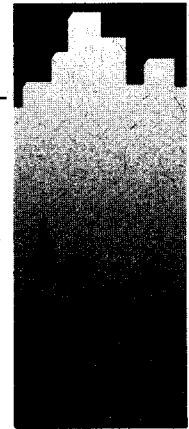


# PWGSC

## Quality in Environmental Services



**PHASE II ENVIRONMENTAL ASSESSMENT  
OF THE  
UNION 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 Union abandoned mine site (60° 18'58" N, 135° 01'59" 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 three of the mine openings are not adequately secured from public access. An assessment of the acid rock drainage potential for the waste rock shows that only a small volume of rock is currently acid generating and there has been little impact on the adjacent stream's water quality. Aesthetic concerns arise from a number of wood tramway standards and a small water heater remaining at the site.

Using applicable federal and territorial criteria as well as northern mine reclamation guidelines, the only recommendation is to secure the mine openings by blasting them shut.

No further test work is recommended on the waste rock.

**Table 1: Summary of Potential Hazards at Union Mine Site**

ASSESSMENT COMPONENT	RISK	RECOMMENDATION
<b>1. Building, Infrastructure, Equipment</b>		
Tramway timbers	Minor aesthetic concern	None
<b>2. Non-Hazardous Waste Material</b>		
400 L hot water heater	Minor aesthetic concern	None
<b>3. Hazardous Materials</b>		
None		
<b>4. Water Quality</b>		
Mine Seepage - None		
Site Drainage - Yes		
Receiving Waters - downstream of Schnabel Cr.	Low environmental risk	None
<b>5. Waste Rock Disposal Areas</b>		
Waste Rock - Small vol. in stream	Low environmental risk	None
<b>6. Mine Openings</b>		
7 Adits - 3 open/ 5 collapsed	Health and safety concern	Blast shut open adits
<b>7. Tailings</b>		
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 Union abandoned mine site, the 1993 report recommended further investigation into possible environmental impacts resulting from the previous mining activities. According to this report, the main areas of concerns included: a safety issue with the three unsecured mine adits and the impact of the access road on the environment, however, it was assumed that natural reclamation of the road surface would be preferable to engineered reclamation. 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 Union abandoned mine site to a) identify specific environmental and human safety risks; and b) provide clean-up recommendations.

### 1.1 LOCATION

The Union abandoned mine site is located at 60° 18'58"N latitude and 135° 01'59"W longitude. It is located approximately 30 km north west of the village of Carcross and 20 km south west of Robinson on the South Klondike Highway south of Whitehorse. The site is near the base of Idaho Hill along within the canyon formed by Schnabel Creek and is between 1065 and 1100 m above sea level.

### 1.2 OVERVIEW OF SITE DEVELOPMENT

The property known as the Union Mine and Idaho Hill was first staked in 1889 by W.P. Schnabel. Nine tonnes of ore were shipped from the property prior to 1906. The claims were supposed to cover ground known as the Lost Mine which was staked in 1893 by Thomas Kerwin and two others and willed to the Catholic Sisters of Juneau, Alaska while Kerwin was lying on his death-bed (GSC Memoir 31, p. 139).

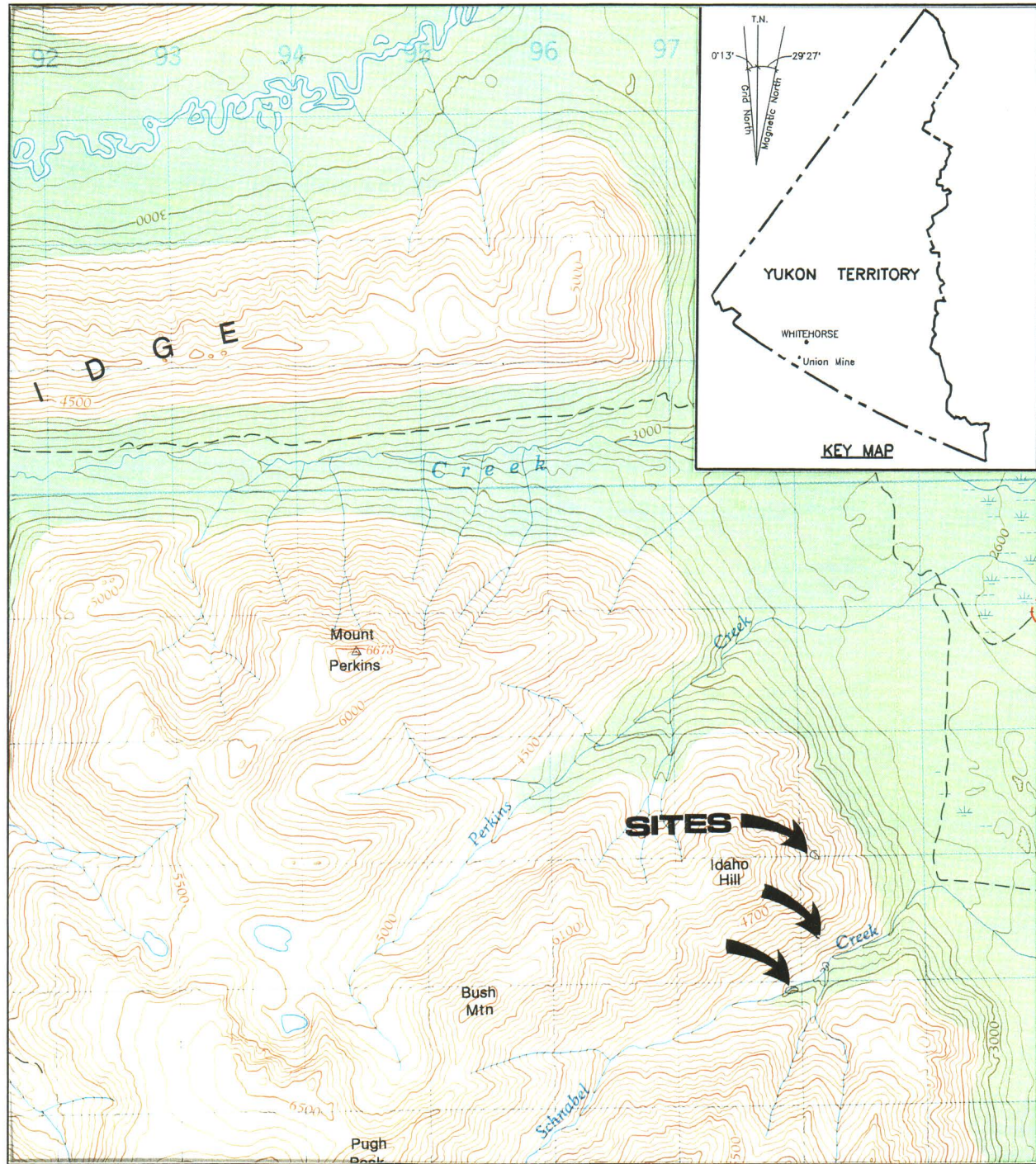


Figure 1. Location of Union Mine - 1:50,000, NTS- 105 D/6 [Energy Mines and Resources Canada: 1986]

In 1948, the workings consisted of a 41 m long cross-cut entering the hillside at an elevation of 1067 m (3,500 ft) and connected by an abandoned aerial tramway to the camp buildings on Schnabel Creek at 834 m above sea level. A road leads to the camp from Robinson. There were also some workings in Schnabel Creek canyon and the open cuts 2.4 km up Schnabel Creek from the camp which were worked on in 1952 (GSC Memoir 312, p. 135 - 136).

### **1.3 SITE ACCESS**

The Union mine site access road is accessible from Annie Lake Road at the west side of Annie Lake. The overgrown access road runs west from the road up through the Schnabel Creek canyon and is accessible only by ATV.

## **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**

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.

### 3.2.2 Application of Criteria and Guidelines

For the Union 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

### 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 Union 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<sub>3</sub> 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**

Silver and lead bearing quartz-calcite veins cut through greywacke at the Union site. The veins are fairly regular and tabular and are generally 10 cm to 20 cm thick, though locally they contain pods 60 to 120 cm thick and 1.5 to 6 m long of mixed rock and ore. The veins consist of a gangue of quartz, locally vuggy and subordinate calcite. They carry galena (PbS) and arsenopyrite (FeAsS), either disseminated throughout the gangue or as solid masses. Additional sulphides present in minor amounts include sphalerite ((Zn, Fe)S), pyrite (FeS<sub>2</sub>) and chalcopyrite (CuFeS<sub>2</sub>) (Yukon Minfile #105D 038).

### **4.2 SURFACE HYDROLOGY**

Both the site and regional drainage are to the east draining into Schnabel Creek and subsequently into Annie Lake approximately 3 km to the east (see Figure 1).

Hydrological and water quality data are not available for Schnabel Creek, the fourth order stream running below the Union mine site.

No seepage was evident from the adits. No seepage from the waste rock piles was detected, however the site topography lends itself to seepage through the waste

rock piles as a result of site drainage, stream flow and surface infiltration from precipitation.

#### **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.

#### **4.4 VEGETATION**

The Union mine site occurs within the Yukon Stikine Highlands ecoregion. Alpine tundra dominates the site, with vegetation including scrub heather, dwarf birch, willow, grass and lichen. At lower elevations, such as those noted at the upper adits, subalpine areas consist of white spruce, alpine fir and white birch. The lower and middle adits were located in a riparian habitat within the Schnabel Creek canyon. The dense low shrubbery was dominated by alder and willow species, while alpine fir and white spruce were dominant further away from the stream.

#### **4.5 FISH AND WILDLIFE RESOURCES**

Typical carnivores in the area include black and grizzly bear and wolf. Arctic ground squirrel, pika and hoary marmot are common rodents noted in the subalpine and alpine ecosystems. Bird species representative of the canyon ecosystem include spruce grouse, eastern phoebe and American dipper. A number of raptors hunt and nest in the area and bald eagle, peregrine falcon and American kestrel were noted near the upper adits.

#### **4.6 SITE TOPOGRAPHY AND SOILS**

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

The lower and middle adits are located on the north side of Schnabel Creek, a steep-walled subalpine canyon. Further west, at higher elevations, the canyon widens out into a subalpine/alpine valley ecosystem. The north side of the valley

is formed by Idaho Hill. The upper adits are located "around the corner" from the middle and lower adits and are high up on the west side of Idaho Hill in an area with little site drainage.

#### **4.7 PERMAFROST**

Union mine 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**

There are no buildings or equipment at the site. The only remaining infrastructure are widely spaced rotted wood timbers remaining from the former tramway up the west face of Idaho Hill that formerly accessed the base camp below. Approximately five standards were noted.

#### **5.2 NON-HAZARDOUS WASTE MATERIALS**

The only non-hazardous waste noted in the area was a discarded 400 L hot water heater near the lower adits.

#### **5.3 HAZARDOUS MATERIALS**

No hazardous wastes were noted at the site.

#### **5.4 SURFACE WATER QUALITY**

Table 2 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 Schnabel Creek downstream of the middle and lower adits, shown in Drawing 1. A sample, UN-WQ-Str101, was collected upstream of the middle adits to represent site background conditions for which downstream sample results will be compared. Samples were collected downstream of the middle adits, UN-WQ-Str201 and downstream of the lower adits, UN-WQ-Str203. A sample, UN-WQ-Str202, was also collected upstream of the lower adits, however, it should be noted that this location is downstream of the middle adits and as such is not background.

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 B. Sample locations are included on Drawing 1.

Comparison of the upstream and downstream water quality from the nearby stream suggests that the downstream environment is unaffected by the waste rock drainage. All samples were below the criteria outlined in Schedule 1 of the Metal Mining Liquid Effluent Regulations and Guidelines and CCME freshwater aquatic life criteria for all parameters. For some metals, detection limits are above background values.

**Table 2: Surface Water Samples - Significant Results**

Sample ID	Sample Location	pH	Conductivity ( $\mu$ mhos/cm)	Metallic Parameters
UN-WQ-Str101	Schnabel Cr. 20 m upstream of middle adits	7.0	120	low
UN-WQ-Str201	Schnabel Cr. 20 downstream of middle adits	8.04	110	low
UN-WQ-Str202	Schnabel Cr. 20 upstream of lower adits (downstream of middle adits)	7.14	100	low
UN-WQ-Str203	Schnabel Cr. 40 m downstream of lower adits	7.62	110	low

## 5.5 WASTE ROCK DISPOSAL AREAS

Small waste rock piles are located adjacent to the adits and open-cuts, as illustrated in Drawing 1. There is approximately 2000 tonnes of waste rock at the middle adits, distributed in seven piles. Samples UN/WR/P301, UN/WR/P302 and UN/WR/P303 were collected from three of the piles. The rock has been deposited within the floodplain of Schnabel Creek. At the time of the site visit no water was observed flowing through the piles but rather was diverted around them.

At the lower adits there is approximately 2500 tonnes of waste rock in two piles. Samples were collected from each of these piles (UN/WR/P304 and UN/WR/P305). The rock piles are adjacent to Schnabel Creek in a narrow canyon and the toes of the piles are in the floodplain of the creek. No water was observed flowing through the piles.

One sample was collected from the waste rock at the upper adits (UN/WR/P306). The volume of waste rock at the upper adits is estimated to be 650 tonnes. The upper adits are located high on the side of Idaho Hill in a dry/arid environment. No surface water was observed in the vicinity of the workings.

The laboratory paste pH values for the samples collected at the middle adits were 5.1, 6.8 and 7.0, indicating that one of the rock piles is slightly acid generating. The neutralization potential to acid potential (NP:AP) ratios for the same samples were below 0.6, indicating that all of the material is potentially acid generating. The total sulphur contents were low (0.12%, 0.11% and 0.54%) and the paste conductivities were also low, below 100 uS/cm.

The laboratory paste pH values for the samples collected at the lower adits were 7.7 and 8.0, indicating that this material is not currently generating acid. The NP:AP ratios for the material were 3.0 and 2.2, suggesting a potential for acid generation.

The laboratory paste pH value for the sample collected at the upper adit was 7.9 and the NP:AP ratio was 10.0, indicating that this material is acid generating. Accounting test results are shown in Table 3.

**Table 3: Summary Acid/Base Accounting Test Results**

Sample #	Paste pH	Total S (%)	SO <sub>4</sub> (%)	AP	NP	Net NP	NP/AP
UN/WR/P301	6.13	0.12	no assay	3.75	2.06	-1.69	0.55
UN/WR/P302	6.60	0.11	no assay	3.44	0.81	-2.63	0.24
UN/WR/P303	3.63	0.54	no assay	16.88	0.13	-16.75	< 0.1
UN/WR/P304	7.25	1.09	0.19	28.13	85.38	57.25	3.04
UN/WR/P305	8.30	1.47	0.18	40.31	87.25	46.94	2.16
AC/WR/P306	7.20	0.12	no assay	3.75	37.38	33.63	9.97

## 5.6 MINE OPENINGS AND EXCAVATIONS

Open cuts and adits are located in three separate areas at Union. The adits at the end of the aerial tramway have been securely buried (upper adits). Of the adits and open cuts in Schnabel Creek canyon (lower adits), one is open and one has been demolished by trenching and is no longer a hazard. Of the middle adits, upstream on Schnabel Creek, one has been demolished by trenching and two are accessible. The open adits at Union do not appear to extend more than 5 m underground. Table 4 shows the results of the mine openings investigation.

**Table 4: Mine Openings**

Adit	Location	Drift Length	Condition
2 upper adits	west side of Idaho Hill on open hill side	approx. 41 m	both collapsed
3 middle adits	Schnabel Creek canyon on south side of Idaho Hill	unknown	1 collapsed; 2 open
2 lower adits	upper Schnabel Creek canyon on south side of Idaho Hill	unknown	1 collapsed; 1 open

## 5.7 TAILINGS

No tailings are present at the Union mine site because no ore was milled on site.

## 6.0 CONCLUSIONS

The primary concerns are the health and safety of humans and wildlife relating to the collapse of the mine openings. A minor concern was noted with regard to the aesthetic appearance of the wood tramway standards and the small water heater.

### 6.1 HEALTH AND SAFETY

Three of the mine openings are in unstable condition and are not adequately secured from public and wildlife access. The canyon is frequently used by snowmobilers in the winter months and there is ample opportunity for the public to enter the open adits.

## 6.2 ENVIRONMENTAL RISKS

Waste rock at Union Mine site is not currently generating acid, with the exception of one small, 25 tonne, pile. However, the waste rock along Schnabel Creek, approximately 4500 tonnes, is potentially acid generating. Low conductivity measurements indicate that oxidation is not occurring. If oxidation were occurring it would indicate that acid was being produced and buffered by available neutralizing potential. Most of the waste rock at Union mine has been exposed for more than 40 years without generating acid. The risk of the remaining waste rock becoming acid generating in the future is low. The surface water sampling program indicates that waste rock is not currently affecting downstream water quality.

## 6.3 AESTHETIC CONCERNS

Minor aesthetic concerns arise from approximately five rotten tramway standard timbers and a small water heater.

## 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 openings be secured from human and animal access for health and safety reasons. The entrances should be blasted shut with explosives to seal the openings with waste rock.

## REFERENCES

- Cairnes, D.D., 1912. Wheaton District, Yukon Territory, Selected Field Reports of the Geological Survey of Canada 1898 to 1933. Geological Survey of Canada Memoir 284.
- Canadian Council of Ministers of the Environment, 1991. Interim Canadian Environmental Quality Criteria for Contaminated Sites. The National Contaminated Sites and Remediation Program.
- DIAND Exploration and Geological Services, 1994. Yukon Minfile #105D 038, Union Mines (Export, Idaho Hill).
- DIAND Technical Services, 1993. Assessment Report, 105 D-06-3, Union Abandoned Mine Assessment. Prepared for Indian and Northern Affairs Canada.
- Ecological Stratification Working Group, November, 1996. A National Ecological Framework for Canada. Produced by Centre for Land and Biological Resources Research and Research Branch, Agriculture and Agri-Food Canada; and, State of the Environment Directorate, Environmental Conservation Service, Environment Canada.
- Energy, Mines & Resources. 1974, National Atlas of Canada. 4th Edition.
- Environment Canada Atmospheric Environment Service. Canadian Climate Normals. 1961-1990.
- Environment Canada Atmospheric Environment Service. Canadian Climate Normals. 1951-1980.
- Environmental Protection and Assessment Branch, June 1996. Draft, Contaminated Sites Regulations. Yukon Renewable Resources.
- Steffen, Robertson, and Kirsten (B.C.), 1992. Mine Reclamation in Northwest Territories and Yukon. Prepared for Northern Water Resource Studies, Northern Affairs Program, DIAND. Report No. QS-8476-000-EF-A1, Minister of Supply and Services Canada.

Wheeler, J.O., 1961. Whitehorse Map-Area, Yukon Territory, 105D. Geological Survey of Canada Memoir 312.

***APPENDIX A***  
***SITE PHOTOGRAPHS***

# UNION MINES

## Photographic Record

July 23, 1996

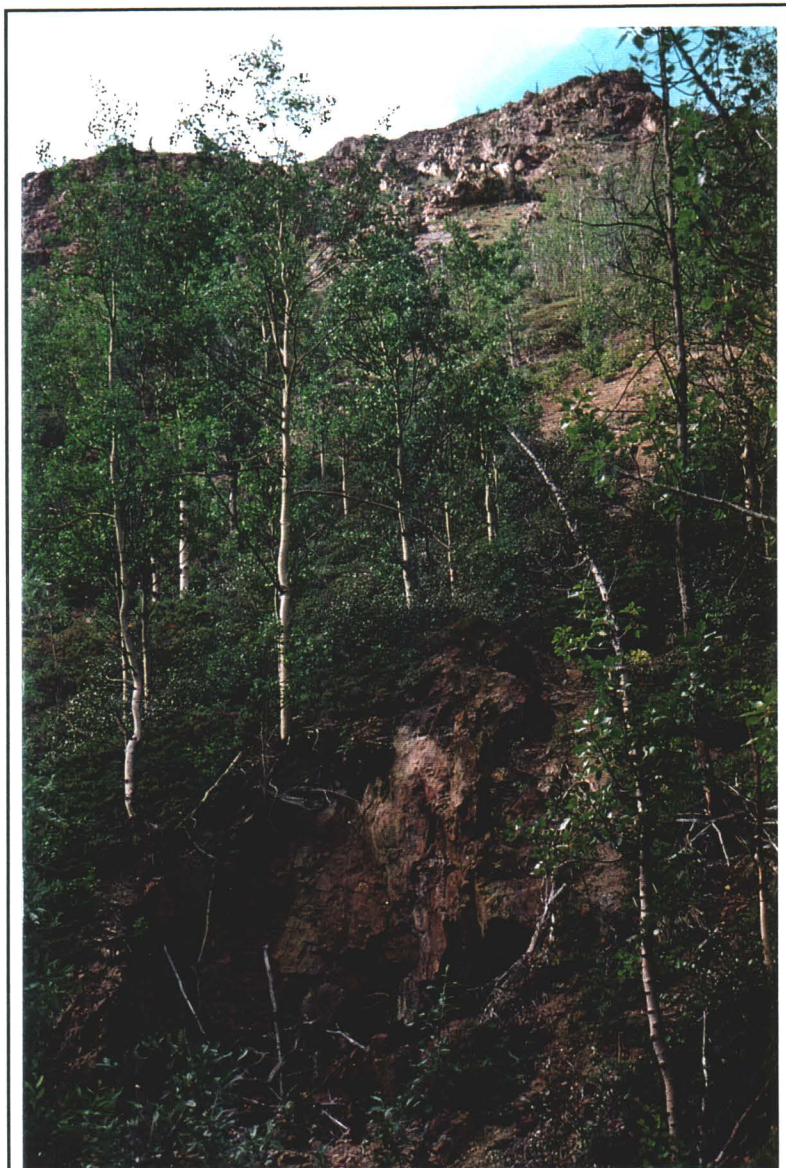
Photos	Description
U.M. # 1	Gorge and Waste Rock, Left Side (West) - Lower Site
U.M. # 2	Adit, Right Side (East) - Lower Adits
U.M. # 3	Middle Adits - Most Westerly Site - Adits Sealed
U.M. # 4	Middle Adits - Most Westerly - Waste Rock
U.M. # 5	Middle Adits - Middle Site, Open Adit
U.M. # 6	Middle Adits - Middle Site, Adit and Waste Rock
U.M. # 7	Middle Adits - Most Easterly Site - Adits Sealed
U.M. # 8	Middle Adits - Most Easterly Site - Waste Rock
U.M. # 9	Schnabel Creek
U.M. # 10	Waste Rock Pile adjacent to Upper Adits
U.M. # 11	Approximate Area of Closed Upper Adit
U.M. # 12	Old Tramway Standard Wood Debris at Upper Adit
U.M. # 13	Discarded Metal Debris
U.M. # 14	Schnabel Creek Downstream of Middle Adits



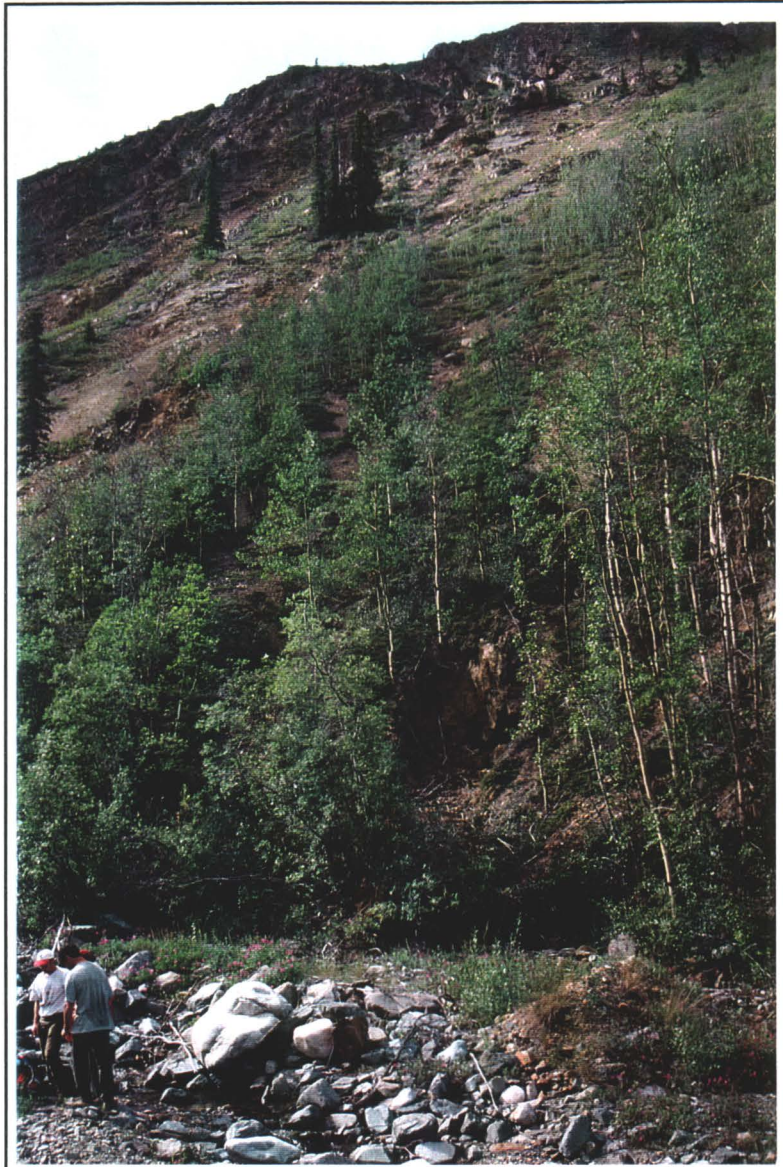
**Photo # 1 - Gorge and Waste Rock, Left Side (West) - Lower Site**



**Photo # 2 - Adit, Right Site (East) - Lower Adits**



**Photo # 3 - Middle Adits - Most Westerly Side -  
Adits Sealed**



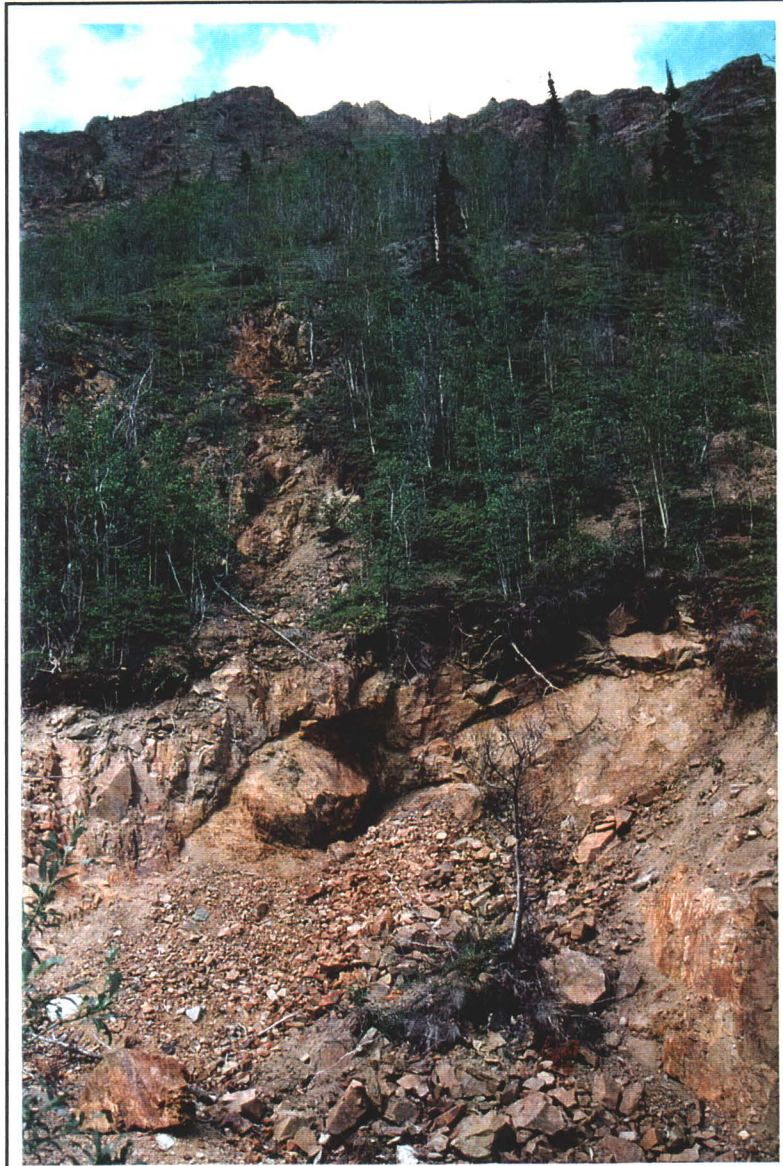
**Photo # 4 - Middle Adits - Most Westerly - Waste Rock**



Photo # 5 - Middle Adits - Middle Site - Open Adit



**Photo # 6 - Middle Adits - Middle Site,  
Adit and Waste Rock**



**Photo # 7 - Middle Adits - Most Easterly Site -  
Adits Sealed**



**Photo # 8 - Middle Adits - Most Easterly Site - Waste Rock**



**Photo # 9 - Schnabel Creek**



**Photo # 10 - Waste Rock Pile adjacent to Upper Adits**



**Photo # 11 - Approximate Area of Closed Upper Adit**



**Photo # 12 - Old Tramway Standard Wood Debris at Upper Adit**



**Photo # 13 - Discarded Metal Debris**



Photo # 14 - Schrabel Creek Downstream of Middle Adits

***APPENDIX B***  
***ANALYTICAL RESULTS***



**RESULTS OF ANALYSIS - Water**

File No. G3765

		BT-WQ- Str 208	UN-WQ- Str 201	UN-WQ- Str 101	AS-WQ- Str 101	UN-WQ- Str 202
		96 07 26	96 07 24	96 07 24	96 07 30	96 07 24
<b>Physical Tests</b>						
Conductivity (umhos/cm)		21.7	175	169	70.9	219
pH		7.08	7.60	7.43	7.39	7.58
<b>Dissolved Anions</b>						
Acidity	CaCO3	1.0	2.3	3.5	3.3	2.7
Alkalinity - Total	CaCO3	4.5	52.2	53.5	31.7	63.8
Sulphate	SO4	3.5	33.4	29.8	3.6	43.4
<b>Total Metals</b>						
Aluminum	T-Al	<0.2	<0.2	<0.2	<0.2	<0.2
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	<0.01	0.01	0.01	<0.01	0.02
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	2.34	31.1	27.6	7.79	36.1
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	<0.01	<0.01	<0.01
Iron	T-Fe	<0.03	<0.03	<0.03	0.66	<0.03
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	0.46	1.37	1.39	1.84	1.93
Manganese	T-Mn	<0.005	<0.005	<0.005	0.017	<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	1.24	2.24	2.01	3.09	2.32
Silver	T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium	T-Na	<2	<2	<2	<2	<2
Strontium	T-Sr	0.019	0.256	0.230	0.039	0.346
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. G3765

	BT-WQ- Str 208	UN-WQ- Str 201	UN-WQ- Str 101	AS-WQ- Str 101	UN-WQ- Str 202
	96 07 26	96 07 24	96 07 24	96 07 30	96 07 24
<hr/>					
<b><u>Total Metals</u></b>					
Zinc      T-Zn	<0.005	0.008	<0.005	0.006	<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**

File No. G3765

	BT-WQ- Str 104	AS-WQ- Str 102	VE-WQ-S 201	UN-WQ- Str 203	VE-WQ-S 301
	96 07 25	96 07 30	96 07 30	96 07 24	96 07 30
<b>Physical Tests</b>					
Conductivity (umhos/cm)	15.1	63.2	435	219	569
pH	6.80	6.99	8.04	7.74	7.84
<b>Dissolved Anions</b>					
Acidity	CaCO <sub>3</sub> 1.6	4.5	1.4	2.3	5.4
Alkalinity - Total	CaCO <sub>3</sub> 4.8	28.3	170	64.2	189
Sulphate SO <sub>4</sub>	1.6	2.7	72.0	43.0	121
<b>Total Metals</b>					
Aluminum T-Al	1.6	<0.2	<0.2	<0.2	<0.2
Antimony T-Sb	<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic T-As	<0.2	<0.2	0.3	<0.2	<0.2
Barium T-Ba	<0.01	<0.01	0.04	0.01	0.02
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	0.2	<0.1	<0.1	<0.1	<0.1
Cadmium T-Cd	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	5.12	9.64	44.6	38.6	84.1
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	<0.01	<0.01	<0.01
Iron T-Fe	0.08	0.11	0.28	<0.03	<0.03
Lead T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	0.19	<0.01	0.02	<0.01	<0.01
Magnesium T-Mg	0.34	1.99	24.8	1.96	21.6
Manganese T-Mn	<0.005	<0.005	0.031	<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	1.20	3.51	3.56	2.43	3.84
Silver T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	<2	<2	5	<2	5
Strontium T-Sr	0.033	0.048	1.10	0.355	1.06
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. G3765

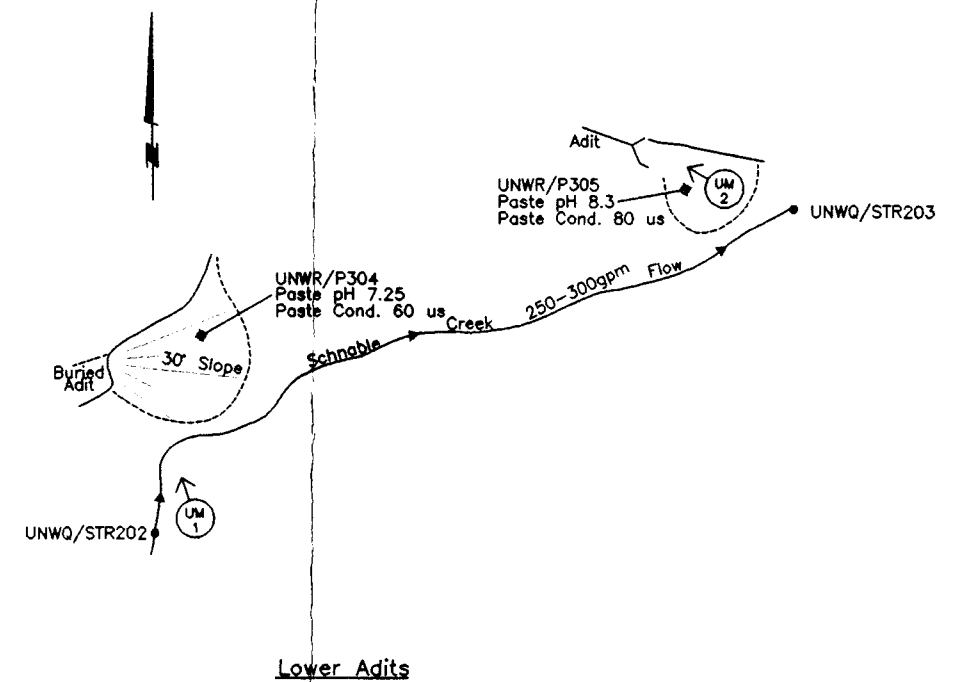
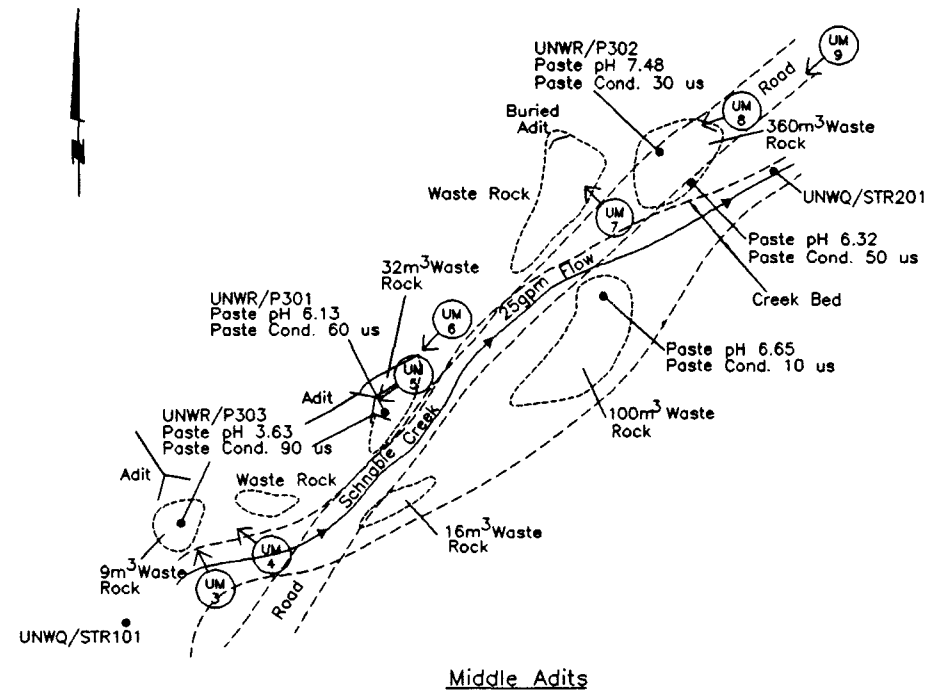
	BT-WQ- Str 104	AS-WQ- Str 102	VE-WQ-S 201	UN-WQ- Str 203	VE-WQ-S 301
	96 07 25	96 07 30	96 07 30	96 07 24	96 07 30
<hr/>					
<u>Total Metals</u>					
Zinc T-Zn	0.012	<0.005	0.038	<0.005	<0.005

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

*APPENDIX C*

*DRAWINGS*

- Legend**
- W/R Waste Rock
  - Adit
  - Road
  - Extent Of Waste Rock
  - UNWR/P1/1 Waste Rock (site designation)
  - UNWQ/A3/1 Water Quality Sample (site designation)
  - UM 1 Photograph No. & Direction

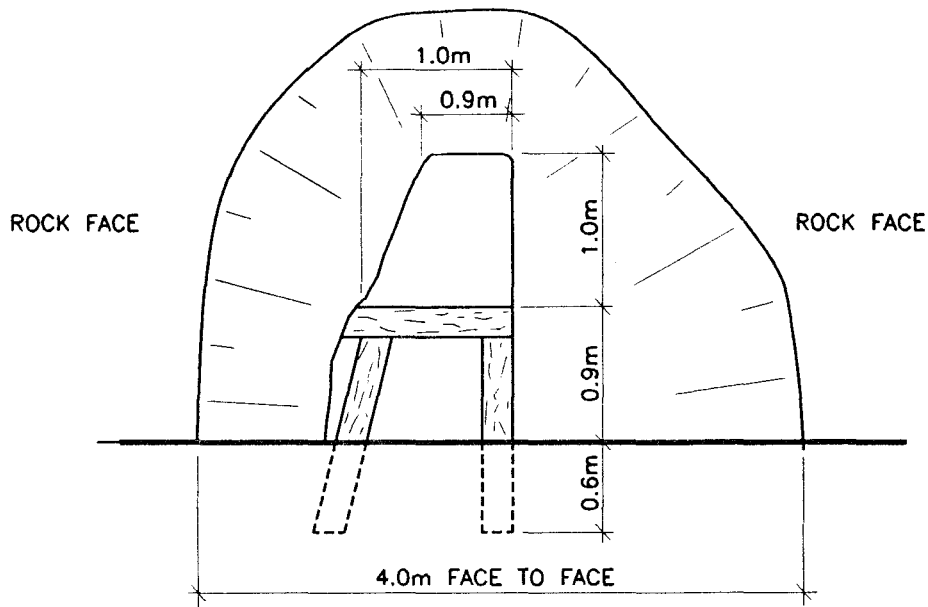


**Note:**  
The Upper Adits Are Located On The North Side Of Idaho Hill And Have Been Securely Sealed. Waste Rock Samples UNWR/P306 Was Collected Here.

Scale 1:1000

PLOT: 1=1  
CAD FILE: INVEN-96\UNION\UNION-2

Public Works And Government Services Canada	Travaux publics et Services gouvernementaux Canada	Date of plot: Drawn by:
		Date of plot: 4-18-96 Drawn by:
Architectural & Engineering Services Western Region		Approved by: Date of approval:
Union Mines Middle And Lower Adits Site Development Yukon Territory		Project no: 626967
		Page no: 1 of 1



FRONT VIEW  
N.T.S.

CAD FILE: INVEN-96/UNION/UNION-1 PLOT: 20=1

Union Mine  
Adit