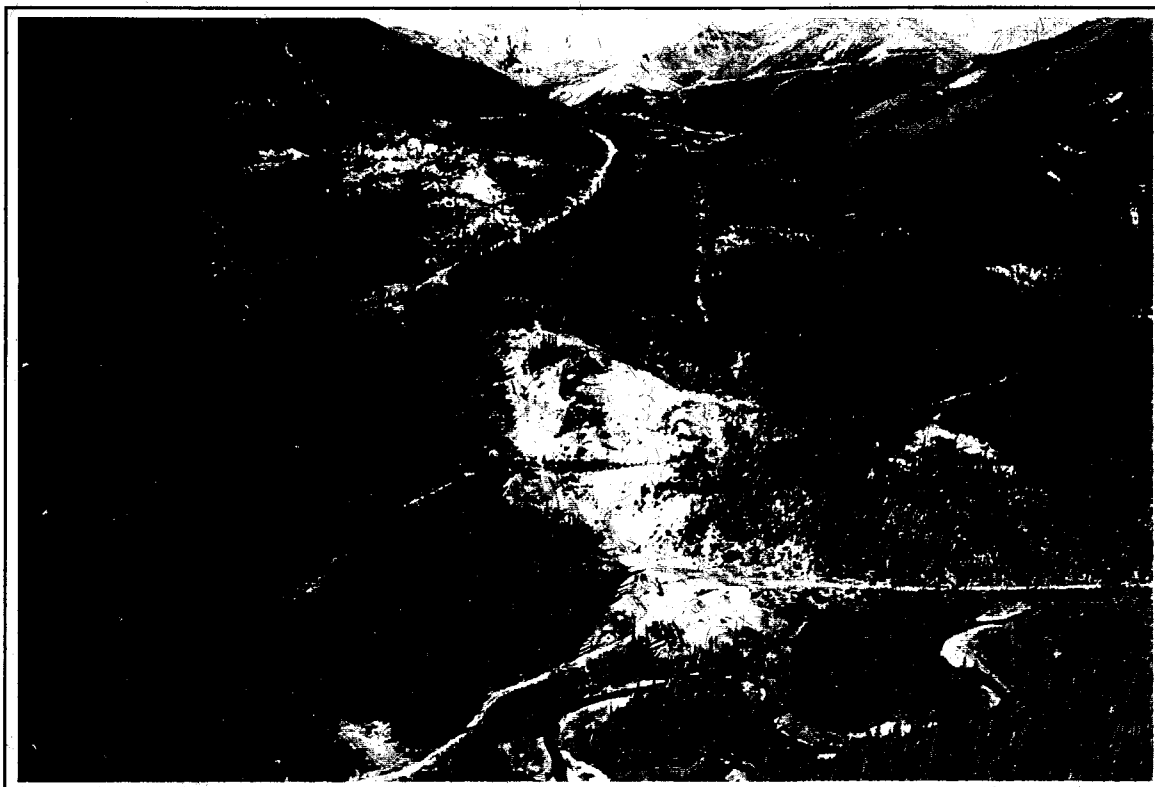


PWGSC**Quality in Environmental Services**

**PHASE II ENVIRONMENTAL ASSESSMENT
OF THE
STUMP
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 Stump abandoned mine site (61° 33' 26 " N, 132° 09 '08" 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 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 the three mine openings are in unstable condition and are not adequately secured from public and wildlife access. The rails and trestles in front of the lower adit are physically unstable and pose a health and safety hazard to humans visiting the site. An assessment of the acid rock drainage potential shows that the risk to the environment due to the presence of waste rock and adits is minor at this time. One 205 litre barrel is full with a hydrocarbon liquid and is suitable for incineration. Aesthetic concerns arise from miscellaneous debris scattered though out the site.

Using applicable federal and territorial criteria, background characteristics, as well as northern mine reclamation guidelines, the recommendations are to secure all three mine openings using surrounding rock and soil, remove and burn timbers, demolish and bury on site rails and trestles, collect and bury on-site all site debris. No further test work is recommended on the waste rock. A sampling program should be initiated shortly to determine the seasonal water quality variation in the adjacent fish bearing Ketz River. It is recommended that every five years a monitoring program be undertaken to obtain water quality data for spring freshet, middle summer and late fall conditions. Should further development occur on the site, regulatory agencies should ensure that an acid drainage prevention plan is developed which includes detailed measures for handling and disposal of mineralized waste rock.

Summary of Conclusions and Recommendations

ASSESSMENT COMPONENT	RISK	RECOMMENDATION
1. Building, Infrastructure, Equipment		
1 shed	Health and Safety	Burn and bury
2 - wood loadout ramps	Aesthetic	Burn and bury
track and trestle	Aesthetic	Burn and bury steel
2. Non-Hazardous Waste Material		
Misc. Wood and metal debris	Aesthetic	Collect and bury in depression
2 ore cars	Aesthetic	Collect and bury in depression
3. Hazardous Materials		
1 barrel full - lower site	Environmental	Remove and incinerate
4. Water Quality		
Mine Seepage - upper adit	Minor environmental risk	No action
Site Drainage - upper and lower site	Minor environmental risk	Monitor quarterly every 5 years
Receiving Waters - stream	Minor environmental risk	Monitor quarterly every 5 years
5. Waste Rock Disposal Areas		
7 small piles - 10,000 tonnes	minor environmental risk	No Action
6. Mine Openings		
2 adits, 1 shaft	Health and Safety	Seal with waste rock
7. Tailings		
None		

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1.0 INTRODUCTION AND BACKGROUND

Phase I 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 in 1993. These assessments were intended to provide a general overview of historical activities, describe site infrastructure, workings and wastes, describe possible environmental or safety concerns on each site, and provide general recommendations for remediation or follow-up work.

The phase I investigation revealed that there exists two unsealed and collapsing adits that pose a public safety hazard. The site also contained assorted waste debris, a small building, a wooden loadout structure, and several piles of waste rock.

In light of these 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 Stump 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 mitigation of these risks.

1.1 LOCATION

Stump mine site is located at 61° 33' 26"N latitude and 132° 09' 08"W longitude (Figure 1). It is located approximately 50 km directly south southeast of the village of Ross River. The site is approximately 1200 m above sea level.

1.2 OVERVIEW OF SITE DEVELOPMENT

The history of development of the site is compiled in the Minfile record 105F 055 and is summarized here. The area was trenched in 1955-56, and 5 holes were drilled in 1967 for a total of 290 m. Between 1968 and 1969 more that 427 m of underground development was completed, including an incomplete 36 m of cross-cut 46 m below the first adit. The property changed hands, and in 1979, Iona Silver Mining Ltd. completed a cross-cut. In 1980, the lower adit was advanced 67 m. Geochemical and geophysical surveys were conducted by Canamax Resources Inc. who optioned in the property in 1985. In 1987, four holes were drilled for a total of 1692 m.

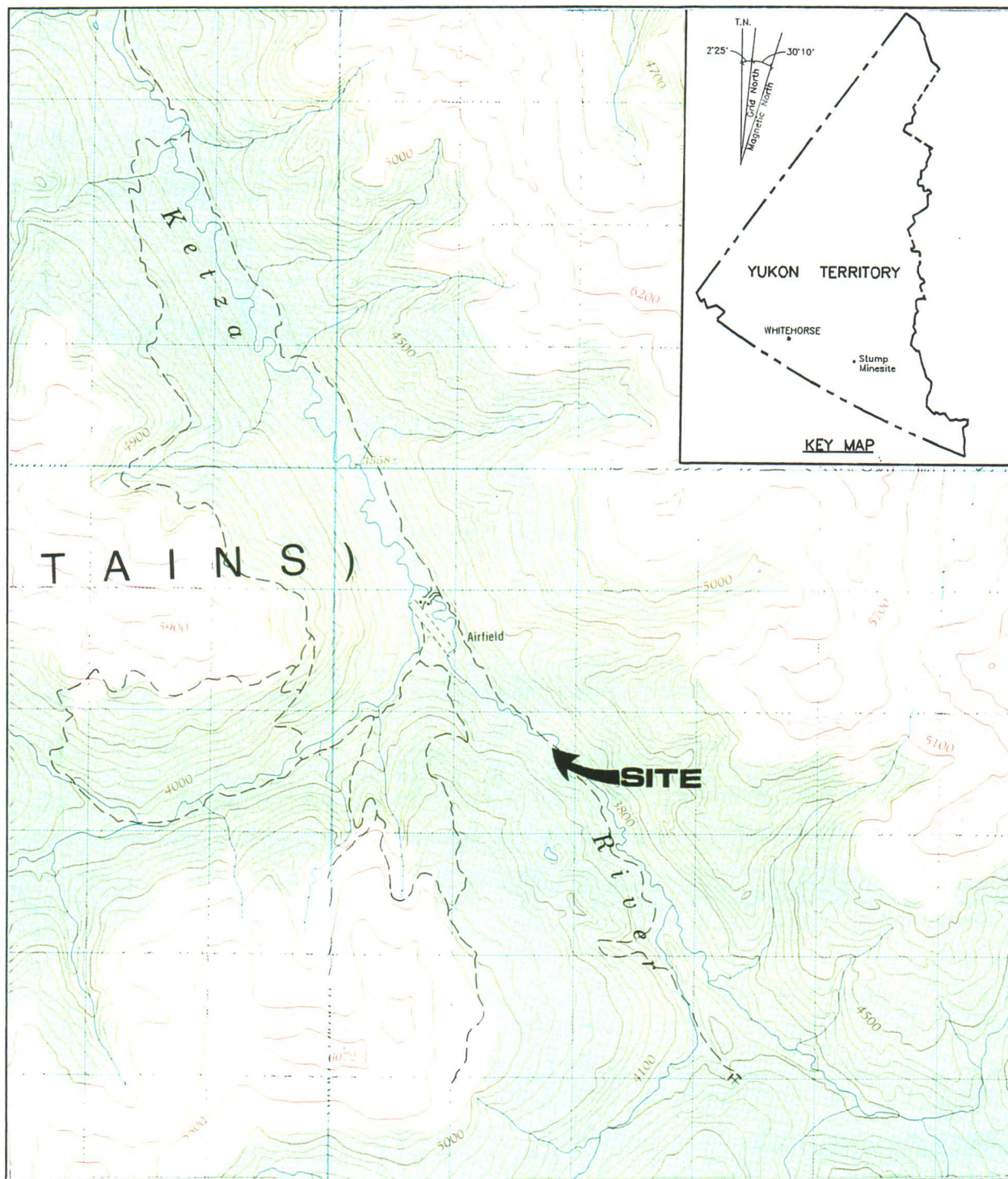


**Figure 1. Location of Stump Mine - 1:50,000, NTS-105F/9
[Energy Mines and Resources Canada: 1971]**

1.3 SITE ACCESS

By road, the site is reached by travelling approximately 35km southeast from Ross River on the Campbell Highway then turning south and travelling 30km on the Ketza River road. The site is located one kilometre south of the Ketza River airstrip and is accessible by two-wheeled drive vehicles.

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, 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.

Barrel Clean Up Protocol (INAC, 1992)

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

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

The following assessment criteria were used for the Stump abandoned mine site:

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 the results of upstream (background) water quality
CCME:	Remediation Criteria for Water - Freshwater Aquatic Life 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. Barrel Clean Up

INAC:	Barrel Clean Up Protocol
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D. Mine Clean-Up and Reclamation:

INAC:	Mine Reclamation in Northwest Territories & Yukon
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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 Stump 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 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

Rhyolite dykes and stocks, and andesite dykes, have intruded granitoid rocks. The dyke rocks are often propylitically to argillically altered and are associated with the mineralized shear zones. The mineralization consists of both massive and disseminated stibnite with lesser amounts of pyrite and sphalerite and traces of realgar, orpiment galena and tetrahedrite in a gangue of quartz and minor barite.

The major commodity identified at this site is antimony. Minor commodities include lead, silver and gold.

4.2 SURFACE HYDROLOGY

Both the site and regional drainage are to the northeast draining into the Ketzá

River (see Figure 1). The Ketza River falls within the Yukon River drainage system.

Mine water seepage flows from the main adit and through stockpiled waste rock drain indirectly to Ketza River. A seasonal stream flows northeast into the Ketza River and occurs immediately adjacent to the south side of the mine site.

Flow from the adit was approximately 0.03 L/sec at the time of the site visit. The Ketza River was flowing approximately 500 L/sec and the small tributary stream was flowing approximately 50 L/sec. Baseline water quality data for the Ketza River is provided in the section on surface water quality (section 5.3)

4.3 CLIMATE

The closest climatological information is from the town of Ross River, 61° 59' N, 132° 27' W; 698m above sea level (Environment Canada, 1980). Total annual precipitation is 263.5 mm. This consists of 152.1mm of rainfall and 105.8mm of snowfall. Highest levels of rainfall occur in July and highest levels of snowfall occur in January. Temperatures range from -28.6° C in January to 12.8° C in July. The mean annual temperature is -5.7° C.

4.4 VEGETATION

Stump minesite occurs within the Pelly Mountains ecoregion. Much of the ecoregion lies above the treeline, and is dominated by treeless tundra vegetation including lichens, dwarf ericaceous shrubs, birch and willows. Wetter sites are occupied by grasses, sedges, cottongrass and mosses. Subalpine regions are characterized by open stands of black and white spruce and alpine fir. Valleys and lower elevation slopes are occupied by aspen and scrub birch. Disturbed areas at the mine opening and along the access road are dominated by fireweed.

4.5 FISH AND WILDLIFE RESOURCES

Alpine habitats are typically low in both species number and diversity. Bird species noted at the site include bald eagle, ptarmigan and rosy finches. Arctic ground squirrels and pika are the dominant rodent species and support a number of carnivorous species including wolf, coyote, and bear. Ungulates include caribou, moose and mountain sheep. This area is only able to support these species during the short summer period and most animals hibernate or move to lower elevations

during the long cold winters.

Arctic Grayling and Slimy Sculpin have been observed and netted in the Ketza River. Though they do not spawn there, Chinook Salmon may overwinter in the river. Other species may include: Broad Whitefish, Rainbow Trout, Cutthroat Trout, Rainbow Trout, and Longnose.

4.6 SITE TOPOGRAPHY AND SOILS

The regional and site topography are mountainous, with a relief of about 1,200 metres at the Ketza River to 2,000 metres at some of the higher peaks. The mountains, though steep, are rounded with few cliffs and rock outcrops and can be easily traversed. The level of the main adit, site workings, and waste rock stockpiles is at 1212 metres lying 8 metres above the Ketza River to the northeast. Towards the southwest lies the upper adit and main shaft on steep slopes.

Topography above the mine site exhibits typical upper-alpine features such as stone nets and felsenmeer interspersed with hummocky tundra. Steep upper slopes are covered with talus or scree material contributed by freeze-thaw fracturing of sedimentary rock. The slope is uniformly covered with talus; at lower elevations, fractured shale outcrops are interspersed with hummocky flats and gentle slopes.

The Pelly Mountains ecoregion is dominated by two soil types - dystic brunisols and eutric brunisols. Turbic cryosolic soil occurs sporadically.

4.7 PERMAFROST

Stump is in a discontinuous permafrost zone. No attempt was made to establish the presence or absence of permafrost at this site.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 BUILDING, INFRASTRUCTURE, and EQUIPMENT

Table 1 lists all buildings, infrastructure and equipment on site by location and volume.

Table 1 Buildings, Infrastructure, and Equipment

ITEM	LOCATION	LENGTH/VOL./NO	MATERIAL
Rail	In front of lower adit	69 metres	steel, wood
Adit support structure	In front of upper and lower adits	< 18 cubic metres	wood
Loadout Trestle	Lower site north of access road	31 metres long x 1 metre high	wood
Shed	Lower site north of road	3 long x 2 wide x 3.5 high	wood
Ore cars	Lower site south west of road	3	steel

5.2 NON-HAZARDOUS WASTE MATERIALS

There was a only small quantities of non-hazardous waste material observed in and around the site. A small amount of metal piping and debris is at the lower site west of the adit and south of the main access road. A very small quantity of debris is scattered throughout the site. Several small piles of timbers used for supporting structures and loadout ramps lay near the adits and total < 50 cubic metres of material. One empty barrel was observed approximately 95 due north of the lower adit.

5.3 HAZARDOUS MATERIALS

One barrel full with hydrocarbon liquids was located approximately 60 metres north-northwest of the lower adit and tested for disposal by incineration. These results are shown in Table 2.

Table 2 Results of Barrel Sampling for Incineration

Parameter	Barrel Clean Up Criteria (ppm)	Stu/Brl/1 (ppm)
Cadmium	2	< 1
Chromium	10	< 1
Lead	100	51.7
Total Organic Halides	1000	17
PCBs	2	< 2

5.4 SURFACE WATER QUALITY

Four water samples were collected. Sample STUWQ/A1 was collected from the discharge from the lower adit. No water was flowing from the upper adit. STUWQ/STR1-1 was collected on the Ketz River 190 metres upstream of the exploration site and sample STUWQ/SRT1-2 was collected 50 metres downstream of the site. Sample STUWQ/STR2-1 was collected from a small tributary stream that runs along the east side and empties into the river upstream of the site.

Flow from the adit was approximately 0.03 L/sec at the time of the site visit. The Ketz River was flowing approximately 500 L/sec and the small tributary stream was flowing approximately 20 L/sec.

Laboratory pH measurements taken from the water sample collected from the adit and from the stream samples were alkaline (range = 7.9 to 8.2). The conductivity was moderate ranging from 441 $\mu\text{S}/\text{cm}$ to 800 $\mu\text{S}/\text{cm}$ (mean = 562 $\mu\text{S}/\text{cm}$). Sulphate concentrations ranged from 73 mg/L to 105 mg/L.

Metal concentrations were generally low in the adit and stream waters. The quality of the adit drainage at Stump was well within the guidelines established under the Metal Mine Liquid Effluent Regulations (MMLE, 1977). Levels of nickel and zinc were also below the Canadian Water Quality Guidelines (CCME, 1987) for these metals (0.3 mg/L and 0.03 mg/L, respectively). Concentrations of arsenic, cadmium, chromium, copper, lead, nickel, selenium, and silver had concentrations below the detection limits of the analytical method used in this project.

No change in metals concentrations was apparent in the downstream sample

collected in the Ketza River compared to the upstream sample.

Table 3 Surface Water Samples - Significant Results

Sample ID	Sample Location	pH	Conductivity ($\mu\text{s}/\text{cm}$)	Metallic Parameters
STUWQ-STR-1-1	upstream in Ketza River	8.1	452	low
STUWQ-STR-1-2	downstream in Ketza River	8.2	554	Fe = 0.29 m/l Mn = 0.26 mg/l
STUWQ-STR-2-1	tributary stream on east side of mine	8.2	441	low
STUWQ-A1-1	lower adit seepage	7.9	800	low

5.5 WASTE ROCK DISPOSAL AREAS

A large (2600 m²) flat staging area constructed from the road toward the river dominates the site. The staging area is elevated approximately 3 m above the stream level and is composed of green-brown, sandy, pebbly, clast-supported waste overlain by approximately 10 cm of brown material of similar texture. Three small waste rock piles have been deposited on top of the staging area. Rock types identified in these piles include light gray to yellow brown, platy to massive schist, and coarse-grained vein quartz. The material in these piles is similar to that underlying the staging area.

A fourth waste pile is located on the west side of the road near the southwest edge of the site, and is covered with schist, weathered pale orange-brown to red-brown. Material within the pile is dark gray, sand to cobble sized schist and contains no visible mineralization.

The lower of the two adits is located at the level of the road. Only a thin layer of waste (<5 tonnes) is spread outside this adit. Two small waste piles have been deposited by end-dumping from a trestle outside of the upper adit, located approximately 20 metre up the hill. Material in these piles is matrix supported and composed of dark gray to green-brown clayey sand with few pebbles and cobbles. Spotty iron oxide staining was observed where individual sulphide grains have weathered.

Finally, a small amount of waste was found near the shaft entrance located above the upper adit. Material in the waste pile is dark gray sand with abundant cobbles and pebbles and rare (< 1%) spots of iron oxide. Scattered around the shaft are cobbles and boulders of orange-brown schist, intensely limonitic and hematitic breccia, and red-brown to black rocks of massive sulphides, primarily galena.

No evidence of seeps were observed from any of the waste rock piles. The total amount of waste at the site was approximately 6800 tonnes (6200 tons).

Eight waste rock samples were collected in seven pits. Locations are shown on the site map (Drawing 1). Samples STUWR/P2, P4, P5, and P6 were collected from the four waste rock piles in the staging area. Samples STUWR/P3-1 and P3-2 were collected from a pit dug into the surface of the staging area itself. In excavating the pit, it was found that the top 10 cm was composed of different material than lower in the pile. Samples STUWR/P1 and P7 were collected from the two waste rock piles below the upper adit, and STUWR/P8 was taken from the pile outside the shaft.

Paste Parameters

All samples collected had laboratory paste pH values near neutral to alkaline (range = 6.2 to 9.1; mean = 7.6), indicating that the waste is not currently generating acid. Field paste conductivity values ranged from 80 $\mu\text{S}/\text{cm}$ to 880 $\mu\text{S}/\text{cm}$ (mean = 426 $\mu\text{S}/\text{cm}$) for those samples measured. Sample P4 collected from the unmineralized schist had the lowest conductivity (80 $\mu\text{S}/\text{cm}$). The highest values were measured on samples P2 (500 $\mu\text{S}/\text{cm}$), P4 (840 $\mu\text{S}/\text{cm}$), and P6 (880 $\mu\text{S}/\text{cm}$) collected from the piles on the staging area.

Acid Base Accounting

Total sulphur concentrations ranged between 0.4% and 8% (mean=3.4%). In all cases, less than 0.5% of the sulphur has been oxidized (i.e. is present as sulphate). The sample collected from the unmineralized pile (P5) and from the pile near the shaft (P8) have NP:AP ratios of 24 and 15, respectively, indicating that they have low potential to generate acid. Sample P3-2, which represents the material underlying the staging area, also has low acid generating potential (NP:AP=13). All other samples were potentially acid generating, with NP/AP ratios ranging from <0.1 to 2.5 (mean= <1.1).

Metals Concentrations

The sample collected from the unmineralized pile (P5) contained generally low metals concentrations. All the other samples collected contained moderate to high concentrations of antimony, arsenic, copper, iron, lead, manganese, and moderate to high concentrations of zinc. Arsenic concentrations ranged from 756 ppm to >10,000 ppm (mean=4654 ppm). Lead concentrations ranged from 3571 ppm to >10,000 ppm (mean=4800 ppm), and silver concentrations ranged from 65 ppm to >200 ppm (mean=100 ppm).

Table 4 Summary Acid/Base Accounting Test Results

Sample #	Paste pH	Total S (%)	SO4 (%)	AP	NP	Net NP	NP/AP
WR/P1/1	0.03	0.72	no assay	22.50	-2.31	-24.81	-0.10
WR/P1/2	0.05	1.32	0.63	21.56	8.63	-12.94	0.40
WR/P2/1	7.55	0.12	no assay	3.75	14.63	10.88	3.90
WR/P2/2	4.95	1.44	0.47	30.31	9.13	-21.19	0.30
WR/P2/3	4.80	1.44	0.48	30.00	8.00	-22.00	0.27
WR/P3/2	7.05	1.03	0.12	28.44	44.63	16.19	1.57
WR/P1/3	6.95	1.49	0.24	39.06	58.38	19.31	1.49
WR/P4/1	7.65	0.61	no assay	19.06	86.38	67.31	4.53
WR/P5/1	8.20	0.55	no assay	17.19	94.88	77.69	5.52
WR/P6/1	7.78	0.89	no assay	27.81	94.25	66.44	3.39
WR/P7/1	6.78	3.01	0.56	76.56	17.94	-58.63	0.23
WR/P7/2	7.37	2.46	0.28	68.13	62.88	-5.25	0.92

5.6 MINE OPENINGS AND EXCAVATIONS

In total, two adits and one shaft remain abandoned on-site. All opening structures are dilapidated and unstable. The surrounding rock and soil above both adits are in unstable condition and presents an immediate safety hazard. Table 4 summarizes the findings of the mine openings investigation.

Table 5 Mine Openings

Adit	Location	Drift Length	Condition
Lower Adit	lower staging area, 1151 m elev.	67 metres	unstable condition - loose rock above opening, timber structure rotting, 2x6 cladding partially blocking entrance
Upper Adit	upper site, 1182 m elev.	Unknown	unstable condition - loose rock above, dilapidated timber support structures, drift partly collapsed at opening
Main Shaft	upper access road, 1197 m elev.	> 55 meters	unstable condition, loose rock surrounding opening, timber support box in poor shape

5.7 TAILINGS

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

6.0 CONCLUSIONS

The primary concern is the health and safety of humans and wildlife relating to the collapsing mine openings and the unstable rails and trestles. A secondary concern is the aesthetic appearance of scattered timbers, metal debris site, and loose tanks and barrels located throughout the.

6.1 HEALTH AND SAFETY

All the three openings are in unstable condition and are not adequately secured from public and wildlife access. The upper adit is collapsed and remains unstable due both to the rotting supporting structure and surrounding soils and rock. The lower adit remains open and is readily accessible to the public. The unstable supporting structure is collapsed and entrance partly blocked by rotting timbers.

The main shaft is left exposed and is an immediate health and safety concern.

The rails and trestles in front of the lower adit are physically unstable and pose a health and safety hazard to humans visiting the site. Several large timbers used for loading and transporting ore are left perched are a safety hazard.

One shack remains on site and presents a safety hazard to visitors. The building is in fair shape with nails and insulation exposed.

6.2 Environmental Risks

Waste rock at the Stump exploration site is not currently generating acid. However, approximately one half, or 3400 tonnes, of the waste is potentially acid generating. Moderate to high conductivity measurements indicate that oxidation is occurring in some of the waste, and acidity produced is likely being buffered by available Neutralizing Potential (NP). Determining if acid will be produced from this waste would require kinetic testing. However, the material has been exposed since at least 1980 indicating that the sulphides in the waste react slowly.

The high metal concentrations in the waste are not being reflected in the adjacent stream and Ketzka River. However, sampling for this project was conducted on one day in the dry season. More of the soluble metal constituents stored in the exposed waste rock may reach the drainages under high precipitation, high runoff conditions. These would also be high stream flow conditions possibly diluting constituents added to the stream.

Since the exploration site is not negatively impacting the water quality of the Ketzka River, it is recommended that the waste be left as is, and that a quarterly water quality monitoring study be undertaken immediately. The objective of the monitoring would be to determine if the waste has any negative impacts on the water quality at other times of the year. Monitoring should be conducted for one full year and the detection limits used in subsequent water analyses should be sufficiently low to enable comparison of the results with the CCME guidelines. If there appears to be no impact from the site, quarterly monitoring should be instigated every 5 years. At one of the visits to the site for each year, a paste survey should also be conducted to detect any change in the pH and conductivity of the waste rock.

If an impact on water quality is detected, options for remediation of the waste rock should be reviewed and action taken.

One full 205 litre barrel is present on site north-northwest of the lower adit. Currently, it is not leaking nor is there any evidence of soils staining, however if not properly disposed of immediately, the barrel presents a potential environmental risk.

6.3 Aesthetic Concerns

The site is on a remote but well-traveled dirt road up the Ketza River valley. Most of the waste rock is adjacent to or visible from the road and, therefore, presents an aesthetic concern.

Miscellaneous site debris, one shed (not suitable for shelter), rail and timbers, and a dilapidated loadout ramp in front of the lower adit also present aesthetic concerns.

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 all three mine openings be secured from human and animal access for health and safety reasons. Since site access is good, adits should be covered with surrounding rock and soil using readily available equipment. Timbers should be removed and buried along with other site debris. Should the mine need to be reopened, access to workings is achievable with heavy equipment.

Recommendation 2.

It is recommended that the rails and trestles, shed, and load out ramp be demolished and buried on site for health and safety reasons. This can be accomplished using locally available resources and labour and 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 3.

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. The method detection limits used are to satisfy the CCME criteria for fresh water aquatic life.

It is recommended that every five years a monitoring program be undertaken to obtain water quality data for spring freshet, middle summer and late fall conditions.

Should further development occur on the site, regulatory agencies should ensure that an acid drainage prevention plan is developed which includes detailed measures for handling and disposal of mineralized waste rock.

Recommendation 4.

One full barrel left on site containing waste petroleum hydrocarbons should be immediately removed from the site and disposed appropriately. If cleanup of this is conducted along with a regional cleanup, the barrel contents may be incinerated at a temporary barrel incineration facility established for the purpose of incinerating waste hydrocarbons at several mine sites in the area.

Recommendation 5.

It is recommended that the miscellaneous site debris be collected and buried on-site for aesthetic reasons.

8.0 COST ESTIMATES TO IMPLEMENT RECOMMENDATIONS

A cost estimate of expected remediation/mitigation costs to an accuracy of 25% is provided under a separate cover. The cost estimate includes contractor and project management costs and contingency.

REFERENCES

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

Determination of Acid Rock Drainage Potential

P118105

**STUMP
ACID ROCK DRAINAGE
ASSESSMENT REPORT**

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SITE MAP

P118105

**STUMP
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 Stump Abandoned Mine Site*, prepared by Environmental Services, Public Works and Government Services Canada (PWGSC). The reader is directed to that report for a comprehensive environmental assessment of the Stump site.

The Stump exploration site is located approximately 50 km south-southeast of Ross River on the Ketz River, approximately 5 km from the Ketz Mine. The site is accessible by vehicle.

Mining related disturbances observed during the site assessment consist of two adits, one shaft, and eight waste rock piles. No mill or tailings pond is present at the site.

The site is located beside the Ketz River and is covered by thick vegetation consisting of willows near the river and black spruce further up the hillside. Portions of the hillside were stripped of vegetation during exploration.

This report reviews the existing, and the potential for, acid rock drainage (ARD) conditions at the Stump 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 Steffen, Robertson and Kirsten (SRK). 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.

2.0 GEOLOGY AND MINERALIZATION

The Stump showing is hosted in black shales and cherts of the Ordovician to Lower Devonian Road River Formation (Yukon Minfile 105O 057). Mineralization consists of galena (PbS) and pyrite (FeS₂) with minor sphalerite (ZnS), tetrahedrite (Cu₁₂Sb₄S₁₃) and arsenopyrite (FeAsS) in a carbonate gangue (DIAND, 1994).

The commodities of interest at the site are lead, silver and zinc.

3.0 WASTE ROCK DISPOSAL AREAS

3.1 Description

The large (3500 m²) flat staging area constructed from the road toward the river dominates the site. The staging area is elevated approximately 3 m above the stream level and is composed of green-brown, sandy, pebble size, clast-supported overburden overlain by approximately 10 cm of brown material of similar texture. Three small waste rock piles have been deposited on top of the staging area. Rock types identified in these piles include light gray to yellow brown, platy to massive schist, and coarse-grained vein quartz. The material in these piles is similar to that underlying the staging area.

A fourth pile is located on the west side of the road near the southwest edge of the site, and is covered with schist, weathered pale orange-brown to red-brown. Material within the pile is dark gray, sand to cobble sized schist and contains no visible mineralization.

The lower of the two adits is located at the level of the road. Only a thin layer of waste rock (<5 tonnes) is spread outside this adit. Two small rock piles have been deposited by end-dumping from a trestle outside of the upper adit, located approximately 20 metres up the hill. Material in these piles is matrix supported and composed of dark gray to green-brown clayey sand with few pebbles and cobbles. Spotty iron oxide staining was observed where individual sulphide grains have weathered.

Finally, a small amount of rock was found near the shaft, located above the upper adit. Material in the pile is dark gray sand with abundant cobbles and pebbles and rare (< 1%) spots of iron oxide. Scattered around the shaft are cobbles and boulders of orange-brown

schist, intensely limonitic and hematitic breccia, and red-brown to black rocks of massive sulphides, primarily galena.

No evidence of seeps were observed from any of the waste rock piles. The total amount of waste rock at the site is approximately 6800 tonnes (6200 tons).

3.2 Samples

Eight waste rock samples were collected in seven pits. Locations are shown on the site map, Drawing 2. Samples STUWR/P2, P4, P5, and P6 were collected from the four rock piles in the staging area. Samples STUWR/P3-1 and P3-2 were collected from a pit dug into the surface of the staging area itself. In excavating the pit, it was found that the top 10 cm is composed of different material than lower in the pile, each was sampled. Samples STUWR/P1 and P7 were collected from the two rock piles below the upper adit, and STUWR/P8 was taken from the pile beside the shaft.

Four water samples were collected. Sample STUWQ/A1 was collected from the discharge from the lower adit. No water was flowing from the upper adit. STUWQ/STR1- 1 was collected on the Ketz River 190 metres upstream of the exploration site and sample STUWQ/STR1-2 was collected 50 metres downstream of the site. Sample STUWQ/STR2 was collected from a small tributary stream that runs along the east side and empties into the river upstream of the site.

3.3 Analytical Results

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

Paste Parameters

All samples collected had laboratory paste pH values near neutral to alkaline (range = 6.2 to 9.1; mean = 7.6), indicating that the waste is not currently generating acid. Field paste conductivity values ranged from 80 $\mu\text{S}/\text{cm}$ to 880 $\mu\text{S}/\text{cm}$ (mean = 426 $\mu\text{S}/\text{cm}$) for those samples measured. Sample P4, collected from the unmineralized schist, had the lowest conductivity (80 $\mu\text{S}/\text{cm}$). The highest values were measured on samples P2 (500 $\mu\text{S}/\text{cm}$), P4 (840 $\mu\text{S}/\text{cm}$), and P6 (880 $\mu\text{S}/\text{cm}$) collected from the piles on the staging area.

Acid Base Accounting

Total sulphur concentrations ranged from 0.4% to 8% (mean=3.4%). In all cases, less than 0.5% of the sulphur has been oxidized (i.e. is present as sulphate). The sample collected from the unmineralized pile (P5) and from the pile near the shaft (P8) have NP:AP ratios of 24 and 15, respectively, indicating that they have low potential to generate acid. Sample P3-1, representing the surface material for the staging area, has a NP:AP ratio of 2.5, and an NNP of 70 kg CaCO₃ eq/tonne. It is unlikely that this material would become net acid generating. Sample P3-2, which represents the material underlying the staging area, also has low acid generating potential (NP:AP=13). All other samples were potentially acid generating, with NP:AP ratios ranging from <0.1 to 2.1 (mean= <1.1).

Metals Concentrations

The sample collected from the unmineralized pile (P5) contained generally low metals concentrations. All the other samples collected contained moderate to high concentrations of antimony, arsenic, copper, lead, and zinc. Arsenic concentrations ranged from 756 ppm to >10,000 ppm (mean> 4654 ppm). Lead concentrations ranged from 3571 ppm to >10,000 ppm (mean> 4800 ppm), and silver concentrations ranged from 65 ppm to >200 ppm (mean> 100 ppm).

Water Quality

Flow from the adit was <1 L/sec at the time of the site visit. The flow in the Ketzra River was approximately 500 L/sec (visual estimate) and in the small tributary stream was approximately 20 L/sec (visual estimate).

Laboratory pH measurements taken from the water sample collected from the adit and from the stream samples were slightly alkaline (range = 7.9 to 8.2). The conductivity ranged from 441 µS/cm to 800 µS/cm (mean=562 µS/cm). Sulphate concentrations were low, ranging from 73 mg/L to 105 mg/L.

Metal concentrations were generally low in the adit and stream waters. The quality of the adit drainage at Stump was well within the guidelines established under the Metal Mine Liquid Effluent Regulations (MMLE, 1977).

Stream samples had iron and zinc concentrations below the CCME criteria for the protection of freshwater aquatic life. Detection limits for the analytical methods for many other metals were above the guidelines.

Compared to the upstream sample, no change in metal concentrations was apparent in the sample collected downstream in the Ketza River.

4.0 EXISTING OR POTENTIAL ACID ROCK DRAINAGE CONDITIONS

Waste rock at the Stump exploration site is not currently generating acid. However, approximately one half, or 3400 tonnes (3100 tons), of the waste may be potentially acid generating. Moderate to high conductivity measurements indicate that oxidation is occurring in some of the waste, and acidity produced is being buffered by the available Neutralizing Potential (NP). The material has, however, been exposed since at least 1980, indicating that the sulphides in the waste react slowly.

The high metal concentrations in the waste are not being reflected in the adjacent stream and Ketza River. Sampling for this assessment, however, was conducted on one day in the dry season. Soluble metal constituents stored in the exposed waste rock may reach the drainages during high precipitation/high runoff conditions.

The results of this assessment indicate that there is no immediate need for remediation with respect to acid generation. The total amount of rock that may become acid generating is small.

5.0 REMEDIATION OPTIONS

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

- source control which includes limiting further oxidation, for instance by placing the waste under water thus preventing oxygen entry;
- migration control which limits the mobility of oxidation products, for example by reducing infiltration to the waste by placing a low permeability cover; and,

- release control by collecting and treating contaminated flows prior to discharge.

Currently, discharge from the site does not appear to be impacting on the receiving environment. Therefore, collection and treatment of water at the Stump site was not considered an option

There is no need to relocate the waste rock at the present time. However, since there is a possibility of acidic drainage developing in approximately half of the material, the option of relocating the waste to the shaft is considered as a viable option. Covering the waste with an overburden and/or soil cover to limit the generation and release of ARD was also considered an option. These options are evaluated against the "do nothing" option, in the table below.

Matrix for Evaluating Applicable/Potential Remediation

Option versus Evaluation Criteria	Stump			
	Collect and Treat	Relocate	Cover	Leave as is
Public Health and Safety 5 = provides full protection of public 1 = provides no protection of public	not applicable	5	5	5
Worker Health and Safety 5 = relative low risk to workers 1 = high risk to workers	not applicable	3	3	5
Ecosystem Preservation and Protection 5 = relative low risk to environment 1 = relative high risk to environment	not applicable	5	4	3
Impact on Mineral Resource 5 = allows for continued exploration 1 = impedes continued exploration	not applicable	4	5	5
Direct Costs (mobilization & materials) 5 = relative low cost 1 = relative high cost	not applicable	3	2	5
Monitoring and Maintenance Costs 5 = relative low cost 1 = relative high cost	not applicable	3	2	3
Acceptability 5 = positive response anticipated 1 = negative response anticipated	not applicable	4	4	3
Total Score	0	27	25	29

It may be possible to relocate the waste rock to the shaft. The depth of the shaft and underground workings is unknown and would have to be investigated. Relocating the waste would decrease the overall environmental risk to Ketza River. However, this option may entail a moderate short-term risk to the ecosystem, since disturbing the waste could cause a release of soluble metal constituents into the receiving environment. Relocation of the waste to the shaft could render the shaft unavailable for future use. Relocation of waste would involve a risk to the health and safety of workers.

As with relocation, cover construction could cause a short-term increased risk to the ecosystem and represent a risk to workers. Furthermore, an additional site would be disturbed to provide the cover material.

The risk to the environment is moderate to small if no remediation is undertaken since the site is relatively dry and no adverse impacts to the environment are currently observed. Relocating or covering the waste rock piles would improve the aesthetics of the site and are, therefore, ranked slightly higher for acceptability.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

The matrix assessment favors the "do nothing" option. Relocation or covering of the waste would be necessary only if it was determined that the waste was going to produce acidic drainage and that the impact on the receiving environment would be significant. This can be determined either by kinetic testing and hydrogeological modeling or by monitoring of the waste and the quality of the water adjacent to the site.

6.2 Recommendations

Since the exploration site does not appear to be impacting the water quality of the Ketza River, it is recommended that the waste be left as is, and that a quarterly water quality monitoring study be undertaken. The objective of the monitoring would be to determine if the waste has any impacts on the water quality at other times of the year. Detection limits used in subsequent water analyses should be sufficiently low to enable comparison of the results with the CCME freshwater aquatic life criteria. If there are no detectable impact from the site, quarterly monitoring could be undertaken every 5 years. A paste

survey should also be conducted once during the calendar year in which the water quality monitoring is undertaken to detect any change in the pH and conductivity of the waste rock.

If an impact on water quality is detected, options for remediation of the waste rock should be reviewed.

7.0 REFERENCES

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

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TABLE 1 Stump Waste Rock Sample Descriptions

Sample ID	Sample Location and Description	Discussion of Results
STUWR/P1	Collected in small waste pile~20m north of upper adit. Top 2cm = crumbly armour. Next 2cm was brown sandy matrix with 30% pebbles. Below this is green-brown waste.	Potentially acid generating (NP/AP=0.6); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn.
STUWR/P2	Collected on small waste rock pile nearest shed. Few cobbles in pit although they are common on surface. No horizons. Northern surface of pile has grey-white weathering product.	Potentially acid generating (NP/AP=0.6); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn.
STUWR/P3-1	Collected in the surface of the staging area. The pit is about 20 cm deep. Top 10 cm is brown waste underlain by green-brown waste.	Potentially acid generating (NP/AP=0.6); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn. Moderate Ca, Sr.
STUWR/P3-2	Collected from below 10cm depth; green brown sandy, pebbly, clast-supported material.	Low potential for acid generation (NP/AP=12.5); high As, Ca, Cu, Fe, Pb, Mn, Zn; moderate Sr.
STUWR/P4	Located in small waste pile on staging area located closest to the river. Thin pavement on surface but no weathering horizons.	Potentially acid generating (NP/AP=<0.1); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn.
STUWR/P5	Located on side of road away from the river, on southwest edge of site. Waste (?) pile is composed primarily of grey shale or schist. Surface is covered with schist weathered to pale orange brown or red brown.	Low potential for acid generation (NP/AP=24); high Ca, Fe, Mn, Sr.
STUWR/P6	Located waste pile at the center of staging area. The surface of the pile is covered with a dry clay-rich armor approx. 2 cm thick. Below, material is moist. Less than 1% FeOx staining.	Potentially acid generating (NP/AP=0.4); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn.
STUWR/P7	Located in waste pile outside upper adit, furthest southeast of adit. Material end-dumped from trestle. Pile still has some timbers from the trestle. Material is relatively unconsolidated and mostly pebbles with few cobbles and little clay.	Potentially acid generating (NP/AP=0.9); high As, Sb, Ca, Cu, Fe, Pb, Mn, Ag, Zn.
STUWR/P8	Surface of pile is composed of orange-brown schist and red brown to black rocks and boulders of sulphides - primarily galena. Also, some intensely limonitic and hematitic breccia.	Low potential for acid generation (NP/AP=15); high As, Sb, Cu, Fe, Pb, Mn, Ag, Zn.

TABLE 2 Stump Waste Rock ABA and ICP Results

Parameter	Units	Sample Number STU/WR/								
		P1	P2	P3/1	P3/2	P4	P5	P6	P7	P8
Field Conductivity	µS/cm	240	500	270	170	840	80	880	na	na
Field pH		6.20	8.20	8.35	8.67	6.50	8.95	7.75	na	na
Lab pH		6.90	6.70	7.78	8.59	6.59	9.14	7.63	8.02	7.16
Sulfur	%	8.02	2.22	1.72	0.71	6.92	0.4	4.64	5.24	1.03
Sulfate	%	0.20	0.30	0.26	0.27	0.43	0.17	0.42	0.15	0.35
AP		244.4	60.0	45.6	13.8	202.8	7.2	131.9	159.1	21.3
NP		142.6	125.4	115.3	171.5	-2.9	171.5	55.4	147.2	316.9
Net NP		-101.8	65.4	69.6	157.8	-205.7	164.3	-76.4	-11.9	295.6
NP/AP		0.6	2.1	2.5	12.5	< 0.1	23.9	0.4	0.9	14.9
Aluminum	%	0.02	0.14	0.40	0.18	0.19	0.21	0.19	0.20	0.21
Antimony	ppm	6584	1121	725	56	1651	<1	1064	1487	2014
Arsenic	ppm	>10000	3255	2994	756	8268	48	6678	>10000	5974
Barium	ppm	21	39	73	59	35	43	38	38	58
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1	0.2	<0.1	0.3	0.7	<0.1
Bismuth	ppm	75	6	14	<1	44	<1	24	<1	<1
Cadmium	ppm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Calcium	%	0.45	2.73	5.29	8.07	0.77	5.22	1.87	2.78	0.93
Chromium	ppm	24	36	49	34	<1	22	<1	<1	<1
Cobalt	ppm	23	19	17	11	25	13	26	23	25
Copper	ppm	6071	1662	1185	93	3516	33	2917	1882	3048
Gallium	ppm	<1	<1	<1	<1	<1	<1	<1	<1	<1
Iron	%	>15	11.86	7.64	3.63	14.81	3.28	14.69	10.99	>15
Lead	ppm	>10000	>10000	9531	282	>10000	51	5636	3751	>10000
Lithium	ppm	<1	<1	5	<1	2	2	<1	<1	2
Magnesium	%	0.75	0.75	1.04	1.33	0.53	1.52	0.83	0.97	0.17
Manganese	ppm	>10000	>10000	5772	1902	>10000	514	>10000	8137	>10000
Molybdenum	ppm	37	23	17	9	10	8	5	2	11
Nickel, total	ppm	104	77	56	33	35	30	34	30	51
Phosphorus	ppm	80	440	590	410	440	370	620	520	500
Potassium	ppm	0.05	0.09	0.09	0.10	0.10	0.10	0.10	0.11	0.08
Silver	ppm	>200	139.0	70.5	3.5	>200	1.1	125.3	65.0	198.0
Sodium	%	<0.01	<0.01	<0.01	0.01	<0.01	0.02	<0.01	<0.01	<0.01
Strontium	ppm	<1	34	132	210	43	114	59	58	88
Titanium	%	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Thorium	ppm	<1	<1	<1	<1	3	<1	<1	<1	7
Tin	ppm	23	14	9	4	<1	4	<1	<1	<1
Tungsten	ppm	<1	<1	<1	<1	3	<1	2	3	5
Uranium	ppm	<1	<1	<1	<1	<1	<1	7	6	2
Vanadium	ppm	3.8	6.1	15.9	6.4	4.6	5.5	6.1	5.0	6.6
Zinc	ppm	594	1511	264	136	506	66	339	398	1432

AP = Acid Potential in tonnes CaCO₃ equivalent per 1000 tonnes of materialNP = Neutralization Potential in tonnes CaCO₃ equivalent per 1000 tonnes of materialNet NP = Net Neutralization Potential = tonnes CaCO₃ equivalent per 1000 tonnes of material

na = no assay / analysis

< = lower detection limit

> = upper detection limit

Steffen Robertson and Kirsten
February, 1997

TABLE 3 Stump Water Quality Results

Parameter	Units	Sample Number StumpWQ/			
		A1	STR1/1	STR1/2	STR2
Lab pH		7.86	8.1	8.17	8.16
Lab Conductivity	µS/cm	800	452	441	554
Acidity (CaCO ₃)	mg/L	10.5	1.2	1.2	1.9
Alkalinity (CaCO ₃)	mg/L	366	178	168	268
Sulfate	mg/L	105	73.3	75.3	59.4
Aluminum, total	mg/L	<0.2	<0.2	<0.2	<0.2
Antimony, total	mg/L	<0.2	<0.2	<0.2	<0.2
Arsenic, total	mg/L	<0.2	<0.2	<0.2	<0.2
Barium, total	mg/L	0.03	0.09	0.08	0.07
Beryllium, total	mg/L	<0.005	<0.005	<0.005	<0.005
Bismuth, total	mg/L	<0.1	<0.1	<0.1	<0.1
Boron, total	mg/L	<0.1	<0.1	<0.1	<0.1
Cadmium, total	mg/L	<0.01	<0.01	<0.01	<0.01
Calcium, total	mg/L	71.5	56.4	56.4	52.8
Chromium, total	mg/L	<0.01	<0.01	<0.01	<0.01
Cobalt, total	mg/L	<0.01	<0.01	<0.01	<0.01
Copper, total	mg/L	<0.01	<0.01	<0.01	<0.01
Iron, total	mg/L	<0.03	<0.03	0.05	0.29
Lead, total	mg/L	<0.05	<0.05	<0.05	<0.05
Lithium, total	mg/L	0.03	<0.01	<0.01	<0.01
Magnesium, total	mg/L	70.8	24.4	23.8	42.9
Manganese, total	mg/L	<0.005	<0.005	0.005	0.026
Molybdenum, total	mg/L	<0.03	<0.03	<0.03	<0.03
Nickel, total	mg/L	<0.02	<0.02	<0.02	<0.02
Phosphorus, total	mg/L	<0.3	<0.3	<0.3	<0.3
Potassium, total	mg/L	<2	<2	<2	<2
Selenium, total	mg/L	<0.2	<0.2	<0.2	<0.2
Silicon, total	mg/L	2.65	2.17	2.15	2.38
Silver, total	mg/L	<0.01	<0.01	<0.01	<0.01
Sodium, total	mg/L	11	<2	<2	3
Strontium, total	mg/L	1.47	0.205	0.196	0.386
Thallium, total	mg/L	<0.1	<0.1	<0.1	<0.1
Tin, total	mg/L	<0.03	<0.03	<0.03	<0.03
Titanium, total	mg/L	<0.01	<0.01	<0.01	<0.01
Vanadium, total	mg/L	<0.03	<0.03	<0.03	<0.03
Zinc, total	mg/L	0.007	0.005	0.006	<0.005

< = lower detection limit

Steffen Robertson and Kirsten
February, 1997

APPENDIX B
Site Photographs

STUMP
Photographic Record

Photos	Description
S. # 1	Aerial View of Site
S. # 2	Aerial View of Site
S. # 3	Lower Site, Staging Area, Waste Rock
S. # 4	Load-out Ramp and Lower Adit
S. # 5	Ore and Waste Rock at North End of Staging Area
S. # 6	Shed and Ore/Waste Rock
S. # 7	Seepage from Lower Adit
S. # 8	Lower Adit Seepage, Full 205L Barrel, Site Debris
S. # 9	Abandoned Ore Cars
S. # 10	Scattered Site Debris at North End of Staging Area
S. # 11	Track and Waste Rock
S. # 12	Stream on West Side of Site
S. # 13	Upper Adit
S. # 14	Upper Adit
S. # 15	Upstream Sampling in the Ketzá River
S. # 16	Waste Rock Sample, Stu-wr-p1-1
S. # 17	Waste Rock Sample, Stu-wr-p2-1
S. # 18	Waste Rock Sample, Stu-wr-p3-1



Photo # 1 - Aerial View of Site



Photo # 2 - Aerial View of Site



Photo # 3 - Lower Site, Staging Area, Waste Rock



Photo # 4 - Load-out Ramp and Lower Adit



Photo # 5 - Ore and Waste Rock at North End of Staging Area

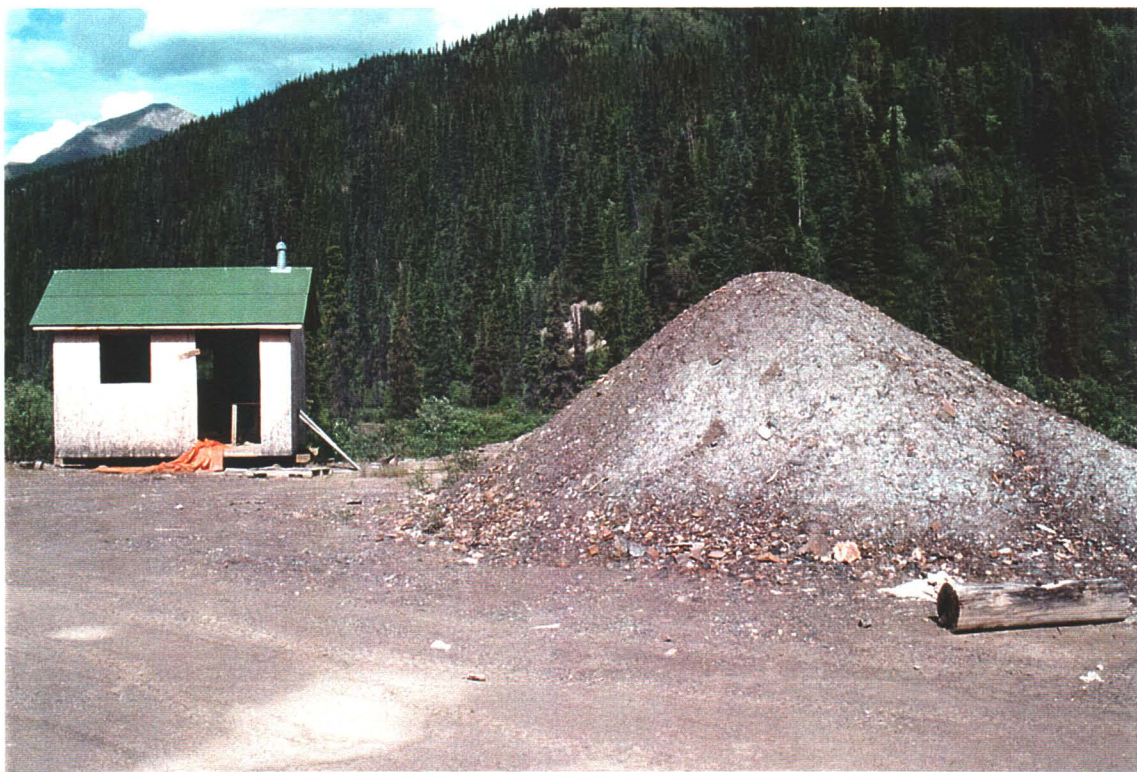


Photo # 6 - Shed and Ore/Waste Rock



Photo # 7 - Seepage from Lower Adit



Photo # 8 - Lower Adit Seepage, Full 205L Barrel, Site Debris



Photo # 9 - Abandoned Ore Cars



Photo # 10 - Scattered Site Debris at North End of Staging Area



Photo # 11 - Track and Waste Rock



Photo # 12 - Stream on West Side of Site



Photo # 13 - Upper Adit



Photo # 14 - Upper Adit



Photo # 15 - Upstream Sampling in the Ketz River



Photo # 16 - Waste Rock Sample, Stu-wr-p1-1



Photo # 17 - Waste Rock Sample, Stu-wr-p2-1

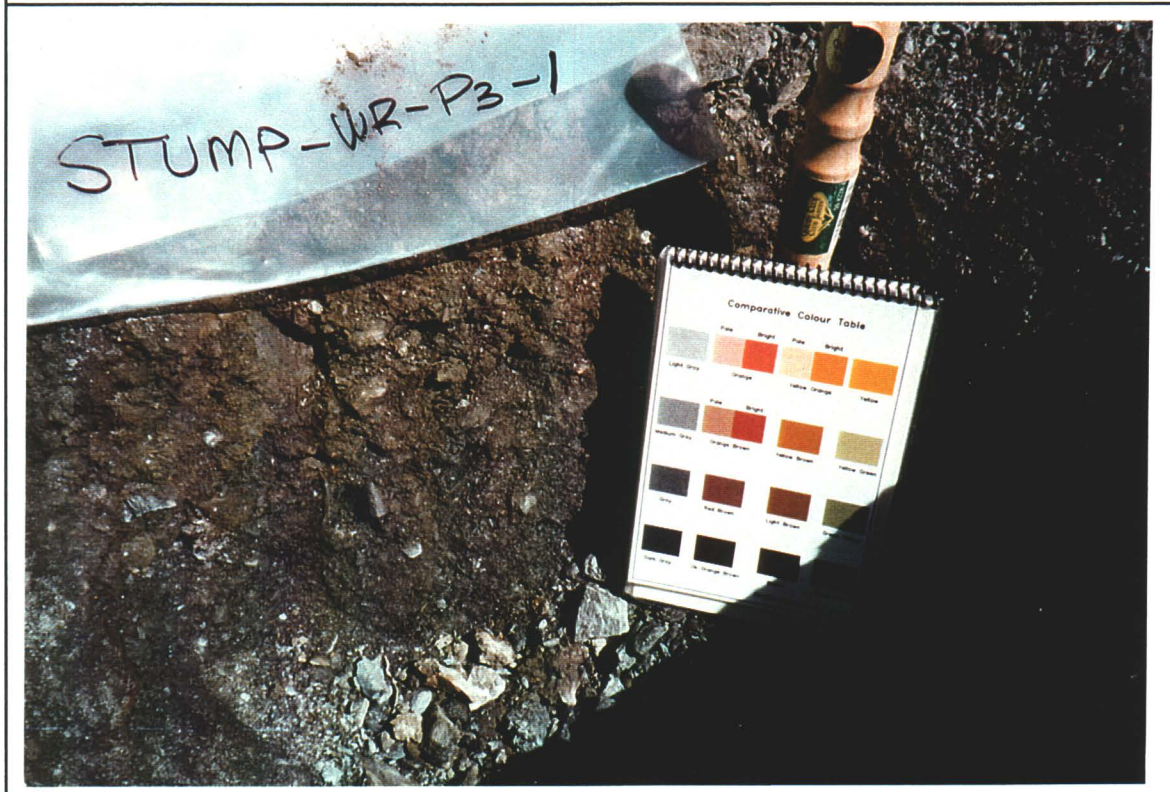


Photo # 18 - Waste Rock Sample, Stu-wr-p3-1

APPENDIX C

Analytical Results

**FAX TRANSMISSION
COMINCO ENGINEERING SERVICES LTD.
LABORATORY**

**1636 West 75th Avenue
Vancouver, British Columbia, Canada, V6P 6G2
Phone (604) 325-9764 Fax (604) 325-7542**

..Page(s) including cover sheet will be sent. If there are any problems with this fax, please call (604) 325-9764.

DATE: SEPT. 26/96

TO: TRAC DELANEY

FAX NO.

(303) 985-9947

FROM: KEN TIMEWELL

(KAREN SAYS HEZCO!)

Re:

**CLIENT : STEFFEN, ROBERTSON AND KIRSTEN
PROJECT :
PROJECT # : P118302
TEST : MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING**

SAMPLE #	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
STU/WR/P1-1	7.91	0.35	0.25	3.1	18.4	15.3	5.9
STU/WR/P4-1	6.59	6.92	0.43	202.8	-2.9	-205.7	<0.1
STU/WR/P6-1	7.63	4.64	0.42	131.9	55.4	-76.4	0.4
STU/WR/P7-1	8.02	5.24	0.15	159.1	147.2	-11.9	0.9
STU/WR/P8-1	7.16	1.03	0.35	21.3	316.9	295.6	14.9

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

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

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

CLIENT : STEFFEN, ROBERTSON AND KIRSTEN
 PROJECT : PWGSC
 PROJECT # : P118302
 TEST : MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING

SAMPLE #	PASTE pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
HOEY/WR/P1-1	7.55	1.01	0.31	21.9	272.0	250.1	12.4
HOEY/WR/P2-1	7.45	2.15	0.31	57.5	101.6	44.1	1.8
HOEY/WR/P3-1	7.69	1.61	0.25	42.5	109.3	66.8	2.6
HOEY/WR/P4-1	8.50	0.68	0.37	9.7	383.5	373.8	39.6
HOEY/WR/P5-1	8.13	1.03	0.27	23.8	105.0	81.3	4.4
STORMY/WR/P1-1	7.91	0.35	0.25	3.1	18.4	15.3	5.9
STU/WR/P1-1	6.90	8.02	0.20	244.4	142.6	-101.8	0.6
STU/WR/P2-1	6.70	2.22	0.30	60.0	125.4	65.4	2.1
STU/WR/P3-1	7.78	1.72	0.26	45.6	115.3	69.6	2.5
STU/WR/P3-2	8.59	0.71	0.27	13.8	171.5	157.8	12.5
STU/WR/P4-1	6.59	6.92	0.43	202.8	-2.9	-205.7	<0.1
STU/WR/P5-1	9.14	0.40	0.17	7.2	171.5	164.3	23.9
STU/WR/P6-1	7.63	4.64	0.42	131.9	55.4	-76.4	0.4
STU/WR/P7-1	8.02	5.24	0.15	159.1	147.2	-11.9	0.9
STU/WR/P8-1	7.16	1.03	0.35	21.3	316.9	295.6	14.9

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

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

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

CLIENT : STEFFEN, ROBERTSON AND KIRSTEN
 PROJECT : PWGSC
 PROJECT # : P118302
 TEST : HEAD ICP

		HOEY\WRIP1-1	HOEY\WRIP2-1	HOEY\WRIP3-1	HOEY\WRIP4-1	HOEY\WRIP5-1	STUI\WRIP1-1	STUI\WRIP2-1
S-T	%	1.01	2.15	1.61	0.68	1.03	8.02	2.22
S-SO4	%	0.31	0.31	0.25	0.37	0.27	0.20	0.30
AG	PPM	4.9	153.6	84.4	2.6	35.7	>200.0	139.0
AL	%	0.16	0.11	0.04	0.12	0.03	0.02	0.14
AS	PPM	74	1	1	97	1	>10000	3255
BA	PPM	75	127	215	94	285	21	39
BE	PPM	0.1	0.1	0.1	0.1	0.1	0.1	0.1
BI	PPM	1	1	1	1	1	75	6
CA	%	8.65	2.81	2.04	10.92	2.08	0.45	2.73
CD	PPM	0.1	0.1	0.1	0.1	0.1	0.1	0.1
CO	PPM	13	222	23	11	23	23	19
CR	PPM	28	36	28	32	23	24	36
CU	PPM	43	528	741	13	179	6071	1662
FE	%	4.39	13.85	>15.00	4.49	>15.00	>15.00	11.86
GA	PPM	1	1	1	1	1	1	1
K	%	0.05	0.06	0.05	0.05	0.05	0.05	0.09
LI	PPM	2	1	1	2	1	1	1
MG	%	2.20	1.35	1.50	2.82	1.55	0.75	0.75
MN	PPM	1892	>10000	>10000	2383	>10000	>10000	>10000
MO	PPM	10	27	35	10	34	37	23
NA	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NI	PPM	33	84	110	34	106	104	77
P	PPM	640	990	90	120	30	80	440
PB	PPM	131	>10000	>10000	585	8111	>10000	>10000
SB	PPM	1	125	161	1	44	6584	1121
SN	PPM	5	16	22	7	23	23	14
SR	PPM	283	91	40	363	42	1	34
TH	PPM	1	1	1	1	1	1	1
TI	%	0.01	0.01	0.01	0.01	0.01	0.01	0.01
U	PPM	1	1	1	1	1	1	1
V	PPM	13.2	10.2	5.4	9.3	5.7	3.8	6.1
W	PPM	1	1	1	1	1	1	1
ZN	PPM	32	41	20	39	131	594	1511

		STUIWRIP3-1	STUIWRIP3-2	STUIWRIP5-1	TIWRIP1-1
S-T	%	1.72	0.71	0.4	0.82
S-SO4	%	0.26	0.27	0.17	0.57
AG	PPM	70.5	3.5	1.1	2.3
AL	%	0.40	0.18	0.21	0.67
AS	PPM	2994	756	48	249
BA	PPM	73	59	43	29
BE	PPM	0.1	0.1	0.1	0.3
BI	PPM	14	1	1	1
CA	%	5.29	8.07	5.22	>15.00
CD	PPM	0.1	0.1	0.1	0.1
CO	PPM	17	11	13	7
CR	PPM	49	34	22	17
CU	PPM	1185	93	33	14
FE	%	7.64	3.63	3.28	0.97
GA	PPM	1	1	1	1
K	%	0.09	0.10	0.10	0.16
LI	PPM	5	1	2	15
MG	%	1.04	1.33	1.52	1.06
MN	PPM	5772	1902	514	295
MO	PPM	17	9	8	6
NA	%	0.01	0.01	0.02	0.02
NI	PPM	56	33	30	17
P	PPM	590	410	370	380
PB	PPM	9531	282	51	93
SB	PPM	725	56	1	6
SN	PPM	9	4	4	2
SR	PPM	132	210	114	487
TH	PPM	1	1	1	1
TI	%	0.01	0.01	0.01	0.01
U	PPM	1	1	1	1
V	PPM	15.9	6.4	5.5	8.0
W	PPM	1	1	1	1
ZN	PPM	264	136	66	46

**RESULTS OF ANALYSIS - Water**

File No. G3602

		Stump-WQ A1-1	Stump-WQ STR1-1	Stump-WQ -STR2-1	Stump-WQ -STR1-2	STO-WQ-A 1-1
		96 07 25	96 07 25	96 07 25	96 07 25	96 07 27
Physical Tests						
Conductivity (umhos/cm)		800	452	554	441	305
pH		7.86	8.10	8.16	8.17	7.68
Dissolved Anions						
Acidity		CaCO ₃ 10.5	1.2	1.9	1.2	3.9
Alkalinity - Total		CaCO ₃ 366	178	268	168	70.2
Sulphate	SO ₄	105	73.3	59.4	75.3	77.4
Total Metals						
Aluminum	T-Al	<0.2	<0.2	<0.2	<0.2	1.0
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	0.03	0.09	0.07	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	71.5	56.4	52.8	56.4	53.6
Chromium	T-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt	T-Co	<0.01	<0.01	<0.01	<0.01	0.02
Copper	T-Cu	<0.01	<0.01	<0.01	<0.01	<0.01
Iron	T-Fe	<0.03	<0.03	0.29	0.05	1.10
Lead	T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium	T-Li	0.03	<0.01	<0.01	<0.01	<0.01
Magnesium	T-Mg	70.8	24.4	42.9	23.8	5.30
Manganese	T-Mn	<0.005	<0.005	0.026	0.005	0.655
Molybdenum	T-Mo	<0.03	<0.03	<0.03	<0.03	0.14
Nickel	T-Ni	<0.02	<0.02	<0.02	<0.02	0.09
Phosphorus	T-P	<0.3	<0.3	<0.3	<0.3	<0.3
Potassium	T-K	6	<2	<2	<2	<2
Selenium	T-Se	<0.2	<0.2	<0.2	<0.2	<0.2
Silicon	T-Si	2.65	2.17	2.38	2.15	3.42
Silver	T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	T-Na	11	<2	3	<2	<2
Strontium	T-Sr	1.47	0.205	0.386	0.196	0.093
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	<0.01	<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. G3602

		Stump-WQ A1-1	Stump-WQ -STR1-1	Stump-WQ -STR2-1	Stump-WQ -STR1-2	STO-WQ-A 1-1
		96 07 25	96 07 25	96 07 25	96 07 25	96 07 27
<u>Total Metals</u>						
Zinc	T-Zn	0.007	0.006	<0.005	0.006	0.011

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

**Appendix 1 - QUALITY CONTROL - Replicates**

File No. G3602

Water

Stump-W9 Stump-W9
-STR2-1 -STR2-1

96 07 25

QC #
69050**Physical Tests**

Conductivity (umhos/cm)

554

553

pH

8.16

8.13

Dissolved Anions

Acidity

CaCO3

1.9

1.3

Sulphate

SO4

59.4

58.4

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



Appendix 1 - QUALITY CONTROL - Replicates

File No. G3602

Water

Stump-W9 Stump-W9
-STR2-1 -STR2-1

96 07 25

QC #
69050

Total Metals

Aluminum	T-Al	<0.2	<0.2
Antimony	T-Sb	<0.2	<0.2
Arsenic	T-As	<0.2	<0.2
Barium	T-Ba	0.07	0.07
Beryllium	T-Be	<0.005	<0.005
Bismuth	T-Bi	<0.1	<0.1
Boron	T-B	<0.1	<0.1
Cadmium	T-Cd	<0.01	<0.01
Calcium	T-Ca	52.8	54.1
Chromium	T-Cr	<0.01	<0.01
Cobalt	T-Co	<0.01	<0.01
Copper	T-Cu	<0.01	<0.01
Iron	T-Fe	0.29	0.30
Lead	T-Pb	<0.05	<0.05
Lithium	T-Li	<0.01	<0.01
Magnesium	T-Mg	42.9	43.6
Manganese	T-Mn	0.026	0.026
Molybdenum	T-Mo	<0.03	<0.03
Nickel	T-Ni	<0.02	<0.02
Phosphorus	T-P	<0.3	<0.3
Potassium	T-K	<2	<2
Selenium	T-Se	<0.2	<0.2
Silicon	T-Si	2.38	2.41
Silver	T-Ag	<0.01	<0.01
Sodium	T-Na	3	3
Strontium	T-Sr	0.386	0.397
Thallium	T-Tl	<0.1	<0.1
Tin	T-Sn	<0.03	<0.03
Titanium	T-Ti	<0.01	<0.01
Vanadium	T-V	<0.03	<0.03
Zinc	T-Zn	<0.005	<0.005

< = Less than the detection limit indicated.

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).

**Appendix 2 - METHODOLOGY**

File No. G3602

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

Conventional Parameters in Water

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

Metals in Water

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

End of Report

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

TOX. SAMPLES

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

PARAMETER	DATE	QA/QC	MATRIX SPIKES				CALIBRATION CHECK		
	ANALYZED	BATCH	DUP	RECOV	CONTROL LIMITS		RECOV	CONTROL LIMITS	
	(DD-MM-YY)	NUM ANAL	Rr	%	LOWER	UPPER	%	LOWER	UPPER
Total Organic Halogens (TOX)	25-10-96	2 RAV	N.A.	NOT APPLICABLE			100.7	80.0	120.0

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

Sample Description : STOMP-BR-1-1
Sample Date & Time : 25-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Chemex Worksheet Number : 96-07805-8
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 : 80% LIQUID surrogate limits : 63% - 134%.

CHEMEX Labs Alberta Inc.

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

PUBLIC WORKS CANADA
ATTENTION : MICHAEL NAHIR

TOX SAMPLES

Sample Description : STOMP-BR-1-1
Sample Date & Time : 25-07-96
Sampled By :
Sample Type : GRAB
Sample Received Date: October 18, 1996
Sample Station Code :

Chemex Worksheet Number : 96-07805-8
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 DATE : November 11, 1996 ANALYST:AAM	BLANK	DUPLICATE		RPD	MATRIX SPIKE			CALIBRATION CHECK		
	CONC. mg/Kg	CONC.1 mg/Kg	CONC.2 mg/Kg		RECOV %	CONTROL LIMITS		RECOV %	CONTROL LIMITS	
				%		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						

Analytical Service Laboratories
1988 Triumph St.
Vancouver, B.C.
V5L 1K5

Date: 8 August 1996
Project#: 1511-44
Powertech Ref#: 96171
P.O.#: ASL Ref G3601

Attention: Heather Ross

Re: Waste Oil Analysis

Number of samples received:	16
Number of samples analyzed:	10
Sample Type:	Waste Organic Liquids
Date Received:	Aug 02, 1996
Date Reported:	Aug 08, 1996 (by fax)

METHODOLOGY

Organic Halogen was determined by a laboratory test method mod. 9020 and was analyzed with a Mitsubishi TOX 10 analyzer. Elements were determined in accordance with laboratory test method ASTM D5185.

Some of the samples contained a layer of water. The water layer was excluded from the analyses. Only the organic liquid layer (oil or fuel) was analyzed. Some of the samples received did not contain an oil or fuel layer and were likely composed of mainly water. The water samples were not analyzed as per discussion with ASL. The ASL lab numbers of the samples not analyzed are as follows: G3601-4, G3602-9, G3605-2,3,4,5.

Results:

Results of analysis are attached

Prepared By: _____
Ed Hall
Sr. Chemical Technologist

Approved By: _____
H. Schellhase
Research Chemist
Applied Chemistry

POWERTECH LABS INC.

Page 2 of 2

Results of Analysis
Powertech Labs Ref: 96171
ASL Ref: G3601

ASL Ref	Powertech Ref	Organic Halogen mg/L	Arsenic mg/L	Cadmium mg/L	Chromium mg/L	Lead mg/L
Tin-Br1- 1	96171-1	<300	<4	<1	<1	297
Tin-Br1- 3	96171-3	<300	<4	<1	<1	14.1
Tin-Br1- 4	96171-4	<300	<4	<1	<1	510
Tin-Br1- 5	96171-5	<300	<4	<1	<1	43.1
Stump-BR 1-1	96172-1	<300	<4	<1	<1	51.7
HOBY-Br 1-1	96173-1	<300	<4	<1	<1	7.8
Cong-Br1 -1	96174-1	<300	<4	<1	<1	4.3
DLB-2	96175-1	<300	<4	<1	<1	23.9
S7BL-3	96175-6	<300	<4	<1	<1	<1
S7BL-4	96175-7	<300	<4	<1	<1	<1

APPENDIX D
Sampling Records

WATER SAMPLING

PROJECT NAME: STUMP MINE NAME OF SAMPLER: Mike Nalin

Location: _____

Date: 7/25/96

SAMPLE#: STUMP-WQ-A1-1-TM/IMMED pH: 8.36 Eh: 770mV

Location description: Lower Adit Seepage

Analysis: metals water chem Eh total sulphur

SAMPLE#: STUMP-WQ-STR1-1-TM/IMMED pH: 8.06 Eh: 360mV

Location description: Downstream of Waste Rock Pile # (MANU)

Analysis: metals water chem Eh total sulphur

SAMPLE#: STUMP-WQ-STR2-1-TM/IMMED pH: 8.62 Eh: 360mV

Location description: Background sample upstream of Main WR Pile

Analysis: metals water chem Eh total sulphur

SAMPLE#: STUMP-WQ-STR2-1-TM/IMMED pH: 9.11

Location description: Stream Runoff ^{not touching} East Side of upper Adit Eh: 400 pV
8/1000 Waste Rock Pile

Analysis: metals water chem Eh total sulphur

SAMPLE#: _____ pH: 8.25

Location description: Downstream of Adit Seepage Eh: 760
favors STR 1

Analysis: metals water chem Eh total sulphur

Comments: _____

Sample # Format site name-Wnumber BL=barrel S=soil
eg. Tintina-W1 W=water WR=waste rock

BARREL SAMPLING

PROJECT NAME: STUMP MINE SAMPLE #: STUMP-BRL-1

Location: _____

Date: July 25 '96

Name of sampler: TIM SACKMAN

Physical Observation

Condition of barrel: poor fair good

Size (L): 205L other _____ Labels _____

Soil staining: Y N

Barrel Contents

Quantity of liquid: 1/4 1/3 1/2 3/4 full

Colour of liquid: light dark multiphase other

Suspected type of liquid: gasoline jet fuel waste oil glycol oil
other w/ water

Sludge observed: Y N Quantity _____

Analysis (if required)

Type of sample taken: composite grab

Analysis required: metals PCBs chlorine other _____

Comments: Good for Transport.

Sample # Format

site name - BL number
eg. Tintina-BL1

BL =barrel
W=water
S=soil
WR=waste rock

APPENDIX E

Barrel Clean Up Protocol

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, words, 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 phases shall have all phases 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 removed 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*

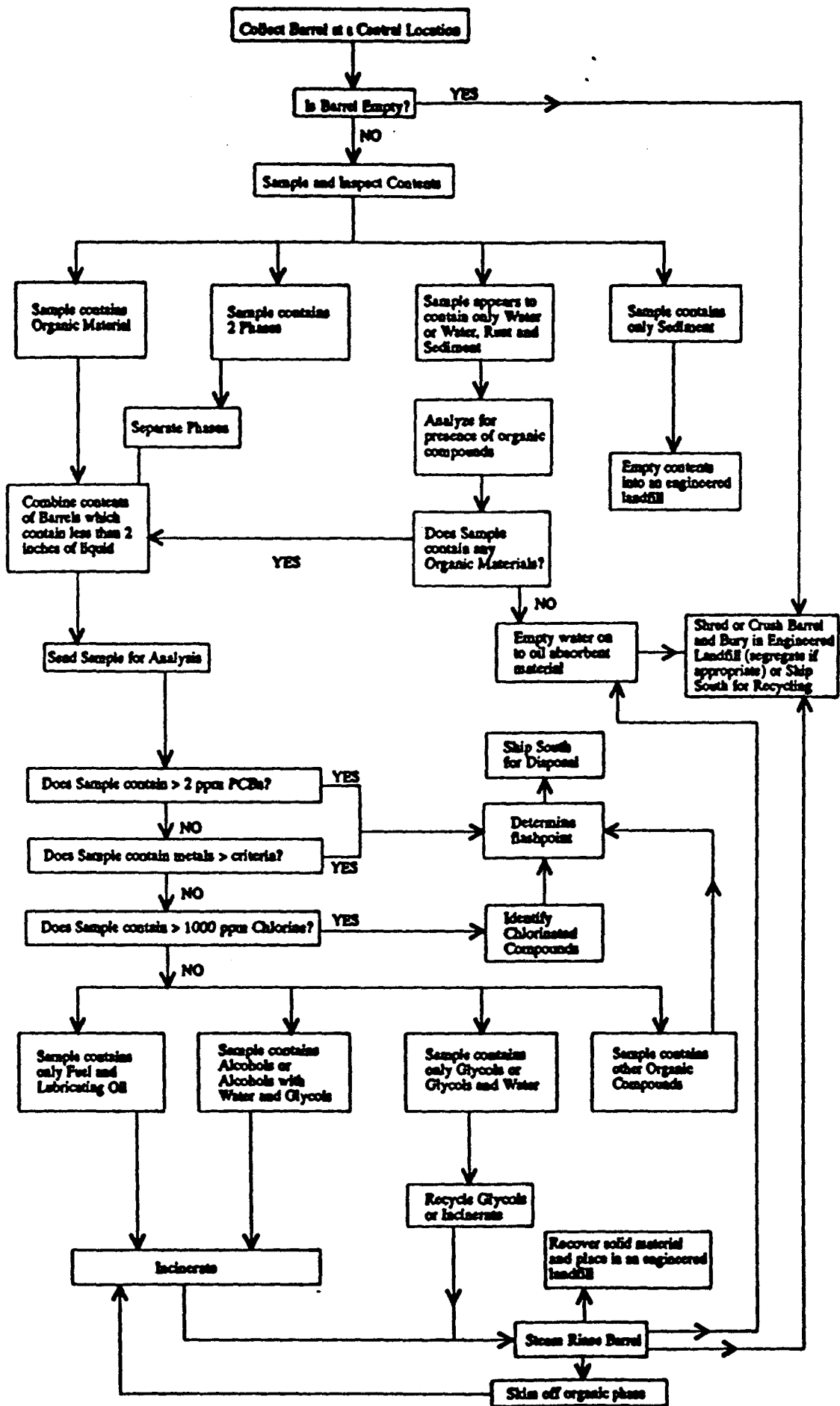
organics phases, and which contain less than 2 ppm PCBs, 1000 ppm chlorine, 2 ppm cadmium, 10 ppm chromium and 100 ppm lead, may be disposed of by incineration. Alternatively these contents may be disposed of off-site at a licensed disposal facility. The solid residual material resulting from incineration 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.

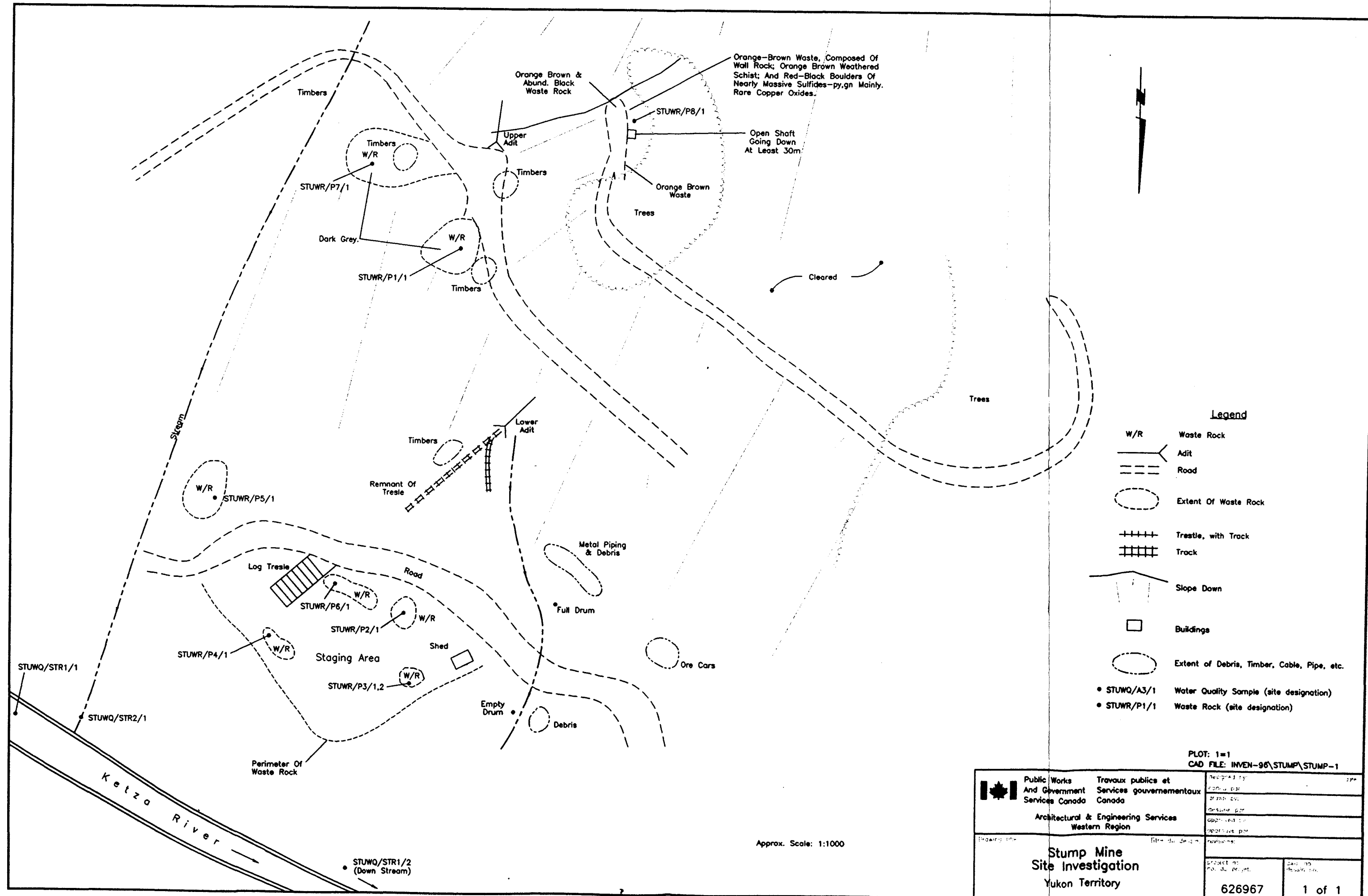
E. Cleaning and Disposing of Barrels

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.

FLOW CHART FOR THE DEW LINE CLEANUP OF BARRELS



DRAWINGS



Approx. Scale: 1:1000

Public Works And Government Services Canada		Travaux publics et Services gouvernementaux Canada	
Architectural & Engineering Services Western Region		Designated by: Approved by: Checked by: Approved by: Revisions:	
Drawing title: Stump Mine Site Investigation Yukon Territory		Project no. 626967	
Plot: 1=1 CAD FILE: INVEN-96\STUMP\STUMP-1		1 of 1	