
FINAL REPORT

MN-060

SITE ASSESSMENT REPORT
PADDY CAMP
ELSA, YUKON

PUBLIC WORKS & GOVERNMENT SERVICES CANADA

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 **NORECOL, DAMES & MOORE**

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1.0 INTRODUCTION AND BACKGROUND

In 1993, an assessment of abandoned mine exploration and development sites in the Yukon was performed by DIAND Technical Services under the Arctic Environmental Strategy Action on Waste. The assessments provided a general overview of the level of environmental impacts associated with the sites. Conditions identified ranged from no environmental or safety concerns from mine workings, to significant occurrence of off-site transport of contaminants (by water and, in some cases, fugitive air emissions). The key area of concerns identified included:

- accessible adits and portals;
- deteriorating buildings and other structures;
- abandoned fuel in drums and tanks;
- potentially acid generating tailings and waste rock; and
- metals leaching in mine water.

No samples were collected or analyzed during the performance of these assessment studies.

Subsequent to the completion of the 1993 study, Indian and Northern Affairs Canada determined that additional investigation would be warranted. Norecol, Dames & Moore, Inc. (NDM) was requested to perform a site assessment on four selected mine sites to identify specific environmental and human safety risks associated with the specific abandoned mine sites and to provide recommendations and Class "D" cost estimates for mitigation or remediation of the identified risks. The site inspection and data collection phase of the work program was performed during the period of August 26, 1996 through September 1, 1996. The four mine sites assessed by NDM on behalf of PWGSC included:

- Kalzas Twins
- Paddy Camp
- Wernecke
- Past Wernecke

A brief discussion of the program's scope of work, approach and methodology have been presented in Section 2.0 of this report.

1.1 LOCATION AND ACCESS

The main area of activity at the Paddy site is located to the north of highway 11, between the communities of Elsa and Keno City. The main area of activity is transected by Christal Creek in a canyon area of the creek's run. The upper road overlooks the lower road and consist primarily of waste rock storage and road cuts.

A third area is located immediately adjacent to Highway 11, on the north site of the highway, approximately 2 km to the east of the Hansen-McQuesten road turn-off.

Access to the main area is gained by travelling along Highway 11 for an approximate distance of 5 km from Elsa. A well-maintained service road, known locally as the Hansen-McQuesten Road, extends northward from this point. From the highway, turn north on the Hansen-McQuesten Road till a gravel pit becomes visible. To access the main camp, turn eastward into the gravel pit and follow the exploration road. The exploration road can be vehicle-accessed for a distance of approximately 1 km, at which point it becomes impassable. The path can be followed to the site on foot from this point.

At the first road crossing of Christal Creek, the northern abutment and the north end of the log bridge have been washed out.

A site location map is presented in Figure 1. A site layout plan is presented in Figure 2. Photographs identifying current site conditions have been presented in Appendix C.

1.2 OVERVIEW OF SITE DEVELOPMENT

An adit in the main area of exploration was driven during the summer of 1969 into the hillside at an elevation of 760 m (2500'). The cross-cut from the portal was driven south initially, and then southwest for a total distance of some 137 m (450'). A raise was driven some 60 m at an angle to the veins.

The rock from this excavation was dumped down the hillside, and the waste rock pile essentially extends down to the creek.

Above the adit at an elevation of 808 m, an excavation was cut in the side of the hill to expose the veins where they outcrop on surface. The material from this excavation was dumped down the hillside. The rock in this waste dump (photo) has started to slump down the hillside.

There are a few areas where the road (which runs along the bank of Christal Creek) leading to the main adit has started to slump down into the creek. The largest area of failure is located at the log bridge crossing the creek near the main adit.

There is an excavation cut into the side of the hill at the third area. There also appears to be an adit which is covered with waste rock. The location of these features have been presented on site diagrams appended to this report.

2.0 PURPOSE AND SCOPE OF WORK

The NDM assessment of the four mine properties included the following primary elements as requested by PWGSC in their standing offer of August 9, 1996. Work program components were streamlined and tailored as appropriate to the specific mine sites:

- Inspect mine openings and workings, buildings and infrastructure, and waste disposal areas (tailings, waste rock dumps).
- Photo document, survey (as appropriate) and map relevant site features.
- Sample stained soils, surface water (including any flows from adits, diamond drill holes, etc.), and petroleum storage containers.
- Identify and map mineralization which may be prone to acid rock drainage (ARD) (where available, existing deposit/mine geology reports will be used to supplement information collected on site for this project).
- Sample tailings and waste rock dumps as required to identify potential or existing ARD conditions. Samples will be collected for acid base accounting (ABA). As well, pH of leachate (if available) and representative paste pH determinations will be made on site.
- Sample landfills and other solid waste disposal facilities for leachate quality and to identify other environmental problems such as proximity to water bodies, stability hazards, etc.
- Identify available, site-specific, mitigation measures, where required.
- Identify and inventory (quantify) hazardous (such as petroleum products) and non hazardous materials (such as materials stockpiles) (explosives will be identified but not disturbed).
- Identify potential and actual environmental pathways and receptors for site contaminants (and quantified where possible through sampling previously discussed).
- Assess human safety hazards and potential for accidental or deliberate access to hazardous areas.
- Develop preliminary cost estimates (class D [+/-25%]) for the following:
 - physical and chemical stabilization of waste rock and tailings disposal areas;
 - sealing all mine openings;
 - consolidation and land filling of non hazardous, non combustible solid wastes;

- closure of existing landfills and dumps containing non hazardous wastes;
- remediation of contaminated soils to CCME industrial standards (or removal if remediation is not feasible);
- removal and disposal of hazardous solid wastes;
- on site flaring of uncontaminated petroleum products or removal and off site disposal of petroleum and other hazardous liquids;
- demolition of buildings and other structures to foundation level and burning of combustible nonhazardous materials in approved locations.

Optionally, at the discretion of DIAND, revegetation cost estimates could also be provided.

Access roads were not included as a general work program requirement; however, areas affected directly by mine development were reviewed where applicable. As directed by PWGSC, only areas identified as associated with the former exploration activities, or adjacent areas reportedly affected by these activities, were evaluated by the NDM project team during the review program.

3.0 SITE ASSESSMENT METHODOLOGY

3.1 ASSUMPTIONS

At each mine site, the assessment was limited to the area specifically developed or occupied for mine exploration or mining purposes and immediately-adjacent areas within applicable claim boundaries, as well as off-site environmental resources believed to be affected by mine exploration or development activities. Access roadways to mine sites were not included in the assessments.

3.2 ASSESSMENT CRITERIA

In 1991, the Canadian Council of Ministers of the Environment (CCME) initiated the National Contaminated Sites Remediation Program (NCSRP) for remediation of high priority sites in Canada. In order to provide consistent standards against which the remediation of these sites could be completed, the CCME requested the development of the Canadian Environmental Quality Criteria for Contaminated Sites.

The interim environmental quality criteria produced in September, 1991, were adopted from existing guidelines and criteria used throughout Canada on federal lands. The CCME noted at the time of their creation that the CCME criteria did not constitute values for uniform environmental quality at all contaminated sites and their use would require consideration of local conditions (CCME, 1991).

For the purposes of evaluating environmental conditions consistently throughout the four specified mine sites, the CCME interim criteria was applied. Soil and groundwater analytical results were assessed according to CCME criteria, where available. Due to the lack of appropriate CCME criteria for mine sites, the commercial/industrial criteria have been applied as an interim measure for evaluating soil conditions. As no CCME criteria currently exist for VPH and LEPH/HEPH parameters, these analyses were performed for characterization purposes only of suspected petroleum hydrocarbons noted at certain sites in surface soils. To provide a reference for comparison, appropriate BC Criteria for Managing Contaminated Sites (CMCS, July, 1995) and the New Petroleum Hydrocarbon Criteria (August, 1995) have been provided. The characterization information resulting from the application of these analyses has provided information concerning the identification of the suspected petroleum hydrocarbon(s) observed.

Surface water samples have been evaluated against the CCME aquatic life criteria.

3.3 METHODS

3.3.1 Program Methodology

During the performance of the site inspection, site specific information was reviewed to identify the potential contaminants of concern (PCOC's). Information was collected from the Yukon Chamber of Mines, Department of Indian and Northern Affairs, Whitehorse Mining District Mining Recorder, United Keno Hill Mines Ltd., Department of energy, Mines and Resources, Environment Canada Atmospheric Environment Service, Yukon Tourism, Keno City Hotel, the Keno City Mining Museum, and Mr. Mike Mancini (Keno City Snack Bar). A full list of references is presented at the end of this report.

Waste rock disposal areas were inspected, measured, characterized and sampled by a professional geologist. Non-hazardous debris was characterized and documented. Mine openings, associated mine workings, and building structures were inspected and assessed by a professional mining engineer for stability and the presence of hazardous materials. Areas of visible contamination were characterized, measured and sampled. Hazardous materials were identified, characterized where possible, and sampled where possible for laboratory analysis. Samples were collected and preserved in anticipation of the finalization of the analytical program to maximize the characterization of the site. Upon completion of the sampling program and data collection phase, NDM consulted DIAND to finalize the analytical program and discuss the identified.

The methodology for assessment of mine openings was based on findings from the field inspection, as well as a review of available reports and other available information. Some records were available on the sites in the DIAND files. Information was also available, in particular of the underground workings, for the "Wernecke" and "Past Wernecke" sites from United Keno Hill Mines Ltd (UKHM).

3.3.2 Sampling Methods and Quality

Samples of waste rock, surface water, barrel contents, and/or visibly stained soils were collected by a trained environmental scientist for further characterization and laboratory analysis. A sample parameter summary chart has been presented in Table 1.

Surface Water Sampling

Water samples were collected from surface streams upstream and downstream of identified mine workings/exploration activities as well as from representative seeps originating from waste rock stockpiles, pits, tailings or adit areas.

Surface water samples were collected into pre-cleaned plastic bottles supplied by the project laboratory according to the analysis selected. The location of the sample with respect to mine workings, other surface water features, etc. was noted in the field. pH readings were collected in the field for each surface water sample and recorded. Visual observations,

including coloration, clarity, odour, etc., was noted and recorded for each sample. Each sample container was clearly labelled with the site name, sample location and sample interval number, and the project scientist's initials. Filled sample containers were stored in ice-packed coolers at the site and during transport to the laboratory. Samples were maintained in a refrigerated state until analysis. Surface water samples were analyzed by CanTest Laboratories, Vancouver, B.C.

Soil Sampling

Soil samples were collected from any areas associated with historical barrel/hazardous materials storage, areas of visible surface staining, garbage dump areas, and boiler houses.

Soil samples were collected by the field scientist using a shovel and/or trowel and were placed into pre-cleaned 250 ml glass jars with Teflon-lined lids, supplied by the project laboratory. The sampling instrument was cleaned between the collection of different samples. Coolers were repacked for shipment with fresh ice packs at the end of the field inspection program, and were immediately delivered to the project laboratory with chain of custody records. All samples were stored under refrigeration at the project laboratory until analysis. Samples were analyzed by CanTest Laboratories, Vancouver, B.C. Soil and Laboratory Quality Assurance/Quality Control information has been presented in Appendix D.

Each sample container was clearly labelled with the site name, sample location and sample interval number, and the project scientist's initials. Visual observations, including size of stained area, presence/absence of odour, particle size, location, etc., were recorded on the field sample sheets. Filled sample containers were stored in ice-packed coolers at the site to minimize dissipation of volatile compounds. Samples were maintained in a refrigerated state prior to analysis.

Waste Rock

Waste rock samples were representatively sampled by the field scientist from as many waste rock piles as could be identified in the field. Field observations such as waste rock pile rock-type composition, colour, presence/absence of visible carbonate/sulphide mineralization, primary and secondary mineralization, etc. were recorded during the site visit. Each waste rock pile was mapped and its dimensions measured.

Each sample was collected by hand and placed into heavy gage plastic bags, sealed tightly, and placed in coolers for shipping. Waste rock samples were analyzed for ABA (Acid Base Accounting) by CESL Laboratories, Vancouver, B.C.

Analytical Parameters

Samples of soil and water were analyzed for compounds of environmental concern that could potentially be present based on existing information and the results of the site inspection. Samples were analyzed to detect PCOC's identified during the performance of the work program. The following parameters were analyzed in soils collected from the Paddy camp: Benzene/Toluene/Ethylbenzene/Xylene (BTEX), Volatile Petroleum Hydrocarbons (VPH), and Total Metals. Surface water samples collected at the Paddy camp were analyzed for conventional parameters (pH, Total Suspended Solids, and sulphate) and Total Metals. Modified Sobek Method Acid-Base Accounting (ABA) analyses were performed on waste rock samples collected by the project team. ABA analysis included total sulphur, sulphurous sulphate, modified sobek neutralization potential and paste pH. Sulphur content used for calculation of acid potential (AP) was total sulphur content minus sulphate content yielding AP in terms of sulphide content.

Soil, water and wasterock sample results have been presented in Tables 1 through 7.

4.0 ENVIRONMENTAL SETTING

4.1 MINERALIZATION

The Paddy camp is located within the Keno Hill Camp. According to the GSC, the deposit is characterized by the presence of silver/lead/zinc (Ag-Pb-Zn) mineralization (Roots & Murphy, 1992). The local geological setting of the Paddy camp includes the presence of Mississippian Keno Hill quartzite, Upper Devonian and Mississippian sedimentary and felsic meta-volcanic rocks. Principle ore minerals include argentiferous (silver-containing) galena, freibergite ("grey copper"), and pyrargyrite ("ruby silver") (UKHM, Report No. UKH/96/01, Site Characterization). Minor ore minerals include polybasite, stephanite, argentite, greenochite and native silver. The primary gangue mineral is siderite, often associated with quartz. Sulphosalts, sphalerite, pyrite, calcite, pyrrhotite, siderite, and arsenopyrite have also been reported.

According to a review of site conditions prepared by Access Mining Consultants (6/1/96), the following major rock types are commonly encountered in the study area:

- schists and phyllite with variable carbon content;
- chloritic phyllite and schists
- quartzite and phyllitic quartzite
- sericite-quartz phyllite; and,
- greenstones

According to the Access report, the mineralogy of the phyllite and argillite is essentially the same. Principal constituents include carbonaceous matter (graphite), quartz, sericite, carbonate minerals, feldspar, chlorite, and metacrysts of pyrite. Accessory minerals include tourmaline, rutile, and zircon.

The quartzite are visible throughout the sedimentary sequence and are often interbedded with assemblages of phyllite, schist, and argillite. Principal constituents include quartz, mica (sericite), and carbonate minerals. Accessory minerals include leucoxene, tourmaline, zircon, apatite, and pyrite. Pyrite mineralization in the quartzite often occurs as discrete cubes and/or crystal groupings.

The term "greenstone" has been applied historically to describe an altered basic intrusive rock commonly found in the study area. Principal minerals include hornblende, saussurite, plagioclase, chlorite, stilpnomelane, biotite, sericite, leucoxene, and carbonate minerals. Accessory minerals include quartz, potash feldspar, illuminite, magnetite, limonite, and apatite. Pyrite is often associated with the greenstone rocks as a minor constituent.

The predominant rocks observed at the site range from grey micaceous to black graphitic schist and phyllite. Significant mineralization has historically been associated with the greenstone rocks which have intruded the surrounding metasedimentary sequences. Small mineralized quartz veins containing pyrite, sphalerite, and possibly arsenopyrite have been found in small quantities in the metasedimentary rocks of the site (DIAND, May 28, 1971). Primary mineral occurrences are associated with veining and brecciation and the presence of galena and/or sphalerite, pyrite, tetrahedrite and limonite.

4.2 SURFACE HYDROLOGY

The main camp area of the Paddy site is transected by Christal creek. According to the Department of Fisheries and Oceans (DFO, February, 1997), Christal Creek flows directly into the McQuestren River. Studies have been performed on the McQuestren River by Environment Canada and by consultants for United Keno Hill Mines as part of their water license application. At the time of the site visit, two small collapsed wooden bridges were observed in the mid-reach of the creek, ie. at the centre of the Paddy camp. A report by Access Mining Consultants (June, 1996) and information provided by DFO indicate that a flow blockage has resulted from the presence of the collapsed bridges in Christal Creek. Sloughing graphitic soils at the lower access road adjacent to the creek were also observed to be impeding surface water flows in sections of the property.

No surface water features were observed at the site north of the highway.

4.3 CLIMATE

A total of four climate stations exist within the study area and include:

- Atmospheric Environment Services (AES) station at the Elsa Townsite;
- Atmospheric Environment Services (AES) station on the southern flank of Keno Hill;
- Seasonal station operated by DIAND at the Flat Creek Catchment; and,
- Principal climatological station at the Mayo Airport, operated by the AES.

Climate records for Keno Hill from July 1974 to February 1982 show average temperatures ranging from -16.7°C in January, the coldest month, to 10.4° in June, the warmest month of the year. The record low temperature during this period was -44.4°C on January 5, 1975, and the record high was on August 1, 1976 and was 27.2°C. Average monthly precipitation ranges from 25.3 mm in February to 79.6 mm in July. The mean annual precipitation for Keno Hill is 597.4 mm.

4.4 VEGETATION

The Elsa area is located within the Mayo Lake - Ross River Ecoregion (Oswald and Senyk, 1977). The site is heavily vegetated with alder (*Alnus crispa*), willow (*Salix* spp.), and black spruce (*Picea mariana*) representing the primary species.

4.5 FISH AND WILDLIFE RESOURCES

4.5.1 Fisheries

Previous studies indicate that Christal Creek has a variety of fisheries habitats throughout its 15 km length. A study performed by Access Mining Consultants Ltd. (6/1/96) has identified the collapse of two bridges within the study area and has assessed that these collapsed structures may have created barriers to fish migration into the upper reach of the creek.

Below the study area, (ie. below the canyon area with the two collapsed bridges), grayling fry, Arctic grayling, burbot, and slimy sculpins were identified in the Access report; however, the only fish to be recorded beyond the canyon and obstructions was the slimy sculpin.

4.5.2 Wildlife

The Elsa-Keno Hill area supports a wide variety of wildlife, including waterfowl, upland game birds, fur-bearers, small mammals, and ungulates. Cariboo have been occasionally harvested in the area; however, no recent occurrences have been recorded. Moose, marten, wolverine and lynx are also known to inhabit the study area. Historically, thin-horn sheep inhabited the area but disappeared in the 1920's because of over-hunting. Small mammals common to the study area include muskrat, ground squirrel, beaver, red squirrel, varying hare, fox, mink, weasel, vole, shrew, porcupine, river otter, and chipmunks. Large carnivorous mammals include grizzly bear, black bear, and timber wolf.

4.6 SITE TOPOGRAPHY AND SOILS

The primary area of the Paddy camp is transected by Christal creek. This area of the property is located within the Christal creek valley with the south slope exhibiting scree and waste rock slides from the upper access road. The north slope is treed and does not exhibit recent human disturbance.

Site soils consist primarily of residual soils formed by the weathering of the underlying bedrock and from the decomposition of glacial till. The soils visible along the lower access road appear to have been formed by the weathering of the underlying graphitic schist. The soil was grey to black, contained a high percentage of graphitic material, and appeared platy. The high percentage of platy minerals within the graphitic soils has resulted in the failure and sloughing of soils along the lower access road. This characteristic of site soils has led to the collapse of two wooden bridges in the vicinity of the camp. As well, the collapse of the lower access road into Christal creek is visible in certain areas of the property. In vegetated areas, a thin layer of organic material overlay the graphitic soil.

The upper access road has been constructed from the surrounding greenstone waste rock, apparent in the site road cuts. This material appeared slightly rusty along weathered surfaces and is present along the south slope overlooking the creek.

4.7 PERMAFROST

The region is characterized by the presence of discontinuous permafrost. According to previous studies (Access Mining Consultants Ltd. 6/1/96), permafrost is irregularly distributed and its character is influenced by several factors including elevation, hillside exposure, depth of overburden, amount of vegetative cover, and the presence of surface and/or groundwater. According to a report produced by P.H. Sevensma Consultants Ltd. (December 8, 1969), the portal, located at the main exploration camp area, was collared in permafrost. This information combined with the canyon-type topography of the main camp area indicates the presence, if not extent of, permafrost within the study area.

5.0 SITE DESCRIPTION AND FINDINGS

5.1 BUILDINGS, INFRASTRUCTURE, EQUIPMENT

During the site inspection, the study team noted a wood clad building located at the far northwestern portion of the main camp area. The approximate dimensions of this structure measure 2.5 x 4 m and the structure is relatively intact. Two additional wooden structures were observed immediately adjacent to the north side of the highway approximately 1 km northeast of the McQueston Road turnoff. Although in relatively good condition, these structures appear to be older in age than the main camp building and are located in an areas of dense vegetation.

Two collapsed bridges were noted at the main camp area in Christal creek. Photograph #4 shows the condition of one of these bridges.

In addition to the wood clad building, a wooden support structure, two ore cars, 25 pieces of rail and 8 pieces of pipe were observed on the northwest bank of Christal creek. Approximately thirty empty barrels were also observed in storage at the convergence of the upper and lower roads. These areas are shown in Photograph #6 and #5, respectively.

An intact adit was noted at the main camp area on the northeast slope above Christal Creek. At the time of the site inspection, surface water was not observed in the vicinity of the adit. The adit was located approximately 100 feet up gradient of Christal Creek on the canyon slope between the upper and lower roads. This feature is shown in Photograph #2.

Remnants of one additional adit was noted adjacent to the highway on the south side. The area is visible from the highway and the remains of the adit are barely visible under a blanket of eroded rock fragments.

A site layout plan identifying soil, water and wasterock sampling locations has been presented in Figure 2. An aerial view of the main camp area is shown in Photograph #1.

5.2 NON-HAZARDOUS MATERIALS

No waste dumps were noted during the site inspection. A borrow pit was noted at the intersection of the main camp access road and McQuesten Road.

5.3 HAZARDOUS MATERIALS

Minor dumping of oil cans was observed near the wooden support structure and ore cars on the northwest bank of Christal Creek. As the support structure had the appearance of a former fuel storage area, one soil sample (PS1) was collected from this location and submitted for total metals, BETX , LEPH/HEPH and VPH analyses. As no CCME criteria is available VPH and LEPH/HEPH, these analyses were performed as a screening process and

have been referenced to BC CMCS and New Petroleum Hydrocarbon criteria (July and August, 1995) for commercial/industrial sites. The VPH and LEPH/HEPH results were within criteria. Analytical results for BTEX in PS1 did not exceed CCME criteria for commercial/industrial land use.

Approximately 30 empty fuel barrels were stored at the convergence of the upper and lower roads to the southeast of the main camp. No surface staining was observed at the time of the site inspection. Two soil samples, PS2 and PS3, were collected immediately up gradient and down gradient of the empty barrel storage area and submitted for total metals, BTEX, LEPH/HEPH and VPH analyses. The analytical results for PS2 and PS3 registered within CCME criteria for the total metals and BTEX. As no CCME criteria is available for VPH and LEPH/HEPH, these analyses were performed as a screening process and have been referenced to BC CMCS and New Petroleum Hydrocarbon criteria (July and August, 1995) for commercial/industrial sites. VPH and LEPH/HEPH results were less than the detection limit and were within CMCS criteria. Soil sample results have been presented in Tables 3 through 5. This area is shown in Photograph #5.

5.4 SURFACE WATER QUALITY

Three surface water samples were collected from Christal Creek (PW1, PW2, and PW2b) and one seepage sample was collected upgradient from Christal Creek (PW2a) (Figure 2). Water sample results have been presented in Tables 6 and 7. All surface water samples were analyzed for pH, total suspended solids (TSS), sulphate, and total metal concentrations. The surface water pH was within the CCME criteria for Freshwater Aquatic Life. Field and lab pH measurements varied, probably due to geochemical interactions over time related to iron oxidation. Total metal concentrations in Christal Creek were greater than CCME for cadmium, iron and zinc. In the seepage (PW2a), total metal concentrations were within the CCME with the exception of zinc concentrations. Sulphate concentrations were moderate (178 mg/L) in Christal Creek and were high in the seepage (502 mg/L). TSS concentrations were low (<10 mg/L) and within an acceptable range. There are no CCME for sulphate and TSS.

5.5 WASTE ROCK DISPOSAL AREAS

Six samples of rock were selected at the Paddy site. The waste rock from the adit and the excavation located above the adit was dumped down the hillside. The waste rock dump below the adit extends down to Christal Creek. The rock in the upper waste rock dump (Photograph #2 and #3) has started to slump down the hillside. The waste rock samples were submitted for ABA tests (Modified Sobeck Method) which provide paste pH, total sulphur, total sulphate, calculated acid and neutralization potential and NP/SAP ratio (Table 2).

Two samples of Quartzite containing visible sulphide minerals (pyrite) were collected from a waste rock pile (PWR1 and PWR2) (Figure 2). Both samples had non-acidic paste pH (6.73 and 6.81) with high sulphide content (5.3 and 5.5%) and low sulphate-sulphur concentrations (0.13 and 0.21%) (Table 5.4-1). The corresponding acid potential (AP) was high (162 and

Not Representative

165 kg CaCO₃/t). The neutralization potential (NP) was moderate (66 and 77 CaCO₃/t). Due to the high sulphide content and NP/AP of 0.4 and 0.5, the material was classified as potentially acid producing.

Four additional waste rock samples were collected from the Paddy site. Two samples were collected from waste rock along the upper road (PWR3 and PWR4) and two samples were collected from the waste rock slide near Christal Creek (PWR5 and PWR6) (Figure 2). The remaining four samples were phyllites⁽³⁾ and argillite⁽¹⁾. The samples were all non-acidic (paste pH varying from 7.4 to 7.6) with moderate total sulphur concentrations (0.34 to 1.5%). Sulphate-sulphur concentrations ranged from 0.1 to 0.3%. The corresponding acid potential (AP) ranged from 3 to 92 kg CaCO₃/t. The neutralization potential (NP) was high and ranged from 122 to 305 kg CaCO₃/t. Due to the high neutralization potential this material was classified as potentially acid consuming.

5.6 TAILINGS

No tailings were noted at the site during the performance of the work program.

5.7 MINE OPENINGS

An adit in the main area of exploration was driven during the summer of 1969 into the hillside at an elevation of 760 m (2,500'). The cross-cut from the portal was driven south initially, and then southwest for a total distance of some 137 m (450'). A raise was driven some 60 m at an angle to the veins. This adit is shown in Photograph #2.

The initial portion of the adit was in permafrost, and was timbered with local round timber. The timber has rotted, and some of the timber caps are broken. This has resulted in caving at the contact of the overburden with bedrock. The opening is sealed by this caved material, and the workings are inaccessible.

The rock from this excavation was dumped down the hillside, and the waste rock pile essentially extends down to the creek.

Above the adit at an elevation of 808 m, an excavation was cut in the side of the hill to expose the veins where they outcrop on surface.

There is an excavation cut into the side of the hill at the third area. There also appears to be an adit which is covered with waste rock.

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 HEALTH AND SAFETY

There were no significant mining hazards at this site. The main adit, located on the flank of the Christal Creek valley, is sealed by overburden which has sloughed over the opening due to failure of the portal timber. The adit, located to the north of Highway 11, is covered with waste rock and appears sealed.

The presence of steep slopes within the canyon area of Christal Creek has contributed to the presence of waste rock slides between the upper and lower roads. Due to the extensive slope failure observed at the upper road, waste rock slides have resulted in the destruction of areas of the upper access road. The upper road is therefore only safely accessible by foot.

The lower road, adjacent to Christal Creek, is slumping, and will eventually settle into the creek. The effect of this slumping has caused the collapse of the two bridges into Christal Creek. A geotechnical assessment is required to ascertain if the instability of the dumps and road pose a health and safety risks.

The presence of graphitic and platy soils along the final section of the lower road has resulted in localized collapse of this access road. Two wooden bridge structures have been severely impacted by the collapse of the road resulting in limited site access. The final 1 km of the access road to the site has been bull-dozed and is impassable by vehicle. A sudden drop-off in the road is present approximately 2 km past the borrow pit on the way to the main camp area.

6.2 ENVIRONMENTAL RISKS

The presence of graphitic residual soils along the last 500 metres of the lower access road, in the area of the main camp, has resulted in the localized caving of soil into Christal Creek. Two wooden bridge structures have collapsed into the creek due to the failure of the creek bank. According to a recent study by Access Mining Consultants Ltd. (1996), the presence of the collapsed bridges in the canyon area of Christal Creek appear to have interfered with the migration of fish stocks through the area. An assessment of the impacts of the lower road slope failure/bridge collapse on local fisheries is a component of the geotechnical assessment previously recommended.

6.3 AESTHETIC CONCERNS

The presence of metal cans, rail pieces, ore cars, and pipe at the site present an aesthetic concern and should be removed once exploration activities have been completed at the site.

7.0 LIMITATIONS

The findings and conclusions documented in this report have been prepared for specific application to this project and have been developed in a manner consistent with that level of care and skill normally exercised by members of the environmental science profession currently practising under similar conditions in the area, and in accordance with the terms and conditions set forth in our proposal. No other warranty, expressed or implied, is made. This report is for the exclusive use of Public Works & Government Services Canada and their representatives. The scope of services performed in execution of this investigation may not be appropriate to satisfy the needs of other users, and any use or re-use of this document or the findings, conclusions, or recommendations presented herein is at the sole risk of said user.

Testing conducted on the site was in locations and for parameters consistent with former site uses. However, as conditions between sampling locations may vary, a potential always remains for the presence of unknown, unidentified, or unforeseen surface and subsurface contamination. Given that the scope of service for this assessment included limited soil and groundwater sampling and analytical testing, it is possible that currently unrecognized contamination may exist at the site and, if present, that the levels of contamination may vary across the site. Further evidence against such potential site contamination would require additional surface and subsurface exploration and chemical analytical testing.

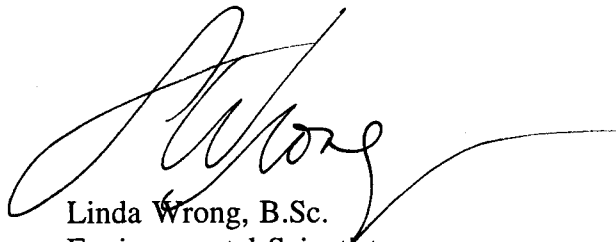
Opinions, conclusions and recommendations in this report apply to site conditions existing at the time of our assessment and are based on comparison of chemical analytical results to the Canadian Council of Ministers of the Environment (1991), B.C. Environment, Lands and Parks "Criteria For Managing Contaminated Sites In B.C.", (July 1995) and the New Petroleum Hydrocarbon Criteria (August, 1995). In the event these criteria are changed, new criteria are introduced, or new information is developed in future site work, Norecol, Dames & Moore, Inc. should be provided the opportunity to reevaluate the conclusions of this report, and to amend our opinions, as appropriate.

Norecol, Dames & Moore, Inc.'s objective is to perform our work in a professional manner and with the best interests of our clients in mind. It is important to recognize that even the most comprehensive scope of services may fail to detect environmental liability on a particular site. Therefore, Norecol, Dames & Moore, Inc. cannot act as insurers and cannot "certify" or "underwrite" that a site is free of environmental contamination, and no expressed or implied representation or warranty is included or intended in our reports except that our

work was performed, within the limits prescribed by our client, with the customary thoroughness and competence of our profession.

NORECOL, DAMES & MOORE, INC.

per:



Linda Wrong, B.Sc.
Environmental Scientist



David P. Harpley, P.Geo.
Senior Consultant
Senior Review

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TABLES

TABLE 1
PADDY SITE
SAMPLE PARAMETERS SUMMARY CHART
PUBLIC WORKS AND GOVERNMENT SERVICES
YUKON ABANDONED MINE SITES - PADDY
20749-013-310

Sample Identification	Sample Type	Parameters Analysed					
		PCB	Total Metals	ABA	BTEX/VPH	LEPH/HEPH	Conventional Parameters
PWR1	waste rock			X			
PWR2	waste rock			X			
PWR3	waste rock			X			
PWR4	waste rock			X			
PWR5	waste rock			X			
PWR6	waste rock			X			
PS1	soil		X		X	X	
PS2	soil		X		X	X	
PS3	soil		X		X	X	
PW1	surface water		X				X
PW2a	surface water		X				X
PW2b	surface water		X				X
PW3	surface water		X				X

PCB - polychlorinated biphenyls

ABA - acid-base accounting

BTEX/VPH - benzene, toluene, ethylbenzene, xylenes, volatile petroleum hydrocarbons

LEPH/HEPH - light extractable petroleum hydrocarbons / heavy extractable petroleum hydrocarbons

Conventional Parameters - pH, sulphate, total suspended solids

PAH - polycyclic aromatic hydrocarbons

TABLE 2
MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING
PUBLIC WORKS AND GOVERNMENT SERVICES
YUKON ABANDONED MINE SITES - PADDY
20749-013-310

Sample No.	Type	Paste pH	S(T) %	S(SO4) %	AP	NP	NET NP	NP/AP
PWR1	Grey Quartzite; 5% massive; blocky cleavage quartzite, cubic crystals of pyrite up to 3mm diameter, 30% oxidized, low carbonate content	6.73	5.32	0.13	162.2	66.1	-96.1	0.4
PWR2	Quartzite, 5% pyrite, 30% oxidized, low carbonate content	6.81	5.48	0.21	164.7	76.9	-87.8	0.5
PWR3	Phyllite, grey schistose, silky sheen, quartz veins, <1% finely disseminated pyrite, 2-3% carbonate	7.52	0.46	0.10	11.3	125.6	114.4	11.2
PWR4	Phyllites, grey schistose, silky sheen, <1% finely disseminated pyrite, 2-3% 5-10 % carbonaceous material (graphite)	7.48	1.47	0.23	38.8	122.5	83.8	3.2
PWR5	Phyllite, grey schistose, silky sheen, <1% finely disseminated pyrite, 2-3% carbonate; 5-10 % graphite	7.44	3.30	0.33	92.8	305.0	212.2	3.3
PWR6	Argillite, dark grey, slightly schistose fabric	7.64	0.34	0.25	2.8	249.4	246.6	88.7

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.

TABLE 3
CONCENTRATION OF BTEX AND VOLATILE PETROLEUM HYDROCARBONS IN SOIL SAMPLES
PUBLIC WORKS AND GOVERNMENT SERVICES
YUKON ABANDONED MINE SITES - PADDY SITE
 20749-013-310
 ug/g (ppm)

		Benzene	Ethylbenzene	Toluene	Xylenes	Volatile Petroleum Hydrocarbons
CCME	Commercial/Industrial	5.	50.	30.	50 (a)	NC
Sample No.	Location/Description					
PS1	At small dump near wood structure	<0.5	<0.5	<0.5	<0.5	<10.
PS2	Downgradient of empty drum storage	<0.5	<0.5	<0.5	<0.5	<10.
PS3	Upgradient of empty drums	<0.5	<0.5	<0.5	<0.5	<10.
Method Detection Limit		0.5	0.5	0.5	0.5	10.

CCME - Canadian Council of Ministers of the Environment Interim Canadian Environmental
 Quality Criteria for Contaminated Sites

< - less than the detection limit indicated

NC - no criteria established

(a) - Criteria for total of m, p and o xylenes.

- Greater than CCME Commercial/Industrial criteria

TABLE 4
CONCENTRATION OF METALS IN SOIL SAMPLES
PUBLIC WORKS AND GOVERNMENT SERVICES
YUKON ABANDONED MINE SITES - PADDY SITE

20749-013-310

ug/g (ppm)

CCME	Commercial/Industrial	Silver	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium*	Copper	Mercury	Manganese	Molybdenum	Nickel	Lead	Antimony	Selenium	Tin	Vanadium	Zinc
Sample No.	Location/Description	40.	50.	NC	2000.	8.	20.	300.	800.	500.	10.	NC	40.	500.	1000.	40.	10.	300.	NC	1500.
PS1	At small dump near wood structure	<2.	0.47	18.	25.4	<1.	1.73	14.	18.	96.	0.02	654.	<4.	29.	113.	<10.	<0.5	38.	18.	216.
PS2	Downgradient of empty drum storage	<2.	0.57	12.	224.	<1.	0.87	9.	20.	42.	0.04	514.	<4.	25.	19.	<10.	<0.5	<5.	35.	131.
PS3	Upgradient of empty drums	<2.	0.41	11.	194.	<1.	0.84	9.	18.	42.	0.04	502.	<4.	25.	19.	<10.	<0.5	<5.	31.	122.
Method Detection Limit		2.	0.05	0.5	0.1	1.	0.25	1.	2.	1.	0.001	0.2	4.	2.	1.	10.	0.5	5.	0.5	1.

CCME - Canadian Council of Ministers of the Environment Interim Canadian Environmental Quality Criteria for Contaminated Sites

< - less than the detection limit indicated

NC - no criteria established

☐ - Greater than CCME criteria for commercial/industrial land use

* - Total Chromium

TABLE 5
CONCENTRATIONS OF LEPH & HEPH IN SOIL SAMPLES
PUBLIC WORKS AND GOVERNMENT SERVICES
YUKON ABANDONED MINE SITES - PADDY SITE
 20749-013-310
 ug/g (ppm)

		LEPH	HEPH
CMCS PHC	Commercial/Industrial	2000.	5000.
Sample No.	Location/Description		
PS1	At small dump near wood structure	<250.	1100.
PS2	Downgradient of empty drum storage	<250.	<250.
PS3	Upgradient of empty drums	<250.	<250.
Method Detection Limit		250.	250.

Page 1 of 1

CMCS PHC - British Columbia Criteria for Managing Contaminated Sites, July 1995
 New Petroleum Hydrocarbon Criteria, August 1995

< - less than the detection limit indicated

NC - no criterion established

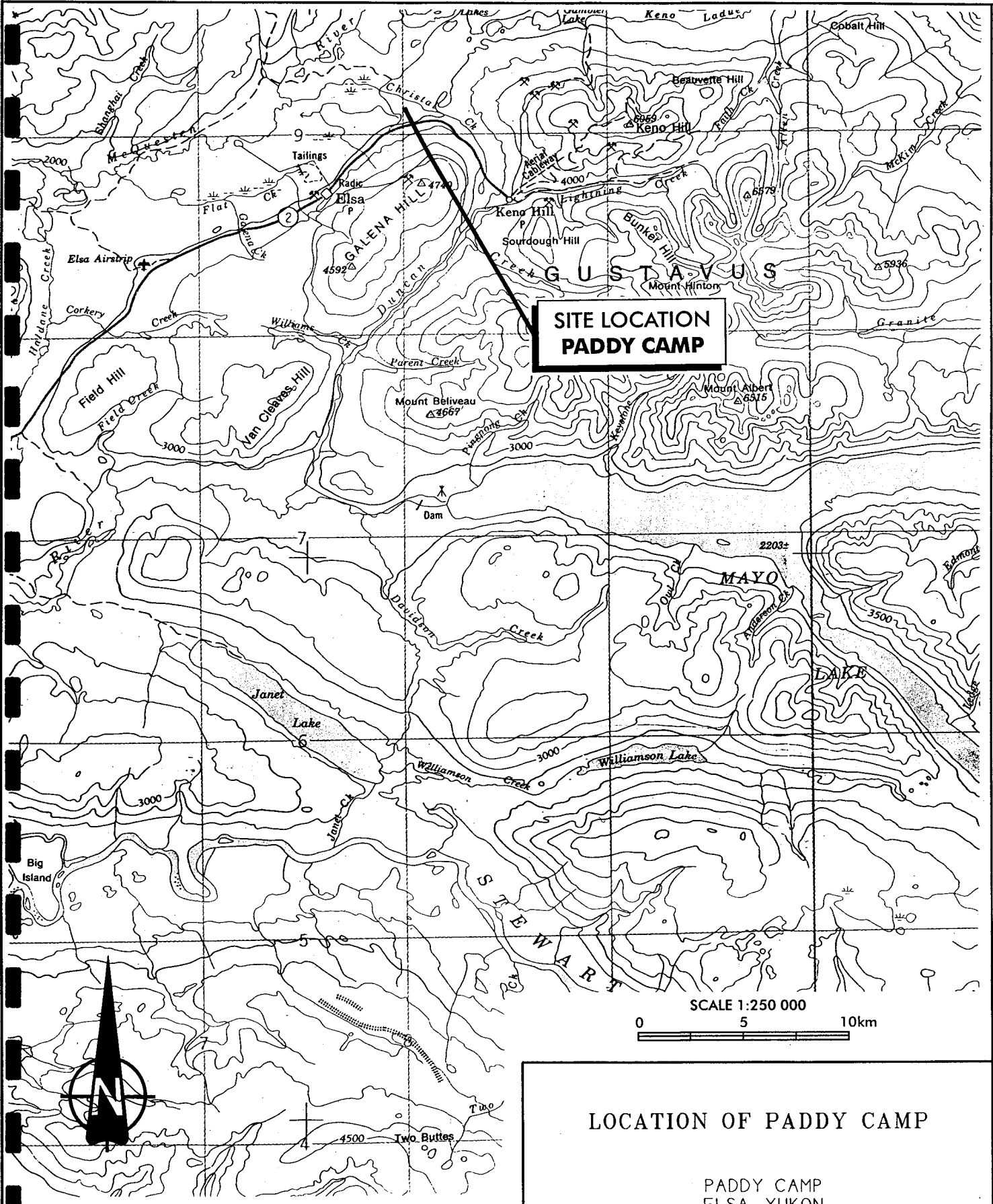
 - Greater than CMCS criteria for commercial land use

TABLE 6
 CONCENTRATION OF CONVENTIONAL PARAMETERS AND METALS IN SURFACE WATER
 PUBLIC WORKS AND GOVERNMENT SERVICES
 YUKON ABANDONED MINE SITES - PADDY SITE
 20749-013-310
 ug/L (ppb)

CCME	Freshwater Aquatic Life	pH	Total Suspended Solids (mg/L)	Sulphate SO4 (mg/L)	Silver	Aluminum*	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium	Copper	Iron	Mercury	Manganese	Molybdenum	Nickel	Lead	Selenium	Tin	Vanadium	Zinc
Sample	Location/Description	6.5-9.0	NC	NC	0.1	5 - 100	50	NC	NC	NC	0.2 - 1.8	NC	2 - 20	2 - 4	300	0.1	100	NC	25 - 150	1 - 7	1	NC	NC	30
PW1	Christal Creek - upgradient of main camp area	8.05	7.	178.	<0.1	<200.	2.	20.	44.	<3.	2.3	<1.	<1.	1.	380.	<0.05	95.	<1.	2.	2.	2.	<1.	<10.	280.
PW2a	In drainage ponds at foot of adit waste rock pile	7.72	Δ0.2	502.	<0.1	<200.	8.	<10.	27.	<3.	1.6	<1.	<1.	3.	<30.	<0.05	4.	<1.	4.	2.	2.	<1.	<10.	120.
PW2b	Christal Creek - centre of main camp area	8.	5.	179.	<0.1	<200.	2.	20.	43.	<3.	2.3	<1.	<1.	1.	290.	<0.05	88.	<1.	2.	1.	1.	<1.	<10.	270.
PW3	Christal Creek - downgradient of main camp area	8.11	4.	181.	<0.1	<200.	2.	30.	42.	<3.	2.2	<1.	<1.	1.	220.	<0.05	84.	<1.	1.	1.	1.	<1.	<10.	250.
Method Detection Limit					0.1	200.	1.	10.	1.	3.	0.2	1.	1.	1.	30.	50.	3.	1.	1.	1.	1.	1.	10.	5.

CCME - Canadian Council of Ministers of the Environment Interim Canadian Environmental Quality Criteria for Contaminated Sites
 < - less than the detection limit indicated
 NC - no criteria established
 □ - Greater than CCME criteria for aquatic life (AW)
 * - Criteria depend on pH or hardness of sample

FIGURES



**SITE LOCATION
PADDY CAMP**

LOCATION OF PADDY CAMP

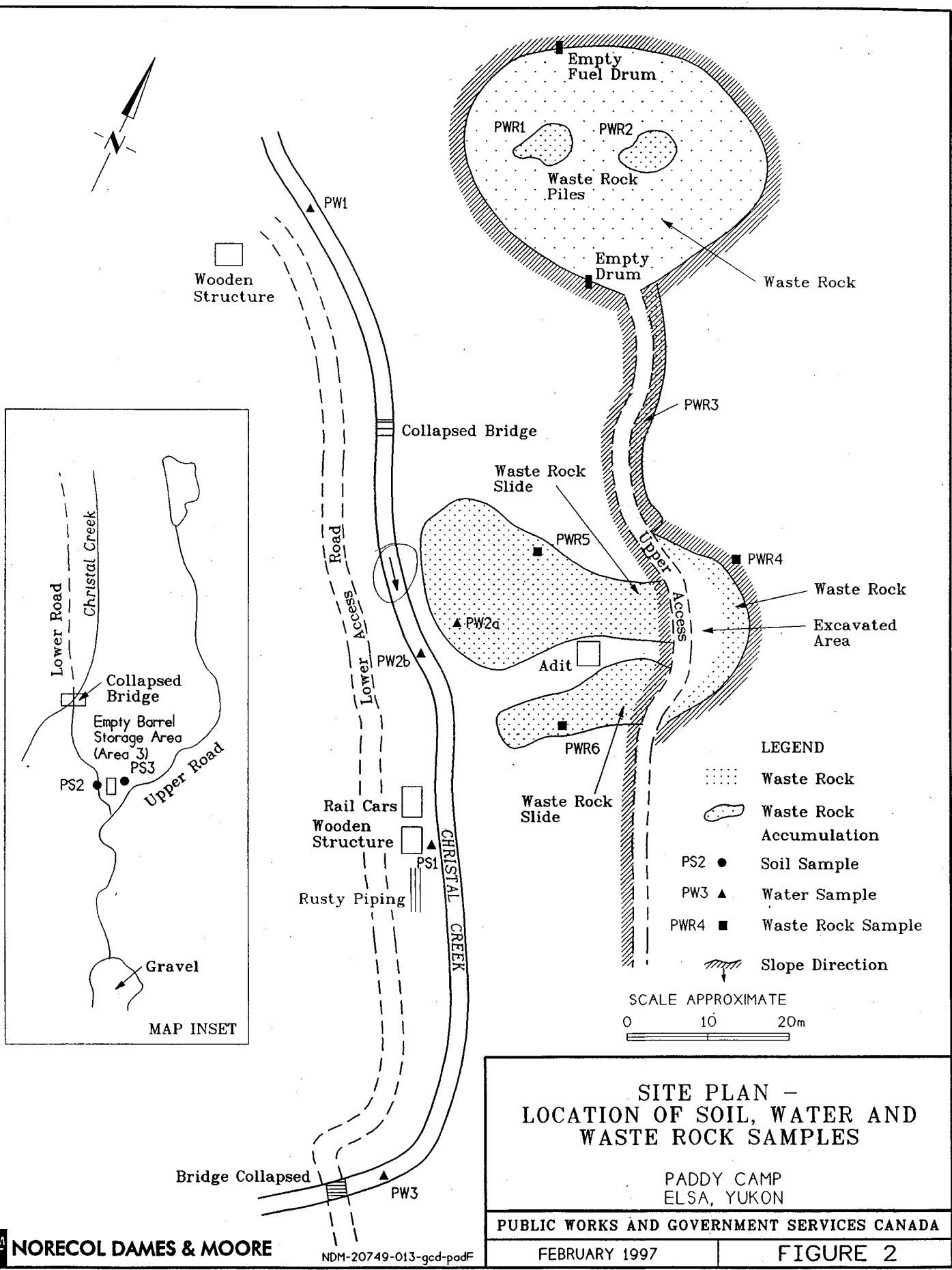
PADDY CAMP
ELSA, YUKON

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

OCTOBER 1996

FIGURE 1

Note: Christal Creek Flows North



**SITE PLAN -
LOCATION OF SOIL, WATER AND
WASTE ROCK SAMPLES**

PADDY CAMP
ELSA, YUKON

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

FEBRUARY 1997

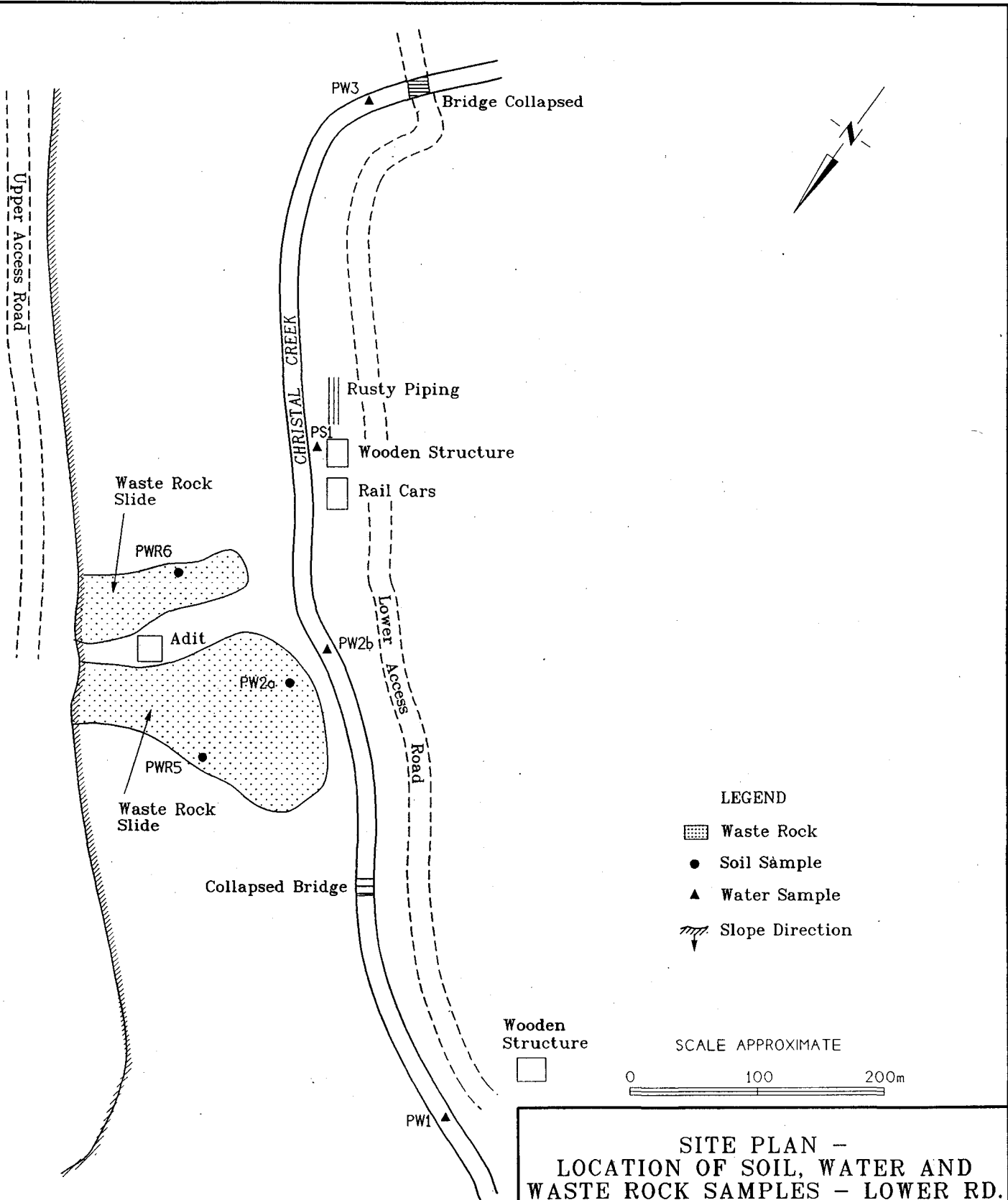
FIGURE 2



NORECOL DAMES & MOORE

NDM-20749-013-gcd-pdf

ROUPE A DAMES & MOORE SUBSIDIARY



SITE PLAN -
LOCATION OF SOIL, WATER AND
WASTE ROCK SAMPLES - LOWER RD.

 PADDY CAMP
 ELSA, YUKON
 PUBLIC WORKS AND GOVERNMENT SERVICES CANADA
 FEBRUARY 1997 FIGURE 3

APPENDIX A
FIELD DATA COLLECTION SHEETS

BARREL SAMPLING

PROJECT NAME: <u>Yukon Mine Site Review</u>	SAMPLE #: _____
Location: <u>Paddy</u>	Date: _____
Name of sampler: _____	_____

Physical Observation			
Condition of barrel:	poor	fair	good
Size (L):	205L	other	Labels _____
Soil staining:	Y / N		

Barrel Contents					
Quantity of liquid:	1/4	1/2	3/4	full	
Colour of liquid:	light	dark	multiphase	other	
Suspected type of liquid:	gasoline	jet fuel	waste oil	glycol	oil
	other	_____			
Sludge observed:	Y / N	Quantity	_____		

Analysis (if required)				
Type of sample taken:	composite	grab		
Analysis required:	metals	PCBs	chlorine	other _____

Comments: No Barrels that were full were identified. - ~ 25 empty barrels observed at convergence of upper + lower roads.

Sample # Format

site name - BL number
eg. Tintina - BL1

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

WATER SAMPLING

PROJECT NAME: 4msR NAME OF SAMPLER: LAW/JD

Location: Paddy Date: 08/28/96

SAMPLE #:	<u>PW1</u>	pH:	<u>6.0</u>
Location description:	<u>Christal Creek - upgradient of main camp area</u>		
Analysis:	<u>metals</u>	<u>water chem</u>	Eh <u>TSS</u> total sulphur

SAMPLE #:	<u>PW2a</u>	pH:	<u>7.0</u>
Location description:	<u>in drainage ponds at foot of adit wash rock pile</u>		
Analysis:	<u>metals</u>	<u>water chem</u>	Eh <u>TSS</u> total sulphur

SAMPLE #:	<u>PW2b</u>	pH:	<u>6.0</u>
Location description:	<u>Christal Creek - at centre of main camp area</u>		
Analysis:	<u>metals</u>	<u>water chem</u>	Eh <u>TSS</u> total sulphur

SAMPLE #:	<u>PW3</u>	pH:	<u>6.0</u>
Location description:	<u>Christal Creek - downgradient of main camp area</u>		
Analysis:	<u>metals</u>	<u>water chem</u>	Eh <u>TSS</u> total sulphur

SAMPLE #:		pH:	
Location description:			
Analysis:	metals	water chem	Eh total sulphur

Comments: _____

Sample # Format

site name - W number
 eg. Tintina - W1

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

APPENDIX B

LABORATORY ANALYTICAL REPORTS

Analysis Report

CANTEST

CanTest Ltd

Professional
Analytical
Services

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

REPORT ON: Analysis of Soil and Water Samples

REPORTED TO: Norecol, Dames & Moore, Inc.
Suite 1900
650 West Georgia Street
Vancouver, B.C.
V6B 4N7

Att'n: Ms. Linda Wrong

CHAIN OF CUSTODY: 19028, 19024, 19025, 19027
PROJECT NAME: PWASC
PROJECT NUMBER: 20749-013

NUMBER OF SAMPLES: 25

REPORT DATE: September 24, 1996

DATE SUBMITTED: September 3, 1996

GROUP NUMBER: 6090406

SAMPLE TYPE: Water and Soil

TEST METHODS:

Volatile Petroleum Hydrocarbons in Soil (VPH-GNS) - analysis was performed using a draft methanol extraction-purge and trap-GC/FID procedure specified by the B.C. MOELP. The VPH compounds elute between n-pentane (n-C5) and n-undecane (n-C11). BTEX compounds are not included in the VPH result. VPH results produced by this method can be compared to Generic Numerical Standard (GNS) criteria.

Volatile Organic Compounds in Soil - analysis was performed using procedures based on U.S. EPA Methods 624/8240, involving methanol extraction, sparging/collection with a Purge and Trap apparatus and analysis using GC/MS.

Conventional Parameters - analyses were performed using procedures based on those described in "British Columbia Environmental Laboratory Manual For the Analysis of Water, Wastewater, Sediment and Biological Materials" (1994 Edition), Province of British Columbia and "Standard Methods for the Examination of Water and Wastewater" 17th Edition, (1989) and 16th Edition (1985), published by the American Public Health Association.

Extractable Petroleum Hydrocarbons in Water/Soil (LEPH/HEPH-GNS) - analysis was performed using a draft DCM extraction-GC/FID procedure specified by the B.C. MOELP. Compounds eluting between n-decane (n-C10) and n-nonadecane (n-C19) are defined as Light Extractable Petroleum Hydrocarbons (LEPH). Compounds eluting between n-nonadecane and n-dotriacontane (n-C32) are defined as Heavy Extractable Petroleum Hydrocarbons (HEPH). These results can be compared to Generic Numerical Standard (GNS) criteria. The results may or may not be corrected for specified PAH's, as noted on the report.

Mercury in Water - analysis was performed using procedures based on Standard Methods for the Examination of Water and Wastewater section 3112 B, acid permanganate digestion, analysis using Cold Vapour Atomic Absorption.

(Continued)

CANTEST LTD.

Richard S. Jorwitz
Supervisor, Inorganic Testing

REPORTED TO: Norecol, Dames & Moore, Inc.



REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Conventional Parameters in Water

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CAN TEST ID	pH	Total Suspended Solids	Sulphate SO4
WW1	Aug 29/96	609040027	7.93	3	433
PWW1	Aug 29/96	609040028	6.08	<	4.6
PWW2	Aug 29/96	609040029	7.18	10	4.8
PWW3	Aug 29/96	609040030	7.83	< 5	3.5
PWW4	Aug 29/96	609040031	7.11	<	5.0
PWW5	Aug 29/96	609040032	7.81	< 5	5.3
KW1	Aug 28/96	609040033	5.62	7	9.1
KW2	Aug 28/96	609040034	5.51	<	8.8
PW1	Aug 28/96	609040035	8.05	7	178
PW2a	Aug 28/96	609040036	7.72	< 0.2	502
PW2b	Aug 28/96	609040037	8.00	5	179
PW3	Aug 28/96	609040038	8.11	4	181
DETECTION LIMIT UNITS			pH units	1 mg/L	1 mg/L

mg/L = milligrams per liter
< = Less than detection limit

REPORTED TO: Norecol, Dames & Moore, Inc.



REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Metals Analysis in Water

CLIENT SAMPLE IDENTIFICATION:	PWW4	PWW5	KW1	KW2		
SAMPLE PREPARATION:	TOTAL	TOTAL	TOTAL	TOTAL		
DATE SAMPLED:	Aug 29/96	Aug 29/96	Aug 28/96	Aug 28/96		
CAN TEST ID:	609040031	609040032	609040033	609040034	DETECTION LIMIT	UNITS
Aluminum Al	<	<	<	<	0.2	mg/L
Antimony Sb	<	<	<	<	0.2	mg/L
Arsenic As	<	<	<	<	0.001	mg/L
Barium Ba	0.011	0.009	0.063	0.069	0.001	mg/L
Beryllium Be	<	<	<	<	0.003	mg/L
Boron B	<	<	<	0.01	0.01	mg/L
Cadmium Cd	0.0004	0.0002	<	<	0.0002	mg/L
Calcium Ca	1.51	1.50	2.42	2.35	0.01	mg/L
Chromium Cr	<	<	<	<	0.001	mg/L
Cobalt Co	<	<	<	<	0.001	mg/L
Copper Cu	<	<	0.003	0.003	0.001	mg/L
Iron Fe	<	<	<	0.06	0.03	mg/L
Lead Pb	0.027	0.016	<	<	0.001	mg/L
Magnesium Mg	0.37	0.37	0.71	0.68	0.05	mg/L
Manganese Mn	0.085	0.075	0.029	0.013	0.003	mg/L
Mercury Hg	<	<	<	<	0.05	µg/L
Molybdenum Mo	<	<	<	<	0.001	mg/L
Nickel Ni	0.002	0.001	0.001	0.002	0.001	mg/L
Phosphorus PO4	<	<	<	<	0.4	mg/L
Potassium K	0.11	0.094	0.59	0.45	0.01	mg/L
Selenium Se	<	<	<	<	0.001	mg/L
Silicon SiO2	3.0	3.0	6.0	6.2	0.1	mg/L
Silver Ag	0.0002	<	<	<	0.0001	mg/L
Sodium Na	0.6	0.6	0.9	0.9	0.1	mg/L
Strontium Sr	0.007	0.007	0.017	0.017	0.001	mg/L
Tin Sn	<	<	<	<	0.001	mg/L
Titanium Ti	<	<	<	<	0.006	mg/L
Vanadium V	<	<	<	<	0.01	mg/L
Zinc Zn	0.018	0.012	0.007	0.009	0.005	mg/L
Zirconium Zr	<	<	<	<	0.02	mg/L

mg/L = milligrams per liter
 < = Less than detection limit

µg/L = micrograms per liter

REPORTED TO: Norecol, Dames & Moore, Inc.

CANTEST

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Polycyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	WS3	
DATE SAMPLED:	Aug 29/96	
CAN TEST ID:	609040051	
ANALYSIS DATE:	Sep 7/96	DETECTION LIMIT
Low Molecular Weight PAH's		
Naphthalene	0.07	0.05
Acenaphthylene	0.12	0.05
Acenaphthene	<	0.05
Fluorene	<	0.05
Phenanthrene	1.8	0.05
Anthracene	0.35	0.05
Total LMW-PAH's	2.34	
High Molecular Weight PAH's		
Fluoranthene	5.2	0.05
Pyrene	6.0	0.05
Benzo(a)anthracene	4.2	0.05
Chrysene	8.3	0.05
Benzo(b)fluoranthene	17	0.05
Benzo(k)fluoranthene		0.05
Benzo(a)pyrene	7.2	0.05
Indeno(1,2,3-c,d)pyrene	15	0.05
Dibenz(a,h)anthracene	1.6	0.05
Benzo(g,h,i)perylene	18	0.05
Total HMW-PAH's	82.5	
Total PAH's	84.8	

Results expressed as micrograms per gram, on a dry weight basis. ($\mu\text{g/g}$)

< = Less than detection limit

NOTE: Benzo(b)fluoranthene and Benzo(k)fluoranthene reported as total.

REPORTED TO: Norecol, Dames & Moore, Inc.



REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Monocyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	KS5	PS1	PS2	PS3	
DATE SAMPLED:	Aug 28/96	Aug 28/96	Aug 28/96	Aug 28/96	
CAN TEST ID:	609040045	609040046	609040047	609040048	
ANALYSIS DATE:	Sep 8/96	Sep 8/96	Sep 8/96	Sep 4/96	DETECTION LIMIT
Volatile Pet. Hydrocarbons	<	<	<	<	10
Benzene	<	<	<	<	0.5
Ethylbenzene	<	<	<	<	0.5
Toluene	<	<	<	<	0.5
Xylenes	<	<	<	<	0.5
Surrogate Recovery					
Toluene-d8	86	87	88	91	-
Bromofluorobenzene	83	84	83	83	-

Results expressed as micrograms per gram, on a dry weight basis. ($\mu\text{g/g}$)

Surrogate recoveries expressed as percent (%)

< = Less than detection limit

REPORTED TO: Norecol, Dames & Moore, Inc.



REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Extractable Petroleum Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	SAMPLE DATE	CAN TEST ID	LEPH-uncorrected for PAH's	HEPH-uncorrected for PAH's
KS1	Aug 28/96	609040041	940	49000
KS2	Aug 28/96	609040042	620	1700
KS3	Aug 28/96	609040043	<	<
KS4	Aug 28/96	609040044	<	<
KS5	Aug 28/96	609040045	<	<
PS1	Aug 28/96	609040046	<	1100
PS2	Aug 28/96	609040047	<	<
PS3	Aug 28/96	609040048	<	<
WS1	Aug 29/96	609040049	<	<
WS4	Aug 29/96	609040053	<	<
PWS1	Aug 29/96	609040054	<	19000
DETECTION LIMIT UNITS			250 $\mu\text{g/g}$	250 $\mu\text{g/g}$

$\mu\text{g/g}$ = micrograms per gram, on a dry weight basis.

< = Less than detection limit

Sample# 609040041 , 609040042 , 609040046 , 609040054 - The presence of hydrocarbon components with boiling points greater than that of C30 were detected.

REPORTED TO: Norecol, Dames & Moore, Inc.



REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Metals Analysis in Soil

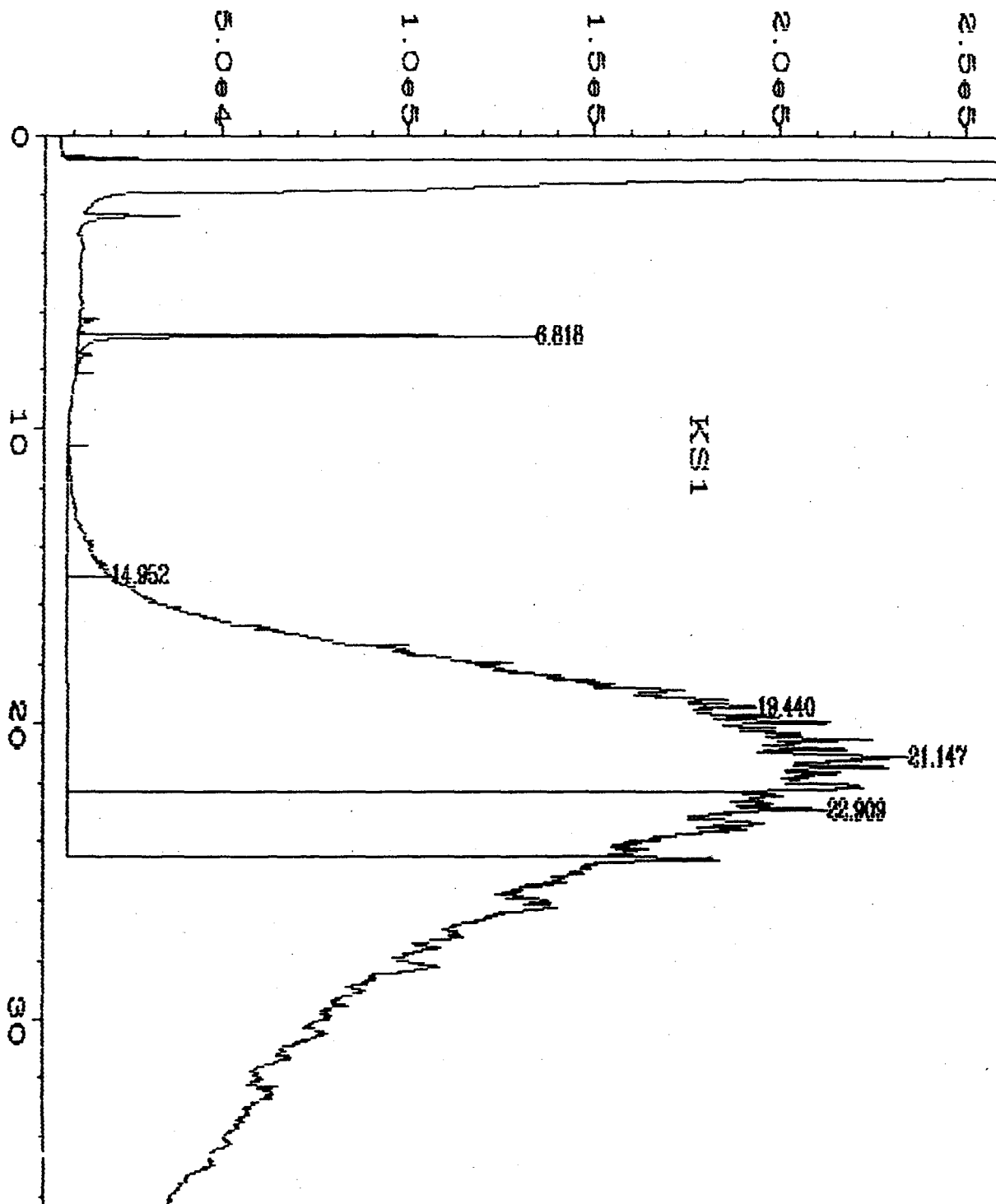
CLIENT SAMPLE IDENTIFICATION:	KS5	PS1	PS2	PS3		
DATE SAMPLED:	Aug 28/96	Aug 28/96	Aug 28/96	Aug 28/96		
LAB TEST ID:	609040045	609040046	609040047	609040048	DETECTION LIMIT	UNITS

Metals Analysis		KS5	PS1	PS2	PS3	DETECTION LIMIT	UNITS
Moisture		19.9	14.1	35.2	36.8	0.01	%
Antimony	Sb	<	<	<	<	10	µg/g
Arsenic	As	0.19	0.47	0.57	0.41	0.05	µg/g
Barium	Ba	202	25.4	224	194	0.1	µg/g
Beryllium	Be	<	<	<	<	1	µg/g
Cadmium	Cd	0.28	1.73	0.87	0.84	0.25	µg/g
Chromium	Cr	23	18	20	18	2	µg/g
Cobalt	Co	9	14	9	9	1	µg/g
Copper	Cu	35	96	42	42	1	µg/g
Lead	Pb	23	113	19	19	1	µg/g
Mercury	Hg	0.02	0.02	0.04	0.04	0.001	µg/g
Molybdenum	Mo	<	<	<	<	4	µg/g
Nickel	Ni	23	29	25	25	2	µg/g
Selenium	Se	<	<	<	<	0.5	µg/g
Silver	Ag	<	<	<	<	2	µg/g
Tin	Sn	<	38	<	<	5	µg/g
Vanadium	V	29	18	35	31	0.5	µg/g
Zinc	Zn	65	216	131	122	1	µg/g
Aluminum	Al	10800	6420	11100	9330	10	µg/g
Boron	B	13	18	12	11	0.5	µg/g
Calcium	Ca	2110	34800	15400	15800	1	µg/g
Iron	Fe	26500	52600	25200	24400	2	µg/g
Magnesium	Mg	3710	10000	7030	6940	0.1	µg/g
Manganese	Mn	385	654	514	502	0.2	µg/g
Phosphorus	PO4	1490	4210	25200	3000	20	µg/g
Sodium	Na	102	87	165	120	5	µg/g
Strontium	Sr	20	50.5	37.8	36.7	0.1	µg/g
Titanium	Ti	168	19	243	211	0.3	µg/g

% = percent

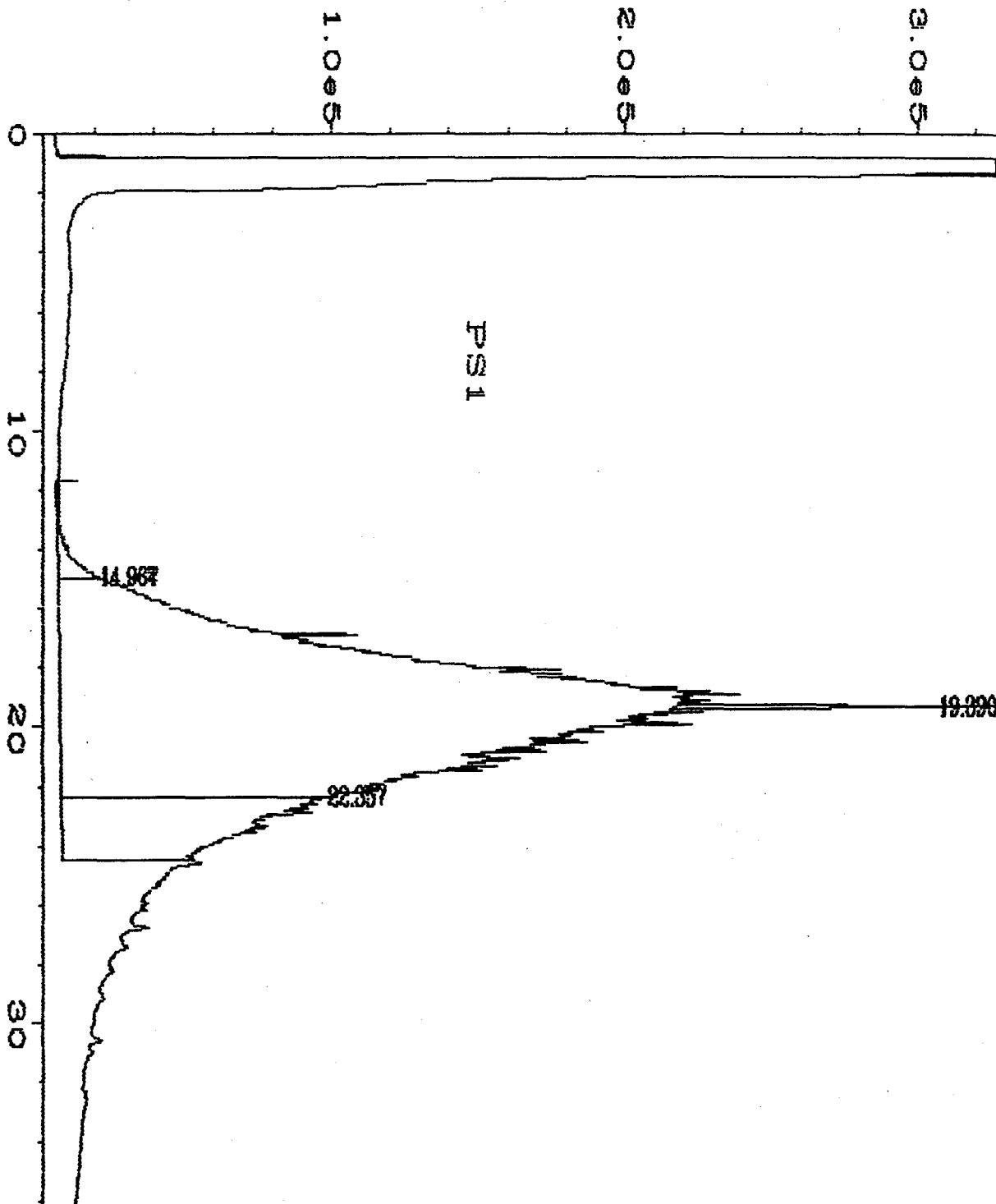
< = Less than detection limit

µg/g = micrograms per gram, on a dry weight basis.



user modified

Data File Name	: C:\HPCHEM\FID\DATA\090696\059F1101.D	Page Number	: 1
Operator	: MK	Vial Number	: 59
Instrument	: FID	Injection Number	: 1
Sample Name	: 609040041-60ML	Sequence Line	: 11
Run Time Bar Code:		Instrument Method	: TEHBAKE.MTH
Acquired on	: 07 Sep 96 06:28 AM	Analysis Method	: !TEH.MTH
Report Created on:	: 11 Sep 96 11:01 AM		



user modified

Sample File Name	: C:\HPCHEM\FID\DATA\090696\065F1301.D	Page Number	: 1
Operator	: MK	Vial Number	: 65
Instrument	: FID	Injection Number	: 1
Sample Name	: 609040046	Sequence Line	: 13
Run Time Bar Code		Instrument Method	: TEHBAKE.MTH
Acquired on	: 07 Sep 96 11:35 AM	Analysis Method	: !TEH.MTH
Report Created on	: 10 Sep 96 06:36 PM		

APPENDIX C
PHOTOGRAPHS



Aerial view of main camp including Upper and Lower Roads.

PHOTO 1



View of adit at main camp.

PHOTO 2



View of waste rock piles and waste rock road - Upper Road.

PHOTO 3



View of collapsed road and bridge at Lower Road.

PHOTO 4



Empty barrel storage at convergence of Upper & Lower Roads.

PHOTO 5



View of piping abandoned along Lower Road.

PHOTO 6

APPENDIX D
CANTEST LABORATORY QA/QC

CANTEST HISTORY AND DESCRIPTION

CANTEST Ltd. is a full service laboratory offering a broad spectrum of analytical services. In addition to providing superior, professional support in the air quality, environmental and industrial fields, CANTEST is often called upon by those in the areas of nutrition and biology as well as clinical and veterinary medicine.

Since incorporation in 1969, CANTEST has grown to become one of the largest independent laboratories in Western Canada. Originally started with a staff of five and two thousand square feet, the company now employs 85 chemists and technicians and occupies ten times the original laboratory space. As a member of the CANAM Group of Laboratories, CAN TEST belongs to an environmental testing network which ranks in the top twenty within North America based on revenues obtained through a survey conducted by IAETL. Revenues have generally doubled every five years and the client base now exceeds 1500.

It should be noted that CANTEST has clearly exhibited innovation with respect to methodology as the company was the first independent facility in Western Canada to employ Gas Chromatography/Mass Spectrometry (GC/MS), Inductively Coupled Argon and Plasma (ICAP) Spectroscopy, and Liquid Chromatography/Mass Spectrometry (LC/MS).

Located in Vancouver, B.C., the 25,000 square foot laboratory was designed specifically for a diversified and safe working environment. There are thirty one fumehoods, three walk-in refrigerators for sample storage, and twenty one individual working areas.

QUALITY ASSURANCE

CANTEST provides a comprehensive program of laboratory services in the areas of environmental, industrial, food, microbiological, and air quality testing. Conclusions based on the analytical data generated by CANTEST may have significant impact on the assessment of environmental quality and workplace safety, as well as on the economic burden placed on industry and the public. Therefore,

the establishment of a continuing program to ensure the reliability and validity of all analytical results is one of the fundamental responsibilities of the laboratory.

This Quality Assurance (QA) Program outlines the policies, organization and operations established for assuring the integrity of the analytical data generated by CANTEST.

Analytical Methodology and Validation

As one of the foremost laboratories in Canada, CANTEST is well known for its analytical capabilities and full-service facility. Regardless of whether an analysis procedure is obtained from a 'standard analytical reference' or developed in-house, methods employed are validated internally. The methods employed at CANTEST are taken from widely accepted sources such as:

- U.S. Environmental Protection Agency
- American Public Health Association/AWWA
- B.C. Ministry of Environmental Laboratory Manual
- American Society for Testing and Materials
- Association of Official Analytical Chemists
- Standards Methods for the Examination of Water and Wastewater

Standard Operating Procedures (CANTEST QA Manual)

CANTEST follows a set of Laboratory Standard Operating Procedures that were developed internally, based largely on those prescribed by the U.S./ E.P.A. Routine methods are written to describe the more common and frequently used laboratory practices. These standard operating procedures include:

- Sample collection, preservation, and holding times
- Sample custody, receipt and document control
- Analytical methods
- Instrument calibration, maintenance and repair
- Quality Control
- Safety, Chemical Hygiene

Confidentiality

These policies are consistent with regulatory guidelines and establish traceability of reagents, standards, samples, and analytical data. The standard operating procedures also provide for the complete documentation relative to the analysis and the reporting of data. This ultimately assures the validity and legal defensibility of the results reported by CANTEST.

Documentation

Chain of Custody relative to the collection of samples begins in the field. As such, the appropriate documentation is initiated at the time of collection by the client. The information submitted with the samples includes specific sample collection data, the identity of the sampler, time and date of collection and the analyses required. Field sampling by CANTEST personnel is documented in this fashion on CANTEST Chain of Custody Form.

At the time of receipt, the CANTEST sample custodian inspects the shipment, and assigns the sample a unique specific identifying number automatically generated by the Laboratory Information Management System (LIMS). With the assistance of the LIMS, the sample custodian enters the following information into the permanent sample record:

Date of receipt

Client demographic information

Client sample identification

Analyses requested

For all sample submissions, a sample transfer sheet is generated as part of the documentation package and follows the sample set through the laboratory during storage, sample preparation, generation of raw data and final reporting.

The samples are stored under conditions which maintain the viability of the parameters being analyzed. Typically this involves storage at 4 degrees Celsius for environmental samples. Special storage facilities are available for samples requiring additional security storage.

The LIMS system automatically generates a workschedule for each analytical parameter (or group of parameters where applicable). The analyses are assigned to specific individuals who perform the work. Raw data is recorded in laboratory notebooks or forms, and as instrument computer printouts. All raw data, including quality control information, calculations, and standard curves are maintained as permanent records. Raw data generated from analysis is used to produce final test results. Analysts who perform the analysis enter the final test results into the LIMS system. When a project is completed, the data is reviewed by either the Department Supervisor or the Department Coordinator before a final report is generated. The final report includes analysis results, method summaries and quality control information, where applicable. In addition to the information in the computer system, a file containing a copy of the final report, the chain of custody and other information submitted with the sample are maintained in secure storage.

QUALITY CONTROL

Introduction

Quality Control (QC) consists of specific activities and procedures designed to measure and control the quality of the data being produced. CANTEST uses a systematic approach to ensure the precision and accuracy of analyses by detecting errors and preventing their recurrence or by measuring the degree of error inherent in the methods applied. Confidence in the accuracy of analytical results and improvements in analytical precision are established by identification of the determinate sources of error. Precision is governed by the indeterminate errors inherent in the procedure and can be monitored by statistical methods.

CANTEST uses the following quality control techniques to assure accurate, precise and unbiased analytical data.

Purity and Contamination Checks

Sample preparation blanks are carried through the entire analytical procedure with the samples to serve as a check on reagent purity and possible laboratory contamination. Normally a blank is considered to be contaminated when it exceeds the method detection limit. When this does occur,

steps are taken to identify the source and eliminate or minimize the contaminant. Blanks are analyzed at a minimum frequency of one blank per sample set or at a level of ten percent.

The Analytical Method determines whether or not the blank values are subtracted from the analytical data prior to reporting.

Accuracy

Accuracy refers to the relationship of an analysis value to the true value. Accuracy can be determined by analysis of Standard Reference Materials (SRM's) obtained from reliable sources (e.g. NIST, EPA). Where SRM's or performance samples are not available, samples are "spiked" with a known quantity of the analyte at the beginning of the analysis. If the value obtained for the reference material or spike is not within a statistically acceptable range of the true value, the procedure is reworked to identify and correct the problem, and the sample set is reanalyzed. Accuracy Checks (SRM's or Spikes) are analyzed at a minimum frequency of one per sample set or at a level of ten percent.

Precision

Precision is a the measure of the reproducibility of an analysis. Precision is monitored by replicate analysis of samples. If the percentage variation between replicates is not within acceptable limits for the specific test, the procedure is reworked to make the precision acceptable and the sample set is reanalyzed. Precision checks (analysis of samples in duplicate) is performed at a minimum frequency of one per sample set or at a level of ten percent.

Standard Calibration Curves

At the beginning of each applicable analysis, a minimum of three standards are run in conjunction with the samples to provide a working standard curve. Calibration verification standards are analyzed upon completion of the standard curve. These solutions of known concentrations serve to verify the validity of the standard curve prior to the analysis of the samples. The samples are then quantified using the responses of the calibration curve. Samples are diluted or concentrated if necessary to fall within the working limits of the standard curve. The standard curve also functions as a check of the

proper operation of the analytical instrument. If the measured instrument response varies by more than 10% of the previous day's standardization, the operation of the instrument is checked and corrected if necessary. If a correction is made, a second standard curve is generated and verified before the analytical run.

Corrective Actions

Defensible data is dependent upon the evaluation of the quality control data. This must be initiated as early as possible in a project so that corrective actions and reanalysis are viable alternatives. The statistical basis for corrective actions are documented in the standard operating procedures. These are dependent upon spike recoveries, the relative percent difference between duplicates, and the blank values. Out of control events define a problem which ultimately requires a corrective action. If an analytical procedure is deemed out of control, CANTEST does not perform that particular test until the problem is resolved. Once the problem has been corrected, and the procedure is validated, sample analysis is allowed to continue.

Detection Limits

CANTEST employs procedures derived from CAEAL, the Ontario MISA program, and the U.S. EPA to determine Method Detection Limits. Section QA-11 of the CANTEST QA Manual provides a more detailed explanation of how the MDL's are derived. This document is available for review upon request.

Certification / Accreditation

Virtually every operating department in CANTEST is accredited by at least one of six internationally recognized agencies. Pursuit of this intra-disciplinary accreditation not only distinguishes CANTEST from other laboratories that may be narrowly focused, but also exemplifies a comprehensive approach to quality testing services that ultimately benefits the company as a whole.

CANTEST is a strong proponent of accreditation and has actively supported those programs which have a direct impact upon the market it serves. The accreditations that are most pertinent include:

1. CAEAL/SCC: CANTEST is accredited for a number of chemical and microbiological tests and as such are registered with the Canadian Association of Environmental Analytical Laboratories (CAEAL) and Standards Council of Canada (SCC).

The CAEAL/SCC accreditation is the formal recognition that an environmental analytical laboratory is competent to carry out specified tests. This implies that a laboratory's capability and performance be evaluated through the use of site inspections and performance evaluation samples. The current program encompasses a site inspection once every two years and the satisfactory participation in interlaboratory comparisons twice a year. Failure to meet specified requirements results in the withholding or removal of accreditation. The CAEAL/SCC certificate(s) are included in Appendix I.

Interlaboratory Studies (Round Robin Data)

Capacity and experience is only a secondary measure of a laboratory's capability as a commitment to the highest achievable quality result must be paramount. CANTEST clearly demonstrates this objective through its involvement in performance evaluation studies, both internally and externally.

As part of its effort to ensure excellent data quality, CANTEST has participated in approximately 140 environmentally orientated interlaboratory studies over the last three years. A brief list of some of the most recent undertakings include:

- CAEAL Certification and Accreditation Program
- B.C. MOELP EDQA Program
- U.S. EPA Performance Evaluation Samples
- Fisheries and Oceans Mercury in Fish Quality Assurance Program
- Ontario Ministry of Environment Interlaboratory Studies
- Federal/Provincial Quality Assurance Program (GLAP)
- Canadian Association of Pesticide Control Officers(CAPCO)
- Agriculture Canada Accreditation Check Sample Programs
- AIHA/NIOSH PAT program
- Regional Asbestos Round Robin Program
- UBC Clinical Microbiology Proficiency Testing

Round Robin Data is available for review upon request.

TURN-AROUND TIME

CANTEST is well aware of the role analytical data plays in all environmental projects. For this reason CANTEST will commit significant resources, including appropriate back-up equipment and personnel, to ensure all specified turnaround times are met and the integrity of data can not be questioned.

Analysis of samples will commence such that the analysis is completed within the time requirements of the proposal and within applicable sample holding times. Most analyses will be completed within a 7 - 10 working day period from the receipt of the samples with a certificate of analysis issued thereafter.

Testing sequence of a sample will be dictated by the recommended holding times for the specified analyte as specified in the attached tables. The attached tables summarize the recommended holding times for various parameters. It should be noted that these holding times are those generally accepted with the scientific community and by regulatory authorities and thus are not exclusive to CANTEST.

SAMPLE CONTAINERS AND SHIPPING

Appropriate sample containers complete with necessary preservatives for the requested analytical parameters will be provided by CANTEST at no additional charge. Sample containers will be shipped in coolers with "cold-packs" as required. Unless other arrangements are requested CANTEST will select a carrier based on destination and delivery time requirements. Coolers supplied by CANTEST remain the property of CANTEST and must be returned after two weeks. Unused sample containers may be retained by the client for future use.

Charges arising from the transportation of the sample containers to or from the laboratory are the responsibility of the client. Deliveries may be either sent collect or may be billed to an account set up by the client with a specific courier.

PRICING

Pricing is based on the proposed number of samples expected over the contract period. A volume discount has already been calculated based on this volume and is reflected in the quoted prices. Thus, the number of samples submitted at any one time will not affect the analytical charges for that submission. In some cases the analysis time can be decreased to accommodate specific requests. These rush turnaround times are typically in the order of 48 hours and normally result in a surcharge of approximately 25%. These surcharges may be waived if adequate advance notice is provided and laboratory capacity is such that "rush" work can be accommodated. There are certain instances where it is physically impossible to complete an analytical procedure in 48 hours and thus it is recommended that non-routine turnaround requests be handled on a job-by-job basis. See the attached tables for details on specific pricing for soil or water.