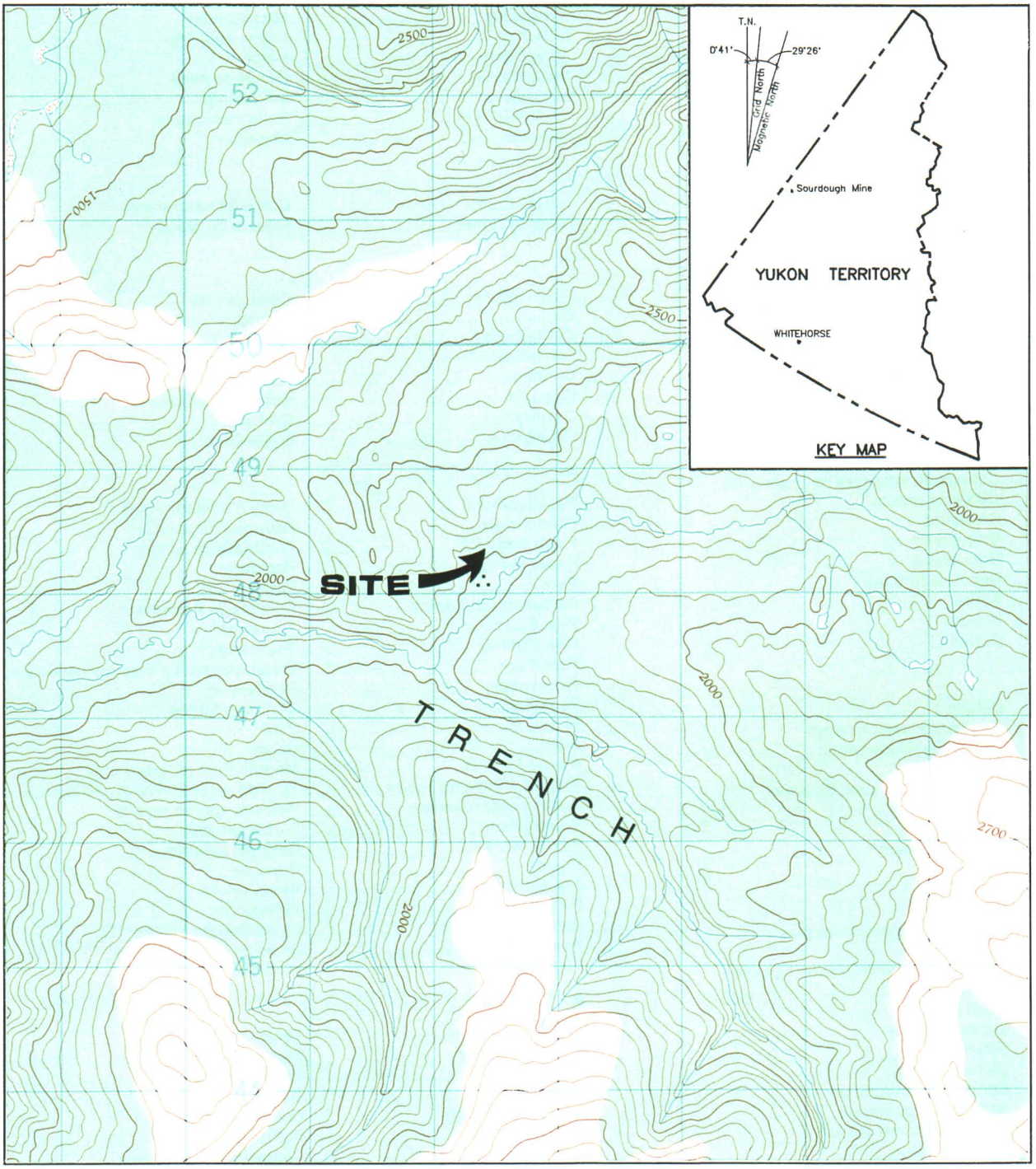


Figure 1. Location of Sourdough Mine - 1:50,000, NTS-116 C/8 [Energy Mines and Resources Canada: 1986]

2.0 PURPOSE AND SCOPE OF WORK

The following assessment activities were completed, where appropriate, during site investigations:

- 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 adit and waste rock seepage, and receiving waters) and barrel contents;
- Identification and inventory of hazardous and non-hazardous materials on the site;
- Identification of potential or actual environmental pathways and receptors for site contaminants; and
- Assessment of human safety hazards and potential for accidental or deliberate access to hazardous areas.

Upon completion of these activities, preliminary cost estimates were generated to meet the following remediation/mitigation requirements:

- Physical stabilization of waste rock disposal areas;
- Chemical stabilization of the waste rock disposal areas as appropriate to local and background conditions, taking into account impact, on-site resources, and accessibility;
- Sealing of all mine openings;
- Consolidation and landfill of all non-hazardous, non-combustible solid wastes;
- Remediation or removal and disposal of contaminated soils as required to meet the more stringent of: Yukon Government's Contaminated Sites Regulations (1996) Schedule 1; and Canadian Council of Ministers of the Environment's Interim Canadian Environmental Quality Criteria for Contaminated Sites (1991) Commercial/Industrial criteria for soils;
- Removal and disposal of hazardous solid wastes;
- Draining, cleaning and disposal of drums or other containers containing petroleum products or other liquid hazardous wastes;
- Onsite 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 approved location

3.0 SITE ASSESSMENT METHODOLOGY

3.1 ASSUMPTIONS

The assessment was limited to the area specifically developed or occupied for exploration or mining purposes, and adjacent areas and resources believed to be affected by these activities. Water samples were taken off-site to determine potential impact to surface water bodies due to mining activities. Access roadways to mine sites were not included in the assessments.

3.2 ASSESSMENT CRITERIA

3.2.1 Criteria and Guidelines

Metal Mining Liquid Effluent Regulations and Guidelines (Environmental Protection Service, Environment Canada, 1977)

The intent of the requirements defined in this document is to limit the discharge of deleterious substances from base-metal, uranium and iron ore mines. These requirements are uniformly applied national standards and intended to provide protection for fish and other aquatic life.

Interim Canadian Environmental Quality Criteria for Contaminated Sites (Canadian Council of Ministers of the Environment, 1992)

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.

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 used as clean-up benchmarks based upon intended land use. Remediation criteria 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 three land uses:

1) Agricultural,
2) Residential/Parkland, and

3) Commercial/Industrial.

Remediation criteria for water are classified by four uses of water likely of concern at contaminated sites:

1) Freshwater aquatic life,
2) Irrigation,
3) Livestock watering, and
4) Drinking water.

Contaminated Sites Regulations (draft) (Yukon Government, 1996)

According to these draft regulations a site is contaminated if it used for agricultural, commercial, industrial, parkland, or residential land use and contains a substance in concentration greater than or equal to:

(I) the generic numerical soil standard of Schedule 1, or
(ii) the matrix (pathway specific) numerical soil standards of Schedule 2

and, surface or groundwater used for aquatic life, irrigation, livestock, or drinking water which exceeds a concentration greater than or equal to:

(I) the generic numerical water standard of Schedule 3, or
(ii) the local background concentration of that substance in the soil, surface water, or groundwater.

Below 3 metres of the surface, commercial land use criteria is applicable.

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;
- special mines such as uranium, sand and gravel, and coal;
- waste rock and tailings disposal;
- acid generation and leaching; and
- estimating cleanup costs.

3.2.2 Application of Criteria and Guidelines

For the Sourdough abandoned mine site assessment the following criteria were used:

A. Soils:

CCME:	Remediation Criteria for Soil - Commercial/Industrial standard
YUKON RENEWABLE RESOURCES:	Draft Contaminated Sites Regulations - used for hydrocarbon screening parameters

B. Water:

ENVIR. CANADA:	Metal Mining Liquid Effluent Regulations and Guidelines - are compared to seepage from mine openings, and river/stream water quality
BACKGROUND:	Downstream water quality results of rivers and streams are compared to results of upstream (background) water quality
CCME:	Remediation Criteria for Water - Freshwater Aquatic Life guideline for river and stream water quality

[Note: In this screening assessment of water quality, analytical results are primarily compared to background values which may more accurately characterize the local environment.]

C. Mine Clean-Up and Reclamation:

INAC:	Mine Reclamation in Northwest Territories and Yukon

3.3 METHODS

3.3.1 Background Information

Available background information was consolidated from the Yukon Chamber of

Mines mine records, Whitehorse Public Library, Yukon Archives holdings, and records and reports from the Yukon Renewable Resources Library, Yukon Water Board, DIAND Lands Branch, DIAND Water Resources, and DIAND Library. INAC (1994) provided an overview assessment of the Sourdough abandoned mine site to that date. Other published information sources were examined for site or regional information as applicable. On the basis of available information, knowledge gaps regarding existing or potential safety and environmental risks at the site were identified and a site assessment plan was developed.

3.3.2 Site Assessment Components

A site assessment was conducted to identify existing or potential safety and environmental risks on the site. The assessment included the following components, as applicable:

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

- Identifying waste rock mineralization with potential to release acidic and/or metal-contaminated drainage
- Mapping and logging waste rock, tailings, pit walls and rock faces
- Collecting and field testing representative samples of mine wastes

Mine Openings were inspected and documented to identify closure requirements.

Non-Hazardous Site Debris was inventoried.

Contaminated Soil Areas were measured and sampled to determine the degree and type of contamination and estimate soil volumes for remediation.

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

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

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

Scale site plans were prepared to identify the dimensions and locations site structures, mine workings and adits, waste rock disposal areas, on-site sampling locations, and any other pertinent information.

3.3.3 Sampling Methods and Quality Assurance

Test Pit Sampling

Test pits were excavated to a depth of about 0.3 to 1.0 m. 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 marked 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 down with a cleaned shovel. All rock larger than 75 mm in size was discarded. The sample was coned and quartered, discarding opposite quarters, until a 2 kg sample was obtained.

For test pit walls showing clearly-distinguishable 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/or adits.

250 ml water samples were collected by hand, facing upstream, ensuring that the sample is 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 destined for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled to minimize head space, placed in a cooler, and maintained at 4° C until delivery to the laboratory.

Soil Sampling

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 observations of

significance.

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 "Whirl-Pak" bags. All samples were placed in a cooler for shipment to the laboratory.

Barrel, Pail, and Above-Ground Storage Tank Sampling

Barrels and pails containing hydrocarbons were sampled with 1.2 m clean hollow glass rods ("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 at least 20-30 ml of product was obtained. The vial was then sealed and placed in a container for shipment to the laboratory. Each used drum thief rod was subsequently destroyed to prevent accidental re-use.

One Above-Ground Storage Tank (AST) was sampled with a stainless steel Bacon bomb sampler. A plunger at the tip of the sampler depressed when contact with the tank bottom was made, allowing petroleum product to enter the body of the sampler. When the sampler was raised, the plunger closed to seal the sampler and allow removal of the sample from the AST. The sampled hydrocarbon was then drained into a 40-ml laboratory-cleaned vial which was then sealed and placed in a container for shipment to the laboratory. The bomb sampler was cleaned with laboratory-grade detergent between sampling events.

Since hydrocarbon samples were collected only for analyses of Total Halides and metals, no cooling or other preservative was required.

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 labeling 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.

4.0 ENVIRONMENTAL SETTING

4.1 MINERALIZATION

The commodity of interest at the Sourdough mine site is coal. Tertiary strata in the Coal Creek area contains four known coal seams.

4.2 SURFACE HYDROLOGY

Both site and regional drainage are to the south, draining into a small tributary to Coal Creek and, subsequently, the Yukon River (see Figure 1). Hydrological and water quality data are not available for the Sourdough mine stream.

No seepage from the waste rock piles was detected, however the site topography lends itself to seepage through the waste rock piles as a result of site drainage and site infiltration from precipitation.

4.3 CLIMATE

The closest climatological information is from the town of Clinton Creek (64° 28'N, 140° 44'W at 576 m in 1990: Environment, Canada 1990). Total annual precipitation is approximately 370 mm. This consists of 225 mm of rainfall and 145 mm of snowfall, with the highest snowfall in December and the highest rainfall in August. Temperatures typically range from -27.1 ^{0} C in January to 14.9 ^{0} C in July. Data on the mean annual temperature is unavailable.

4.4 VEGETATION

Sourdough mine site occurs within the Klondike Plateau ecoregion. Warmer boreal areas within the Klondike Plateau are characterized by open stands of black and white spruce with some aspen and, occasionally, lodgepole pine. Vegetation on slopes underlain by permafrost include black spruce and paper birch. In valley areas, scrub birch and willow form large stands, while balsam poplar is found along floodplains.

4.5 FISH AND WILDLIFE RESOURCES

Typical mammals in the area include grizzly and black bear, Dall's sheep, caribou, moose, wolf, beaver, fox and hare. Typical bird species include raven, rock and willow ptarmigan, and golden eagle.

4.6 SITE TOPOGRAPHY AND SOILS

The soil development in this ecoregion is dominated by turbic cryosols and eutric brunisols with eutric regosols occurring on floodplains.

4.7 PERMAFROST

Sourdough is in an area of discontinuous permafrost. No evidence of permafrost was discovered during the site visit.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 BUILDING, INFRASTRUCTURE, EQUIPMENT

Remnants of several structures were observed at the site. All buildings have either collapsed or will do so in the near future. A summary of the buildings, infrastructure and equipment observed at Sourdough Mine is listed in Table 2.

Table 2: Buildings, Infrastructure and Equipment

Item	Size	Location	Comments
1) Cookhouse	17m X 25m	Along edge of creek at centre of site	Collapsed, untreated wood, contains misc. kitchen metal waste
2) Bunkhouse	16m X 12m	Immed. southwest of cookhouse	Collapsed, rotting timbers
3) Log Residence	8m X 7m X 7m	Approx. 25m west of bunkhouse	Unstable structure, 2 storey, minor debris surrounding
4) Maintenance Building & Shed	15m X 15m (2m X 3m)	Approx. 15m southwest of log residence	Collapsed, contains many pipes, beside 5m long boiler, shed next to waste rock
5) Warehouse	12m X 7m	Southwest of Maint. Bldg. at terminus of right-of-way (r.o.w.) for railcars	Collapsed, metal clad roof
6) Powerhouse	Approx. 10m X 35m	Approx. 50m east of landing area	Extremely poor shape, badly degraded concrete, several foundations surround facility, two sump structures surround north and east sides
7) Shed	3m X 2.5m	Across creek, near powerhouse	Metal clad roof, trough-like structure inside

5.2 NON-HAZARDOUS WASTE MATERIALS

The non-hazardous waste material observed in and around the site is listed in Table 3.

Table 3 Non-Hazardous Waste Materials

Waste Material	Number/ Volume	Location	Comments
Riveted boiler units	2	1) 5m X 1m at maint. bldg, 2) 9m X 2m along railway r.o.w.	Empty, rendered unusable
Rail ore cars	6	Along end of railway r.o.w.	Primarily wood, most undercarriages removed
Rail pump car	1	10m east of bunkhouse	Fair condition, possible heritage value
Collected wood debris	<75 m^3	West of Powerhouse	Three piles of wood from collapsed buildings
Misc. wood debris	<20 m^3	Scattered around site and around old buildings	Non-preserved, burnable
Misc. metal debris	<10 m^3	Scattered around site and near cookhouse & log residence	Non-burnable and rusted
Cement bags	<6 m^3	Approx. 20m NW of Powerhouse	Decaying bags piled together

5.3 HAZARDOUS MATERIALS

No hazardous materials were observed at the site.

5.4 SURFACE WATER QUALITY

Two water samples were taken in the tributary to Coal Creek, one upstream of the mine site and one downstream. Table 4 identifies the significant findings of the sampling program conducted to determine the potential impact of the site to surface water bodies. The upstream background sample was taken to represent the background condition to which the downstream sample results will be compared. Field measurements of pH and conductivity were taken. Complete analytical results are provided in Appendix B.

There is little difference in the quality of the water upstream and downstream of the minesite. The stream water is alkaline (pH=8) with the conductivity below 300 μS/cm. Iron concentrations were approximately 0.17 mg/L and strontium concentrations were 0.3 mg/L. Concentrations of all other metals were low, however the detection limits are higher than the CCME guidelines.

Table 4 Surface Water Samples - Significant Results

Sample ID	Sample Location	pH	Conductivity (μS/cm)	Metals	Other
SD/WQ-STR1-1	Downstream approx. 200m of site	8.33 (7.9)	270 (250)	Moderate Fe; other metals low	Sulphate= 18 mg/L
SD/WQ-STR1-2	Upstream approx. 50m of site	8.02 (8.5)	281 (250)	Moderate Fe; other metals low	Sulphate= 18 mg/L

Note: pH and conductivity readings in parentheses are field measurements; values not in parentheses are lab measurements.

5.5 WASTE ROCK DISPOSAL AREAS

Three waste rock piles and one coal stockpile were found on the site. Other waste and ore piles may be present and hidden in the thick bush covering the area. The coal was composed of sand to cobble sized particles. The waste was composed primarily of shale with rare pieces of coal. The total amount of waste and ore on site is approximately 4039 tonnes (4452 tons).

A pit was dug into each pile and a sample collected. The samples were submitted for Acid Base Accounting (ABA) tests and determination of metals by Inductively Coupled Plasma - Atomic Emission Spectrophotometry (ICP-AES).

Results of these analyses are presented in Appendix B. Sample P1 had a paste pH of 7.8 and a paste conductivity of 250 μS/cm. The total sulphur concentration was 0.11%, the lowest of all of the samples collected at the site. This material had high neutralizing potential and was net acid consuming (NP/AP=11).

Samples P2, P3 and P4 all had acidic paste pH values (range=4.6 to 5.8). Paste conductivities were low, ranging from 10 μS/cm to 60 μS/cm. All three samples were potentially acid generating with NP/AP ratios less than zero. Metal concentrations were low, generally below those in sample P1.

5.6 MINE OPENINGS AND EXCAVATIONS

There were no mine openings or excavations found on site.

5.7 TAILINGS

No milling of ore was done on site. Therefore, no tailings are present.

6.0 CONCLUSIONS

The primary concern at Sourdough Mine is the health and safety of humans and wildlife relating to the collapsing buildings. Aesthetic concerns relating to the numerous collapsed buildings are minor given the remoteness of the site and the high degree of revegetation.

6.1 HEALTH AND SAFETY

The Powerhouse structure and the log residence are physically unstable and pose a health and safety hazard to humans. The concrete walls and roof of the powerhouse are deteriorating rapidly, exposing steel support beams and columns. Two concrete sumps are open. The log residence appears unstable and should not be entered.

6.2 ENVIRONMENTAL RISKS

Much of the waste rock at the site (represented by samples P2 and P3) and the coal pile (P4) are currently generating acid, as indicated by the acidic paste pH values. However, no seeps were seen coming from the piles and none of the piles are close to the Coal Creek tributary. In addition, the material has been exposed since at least 1913 with little apparent negative impact on nearby stream water or vegetation. As a result, there does not appear to be a significant risk to the environment at this time.

6.3 AESTHETIC CONCERNS

The waste piles and collapsed building sites present no aesthetic concerns as they are beginning to become overgrown with the same thick vegetative cover that blankets the rest of the mine site.

7.0 RECOMMENDATIONS

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

Due to the remoteness of the site and the fact that heavy equipment can not be brought to the mine without disturbing the vegetative cover that has reclaimed much of the site, limited work is recommended. The remaining unstable buildings should be secured from human and animal access for health and safety reasons. In the case of the Powerhouse and surrounding area, it should be fenced and posted with warning signs. The log residence may collapse shortly and should simply be posted with warning signs advising of the danger of entering. Wood and metal debris scattered around the site pose only minor aesthetic concerns that do not require any action.

8.0 COST ESTIMATES TO IMPLEMENT RECOMMENDATIONS

The estimated cost to implement the recommendations is provided under separate cover.

REFERENCES

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, 1993. Assessment Report, 116 C-08-2, Sourdough Abandoned Mine Assessment. Prepared for Indian and Northern Affairs Canada.

Ecological Stratification Working Group, November, 1996. A National Ecological Framework for Canada. Produced by Centre for Land and Biological Resources Research and Research Branch, Agriculture and Agri-Food Canada; and, State of the Environment Directorate, Environmental Conservation Service, Environment Canada.

Energy, Mines & Resources. 1974, National Atlas of Canada. 4th Edition.

Environment Canada Atmospheric Environment Service. Canadian Climate Normals. 1961-1990.

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

Environmental Protection and Assessment Branch, June 1996. Draft, Contaminated Sites Regulations. Yukon Renewable Resources.

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

Yukon Minfile Report, No. 116C 031.

APPENDIX A

SITE PHOTOGRAPHS

SOURDOUGH (COAL CREEK)

Photographic Record

August 15, 1996

Photos	Description
S. # 1	Overview of Sourdough Mine from west
S. # 2	Remnants of Cookhouse
S. # 3	Cookhouse Structure
S. # 4	Bunkhouse
S. # 5	Rail Push Car
S. # 6	Log Residence
S. # 7	Interior of Log Residence
S. # 8	Maintenance Building (Collapsed)
S. # 9	Boiler Unit near Maintenance Building
S. # 10	Coal Waste Pile (SD-WR-P1-1)
S. # 11	Rail Ore Cars
S. # 12	Large Boiler Unit along Railway R.O.W.
S. # 13	Warehouse Building (Collapsed)
S. # 14	Downstream Water Quality Sample (SD-WQ-STR1-1)
S. # 15	View of Powerhouse from southeast
S. # 16	Powerhouse Structure
S. # 17	Powerhouse Structure
S. # 18	Top of Powerhouse Facility
S. # 19	Typical Sump Structure near Powerhouse
S. # 20	Collected Wood Debris west of Powerhouse
S. # 21	Shed across Stream, near Powerhouse

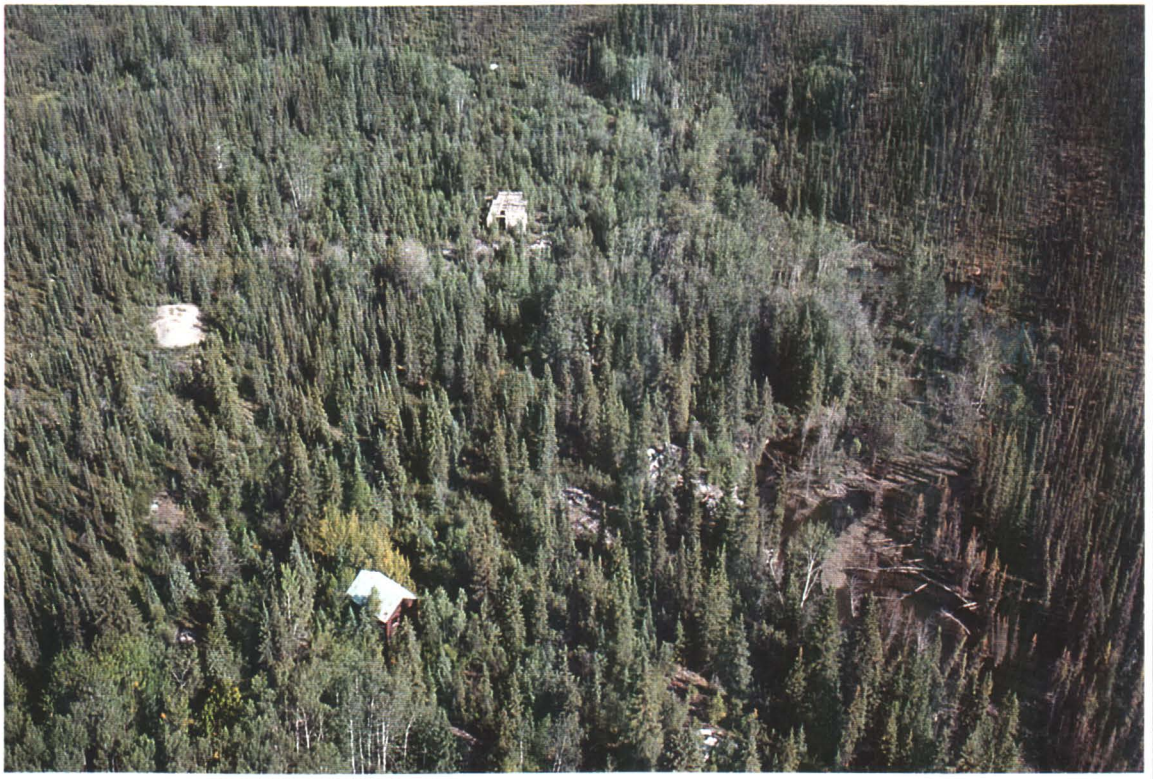


Photo # 1 - Overview of Sourdough Mine from west

Photo # 2 - Remnants of Cookhouse

Photo # 3 - Cookhouse Structure

Photo # 4 - Bunkhouse

Photo # 5 - Rail Push Car

Photo # 6 - Log Residence

Photo # 7 - Interior of Log Residence

Photo # 8 - Maintenance Building (Collapsed)

Photo # 9 - Boiler Unit near Maintenance Building

Photo # 10 - Coal Waste Pile (SD-WR-P1-1)

Photo # 11 - Rail Ore Cars

Photo # 12 - Large Boiler Unit along Railway R.O.W.

Photo # 13 - Warehouse Building (Collapsed)

Photo # 14 - Downstream Water Quality Sample (SD-WQ-STR1-1)

Photo # 15 - View of Powerhouse from southeast

Photo # 16 - Powerhouse Structure

Photo # 17 - Powerhouse Structure

Photo # 18 - Top of Powerhouse Facility

Photo # 19 - Typical Sump Structure near Powerhouse

Photo # 20 - Collected Wood Debris west of Powerhouse

Photo # 21 - Shed across Stream, near Powerhouse

APPENDIX B

ANALYTICAL RESULTS

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: September 13, 1996

ASL File No. G4225

Report On: Soil And 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: August 19, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Heather A. Ross, B.Sc.
Project Chemist

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

REMARKS

File No. G4225

The Acid Base Accounting of the rock samples were subcontracted to BC Research Inc. Please refer to the attached subconsultants report for details.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4225

		CN-WR-P1-1	CN-WR-P2-1	CL-WR-P1-1	SC-WR-P1-1	CA-WR-P1-1
		96 08 13	96 08 13	96 08 13	96 08 14	96 08 11
Physical Tests						
Moisture	%	9.5	8.7	7.6	7.4	4.1
Total Metals						
Antimony	T-Sb	48	61	<20	<20	<20
Arsenic	T-As	871	2050	52.1	63.9	44.5
Barium	T-Ba	50	161	22	127	14
Beryllium	T-Be	0.6	0.8	<0.5	<0.5	<0.5
Cadmium	T-Cd	4	2	<2	<2	<2
Chromium	T-Cr	3	6	229	22	20
Cobalt	T-Co	5	7	89	12	110
Copper	T-Cu	588	407	3	94	737
Lead	T-Pb	5270	3870	<50	<50	<50
Mercury	T-Hg	0.099	0.054	0.640	0.225	0.025
Molybdenum	T-Mo	127	101	<4	14	<4
Nickel	T-Ni	<2	3	1930	56	2140
Selenium	T-Se	<20	<20	<20	<20	<20
Silver	T-Ag	5	21	<2	2	<2
Tin	T-Sn	<30	<30	<30	<30	<30
Vanadium	T-V	18	32	<2	34	34
Zinc	T-Zn	491	254	5	222	90

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4225

		SD-WR-P4-1	SD-WR-P3-1	SD-WR-P2-1	SD-WR-P1-1	CA-WR-P2-1
		96 08 15	96 08 15	96 08 15	96 08 15	96 08 11
Physical Tests						
Moisture	%	17.7	21.4	22.6	13.7	7.4
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	<40
Arsenic	T-As	7.14	8.28	6.95	21.9	17.7
Barium	T-Ba	27	25	38	111	17
Beryllium	T-Be	1.5	4.2	1.5	1.0	<1
Cadmium	T-Cd	<2	<2	<2	<2	<4
Chromium	T-Cr	2	6	3	52	19
Cobalt	T-Co	<2	3	3	21	158
Copper	T-Cu	9	14	11	43	2590
Lead	T-Pb	<50	<50	<50	<50	<100
Mercury	T-Hg	0.150	0.077	0.234	1.26	0.052
Molybdenum	T-Mo	<4	<4	<4	<4	<8
Nickel	T-Ni	13	19	16	90	6510
Selenium	T-Se	<20	<20	<20	<20	<20
Silver	T-Ag	<2	<2	<2	<2	<4
Tin	T-Sn	<30	<30	<30	<30	<60
Vanadium	T-V	15	17	14	52	32
Zinc	T-Zn	15	22	40	135	342

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

Appendix 1 - QUALITY CONTROL - Replicates

File No. G4225

Sediment/Soil[1]		SD-WR-P2-1 96 08 15	SD-WR-P2-1 QC # 70641
Physical Tests			
Moisture	%	22.6	24.1
Total Metals			
Antimony	T-Sb	<20	<20
Arsenic	T-As	6.95	5.14
Barium	T-Ba	38	50
Beryllium	T-Be	1.5	1.9
Cadmium	T-Cd	<2	<2
Chromium	T-Cr	3	4
Cobalt	T-Co	3	3
Copper	T-Cu	11	15
Lead	T-Pb	<50	<50
Mercury	T-Hg	0.234	0.296
Molybdenum	T-Mo	<4	<4
Nickel	T-Ni	16	20
Selenium	T-Se	1.2	1.1
Silver	T-Ag	<2	<2
Tin	T-Sn	<30	<30
Vanadium	T-V	14	17
Zinc	T-Zn	40	54

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. G4225

			CL-WQ-STR-1	SD-WQ-STR1-1	CL-WQ-STR-2	SD-WQ-STR1-2
			96 08 13	96 08 15	96 08 13	96 08 15
Physical Tests						
Conductivity (umhos/cm)			535	281	548	270
pH			8.04	8.02	8.17	8.33
Dissolved Anions						
Acidity		CaCO3	4.4	4.4	<1.0	<1.0
Alkalinity - Total		CaCO3	143	134	148	132
Sulphate	SO4		135	18.9	138	18.2
Total Metals						
Aluminum	T-Al		<0.2	<0.2	<0.2	<0.2
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.06	0.06	0.06	0.06
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi		<0.1	<0.1	<0.1	<0.1
Boron	T-B		<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.01	<0.01	<0.01	<0.01
Calcium	T-Ca		69.5	34.1	66.1	33.6
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.01	<0.01	<0.01	<0.01
Iron	T-Fe		<0.03	0.16	0.09	0.17
Lead	T-Pb		<0.05	<0.05	<0.05	<0.05
Lithium	T-Li		<0.01	<0.01	<0.01	<0.01
Magnesium	T-Mg		26.0	12.4	27.5	11.9
Manganese	T-Mn		0.005	0.036	0.008	0.025
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	<0.02	<0.02
Phosphorus	T-P		<0.3	<0.3	<0.3	<0.3
Potassium	T-K		<2	<2	2	<2
Selenium	T-Se		<0.2	<0.2	<0.2	<0.2
Silicon	T-Si		3.02	2.80	2.93	2.77
Silver	T-Ag		<0.01	<0.01	<0.01	<0.01
Sodium	T-Na		3	6	4	5
Strontium	T-Sr		0.402	0.305	0.379	0.303
Thallium	T-Tl		<0.1	<0.1	<0.1	<0.1
Tin	T-Sn		<0.03	<0.03	<0.03	<0.03
Titanium	T-Ti		<0.01	<0.01	<0.01	<0.01
Vanadium	T-V		<0.03	<0.03	<0.03	<0.03

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).

RESULTS OF ANALYSIS - Water[1]

File No. G4225

		CL-WQ-STR-1	SD-WQ-STR1-1	CL-WQ-STR-2	SD-WQ-STR1-2
		96 08 13	96 08 15	96 08 13	96 08 15
Total Metals					
Zinc	T-Zn	<0.005	<0.005	<0.005	<0.005

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).

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

Moisture

This analysis is carried out gravimetrically by drying the sample to constant weight at 103 C.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050 or Method 3051, published by the United States Environmental Protection Agency (EPA). The procedures involve a digestion using a 1:1 ratio of nitric acid and hydrochloric acid, along with hotplate or microwave heating. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010).

Method Limitation: The stated acid digestion will provide excellent results for total recoverable metals; however, it is only partially effective on mineralized or non-environmentally available metals.

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).

End of Report

APPENDIX

RESULTS OF SUBCONTRACTED ANALYSES

BCRI

September 9, 1996
File: 2-21-900

Mr. Fred Chen
ASL Ltd.
1988 Triumph St.
Vancouver, B.C.
V6C 2V6

Dear Fred:

Subject: ***Results of Acid Base Accounting of Soil Samples.***

Below are the results of acid base accounting of 10 soil samples received August 21, 1996. Samples G4225-1, G4225-5, G4225-6, G4225-7, G4225-8 and G4225-10 are potential net acid producers. All remaining samples are net acid consumers.

Results of Acid Base Accounting:

Sample ID	Paste pH	Total Sulphur (Wt. %)	Maximum Potential Acidity (kg $CaCO_3$/tonne)	Neutralization Potential (kg $CaCO_3$/tonne)	Net Neutralization Potential (kg $CaCO_3$/tonne)
G4225-1	5.7	0.52	16.3	2.0	-14.3
G4225-2	5.4	0.14	4.4	5.0	0.6
G4225-3	9.0	0.02	0.6	422.8	422.2
G4225-4	8.1	0.17	5.3	71.4	66.1
G4225-5	5.4	1.17	36.6	3.7 / 3.2*	-32.9
G4225-6	3.2	0.74	23.1	-20.8	-43.9
G4225-7	4.8	0.30/0.30*	9.4	-3.4	-12.8
G4225-8	4.1	0.62	19.4	-16.9	-36.3
G4225-9	7.7	0.11	3.4	37.2	33.8
G4225-10	5.6	2.22	69.4	19.5	-49.9

*Duplicate analysis.

The analysis were carried out according to Sobek A. et al., EPA-600/2-78-054, March, 1978. Total cost for this work is $700.00, based on our price of $70 per sample. Please find enclosed our invoice for $700.00 plus GST. Thank you for using BCRI.

Sincerely,
BCRI

Tim O'Hearn, P.Eng.
Mine Waste & Drainage
Environmental Services and Technology

BC Research Inc.
3650 Wesbrook Mall
Vancouver, BC
Canada V6S 2L2

Canada
Tel: (604) 224-4331
Fax: (604) 224-0540

USA
Tel: (360) 738-0958
Fax: (360) 733-3590

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

analytical service laboratories ltd.
Specialists in Environmental Chemistry
1988 Triumph Street
Vancouver, BC
Canada V5L 1K5
FAX: (604) 253-6700
TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT Public Works Canada

PAGE 1 OF 2

ASL CONTACT

CLIENT PROJECT #

PO #

PH/FAX# 403-497-3846/497-3996

CONTACT Ed Donigan

DATE SUBMITTED Aug 16/96

SAMPLED BY " "

RESULTS REQUIRED BY

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	DATE/TIME SAMPLED (Y M D)	FIELD PRESERVATION	Metals by ICP	ABA acid-base	TM	IMM	COMMENTS
	CN-WR-P1-1	Rock	96 08 13	NO	✓	✓			
	CN-WR-P2-1	"	96 08 13	NO	✓	✓			
	CL-WR-P1-1	"	96 08 13	"	✓	✓			
	SC-WR-P1-1	"	96 08 14	"	✓	✓			
	CA-WR-P1-1	"	96 08 11	"	✓	✓			
	SD-WR-P4-1	"	96 08 15	"	✓	✓			
	SD-WR-P3-1	"	96 08 15	"	✓	✓			
	SD-WR-P2-1	"	96 08 15	"	✓	✓			
	SD-WR-P1-1	"	96 08 15	"	✓	✓			
	CA-WR-P2-1	"	96 08 11	"	✓	✓			
	CL-WQ-STR-1 (IMM)	Water	96 08 13					✓	
	CL-WQ-STR-1 (TM)	"	96 08 13	Nitric Acid			✓		
	SD-WQ-STR1-1 (IMM)	"	96 08 15	None				✓	
	SD-WQ-STR1-1 (TM)	"	96 08 15	Nitric Acid			✓		

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN
COLD
AMBIENT
TOTAL PACKAGES

RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y M D : AM PM	Y M D : AM PM
AFFILIATION		

CHAIN OF CUSTODY / ANALYTICAL REQUEST FORM

analytical service laboratories ltd.
Specialists in Environmental Chemistry
1988 Triumph Street
Vancouver, BC
Canada V5L 1K5
FAX: (604) 253-6700
TEL: (604) 253-4188
TOLL FREE: (800) 665-0243

CLIENT Public Works Canada

PAGE 2 OF 2

ASL CONTACT

CLIENT PROJECT #

PO #

PH/FAX# (403) 497-3846 / 497-3796

CONTACT Ed Domjan

DATE SUBMITTED Aug 16/96

SAMPLED BY Ed Domjan

RESULTS REQUIRED BY

ANALYSIS REQUESTED

LAB USE	SAMPLE IDENTIFICATION	SAMPLE TYPE	DATE/TIME SAMPLED (Y M D)	FIELD PRESERVATION	TM	IMM	COMMENTS
	CL-WQ-STR-2 (IMM)	Water	96 08 13	None		✓	
	CL-WQ-STR-2 (TM)	"	96 08 13	Nitric Acid	✓		
	SD-WQ-STR1-2 (IMM)	"	96 08 15	None		✓	
	SD-WQ-STR1-2 (TM)	"	96 08 15	Nitric Acid	✓		

NOTES/COMMENTS

CONDITION RECEIVED
FROZEN
COLD
AMBIENT
TOTAL PACKAGES

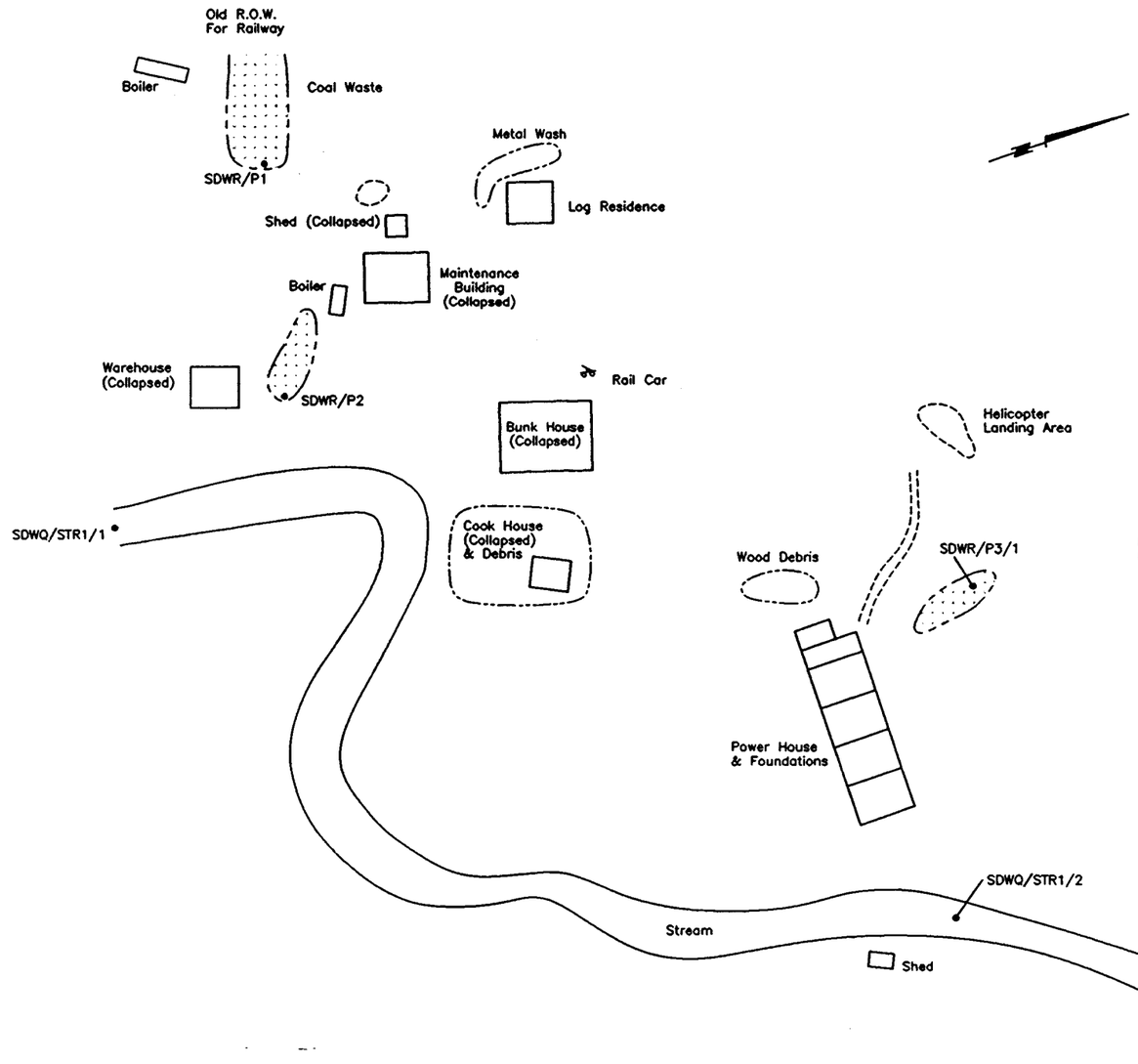
RELINQUISHED BY		
AFFILIATION		
RECEIVED BY	Y M D	Y M D
AFFILIATION	: AM PM	: AM PM

APPENDIX C

DRAWINGS

Legend

W/R	Waste Rock
	Road
	Extent Of Waste Rock
• SDWQ/A3/1	Water Quality Sample (site designation)
• SDWR/P1	Waste Rock (site designation)
	Coal Waste
	Buildings
	Extent of Debris, Timber, Cable, Pipe, etc.



Approx. Scale: 1:1000

PLOT: 1=1
CAD FILE: INVEN-96\SOUDOUGH\SOUDOU-1

Public Works And Government Services Canada	Travaux publics et Services gouvernementaux Canada	designed by: / conçu par: — date:
Architectural & Engineering Services Western Region		drawn by: / dessiné par:
		approved by: / approuvé par:
Drawing title: / Titre du dessin: Sourdough (Coal Creek) Mine Site Development & Geological Information Yukon Territory		revisions:
		project no. / No. du projet: 626967 — dwg. no. / dessin no.: 1 of 1