MN-002

PWGSC

Quality in Environmental Services

PHASE II ENVIRONMENTAL ASSESSMENT OF THE ARCTIC CARIBOU 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

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EXECUTIVE SUMMARY

A phase II environmental assessment was conducted at the Arctic Caribou abandoned mine site (60^0 05'19" N, 134^0 41'53" W) in July, 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 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 the mine opening is not adequately secured from public access. An erosion gully has formed through the waste rock which will cause additional erosion to the slope. An assessment of the acid rock drainage potential for the waste rock and adit shows that some of the rock is currently acid generating, however, there has been little impact on the adjacent stream's water quality. Two barrels at the site also contained significant volumes of contaminated petroleum hydrocarbons and present some risk to the environment. Aesthetic concerns arise from three buildings, rail track, pipe and assorted metal and wood debris at the site.

Using applicable federal and territorial criteria as well as northern mine reclamation guidelines, the recommendations are to secure the mine openings using surrounding rock and soil, demolish and burn buildings, rail timbers and other wood waste and to collect these ashes and bury with the rails, pipe and remaining metal waste on site. The barrels and contents should be removed from the site and disposed of as hazardous waste.

No further test work is recommended on the waste rock. Additional water quality sampling is required to monitor the impact of the acid generating waste on the receiving environment. It is recommended that every three years a monitoring program be undertaken to obtain water quality data for spring freshet, middle summer and late fall conditions.

Table 1: Summary of Potential Hazards at Arctic Caribou Mine Site

ASSESSMENT COMPONENT	RISK	RECOMMENDATION
1. Building, Infrastructure, Equipment		
3 Buildings	Health and safety concern	Burn and bury on site
Track	Aesthetic concern	Cut and bury on site
2. Non-Hazardous Waste Material		
Rails / pipe / sleigh	Aesthetic concern	Cut and bury in waste rock
Ore sample in boxes	Aesthetic concern	Bury in waste rock
Core sample boxes	Aesthetic concern	Bury in waste rock
3. Hazardous Materials		
2 barrels with product	Health and safety concern	Remove and ship to hazardous waste facility
4. Water Quality		
Mine Seepage - Yes	Low environmental risk	Monitor (3 years)
Site Drainage - None		
Receiving Waters - downstream of local stream	Low environmental risk	Monitor (3 years)
5. Waste Rock Disposal Areas		
Waste Rock - ARD potential	Low environmental risk	None
High arsenic and metals - small vol.	Low environmental risk	None
Poor stability	Health and safety concern	Re-contour below adit and riprap
6. Mine Openings		
1 Adit - open	Health and safety risk	Backfill with waste rock
7. Tailings		
None		

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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 and/or mitigation work, as appropriate.

At the Arctic Caribou abandoned mine site, the 1993 report recommended further investigation into possible environmental impacts resulting from the previous mining activities. According to this report, the potential areas of concern included: a safety concern at the unsecured mine adit; an environmental concern regarding erosion of the steeply sloped waste rock pile and tote roads leading to the trench sites; and aesthetic concerns with regard to the buildings and other metal wastes noted at the site. No rock, tailings, soil or water samples were collected in this assessment.

In light of these preliminary findings, Indian and Northern Affairs Canada has determined that further investigation is warranted. Environmental Services, Public Works and Government Services Canada was retained to conduct an environmental assessment of the Arctic Caribou abandoned mine site to a) identify specific environmental and human safety risks; and b) provide clean-up recommendations.

1.1 LOCATION

The Arctic Caribou abandoned mine site is located at 60° 05'19"N latitude and 134° 41'53"W longitude. It is located 8 km south of the village of Carcross between Brute Mountain and Sugarloaf Hill in the Boundary Ranges (Coast Mountains). The site is between 1500 and 1550 m above sea level.

1.2 OVERVIEW OF SITE DEVELOPMENT

The site is also known as the Peerless or lower camp. It was originally part of the old Big Thing property and the Arctic Caribou Mine. The claims encompass the original lower workings of the Big Thing property, including part of the 707 m (2,320 foot) 5100-Level adit, several irregular crosscuts, drifts and two long raises, driven from the northwest side of Sugarloaf Hill during the years 1905 to 1912. Assuming that the rock has a specific gravity of 2.65 and that the adit is 10 feet by 8 feet, it is estimated that more than 14,000 tonnes (15,500 tons) of waste rock were produced

Figure 1. **Location of Arctic Caribou Mine - 1:50,000, NTS-105 D/2 [Energy Mines and Resources Canada: 1986]**

from the 5100-Level adit. Between 1915 and 1916 the workings were rehabilitated, additional drifts were developed and a raise branched off one of the existing raises.

In 1967 was constructed in 1967. The Arctic Gold and Silver Mill operated from May to December in 1968 and March to October in 1969 and treated 50,751 tonnes (55,826 tons).

The Arctic Caribou/Peerless/lower camp adit is currently covered by the Barb claims. The Barb claims were staked in 1985 for Feather Gold Resources Ltd.

1.3 SITE ACCESS

The site is accessible by road from the South Klondike Highway at the south end of the Nares River bridge. It is adjacent to and is covered by the same claims as 105D-02-2, the abandoned Big Thing mine site.

2.0 PURPOSE AND SCOPE OF WORK

The following assessment activities were completed:

- 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, recommendations 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

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

According to these draft regulations a site is contaminated if it is 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 m of the surface, commercial land use criteria is applicable.

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.

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.

Barrel Clean Up Protocol, (INAC, 1992)

See Appendix E for protocol on testing and cleaning of barrels and contents.

3.2.2 Application of Criteria and Guidelines

For the Arctic Caribou 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:

ENVIRONMENT 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 the results of upstream (background) water quality (where (available)

CCME: Remediation Criteria for Water - Freshwater Aquatic Life standard

[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 Territory

D. Barrels Clean-Up:

INAC: Barrel Clean Up Protocol

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 Arctic Caribou 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:

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 of 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 was not contaminated by disturbed sediment, debris and other floating materials. Sample bottles were rinsed three times with water from the sample stream prior to collecting the sample.

2 ml of HNO_3 were immediately added to water samples 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 Sampling

Barrels 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.

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

Approximately 20 polymetallic, gold-bearing quartz veins are hosted in rocks of the mid-Cretaceous Montana Mountain volcanic complex and Montana pluton along an 8 km, northwest-trending belt between Windy Arm and Brute Mountain.

The gold and silver ores occur in a series of northeast striking quartz veins that cut medium to coarse grained, locally porphyritic granodiorite. The granodiorite is part of a larger stock that probably extends north to Carcross. Sulphide mineralization consists chiefly of pyrite, arsenopyrite, sphalerite, galena and minor chalcopyrite occurring in irregular lenses and shoots within quartz vein material. The vein

structures are commonly bordered by a selvage zone of altered granodiorite, consisting of bleaching and pyritization extending up to 9.1 m (30 ft) either side of the vein. Weakly disseminated molybdenite is sometimes present in the alteration envelope.

The major commodities identified at this site are gold and silver. Minor commodities include lead, zinc, copper, and molybdenum.

4.2 SURFACE HYDROLOGY

Both the site and regional drainage are to the north draining into MacDonald Creek and subsequently into Lake Bennet to the west (see Figure 1).

Hydrological and water quality data are not available for the unnamed first order stream running below the Arctic Caribou mine site.

Small seepage volumes (1 L/sec) were evident from the adit and drain towards the stream. No seepage from the waste rock piles was detected, however obvious erosion paths were evident below the waste rock.

4.3 CLIMATE

The closest climatological information is from the town of Carcross, 60° 11' N, 134° 41' W; 663 m above sea level (Environment Canada, 1980). Total annual precipitation is 211.4 mm. This consists of 118.7 mm of rainfall and 101.3 mm of snowfall. Highest levels of rainfall occur in August and highest levels of snowfall occur in January. Temperatures range from -19.4° C in January to 12.7° C in July. The mean annual temperature is -1.4° C. Due to its higher elevation it is assumed that Arctic Caribou experiences colder temperatures.

4.4 VEGETATION

Arctic Caribou mine site occurs within the Stikine Highlands ecoregion. Alpine tundra dominates at higher elevations including the area of the mine site, with vegetation including scrub heather, dwarf birch, willow species, grass and lichen. At lower elevations, on the access road to the site, the subalpine ecosystem is dominated by white spruce, alpine fir and white birch. Much of the area surrounding the access road consists of second growth birch and alder and appears to have been cleared in the past.

4.5 FISH AND WILDLIFE RESOURCES

Typical carnivores in the area include grizzly and black bear and wolf. Arctic ground squirrel, pika and hoary marmot are common rodents noted at the site. Bird species representative of this alpine habitat include several ptarmigan species and rosy finch. A number of raptors hunt and nest in the area, and waterfowl such as mergansers and harlequin ducks are found in the rivers at lower elevations.

4.6 SITE TOPOGRAPHY AND SOILS

The soils within the Yukon Stikine Highlands ecoregion are predominantly brunisolic and regosolic. Occasionally, cryosolic soils, dystric brunisols and eutric brunisols are also found.

The site is located on the east side of an alpine valley. The valley is approximately 750 m wide and first order stream runs north along the broad valley floor. The south end of the valley is closed and limits the cross flow of winds through the site. The east and west sides of the valley are high vegetated hills with few rock outcroppings. The site slopes noticeably towards the north.

4.7 PERMAFROST

Arctic Caribou is in an area of discontinuous permafrost. No evidence of permafrost was discovered during the site visit and is not likely to affect project components.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 BUILDING, INFRASTRUCTURE, EQUIPMENT

The buildings, infrastructure and equipment observed in and around the site are listed in Table 2.

Table 2: Buildings, Infrastructure and Equipment

Inventoried Material	Number/ Volume	Location	Comments
4.5 m x 4.5 m shack	1	building area below and north of waste rock pile	collapsing wood construction; wood debris inside
5.5 m x 4.1 m living quarters	1	building area	log construction; tin roof; wood debris inside
2 m x 2.8 m shack (outhouse)	1	building area	wood frame and tar paper; wood debris and pails inside
track	100 m	exiting from adit	partially collapsed over eroded waste rock
core sample boxes	10 m x 10 m	building area	poor condition

5.2 NON-HAZARDOUS WASTE MATERIALS

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

Table 3: Non-Hazardous Waste Materials

Waste Material	Number/Volume	Location
wood debris from collapsed building	< 5 m^3	building area adj. to core sample boxes
empty spool, metals and wood debris	< 3 m^3	building area adj. to living quarters
wood debris	< 10 m^3	building area adjacent to shack
core pile	.5 m diameter x .5 m high	northeast corner of site near access road
sleigh parts	1	adjacent to buildings
wood debris	< 5 m^3	adjacent to adit
PVC pipe; metal pipe	8 PVC; 1 metal (15 m)	in front of adit
wood debris	< 10 m^3	slopes of waste rock
rail and miscellaneous steel	< 6 m; ~100 pieces	adjacent to adit

5.3 HAZARDOUS MATERIALS

The only hazardous wastes noted at the site were two 205 L barrels containing significant quantities of petroleum hydrocarbon based liquids and a surface soil stain noted below the adit. Barrel 1, located approximately 5 m south west of the living quarters building was sampled (AC-B101). Barrel 2, located approximately 12 m south west of the first barrel, contained two liquid phases and both were sampled (AC-B102A & AC-B102B).

Based on the elevated concentrations of halogenated organics in both barrels, the contents may not be incinerated. Laboratory results are listed in Table 4.

Table 4: Barrel Sample Laboratory Results (ppm)

Parameter	Barrel Clean Up Protocol	Sample #		
		AC-B101	AC-B102-A	AC-B102-B
PCBs	2	< 2	< 2	< 2
Total Halogenated Organics	1000	15,160	8,680	< 300
Cadmium	2	< 1	< 1	< 1
Chromium	10	< 1	< 1	< 1
Lead	100	< 1	1	< 1

Soil Stains

Black surface soil staining was noted below a pipe extending from the ground approximately 15 m from the mine opening. The pipe probably originates from inside the mine and the stain appears to be the result of waste oil. Soil samples were collected from stained surface soils in this area and subjected to lab analysis of a number of hazardous compounds typically found in waste oil. All analytes were below laboratory detection limits. Laboratory results are shown in Table 5 below. Complete analytical results are provided in Appendix C. Sample locations are included on Drawing 1.

Table 5: Stained Soil Laboratory Results

Sample ID	Sample Location	Light Hydrocarbons	BTEX	PAHs
AC-S201	2 m below pipe extending from waste rock	below detection limits	below detection limits	below detection limits
AC-S202	adj. to adit drainage 3 m from portal entrance	below detection limits	below detection limits	below detection limits
AC-S203	area of stressed vegetation approx. 1/2 way to stream below adit	no assay	no assay	below detection limits

5.4 SURFACE WATER QUALITY

Table 6 identifies the significant findings of the sampling program conducted to determine the potential impact of the site on surface water bodies. Samples were taken from one of the mine openings, waste rock seepage and downstream waters from the stream running below the site, shown in Drawing 2. An upstream sample was also collected to represent site background conditions for which downstream sample results will be compared. Field measurements of pH and conductivity were taken to guide the sampling for laboratory analysis, as well as for a secondary measurement. Complete analytical results are provided in Appendix C. Sample locations are included on Drawing 1.

A sample, AC-WQ-A101, was collected from the water discharging from the adit. The flow (estimated to be < 42 L/min) from the adit was absorbed by the waste rock within 10 m of the portal. No seeps were present near the toe of the waste rock pile.

Two water samples were collected in the unnamed stream that flowed past the mine site. AC-WQ-Str101 was collected 100 m upstream of the waste rock pile and AC-WQ-Str102 was collected 100 m downstream of the confluence with the surface drainage area affected by the waste rock pile.

The water quality of the adit discharge indicates some sulphide oxidation is occurring in the adit. However, the acid associated with this oxidation is being

effectively neutralized. Dissolved metals concentrations are low due to the naturally high alkalinity of the groundwater inflow to the mine workings.

Comparison of the upstream and downstream water quality from the nearby stream suggests that the downstream environment is unaffected by the waste rock drainage. There is no evidence of surface run off directly entering the nearby stream. There is also no evidence of ponding of potentially contaminated water that may be used by wildlife.

The water quality of the downstream sample is below the criteria outlined in Schedule 1 of the Metal Mining Liquid Effluent Regulations and Guidelines for all parameters. None of the inorganic parameters analytes in the downstream water sample (AC-WQ-Str102) were above background concentrations. For some metals, detection limits were above background values.

The adit discharge (AC-WQ-A101) indicates that carbonate and silicate dissolution is occurring in the adit. The discharge meets the Metal Mine Liquid Effluent Regulations and Guidelines criteria.

Black surface soil staining was noted below a pipe extending from the ground approximately 15 m from the mine opening. The pipe probably originates from inside the mine and the stain appears to be the result of waste oil. A water sample was collected from the adit discharge water to determine if potential hazardous components of waste oil are present in the adit water, however, analytes were below laboratory detection limits. The results are also presented in Table 6.

Table 6: Surface Water Samples - Significant Results

Sample ID	Sample Location	pH	Conductivity (μmhos/cm)	Metallic Parameters	BTEX & Light Hydro-carbons
AC-WQ-Str101	unnamed stream 100m downstream of mine site drainage	6.82	44.5	low	no assay
AC-WQ-Str102	unnamed stream 100 m upstream of mine site drainage	6.9	43.4	low	no assay
AC-WQ-A101	drainage from adit	7.68	746	low	below detection limits

5.5 WASTE ROCK DISPOSAL AREAS

Limited waste rock is present at the site as a result of the underground development. A visual estimate of 12,500 m^3 of waste rock exists at the portal entrance. Assuming a specific gravity of 2.65 and an expansion factor of 1.6 this volume of waste rock would weigh 20,700 tonnes (22,800 tons). This tonnage is comparable to the recorded development from the 5100-Level adit, greater than 18,250 tonnes (20,200 tons). On the surface the waste rock pile is 30% granodiorite and 70% mineralized waste.

Three pits were dug in the waste rock pile and samples collected for analysis. The sample locations are shown on the site map and the test pit logs with the analytical results included are attached. Sample AC/WR/P301 was collected from the mineralized portion of the rock pile where the surface showed secondary mineralization, as it was weathered to a yellow/brown colour. Sample AC/WR/P302 was collected from the mineralized portion of the rock pile that was not stained to a yellow/brown colour from secondary mineralization. Sample AC/WR/P303 was collected from the unmineralized portion of the waste rock pile, in the granodiorite development rock.

The rock samples collected from the mineralized portion of the waste rock pile are potential acid producers. The rock that has weathered to a yellow/ brown colour has begun to produce acid. The remaining mineralized waste has a slightly elevated acid potential compared to its neutralizing potential. The rock collected from the unmineralized granodiorite is not a potential acid generator. In general the waste rock is anomalously high in Ag, As, Bi, Cd, Co, Th, and anomalously low in Na. Accounting test results are shown in Table 7.

Table 7: Summary Acid/Base Accounting Test Results

Sample #	Paste pH	Total S (%)	SO_4 (%)	AP	NP	Net NP	NP/AP
AC/WR/P301/1	2.56	1.82	0.20	50.63	1.94	-48.69	< 0.1
AC/WR/P301/2	6.66	0.72	no assay	22.50	15.56	-6.94	0.69
AC/WR/P302	6.68	0.94	no assay	29.38	25.06	-4.31	0.85
AC/WR/P303	8.33	0.34	no assay	10.63	34.88	24.25	3.28

5.6 MINE OPENINGS AND EXCAVATIONS

A single adit was driven at an elevation of 1555 m. Table 8 shows the results of the mine openings investigation.

Table 8: Mine Openings

Adit	Location	Drift Length	Condition
1 open adit	approx. 60 m below access road level	697 meters	exposed wooden entrance in satisfactory condition

5.7 TAILINGS

Ore was not processed at the site and, therefore, no tailings are present at the Arctic Caribou site. Hand-picked ore samples were shipped off the property for milling in 1910, 1911 and 1925. The milling likely occurred at the Conrad mill on the west shore of Windy Arm. The Arctic Gold and Silver Mill, which received ore from the site in the 1960's is located four kilometers to the north.

6.0 CONCLUSIONS

The primary concerns are the health and safety of humans and wildlife relating to the collapse of the mine opening and buildings and the barrels left at the site containing hazardous waste. Secondary concerns are erosion of the waste rock and the aesthetic appearance of metal track rail and pipe and scattered wood and metal debris throughout the site.

6.1 HEALTH AND SAFETY

The mine opening is not adequately secured from public and wildlife access. At the time of the site investigation, access was partially blocked by ice and melting snow, however, there is still some access into the opening.

6.2 ENVIRONMENTAL RISKS

The two barrels, currently in satisfactory condition, have significant volumes of petroleum hydrocarbons containing concentrations of halogenated organics greater

than established criteria. If left as is, the barrels will degrade with time and eventually result in a hazardous waste spill that may impact on the surrounding environment. As well, hazardous air emissions would be released if the barrel contents were burned.

The water quality of the adit discharge indicates some sulphide oxidation is occurring in the adit. However, the acid associated with this oxidation is being effectively neutralized. Dissolved metals concentrations are low due to the naturally high alkalinity of the groundwater inflow to the mine workings. A "do nothing" option is the preferred approach for the Arctic Caribou waste rock piles. This is supported by the fact that the waste rock at the Arctic Caribou site has been exposed to weathering for 20 to 30 years without negatively impacting the downstream environment. Therefore, from a geochemical standpoint, no remediation action at Arctic Caribou is required.

A deep erosion gully has formed through the waste rock pile below the adit and has resulted in a considerable volume of soil and waste rock eroding towards the bottom of the valley.

6.3 AESTHETIC CONCERNS

Aesthetic concerns arise from 100 m of rail tracks, a pile of core sample boxes, metal and PVC pipes and other metal and wood debris scattered near the buildings, adit and waste rock pile.

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.

Recommendation 1.

It is recommended that the mine opening be secured from human and animal access for health and safety reasons. The exposed wooden entrance should be cut back to the original plane of the ground and the adit filled with waste rock.

Recommendation 2.

It is recommended that the erosion gully through the waste rock be reshaped, a swale constructed and the area riprapped to prevent further erosion.

Recommendation 3.

It is recommended that the two barrels located at the site be transported from the site and disposed of at a suitable hazardous waste disposal facility.

Recommendation 4.

No further test work is recommended on the waste rock. It is anticipated that the mineralized rock, that has not yet become acid generating, will do so at some future date. This could affect the downstream receiving environment. Therefore, additional water quality sampling is required to monitor the impact of the acid generating waste on the receiving environment. Water samples are to be collected at AC-WQ-Str101 and AC-WQ-Str102. It is recommended that monitoring be undertaken every three years to obtain water quality data for spring freshet, middle summer and late fall conditions.

Recommendation 5.

It is recommended that the buildings be demolished and burned and the ashes buried on site and the rails be demolished and buried on site for aesthetic reasons. These activities can be accomplished using locally available resources and labour and the rails can be buried on-site together with other site debris. Burial can occur by covering waste material with surrounding rock and soil on a clearing adjacent to a rock slope.

Recommendation 6.

It is recommended that metal site debris be collected and buried on-site for aesthetic reasons. The metal pipe and miscellaneous metal debris, surrounding the site can be collected using locally available labour.

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APPENDIX A

DETERMINATION OF ACID ROCK DRAINAGE POTENTIAL

P118105

ARCTIC CARIBOU ACID ROCK DRAINAGE ASSESSMENT REPORT

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LIST OF TABLES

P118105

ARCTIC CARIBOU ACID ROCK DRAINAGE ASSESSMENT REPORT

1.0 INTRODUCTION

This site specific report has been prepared in conjunction with a *Phase II Environmental Assessment of the Arctic Caribou Abandoned Mine Site*, prepared by Environmental Services, Public Works and Government Services Canada (PWGSC). As part of the Phase II assessment prepared by PWGSC, Steffen Robertson and Kirsten (SRK) was requested to assess the potential for acid rock drainage associated with the site which is the subject of this report. The reader is directed to the PWGSC report for a comprehensive environmental assessment of the Arctic Caribou site.

This report assesses the existing, and potential acid rock drainage (ARD) conditions at the Arctic Caribou site and provides recommendations for remediation. This site specific report is part of the *Acid Rock Drainage Review Report, Yukon Abandoned Mine Site Assessments*, prepared by SRK, which includes similar assessments for a number of sites. The reader is directed to that report for detail regarding the scope of work, site assessment methodology, ARD remediation options and the evaluation of potential remediation options.

The Arctic Caribou site is located in the Wheaton River district, approximately eight kilometres west of the Village of Carcross, Yukon Territory. The site is accessible by vehicle.

Mining related disturbances observed during the site assessment consist of an adit and a waste rock pile. Mill foundations and a tailings pond are located four kilometres to the north on a separate site, the Arctic Gold and Silver site. The waste rock present at the Arctic Caribou site is the result of development work between 1905 and 1916 and again in 1967. The last reported underground activity was in 1975 and 1976, when the workings were rehabilitated and ore stockpiled at the adjacent Big Thing site (Yukon Minfile 105D-009).

The site is above the treeline and is covered with short grasses and alpine vegetation. It is located near a glacier on Montana Mountain. A stream that originates 500 metres upstream of the site flows within 300 metres of the toe of the waste rock pile.

2.0 GEOLOGY AND MINERALIZATION

Approximately 20 polymetallic, gold-bearing quartz veins are hosted in rocks of the mid-Cretaceous Montana Mountain volcanic complex and Montana pluton along an eight kilometre, northwest-trending belt between Windy Arm and Brute Mountain (Hart, C.J.R. Radloff, J.K., 1990, p. 88).

At the Arctic Caribou site gold and silver occurs in a series of northeast striking quartz veins that cut medium to coarse grained, locally porphyritic granodiorite. Sulphide mineralization consists chiefly of pyrite (FeS_2), arsenopyrite (FeAsS), sphalerite ((Zn,Fe)S), galena (PbS) and minor chalcopyrite ($CuFeS_2$) occurring in irregular lenses and shoots within quartz vein material. The vein structures are commonly bordered by a selvage zone of altered granodiorite, consisting of bleaching and pyritization, extending up to 9 metres either side of the vein. Weakly disseminated molybdenite (MoS_2) is sometimes present in the alteration envelope (GSC Paper 68-68, p. 58-62).

3.0 WASTE ROCK DISPOSAL AREAS

3.1 Description

The volume of waste rock produced from all the historical underground development is between 18,000 and 20,000 tonnes (PWGSC report).

On the surface of the waste rock pile 30% is predominately granodiorite development rock and 70% mineralized rock. It is estimated that there is 14,000 tonnes of mineralized waste rock at the Arctic Caribou site, assuming that the proportion of mineralized to unmineralized waste rock on the surface is representative of the total waste rock pile. 30% of the surface area of the mineralized waste rock exhibits secondary mineralization. The distribution of mineralization in the waste rock piles is shown on a site map, Drawing 2.

No tailings are present at the Arctic Caribou site, since the ore was processed of site.

3.2 Samples

Three pits were dug in the waste rock pile and samples collected for analysis. The sample locations are shown on the site map. The test pit logs are summarized in Table 1. Sample ACWR/P301/1 was collected from the mineralized portion of the rock pile exhibiting secondary mineralization, characterized by a orange/brown colour. Samples ACWR/P301/2 and ACWR/P302 were collected from the mineralized portion of the rock pile that was not stained by secondary mineralization. Sample ACWR/P303 was collected from the unmineralized granodiorite development rock.

A sample, ACWQ/A101, was collected of the water discharging from the adit. The flow (estimated to be 1 L/sec) from the adit infiltrated into the waste rock within 10 metres of the portal. The pH of the water was 6.42 and its conductivity was 530 μS/cm. No seeps were present at the toe of the waste rock pile.

Two water samples were collected in the stream that flowed past the mine site. ACWQ/STR-101 was collected 100 metres upstream and ACWQ/STR-102 was collected 100 metres downstream of the surface drainage area affected by the waste rock pile.

3.3 Analytical Results

Results of geochemical analyses of waste rock samples are provided in Table 2 and the analytical results for the water samples are provided in Table 3.

Paste Parameters

The paste pH values for the unstained mineralized and the development waste rock are neutral to alkaline. The mineralized waste rock that exhibited iron staining had an acidic paste pH, indicating that the material is net acid generating.

The paste conductivities were elevated in the upper portion of pit P301, excavated in the visibly stained mineralized waste rock, and in pit P302, excavated in the unstained mineralized waste rock. These values indicate that a significant amount of stored oxidation products are present in the waste rock.

The low paste conductivity of the development rock indicates a minimal amount of stored soluble salts.

Acid Base Accounting

The rock samples collected from the mineralized portion of the waste rock pile indicate that this material is potentially acid generating. Their Neutralizing Potential to Acid Potential (NP:AP) ratios are less than one. The rock that has weathered a orange/ brown colour has already gone acid. The unstained sample from pit P302 has not yet become net acid generating.

The development waste rock has a NP:AP ratio of 3.28 and is net acid consuming.

Metals Concentrations

All rock samples contained elevated concentrations of arsenic and lead, with minor concentrations of chromium, copper and molybdenum.

Water Quality

Water samples from the nearby stream generally had metal concentrations below the limits of detection. The upstream sample had a total aluminum concentration of 0.3 mg/L which is above the CCME freshwater aquatic life criteria. The method detection limits for arsenic, cadmium, chromium, copper and lead were higher than the CCME criteria for these elements.

The adit discharge (ACWQ/A101) indicate that carbonate and silicate dissolution is occurring in the adit. The discharge meets the criteria specified in Schedule 1 of the Metal Mine Liquid Effluent Regulations and Guidelines; however, its iron and zinc levels exceed the CCME freshwater aquatic life criteria.

4.0 EXISTING AND POTENTIAL ACID ROCK DRAINAGE CONDITIONS

The mineralized waste rock exhibiting orange/brown staining is currently generating acidic drainage. The amount of this material is estimated to be between 1,000 and 4,000

tonnes. An additional 10,000 to 13,000 tonnes of mineralized waste rock has the potential to become net acid generating.

The water quality of the adit discharge indicates some sulphide oxidation is occurring in the adit. However, the acid associated with this oxidation is being effectively neutralized. Metals concentrations are low due to the naturally high alkalinity of the groundwater inflow to the mine workings.

Comparison of the upstream and downstream water quality from the nearby stream suggests that the downstream environment is unaffected by the waste rock drainage. There is no evidence of surface run off directly entering the nearby stream. There is also no evidence of ponding of potentially contaminated water that may be used by wildlife.

It is concluded that the impact on the receiving environment is minimal. Remediation requirements are therefore limited to providing public safety and improving the aesthetic appearance of the site.

5.0 REMEDIATION OPTIONS

Typical reclamation and control options for acid generating mine waste and mine openings include:

- release control by collecting and treating contaminated flows prior to discharge;
- source control which includes limiting further oxidation, for instance, by placing the waste under water or flooding the underground workings; and
- migration control which limits the release of oxidation products to the environment, for example, by reducing infiltration to the waste by placing a low permeability soil cover.

Collection and treatment of the runoff from the Arctic Caribou site is not required at present. Relocation of the waste rock to limit further oxidation was not considered since there is no secure placement location readily available, such as the underground workings or an open pit for all of the material. It will, however, be necessary to seal the adit. This may be done by backfilling it with some of the waste rock, which will limit oxygen entry to the adit and thus reduce the potential for acid generation from the underground workings.

Covering it with soil and/or geomembrane to control future acid generation was considered as a remediation option. This option is compared to the "do nothing" option in the table below.

Matrix for Evaluating Applicable/Potential Remediation

Option versus Evaluation Criteria	Arctic Caribou			
	Collect and Treat	**Relocate**	**Cover**	**Do Nothing**
Public Health and Safety 5 = provides full protection of public 1 = provides no protection of public	not applicable	not applicable	4	4
Worker Health and Safety 5 = relative low risk to workers 1 = high risk to workers	not applicable	not applicable	3	5
Ecosystem Preservation and Protection 5 = relative low risk to environment 1 = relative high risk to environment	not applicable	not applicable	4	3
Impact on Mineral Resource 5 = allows for continued exploration 1 = impedes continued exploration	not applicable	not applicable	5	5
Direct Costs (mobilization & materials) 5 = relative low cost 1 = relative high cost	not applicable	not applicable	2	5
Monitoring and Maintenance Costs 5 = relative low cost 1 = relative high cost	not applicable	not applicable	3	4
Acceptability 5 = positive response anticipated 1 = negative response anticipated	not applicable	not applicable	5	3
Total Score	**0**	**0**	**26**	**29**

The waste rock pile at the Arctic Caribou site is steep, but it does not represent a significant health and safety risk, except to workers during the placement of the cover.

Placing a cover on the waste rock would decrease the amount of infiltration through the pile. However, the recent site visit indicated that the waste rock currently has little impact on the downstream water quality. Should a cover be placed a moderate risk to the ecosystem will result for two reasons. First, disturbing the waste may cause a short term release of soluble metal constituents into the receiving environment. Second, an additional site would be disturbed to provide the cover material.

The risk to the environment is ranked higher if no remediation action is undertaken since the zone of oxidation may increase in the future. However, the waste rock piles are located at a moderately dry site in an area that has anomalous background mineralization and sulphides, thus the impact on the receiving environment from the small volume of waste rock will continue to be low relative to local conditions.

Exploration on the site would not be impeded by either remediation measure.

Due to the poor condition of the access road the cost to cover the waste rock would be relatively high. Maintenance of the cover would also be required. Monitoring of the receiving water would be required for either option.

Covering the waste rock pile would improve the aesthetic appearance of the site and is therefore ranked slightly higher for acceptability.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The above evaluation illustrates that "do nothing" is the preferred option for the Arctic Caribou waste rock pile. This is supported by the fact that the waste rock at the Arctic Caribou site has been exposed to weathering for 20 to 30 years without any apparent negative impact on the receiving environment. Therefore, with respect the ARD, no remediation action at Arctic Caribou is required.

Backfilling the adit, required from a public safety perspective, will reduce the risk for potential acidic discharge from the underground openings.

6.2 Recommendations

No further laboratory test work is recommended on the waste rock. It is anticipated that the mineralized rock that has not yet become acid generating will do so at some future date. This could affect the downstream receiving environment. Therefore, water quality sampling is required to monitor the impact of the acid generating waste on the receiving environment.

It is recommended that monitoring be undertaken every three years to obtain water quality data for spring freshet, middle summer and late fall conditions. Water samples should be collected at ACWQ/STR101 and ACWQ/STR102. The method detection limits used are to correspond to the CCME criteria for freshwater aquatic life. A paste pH and conductivity survey of the mine rock should be conducted in conjunction with the water sampling in order to detect changes in the oxidation rate of the material.

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TABLE 1 Arctic Caribou Waste Rock Sample Descriptions

Sample ID	Sample Description
ACWR/P301/1	mineralized oxidized cap, 10 cm thick orange/brown stained quartz porphyry waste rock, cobbles and gravel sized material. The paste pH of the waste rock was 2.56 and the paste conductivity was 720 μS/cm.
ACWR/P301/2	mineralized, sample collected below ACWR/P301/1 for 25 cm . The orange/brown staining was not as prevalent as above. The material was a grey colour with rusty lenses, 50% cobbles and 50% sand. The paste pH of the waste rock was 6.66 and the paste conductivity was 210 μS.
ACWR/P302	mineralized waste, not stained. 80% granodiorite and 20% quartz / carbonate vein material with <1% galena and pyrite observed and 2% oxidized lenses overall. The sample was collected equally from the 40 cm deep pit. The paste pH was 6.68 and the paste conductivity was 1190 μS/cm.
ACWR/P303	granodiorite, unmineralized development rock. The sample was collected from the 50 cm deep pit. The material was 40% cobbles with 60% sand. Some cobbles had iron stained surfaces. The paste pH was 8.33 and the paste conductivity was 150 μS/cm.

TABLE 2 Arctic Caribou Waste Rock ABA and ICP Results

Parameter	Unit	Sample Number ACWR			
		P301/1	P301/2	P302	P303
Field Paste pH		2.56	6.66	6.68	8.33
Field Cond	µS/cm	720	210	1190	150
Lab Paste pH		5.21	7.60	7.63	8.27
Total Sulfur	%	1.82	0.72	0.94	0.34
Sulfate	%	0.20	na	na	na
AP		50.63	22.50	29.38	10.63
NP		1.94	15.56	25.06	34.88
NET NP		-48.69	-6.94	-4.31	24.25
NP/AP		<0.1	0.69	0.85	3.28
Aluminum	%	0.39	0.47	0.45	0.62
Antimony	ppm	199	50	50	6
Arsenic	ppm	>10000	7181	3869	478
Barium	ppm	28	35	37	43
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1
Bismuth	ppm	21	5	<1	<1
Cadmium	ppm	>100	>100	57.8	<0.1
Calcium	%	0.42	0.90	1.42	1.68
Chromium	ppm	101	116	94	107
Cobalt	ppm	15	14	7	4
Copper	ppm	236	63	82	27
Gallium	ppm	<1	<1	<1	<1
Iron	%	4.12	2.35	2.13	1.77
Lead	ppm	1607	295	212	44
Lithium	ppm	4	4	4	5
Magnesium	%	0.13	0.18	0.20	0.26
Manganese	ppm	362	540	779	807
Molybdenum	ppm	23	17	15	29
Nickel	ppm	14	12	11	12
Potassium	%	0.14	0.15	0.16	0.15
Phosphate	ppm	310	290	330	340
Silver	ppm	68.9	13.4	17.8	1.5
Sodium	%	<0.01	<0.01	<0.01	<0.01
Strontium	ppm	13	24	36	50
Thorium	ppm	<1	7	9	13
Tin	ppm	2	<1	<1	<1
Titanium	%	<0.01	<0.01	<0.01	<0.01
Tungsten	ppm	4	6	5	5
Uranium	ppm	<1	<1	<1	<1
Vanadium	ppm	3.9	3.6	3.0	5.0
Zinc	ppm	335	88	209	43

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

Steffen, Robertson and Kirsten
February, 1997

TABLE 3 Arctic Caribou Water Quality Results

Parameter	Units	Sample Number ACWQ/		
		Str101	Str102	A101
Field Conductivity	umhos/cm	50	60	550
Field pH		7.19	6.11	7.3
Lab Conductivity	umhos/cm	44.5	43.4	746
Lab pH		6.82	6.9	7.68
Acidity (to pH 8.3) CaCO3	mg/L	3.1	2.9	4.7
Alkalinity-Total CaCO3	mg/L	11.8	12	98.1
Sulphate SO4	mg/L	7.4	6.3	337
Aluminum T-Al	mg/L	0.3	<0.2	0.2
Antimony T-Sb	mg/L	<0.2	<0.2	<0.2
Arsenic T-As	mg/L	<0.2	<0.2	<0.2
Barium T-Ba	mg/L	<0.01	<0.01	<0.01
Beryllium T-Be	mg/L	<0.005	<0.005	<0.005
Bismuth T-Bi	mg/L	<0.1	<0.1	<0.1
Boron T-B	mg/L	<0.1	<0.1	<0.1
Cadmium T-Cd	mg/L	<0.01	<0.01	<0.01
Calcium T-Ca	mg/L	6.08	5.54	130
Chromium T-Cr	mg/L	<0.01	<0.01	<0.01
Cobalt T-Co	mg/L	<0.01	<0.01	<0.01
Copper T-Cu	mg/L	<0.01	<0.01	<0.01
Iron T-Fe	mg/L	<0.03	<0.03	0.1
Lead T-Pb	mg/L	<0.05	<0.05	<0.05
Lithium T-Li	mg/L	<0.01	<0.01	<0.01
Magnesium T-Mg	mg/L	0.8	0.77	21.6
Manganese T-Mn	mg/L	<0.005	<0.005	0.937
Molybdenum T-Mo	mg/L	<0.03	<0.03	<0.03
Nickel T-Ni	mg/L	<0.02	<0.02	<0.02
Phosphorus T-P	mg/L	<0.3	<0.3	<0.3
Potassium T-K	mg/L	<2	<2	<2
Selenium T-Se	mg/L	<0.2	<0.2	<0.2
Silicon T-Si	mg/L	1.45	1.38	3.72
Silver T-Ag	mg/L	<0.01	<0.01	<0.01
Sodium T-Na	mg/L	<2	<2	3
Strontium T-Sr	mg/L	0.031	0.03	0.569
Thallium T-Tl	mg/L	<0.1	<0.1	<0.1
Tin T-Sn	mg/L	<0.03	<0.03	<0.03
Titanium T-Ti	mg/L	<0.01	<0.01	<0.01
Vanadium T-V	mg/L	<0.03	<0.03	<0.03
Zinc T-Zn	mg/L	<0.005	<0.005	0.056

< = lower detection limit

Steffen Robertson and Kirsten
February, 1997

APPENDIX B

SITE PHOTOGRAPHS

ARCTIC CARIBOU

Photographic Record

July 26, 1996

Photos	Description
A.C. # 1	Living Quarters
A.C. # 2	Collapsing Shack
A.C. # 3	Core Samples / Boxes
A.C. # 4	Wood Debris
A.C. # 5	Outhouse, Debris
A.C. # 6	Parts of Sleigh
A.C. # 7	Pile of Cores
A.C. # 8	Building Area
A.C. # 9	Inside Adit
A.C. # 10	Adit - Exterior
A.C. # 11	Debris at Entrance to Adit
A.C. # 12	Tracks, PVC Pipe in Background
A.C. # 13	Rails, Pipe, Stockpile
A.C. # 14	Twisted Track
A.C. # 15	Twisted Track, Debris
A.C. # 16	Gravel Alluvial Fan
A.C. # 17	Overall Site
A.C. # 18	Creek below Overall Site
A.C. # 19	Ledge and Debris
A.C. # 20	Toe of Mineralized Rock Pile
A.C. # 21	Unnamed Creek Downstream of Mine
A.C. # 22	Unnamed Creek Upstream of Mine
A.C. # 23	205L Barrel containing Liquid

Photo # 1 - Living Quarters

Photo # 2 - Collapsing Shack

Photo # 3 - Core Samples / Boxes

Photo # 4 - Wood Debris

Photo # 5 - Outhouse, Debris

Photo # 6 - Parts of Sleigh

Photo # 7 - Pile of Cores

Photo # 8 - Building Area

Photo # 9 - Inside Adit

Photo # 10 - Adit - Exterior

Photo # 11 - Debris at Entrance to Adit

Photo # 12 - Tracks, PVC Pipe in Background

Photo # 13 - Rails, Pipe, Stockpile

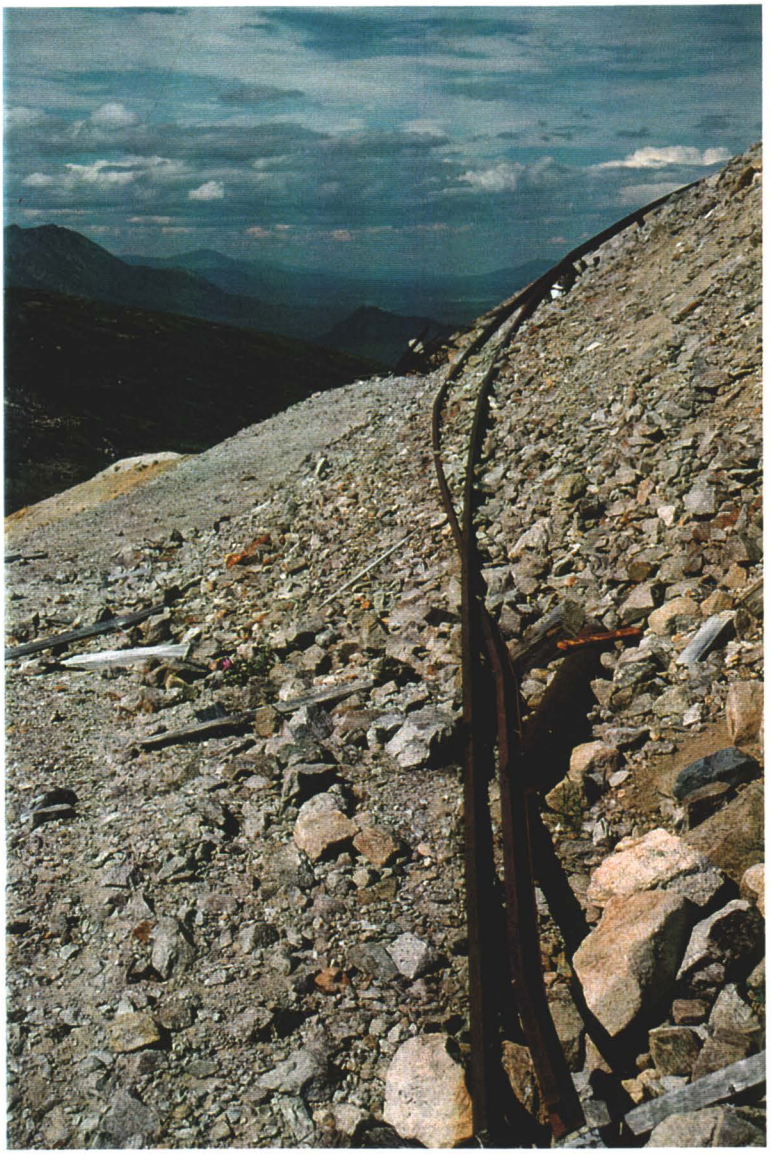

Photo # 14 - Twisted Track

Photo # 15 - Twisted Track, Debris

Photo # 16 - Gravel Alluvial Fan

Photo # 17 - Overall Site

Photo # 18 - Creek below Overall Site

Photo # 19 - Ledge and Debris

Photo # 20 - Toe of Mineralized Rock Pile

Photo # 21 - Unnamed Creek Downstream of Mine

Photo # 22 - Unnamed Creek Upstream of Mine

Photo # 23 - 205L Barrel containing Liquid

APPENDIX C

ANALYTICAL RESULTS

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

Sample Description : AC-B101
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

TOX SAMPLES
Chemex Worksheet Number : 96-07805-17
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 5, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R E S U L T S	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	15160.	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
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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	MATRIX SPIKES DUP Rr	RECOV %	CONTROL LIMITS LOWER	UPPER	CALIBRATION CHECK RECOV %	CONTROL LIMITS LOWER	UPPER
Total Organic Halogens (TOX)	05-11-96	4	RAV	N.A.	NOT APPLICABLE			102.6	80.0	120.0

CHEMEX Labs Alberta Inc.

Calgary : 2021 - 41st Avenue N.E., T2E 6P2. Telephone (403) 291-3077, FAX (403) 291-9468
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TOX SAMPLES
Chemex Worksheet Number : 96-07805-17
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	< 2.	mg/Kg	2.
Aroclor 1221	< 2.	mg/Kg	2.
Aroclor 1232	< 2.	mg/Kg	2.
Aroclor 1242	< 2.	mg/Kg	2.
Aroclor 1248	< 2.	mg/Kg	2.
Aroclor 1254	< 2.	mg/Kg	2.
Aroclor 1260	< 2.	mg/Kg	2.
Aroclor 1262	< 2.	mg/Kg	2.
Aroclor 1268	< 2.	mg/Kg	2.

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 : 82% LIQUID surrogate limits : 63% - 134%.

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B101
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18. 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-17
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						

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102-A
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-18
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 8, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R E S U L T S	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	8680.	2.

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102-A
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Station Code :

Chemex Worksheet Number : 96-07805-18
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	MATRIX SPIKES 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)	08-11-96	4 RAV	N.A.	NOT APPLICABLE			100.1	80.0	120.0

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102-A
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-18
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 13, 1996

AROCLORS (PCBS) BY MODIFIED EPA METHOD 8081

COMPONENT	CONCENTRATION	UNIT	MDL
Aroclor 1016	< 2.	mg/Kg	2.
Aroclor 1221	< 2.	mg/Kg	2.
Aroclor 1232	< 2.	mg/Kg	2.
Aroclor 1242	< 2.	mg/Kg	2.
Aroclor 1248	< 2.	mg/Kg	2.
Aroclor 1254	< 2.	mg/Kg	2.
Aroclor 1260	< 2.	mg/Kg	2.
Aroclor 1262	< 2.	mg/Kg	2.
Aroclor 1268	< 2.	mg/Kg	2.

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 : 74% LIQUID surrogate limits : 63% - 134%.

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102-A
Sample Date & Time : 27-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-18
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 13, 1996

BATCH SPECIFIC QUALITY ASSURANCE REPORT

BATCH : 11	BLANK	DUPLICATE			MATRIX SPIKE			CALIBRATION CHECK		
DATE : November 13, 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	< 2.	< 2.	0						
Aroclor 1221	< 0.2	< 2.	< 2.	0						
Aroclor 1232	< 0.2	< 2.	< 2.	0						
Aroclor 1242	< 0.2	< 2.	< 2.	0				102	74.	130.
Aroclor 1248	< 0.2	< 2.	< 2.	0						
Aroclor 1254	< 0.2	< 2.	< 2.	0	108	64.	130.			
Aroclor 1260	< 0.2	< 2.	< 2.	0				100	61.	120.
Aroclor 1262	< 0.2	< 2.	< 2.	0						
Aroclor 1268	< 0.2	< 2.	< 2.	0						

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

Sample Description : AC-B102B
Sample Date & Time : 26-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

TOX SAMPLES
Chemex Worksheet Number : 96-07805-14
Chemex Project Number : PUBI010-0502
Sample Access :
Sample Matrix : LIQUID
Report Date : November 15, 1996
Analysis Date : November 5, 1996

PARAMETER DESCRIPTION	NAQUADAT CODE	UNITS	R E S U L T S	DETECTION LIMIT
Total Organic Halogens (TOX)		ug/g	8107.	2.

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102B
Sample Date & Time : 26-07-96
Sampled By :
Sample Type : GRAB
Sample Station Code :

Chemex Worksheet Number : 96-07805-14
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	MATRIX SPIKES DUP Rr	RECOV %	CONTROL LIMITS LOWER	UPPER	CALIBRATION CHECK RECOV %	CONTROL LIMITS LOWER	UPPER
Total Organic Halogens (TOX)	05-11-96	3	RAV	N.A.	NOT APPLICABLE			99.5	80.0	120.0

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

Sample Description : AC-B102B
Sample Date & Time : 26-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

TOX SAMPLES
Chemex Worksheet Number : 96-07805-14
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	< 0.2	mg/Kg	0.2
Aroclor 1221	< 0.2	mg/Kg	0.2
Aroclor 1232	< 0.2	mg/Kg	0.2
Aroclor 1242	< 0.2	mg/Kg	0.2
Aroclor 1248	< 0.2	mg/Kg	0.2
Aroclor 1254	< 0.2	mg/Kg	0.2
Aroclor 1260	< 0.2	mg/Kg	0.2
Aroclor 1262	< 0.2	mg/Kg	0.2
Aroclor 1268	< 0.2	mg/Kg	0.2

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 : 94% LIQUID surrogate limits : 63% - 134%.

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PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : AC-B102B
Sample Date & Time : 26-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-14
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						

RESULTS OF ANALYSIS - Product[1,2]

File No. G3879

		AC-B102A	AC-B101	AC-B102B	SM-B201	SM-B202
		96 07 27	96 07 27	96 07 27	96 07 29	96 07 29
Total Metals						
Cadmium	T-Cd	<1	<1	<1	<1	<1
Chromium	T-Cr	<1	<1	<1	<1	<1
Lead	T-Pb	1	<1	<1	<1	<1

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1] Adsorbable Organic Halide may be considered to be Total Organic Halide in product samples.
[2] Results are expressed as milligrams per litre.

RESULTS OF ANALYSIS - Product[1,2]

File No. G3879

	AC-B102A	AC-B101	AC-B102B	SM-B201	SM-B202
	96 07 27	96 07 27	96 07 27	96 07 29	96 07 29
Organic Parameters					
Adsorbable Organic Halide	7800	14900	7720	<300	<300

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
[1]Adsorbable Organic Halide may be considered to be Total Organic Halide in product samples.
[2]Results are expressed as milligrams per litre.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G3879

	AC-S201	AC-S202	AC-S203	SM-S102	SM-S201
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	<0.5	<0.01	-	-	-
Acenaphthylene	<0.5	<0.01	-	-	-
Anthracene	<0.5	<0.01	-	-	-
Benzo(a)anthracene	<0.5	<0.01	-	-	-
Benzo(a)pyrene	<0.5	<0.01	-	-	-
Benzo(b)fluoranthene	<0.5	<0.01	-	-	-
Benzo(g,h,i)perylene	<0.5	<0.01	-	-	-
Benzo(k)fluoranthene	<0.5	<0.01	-	-	-
Chrysene	<0.5	<0.01	-	-	-
Dibenz(a,h)anthracene	<0.5	<0.01	-	-	-
Fluoranthene	<0.5	<0.01	-	-	-
Fluorene	<0.5	<0.01	-	-	-
Indeno(1,2,3-c,d)pyrene	<0.5	<0.01	-	-	-
Naphthalene	<0.5	<0.01	-	-	-
Phenanthrene	<0.5	<0.01	-	-	-
Pyrene	<0.5	<0.01	-	-	-
Extractables					
Total Extr Hydrocarbons (C10-30)	<40	<40	<40	304000	25000
Organic Parameters					
Extractable Organic Halide	<1.5	<1.5	<1.5	-	-

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. G3879

		AC-S201	AC-S202	AC-S203	SM-S102	SM-S201
Physical Tests						
Moisture	%	10.4	16.4	8.4	77.8	4.0
Total Metals						
Antimony	T-Sb	<20	<20	<20	<20	<20
Arsenic	T-As	4170	637	42.4	17.8	54.8
Barium	T-Ba	52	25	23	356	98
Beryllium	T-Be	0.6	<0.5	<0.5	<0.5	1.0
Cadmium	T-Cd	24	3	<2	<2	<2
Chromium	T-Cr	4	4	6	25	57
Cobalt	T-Co	44	9	6	7	6
Copper	T-Cu	276	40	63	70	147
Lead	T-Pb	136	<50	<50	108	132
Mercury	T-Hg	0.028	0.006	<0.005	0.033	0.007
Molybdenum	T-Mo	16	<4	<4	<4	5
Nickel	T-Ni	16	5	3	12	28
Selenium	T-Se	<50	<50	<50	<50	<50
Silver	T-Ag	<2	<2	<2	<2	<2
Tin	T-Sn	<30	<30	<30	<30	<30
Vanadium	T-V	13	9	10	5	56
Zinc	T-Zn	546	108	48	225	361
Non-halogenated Volatiles						
Benzene		<0.05	<0.05	-	-	-
Ethylbenzene		<0.05	<0.05	-	-	-
Toluene		<0.05	<0.05	-	-	-
meta- & para-Xylene		<0.05	<0.05	-	-	-
ortho-Xylene		<0.05	<0.05	-	-	-
Light Hydrocarbons (C5-9)		<5	<5	-	-	-

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

RESULTS OF ANALYSIS - Water File No. G3765

			AC-WQ-Str 102	AC-WQ-A 101	BT-WQ-A 103	BT-WQ-Str 102	BT-WQ-S 101
			96 07 26	96 07 26	96 07 25	96 07 25	96 07 25
Physical Tests							
Conductivity (umhos/cm)			43.4	746	56.1	22.6	44.2
pH			6.90	7.68	5.46	6.68	6.62
Dissolved Anions							
Acidity		CaCO3	2.9	4.7	5.2	1.9	4.1
Alkalinity - Total		CaCO3	12.0	98.1	<1.0	6.3	9.3
Sulphate	SO4		6.3	337	20.3	3.5	6.3
Total Metals							
Aluminum	T-Al		<0.2	0.2	3.5	0.3	<0.2
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	0.7	<0.2	0.4
Barium	T-Ba		<0.01	<0.01	0.04	<0.01	<0.01
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi		<0.1	<0.1	<0.1	<0.1	<0.1
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.01	<0.01	<0.01	<0.01	<0.01
Calcium	T-Ca		5.54	130	6.41	2.49	5.15
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.01	<0.01	0.02	<0.01	<0.01
Iron	T-Fe		<0.03	0.10	5.08	<0.03	0.08
Lead	T-Pb		<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	T-Li		<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	T-Mg		0.77	21.6	1.85	0.47	0.71
Manganese	T-Mn		<0.005	0.937	0.506	<0.005	0.005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	T-P		<0.3	<0.3	<0.3	<0.3	<0.3
Potassium	T-K		<2	<2	<2	<2	<2
Selenium	T-Se		<0.2	<0.2	<0.2	<0.2	<0.2
Silicon	T-Si		1.38	3.72	4.07	1.35	2.87
Silver	T-Ag		<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	T-Na		<2	3	<2	<2	<2
Strontium	T-Sr		0.030	0.569	0.034	0.019	0.017
Thallium	T-Tl		<0.1	<0.1	<0.1	<0.1	<0.1
Tin	T-Sn		<0.03	<0.03	<0.03	<0.03	<0.03
Titanium	T-Ti		<0.01	<0.01	0.03	<0.01	<0.01
Vanadium	T-V		<0.03	<0.03	<0.03	<0.03	<0.03

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

RESULTS OF ANALYSIS - Water File No. G3765

		AC-WQ-Str 102	AC-WQ-A 101	BT-WQ-A 103	BT-WQ-Str 102	BT-WQ-S 101
		96 07 26	96 07 26	96 07 25	96 07 25	96 07 25
Total Metals						
Zinc	T-Zn	<0.005	0.056	0.168	<0.005	0.009

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

RESULTS OF ANALYSIS - Water File No. G3765

			WM-WQ-S 201	TH-WQ-Str 302	TH-WQ-S 301	SM-WQ-Str 101	AC-WQ-Str 101
			96 07 28	96 07 28	96 07 28	96 07 29	96 07 26
Physical Tests							
Conductivity (umhos/cm)			106	252	424	59.9	44.5
pH			7.60	7.80	7.33	5.11	6.82
Dissolved Anions							
Acidity		CaCO3	1.7	3.5	10.8	4.7	3.1
Alkalinity - Total		CaCO3	61.4	61.4	171	<1.0	11.8
Sulphate	SO4		1.7	27.2	58.9	23.9	7.4
Total Metals							
Aluminum	T-Al		0.2	<0.2	1.6	0.3	0.3
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.2	<0.2	<0.2	<0.2	<0.2
Barium	T-Ba		0.02	0.10	0.16	0.08	<0.01
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi		<0.1	<0.1	<0.1	<0.1	<0.1
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.01	<0.01	<0.01	<0.01	<0.01
Calcium	T-Ca		17.0	36.2	42.0	4.16	6.08
Chromium	T-Cr		<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.01	<0.01	0.03	0.03	<0.01
Iron	T-Fe		<0.03	<0.03	3.21	0.23	<0.03
Lead	T-Pb		<0.05	<0.05	0.06	<0.05	<0.05
Lithium	T-Li		<0.01	<0.01	0.01	<0.01	<0.01
Magnesium	T-Mg		2.72	6.85	27.2	1.31	0.80
Manganese	T-Mn		<0.005	<0.005	0.231	0.033	<0.005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	T-P		<0.3	<0.3	<0.3	<0.3	<0.3
Potassium	T-K		<2	<2	2	<2	<2
Selenium	T-Se		<0.2	<0.2	<0.2	<0.2	<0.2
Silicon	T-Si		2.30	1.90	4.13	6.57	1.45
Silver	T-Ag		<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	T-Na		<2	2	7	2	<2
Strontium	T-Sr		0.026	0.307	1.88	0.046	0.031
Thallium	T-Tl		<0.1	<0.1	<0.1	<0.1	<0.1
Tin	T-Sn		<0.03	<0.03	<0.03	<0.03	<0.03
Titanium	T-Ti		<0.01	<0.01	0.02	0.01	<0.01
Vanadium	T-V		<0.03	<0.03	<0.03	<0.03	<0.03

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

RESULTS OF ANALYSIS - Water

File No. G3765

		WM-WQ-S 201	TH-WQ-Str 302	TH-WQ-S 301	SM-WQ-Str 101	AC-WQ-Str 101
		96 07 28	96 07 28	96 07 28	96 07 29	96 07 26
Total Metals						
Zinc	T-Zn	<0.005	<0.005	0.073	0.139	<0.005

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

RESULTS OF ANALYSIS - Water[1]

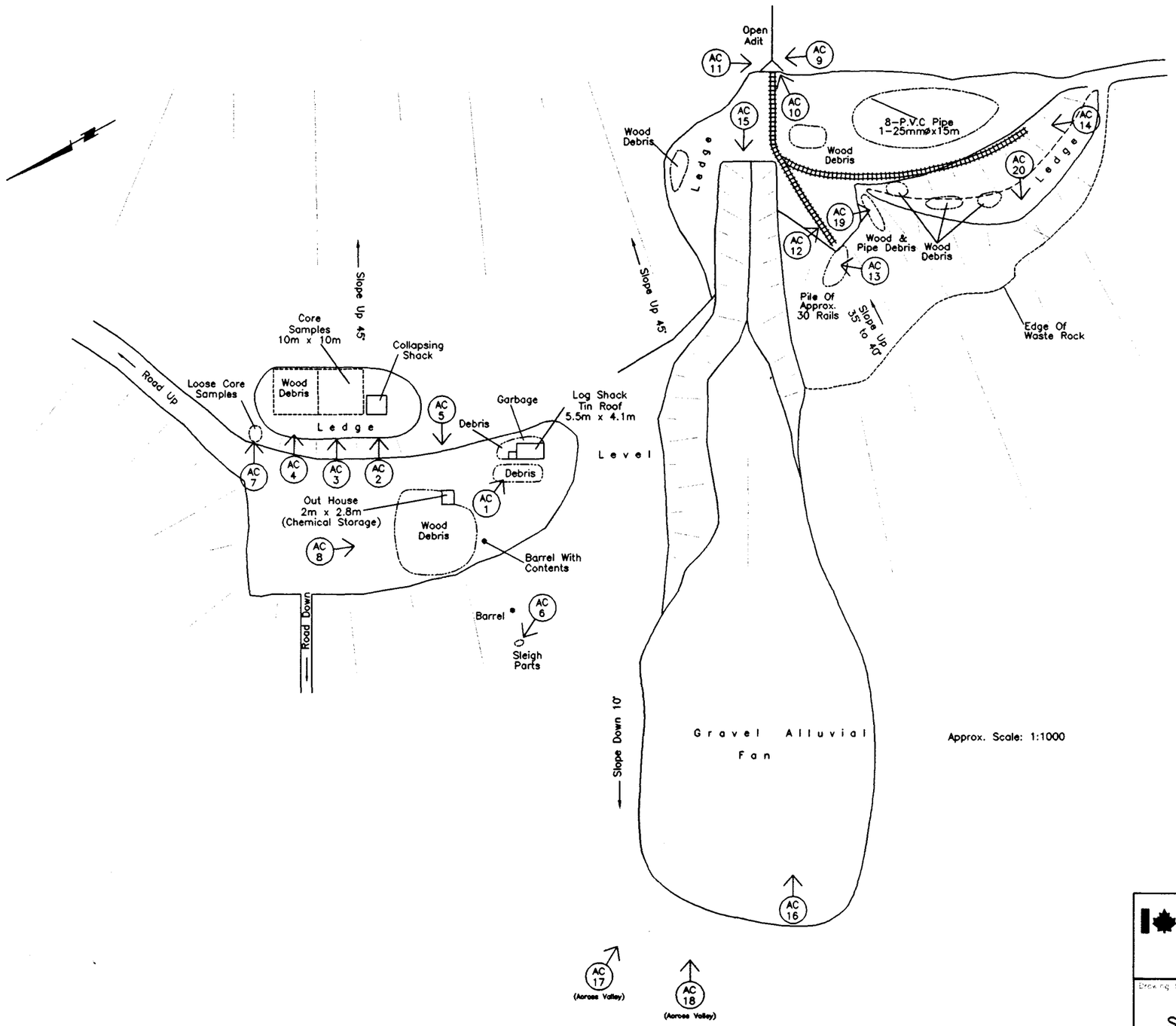
File No. G3879

	AC-WQ-A 101 96 07 26
Non-halogenated Volatiles	
Benzene	<0.0005
Ethylbenzene	<0.0005
Toluene	<0.0005
meta- & para-Xylene	<0.0005
ortho-Xylene	<0.0005
Light Hydrocarbons (C5-9)	<0.1

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.

APPENDIX D

DRAWINGS



Approx. Scale: 1:1000

Legend

- Adit
- Road
- Extent Of Waste Rock
- Track
- Slope Down
- Buildings
- Extent of Debris, Timber, Cable, Pipe, etc.
- AC 1 — Photograph No. & Direction

PLOT: 1=1
CAD FILE: INVEN-96\ARCTIC-C\ARCTIC-1

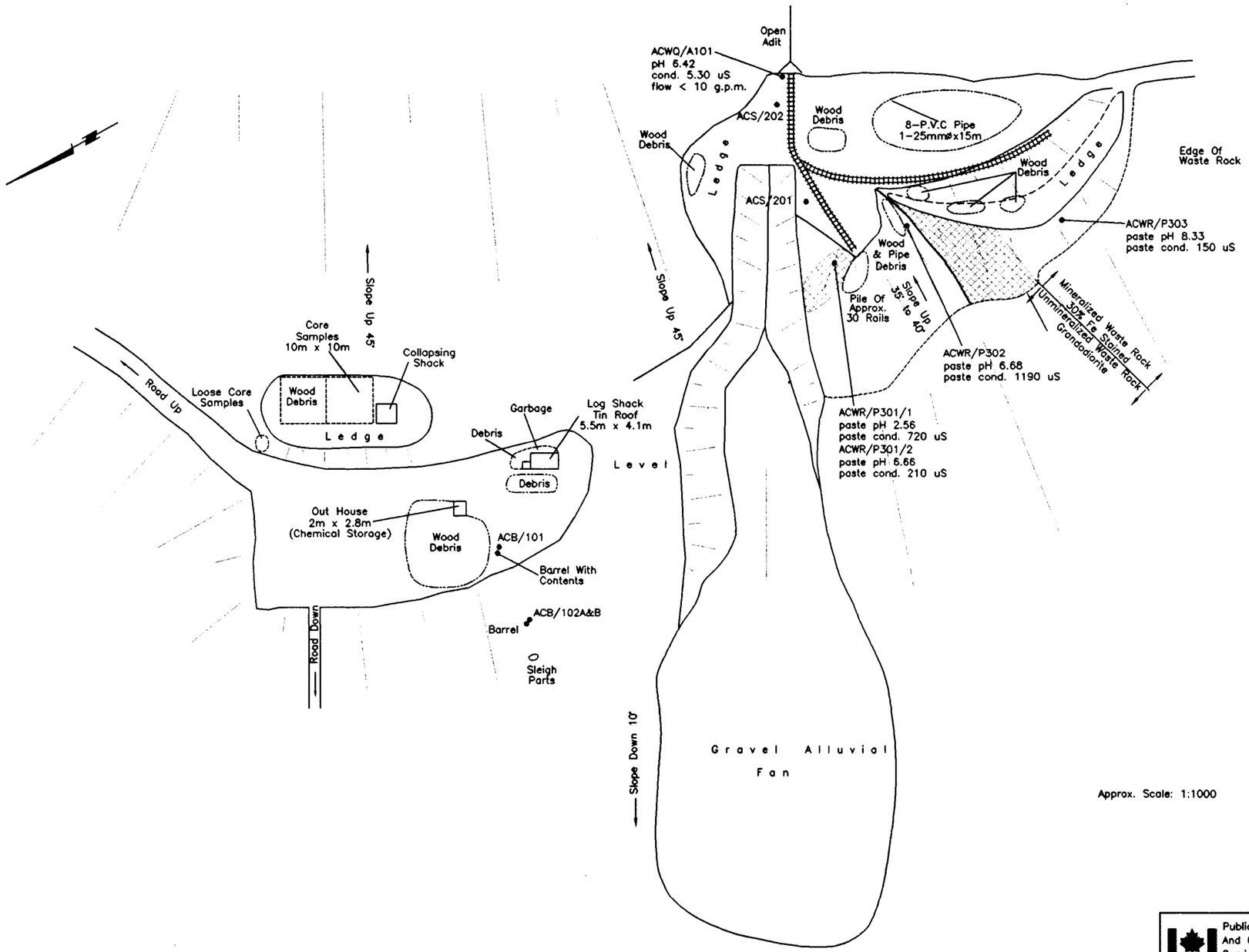
Public Works And Government Services Canada / Travaux publics et Services gouvernementaux Canada

Architectural & Engineering Services
Western Region

Arctic Caribou Mine
Site Development & Photo's
Yukon Territory

626967

1 of 2



Approx. Scale: 1:1000

Legend

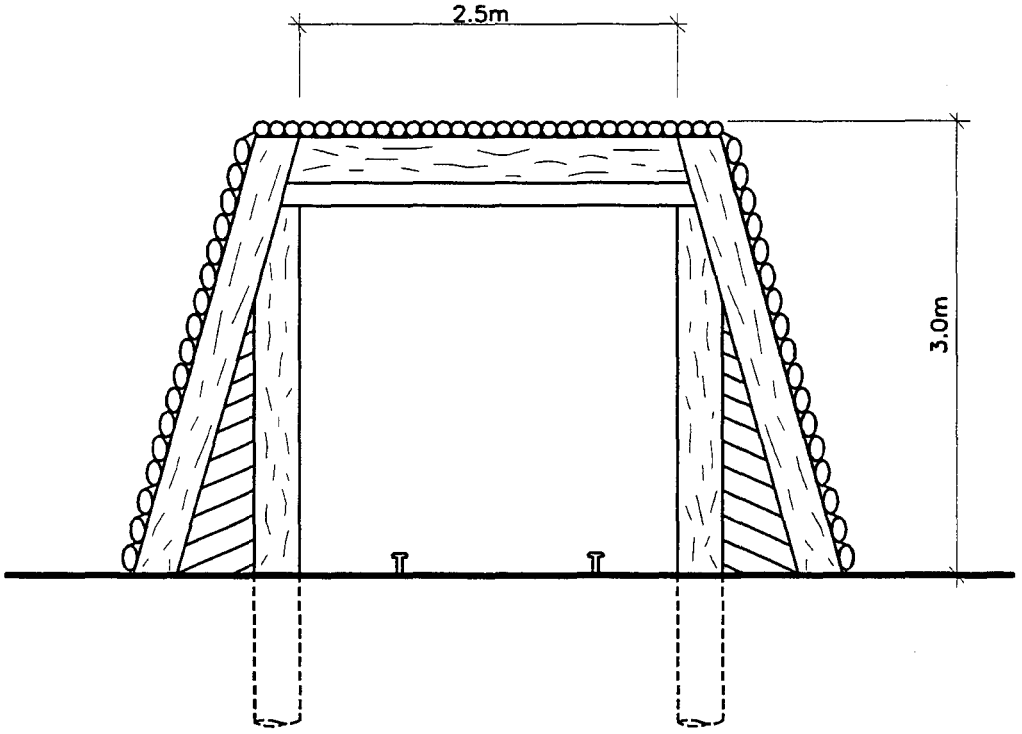
- Adit
- Road
- Extent Of Waste Rock
- Track
- • ACWQ/A3/1 — Water Quality Sample (site designation)
- • ACWR/P1/1 — Waste Rock (site designation)
- • ACS/1 — Soil Sample (site designation)
- • ACB/1 — Barrel Sample (site designation)
- Slope Down
- Yellow/Brown Weather Surface > 50% Staining
- Buildings
- Extent of Debris, Timber, Cable, Pipe, etc.

PLOT: 1=1
CAD FILE: INVEN-96\ARCTIC-C\ARCTIC-2

Public Works And Government Services Canada / Travaux publics et Services gouvernementaux Canada
Architectural & Engineering Services
Western Region

Drawing title / Titre du dessin:
Arctic Caribou Mine Geological Information
Yukon Territory

Project no. / no. du projet: 626967
Dwg. no. / dessin no.: 2 of 2



FRONT VIEW
N.T.S.

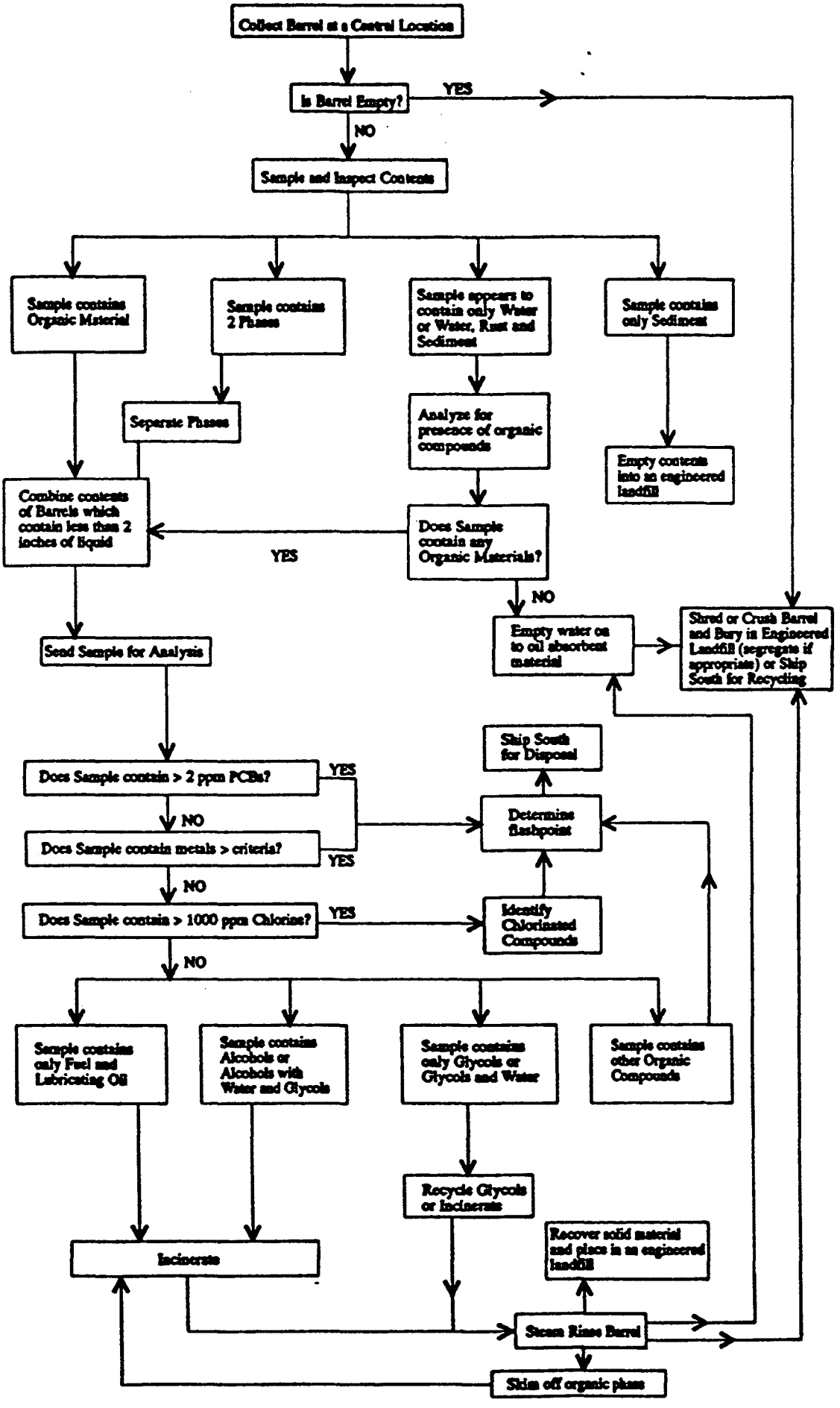
CAD FILE: INVEN-96/ARCTIC-C/ARCTIC-2 PLOT: 20=1

Arctic Caribou Mine
Adit

APPENDIX E

BARREL PROTOCOL

FLOW CHART FOR THE DEW LINE CLEANUP OF BARRELS



BARREL CLEAN UP PROTOCOL

A flow diagram of the methodology for the processing, cleanup and disposal of barrels is attached.

A. Inspection

1. *The area around the barrels should be tested with a VOC metre to ensure safe working conditions. If the VOC levels exceed 20% of the Lower Explosive Limit (LEL), then all work shall be conducted in accordance with appropriate sections of the NIOSH Guidelines, the National Fire Code of Canada and the TDGA for flammable and combustible materials.*

2. *All barrels are to be inspected to address the following items which shall be recorded and used as a guide when opening barrels (section B.3):*

    1. *Symbols, words, or other marks on the barrel that identify its contents, and/or that its contents are hazardous: e.g. radioactive, explosive, corrosive, toxic, flammable.*
    2. *Symbols, works, or other marks on the barrel that indicate that it contains discarded laboratory chemicals, reagents, or other potentially dangerous materials in small-volume containers.*
    3. *Signs of deterioration or damage such as corrosion, rust, or leaks at seams, rims, and V grooves.*
    4. *Spillage or discolouration on the top and sides of the barrel.*
    5. *Signs that the barrel is under pressure such as bulging and swelling.*

B. Opening and Sampling

1. *Pressurized barrels are extremely hazardous and shall be opened with extreme caution. Only non-sparking equipment shall be used to open barrels. All personnel responsible for opening barrels shall be provided with appropriate safety equipment and clothing. Procedures outlined in NIOSH USEPA 1988 Safety and Health Compliance for Managers (165.8) USEPA-29-CFR, 1910-1920, shall be followed.*

2. *If the bungs can readily be moved; then the barrels shall be opened slowing allowing time for any pressure in the barrel to be released before the bung is fully removed.*

3. *If the bungs are not readily moved, or inspection suggests that opening of the barrel presents a special hazard, then the barrels shall be vented remotely to relieve any internal pressure that may be present prior to opening. Remote venting shall be conducted using a suitable device such as a sharp spear weighted and dropped from an appropriate height or released from a tube housing a spring to penetrate the barrel. The remote venting operation shall be conducted from a safe distance from other site operations and from behind suitable walls or barricades. After sampling, the spear opening shall be plugged.*

4. *Samples of the contents of all barrels shall be extracted using a drum thief. All barrels shall be clearly numbered using spray paint or other suitable marker.*

5. *Barrels shall not be transported until it has been determined that they are not under pressure, do not leak and are sufficiently sound for transport.*

6. *Barrels containing less than 50 mm of liquid may be combined with compatible material prior to sampling; samples inferred to contain only water on a visual examination shall be tested prior to this consolidation. Barrel contents which consist of black oil shall not be consolidated.*

7. *Consolidation of barrel contents shall take place in a secure barrel processing area. At many DEW Line sites several caches of barrels are present and, therefore, it may be desirable to establish several secure sorting areas; barrels scattered on the tundra may be vented, then closed, and then transported to a barrel sorting area for sampling and possible consolidation.*

C. *Testing*

1. *Liquid samples shall be inspected and classified as either containing water or organic materials. Samples thought to contain water shall be analysed on-site to confirm that they are indeed water and contain less than 2% glycols or alcohols by Fourier transform infrared spectroscopy (FTIR).*

2. *The contents of barrels containing organic materials, including aqueous samples which contain more than 2% glycols or alcohols, shall be tested for PCBs, Total chlorine, cadmium, chromium and lead, in addition to identification of the major components e.g. fuel oil, lubricating oil. Samples containing greater than 1000 ppm chlorine shall be further tested to identify the chlorinated compounds present.*

3. *Contents of barrels which contain two or more phrases shall have all phrases analysed; the organic phases as described above and the aqueous phases to ascertain whether it contains less than 2% organics. In addition, the aqueous phases shall be tested for any components found in the organic phases above the criteria described below.*

D. *Disposal of Barrel Contents*

1. *Barrels containing only rust and sediment shall be treated as empty barrels.*

2. *Barrel contents comprising water only (less than 2% glycols or alcohols) shall be transferred to an open vessel such as a utility tub or half-barrel and any organic material removal by agitation with a pillow or segment of oil absorbent material. The water may then be discarded on to the ground that is a minimum of 30 metres distance from natural drainage courses. Used oil absorbent material shall be treated as described in Section D.5.*

3. *Barrel contents which are composed of water with glycols and/or alcohols or*

organics phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium and 100 ppm lead, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration shall be subjected to a leachate extraction test. Material found to be not leachate toxic material shall be treated as hazardous waste, packaged in accordance with TDGA and/or IATA regulations as required, and disposed of off-site at a licensed disposal facility.

4. *Barrel contents which contain greater than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium or 1000 ppm lead shall be disposed of off-site at a licensed disposal facility. Contents may be combined with compatible materials for shipping purposes (note section E.1). Flash point may be required to be determined if they cannot be inferred from the product identification.*

5. *Used oil absorbent material should be treated as hazardous waste and disposed of off-site at a licensed disposal facility unless, it is shown to be uncontaminated with PCBs (<2 ppm), chlorine (<1000 ppm) cadmium (<2 ppm), chromium (<10 ppm) and lead (<100 ppm) in which case it may be incinerated on site.*

E. Cleaning and Disposing of Barrels

1. *Empty barrels resulting from consolidation of contaminated material (Section D.4) shall be triple rinsed with solvent (varsol, diesel, etc.) Prior to steam cleaning; solvent washings shall be added to the bulked contaminated products unless analysed separately and shown to be suitable for incineration. Alternatively, the empty barrels may be shipped off-site and labelled appropriately (TDGA).*

2. *Only empty barrels resulting from consolidation of small volumes (section B.6), from incineration (section D.3) and from solvent washing (section E.1) require steam cleaning; after cleaning they shall be treated as described in E.3. Recycling of rinsate is permitted. The resulting wash water shall have any organic material removed by agitation with a pillow or segment of oil absorbent material. The water shall then be analysed for cadmium, chromium and lead. If these metals are present at less than 0.01, 0.10 and 0.10 ppm respectively, then the water may be discarded on land that is a minimum of 30 metres from natural drainage courses, but if not then it shall be disposed of off-site at a licensed disposal facility. Alternatively, the wash water may be shipped off site without testing for disposal at a licensed disposal facility. Used absorbent material shall be disposed of as described in section D.5.*

3. *Empty barrels may be crushed or shredded and be landfilled on-site as non-hazardous wastes. The barrels shall be crushed in such a manner so as to reduce their volume by a minimum of 75%. Shredded barrels may be disposed of off-site as recycled metals.*