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FINAL REPORT

MN-041

SITE ASSESSMENT REPORT  
KALZAS TWINS CAMP  
KALZAS TWINS, YUKON

PUBLIC WORKS & GOVERNMENT SERVICES

Job No. 20749-013-310

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**NORECOL, DAMES & MOORE**

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**SITE ASSESSMENT REPORT  
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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 site is located approximately 70 km southeast of the community of Mayo, Yukon, within the Kalzas Plateau. The camp is situated to the northwest of Big Kalzas Lake and immediately south of Rockfork Creek on the western flank of Kalzas Twins Mountain. The elevation of the site is approximately 1700 to 1800 metres above sea level. A site location map has been presented in Figure 1. A site layout plan has been presented in Figure 2. Photographs identifying current site conditions had been presented in Appendix C.

The site is accessible only by aircraft. A gravel air strip has been constructed approximately 1 km north of the camp. The camp, airstrip, and exploration site, are connected by a series of access roads. A small creek is located to the north of the site and appears to discharge into a small pond located to the northeast of the airstrip.

Access to the site during the NDM inspection was provided by Transnorth helicopters, Mayo, Yukon.

## **1.2 OVERVIEW OF SITE DEVELOPMENT**

According to a copy of Claim Map Sheet 105M-7 (November 17, 1995), the site is located within the "Pat", "Blackie", "David" and "Wolf" claims. The area was first staked in August, 1978 by J. Randolph. With the exception of a limited claim option to Union Carbide Mining Ltd. in 1980, claim ownership has been continuous by J. Randolph. The activity on the site since this point has consisted primarily of mineral exploration, including mapping, trenching, limited diamond drilling, and rock sampling.

Tungsten and tin have been identified as the primary commodities associated with minor molybdenum, lead, silver, and beryllium. Limited information was available on the site from DIAND's mining records office as the claims are still active.

## 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 [ $\pm 25\%$ ]) 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 concerns.

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 Assurance**

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.

### ***Barrel Sampling***

A total of three semi-full fuel barrels were observed at the site, two located outside of the kitchen tent (one connected by line to the stove, one unconnected), and one located adjacent to the office tent. With the exception of the one connected barrel, which was inaccessible

due to the project team's inability to detach the bung without causing spillage, all barrels were sampled. At the time of sampling, the field scientist dropped a 40 ml pre-cleaned glass vial, attached to a 100% pure cotton string, through the bung opening. The vial was raised and lowered several times within the barrel to permit adequate mixing of the contents and the collection of a representative sample. This process was performed several times and the contents poured into a pre-cleaned 250 ml teflon-lined sample jar. The samples were then placed in coolers and kept refrigerated during shipment to the laboratory.

### ***Analytical Parameters***

Samples of soil and water were analyzed for compounds of environmental concern (PCOC's) that could potentially be present based on existing information and the results of the site inspection. Samples were analyzed to detect potential contaminants of concern (PCOC's) identified during the performance of the work program. The following parameters were analyzed in soils collected from the Kalzas Twins camp: Benzene / Toluene / Ethylbenzene / Xylene (BTEX), Volatile Petroleum Hydrocarbons (VPH), Light Extractable Petroleum Hydrocarbons and Heavy Extractable Petroleum Hydrocarbons (LEPH/HEPH), and Total Metals. Barrel contents were analyzed for Total Organic Halogens (TOX), Polychlorinated Biphenyls (PCBs), General Metals Scan, and Characterization. Surface water samples collected at the Kalzas Twins 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.

## **4.0 ENVIRONMENTAL SETTING**

### **4.1 MINERALIZATION**

Mineralization at the site consists of quartz stockwork cross-cutting quartzite and phyllitic rocks of the late Proterozoic/early Cambrian Hyland group. Stockwork veining ranges in width up to 60 cm and is associated with minor scheelite, molybdenite, cassiterite, galena, and beryl. Primary commodities identified at the site include tungsten and tin. Minor commodities listed include molybdenum, lead, silver, and beryllium. Molybdenite, arsenopyrite, pyrrhotite, and argentiferous galena are associated with quartz veining adjacent to the primary tungsten-tin zone.

The presence of sulphide mineralization and/or carbonate minerals at the site is significant in interpreting Acid Base Accounting data as discussed in Section 5.5.

### **4.2 SURFACE HYDROLOGY**

A small creek is located adjacent to the north side of the camp and appears intermittent in character. A preliminary review of the creek's drainage system as shown on a 1:25,000 claim map (Sheet 105M-7, Indian and Northern Affairs, 1995) indicates that the creek flow originates upgradient of the camp and discharges into a small pond located downgradient of the camp and airstrip. A review of the 1:50,000 NTS mapping does not clearly identify the stream's terminus. Rockfork Creek is located downgradient and to the north of the study area, approximately 3 km from the camp. Big Kalzas Lake is located approximately 5500 m from the exploration site, on the opposite side of Kalzas Twins Mountain. No other surface water features were observed during the site inspection.

### **4.3 CLIMATE**

Climate records for the immediate vicinity of Kalzas Twins were not available. The closest measurements on record were taken at the town of Mayo, located approximately 68 km to the north of Kalzas Twins. Over a 30 year period, the records show average temperatures ranging from -29°C in January, the coldest month, to 15.2°C in July, the warmest month of the year. The record low was -62.2°C and the record high 36.1°C. The average winter season, defined as days when the mean temperature is below 0°C, is from October 8 to April 17, and the average summer season, defined as days when the mean temperature is above 10°C is from May 24 to Sept 4. The mean annual precipitation for Mayo is 306.3 mm, of which 60.4% is rain, and 39.6% is snow.

#### **4.4 VEGETATION**

The exploration site is located immediately above the treeline on the barren eroded flank of Kalzas Twins Mountain. Sparse vegetation including black spruce, willows, short grasses, and Labrador tea, are present at the exploration camp and downgradient of the exploration site. Vegetation in the exploration area (upgradient of the camp) becomes increasingly sparse. The site is located within the Mayo Lake - Ross River Ecoregion (Oswald and Senyk, 1977).

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

##### **4.5.1 Fisheries**

A small creek is located adjacent to the north side of the camp and appears intermittent in character. A preliminary review of the creek's drainage system as shown on a 1:25,000 claim map (Sheet 105M-7, Indian and Northern Affairs, 1995) indicates that the creek flow originates upgradient of the camp and discharges into a small pond located downgradient of the camp and airstrip. Rockfork Creek is located downgradient and to the north of the study area, approximately 3 km from the camp. No other surface water features were observed during the site inspection.

According to discussions with the Department of Fisheries and Oceans (DFO), very little fisheries data is available for this area. The area is characterized by the presence of tarns (small banked mountain lakes or pools), swampy plateaus, and interconnecting river and lake systems. In certain cases, tarns may provide adequate fisheries habitat should the tarn be connected by a valley to a larger fish-bearing water body. A brief inspection of this surface water feature proved inconclusive to determining whether this tarn fits the criteria to be potentially fish-supporting. A brief inspection of a small spring-fed creek located to the east of the camp indicated that it was intermittent in nature and therefore presented a low probability of supporting fish habitat.

##### **4.5.2 Wildlife**

The study area is located within a region known to support a wide variety of wildlife, including waterfowl, upland game birds, fur-bearers, small mammals, and ungulates. Moose, marten, wolverine and lynx, and smaller mammals such as muskrat, ground squirrel, beaver, red squirrel, varying hare, fox, mink, weasel, vole, shrew, porcupine, river otter, and chipmunks have been noted with the region. Large carnivorous mammals include grizzly bear, black bear, and timber wolf (Access Mining Consultants 6/1/96).

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

The exploration camp is located on a barren eroded peak above the treeline. Ground materials noted at the site included the minimal presence of residual soils formed by the weathering of the underlying bedrock and from the decomposition of glacial till. In vegetated areas, a thin layer of organic material overlay the residual soil. Weathered and broken

bedrock and weathered till was noted on the ground surface. Downgradient of the air strip, the topography of the study area slopes into a low-lying valley characterized by boggy, poorly drained soils and increased vegetative cover.

#### **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 ground water. Due to the elevation and topography of the site, it is therefore probable that permafrost conditions may be encountered in the study area.

## **5.0 SITE DESCRIPTION AND FINDINGS**

### **5.1 BUILDINGS, INFRASTRUCTURE, EQUIPMENT**

A total of three wooden structures were noted at the camp and are shown in Figure 1. Cabin 1 appeared to have been used as an office, Cabin 2 appeared to have been the kitchen, and Cabin 3 appeared to have been used as housing. These features are shown in Photographs #1 and #3.

All structures were constructed of wood frame and were in good condition. Other structures noted at the site included an outhouse, a generator stand and core splitter, and a core shack.

A previous report produced by DIAND (1993) indicated that a vehicle was parked at the time of that study at the shed attached to Cabin 1. At the time of the NDM study, the vehicle had been removed.

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

No borrow areas or landfills were observed during the NDM field inspection. A small garbage dump was observed downgradient of the kitchen cabin on the north side of the building in a small depression. Garbage composition included cans, bottles, and other non-combustible items. The presence of black ash at the dump indicated that some combustion of other garbage constituents may have occurred historically. Two soil samples (KS3 and KS4) were collected by the NDM project team and analyzed for BTEX, VPH, LEPH/HEPH, and metals due to the presence of empty oil cans and a black greasy ash at this location. This feature is shown in Photograph #6.

KS3 was collected from the dump area and KS4 was collected from the drainage area immediately downgradient of the dump. 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. According to the analytical results, the KS3 and KS4 did not exceed criteria for any of the parameters analyzed. Sample analytical results have been presented in Tables 5 through 8.

### **5.3 HAZARDOUS MATERIALS**

#### ***Soils***

One soil sample (KS1) was collected from the area adjacent to the suspected generator shed and core splitter. Due to the presence of surface staining of the ground at this location, KS1 was analyzed for BTEX, VPH, LEPH/HEPH, and metals. This feature is shown in Photograph #4. 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. BTEX and VPH results were less than the detection limits and were within criteria. LEPH was detected but was within criteria for commercial/industrial land use. HEPH exceeded criteria for commercial/industrial land use and was characterized as a heavy fuel or hydraulic oil; however, the area of staining is small, measuring approximately 1 m<sup>2</sup> laterally and is limited to the upper 0.15 m vertically, and is not considered to represent a manageable unit.

One soil sample (KS2) was collected from the soil adjacent to the barrel storage area adjacent to the kitchen cabin. No leakage of the barrels was observed at the time of the site visit. According to the analytical results, the sample did not exceed any of the selected criteria for the parameters tested. This area is shown in Photograph #5.

An airstrip is located about 1 km downgradient of the camp. The airstrip was barren except for a small wooden pallet. Based on previously collected information, it is believed that this pallet was once used for fuel drum storage. A soil sample (KS5) was collected and submitted for BTEX, VPH, LEPH/HEPH, and metals analyses. The results of the analysis showed that the sample was within the selected criteria for all parameters analyzed. This area is shown in Photograph #2.

Soil sample analytical results have been presented in Tables 5 through 7.

### ***Barrels***

Two barrels, labelled as AVGAS and carrying an aviation fuel warning were observed adjacent to the kitchen cabin. One barrel was still connected by a fuel line at the time of the site visit. The second barrel was adjacent to the first barrel but was unattached. Sampling of both barrels was not possible at the time of the site visit as the bung on the connected barrel was stuck and attempts to remove the bung were unsuccessful. One sample (KBL1) was collected from the most accessible barrel and submitted for PCBs, metals, and characterization analyses. According to the results of the analyses, the contents of the unconnected kitchen cabin barrel was diesel. PCB levels in the barrel sample was less than the detection limit.

A third barrel sample (KBL2) was collected from a barrel stored on the exterior western side of Cabin 1 (office tent). An aviation fuel warning label was observed on the barrel surface. The sample (KBL2) was analyzed for PCBs, metals and characterization. According to the results of the analyses, the fuel was characterized as diesel. PCB levels in the barrel sample registered less than the detection limit.

Analytical results for the submitted barrel samples have been presented in Tables 2 and 3.



## **5.4 SURFACE WATER QUALITY**

A small intermittent spring-fed creek was noted to the east of the camp. Two surface water samples were collected from the nearby creek and analyzed for pH, total suspended solids (TSS), sulphate, and total metal concentrations (Table 8). Field pH measurements were collected from each sample at the time of the site visit and are presented in Table 8. The surface water pH was less than the CCME for Freshwater Aquatic Life and total metal concentrations within the CCME for Freshwater Aquatic Life. Sulphate and TSS concentrations were low (<10 mg/L) and within an acceptable range. There are no CCME for sulphate and TSS. Surface water analytical results have been presented in Tables 5 through 8.

## **5.5 WASTE ROCK DISPOSAL AREAS**

Two samples of glacial till waste rock were selected at the Kalsas Twins site. The samples were submitted for ABA tests (Modified Sobek Method) which provide paste pH, total sulphur, total sulphate, calculated acid and neutralization potential and neutralization potential versus acid potential (NP/AP) ratio (Table 4). Samples of rock were weakly acidic (paste pHs 4.38 and 3.98) with negligible total sulphur concentrations (0.04%) of which 50% was in the form of sulphide. The corresponding acid potential (SAP) was 0.6 kg CaCO<sub>3</sub>/t. The neutralization potential (NP) was slightly negative due to acidity (-0.3 and -0.7 kg CaCO<sub>3</sub>/t). Due to the negligible sulphide content, this material can be classified as inert with no leaching or acid potential.

## **5.6 TAILINGS**

No tailings were observed during the NDM site inspection.

## **5.7 MINE OPENINGS**

No mine openings were observed during the NDM site inspection.

## **6.0 CONCLUSIONS AND RECOMMENDATIONS**

### **6.1 HEALTH AND SAFETY**

As a result of the NDM site assessment, we believe the exploration camp at Kalzas Twins does not pose a significant health and safety risk. Most areas of concern presented in previous reports (DIAND, 1993) have been addressed. The vehicle and the large store of fuel barrels at the airstrip reported in the DIAND assessment have since been removed from the site. With the exception of three partially full fuel barrels, no hazardous materials were identified during the NDM site inspection.

### **6.2 ENVIRONMENTAL RISKS**

The presence of product-containing fuel barrels at the site present an on-going environmental risk due to spill/leakage potential. It is recommended that the contents of the two barrels be flared onsite by an appropriate contractor under controlled conditions using fire-extinguishing equipment and proper petroleum hydrocarbon absorbent materials. It is recommended that the third barrel, currently connected by fuel line to the kitchen, be disconnected, properly sealed in an over-pack drum enclosure, and transported off-site for sampling, analysis and destruction.

The presence of HEPH in soils at the generator stand at levels exceeding B.C. criteria for commercial/industrial landuse is not considered to be an environmental risk as the lateral and vertical extent (approximately 1 m each) of the stained area does not represent a manageable unit.

No other environmental risks were identified by the study team at the time of the site visit.

### **6.3 AESTHETIC CONCERNS**

To address aesthetic concerns, the small garbage dump site located downgradient of the kitchen cabin should be addressed. A preliminary evaluation of costs to address this indicated that it would be least expensive to transport the waste off-site in a poly-lined net via helicopter to a landfill than it would be to transport a small loader to the site and bury the material. This removal approach is therefore recommended and was costed below.

To restore the camp to a more natural state, remaining camp structures may be divided into combustible and non-combustible, and the combustible materials burned. According to the mining recorder, exploration activities at the site are on-going. As such, the removal of any camp equipment is not recommended until the camp has been officially abandoned.

## 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.

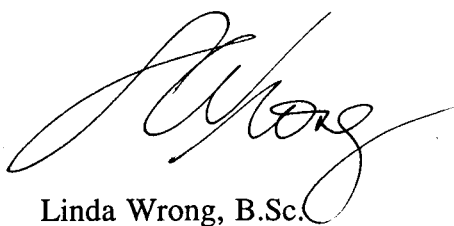
Opinions, conclusions and recommendations in this report apply to site conditions existing at the time of our assessment and are based on comparison of chemical analytical results to the Canadian Council of Ministers of the Environment (1991), B.C. Environment, Lands and Parks "Criteria For Managing 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 Geologist



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

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## TABLES

**TABLE 1**  
**KALZAS TWINS**  
**SAMPLE PARAMETERS SUMMARY CHART**  
**20749-013-310**

Sample Identification	Sample Type	Parameters Analysed						
		PCB	TOX	Total Metals	ABA	BTEX/VPH	LEPH/HEPH	Conventional Parameters
KBL1	barrel	X	X	X				
KBL2	barrel	X	X	X				
KWR1	waste rock				X			
KWR2	waste rock				X			
KS1	soil			X		X	X	
KS2	soil			X		X	X	
KS3	soil			X		X	X	
KS4	soil			X		X	X	
KS5	soil			X		X	X	
KW1	surface water			X				X
KW2	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  
 CHARACTERIZATION OF ABANDONED BARREL CONTENTS  
 AND CONCENTRATION OF PCBs  
 PUBLIC WORKS AND GOVERNMENT SERVICES  
 YUKON ABANDONED MINE SITES - KALZAS SITE  
 20749-013-310

Sample	PCB (µg/mL)		TOX (mg/L)		Characterization (mg/L)	
	NC	NC	NC	NC	NC	NC
KBL1	<3.7		191.		Diesel	
KBL2						
	<0.7		373.		Diesel	

< - less than the detection limit indicated  
 NC - no criteria established  
 TOX - total organic halides



TABLE 3  
CONCENTRATION OF METALS IN ABANDONED BARREL CONTENTS  
PUBLIC WORKS AND GOVERNMENT SERVICES  
YUKON ABANDONED MINE SITES - KALZAS SITE  
20749-013-310  
ug/g (ppm)

Sample No.	Location	Silver	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium*	Copper	Mercury	Manganese	Molybdenum	Nickel	Lead	Antimony	Selenium	Tin	Vanadium	Zinc
KBL1	Kitchen Cabin	<0.3	<3.	<0.1	<0.01	<0.03	<0.25	<0.2	<0.3	<0.15	---	<0.03	<0.4	<0.25	3.29	<1.5	---	<0.3	<0.1	<0.15
KBL2	Office Cabin	<0.3	<3.	<0.1	<0.01	<0.03	<0.25	<0.2	<0.3	0.26	---	<0.03	<0.4	<0.25	1.65	<1.5	---	<0.3	<0.1	<0.15
Method Detection Limit		0.3	3.	0.1	0.01	0.03	0.25	0.2	0.3	0.15	0.05	0.03	0.4	0.25	0.8	1.5	1.	0.3	0.1	0.15

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 commercial/industrial criteria

**TABLE 4**  
**MODIFIED SOBEK METHOD ACID-BASE ACCOUNTING**  
**PUBLIC WORKS AND GOVERNMENT SERVICES**  
**YUKON ABANDONED MINE SITES - KALZAS**  
**20749-013-310**

Sample No.	Type	Paste pH	S(T) %	S(SO <sub>4</sub> ) %	AP	NP	NET NP	NP/AP
KWR1	Glacial till, composed of Hyland Group; green to maroon mudstone, siltstone and quartz-sandstone	4.38	0.04	0.02	0.6	-0.7	-1.3	<0.1
KWR2	Glacial till, composed of Hyland Group; green to maroon mudstone, siltstone and quartz-sandstone	3.98	0.04	0.02	0.6	-0.3	-0.9	<0.1

AP = Acid Potential in Tonnes CaCO<sub>3</sub> Equivalent per 1000 Tonnes of material.

NP = Neutralization Potential in Tonnes CaCO<sub>3</sub> Equivalent per 1000 Tonnes of Material.

NET NP = Net Neutralization Potential = Tonnes CaCO<sub>3</sub> Equivalent per 1000 Tonnes of Material.

TABLE 5  
CONCENTRATION OF BTEX AND VOLATILE PETROLEUM HYDROCARBONS IN SOIL SAMPLES  
PUBLIC WORKS AND GOVERNMENT SERVICES  
YUKON ABANDONED MINE SITES - KALZAS SITE  
20749-013-310  
ug/g (ppm)

CCME Sample No.	Commercial/Industrial		Depth (m)	Benzene					Ethylbenzene		Toluene		Xylenes		Volatile Petroleum Hydrocarbons	
	Location			5.		50.	30.	50 (a)								
KS1	Generator stand		0 - 0.15	<0.5		<0.5	<0.5	<0.5			<0.5		<0.5		<10.	
KS2	Kitchen drum storage		0 - 0.15	<0.5		<0.5	<0.5	<0.5			<0.5		<0.5		<10.	
KS3	Downgradient of kitchen		0 - 0.15	<0.5		<0.5	<0.5	<0.5			<0.5		<0.5		<10.	
KS4	Garbage dump		0 - 0.15	<0.5		<0.5	<0.5	<0.5			<0.5		<0.5		<10.	
KS5	Air strip		0 - 0.15	<0.5		<0.5	<0.5	<0.5			<0.5		<0.5		<10.	
Method Detection Limit				0.5		0.5	0.5	0.5			0.5		0.5		10.	

Page 1 of 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

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

☐ - Greater than CCME commercial/industrial criteria

**TABLE 6**  
**CONCENTRATIONS OF LEPH & HEPH IN SOIL SAMPLES**  
**PUBLIC WORKS AND GOVERNMENT SERVICES**  
**YUKON ABANDONED MINE SITES - KALZAS SITE**  
 20749-013-310  
 ug/g (ppm)

CMCS PHC	Commercial/Industrial	LEPH	HEPH
Sample No.	Location	Depth (m)	
KS1	Generator Stand	0 - 0.15	940.
KS2	Kitchen Drum Storage	0 - 0.15	620.
KS3	Downgradient of Kitchen	0 - 0.15	<250.
KS4	Garbage Dump	0 - 0.15	<250.
KS5	Air Strip	0 - 0.15	<250.
Method Detection Limit			250.
			5000.
			49000.
			1700.
			<250.
			<250.
			<250.

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

< - less than the detection limit indicated

☐ - Greater than CMCS commercial/industrial land use criteria

TABLE 7  
CONCENTRATION OF METALS IN SOIL SAMPLES  
PUBLIC WORKS AND GOVERNMENT SERVICES  
YUKON ABANDONED MINE SITES - KALZAS SITE  
20749-013-310  
ug/g (ppm)

CCME Sample No.	Commercial/Industrial Location	Depth (m)	Silver	Arsenic	Boron	Barium	Beryllium	Cadmium	Cobalt	Chromium	Copper	Mercury	Manganese	Molybdenum	Nickel	Lead	Antimony	Selenium	Tin	Vanadium	Zinc
KS1	Generator Stand	0 - 0.15	<2.	0.17	8.	12.3	<1.	0.36	2.	12.	25.	0.03	125.	<4.	5.	31.	<10.	<0.5	<5.	24.	425.
KS2	Kitchen Drum Storage	0 - 0.15	<2.	0.21	6.	139.	<1.	0.52	<1.	18.	22.	0.13	226.	<4.	5.	71.	<10.	<0.5	<5.	9.	51.
KS3	Downgradient of Kitchen	0 - 0.15	<2.	0.34	23.	326.	<1.	<0.25	16.	39.	99.	0.07	441.	<4.	34.	27.	<10.	<0.5	<5.	61.	95.
KS4	Garbage Dump	0 - 0.15	<2.	0.2	16.	176.	<1.	1.61	8.	29.	48.	0.1	296.	<4.	20.	147.	<10.	<0.5	11.	44.	132.
KS5	Air Strip	0 - 0.15	<2.	0.19	13.	202.	<1.	0.28	9.	23.	35.	0.02	385.	<4.	23.	23.	<10.	<0.5	<5.	29.	65.
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 commercial/industrial criteria

TABLE 8  
CONCENTRATION OF CONVENTIONAL PARAMETERS AND TOTAL METALS IN SURFACE WATER  
PUBLIC WORKS AND GOVERNMENT SERVICES  
YUKON ABANDONED MINE SITES - KALZAS SITE  
20749-013-310  
ug/L (ppb)

Sample	Lab pH	Total Suspended Solids (mg/L)	Sulphate SO <sub>4</sub> (mg/L)	Silver	Aluminum*	Arsenic	Barium	Cadmium	Chromium	Copper	Iron	Mercury	Manganese	Molybdenum	Nickel	Lead	Selenium	Zinc
CCME	6.5-9.0	NC	NC	0.1	5 - 100	50	NC	0.2 - 1.8	2 - 20	2 - 4	300	0.1	100	NC	25 - 150	1 - 7	1	30
Location																		
KW1	5.62	7.	9.1	<0.1	<200.	<1.	63.	<0.2	<1.	3.	<30.	<0.05	29.	<1.	1.	<1.	<1.	7.
KW2	5.51	<1.	8.8	<0.1	<200.	<1.	69.	<0.2	<1.	3.	60.	<0.05	13.	<1.	2.	<1.	<1.	9.
Method Detection Limit				0.1	200.	1.	1.	0.2	1.	1.	30.	50.	3.	1.	1.	1.	1.	5.

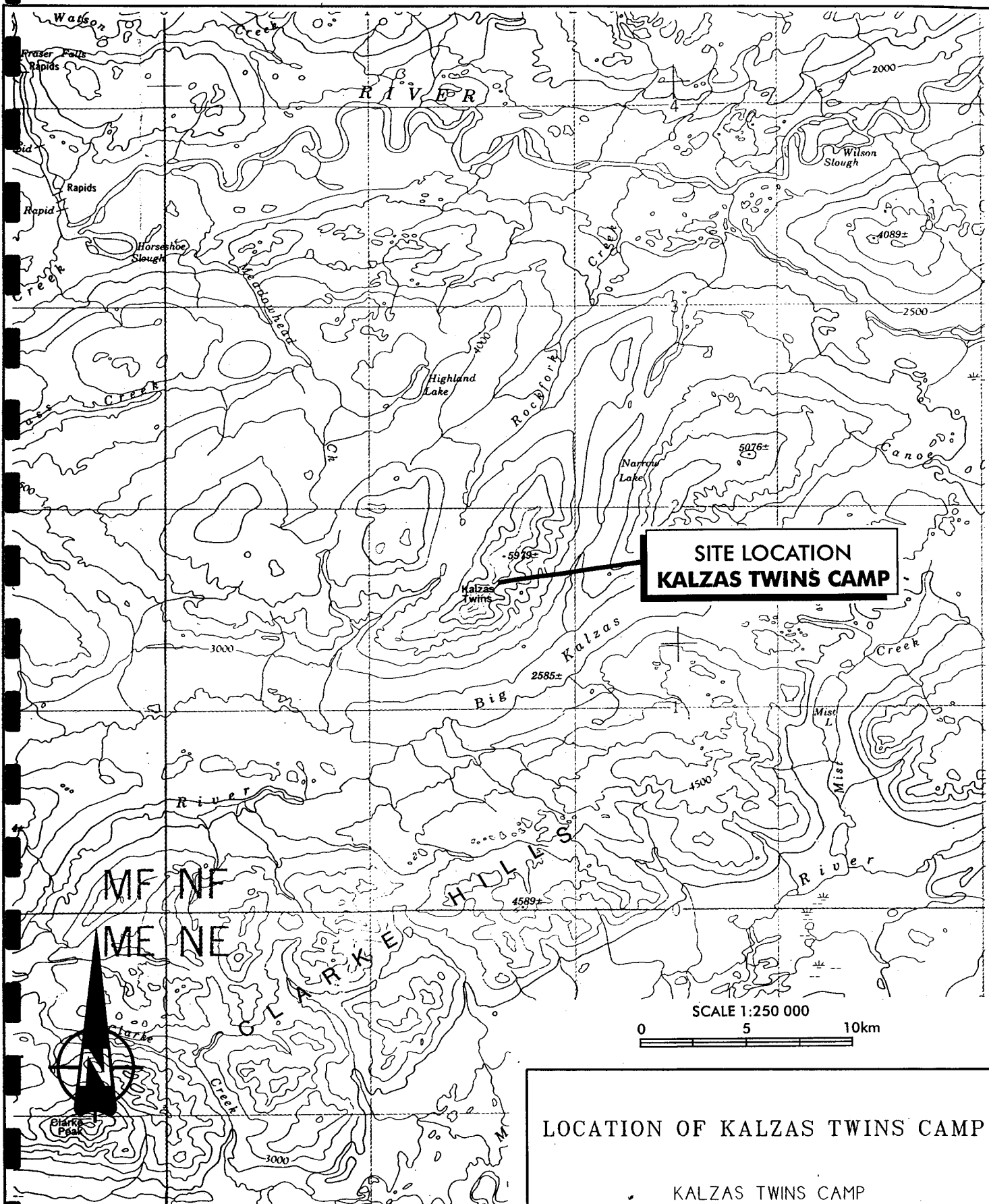
CCME - Canadian Council of Ministers of the Environment Interim Canadian Environmental Quality Criteria for Contaminated Sites  
< - less than the detection limit indicated

NC - no criteria established

□ - Greater than CCME criteria for freshwater aquatic life

\* - Criteria depend on pH or hardness of sample

**FIGURES**



## LOCATION OF KALZAS TWINS CAMP

KALZAS TWINS CAMP  
KALZAS TWINS, YUKON

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

OCTOBER 1996

FIGURE 1



NORECOL DAMES & MOORE

NDM-20749-013-gcd-border

OUR A DAMES & MOORE SUBSIDIARY





Dump - Dry  
No Surface Water

KS4

Drainage  
Ditch

Dry Drainage  
Ditch

KS3

KS2

Tent 2  
(Kitchen)

2 Diesel Drums

KBL1

2 Empty  
Avgas Drums  
(inside cabin)

Tent 1  
(Office)

KBL2

Shed

Tent 3  
(Housing)

Outhouse

Core  
Shack

Former  
Generator  
Stand

KS1

Glacial Till

KWR2

KWR1

To Airstrip

KW1

KW2

CREEK

To Exploration  
Trails

#### LEGEND



Waste Rock Accumulation

KBL1

Barrel Sample

KS4

Soil Sample

KW1

Water Sample

KWR1

Waste Rock Sample



Slope Direction

SCALE APPROXIMATE

0 10 20m

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

KALZAS TWINS  
KALZAS TWINS, YUKON

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

FEBRUARY 1997

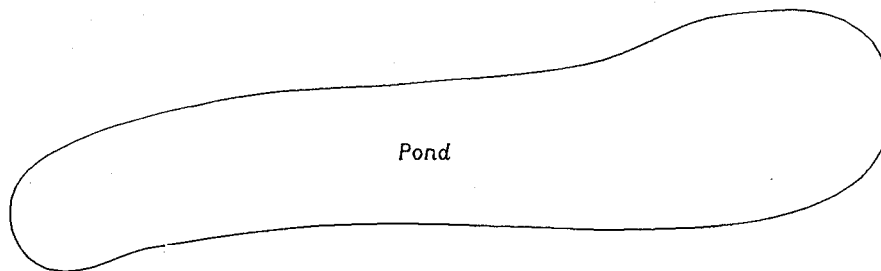
FIGURE 2



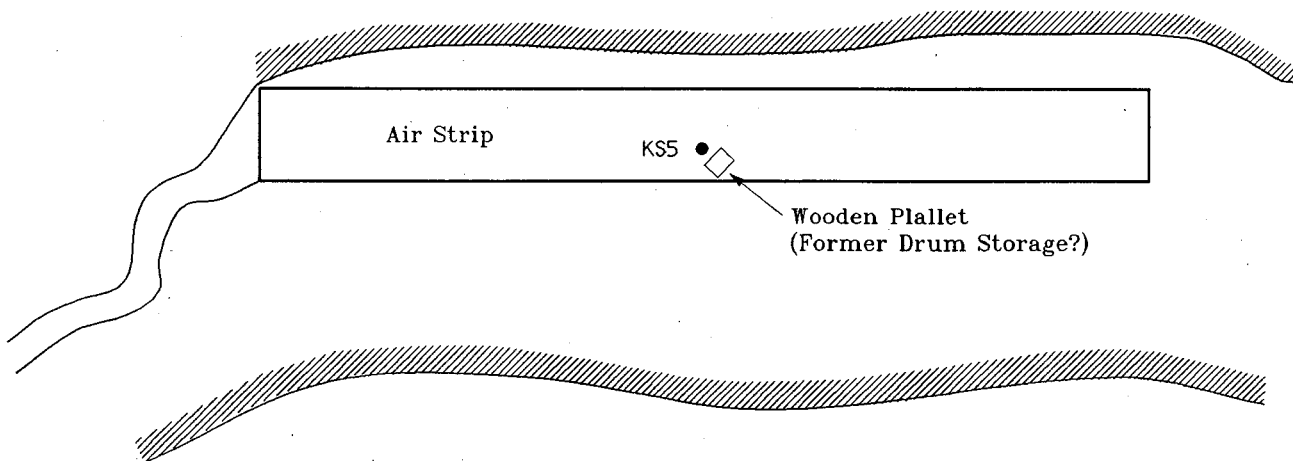
NORECOL DAMES & MOORE

NDM-20749-013-GCD-kal

GROUP A DAMES & MOORE SUBSIDIARY



Pond




Air Strip

KS5

Wooden Pallet  
(Former Drum Storage?)

#### LEGEND

KS5 • Soil Sample

 Slope Direction

SCALE, APPROXIMATE  
0 50 100m

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

KALZAS TWINS  
KALZAS TWINS, YUKON

PUBLIC WORKS AND GOVERNMENT SERVICES CANADA

FEBRUARY 1997

FIGURE 3

**APPENDIX A**  
**FIELD DATA COLLECTION SHEETS**

# BARREL SAMPLING

<b>PROJECT NAME:</b>	<u>Yukon Mine Site (Review)</u>	<b>SAMPLE #:</b>	<u>KBLZ</u>
<b>Location:</b>	<u>Kalzas Twins</u>	<b>Date:</b>	<u>08/28/96</u>
<b>Name of sampler:</b>	<u>Linda Wong / James Dick</u>		

<b>Physical Observation</b>			
<b>Condition of barrel:</b>	poor	<u>fair</u>	good
<b>Size (L):</b>	<u>205L</u>	other	<b>Labels</b> <u>Warning - Aviation Fuel</u>
<b>Soil staining:</b>	Y <u>N</u>		

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

<b>Analysis (if required)</b>				
<b>Type of sample taken:</b>	composite	<u>grab</u>		
<b>Analysis required:</b>	<u>metals</u>	<u>PCBs</u>	chlorine	<u>other</u> <u>Toxic characterization</u>

**Comments:** Barrel is located outside of Cabin 1 - Office  
Two other empty barrels located inside cabin

Sample # Format

site name - BL number  
 eg. Tintina - BL1

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

# BARREL SAMPLING

<b>PROJECT NAME:</b>	<u>Yukon Mine Site Review</u>	<b>SAMPLE #:</b>	<u>KBL1</u>
<b>Location:</b>	<u>Kalzas Twins</u>	<b>Date:</b>	<u>08/28/96</u>
<b>Name of sampler:</b>	<u>Linda Wong / James Dick</u>		

<b>Physical Observation</b>			
<b>Condition of barrel:</b>	poor	<input checked="" type="radio"/> fair	good
<b>Size (L):</b>	<input checked="" type="radio"/> 205L	other	<b>Labels</b> <u>Diesel label + Augas warning</u>
<b>Soil staining:</b>	<input checked="" type="radio"/> Y	<input type="radio"/> N	

<b>Barrel Contents</b>				
<b>Quantity of liquid:</b>	1/4	1/2	3/4	<input checked="" type="radio"/> full
<b>Colour of liquid:</b>	light	<input checked="" type="radio"/> dark	multiphase	other
<b>Suspected type of liquid:</b>	gasoline	jet fuel	waste oil	glycol oil
	other	<u>diesel / Stove Oil</u>		
<b>Sludge observed:</b>	<input checked="" type="radio"/> Y	<input type="radio"/> N	<b>Quantity</b>	<u>2</u>

<b>Analysis (if required)</b>				
<b>Type of sample taken:</b>	composite	<input checked="" type="radio"/> grab		
<b>Analysis required:</b>	<input checked="" type="radio"/> metals	<input checked="" type="radio"/> PCBs	chlorine	<input checked="" type="radio"/> other <u>Tox / characterization</u>

**Comments:** One of two barrels located outside of kitchen  
cabin - other barrel has label indicating stove oil  
but is hooked up to line connected to stove in cabin -  
barrels lying horizontally on ground.

**Sample # Format**      site name - BL number  
eg. Tintina - BL1

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

## SOIL SAMPLING

Date: 08/28/96  
Name of Sampler: LAW/JD

**Location:** Kalzas Twine

[illegible]

Comments:  
Sample # format  
site name - S-number  
eg. Tintina-S1

# WATER SAMPLING

PROJECT NAME: YMSR NAME OF SAMPLER: LW/JD

Location: Kalzas Tunnels Date: 08/28/96

<b>SAMPLE #:</b>	<u>KW1</u>	<b>pH:</b>	<u>5.0</u>
<b>Location description:</b>	<u>At spring source upgradient of camp</u>		
<b>Analysis:</b>	<u>metals</u>	<u>water chem</u>	<u>Eh</u> <u>total sulphur</u> <u>TSS</u>
		<u>metals</u>	

<b>SAMPLE #:</b>	<u>KW2</u>	<b>pH:</b>	<u>5.0</u>
<b>Location description:</b>	<u>Downgradient of camp</u>		
<b>Analysis:</b>	<u>metals</u>	<u>water chem</u>	<u>Eh</u> <u>TSS</u> <u>total sulphur</u>

<b>SAMPLE #:</b>		<b>pH:</b>	
<b>Location description:</b>			
<b>Analysis:</b>	<u>metals</u>	<u>water chem</u>	<u>Eh</u> <u>total sulphur</u>

<b>SAMPLE #:</b>		<b>pH:</b>	
<b>Location description:</b>			
<b>Analysis:</b>	<u>metals</u>	<u>water chem</u>	<u>Eh</u> <u>total sulphur</u>

<b>SAMPLE #:</b>		<b>pH:</b>	
<b>Location description:</b>			
<b>Analysis:</b>	<u>metals</u>	<u>water chem</u>	<u>Eh</u> <u>total sulphur</u>

**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 Oil Samples

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

Attention: Linda Wong

**FILE NUMBER:** 6858-K

**REPORT DATE:** October 7, 1996

We have tested the samples submitted by you on September 3, 1996 and report as follows:

### SAMPLE IDENTIFICATION:

The sample was submitted in a plastic bottle labelled as shown under the "Results of Testing".

### METHODS OF TESTING:

The submitted sample was analyzed for the requested parameters using the following techniques and instrumentation:

**General Metals Scan** - The analysis for metals was carried out after duplicate 10.00 gram aliquotes of the oil submitted were ashed in a quartz vessel at 550°C overnight. A reagent blank was digested and analyzed in the same manner as the samples. The analysis for metals was performed using a Jarrell Ash Model #975 Inductively Coupled Argon Plasma Spectrograph (ICAP).

**Total Organic Halogens (TOX)** - This parameter was determined after combusting the sample in the "Parr" Oxygen Bomb. The bomb washings after the addition of an indicator reagent were titrated with mercuric nitrate to a purple colour end point. Results are expressed to be total organic halogens as total chloride + fluoride.

**Polychlorinated Biphenyls** - in oil were determined with methodology based upon USEPA Methods 3580/8080, involving dilution, clean-up steps and analysis with GC/ECD.

**Characterization** - The sample was diluted with dichloromethane and the resulting solution was analyzed using GC/FID. The resulting chromatogram is compared to that of known hydrocarbon mixtures. Results are reported as the type of hydrocarbon mixture detected or as an unidentified pattern, and the approximate boiling range is specified. Mixtures in the boiling range of C10 to C30 can be determined, while lighter components (C7 to C10) can be estimated.

### TEST RESULTS:

See the following pages.

CANTEST LTD.

Richard S. Joritz  
Supervisor, Inorganic Testing

RSJ/wm

D:\INORGAN\REPORTS\NORE6858.DOC

REPORTED TO: Norecol, Dames & Moore

REPORT DATE: October 7, 1996

FILE NUMBER: 6858-K

## Metals and Total Organic Halogens Results

CLIENT SAMPLE IDENTIFICATION:		KBL1	KBL2	Detection Limit
CANTEST ID:		6858-1	6858-2	
Total Organic Halogens (TOX)		191	373	
Aluminum	Al	<	<	1.5
Antimony	Sb	<	<	1.5
Arsenic	As	<	<	3.0
Barium	Ba	<	<	0.01
Beryllium	Be	<	<	0.03
Bismuth	Bi	<	<	5.0
Boron	B	<	<	0.10
Cadmium	Cd	<	<	0.25
Calcium	Ca	0.13	0.29	0.10
Chromium	Cr	<	<	0.30
Cobalt	Co	<	<	0.20
Copper	Cu	<	0.26	0.15
Iron	Fe	<	<	0.30
Lead	Pb	3.29	1.65	0.80
Magnesium	Mg	0.05	0.16	0.01
Manganese	Mn	<	<	0.03
Molybdenum	Mo	<	<	0.40
Nickel	Ni	<	<	0.25
Phosphorus	PO <sub>4</sub>	<	<	4.0
Silicon	SiO <sub>2</sub>	2.1	1.0	0.8
Silver	Ag	<	<	0.3
Sodium	Na	<	<	1.0
Strontium	Sr	<	<	0.01
Tin	Sn	<	<	0.30
Titanium	Ti	<	<	0.06
Vanadium	V	<	<	0.10
Zinc	Zn	<	<	0.15

All results expressed as micrograms per gram.  
 < = Less than

REPORTED TO: Norecol, Dames & Moore

REPORT DATE: October 7, 1996

FILE NUMBER: 6858-K

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## Polychlorinated Biphenyls in Oil Results

CLIENT SAMPLE IDENTIFICATION:	KBL1	KBL2
CANTEST ID:	6858-1	6858-2
PCB	< 3.7 µg/mL	< 0.7 µg/mL

µg/mL = Micrograms per millilitre

**REPORTED TO:** Norecol, Dames & Moore

**REPORT DATE:** October 7, 1996

**FILE NUMBER:** 6858-K

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## Characterization Results

CLIENT SAMPLE IDENTIFICATION:	KBL1	KBL2
CANTEST ID:	6858-1	6858-2
Characterization	Diesel	Diesel

## 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. Joritz  
Supervisor, Inorganic Testing

**REPORTED TO:** Norecol, Dames & Moore, Inc.

**REPORT DATE:** September 24, 1996

**GROUP NUMBER:** 6090406

**CANTEST**

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**Metals in Water** - analysis was performed using Inductively Coupled Plasma Spectroscopy (ICP) or Graphite Furnace Atomic Absorption.

**Metals in Water** - analysis was performed using procedures based on U.S. EPA Method 200.8, Determination of Trace Elements in Waters and Wastes by Inductively Coupled Plasma-Mass Spectroscopy (ICP/MS).

**Polynuclear Aromatic Hydrocarbons** - analysis was performed using procedures based on U.S. EPA Methods 625/8270, involving extraction, clean-up steps, and analysis using GC/MS.

**Arsenic in Soil** - analysis was performed using Zeeman background-corrected Graphite Furnace Atomic Absorption Spectrophotometry.

**Cadmium in Soil** - analysis was performed using background-corrected Flame Atomic Absorption Spectrophotometry.

**Mercury in Soil** - analysis was performed using Cold Vapour Atomic Absorption Spectrophotometry.

**Lead in Soil** - analysis was performed using background-corrected Flame Atomic Absorption Spectrophotometry.

**Metals in Soil** - Undried representative samples were digested with a mixture of nitric acid and hydrochloric acid-"Aqua Regia". Analysis was performed using Inductively Coupled Argon Plasma Spectroscopy (ICAP) or by specific techniques as described. Moisture was determined gravimetrically at 105 on a separate sample portion.

**Selenium in Soil** - analysis was performed using Zeeman background-corrected Graphite Furnace Atomic Absorption Spectrophotometry.

**TEST RESULTS:**

(See following pages)

REPORTED TO: Norecol, Dames & Moore, Inc.

CANTEST

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			-	1	1
UNITS			pH units	mg/L	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

**CANTEST**

**Metals Analysis in Water**

CLIENT SAMPLE IDENTIFICATION:		WW1	PWW1	PWW2	PWW3		
SAMPLE PREPARATION:		TOTAL	TOTAL	TOTAL	TOTAL		
DATE SAMPLED:		Aug 29/96	Aug 29/96	Aug 29/96	Aug 29/96		
CAN TEST ID:		609040027	609040028	609040029	609040030	DETECTION LIMIT	UNITS
Aluminum	Al	<	<	<	<	0.2	mg/L
Antimony	Sb	<	<	<	<	0.2	mg/L
Arsenic	As	<	<	<	<	0.001	mg/L
Barium	Ba	0.008	0.017	0.019	0.018	0.001	mg/L
Beryllium	Be	<	<	<	<	0.003	mg/L
Boron	B	<	0.01	<	<	0.01	mg/L
Cadmium	Cd	0.0002	0.0012	0.0014	0.0008	0.0002	mg/L
Calcium	Ca	167	1.78	1.81	1.18	0.01	mg/L
Chromium	Cr	<	<	<	<	0.001	mg/L
Cobalt	Co	<	<	<	<	0.001	mg/L
Copper	Cu	<	0.002	<	<	0.001	mg/L
Iron	Fe	0.05	<	<	<	0.03	mg/L
Lead	Pb	<	0.32	0.19	0.11	0.001	mg/L
Magnesium	Mg	39.7	0.56	0.55	0.30	0.05	mg/L
Manganese	Mn	0.029	0.055	0.042	0.010	0.003	mg/L
Mercury	Hg	<	<	<	<	0.05	µg/L
Molybdenum	Mo	0.003	<	<	<	0.001	mg/L
Nickel	Ni	0.002	0.002	0.002	<	0.001	mg/L
Phosphorus	PO4	<	<	<	<	0.4	mg/L
Potassium	K	1.07	0.14	0.12	0.10	0.01	mg/L
Selenium	Se	<	<	0.001	<	0.001	mg/L
Silicon	SiO2	2.2	3.2	2.8	2.9	0.1	mg/L
Silver	Ag	<	0.0029	0.0018	0.0037	0.0001	mg/L
Sodium	Na	1.2	0.7	0.6	0.6	0.1	mg/L
Strontium	Sr	0.50	0.009	0.008	0.007	0.001	mg/L
Tin	Sn	<	<	<	<	0.001	mg/L
Titanium	Ti	<	<	<	<	0.006	mg/L
Vanadium	V	<	<	<	<	0.01	mg/L
Zinc	Zn	0.047	0.065	0.075	0.035	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

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	DETECTION LIMIT	UNITS
CAN TEST ID:		609040031	609040032	609040033	609040034		
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

**Metals Analysis in Water**

CLIENT SAMPLE IDENTIFICATION:		PW1	PW2a	PW2b	PW3		
SAMPLE PREPARATION:		TOTAL	TOTAL	TOTAL	TOTAL		
DATE SAMPLED:		Aug 28/96	Aug 28/96	Aug 28/96	Aug 28/96		
CAN TEST ID:		609040035	609040036	609040037	609040038	DETECTION LIMIT	UNITS
Aluminum	Al	<	<	<	<	0.2	mg/L
Antimony	Sb	<	<	<	<	0.2	mg/L
Arsenic	As	0.002	0.008	0.002	0.002	0.001	mg/L
Barium	Ba	0.044	0.027	0.043	0.042	0.001	mg/L
Beryllium	Be	<	<	<	<	0.003	mg/L
Boron	B	0.02	<	0.02	0.03	0.01	mg/L
Cadmium	Cd	0.0023	0.0016	0.0023	0.0022	0.0002	mg/L
Calcium	Ca	90.7	192	90.7	92.3	0.01	mg/L
Chromium	Cr	<	<	<	<	0.001	mg/L
Cobalt	Co	<	<	<	<	0.001	mg/L
Copper	Cu	0.001	0.003	0.001	0.001	0.001	mg/L
Iron	Fe	0.38	<	0.29	0.22	0.03	mg/L
Lead	Pb	0.002	0.002	0.001	0.001	0.001	mg/L
Magnesium	Mg	16.8	58.1	17.2	17.7	0.05	mg/L
Manganese	Mn	0.095	0.004	0.088	0.084	0.003	mg/L
Mercury	Hg	<	<	<	<	0.05	µg/L
Molybdenum	Mo	<	<	<	<	0.001	mg/L
Nickel	Ni	0.002	0.004	0.002	0.001	0.001	mg/L
Phosphorus	PO4	<	<	<	<	0.4	mg/L
Potassium	K	0.43	1.10	0.40	0.36	0.01	mg/L
Selenium	Se	0.002	0.001	0.003	0.002	0.001	mg/L
Silicon	SiO2	5.5	4.6	5.2	5.3	0.1	mg/L
Silver	Ag	<	<	<	<	0.0001	mg/L
Sodium	Na	1.2	3.1	1.2	1.3	0.1	mg/L
Strontium	Sr	0.20	0.38	0.20	0.20	0.001	mg/L
Tin	Sn	<	<	<	<	0.001	mg/L
Titanium	Ti	<	<	<	<	0.006	mg/L
Vanadium	V	<	<	<	<	0.01	mg/L
Zinc	Zn	0.28	0.12	0.27	0.25	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.

CANTEST

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Monocyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	KS1	KS2	KS3	KS4	DETECTION LIMIT
DATE SAMPLED:	Aug 28/96	Aug 28/96	Aug 28/96	Aug 28/96	
CAN TEST ID:	609040041	609040042	609040043	609040044	
ANALYSIS DATE:	Sep 8/96	Sep 8/96	Sep 8/96	Sep 8/96	
Volatile Pet. Hydrocarbons	<	<	<	<	
Benzene	<	<	<	<	10
Ethylbenzene	<	<	<	<	0.5
Toluene	<	<	<	<	0.5
Xylenes	<	<	<	<	0.5
<b>Surrogate Recovery</b>					
Toluene-d8	101	103	104	104	-
Bromofluorobenzene	86	93	91	89	-

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.

CANTEST

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Monocyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	KS5	PS1	PS2	PS3	DETECTION LIMIT
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	
Volatile Pet. Hydrocarbons	<	<	<	<	
Benzene	<	<	<	<	10
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.

CANTEST

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

Monocyclic Aromatic Hydrocarbons in Soil

CLIENT SAMPLE IDENTIFICATION:	WS1	WS4	PWS1	
DATE SAMPLED:	Aug 29/96	Aug 29/96	Aug 29/96	
CAN TEST ID:	609040049	609040053	609040054	
ANALYSIS DATE:	Sep 8/96	Sep 8/96	Sep 8/96	DETECTION LIMIT
Volatile Pet. Hydrocarbons	<	<	10	10
Benzene	<	<	<	0.5
Ethylbenzene	<	<	<	0.5
Toluene	<	<	<	0.5
Xylenes	<	<	<	0.5
Surrogate Recovery				
Toluene-d8	91	92	94	-
Bromofluorobenzene	84	79	92	-

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.

CANTEST

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.

**CANTEST**

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

**Metals Analysis in Soil**

CLIENT SAMPLE IDENTIFICATION:		KS1	KS2	KS3	KS4		
DATE SAMPLED:		Aug 28/96	Aug 28/96	Aug 28/96	Aug 28/96	DETECTION LIMIT	UNITS
CAN TEST ID:		609040041	609040042	609040043	609040044		
Metals Analysis							
Molsture		26.8	55.2	42.8	33.5	0.01	%
Antimony	Sb	<	<	<	<	10	µg/g
Arsenic	As	0.17	0.21	0.34	0.20	0.05	µg/g
Barium	Ba	12.3	139	326	176	0.1	µg/g
Beryllium	Be	<	<	<	<	1	µg/g
Cadmium	Cd	0.36	0.52	<	1.61	0.25	µg/g
Chromium	Cr	12	18	39	29	2	µg/g
Cobalt	Co	2	<	16	8	1	µg/g
Copper	Cu	25	22	99	48	1	µg/g
Lead	Pb	31	71	27	147	1	µg/g
Mercury	Hg	0.03	0.13	0.07	0.10	0.001	µg/g
Molybdenum	Mo	<	<	<	<	4	µg/g
Nickel	Ni	5	5	34	20	2	µg/g
Selenium	Se	<	<	<	<	0.5	µg/g
Silver	Ag	<	<	<	<	2	µg/g
Tin	Sn	<	<	<	11	5	µg/g
Vanadium	V	24	9	61	44	0.5	µg/g
Zinc	Zn	425	51	95	132	1	µg/g
Aluminum	Al	5320	3630	29000	20200	10	µg/g
Boron	B	8	6	23	16	0.5	µg/g
Calcium	Ca	1100	2340	2100	3420	1	µg/g
Iron	Fe	15300	8270	45100	33000	2	µg/g
Magnesium	Mg	876	526	5380	4000	0.1	µg/g
Manganese	Mn	125	226	441	296	0.2	µg/g
Phosphorus	PO4	1530	2700	3500	3520	20	µg/g
Sodium	Na	77	49	140	198	5	µg/g
Strontium	Sr	9	16.7	26.0	50.9	0.1	µg/g
Titanium	Ti	101	66	200	191	0.3	µg/g

% = percent

< = Less than detection limit

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



REPORTED TO: Norecol, Dames & Moore, Inc.

CANTEST

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	DETECTION LIMIT	UNITS
CAN TEST ID:		609040045	609040046	609040047	609040048		
Metals Analysis							
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.

REPORTED TO: Norecol, Dames & Moore, Inc.

REPORT DATE: September 24, 1996

GROUP NUMBER: 6090406

**CANTEST**

**Metals Analysis in Soil**

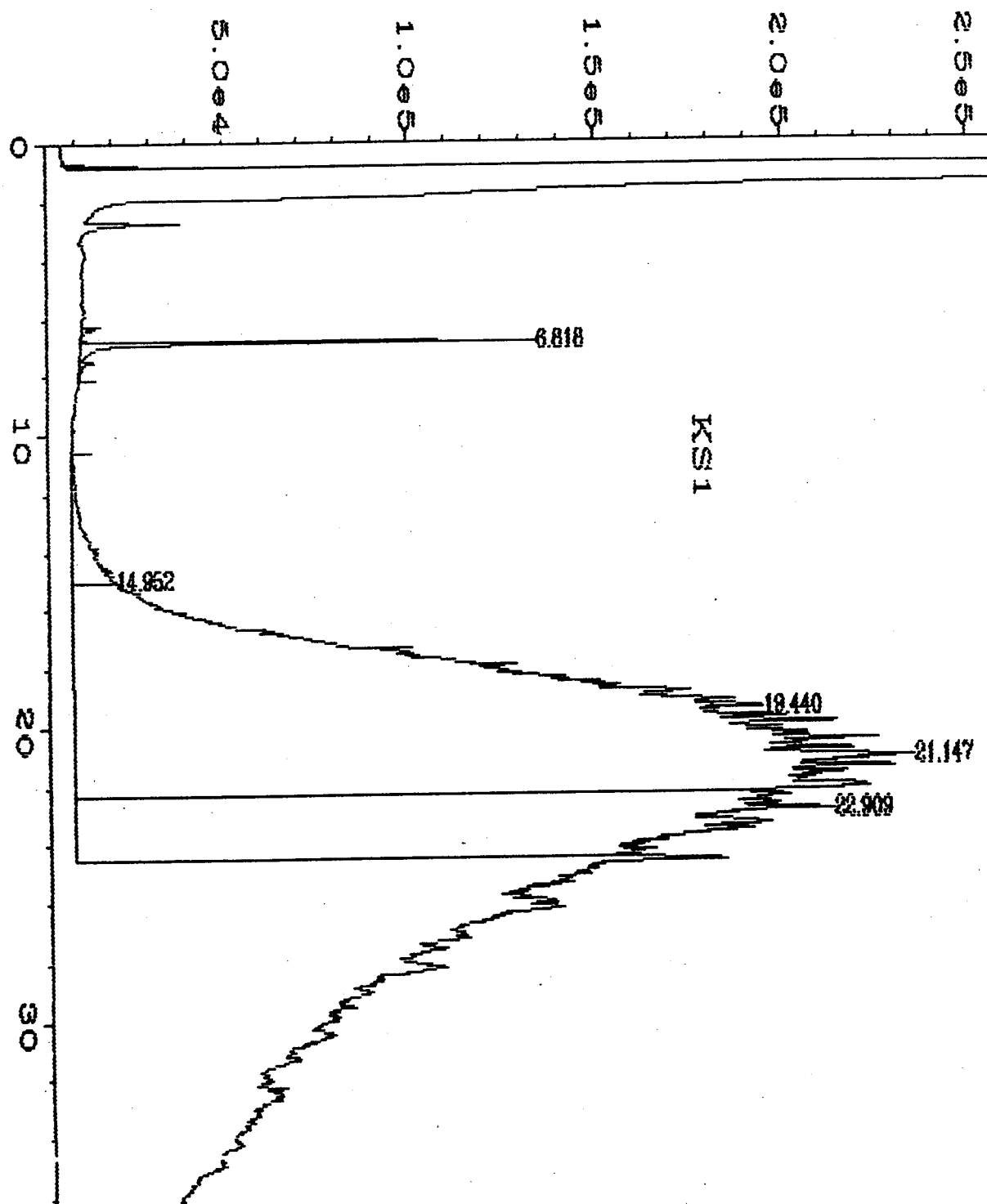
CLIENT SAMPLE IDENTIFICATION:		WS2	WS3	WS4	PWS1		
DATE SAMPLED:		Aug 29/96	Aug 29/96	Aug 29/96	Aug 29/96	DETECTION LIMIT	UNITS
CAN TEST ID:		609040050	609040051	609040053	609040054		
Metals Analysis							
Molsture		16.6	20.5	29.8	9.8	0.01	%
Antimony	Sb	37	59	110	<	10	µg/g
Arsenic	As	0.20	0.14	0.18	0.47	0.05	µg/g
Barium	Ba	49.8	123	63.2	46	0.1	µg/g
Beryllium	Be	<	<	<	<	1	µg/g
Cadmium	Cd	242	35.4	222	18.2	0.25	µg/g
Chromium	Cr	35	18	7	8	2	µg/g
Cobalt	Co	2	12	<	4	1	µg/g
Copper	Cu	79	91	61	110	1	µg/g
Lead	Pb	2730	2350	2720	1720	1	µg/g
Mercury	Hg	1.5	0.06	1.4	0.19	0.001	µg/g
Molybdenum	Mo	<	<	<	<	4	µg/g
Nickel	Ni	12	33	10	14	2	µg/g
Selenium	Se	<	<	<	<	0.5	µg/g
Silver	Ag	35	33	51	<	2	µg/g
Tin	Sn	<	16	<	<	5	µg/g
Vanadium	V	21	24	12	11	0.5	µg/g
Zinc	Zn	16700	1910	17200	1480	1	µg/g
Aluminum	Al	2680	25400	1830	43900	10	µg/g
Boron	B	55	84	46	12	0.5	µg/g
Calcium	Ca	12100	29400	4420	6630	1	µg/g
Iron	Fe	161000	103000	112000	24200	2	µg/g
Magnesium	Mg	16600	2880	9120	2520	0.1	µg/g
Manganese	Mn	23400	2000	40400	2290	0.2	µg/g
Phosphorus	PO4	3020	2740	1760	1700	20	µg/g
Sodium	Na	49	421	116	40	5	µg/g
Strontium	Sr	15.6	182	6.8	12	0.1	µg/g
Titanium	Ti	21.8	18.8	7.9	27	0.3	µg/g

% = percent

< = Less than detection limit

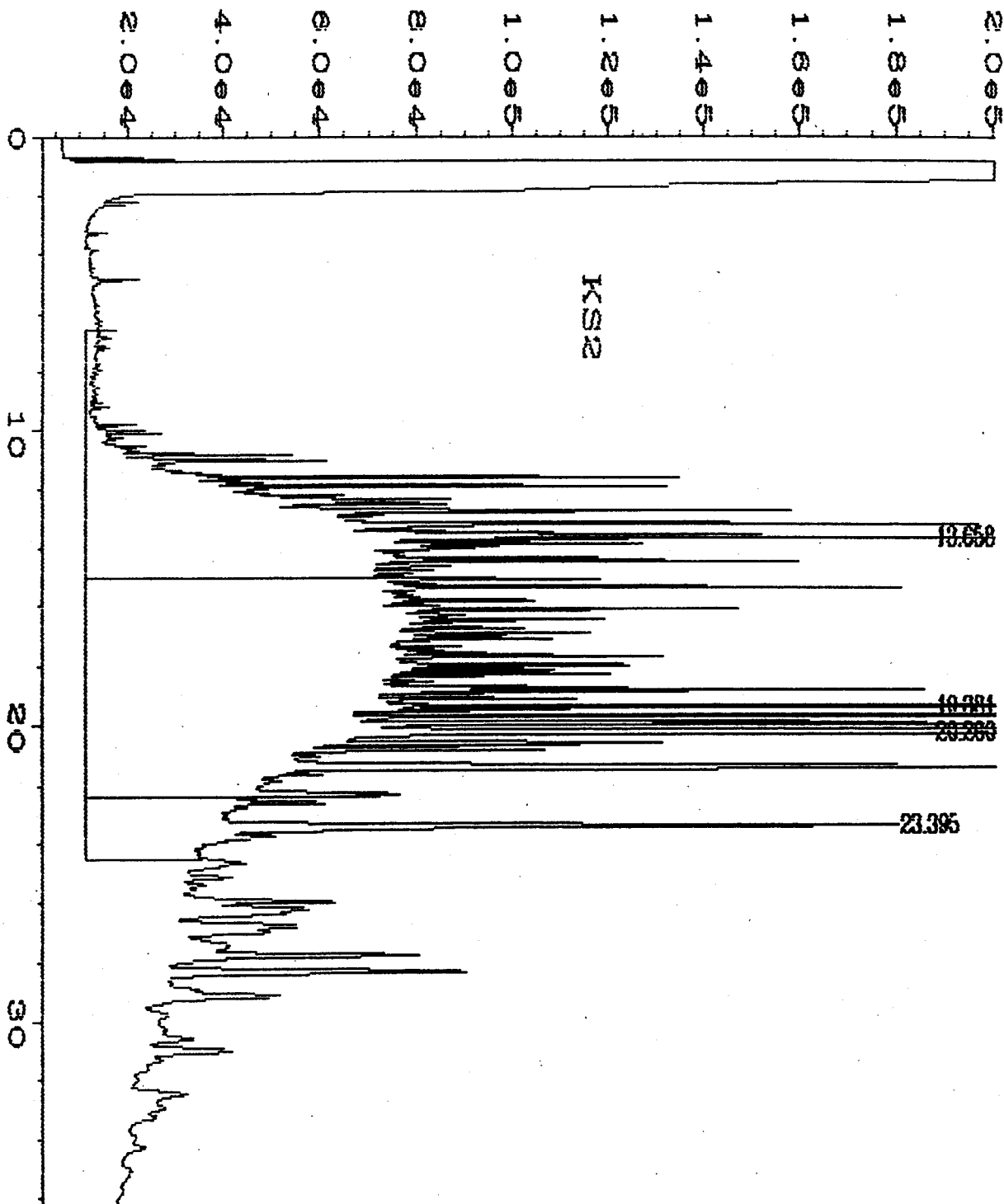
µg/g = micrograms per gram, on a dry weight basis.





user modified

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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

Data File Name : C:\HPCHEM\FID\DATA\090696\060F1101.D

Operator : MK

Instrument : FID

Sample Name : 609040042

Run Time Bar Code:

Acquired on : 07 Sep 96 07:11 AM

Report Created on: 10 Sep 96 06:19 PM

Page Number : 1

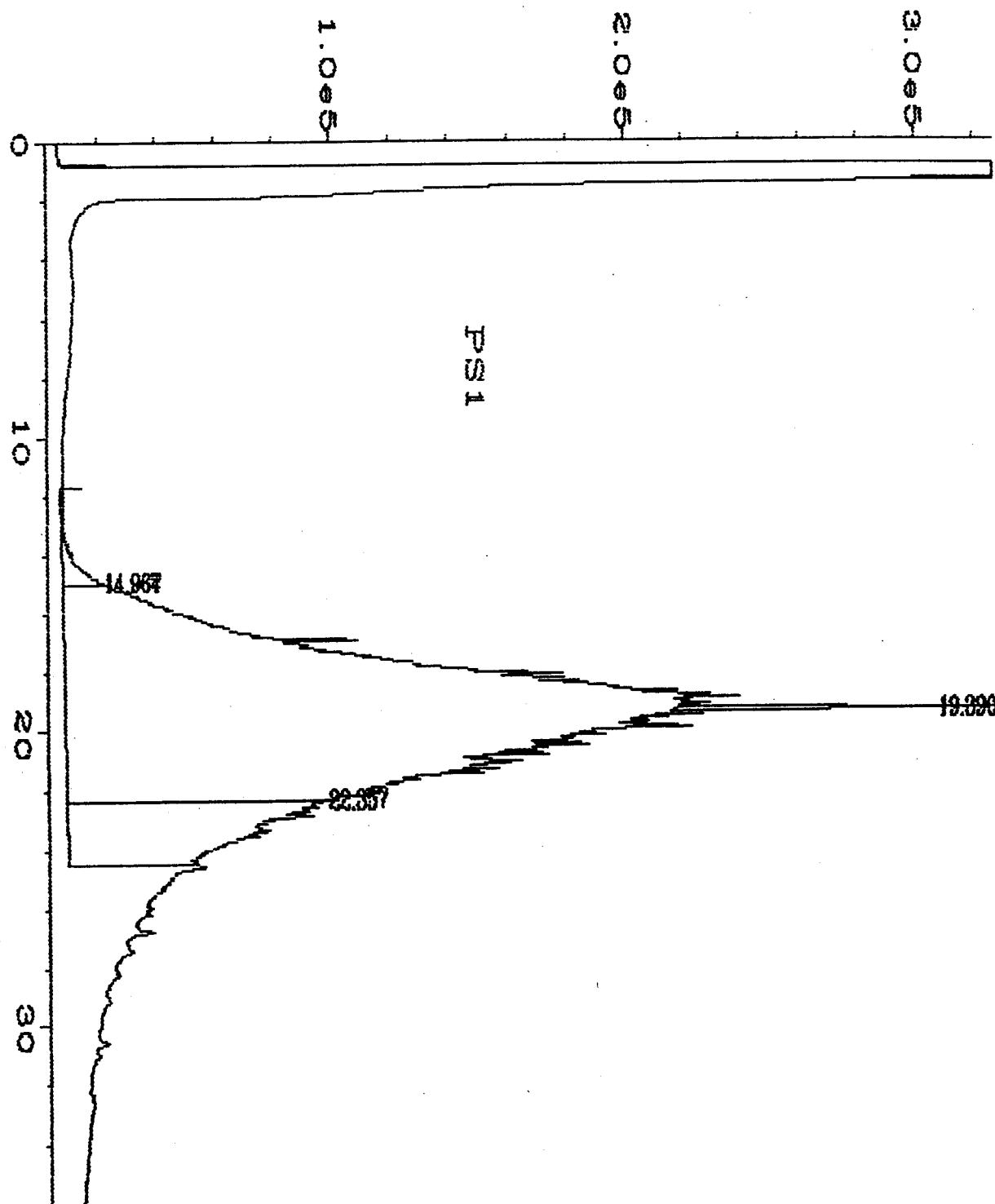
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Injection Number : 1

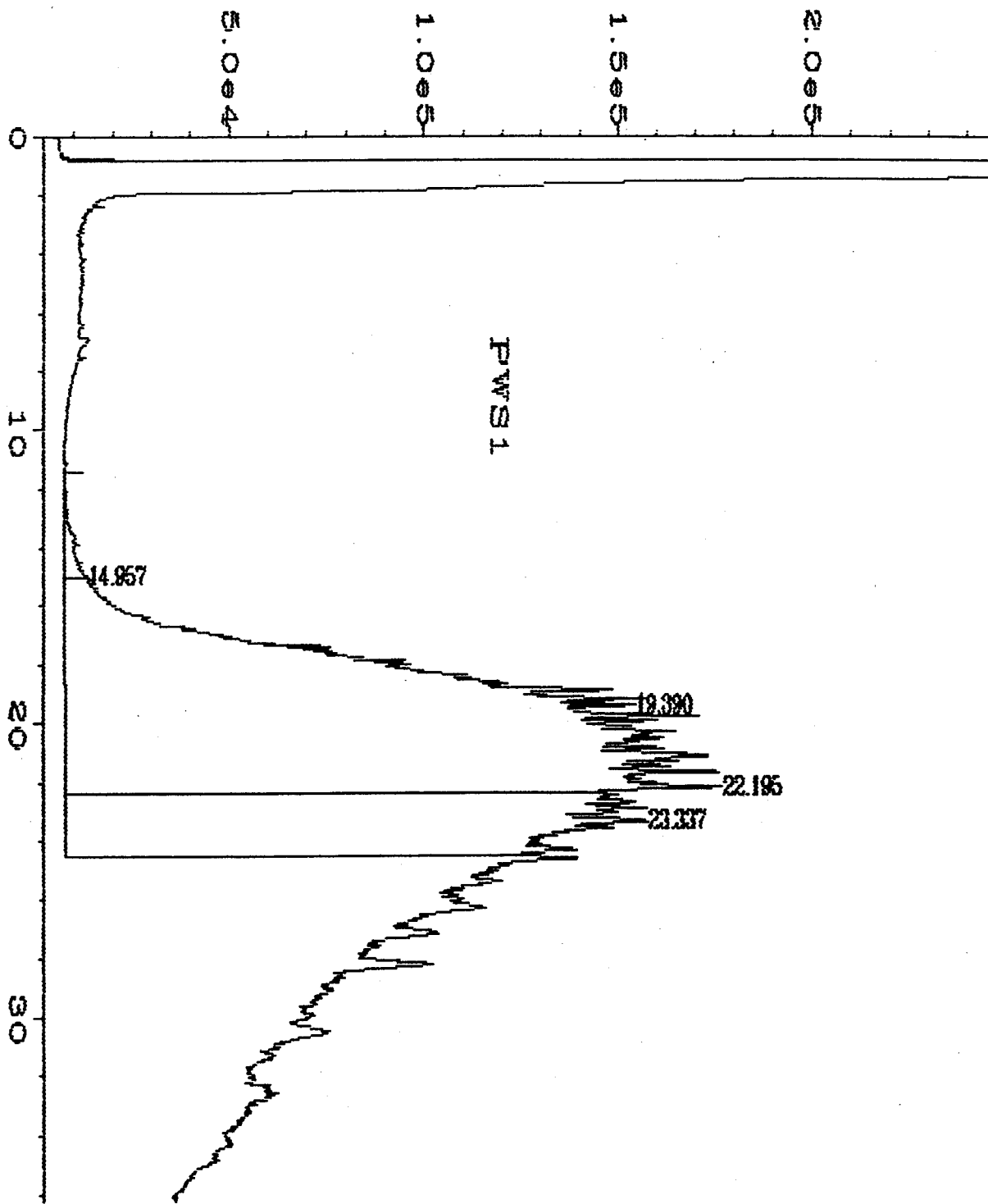
Sequence Line : 11

Instrument Method: TEHBAKE.MTH

Analysis Method : !TEH.MTH



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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		



user modified

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Operator	: MK	Vial Number	: 71
Instrument	: FID	Injection Number	: 1
Sample Name	: 609040054-40ML	Sequence Line	: 15
Run Time Bar Code:		Instrument Method	: TEHBAKE.MTH
Acquired on	: 07 Sep 96 04:43 PM	Analysis Method	: !TEH.MTH
Report Created on:	10 Sep 96 07:26 PM		

**APPENDIX C**  
**PHOTOGRAPHS**





View of exploration camp.

**PHOTO 1**



Soil sampling at suspected former drum storage area at the airfield.

**PHOTO 2**





Abandoned housing cabin.

**PHOTO 3**



Former generator stand with core splitter.

**PHOTO 4**





Diesel fuel drums at kitchen cabin.

**PHOTO 5**



Garbage dump down gradient of kitchen cabin.

**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 Appenix I.

#### Interlaboratory Studies (Round Robin Data)

Capacity and experience is only a secondary measure o 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.