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PHASE II ENVIRONMENTAL ASSESSMENT OF THE GAMBLER ABANDONED MINE SITE

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EXECUTIVE SUMMARY

The underground development took place on the Gambler abandoned mine site (63°56'52"N, 135°12'50"W) between 1919 and 1957. Total production from the Gambler vein is reported as 223 tonnes. The last reported work on the property was a 1980 trenching program.

DIAND Technical Services completed a Phase I environmental assessment on the property in 1993. The initial assessment (DIAND, 1994) identified safety concerns associated with an inaccessible portal on the head-wall of Faro Gulch. A low-level environmental risk from the abandoned rail track was also identified (note that the site was incorrectly identified as the Segsworth site in DIAND, 1994). No rock, soil, water, or product samples were collected for this overview assessment.

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

- The existing buildings are in various states of collapse and pose a health and safety hazard on a popular hiking trail. It is recommended that all but one of the buildings be demolished. The local tourism association has expressed interest in preserving historic artifacts. They would likely be willing to take responsibility for the care and maintenance of the remaining cabin.

- The waste rock appears to be acid generating and has a potential for metal leaching; however no adverse impacts were observed. No mitigation measures are recommended regarding the waste rock.

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

- The adit on the head-wall of Faro Gulch is not part of the Gambler abandoned mine site. It is part of United Keno Hill Mines underground workings on Keno Hill.

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1.0 INTRODUCTION

1.1 Background

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

The abandoned Gambler (Segsworth) mine was one of the sites chosen for further investigation. The initial assessment (DIAND, 1994) identified safety concerns associated with an inaccessible portal on the head-wall of Faro Gulch. A low-level environmental risk from the abandoned rail track was also identified. No rock, soil, water, or product samples were collected for this overview assessment.

Environmental Services, Public Works and Government Services Canada, retained Steffen Robertson and Kirsten (SRK) to do further investigation. SRK staff were at the site September 18, 1996.

In its 1993 assessment, DIAND Technical Services incorrectly identified the site as the Segsworth site. The 1996 site inspection confirmed that the site assessed by DIAND was, in fact, the Gambler mine site, not the Segsworth (which is located in an adjacent gulch). The Segsworth site proper is located on the northeast side of Silver Basin Gulch, 3 km east of Faro Gulch. Two adits were driven into Caribou hill. In 1920 a 14 metre adit was driven and 40 metres of drifting occurred. In 1952 a new 8 metre adit was driven into Caribou hill southwest of the original adit. Both adits are reported to have collapsed (Yukon Minfile # 105M 062, 1993). Access to the Segsworth site is by helicopter or by hiking cross country in rugged terrain approximately two kilometres from the nearest trail that receives use.

1.2 Location and Site Access

The Gambler mine site is located in Faro Gulch, 6 km northeast of the community of Keno Hill and 1 km north of Keno Summit at 1430 metres to 1490 metres (4700 to 4900 feet) above sea level (see Figures 1 and 2). Access to the property is via the Silver Trail Tourism Association's Keno City trail network, Trail Number 5 - Faro Gulch. An unserviced gravel road, with rough sections, from Keno City provides the access. The first 5 km of this "trail" is driven by tourists regularly in the summer months. The last 2 km is designated a footpath; however, it is suitable for vehicle traffic.

1.3 Overview of Site Development

The Gambler property was staked in 1919-1920, following the discovery of the rich No. 9 vein on Keno Hill (Yukon Minfile # 105M 069). Work on the claims to 1923 included an upper adit 15.2 metres long and a second adit 12.1 metres long approximately 15 metres lower in elevation. During the period 1951 to 1953 the lower adit was extended an additional 155 metres and a 12 metre raise was driven. A total of 223 tonnes of silver/lead ore is reported as being produced. Ore was last recovered from the underground workings in 1957. The last reported exploration work consisted of trenching 75 metres southwest of the adits in 1980.

The Phase I assessment identified another adit to the southeast of the Gambler mine site. The adit, located on the face of a cliff at the head wall of Faro Gulch (Photo 1), is not part of the Gambler mine site, but, rather part of the United Keno Hill Mines (UKHM) workings (pers. comm., J.B. O'Neill). GSC Bulletin 111, Figure 9, shows a number of adit openings developed into the head wall of Faro Gulch. Most of these presumably have caved or been buried under talus. The adit identified in the Phase I assessment is probably a crosscut driven to Faro Gulch from the 200 level drift on UKHM's No. 3 vein "to serve as a waste haulageway and ventilation" (GSC Paper 68-68, p.22).

The Gambler mine site is on the Gambler claim, which is held by Comstock Keno Mines Ltd., 8 King Street East, Suite 1700, Toronto, Ontario, M5C 1B5. The Segsworth site is on the Caribou claim which was recently acquired from AEC West Ltd. (formerly Conwest Exploration Co. Ltd.) by Brancote Canada Limited, 127 Cheney Street, Reno, Nevada, 89501.

2.0 OBJECTIVES AND SCOPE

2.1 Objectives

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

- Identify potential environmental and human safety risks and/or aesthetic concerns; and,
- Provide recommendations and preliminary cost estimates for mitigation of those risks and/or concerns.

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

2.2 Review of Available Information

The investigation was initiated with a review of background information. Available public information was consolidated from the Geological Survey of Canada, Yukon Assessment files, DIAND Exploration and Geological Services, and DIAND Mineral Resource Directorate. Indian and Northern Affairs Canada provided an overview of the Gambler mine site titled Yukon Assessment Report 105M-14-7 Segsworth [sic] Abandoned Mines Assessment, (DIAND, 1994). Other published information sources were examined for site or regional information as applicable. A list of references examined is included in Section 8.0 of this report. J.B. O'Neill, a retired miner with personal experience in the Keno Hill area, was also contacted to confirm site names, locations and history of development.

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

2.3 Site Investigation

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

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

2.4 Review and Cost Estimates

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

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

- Removal and disposal of hazardous solid wastes;

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

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

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

3.0 SITE INVESTIGATION METHODOLOGY

3.1 Area Investigated

The investigation was limited to the area specifically developed, or occupied during, exploration and mining purposes, immediately-adjacent areas, and the resources believed to be affected by these activities. The trail to the mine site was not included in the investigation. The assessment was limited to the Gambler mine site and did not include other mine workings within Faro Gulch (note that the site was incorrectly identified as the Segsworth site in DIAND, 1994, as discussed in Section 1). The workings on the head-wall of Faro Gulch, that are part of UKHM's No. 3 vein, were not examined due to the precarious nature of the access down the steep face of the cirque.

3.2 Assessment Criteria

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

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

The *Interim Canadian Environmental Quality Criteria for Contaminated Sites* (CCME criteria, 1992) are numerical limits for contaminants in soil and water intended to protect, maintain or improve environmental quality and human health at contaminated sites in general.

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

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

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

3.3 Components Investigated

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

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

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

- Identifying variations in rock type, mineralization and alteration;
- Mapping and logging waste rock, tailings, pit walls and rock faces; and,
- Collecting and field testing representative samples of mine wastes.
- Collecting and field testing (paste pH and paste conductivity) representative samples of mine wastes.

- Laboratory testing of selected samples, including whole rock analysis (solids assay) and acid base accounting (ABA). Laboratory leach tests (static or kinetic) were not included in the Phase II assessment.

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

Non-Hazardous Site Debris was to be inventoried.

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

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

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

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

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

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

3.4 Sampling Methods and Quality Assurance

Mine Waste Sampling

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

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

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

Water Sampling

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

250 ml water samples were collected by hand, facing upstream, ensuring that the sample was not contaminated by disturbed sediment, debris and other floating materials. Sample bottles were rinsed three times with water from the sample stream prior to collecting the sample.

2 ml of nitric acid (HNO_3) were immediately added to water samples destined for metals analyses. For analyses of non-metallic parameters, water samples were brim-filled to

minimise head space. The water samples were stored in a cooler, with freezer packs, to maintain a temperature of approximately 4° C until delivery to the laboratory.

Soil Sampling

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

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

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

Barrel and Pail Sampling

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

Quality Assurance

Quality Assurance (QA) is a set of procedures for ensuring that the results of chemical analyses are, and can be shown to be, accurately representative of field conditions. A complete QA program includes both a field component and a laboratory component.

In addition to the standard sample collection methods outlined above, the field QA measures that were implemented for this assessment study include:

- chain of custody procedures and forms;
- a sample labelling and sample location identification scheme;
- laboratory preparation of all sampling containers;
- laboratory defined sample preservation and shipping procedures; and,
- regular maintenance (including re-calibration) and cleaning of field equipment.

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

3.5 Analytical Methods

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

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

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

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

4.0 ENVIRONMENTAL SETTING

4.1 Mineralization

The commodities of interest at the Gambler site are silver, gold, lead and zinc. The Keno Hill-Galena Hill silver-lead ores occur in erratic shoots and lenses lying in vein-faults that cut fine-bedded to massive quartzite, intercalated greenstone sills and lenses, and various schistose rocks (GSC Paper 68-68, p.21).

The Gambler vein cuts through thick-bedded quartzite with interbeds of graphite schist and phyllite, dips 60° south and varies from 1.5 to 4.6 metres in width. Mineralization consists of pyrite (FeS_2), arsenopyrite (FeAsS), galena (PbS), sphalerite ((Zn,Fe)S) and freibergite (silver-bearing tetrahedrite ($(Cu,Fe)_{12}Sb_4S_{13}$)) in quartz (SiO_2), calcite ($CaCO_3$) and siderite ($FeCO_3$) gangue (GSC Bulletin 111, p.39).

4.2 Surface Hydrology

Regional drainage flows west to east along Keno Ladue River (Figure 2), which joins up with Beaver River, which is a tributary of Stewart River. No hydrological data is available for the Keno Ladue River.

The surface runoff from the mine site flows northward into Faro Gulch, a tributary of Keno Ladue River. The nearest surface water to the mine site and camp is Faro Gulch, which is located 300 metres west of the waste rock pile and approximately 60 metres lower in elevation. Faro Gulch is a fast flowing (6 L/sec on September 18, 1996) stream up to 2 metres wide on a 11° slope (Photo 9) below the mine site.

4.3 Climate

The area has a continental climate characterized by low precipitation and a wide temperature range. Winters are cold and long, but the short summer has almost continuous daylight during June and July (GSC Memoir 364, pp.3-4). The nearest climatological information, compiled in Environment Canada's Canadian Climate Normals, 1951 to 1980, is from the town of Elsa 15 km west-southwest of the site (Latitude 63°55', longitude 135°29', elevation 814 metres above mean sea level). Total annual precipitation is approximately 410 mm, with the highest snowfall period being

October to December and the highest rainfall period in July and August. Elsa has on average 122 days with precipitation per year. Temperatures typically range from - 28°C in January and 20°C in July. The mean annual temperature is -4°C. Both Elsa and the Gambler mine site are on the northern side of the Gustavus Range, however Gambler is approximately 600 metres higher in elevation than Elsa and therefore likely colder.

4.4 Vegetation

The Gambler mine site occurs within the Yukon Plateau North ecoregion. The mine site is located in a well vegetated area of the subalpine (except on talus slopes and the waste rock pile where vegetation is sparse to non existent). The following trees and shrubs were identified during the site assessment: stunted black spruce (sparse), a variety of willow (2 - 3 metres high), scrub birch, heather, hudson bay tea, a variety of mosses and lichens, black berries, low bush cranberries, fireweed and sedges.

Below the mine site on Faro Gulch the area surrounding the stream is well vegetated with dense willows, grasses and moss. The streambed contains boulders within fine gravel and sand. The bank of the stream is over hung and plants are growing in the stream.

4.5 Fish and Wildlife Resources

The Gambler site is a good wintering site for moose. Signs indicating the presence of moose, fox and ptarmigan were observed during the assessment.

Faro Gulch is not suitable for fish due to the steepness and fast flowing nature of the stream.

4.6 Site Topography and Soils

The site is found on the northeast side of Faro Gulch on Keno Hill at 1475 metres above sea level. Keno Hill trends northeast and lies between Keno Ladue-McQuesten River valley and Allen, Faith, Lightning, and Christal Creeks. The hill has relatively gentle southern and southeastern slopes and a precipitous northern slope, marked by two cirques, Faro Gulch and Silver Basin Gulch. The terrain above 1375 metres is relatively flat and rolling with five prominent rocky knolls known as Keno, Minto, Monument (the highest point on Keno Hill, elevation 1849 metres), Caribou, and Beauvette. On the slopes of the hill several streams follow steep gulches in the rock strata, the principal ones being Gambler, Faro, McKay, and Silver Basin on the northern slope, Faith, Hope and Charity on the northeastern and southern slopes, and Erickson on the western slope (GSC Bulletin 111, p.4).

The site is dominated by well drained, coarse textured soils.

4.7 Permafrost

The Gambler site is on a north facing slope and is underlain by permanently frozen ground (GSC Bulletin 111, p.7; pers. comm. J.B. O'Neill). The permafrost is irregularly distributed and its occurrence is dependent upon the elevation, hillside exposure, depth of overburden , amount of vegetation cover, and presence of flowing underground and surface water. The mine workings on the top of Keno Hill and on the northern slope encounter frozen ground some 125 metres below the surface.

The effects of frost action, soil creep, and erosion are evident above the adits. Frost action is responsible for features such as stone rings and stripes, and produces a general 'boiling action' that brings rock float, mineralized float, and soil from deeper layers to the surface.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 Buildings, Infrastructure, and Equipment

Camp

At present there are five (5) wooden buildings on the site. Photographs of the buildings are included in Appendix B and are illustrated Figure 3. The buildings on the site are described below with the designation letter used in the site plan.

A: A 6 x 5 metre, wooden framed, clapboard structure with a small addition (wood storage) on the southwest corner. The building consists of a main section with a large table, various shelves and kitchen sink, and a later addition (south end) containing a wooden frame bed. The floor, roof, and ceiling joists (2"x 4" construction on 3 foot centre) of the building are in reasonable condition (Photos 2, 3, and 5).

B: A 5 x 4.5 metre, wooden framed, clapboard building with a partially collapsed roof. The roof timbers are unstable in the present condition. The floor is in fair to poor condition (Photos 2 and 3).

C: A 3 x 3 metre, open topped, wooden structure that was designed to be covered by a canvas roof. The walls and floor are in reasonable condition (Photos 3 and 4).

D: A 3 x 3 metre wooden tent platform. Floor is in fair to poor condition (Photo 4).

E: Wooden outhouse; about to fall over (Photo 4).

Mine Workings

The infrastructure remaining at the mine workings consists of two buried adits and related track and waste dump facilities. Tracks at the lower adit extend from the underground workings out over the waste pile by approximately 2 metres and, although twisted, are in reasonable condition (surface corrosion only). A wooden platform covers part of the tracks at the edge of the waste rock pile (Photos 5 and 6).

The remains of a collapsed shack is located on the roadway to the adit, 6 to 8 metres from the track at the lower adit (Photos 5 and 6).

5.2 Non-Hazardous Waste Material

At least fourteen (14) 205 litre steel barrels were observed below the waste dump area. These barrels were all empty, with some of them split or cut open, and rusted. Markings were not visible on most of the barrels. Four (4) were marked as having contained diesel fuel. One empty 20 litre transmission fluid can was also found below the waste pile.

The wooden supports for the track that extends beyond the waste pile have partially fallen over and are now part of the debris sticking out of the waste rock (Photos 5 and 6).

TABLE 1
Non-Hazardous Waste Materials

Waste Material	Number / Volume	Location	Comments
205 litre barrel	14+	scattered below lower adit (≤ 200 m)	empty, rusted, no staining - had contained diesel, lubricating oil or are unmarked
timbers	< 5 m^3	scattered around lower adit and nearby collapsed shack	non-preserved, burnable
metal scrap, bottles, food cans	< 1 m^3	scattered downhill of dwellings and around collapsed shack at lower adit	non-burnable, rusted

5.3 Hazardous Materials

No hazardous materials were observed at the site.

5.4 Water Quality

To identify potential environmental impact on the surrounding surface water, samples were collected from upstream and downstream of the site and from the water seeping from the mine workings. No seepage from the waste rock was observed.

Four water samples were collected. Field measurements and a summary of the laboratory analysis are listed in Table 2. Analytical results are presented in Appendix C. Sample GA/WQ/Str001 was collected approximately 1 km downstream of the drainage from the mine workings and camp in Faro Gulch. Sample GA/WQ/Str002 was collected from a small stream emanating from a spring on the slope 400 metres below the cabins. Sample GA/WQ/Str003 was collected a few metres upstream of the drainage pathway of the waste rock pile at the head of Faro Gulch.

No seepage was observed from the upper adits. Groundwater was observed to be flowing out of the lower adit at less than one litre per second (visual estimate). The water flowed across the surface for less than 10 metres before disappearing into the ground at the northern edge of the waste rock pile. A sample (GA/WQ/S100) of this water was collected (Figure 3) and submitted for analysis. The catchment area above the waste rock piles is small and most surface runoff is naturally directed to the seep channel at the lower adit. No seepage, or signs thereof, were observed emanating from the lower pile.

The neutral pH, low sulphate and low acidity measured in the sample collected from the seepage from the lower adit (GA/WQ/S100) suggests that acid generation (as a result of oxidation of sulphide minerals) is not occurring in the underground workings. Nonetheless, metal concentrations are relatively high, as indicated in Table 2. Metal concentrations in the adit seepage are generally lower, however, than those in the "background" sample GA/WQ/Str003, with the exception of arsenic, iron and lead).

No significant increases over "background" concentrations are observed when the upstream sample (GA/WQ/Str003) is compared to the downstream sample (GA/WQ/Str001). Metal concentrations measured in GA/WQ/Str001, were generally lower than those measured in GA/WQ/Str003 (with the exception of iron and lead) suggesting that, at the time the samples were collected, drainage from the Gambler adit and the waste rock was having little impact on the water quality in Faro Gulch.

TABLE 2
Surface Water Samples

Sample ID	Location	Flow L/sec	pH	Cond. µS/cm	Comments
GAWQ/Str001	Faro Gulch, 1 km downstream of area drained by mine and camp	8	8	390	Ag, Al, Fe, Pb, Se and Zn elevated above CCME freshwater aquatic life criteria
GAWQ/Str002	Tributary of Faro Gulch, 400 metres below camp	2	8	440	Al and Se elevated above CCME freshwater aquatic life criteria
GAWQ/Str003	Faro Gulch, upstream of mine and waste rock drainage	4	7	840	Ag, Al, Cd, Pb, Se and Zn elevated above CCME freshwater aquatic life criteria
GAWQ/S100	5 metres from lower adit on north edge of waste rock	< 1	7	50	Ag, As, Al, Cd, Cu, Fe, Pb and Zn elevated above CCME freshwater aquatic life criteria

CCME = Canadian Council for the Ministers of the Environment
L/sec = litres per second (based on visual observation)
pH = field measurement
Cond. = Conductivity, field measurement

5.5 Waste Rock Disposal Areas

The volume of waste rock produced from the underground exploration program is in the order of 5,000 tonnes: The assumptions made to derive this estimate are:

- a specific gravity of 2.65;
- a total of 195 metres of lateral development;
- mine openings 2.5 metres by 2.7 metres; and,
- 1500 tonnes of waste from stoping activities in 1957.

There are two waste rock piles on the site as shown in Figure 3. Both waste piles appear to have been formed by end dumping from the adit openings by hand car at the upper adit and from a rail line at the lower adit.

The slope angle of the upper waste rock pile was measured to be between 40° and 32°. While some surface ravelling is evident, the stability of the upper pile is similar to that of the adjacent natural talus slopes.

The material forming the lower waste rock pile is finer than that in the upper pile, and contains significant quantities of sand and silt. The slope of the material is similar to the underlying talus slope and varies from 40° at the crest to 30° near the toe. Slump features were observed on the face of the pile near the crest, indicating that the face of the dump is marginally stable and may be undergoing active creep deformation (possibly related to poor drainage and frost action). Such shallow surface deformation is likely to continue in the future, and may result in a gradual extension of the toe. Rapid, large-scale failure does not appear likely, however.

The waste rock is located approximately 300 metres away from the stream and separated from it by a natural talus field consisting of angular cobbles and boulders. In the event the pile were to fail, it is unlikely that any of the waste rock would reach the stream.

Approximately 90% of the surface of the waste rock pile is covered with mineralized rock, and 10% contains a significant amount of chert. The distribution of chert rich material on the waste rock pile is shown on the site map, Figure 3.

Four samples were collected from three pits dug in the waste rock at the locations shown in Figure 3. Sample GA/WR/P201 was collected from the chert rich material deposited outside of the upper adit. The lower waste rock pile was relatively homogenous and did not have definable units of different mineralogy. However, two kinds of alteration were evident. Sample P202 was collected in material that was oxidized reddish and pit GA/WR/P303 was dug in darker graphitic rich material. Sample P203/1 was collected from an oxidized/welded layer, 10 cm deep, on the surface of the graphite rich material and P203/2 was collected beneath this layer.

Paste pH and conductivity values of the waste rock were measured in the field. Results of the paste pH, ABA and ICP-AES analyses are presented in Appendix A. The waste rock sample descriptions and the analytical results are summarized in Table 3.

TABLE 3
Waste Rock Sample Descriptions and Select ABA and ICP Results

Sample ID	Location and Description	Comments
GA/WR/P201	Upper adit. Sample collected over a thickness of 40 cm in gravel and sand containing mostly 20 % quartzite. Angular fragments up to 5 cm x 8 cm.	Field paste pH 6.62 and paste conductivity 10 μS/cm, elevated concentrations of arsenic 1357 ppm, and chromium 142 ppm
GA/WR/P202	Lower adit , south side of waste pile. Sample collected over a thickness of 30 cm. 80%-85% was black graphitic sand and silt. Remainder was lenses of reddish oxidized sand or yellow sericitic lenses of sand	Field paste pH 4.78 and paste conductivity 330 μS/cm, elevated concentrations of arsenic 905 ppm, cadmium >100 ppm, copper 635 ppm, manganese 9792 ppm, lead >10000 ppm, antimony 614 ppm, and zinc >10000 ppm.
GA/WR/P203/1	Lower adit, north side of waste pile. Sample of the 10 cm oxidized surface. Consisted of a 2 cm band of fine black material with quartz sand and gravel overlying an 8 cm band of yellow/dark green oxidized (welded) sand and silt (hardpan)	Field paste pH 3.47 and paste conductivity 350 μS/cm elevated concentrations of arsenic 1135 ppm, cadmium 33.9 ppm, manganese 4399 ppm, lead >10000 ppm, and zinc 5383 ppm.
GA/WR/P203/2	Lower adit, collected beneath sample P203/1 in same pit over a thickness of 30 cm. 95% black fine grained graphitic material.	Field paste pH 3.02 and paste conductivity 470 μS/cm elevated concentrations of arsenic 1835 ppm, cadmium 27.6 ppm, and lead 1142 ppm.

The samples from the lower pile (GA/WR/P202 and P203) are potentially acid generating, based on the ABA test results (acid generation potential exceeded neutralization potential). The samples also showed acidic paste pH values, indicating that they are actively generating acid.

The sample collected from the upper pile (GA/WR/P201) showed neutral paste pH. The total sulphur content was low (0.07%) with most of the sulphur present as sulphate. This, together with a negative neutralization potential, suggests that the sample has undergone acid generation in the past but that its acid generation potential has been nearly exhausted.

All of the waste rock samples showed relatively high metal contents, particularly for silver, arsenic, cadmium, copper, manganese, lead, antimony and zinc.

Based on the limited testing completed in this assessment, it is likely that most of the waste rock is acid generating and has the potential for metal leaching. However, no adverse impacts such as metal oxide stains or vegetation kill were observed below the dump, even though it has been there for more than 40 years.

5.6 Mine Openings and Excavations

There are two adits on the site (Figure 3). Both adits have collapsed and are buried. The rock around the openings appears to be fairly stable.

The upper adit (Photo 7) is located approximately 15 metres in elevation above the lower adit. There is a shallow depression, 0.3 to 0.4 m across, in the ground at this location which may have been caused by the settling of fines within the material use to block the adit. The opening created appears to be 2 metres deep. While the adit does not currently pose a safety hazard, there is some concern that the seal may not be adequate over the longer term.

The lower adit is completely sealed by waste rock and overburden. The rock around and above the adit appears to be stable. No stability concerns were evident.

5.7 Tailings

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

6.0 RISKS AND CONCERNS

6.1 Health and Safety Risks

The existing buildings are in various states of collapse and pose a health and safety hazard. Because the site is on a popular hiking trail and receives many visitors each year, the potential exposure to personal injury is high. Therefore, the risk associated with the buildings is considered high.

The lower adit is securely sealed and does not pose and health and safety hazard. The fill used to seal the upper adit shows signs of settlement. While the closure of the upper adit is adequate at the moment, there is concern that it may deteriorate with time and may require additional work to insure it performs adequately over the long term.

6.2 Environmental Risks

There is no evidence to indicate that acid generation is occurring in the underground workings. Nonetheless, the water draining from the lower adit contains high metal concentrations (aluminum, cadmium, copper, iron, and zinc). The quantity of flow from the adit is extremely low (<1 L/sec), and relative to upstream water quality, the discharge appears to have little impact on the water in Faro Gulch (with the possible exception of arsenic, iron and lead). Therefore, while metal leaching was identified as a concern for the underground workings, the risk associated with it is considered low.

Chemical stability issues were also identified for the waste rock, but, like the underground workings, the level of risk is considered low. Based on the sampling and testing completed in this assessment, the waste rock appears to be acid generating and to contain high concentrations of several metals. The quantity of rock is low (approximately 5000 tonnes) however, and the amount of seepage very low. After 40 years on the surface there is no evidence of staining or vegetation kill in the area below the pile. Based on a comparison of water quality for samples collected upstream and downstream of the pile, what little drainage is coming from the pile appears to be having little impact on the water quality in Faro Gulch. Therefore, the chemical stability risk associated with the waste rock is considered low.

The physical stability issue associated with the shallow slumping or creep evident in the face of the lower dump. Further deformation is likely to occur, but is not expected to result in rapid, large-scale failure, and the risk therefore considered to be low.

6.3 Aesthetic Concerns

The site is an attraction for local tourism. The buildings and equipment are of historic interest and should be preserved to the extent possible while still meeting the objectives of safety and environmental protection. Empty barrels, timber, pipe and other debris, on the other hand, detract from the aesthetics of the site, and should be burned, buried, or removed from the site.

The local Silver Trails Tourism Association has expressed concern that no additional buildings be demolished on Keno Hill without first consulting the local tourism association. Several mine buildings on Keno Hill are being promoted as attractions.

7.0 RECOMMENDATIONS

Prior to undertaking any additional work on the Gambler mine site it is recommended that the Silver Trails Tourism Association be contacted.

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

- Demolishing four of the five wooden buildings, at the camp site, by burning.
- Collecting all other wood debris at the camp and adit and burning.
- Collecting metal and other non-wood debris and transporting to landfill (offsite).
- Refurbishing the main living quarters.
- Repairing the mine rock seal at upper adit.

Four of the five buildings should be demolished and burned as they are in various states of collapse. The fifth building (main living quarters) requires repairs to the roof and floor to both preserve and make the building safe. If refurbished, the cabin will require periodic care and maintenance. However, the local residents and tourism association show a keen interest in maintaining historic sites and artifacts, and would likely be willing to take responsibility of its long-term maintenance. The local tourism association may also be interested in organizing and carrying out the reclamation work.

The opening observed in the mine rock seal on the upper adit should be filled in to block any access. This can be accomplished with hand tools and using loose rock near the opening.

Heavy equipment, such as the ore car and tracks, should be left on site for its historic value.

Measures to stabilize the mine rock piles are not considered necessary, nor are additional investigations to assess chemical stability.

8.0 REFERENCES

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

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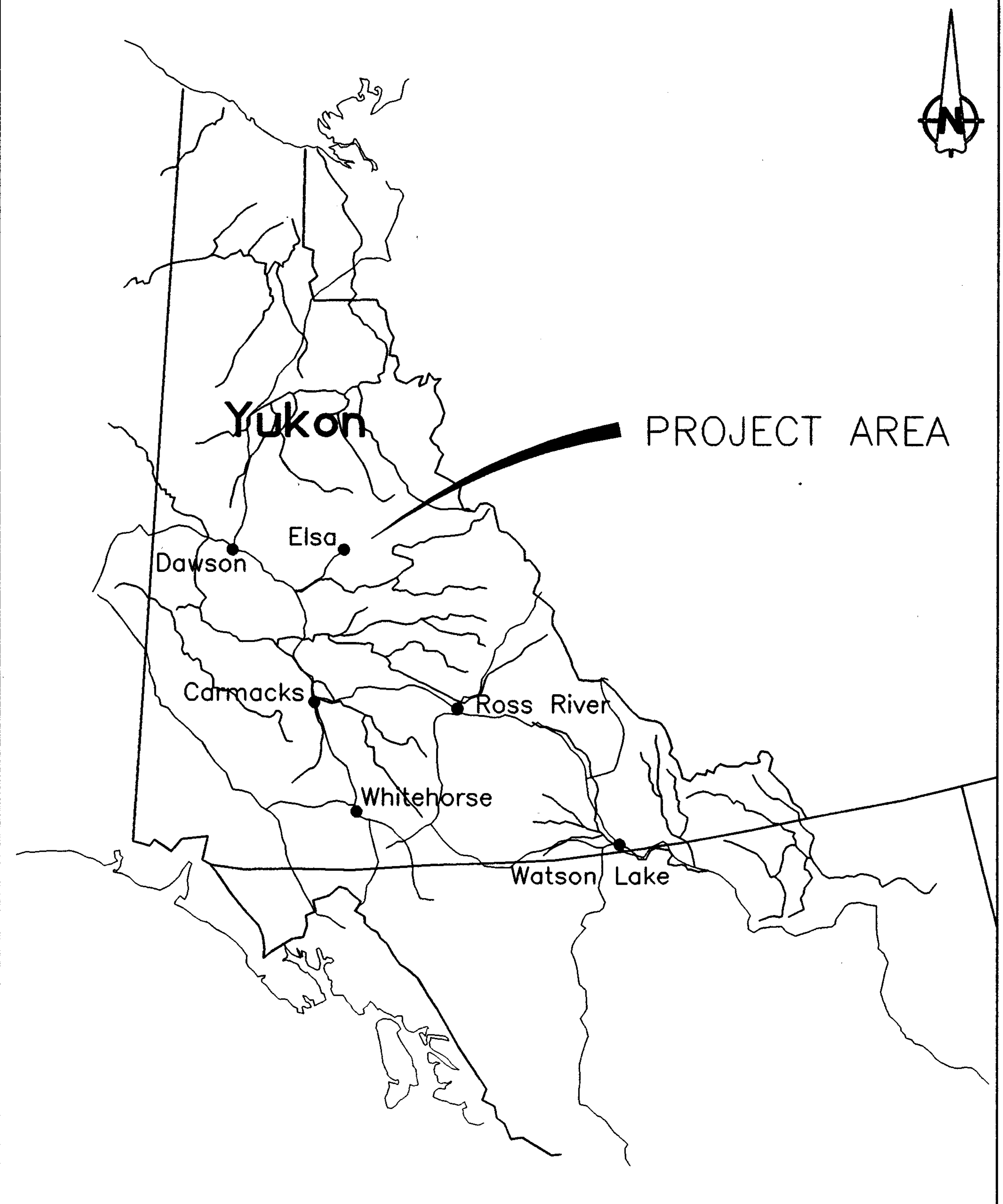
Senior Review

R-133/tg

FIGURES



NOT TO SCALE

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

PROJECT NO.	DATE	APPROVED	FIGURE
P118401	Feb. 1997		1

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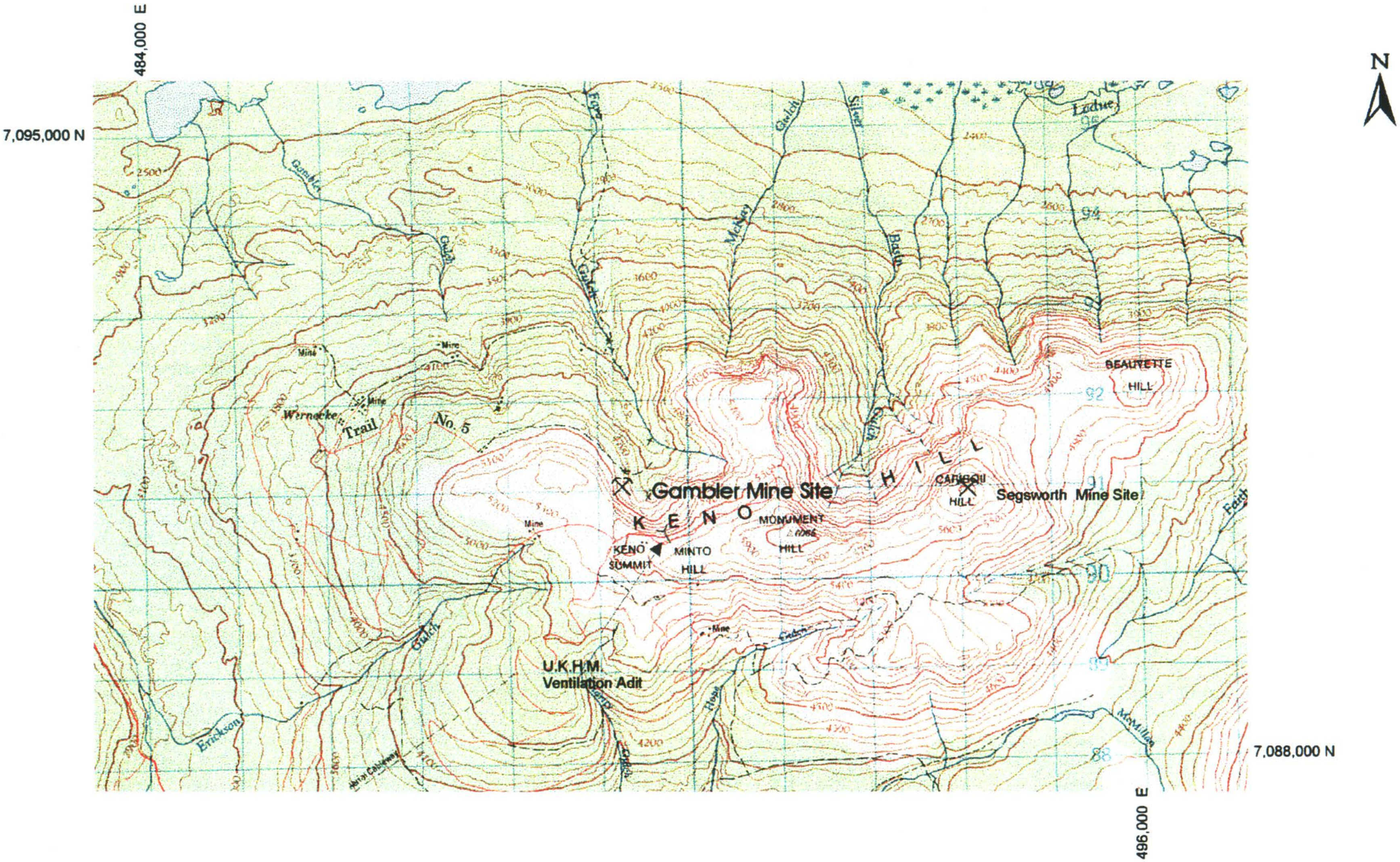
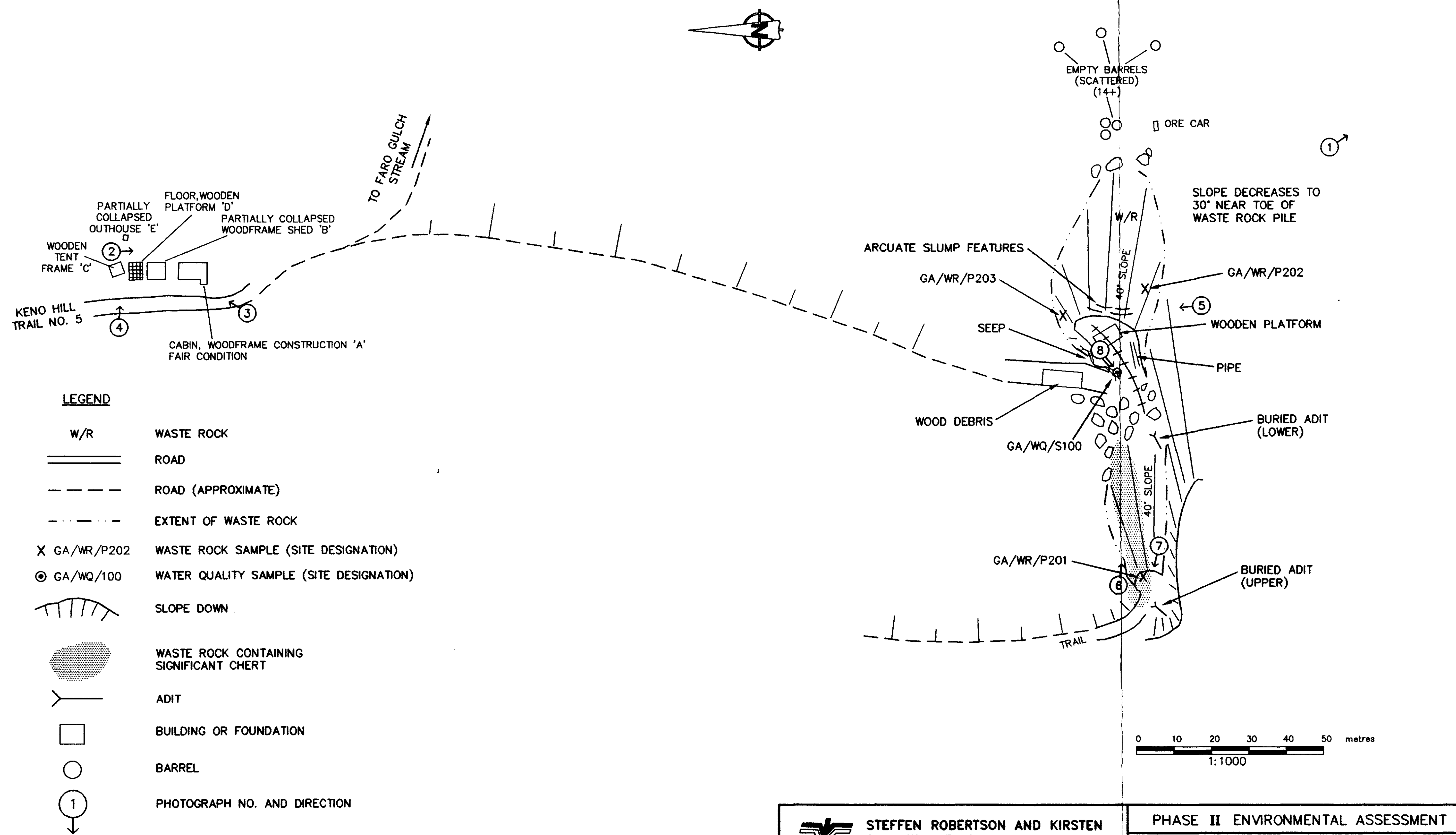


Scale: 1:50,000 Mapsheet: NTS 105M14

SRK STEFFEN ROBERTSON AND KIRSTEN Consulting Engineers	Phase II Environmental Assessment
Public Works and Government Services Canada	Gambler Mine Site Location Map

PROJECT NO.	DATE	APPROVED	FIGURE
P118401	Feb. 1997		2



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

FILE REF: GAMBLER

STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

PUBLIC WORKS AND GOVERNMENT SERVICES

PHASE II ENVIRONMENTAL ASSESSMENT

GAMBLER MINE
SITE PLAN

PROJECT NO.	DATE	APPROVED	FIGURE
P118401	FEB. 1997		3

APPENDIX A

WASTE ROCK TEST RESULTS

Waste Rock Test Results

Parameter	Units	Sample Number GAWR/			
		P201	P202	P203/1	P203/2
Field Paste pH		6.62	4.78	3.47	3.02
Field Cond	μS/cm	10	330	350	470
Lab Paste pH		7.62	5.71	5.74	4.30
Total Sulfur	%	0.07	3.75	1.37	1.11
Sulfate	%	0.05	0.24	0.28	0.17
AP		0.6	109.7	34.1	29.4
NP		-1.6	7.8	9.1	2.0
NET NP		-2.2	-101.9	-24.9	-27.4
NP/AP		<0.1	<0.1	0.30	<0.1
Aluminum	%	0.22	0.23	0.16	0.46
Antimony	ppm	9	614	127	28
Arsenic	ppm	1357	905	1135	1836
Barium	ppm	60	36	39	45
Beryllium	ppm	<0.1	<0.1	<0.1	<0.1
Bismuth	ppm	<1	8	<1	<1
Cadmium	ppm	<0.1	>100	33.9	27.6
Calcium	%	0.09	0.30	0.54	0.26
Chromium	ppm	142	84	92	114
Cobalt	ppm	6	9	6	3
Copper	ppm	16	635	101	20
Gallium	ppm	<1	<1	<1	<1
Iron	%	1.62	4.64	3.95	2.00
Lead	ppm	547	>10000	>10000	1142
Lithium	ppm	2	<1	<1	<1
Magnesium	%	0.04	0.19	0.10	0.04
Manganese	ppm	372	9792	4399	940
Molybdenum	ppm	6	21	11	6
Nickel	ppm	18	57	33	12
Potassium	%	0.05	0.05	0.06	0.07
Phosphate	ppm	420	450	650	500
Silver	ppm	2.7	>200	108.3	17.3
Sodium	%	<0.01	<0.01	<0.01	<0.01
Strontium	ppm	17	14	13	11
Thorium	ppm	<1	<1	<1	<1
Tin	ppm	2	8	5	2
Titanium	%	<0.01	<0.01	<0.01	<0.01
Tungsten	ppm	8	97	14	10
Uranium	ppm	<1	<1	<1	<1
Vanadium	ppm	6.4	5.8	6.2	3.6
Zinc	ppm	214	>10000	5383	2088

AP = Acid Potential in tonnes $CaCO_3$ equivalent per 100 tonnes of material

NP = Neutralization Potential in tonnes $CaCO_3$ equivalent per 1000 tonnes of material

Net NP = Net Neutralization Potential = tonnes $CaCO_3$ equivalent per 1000 tonnes of material

na = no assay / analysis

< = lower detection limit

> = upper detection limit

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

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

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

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

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

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

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

Engineering

APPENDIX B

PHOTOS

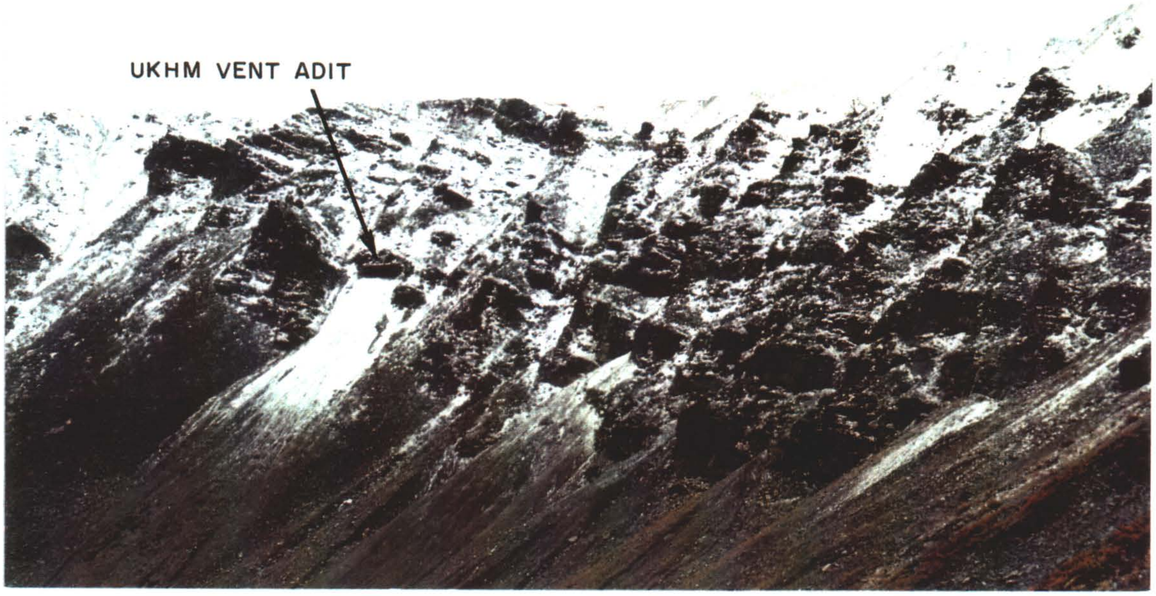


Photo 1: Head wall of Faro Gulch. Platform from UKHM underground workings breakthrough at left of centre, looking southeast. September 18, 1996

Photo 2: Gambler Mine Site, Main Cabin and partially collapsed cabin looking southwest. September 18, 1996.

Photo 3: Camp at Gambler Mine Site, buildings looking northeast. September 18, 1996

Photo 4: Remnants of wooden buildings and outhouse, looking east. September 18, 1996.

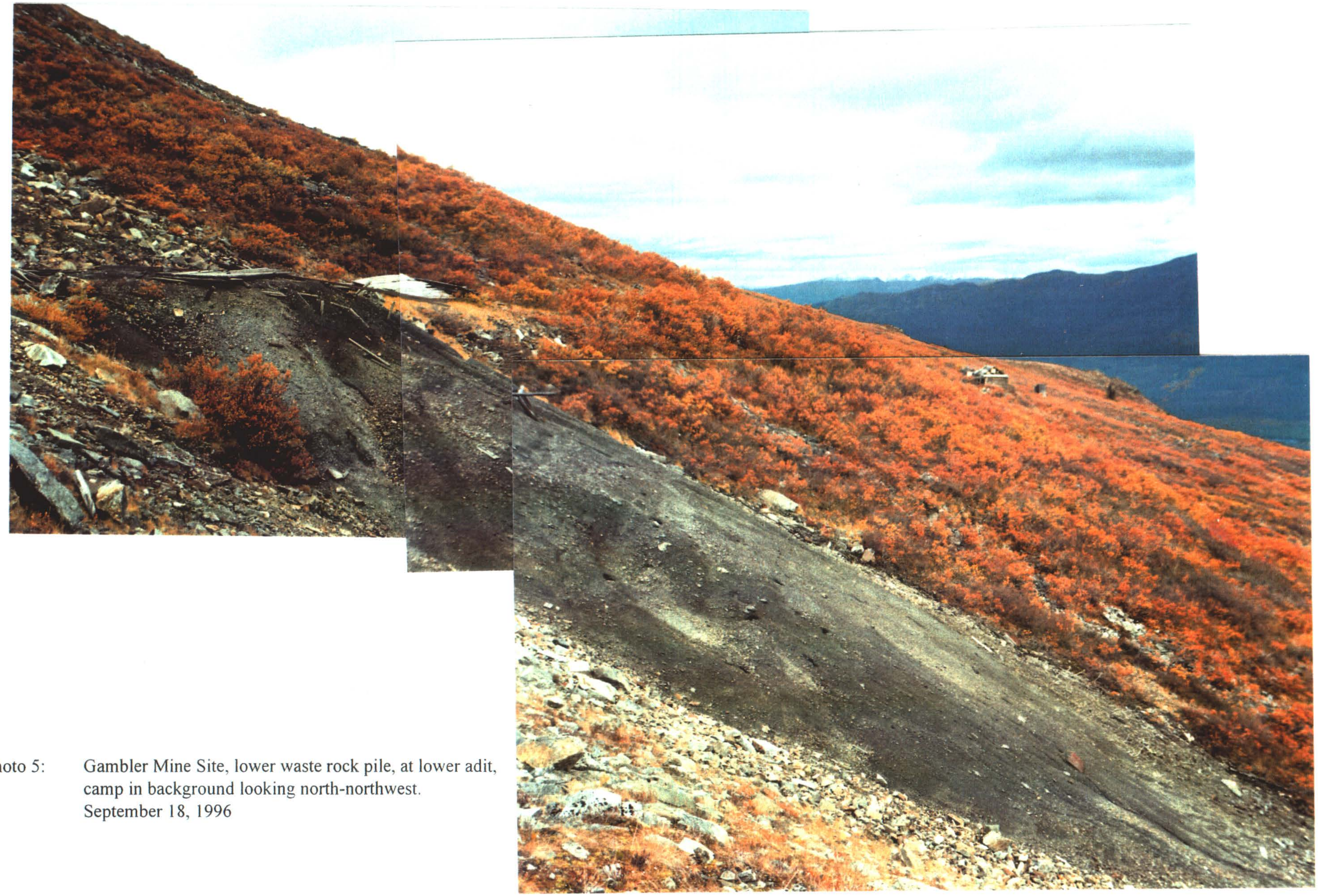


Photo 5: Gambler Mine Site, lower waste rock pile, at lower adit, camp in background looking north-northwest.
September 18, 1996

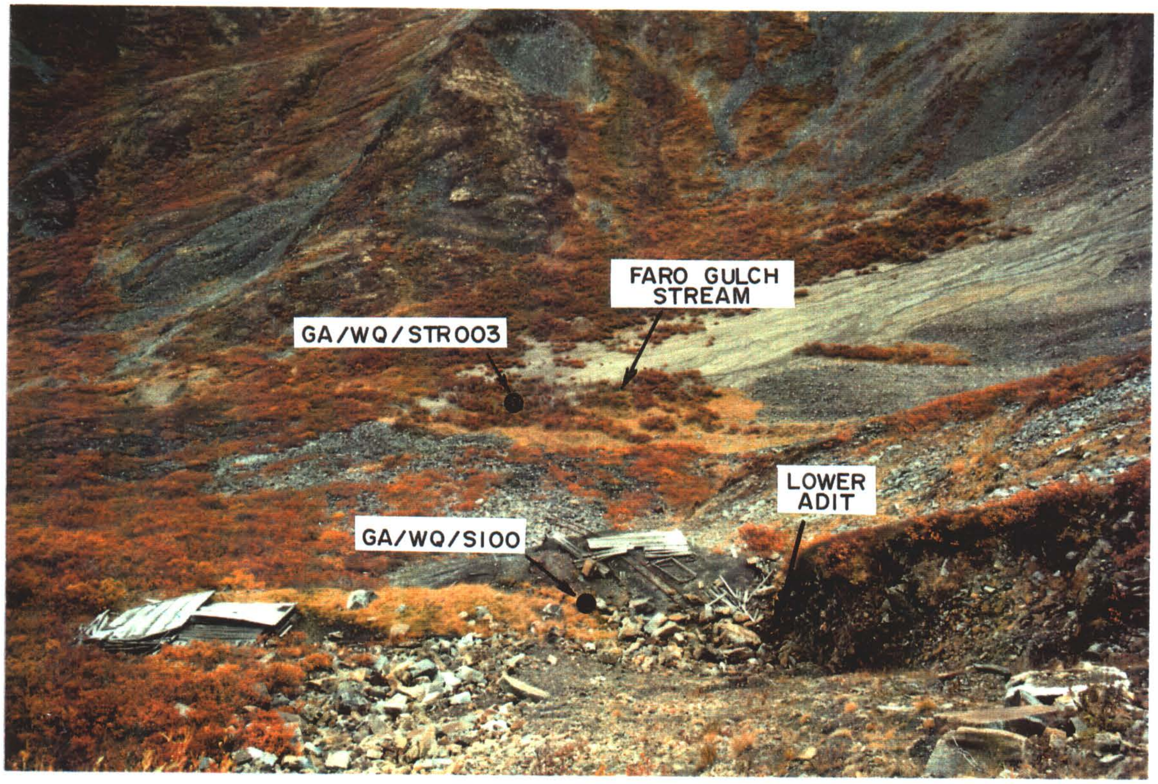


Photo 6: Lower adit and Faro Gulch Stream as seen from upper adit looking east. September 18, 1996.

Photo 7: GA/WR/P201 sample site, at buried upper adit looking west. September 18, 1996.

Photo 8: Seep from lower adit, Water Sample Site, FA/WQ/S100. September 18, 1996

Photo 9: Water sample site GA/WQ/Str002, tributary of Faro Gulch below cabins. September 18, 1996.

APPENDIX C

WATER QUALITY ANALYTICAL RESULTS

Water Quality Results - Gambler Site

Sample ID. / Sample Date	GA/WQ/ Str001 18-Sep-96	GA/WQ/ Str002 18-Sep-96	GA/WQ/ Str003 18-Sep-96	GA/WQ/ S100 18-Sep-96	CCME Freshwater Aquatic Life
Physical Tests					
Conductivity (umhos/cm)	371	456	792	79.2	NA
Hardness (as $CaCO_3$)	166	228	396	26	NA
pH	7.69	7.95	6.99	6.99	6.5 - 9.0
Dissolved Anions					
Acidity (as $CaCO_3$)	2.0	2.0	7.1	3.1	NA
Alkalinity - Total (as $CaCO_3$)	42.5	73.2	12.7	4.9	NA
Sulphate (as SO_4)	131	143	403	22.4	NA
Total Metals					
Aluminum T-Al	**0.111**	**0.337**	**0.138**	**0.14**	0.005 to 0.1 *
Arsenic T-As	0.0048	0.0009	0.0113	**0.0738**	0.05
Barium T-Ba	0.03	0.05	0.02	<0.01	NA
Beryllium T-Be	<0.005	<0.005	<0.005	<0.005	NA
Boron T-B	<0.1	<0.1	<0.1	<0.1	NA
Cadmium T-Cd	0.004	<0.0002	**0.0238**	**0.0114**	0.002 to 0.018 *
Calcium T-Ca	46.5	70.9	88.6	7.94	NA
Chromium T-Cr	<0.001	<0.001	<0.001	<0.001	NA
Cobalt T-Co	<0.02	<0.02	<0.02	<0.02	NA
Copper T-Cu	0.003	<0.001	0.003	**0.014**	0.002 to 0.004 *
Iron T-Fe	**0.32**	0.04	0.23	**1.08**	0.3
Lead T-Pb	**0.091**	<0.001	**0.074**	**0.805**	0.001 to 0.007
Lithium T-Li	<0.02	0.05	<0.02	<0.02	NA
Magnesium T-Mg	12	12.3	42.6	1.5	NA
Manganese T-Mn	0.142	<0.005	1.43	0.275	NA
Mercury T-Hg	<0.00005	<0.00005	<0.00005	<0.00005	0.0001
Molybdenum T-Mo	<0.03	<0.03	<0.03	<0.03	NA
Nickel T-Ni	<0.02	<0.02	0.03	<0.02	0.025 to 0.150
Selenium T-Se	**0.0012**	**0.0014**	**0.002**	0.0006	0.001
Silver T-Ag	**0.0005**	<0.0001	**0.0008**	**0.004**	0.0001
Sodium T-NA	<2	<2	<2	<2	NA
Vanadium T-V	<0.03	<0.03	<0.03	<0.03	NA
Zinc T-Zn	**0.35**	0.008	**3.58**	**1.05**	0.03

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

str = stream sample
S = seep (groundwater) sample
A = adit sample

Aluminum: 0.1 mg/L if pH >6.5, Ca^{2+} >4.0 mg/L, and DOC >2.0 mg/L
Cadmium: 0.008 mg/L if hardness is 60 - 120 mg/L $CaCO_3$
0.018 mg/L if hardness is >180 mg/L $CaCO_3$
Chromium: 0.02 mg/L to protect fish and 0.002 mg/L to protect aquatic life, including zooplankton and phytoplankton.

Copper: 0.002 mg/L if hardness is 0 - 120 mg/L $CaCO_3$
0.004 mg/L if hardness is >180 mg/L $CaCO_3$
Lead: 0.002 mg/L if hardness is 60 - 120 mg/L $CaCO_3$
0.004 mg/L if hardness is 120 - 180 mg/L $CaCO_3$
0.007mg/L if hardness is >180 mg/L $CaCO_3$
Nickel: 0.065 mg/L if hardness is 60 - 120 mg/L $CaCO_3$
0.150mg/L if hardness is >180 mg/L $CaCO_3$

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CHEMICAL ANALYSIS REPORT

Date: October 9, 1996

ASL File No. G5281

Report On: P118401 Water Analysis

Report To: **Public Works & Gov't Services**
Environmental Services
204-1166 Alberni Street
Vancouver, BC
V6E 3W5

Attention: **Mr. Tim Sackmann**, Manager, Contaminated Sites

Received: September 23, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

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RESULTS OF ANALYSIS - Water

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

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

RESULTS OF ANALYSIS - Water File No. G5281

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

Results are expressed as milligrams per litre except for pH and Conductivity (umhos/cm).
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Appendix 1 - QUALITY CONTROL - Replicates

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

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

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

Conventional Parameters in Water

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

Metals in Water

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

Mercury in Water

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

End of Report