ENVIRONMENTAL ASSESSMENT

OF

YUKON ABANDONED MINE SITES:

KATHLEEN LAKE NORTH

EXPLORATION SITE

Report Prepared for

Public Works and Government Services Canada

By

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Applied Research Division,

In Association With

UMA Engineering

Minesite Drainage Assessment Group

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Executive Summary

Royal Roads University - Applied Research Division (RRU-ARD), in association with UMA Engineering, Edmonton and the Minesite Drainage Assessment Group (Morwijk Enterprises) of Vancouver, B.C., were retained by Public Works and Government Services Canada to provide a detailed assessment of the Kathleen Lake North Exploration Site, 116 km north of Mayo which was previously identified under the Arctic Environmental Strategy Action on Waste (AES) program. This included identifying potential environmental, and human health and safety risks associated with the exploration site and providing recommendations and preliminary cost estimates for the remediation or mitigation of those risks.

Potential or existing safety and environmental risks were assessed during an on-site investigation on August 30, 1996. This included photodocumentation and mapping of site features and sampling locations; examination of infrastructure; inventory of hazardous and non-hazardous site debris; sampling/analysis of acid rock/metal leaching areas; examination/sampling (where required) of barrels and other containers; and sampling/analysis of contaminated soil areas.

The Kathleen Lake North exploration area is remote from any populated areas and there was only a limited amount of debris was identified during the site visit including drill rod, empty core boxes, wooden helipad, pails, a few empty barrels and cable spools. There is little potential for any risks to human safety. Small amounts of these materials were partially buried in waste rock along the north slope above the main trench area, as well as in a second trench on the eastern side of the exploration peak. Evidence of mine exploration activity was limited to trails, trenches, and core storage areas.

The abundant dolomite and limestone in the area would likely neutralize any acidic drainage, and thus the probability rating for acidic drainage on all scales, based on acid base accounting testing, is minimal. Substrate on the waste rock pile near a core box cache by the main trench area is contaminated with high concentrations of arsenic, cadmium copper, lead, mercury and zinc. Migration of these contaminants into the surrounding environment is anticipated to be extremely limited and any anticipated environmental or human health risks are therefore low. One stained area along the east portion of the site is highly contaminated with diesel hydrocarbon (56,900 ppm) and has resulted in localized vegetation kill. A second spill of white soluble oil by a drill hole in the vicnity does not pose any environmental risks but is an aesthetic concern.

It is recommended that all non combustible, non-hazardous debris, including empty barrels, and partially buried materials be removed from the site. Contaminated soils from localized stained areas should be containerized and similarly removed. Wood and other combustible materials should be burned on site. In consideration of the limited scope of cleanup work, it is recommended this project be undertaken only in conjunction with the cleanup of the Vera Mine site in which all materials removed from Kathleen Lake North would be disposed of in facilities at Vera.

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Many thanks to Beverley Hall who spent many hours in assisting with editorial changes to the report and proofing. Jerald Graham in the Mining Recorder's Office, Indian and Northern Affairs, Mayo was also extremely helpful in providing updated information on the claims status of the site. Nick De Graff in YTG Fisheries in Whitehorse was kind enough to provide information on Fisheries Resources at this site and others we investigated. Thank you also to Pat Daymon at TransNorth Helicopters, Mayo for assisting us with logistics planning and helicopter time. Mikolay Peter from the First Nation of Na-cho Nyak Dun, Mayo was also extremely helpful in providing us with his capable assistance during the field and sampling program.

1. Introduction And Background

A number of abandoned mining exploration and development sites, including Kathleen Lake North, were previously identified and investigated by Indian and Northern Affairs (DIAND) Technical Services under the Arctic Environmental Strategy Action on Waste (AES) program in 1993/94. Royal Roads University - Applied Research Division (RRU-ARD) was retained as a prime contractor by Public Works and Government Services Canada to provide more detailed investigations and recommendations for remedial actions which would be required to close the sites in a safe and environmentally sound manner. The RRU-ARD was joined by associate consultants UMA Engineering of Edmonton, Alta. and Minesite Drainage Assessment Group of Vancouver, B.C. on this project. This report addresses the investigation, findings and recommendations for the abandoned Kathleen Lake North exploration site.

1.1 Location and Site Access (B)

Kathleen Lake North (64° 17' 09" N, 134° 11' 50" W) is located in northeastern Yukon, 116 km northeast of Mayo along the slopes of an unnamed mountain 5 km north of the Kathleen Lakes (Map 1-1). The exploration site is situated near the region where the Wernecke Mountains join the Yukon Plateau, at an elevation of 1200 m above sea level (Photograph 1-1). The site was once accessible by a trail which leads past Clark Lakes to the north of Kathleen Lakes. This trail crosses several streams, limiting site access to the winter months. Helicopter is probably the easiest way of reaching the site year-round.

1.2 Overview of Site Development (B)

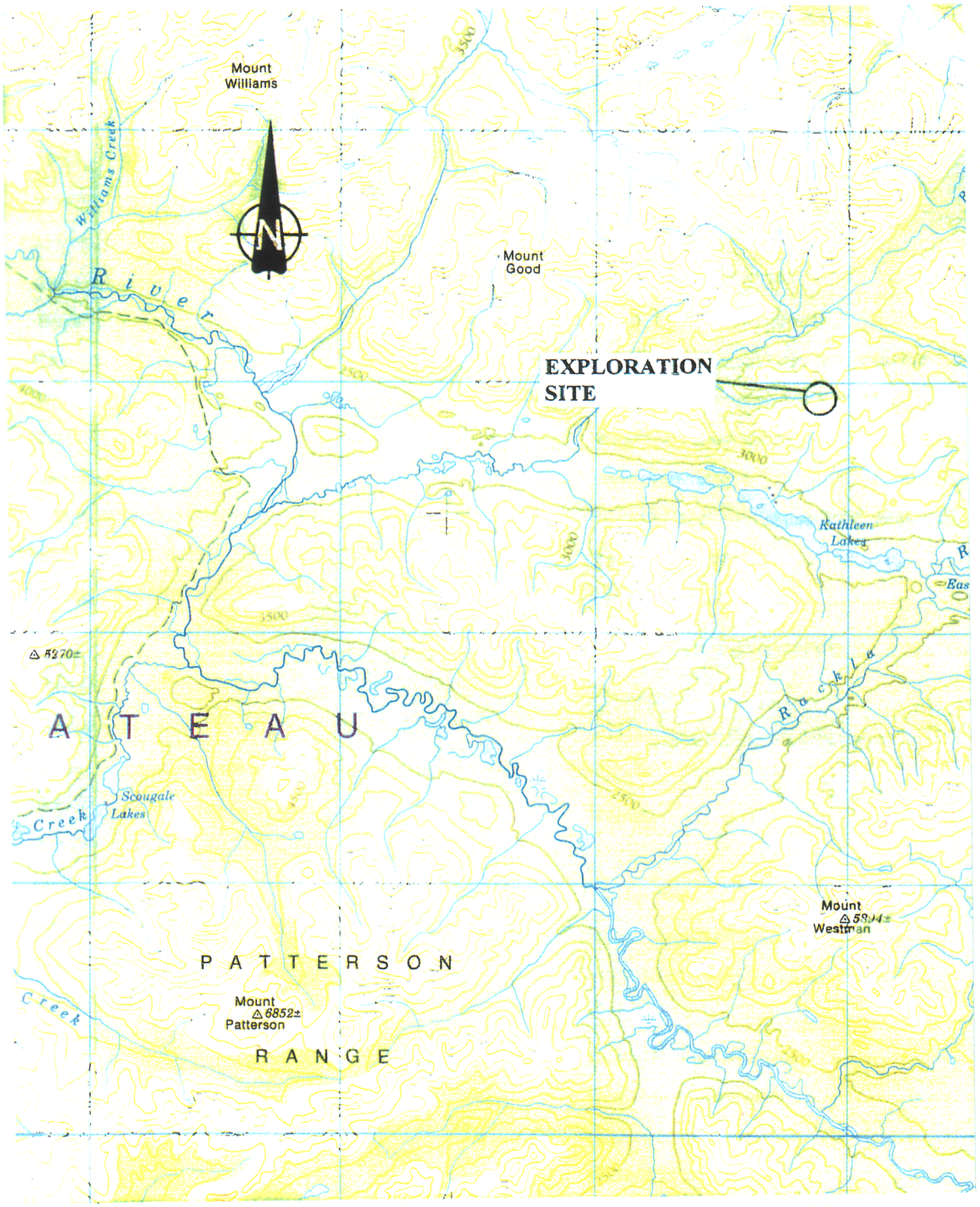
A work history of the site was compiled by DIAND Technical Services (1994) using information supplied from DIAND Yukon Minfile record 106D 006 and the Indian and Northern Affairs Mining Recorder's Office in Mayo, Yukon. This information is summarized below.

Kathleen Lake North was originally staked as Donald claims by a G. Dickson in 1951 and the site was explored via trenching by Leitch Gold Mining Ltd. in 1953. In 1954, on behalf

of a syndicate including Noranda Mines and Kerr Addison Gold Mines Ltd, Prospectors Airways conducted extensive sampling and mapping including approximately 40 hand trenches. The property was re-staked as Dago claims by Dickson in 1959, and trenching was continued until 1966 at which time the property was optioned to Atlas Exploration Ltd. This company added the Soda claims and conducted evaluation and geochemical surveys. With the addition of the Bud claims in 1968, Dickson formed the new Rackla River Mines Ltd. which continued to sample, trench and develop the property before optioning the claims to Casino Silver Mines in 1969. The property was surveyed by this latter company which drilled 580 m from 4 holes between 1969 and 1970. Following grid soil sampling and limited packsack drilling, the Con claims were added in 1972 by Rackla River Mines.

After another name-change to North Atlantic Resources Ltd. in 1976, Rackla River Mines Ltd. transferred the site back to Dickson who subsequently optioned it to Pan Acheron Mining Ltd. in 1977. This latter company expanded the property the same year. In 1978 they drilled 1554 m from 22 holes and in 1979 added the Scotty and Fanale claims. Mapping, geochemical sampling and trenching of the property was completed in 1983, followed by additional hand-trenching on the Bud and Dago claims by Dickson in 1984. The major commodities identified were lead, zinc and silver. The Dago 3 and 5 claims by Dickson expiried in July 1993 and none of these claimes have since been renewed (Assistant Mining Recorder, Indian and Northern Affairs Officepers. comm.).

Exploration was limited to surface drilling and trenching with a number of areas exposed from the development of trenches and exploration trails. One major trench area with waste rock exists on the south slope of a hill top at the site, along with smaller trenches and drill sites to the east and west of this location. A few pieces of metal debris consisting primarily of crushed barrels and cans are partially buried in a few of these smaller trenches. A small wooden pad, possibly for helicopters, and a few empty barrels are also scattered along this same slope approximately a few hundred metres to the west of the main trench. No adits or permanent camp facilities were constructed at this site.



Map 1-1: Regional Location of the Kathleen Lake North Exploration Site (1:250000, adapted from DIAND Technical Services Report, 1994)

Photograph 1-1: 1968 Aerial Photograph of Kathleen Lake North Exploration Site (1:56000 adapted from DIAND Technical Services Report, 1994)

2. Purpose And Scope Of Work

The key objectives of this assessment were to identify potential environmental and human health and safety risks associated with the exploration site, and to provide recommendations and preliminary cost estimates for the remediation or mitigation of those risks. The scope of work for the project consisted of three phases described below.

2.1 Phase I - Data Collection and Review

Relevant site information was collected and reviewed including the following:

- historical land use and mining exploration/development;
- site location and access;
- topographical maps and aerial photography;
- area mineralization and geology; and
- existing infra-structures.

Much of the above information was provided in the DIAND Technical Services Report (1994) for this site. Additional information was supplied through interviews with personnel in the Indian and Northern Affairs (AES) Action on Waste (Waste Management) and Mining Records Offices in Whitehorse, and the Trans North Helicopter Office in Mayo, which operates charters in the region.

2.2 Phase 2 - Site Investigation and Sample Collection

The site was vfisited on August 30, 1996 by the assessment team and a representative of the N'Yak-Cho Dun First Nations in Mayo. Based on the terms of reference, information review, and site reconnaissance, investigations at the Kathleen Lake North Site were directed to the following:

- photo-documentation, Geographical Positioning Co-ordinates (GPS) of specific locations (presented in Appendix E), and mapping of relevant site features;
- identification and inventory of hazardous and non-hazardous site debris, including barrel contents containing petroleum products;
- sampling of waste rock disposal areas, stained soils, associated surface water and barrel contents
- identification of potential sources of environmental contamination (contaminated soils), and actual or potential environmental pathways and receptors (e.g., surface waters);
- assessment of waste rock and mine development areas for potential acid rock drainage conditions;
- assessment of potential human safety risks, including access to hazardous areas.

2.3 Phase 3 - Reporting and Cost Estimates

Information, observations, and findings were incorporated into this report using a generic format specified in the terms of reference for the project. Site-specific plans were originally prepared in AutoCAD™ and presented in Corel™ format. The report includes an assessment of potential risks to human safety and environmental health, and recommendations for the remediation of identified risks. These recommendations are based on applicable Federal and/or Territorial environmental guidelines (see Section 3). Preliminary (Class D) cost estimates were generated to meet the following remediation/mitigation requirements specific to the Kathleen Lake North site::

- Physical and/or chemical stabilization (where required) of waste rock disposal areas;
- Remediation and/or removal and disposal of contaminated soils;

- Consolidation, and landfill (where feasible/practical) or removal (off-site disposal) of all non-hazardous, non-combustible solid wastes;

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

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

3. Site Assessment Methodology

The assessment at the mine site was limited to the area specifically developed or occupied for mining-related activities, as well as adjacent or off-site areas which may be potentially affected by these activities. Access roadways and mining trails were noted, but not included in the assessment.

Other assumptions applicable to this site include the following:

- the reliability of the background information provided in the DIAND Technical Services Report (1994) for this site;
- potential pathways/receptors of environmental contaminants based on biophysical and geological characteristics of both the site and the region, as well as current site use;
- soil conditions, areas and volumes were assessed by surface soil observations; extensive excavations were not carried out due to time constraints, areas of discontinuous permafrost and bedrock, and the difficulty of excavating with hand tools;

3.1 Methods

3.1.1 Site Assessment Components

As described in Section 2.1 information was complied from reports and interviews with Indian and Northern Affairs personnel and other government officials in Whitehorse. Information gaps were identified and a site specific assessment plan was developed to address these deficiencies.

The site assessment consisted of the following components:

- *Site reconnaissance* was done by ground and air for photo documentation, and to identify site features;

- *Non-hazardous site debris* was examined and inventoried;
- *Barrels and other containers* were examined and inventoried;
- *Contaminated soil areas* were sampled and measured to determine the degree and type of contamination and to estimate soil volumes;
- *Scale site plans* were compiled (including GPS waypoints) to identify the locations of structures, waterways, sampling points, and other useful information.

Specific sampling procedures are discussed in Section 3.2.2 below.

3.1.2 Sampling Methods

Soil

All soil samples were collected, transported, and stored under conditions required for maintaining sample integrity. The general protocols presented in Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (CCME, 1993) were used. Samples were collected with stainless steel scoops, which had been pre-cleaned, baked and wrapped in aluminum foil to preclude contaminants. The samples were placed into either a 125 mL glass jar sealed with a Teflon lined-lids or a zip-lock bag. These containers were labeled and placed in coolers. Sample information was recorded on the chain-of-custody forms and the coolers were shipped to the laboratory via air freight. A copy of the chain-of-custody form accompanied each cooler.

Waste Rock and Cores

Rocks, gravel and other overburden material which, based on colour and appearance, appeared to be oxidized or contain mineralizations (e.g., sulphur) with the potential to release acidic or metal-contaminated drainage were identified by a professional geologist. Included were materials in areas along excavation trenches and rock units from stored core boxes, as well as natural outcrops. Representative samples of rock were obtained from these locations using a handpick and placed in plastic zip lock bags for storage.

3.1.3 Chemical Analysis

More detailed descriptions of the analyses below are presented with the laboratory reports in Appendix C.

Field Screening Tests for Hydrocarbons

Millipore EnviroGard™ immunoassay test kit which were obtained from Diagnostix Inc., Mississauga, Ontario were used for the detection of total petroleum hydrocarbons (TPH). The kit utilizes the enzyme-linked immunoabsorbent assay technique which is based on antibodies that are designed to bind to specific analytes. Quantitation is achieved by

comparing the colourimetric signal generated by a unknown sample with a set of standards using a portable spectrophotometer. At least 20% of the samples were also subjected to laboratory analysis as per US EPA protocols for field test kits.

Metals in Soils

This analysis was carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050 or Method 3051, published by the US EPA. The metals analyzed included antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), copper (Cu), lead (Pb), molybdenum (Mo), nickel (Ni), selenium (Se), silver (Ag), tin (Sn), vanadium (V) and zinc (Zn).

Non-Halogenated Volatiles in Soil -Headspace method

This analysis was carried out in accordance with US EPA Methods 3500/3810 and 8020/8015 (Publ. # SW-846, 3rd ed., Washington DC 20460).

Volatile Petroleum Hydrocarbons in Soil

The analysis was carried out in accordance with the BC Ministry of Environment Land and Parks Method "Volatile Petroleum Hydrocarbons Soil".

Light Hydrocarbons in Soil

The analysis was carried out in accordance with US EPA Method 3810/8015 (Publ. # SW-846, 3rd ed., Washington DC 20460 and covered carbon atoms in the C5 - C9 range.

Extractable Petroleum Hydrocarbons (EPH) in Soil

The method used was equivalent to the BC Ministry of Environment Land and Parks Method for "Extractable Petroleum Hydrocarbons (EPH) in Soils by GC/FID, January 1996" but does not provide correction for Polycyclic Aromatic Hydrocarbons (PAH). EPH results are presented for components in the C10 to C18 and C19 to C32 ranges.

Polycyclic Aromatic Hydrocarbons (PAHs) in Soil

Samples were analyzed for PAHs in accordance with US EPA methods 3500, 3630 and 8270 (Publ. # SW-846, 3rd ed., Washington DC 20460). The analytes included acenaphthene, acenaphthylene, acridine, anthracene, benzo(a)anthracene, benzo(a)pyrene, benzo(b)fluoranthene, benzo(g,h,i)perylene, benzo(k)fluoranthene, chrysene, dibenz(a,h)anthracene, fluoranthene, fluorene, indeno(1,2,3-c,d)pyrene, naphthalene, phenanthrene and pyrene.

3.1.4 Acid Drainage and Metal Leaching Potential for Rock Samples

The potential for acidic drainage and metal leaching is normally determined through a combination of one-time static tests and long-term kinetic tests. For this assessment, the analytical program was limited to static tests including *expanded* acid-base accounting (ABA) and total-metal contents.

Total-metal contents in the rock samples were also determined using ICP analyses. Details of these analyses are presented in Appendix B.

3.1.5 Quality Assurance/Quality Control (QA/QC)

In order to ensure the integrity of the samples and the quality of the data obtained, the quality assurance/quality control (QA/QC) program was developed to cover all aspects of the program such as, sampling, analysis, data interpretation and evaluation. The quality control data are reported in Appendix D. The program included:

- documentation of sampling (date, time, site identification, site conditions, sampling equipment, sample type, chain-of-custody forms, etc.);
- use of pre-cleaned sampling scoops and containers;
- sample preservation and storage;
- collection of field duplicates;

- analysis of quality control samples to define precision and accuracy and to demonstrate contamination control for the samples and analytes; and
- data validation.

3.2 Assessment Criteria for Contaminants

On federal lands, results of soil contamination investigations are evaluated in terms of the CCME Interim Remediation Criteria that, for soils, are divided into three categories - agricultural (AG), residential/parkland (R/P), and commercial/industrial (C/I). A list of the CCME R/P criteria for soils are provided in Appendix F, Tables 1 and 2). CCME remediation criteria serve as benchmarks to evaluate the need for further investigation or remediation with respect to a specified land use.

For surface soils at Kathleen Lake North Exploration Site, the more stringent CCME residential/parkland (R/P) criteria would normally be the most appropriate assessment criteria given the remoteness of the site which is surrounded by otherwise pristine wilderness, resulting exposure by wildlife, current public perception and the anticipated future land use at this location. Contaminant levels, however, were also compared with the commercial/industrial (C/I) criteria reflecting its past use at the request of the client (PWGSC).

CCME Remediation Criteria for Water are divided into four usage categories - freshwater aquatic life, irrigation, livestock watering, and drinking water. The criteria for freshwater aquatic life (Appendix F, Table 3) were used in the assessment to evaluate contaminants in mine adit and waste rock seeps, and in surface waters.

Screening level guidance for hydrocarbons is scarce. There is considerable variance between provinces in the application of group parameters for soil screening and remediation; for example, there is no consensus between regulatory jurisdictions on criteria for oil and grease (O&G) total petroleum hydrocarbons (TPH), total extractable hydrocarbons (TEH), or volatile, light and heavy extractable hydrocarbons (VPHs, LEPHs, and HEPHs, respectively). B.C. (1995) Draft Soil Standards for VPHs, LEPHs,

and HEPHs have been used in the mine assessments as screening criteria for soil analyses (see Appendix F, Table 2). There are no standards or criteria for VPHs, LEPHs, or HEPHs in sediment, groundwater, or surface water. The B.C. Draft Soil Standards for hydrocarbons are classified by land uses: agricultural, urban park, residential, commercial and industrial. For the mine site assessment, the urban park/residential criteria were used for reasons described above. In each case, however, the commercial/industrial criteria were also used as part of the assessment.

3.2.1 Preliminary Risk Assessment

Possible pathways of human exposure to metal and organic contaminants were examined qualitatively, based on known or anticipated uses of the site. Human health risks might be investigated further in areas where humans have some possibility of obtaining contaminated food substances or drinking water from the area, or could be subjected to extended contaminant uptake through soil exposure.

Likewise, human safety risks were assessed on a premise based on the presence of physical hazards including unsafe buildings and other structures, as well as potential chemical hazards (e.g., fuel, acids or solvents) which might be stored within these structures.

Environmental risk relates to possible change in any number of components at or around specific sites; for example, contaminant-induced effects on microbes, plants, animals, species interactions, productivity, or resilience (or ability to recover) of whole ecosystems against natural or non-natural perturbations. The assessment of environmental risk, therefore, is considerably more complicated than human health risk. Remediation criteria established by the Canadian Council of Ministers of the Environment (CCME, 1991), however, are designed to minimize environmental risk, subject to site-specific conditions and are therefore a reasonable approach to providing a preliminary risk assessment.

For this study, the assessment of environmental risk was first based on whether contaminated soil and water were found: If all contaminants were found only at levels below CCME remediation criteria or equivalent guidelines, then the associated risk was

assumed to be trivial, unless some local condition (e.g., presence of a highly sensitive biotic element) suggested otherwise. Evidence of the migration of contaminants - regardless of the concentrations - along water courses and into fish-bearing waters is taken as a sign of possible direct risk, and has implications under the federal Fisheries Act. Indications of risk also included visual evidence of the use of a contaminated area by wildlife and humans, as well as direct signs of impact such as the presence of dead or stunted vegetation.

The assessment of either environmental or human health risk during this study was limited by the small number of samples collected; however, the sampling effort focused on detecting and assessing the most contaminated areas, which minimizes the probability of under-estimating the risk.

Recommendations for remedial actions were provided where contaminated areas were found (or a reasonable possibility existed that contaminated areas may be found in the future), and where there is some possibility that the contaminants could lead to adverse effects on biological 'receptors' in the proximity of the site. Recommendations were also provided for actions where existing, or future physical and/or chemical hazards, could pose a risk to human safety.

4. Environmental Setting

4.1 Regional and Site Mineralization

The main rock units reported at Kathleen Lake North were Ordovician to Lower Devonian Road River Formation, containing limestone and calcareous shale, and the underlying Late Proterozoic orange-weathered dolomite and limestone (DIAND Technical Services, 1994). The economic minerals are: sphalerite (zinc sulphide) and minor galena (lead sulphide) with low silver values. These rock units and minerals were found at Kathleen Lake North and tested as part of this study.

4.2 Climate

Climate in the area is predominantly dry sub-alpine to alpine on the exploration slopes with freezing temperatures arriving by late August and dissipating by late June. Based on climate information at similar altitudes in the region, annual precipitation is approximately 500 mm with the majority falling as snow. Mean annual temperatures of 0 to -10°C are expected for this region

4.3 Topography, Surface Hydrology and Drainage

Topography in the area is quite steep, particularly on the mountain slopes where a majority of the exploration trails, trenching and drill sites are situated (Photograph 4-1). The terrain ranges from rugged to undulating. The site is relatively high and dry, and no surface water features, such as springs or streams, were found along the slopes in the main exploration areas. Surface substrate in the area consists primarily of mixed glacial till including boulders, cobble, gravel, sand and silt. This well-drained substrate may partially explain the lack of visible surface drainage in the area. Peat-rich soils occur as pockets among the rocky till.

Permafrost was not encountered in the shallow testpits excavated; however, it is anticipated that discontinuous permafrost is present at greater depths.

4.4 Vegetation

Vegetation consists primarily of alpine tundra plants along the exploration areas on the mountain slopes which rise above the tree line. Smaller trees, shrubs and perennials occur, including willow (*Salix* sp.), ground birch (*Betula* sp.), heather (*Cassiope* sp.), lupine (*Lupinus* sp.), lichen, moss, grasses, and sedge (*Carex* sp.) (Photograph 4-2). The valley below the exploration areas is dominated by sparse to moderate dense stands of black spruce (*Picea maritima*).

4.5 Fish and Wildlife Resources

Little evidence of wildlife activity was apparent at the time of the site visit; grizzly bears, however, occur in the region and probably feed in this area during the summer months. Caribou and other large game may also pass through. Rivers in the surrounding valleys undoubtedly support fish resources, but no streams or lakes were found in the exploration area. The Kathleen Lakes, situated a few kilometres to the south of the site, are classified as Type 1 habitat by the Yukon Placer Authorization (Nick de Graff, YTG Fisheries, pers.comm.) indicating the stream can potentially support spawning by trout, salmon and char based on physical and chemical environmental characteristics.

←

Photograph 4-1: General topography of site showing worked areas and partially-buried materials

Photograph 4-2: Vegetation on less worked slopes of site and west core box cache (near center of photograph)

5. Site Description And Findings

5.1 Buildings, Infrastructure, and Equipment

Evidence of mine exploration activity was limited to trails, trenches, and core storage areas. No camp facilities were observed, but a wooden platform, believed to be a helicopter landing pad, was observed in the general area. An overview of the site is presented on Map 5-1.

5.2 Non-Hazardous Waste Materials

Debris; including drill rod, empty core boxes, pails, wood scraps, approximately a dozen empty barrels, and cable spools; was observed in the vicinity of abandoned drill holes. Small amounts of these materials (mostly cans and crushed barrels) were partially buried in waste rock along the north slope above the main trench area, as well as in a second trench on the eastern side of the exploration peak (Photograph 5-1)..

5.3 Hazardous Waste Materials

Hazardous materials are generally defined as those materials classified as dangerous goods under the Transportation of Dangerous Goods Regulations or regulated substances under the Canadian Environmental Protection Act. These materials can include:

- explosives;
- compressed gases (propane, carbon dioxide);
- flammable liquids (fuel)
- flammable solids;
- corrosive or reactive substances (batteries);
- radioactive materials;
- environmental hazardous materials (asbestos, PCBs over 50ppm).

For the purposes of this assessment, contaminated soils were also placed under the hazardous materials category at the request of the client (PWGSC).

At the Kathleen Lakes North site, several unlabelled containers, which may have contained drilling fluid additives, but are now empty, were observed in the area Photograph 5-2 & 5-4). Three empty fuel barrels were also identified. Empty containers, which at one time contained dangerous goods, are classified as such. However, given the age of these containers and the lack of residue, they may be disposed of as non-hazardous materials, without posing an environmental risk.

Contaminated soil areas are discussed in the sub-section below.

Stained/Contaminated Soil Areas

Approximately 180 coreboxes were identified on the north slope of the peak just below one of the main exploration trenches (Photograph 4-1). Two surface soil samples were obtained from below these boxes: KA-01 from the west side of the pile and KA-02 from the east (Photograph 5-4); (Map 5-1). Selected analytical results for total metals are presented in Table 5-1 below. Full analytical results for these and the other samples listed in the table are provided in Appendix A.

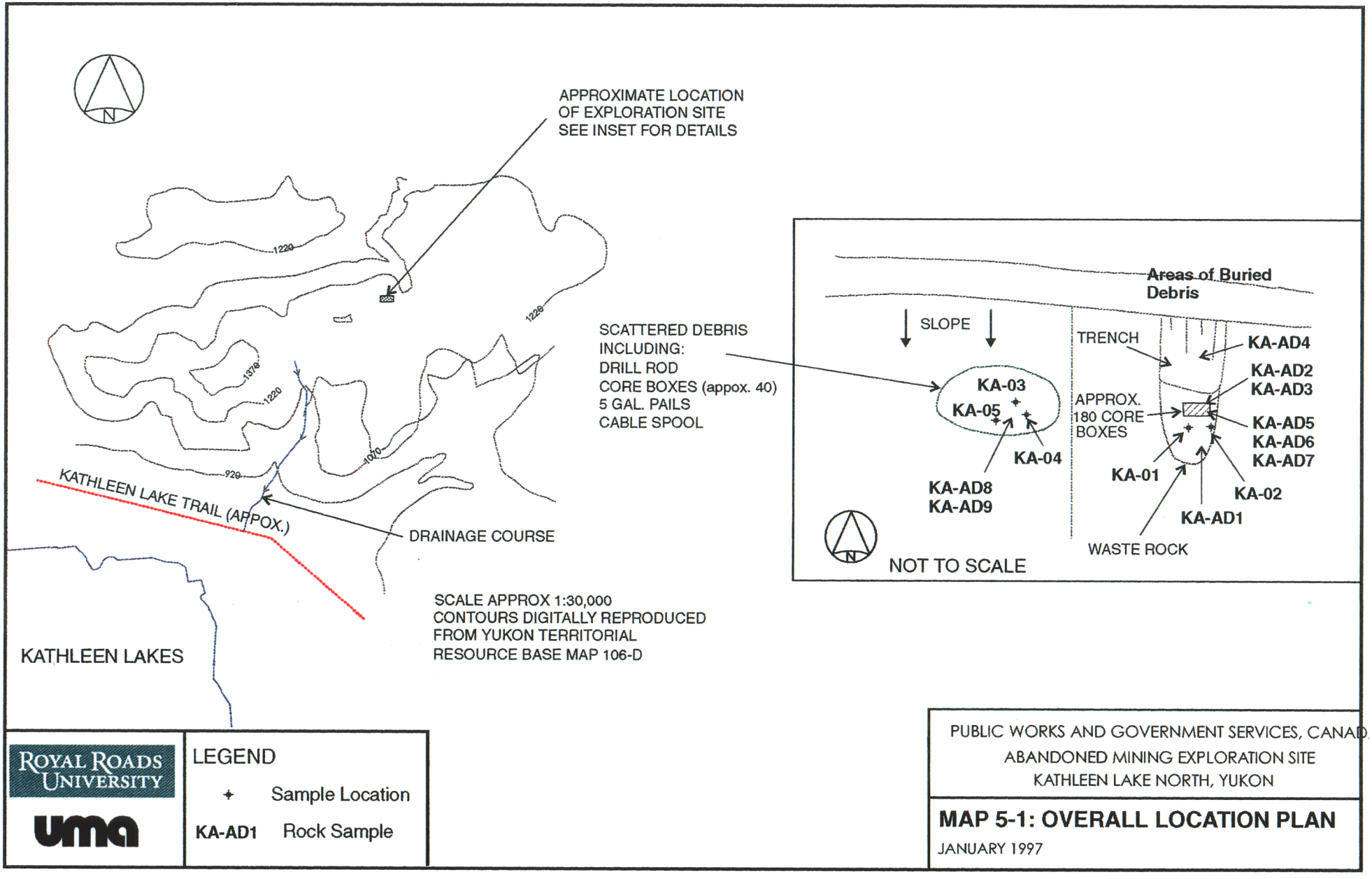

APPROXIMATE LOCATION
OF EXPLORATION SITE
SEE INSET FOR DETAILS
SCATTERED DEBRIS
INCLUDING:
DRILL ROD
CORE BOXES (appox. 40)
5 GAL. PAILS
CABLE SPOOL
1220
1220
1370
1220
1070
920
KATHLEEN LAKE TRAIL (APPOX.)
DRAINAGE COURSE
KATHLEEN LAKES
SCALE APPROX 1:30,000
CONTOURS DIGITALLY REPRODUCED
FROM YUKON TERRITORIAL
RESOURCE BASE MAP 106-D
Areas of Buried
Debris
SLOPE
TRENCH
KA-AD4
KA-AD2
KA-AD3
KA-03
KA-05
APPROX.
180 CORE
BOXES
KA-AD5
KA-AD6
KA-AD7
KA-04
KA-01
KA-AD8
KA-AD9
KA-02
KA-AD1
WASTE ROCK
NOT TO SCALE
ROYAL ROADS UNIVERSITY
uma
LEGEND
Sample Location
KA-AD1 Rock Sample
PUBLIC WORKS AND GOVERNMENT SERVICES, CANADA
ABANDONED MINING EXPLORATION SITE
KATHLEEN LAKE NORTH, YUKON
MAP 5-1: OVERALL LOCATION PLAN
JANUARY 1997

Table 5-1: Selected Analytical Results for Soils at Kathleen Lake North

Sample No.	KA-01	KA-02	KA-03	KA-04	KA-05	CCME/B.C. R/P Criteria	CCME/B.C. C/I Criteria
Physical Tests							
Moisture %	15.3	14.3	73.2	-	-	-	
Total Metals (µg/g or ppm)							
Antimony	<20	<20	<40	-	-	**20**	**40**
Arsenic	<0.05	3.54	1.56	-	-	**20**	**50**
Barium	58	38	133	-	-	**500**	**2000**
Beryllium	<0.5	<0.5	<1.0	-	-	**4**	**8**
Cadmium	**647**	**403**	<4	-	-	**5**	**20**
Chromium	<2	3	7	-	-	**250**	**800**
Cobalt	6	5	6	-	-	**50**	**300**
Copper	**142**	50	16	-	-	**100**	**500**
Lead	**20700**	**9460**	<100	-	-	**500**	**1000**
Mercury	**7.53**	**2.05**	0.09	-	-	**2**	**10**
Molybdenum	<4	<4	<8	-	-	**10**	**40**
Nickel	8	6	7	-	-	**100**	**500**
Selenium	<0.1	<0.1	0.7	-	-	**3**	**10**
Silver	89	46	<4	-	-	**20**	**40**
Tin	<10	**81**	<20	-	-	**50**	**300**
Vanadium	<2	7	11	-	-	**200**	-
Zinc	**61500**	**42000**	232	-	-	**500**	**1500**
Hydrocarbons (µg/g or ppm)							
Test Kits (TPH)	-	-	-	-	75-375	-	
Non-halogenated Volatiles							
Benzene	-	-	-	-	<0.2	**0.5**	**5**
Ethylbenzene	-	-	-	-	<0.2	**5**	**50**
Toluene	-	-	-	-	<0.2	**3**	**30**
meta- & para-Xylene	-	-	-	-	<0.2	**5**	**50**
ortho-Xylene	-	-	-	-	<0.2	**5**	**50**
	-	-	-	-			
Light Hydrocarbons (C5-9)	-	-	-	-	<5	-	
VPH	-	-	-	-	<10	**200**	**200**
Extractables	-	-	-	-			
EPH (C10-18)	-	-	-	<250	**30300**	**1000**	**2000**
EPH (C19-31)	-	-	-	<250	**56900**	**1000**	**5000**
Site/Sample Descriptions	Surface soil sample under core box pile to W, just below main exploration site on S slope, coarse iron-rich sand	Surface soil sample under core box pile to E, just below main exploration site on S slope, coarse iron-rich sand	Surface soil sample under core box pile located 16 m SE of drilling location on SW slope, coarse iron-rich sand	Surface soil sample in low-lying area at drilling site on SW slope, white substance (soluble oil?), mixed with organic soil	Surface soil sample in stained area approximately (See Tanya's Notes) m NE of KA-03, dry peaty (tundra-like) soil		

High concentrations of cadmium (647 and 403 ppm), copper (KA-01: 142 ppm), lead (9460 and 20,700 ppm), mercury (2.1 and 7.5 ppm) and zinc (61,500 and 42,000 ppm) were found at these locations. All of these exceeded the CCME/B.C. residential/parkland (R/P) remediation criteria for soil; concentrations of cadmium, lead and zinc in these samples also exceeded the C/I (commercial/industrial) remediation criteria. These results suggest that the cores and the waste rock they represent are a potential source of metal contaminants to the surrounding environment.

A second corebox pile with approximately 30 boxes was identified along a vegetated slope further to the west and approximately 16 m southwest of a drilling site (Photograph 4-2, 5-3). One sample, KA-03 (Map 5-1), was obtained from organic soil beneath this pile and analyzed for total metals (Table 5-1); concentrations were either below detection or well below the CCME/B.C. R/P remediation criteria.

A drill site was located in a depression by a rock face near the helicopter landing pad above the second corebox pile. The depression around this hole contained a white milky substance thought to be soluble oil (Photograph 5-4). One sample, KA-04, was obtained from the substrate and analyzed for extractable hydrocarbons. Concentrations of both light (C10-18) and heavy (C19-31) extractable hydrocarbons were below detection (< 250 ppm; Table 5-1).

A small black-stained area of dead vegetation, approximately 1 m^2, was identified on the slope in the same area, just to the west of the drill site (Photograph 5-6). One sample, KA-05, was obtained from this location (Map 5-1) and analyzed for hydrocarbons. Immuno-assay field screening tests of this area indicated the total petroleum hydrocarbon (TPH) concentration to be in the range of 75-375 ppm (Table 5-1). More precise laboratory hydrocarbon analysis indicated this sample contained even higher concentrations of light (C10-18: 30,300 ppm) and heavy (C19-31: 56900 ppm) extractable hydrocarbons, exceeding both the CCME/B.C. R/P (residential/parkland) and C/I (commerical/industrial) remediation criteria (Table 5-1). Chromatographic analysis of the hydrocarbon peaks

indicated the hydrocarbon product to be primarily diesel in composition; these peaks are presented in Appendix C. Additional hydrocarbon analysis was conducted for PAHs (polycyclic aromatic hydrocarbons; see Appendix A for these results) and BTEX (benzene, toluene, ethylbenzene and xylenes) in the sample. Concentrations of PAHs were either below detection, or at very low concentrations and well below the CCME R/P remediation criteria for soils. Levels of BTEX, along with light hydrocarbons (C5-9) and volatile petroleum hydrocarbons, were all below detection (Table 5-1).

The apparent lack of parent (unsubstituted) PAHs and other more "conventionally-analyzed" hydrocarbon constituents, such as BTEX, has also been found in hydrocarbon contamination (such as diesel) at abandoned Yukon military sites studied as part of the Haines Fairbanks Pipeline (UMA/AMBIO, 1995). Additional analysis using a broader suite of analytes revealed that a significant proportion of the constituents consisted of (alkyl-) substituted PAHs. Analysis for these compounds was out of the scope of this study. Although substituted PAH compounds have been found to comprise a greater proportion of most petroleum deposits and products than unsubstituted PAHs, the formers' environmental and toxicological significance are largely unknown (Royal Roads University, 1996). No environmental criteria exist as yet for alkyl-substituted PAHs.

5.4 Surface Water Quality

No surface waters or drainage were available for sampling at this site.

5.5 Waste Rock Disposal/Core Storage Areas

The regional and local geology and mineralization at the site have been described in Section 4.1 and are consistent with the mineralogical observations made during the site visit. This section deals specifically with the potential for acidic drainage.

Nine different samples of rock were collected from various areas of the site. These included excavated rocks around the main trench area (KA-AD1 to KA-AD4), samples from the main core cache at the base of the trench (KA-AD5 to KA-AD7) and the smaller cache further to the east (KA-AD8 and KA-AD9). Sampling locations are indicated on

Map 5-1. Sample descriptions as well as acid-base accounting (ABA) and total metal tests for potential acidic drainage and metal leaching are provided in Appendix A. These results are summarized and discussed in terms of acid leaching potential in Section 5.5.2 below.

5.5.1 Potential for Acid Drainage

Acidic drainage is scale dependent. In other words, a small trickle of water flowing from sulphide minerals may be acidic, but the acidity is neutralized if it encounters acid-neutralizing minerals. As a result, acidic drainage can occur on a "small scale" around mineral grains and pieces of rock, on a "medium scale" over distances of several meters to tens of meters, and on a "large scale" over tens to thousands of meters. All of these scales are important with respect to assessing the acid drainage potential at a site. Because of this scale dependency, the probability of acidic drainage appearing at the site is rated separately for all three scales.

The abundant dolomite and limestone in the area would likely neutralize any acidic drainage, and thus the probability rating for acidic drainage on a large scale is minimal. For medium and small scales, ABA results (Appendix B) show that all samples have high values of xNNP (net neutralizing potential) and xNPR (net potential ratio) and are thus net acid neutralizing. All samples had neutralization potentials exceeding 100 parts per thousand. Thus, the probability of acidic drainage on medium and small scales is low (Table 5-2). A more detailed analysis of acid drainage potential at the site is provided in Appendix B.

TABLE 5-2: Probability Ratings of Acidic Drainage by Scale for Vera

Scale:	**Small**	**Medium**	**Large**
Probability Rating:	low	low	minimal

5.6 Mine Adits

No mining portals or adits were found.

Photograph 5-1: Partially buried debris and wood scraps on eastern portion of exploration peak

Photograph 5-2: East core box cache (180 boxes) on north slope of peak below main exploration trench ↓

Photograph 5-3: West corebox cache (30 boxes) near drilling site

← Photograph 5-4: White milky substance by drilling site (KA-04)

Photograph 5-5: Hydro-carbon stain area west of drill site (KA-05)

Photograph 5-6: Empty drilling additive containers on west side of site ↓

6. Conclusions And Recommendations

The preliminary environmental assessment of the Kathleen Lake North site provides evaluation of the site on the basis of the following three components:

- physical or public safety hazards;
- environmental risks, including human health and ecological risks;
- aesthetic concerns.

This section describes the primary considerations for each of the three components relative to the Crest exploration area.

6.1 Health and Safety

Safety is the condition of being secure from undergoing or causing injury or loss, and may generally be referred to as the prevention of "slip-trip-fall" type injuries. Since there was only a limited amount of debris identified during the site visit, there was little potential for any safety incidences. In addition, this site is relatively remote from populated areas.

It is recommended that the debris be removed only in conjunction with other cleanup or construction projects in the area.

6.2 Environmental Risks

The main concern at this site is the substrate on the waste rock pile by the main trench area which is contaminated with high concentrations of arsenic, cadmium copper, lead, mercury and zinc exceeding the CCME/B.C. R/P remediation criteria for soil. Some of these levels also exceeded the higher C/I (commercial/industrial) criteria. These high levels probably reflect the high mineralization of the waste rock pile, excavated from the trench, and the collected cores. This suggests that this area may serve as a significant source of metal contaminants to the surrounding environment. The potential for acidic drainage on a medium scale (tens of metres) at this location, however, is low based on probability

ratings; in addition, this high area is dry with no evidence of seepage or infiltration. These observations suggest that contaminant migration into the surrounding environment is extremely limited.

In terms of ecological receptors, there is little evidence of significant wildlife activity at this location. Vegetation, which is beginning to encroach on the waste rock pile, appears to be relatively unaffected and natural reclamation will probably occur with time. There is a possible risk of some metals accumulating in plants growing on the substrate but this would have to be confirmed by the collection and analysis of plant tissues. Given the limited potential for contaminant migration and the low frequency of wildlife occurring in this area, environmental risks posed by the metal contaminants are anticipated to be low. Risks to human health are also extremely low based on remoteness and accessibility, and the lack of any surface water which could serve as a drinking source. It is recommended, as a precautionary measure, that the coreboxes be removed from this site and disposed in a proper containment facility at a nearby site (e.g., Vera mine site located to the northeast).

The small stain, located near the helicopter pad area to the west side of the main trench area on the same summit, contained concentrations of hydrocarbon (diesel) which exceed the B.C. remediation criteria at both the R/P and C/I levels. This indicates the presence of a significant contaminant source. Aside from a small area of dead vegetation directly affected by the spill, the stain is localized and no evidence of any other ecological receptors (i.e., wildlife) is indicated in the vicinity. Ecological and human health risks at this location, therefore, are minimal. However, based on the high levels of soil hydrocarbon contaminants, vegetation kill and associated aesthetic considerations at this location, it is recommended that the affected soils be excavated by hand from the site and disposed of in a engineered facility at a nearby location (e.g., Vera). Scarification and fertilization of the soil would be less cost-effective at this remote site due to the requirement for heavy equipment, and the on-going maintenance needed to achieve the desired results.

6.3 Aesthetic Concerns

Aesthetic concerns at Kathleen Lake North include the trench areas and associated waste rock, coreboxes, drilling exploration trails, empty fuel barrels, wood debris (including a helicopter pad), partially buried materials along the slope, the oil stain on tundra in the vicinity of the helicopter pad, and soluble oil situated around one of the drill holes located along the slope. Cleared vegetation along the exploration trails, and trenches along the slopes at the site, may pose an aesthetic concern which will largely diminish as natural vegetation continues to reclaim these areas. Regrading of these areas would probably cause more environmental damage to the existing vegetation than good.

Core boxes and other combustible wood materials scattered in the vicinity of the summit should be incinerated on site. Non-combustible materials including empty fuel barrels and drilling rod should be removed from the area and disposed of in an engineered facility at a nearby site (e.g., Vera). It is recommended that the partially-buried debris identified on the slope be excavated by hand and removed to a proper containment facility at a nearby site (e.g., Vera). Rock core material should placed in the waste rock pile at the main trench. Although the soluble oil by the drill site is low in hydrocarbon content, this substance does provide an aesthetic concern and should be excavated by hand, containerized, removed off site and disposed of as for other materials discussed above.

7. Class "D" Cost Estimates

An general breakdown of Class D Cost estimates based on the recommendations for cleanup work is provided under a separate cover to this report. The major components of work included in the cleanup are as follows:

- collection and transport off site of non combustible, non-hazardous debris for disposal;
- containerization and off-site disposal of localized areas of contaminated soil;

This site is remote, with access overland on winter trails, or by helicopter. In consideration of the limited environmental risks associated with this site, and the limited scope of cleanup work, it is recommended this be undertaken in conjunction with the cleanup of the Vera site.

This recommendation has been included in the following estimate:

The estimated volume of debris to be transported off site is in the order of 10 m^3 (barrels and drill rod) with the ultimate disposal location assumed to be Vera. The volume of contaminated soil to be removed is estimated as approximately 2 m^3. This material would be manually excavated and containerized for transport to Vera.

The work involved for the cleanup of Northern Mine sites is unique, in that there are few sources of historical or empirical cost data related to northern environmental work. As a result, cost estimates for the work have been prepared using "construction type" estimating.

"Construction Type" estimating requires the development of a work breakdown structure to identify the major items of work included in the cleanup of the site. For each work item, an appropriate equipment fleet and and labour crew are selected based on the nature of the work and estimated production rates. From this information, the duration of the activity is estimated. This duration is applied to the hourly cost of the equipment and labor, to provide the direct cost of the work activity. The cost of materials, services, or

sub-contracts required to complete the work are added to this cost to provide the total direct cost of the work item.

The overall duration of the cleanup contract is estimated based upon scheduling and equipment/labour usage in individual work tasks, and is used to calculate the site indirect costs and overhead costs. Indirect costs to mobilize, supervise and support the equipment fleet and labour crew have been included under the following categories on the estimate summary sheet: administrative costs; camp set-up, operation and logistics; and equipment and materials transportation.

Contractor's markup and contingency has been included at 15% for all costs. A 10% estimating and design contingency has also been included as the Scope of Work for estimating has been based only on a preliminary environmental assessment.

8. STANDARD LIMITATIONS

The information, data, recommendations and costing provided in this report, including without the results of any sampling and analyses conducted by Royal Roads University - Applied Research Division (RRU-ARD) or any of its associates, have been developed or obtained through the exercise of professional and scientific judgment and is set forth to the best of RRU-ARD's knowledge, information and belief. Although every effort has been made to confirm that such information and data is factual, complete and accurate; RRU-ARD makes no guarantees or warranties whatsoever, whether expressed or implied, with respect to such data or information.

By the act of issuing this report, RRU-ARD shall not be deemed to have represented thereby that any sampling and analyses conducted by it have been exhaustive or will identify all contamination at the sites. Person relying on the results thereof do so at their own risk.

This report and the information contained within it are to treated as confidential, except as required by law, and may be used and relied upon only by Public Works and Government Services Canada (PWGSC), its officers and employees and others having legitimate business relations with PWGSC. Any such use and reliance shall be subject to the limitations set forth in the preceding paragraphs.

9. REFERENCES

Canadian Council of Ministers of the Environment (CCME), 1991. Interim Canadian Environmental Quality Guidelines for Contaminated Sites. Report CCME EPC-CS34, prepared for the The National Contaminated Sites Remediation Program, September, 1991.

B.C. Environment, 1995. Draft 3 Contaminated Sites Regulation (under *the Waste Management Amendment Act*, 1993). Prepared by the Environmental Protection Division, December 4, 1995.

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UMA Engineering Ltd. and Ambio Research Associates Inc., 1995. Preliminary Environmental Assessment, Haines-Fairbanks Pipeline. Prepared for Indian and Northern Affairs Canada, Arctic Environmental Strategy, August, 1995

Yukon Abandoned Mines Assessment Report 106D-08-1 Kathleen Lake North. Indian and Northern Affairs Canada. Prepared by DIAND Technical Services. March 1994

10. APPENDICES

A) Sample Descriptions and Analytical Results (Soils/Sediment)

B) Determination of Acid Rock Drainage Potential and Geology Field Notes

C) Laboratory Reports

D) Quality Assurance/ Quality Control (QA/QC)

E) Geographic Positioning System (GPS) Co-ordinates for Field Investigation

F) Environmental Quality Criteria

A. Sample Descriptions and Analytical Results

A.1 Inorganic Element Results for Soils and Sediments

Sample No.	KA-01	KA-02	KA-03
Sampling Date	960830	960830	960830
Moisture %	15.3	14.3	73.2
Total Metals (mg/kg)			
Aluminum T-Al	1170	1230	4750
Antimony T-Sb	<20	<20	<40
Arsenic T-As	<0.05	3.54	1.56
Barium T-Ba	58	38	133
Beryllium T-Be	<0.5	<0.5	<1.0
Bismuth T-Bi	42	33	<20
Cadmium T-Cd	647	403	<4
Calcium T-Ca	100000	66600	39400
Chromium T-Cr	<2	3	7
Cobalt T-Co	6	5	6
Copper T-Cu	142	50	16
Iron T-Fe	36000	35700	5760
Lead T-Pb	20700	9460	<100
Lithium T-Li	<1	<1	2
Magnesium T-Mg	33600	19800	3930
Manganese T-Mn	15000	9850	554
Mercury	7.53	2.05	0.09
Molybdenum T-Mo	<4	<4	<8
Nickel T-Ni	8	6	7
Phosphorus T-P	<50	187	1200
Potassium T-K	<200	455	1130
Selenium T-Se	<0.1	<0.1	0.7
Silver T-Ag	89	46	<4
Sodium T-Na	<200	<200	<400
Tin T-Sn	<10	81	<20
Titanium T-Ti	5	24	234
Vanadium T-V	<2	7	11
Zinc T-Zn	61500	42000	232
Site/Sample Descriptions	Surface soil sample under core box pile to W, just below main exploration site on S slope, coarse iron-rich sand	Surface soil sample under core box pile to E, just below main exploration site on S slope, coarse iron-rich sand	Surface soil sample under core box pile located 16 m SE of drilling location on SW slope, coarse iron-rich sand

A.2 Hydrocarbon Results for Soil/Sediment Samples

Sample No.	KA-04	KA-05
Sampling Date	960830	960830
TPH -Test Kits (mg/kg)	-	75-374
Non-halogenated Volatiles (mg/kg)		
Benzene	-	<0.2
Ethylbenzene	-	<0.2
Toluene	-	<0.2
meta- & para-Xylene	-	<0.2
ortho-Xylene	-	<0.2
Light Hydrocarbons (C5-9)	-	<5
VPH	-	<10
Extractables (mg/kg)		
EPH (C10-18)	<250	30300
EPH (C19-31)	<250	56900
PAHs (mg/kg)		
Acenaphthene	-	<0.5
Acenaphthylene	-	<0.5
Anthracene	-	<0.5
Benzo(a)anthracene	-	<0.5
Benzo(a)pyrene	-	<0.5
Benzo(b)fluoranthene	-	<0.5
Benzo(g,h,i)perylene	-	<0.5
Benzo(k)fluoranthene	-	<0.5
Chrysene	-	<0.5
Dibenz(a,h)anthracene	-	<0.5
Fluoranthene	-	<0.5
Fluorene	-	<0.5
Indeno(1,2,3-c,d)pyrene	-	<0.5
Naphthalene	-	<0.5
Phenanthrene	-	1.5
Pyrene	-	<0.5
Site/Sample Descriptions	Surface soil sample in low-lying area at drilling site on SW slope, white substance (soluble oil?), mixed with organic soil	Surface soil sample in stained area NE of KA-03, dry peaty (tundra-like) soil

B. Determination of Acid Rock Drainage Potential and Geology Field Notes

B.1 Introduction

The potential for acidic drainage and metal leaching is determined through a combination of one-time static tests and long-term kinetic tests. For this assessment, the analytical program was limited to expanded acid-base accounting (ABA) and total-metal contents.

Acid-base accounting is a specialized chemical procedure that determines a sample's balance of potentially acid-generating and acid-neutralizing minerals. The internationally accepted method known as Sobek or EPA 600 was used for this study. The total acid-generating potential, also known as Total Acid Potential (TAP), is mathematically calculated from ABA's total sulphur (TAP = %S total * 31.25). The conversion factor is based on various stoichiometric and environmental assumptions, and provides TAP in any one of three equivalent units: tonnes (t) of $CaCO_3$ equivalent/1000 tonnes of sample, kg of $CaCO_3$ equivalent/t of sample, or parts of $CaCO_3$ equivalent per thousand.

Since not all forms of sulphur are acid generating, expanded ABA also includes analyses of non-acid-generating sulphate (including gypsum) and acid-generating sulphide. In theory, total sulphur equals sulphate plus sulphide, but other forms of sulphur and analytical accuracy often cause some discrepancy (del %S). The discrepancy is added to sulphide so that Sulphide Acid Potential [SAP = (%S sulphide + del %S) * 31.25] is not underestimated.

Expanded ABA also includes measurements of bulk Neutralization Potential (NP), based on a 24-hour acid bath, and Carbonate Neutralization Potential (CaNP), based on CO_2 measurement. The comparison of NP to CaNP reveals that amount of NP consisting of fast-neutralizing carbonate minerals and slower-neutralizing aluminosilicate minerals. Like acid potentials, these NPs are expressed in any one of three equivalent units: tonnes (t) of $CaCO_3$ equivalent/1000 tonnes of sample, kg of $CaCO_3$ equivalent/t of sample, or parts of $CaCO_3$ equivalent per thousand.

The net balance of acid potentials ("xAP") and neutralization potentials ("xNP") are determined through either subtraction or division. With subtraction, Total Net Neutralization Potential is calculated from Total Acid Potential (TNNP = NP - TAP) and Sulphide Net Neutralization Potential (SNNP = NP - SAP). In contrast, Total Net Potential Ratio (TNPR = NP / TAP) and Sulphide Net Potential Ratio (SNPR = NP / SAP) are calculated through division.

According to general criteria, any sample with a TNNP or SNNP less than +10 t $CaCO_3$/1000 t is declared net acid generating, although it may not be so at the time of analysis. Similarly, any sample with a TNPR or SNPR less than 1.0-2.0 is considered net acid generating. Negligible levels of sulphide (0.05%S) are considered non-acid-generating regardless of their xNNP and xNPR values. Exceptions to these criteria are known, and site-specific kinetic testwork is needed to determine site-specific criteria ofxNNP and xNPR.

Finally, ABA also includes a measurement of "paste pH" on a mixture of pulverized sample and water. If a sample's paste pH is acidic, net acid generation has already begun and any measured NP is not available for neutralization.

Acidic drainage is scale dependent. In other words, a small trickle of water flowing from sulphide minerals may be acidic, but the acidity is neutralized if it encounters acid-neutralizing minerals. As a result, acidic drainage can occur on a "small scale" around mineral grains and pieces of rock, on a "medium scale" over distances of several meters to tens of meters, and on a "large scale" over tens to thousands of meters. Because of this scale dependency, the probability of acidic drainage appearing at the site is rated separately for all three scales.

Total-metal contents are simply ICP analyses of a rock sample. Although each metal leaches at a different rate, total-metal contents are used to identify metals at relatively high levels which may be more susceptible to leaching. Elevated levels are metals are identified by comparing measured values to ranges in the literature for various types of rock around the world (e.g., Drever, J.I. 1982. The Geochemistry of Natural Waters. Prentice-Hall Inc.).

B.2 Acid-Base Accounting and Probability Ratings for Acidic Drainage

Indian and Northern Affairs (1994, Assessment Report 106D-08-1) reported that the main rock units at Kathleen Lake North were Ordovician to Lower Devonian Road River Formation, containing limestone and calcareous shale, and the underlying Late Proterozoic orange-weathered dolomite and limestone. The economic minerals are: sphalerite (zinc sulphide) and minor galena (lead sulphide) with low silver values. These rock units and minerals were found at Kathleen Lake North (Table 1 and Section 4, Field Notes) and tested as part of this study.

The abundant dolomite and limestone in the area would likely neutralize any acidic drainage, and thus the probability rating for acidic drainage on a large scale is minimal. For medium and small scales, ABA results (Table 2) show that all samples have high values of xNNP and xNPR and are thus net acid neutralizing. All samples had neutralization potentials exceeding 100 parts per thousand. Thus, the probability of acidic drainage on medium and small scales is low (Table 3).

TABLE 1	
Project:	Abandoned Yukon Mines
Location:	Kathleen Lake North
Data:	Sample Description
SAMPLE	SAMPLE DESCRIPTION
KA-AD1	Disturbed Rock #1; ~50 m downslope of main (west) core box area; brown-olive stained gravel and cobbles containing light to dark brownsilicified rock with occasional quartz veins or patches.
KA-AD2	Disturbed Rock #2; ~20 m above main (west) core area, in east trench; heavily oxidized, orange, brownvuggy (ancient acid leached) gravel and cobbles with band of galena (~0.2 cm thick).
KA-AD3	Disturbed Rock #3; ~40 m above main core area and just above white quartz outcrop in trench; dark gray/black gravel and cobbles with internal dark brown patches; in places, outer surfaces weathered to dark brown.
KA-AD4	Disturbed Rock #4; west side of disturbed areamidslope; dark gray gravel with occasional quartz bands and some black patches with cleavage faces; dark brown oxidation on outer surfaces.
KA-AD5	Core #1 from main west cache; dark gray sandy slate (?); friable into "poker chips" in places; minor quartz banding; minor iron oxidation on outer surfaces.
KA-AD6	Core #2 from main west cache; medium graysilicified rock with fine quartz veins throughout; some light orange-brown oxide on some outer surfaces.
KA-AD7	Core #3 from main west cache; iron-stained white rock, also seen in trench outcrop; finely irregularly fractured quartzite with minor inclusions of black fine-grained rock; heavy Fe oxide and staining on some exposed fractures.
KA-AD8	Core #1 from east cache; gray, thinly laminated slate (?); moderately iron-oxidized and iron-stained on all exposed surfaces.
KA-AD9	Core #2 from east cache; brown to black rock with quartz grains and veins; some surface oxidation.

TABLE 2																					
Project:	Abandoned Yukon Mines																				
Location:	Kathleen Lake North																				
Data:	ABA Data																				
SAMPLE	Paste pH	% S (Total)	% S (Sulphide)	% S (Sulphate)	% S ($BaSO_4$)	% S (del)	TAP (tonnes $CaCO_3$/ 1000 tonnes)	SAP (tonnes $CaCO_3$/ 1000 tonnes)	HAP (tonnes $CaCO_3$/ 1000 tonnes)	NP (tonnes $CaCO_3$/ 1000 tonnes)	% CO_2 (inorganic)	CaNP (tonnes $CaCO_3$/ 1000 tonnes)	TNNP (tonnes $CaCO_3$/ 1000 tonnes)	SNNP (tonnes $CaCO_3$/ 1000 tonnes)	RNNP (tonnes $CaCO_3$/ 1000 tonnes)	HNNP (tonnes $CaCO_3$/ 1000 tonnes)	TNPR	SNPR	RNPR	HNPR	(CaNP/ NP) *100
KA-AD1	8.80	0.040	0.020	0.010	0.0019	0.008	1	1	1	649	33.6	764	648	648	763	648	10.00	10.00	10.00	10.00	118
KA-AD2	7.10	1.060	0.930	0.060	0.0012	0.069	33	31	29	132	25.2	573	99	101	542	103	3.98	4.23	18.36	4.54	434
KA-AD3	8.80	0.005	0.005	0.005	0.0002	0.000	0	0	0	177	8.6	196	177	177	195	177	10.00	10.00	10.00	10.00	111
KA-AD4	8.50	0.080	0.010	0.070	0.0007	0.000	3	0	0	603	27.9	635	601	603	634	603	241.20	10.00	10.00	10.00	105
KA-AD5	8.20	0.280	0.260	0.020	0.0009	0.000	9	8	8	918	40.8	928	909	910	920	910	104.91	112.98	114.20	112.98	101
KA-AD6	8.70	0.050	0.050	0.005	0.0026	0.000	3	2	2	910	40.5	921	908	908	920	908	10.00	10.00	10.00	10.00	101
KA-AD7	8.70	0.080	0.100	0.005	0.0002	0.000	2	3	3	995	46.6	1060	993	992	1057	992	398.00	318.40	339.14	318.40	107
KA-AD8	8.90	0.010	0.005	0.010	0.0054	0.000	0	0	0	588	26.1	594	588	588	593	588	10.00	10.00	10.00	10.00	101
KA-AD9	8.70	5.540	5.470	0.040	0.0042	0.026	173	172	171	596	28.2	641	423	424	470	425	3.44	3.47	3.73	3.49	108
Maximum	8.90	5.540	5.470	0.070	0.0054	0.069	173	172	171	995	46.6	1060	993	992	1057	992	398.00	318.40	339.14	318.40	434
Minimum	7.10	0.005	0.005	0.005	0.0002	0.000	0	0	0	132	8.6	196	99	101	195	103	3.44	3.47	3.73	3.49	101
Mean	8.49	0.794	0.761	0.025	0.0019	0.011	25	24	24	619	30.8	701	594	595	677	595	87.95	54.34	58.38	54.38	143
Std Deviation	0.560	1.811	1.791	0.025	0.0018	0.023	57	56	56	306	11.3	256	318	317	267	317	140.71	104.94	110.81	104.92	109
10 Percentile	7.98	0.009	0.005	0.005	0.0002	0.000	0	0	0	168	21.9	498	161	162	415	162	3.88	4.08	8.75	4.33	101
Median	8.70	0.080	0.050	0.010	0.0012	0.000	3	2	2	603	28.2	641	601	603	634	603	10.00	10.00	10.00	10.00	107
90 Percentile	8.82	1.956	1.838	0.062	0.0044	0.034	61	59	57	933	42.0	954	926	926	947	926	272.56	154.07	159.19	154.07	181
Count	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
NOTE : If a value was reported as < detection limit half the detection limit is shown in italics.																					

TABLE 3

Probability Ratings of Acidic Drainage by Scale for Vera

(see text for discussion of scale)

Scale:	Small	Medium	Large
Probability Rating:	low	low	minimal

B.3 Total-Metal Contents

As explained in Section 1, total-metal contents were measured (Table 4) to determine which metals occur at relatively high levels compared to worldwide averages. This is not a sufficient condition for accelerated metal leaching, but may highlight metals which might leach at high levels. Only long-term kinetic tests and on-site monitoring will demonstrate which metals are leaching at detectable levels. Based on worldwide averages, the metals in Vera rock that frequently occur (>20% of samples) at elevated levels (> 5x worldwide maximum average) are: silver, cadmium, lead, antimony, tungsten, and zinc. High levels of lead were expected for VE-AD10, because it was nearly pure galena (lead sulphide), which apparently include some minor sphalerite (zinc sulphide) based on the zinc level of 4580 ppm. Waste rock outside the portal, despite being visibly oxidized and leached, still contained significant levels of silver, copper, lead, and zinc.

TABLE 4

Project:	Abandoned Yukon Mines
Location:	Kathleen Lake North
Data:	ICP Metals Data (Triple Acid Digestion)

SAMPLE	Ag (ppm)	Al (ppm)	As (ppm)	Ba (ppm)	Be (ppm)	Bi (ppm)	Ca (ppm)	Cd (ppm)	Co (ppm)	Cr (ppm)	Cu (ppm)	Fe (ppm)	Hg (ppm)	K (ppm)	Mg (ppm)	Mn (ppm)	Mo (ppm)	Na (ppm)	Ni (ppm)	P (ppm)	Pb (ppm)	Sb (ppm)	Sr (ppm)	Ti (ppm)	V (ppm)	W (ppm)	Zn (ppm)
KA-AD1	14.4	6400	2	80	0.25	1	215000	500.0	15.0	11	42	84600	0.93	2300	31000	10000	0.5	100	7.0	280	2100	11.0	58	200	41	20	10000
KA-AD2	100.0	2500	50	50	5.00	10	2000	4430.	10.0	20	370	42500	10	500	500	1370	5.0	250	5.0		10		5	250	5		10000
KA-AD3	4.2	5200	1	10	0.25	1	68200	74.50	14.0	9	10	250000	0.35	1200	6400	10000	0.5	100	7.0	430	168	0.8	76	50	37	60	10000
KA-AD4	7.2	5900	1	30	0.25	1	203000	50.00	11.0	22	16	123500	0.12	2200	17300	10000	0.5	100	6.0	360	164	2.0	35	200	30	40	7420
KA-AD5	0.1	7700	1	40	0.25	6	250000	1.50	5.0	22	9	7400	0.14	3400	10200	620	1.0	300	7.0	440	8	0.8	406	300	40	5	136
KA-AD6	0.1	11600	2	110	0.25	1	186500	1.50	2.0	32	1	11800	0.07	6200	102500	1415	0.5	300	6.0	260	62	0.4	99	400	25	5	212
KA-AD7	0.1	800	1	10	0.25	1	224000	1.50	1.0	4	5	21500	0.01	400	109500	3630	0.5	200	1.0	260	24	0.4	57	50	20	10	288
KA-AD8	0.1	40400	1	230	1.00	1	132000	0.50	10.0	48	32	22200	0.02	20900	56000	860	0.5	500	11.0	420	42	10.0	133	2200	57	5	176
KA-AD9	57.6	8400	16	180	0.25	1	110000	426.0	14.0	50	216	87100	6.42	3700	47800	10000	0.5	300	11.0	320	3000	15.0	88	300	24	20	10000
Maximum	100.0	40400	50	230	5.00	10	250000	4430.	15.0	50	370	250000	6.42	20900	109500	10000	5.0	500	11.0	440	3000	15.0	406	2200	57	60	10000
Minimum	0.1	800	1	10	0.25	1	2000	0.50	1.0	4	1	7400	0.1	400	500	620	0.5	100	1.0	260	8	0.4	5	50	5	5	136
Mean	20.4	9878	8	82	0.86	3	154522	609.5	9.1	24	78	72289	0.9	4533	42356	5322	1.1	239	6.8	346	620	5.0	106	439	31	21	5359
Std Deviation	35.1	11875	16	78	1.57	3	82293	1445.	5.3	16	129	77798	2.09	6398	40585	4518	1.5	132	3.0	77	1119	5.9	118	670	15	20	4959
10 Percentile	0.1	2160	1	10	0.25	1	54960	1.30	1.8	8	4	10920	0.01	480	5220	812	0.5	100	4.2	260	10	0.4	29	50	17	5	168
Median	4.2	6400	1	50	0.25	1	186500	50.00	10.0	22	16	42500	0.12	2300	31000	3630	0.5	250	7.0	340	62	1.4	76	250	30	15	7420
90 Percentile	66.1	17360	23	190	1.80	7	229200	1286.	14.2	48	247	148800	2.03	9140	103900	10000	1.8	340	11.0	433	2280	12.2	188	760	44	46	10000
Count	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	8	9	8	9	9	9	8	9

NOTE : If a value was reported as < detection limit half the detection limit is shown in italics.

NOTE : If a value was reported as > detection limit the detection limit is shown underlined.

B.4 Transcription and Expansion of Field Notes by K. Morin

Location: **Kathleen Lake North**

Date: August 30, 1996 (afternoon); rain and fog

Comments: ~180 core boxes and some trenches extending ~100m; no visible seepage up slope; pyrite very minor in core, showing signs of oxidation.

Disturbed rock #1 (Sample KA-AD1): ~50m down slope of core boxes.

Lower portions of trenches and disturbed rock have significant percentage of orange-brown rock showing ancient oxidation and localized acid leaching.

Disturbed Rock #2 (KA-AD2): ~20 m above main west core area; orange brown heavily oxidized and acid-leached rock with galena (ore?).

Disturbed Rock #3 (KA-AD3): ~40 m above main west core area, above white quartz outcrop; grey rock; some rock shows dark brown outer oxidation.

Disturbed Rock #4 (KA-AD4): west side of disturbed area, mid slope; dark brown oxidation on grey gravel.

Core #1 (KA-AD5): west core cache

Core #2 (KA-AD6): west core cache

Core #3 (KA-AD7): hard rock also seen in trench outcrops.
Second [East] Core Cache: towards east side of area, on undisturbed ground at drill holes; 20 core trays; empty core boxes scattered tens of

meters to the west; some heavy recent oxidation on minor portion of core; lighter oxidation on all other core.

B.5 LIST OF SAMPLES

CODE	SOURCE
KA-AD1	Disturbed Rock #1; ~50 m downslope of main (west) core box area; brown-olive stained gravel and cobbles containing light to dark brown silicified rock with occasional quartz veins or patches.
KA-AD2	Disturbed Rock #2; ~20 m above main (west) core area, in east trench; heavily oxidized, orange, brown, vuggy (ancient acid leached) gravel and cobbles with band of galena (~0.2 cm thick).
KA-AD3	Disturbed Rock #3; ~40 m above main core area and just above white quartz outcrop in trench; dark gray/black gravel and cobbles with internal dark brown patches; in places, outer surfaces weathered to dark brown.
KA-AD4	Disturbed Rock #4; west side of disturbed area, midslope; dark gray gravel with occasional quartz bands and some black patches with cleavage faces; dark brown oxidation on outer surfaces.
KA-AD5	Core #1 from main west cache; dark gray sandy slate (?); friable into "poker chips" in places; minor quartz banding; minor iron oxidation on outer surfaces.
KA-AD6	Core #2 from main west cache; medium gray silicified rock with fine quartz veins throughout; some light orange-brown oxide on some outer surfaces.
KA-AD7	Core #3 from main west cache; iron-stained white rock, also seen in trench outcrop; finely irregularly fractured quartzite with minor inclusions of black fine-grained rock; heavy Fe oxide and staining on some exposed fractures.

KA-AD8 Core #1 from east cache; gray, thinly laminated slate (?); moderately iron-oxidized and iron-stained on all exposed surfaces.

KA-AD9 Core #2 from east cache; brown to black rock with quartz grains and veins; some surface oxidation.

C. Laboratory Reports

1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

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CHEMICAL ANALYSIS REPORT

Date: November 19, 1996

ASL File No. G4671r

Report On: Soil And Water Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Mr. William Dushenko**, PhD

Received: September 3, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Brent A. Makelki, B.Sc.
Project Chemist

Katherine Thomas, B.Sc.
Project Chemist

REMARKS

File No. G4671r

This file replaces the previous ASL report, G4671, and includes the results for the additional analytical requests.

The Total Metals detection limits for the soil samples "CR-04S" and "KA-03" were increased due to the high moisture contents.

The detection limits for some of the Non-halogenated Volatiles have been increased due to detection of hydrocarbon material that interfered with the quantification of these compounds.

The Hydrocarbon Distribution Reports for the samples with detectable levels of Total Extractable Hydrocarbons are included the Appendix. These qualitative reports may be useful in determining the types of petroleum products present.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		CR-01S	CR-02S	CR-03S	CR-03 D1	CR-04S
		96 08 27	96 08 27	96 08 27	96 08 27	96 08 27
Physical Tests						
Moisture	%	8.5	17.6	8.5	24.8	73.6
Total Metals						
Aluminum	T-Al	20600	14400	18800	18300	10300
Antimony	T-Sb	<20	<20	<20	<20	<40
Arsenic	T-As	1.71	1.43	1.39	1.35	1.43
Barium	T-Ba	139	97	77	93	340
Beryllium	T-Be	0.8	<0.5	0.5	0.6	<1.0
Bismuth	T-Bi	41	33	31	34	<20
Cadmium	T-Cd	<2	<2	<2	<2	<4
Calcium	T-Ca	74900	113000	92400	65700	24800
Chromium	T-Cr	45	30	38	42	17
Cobalt	T-Co	16	11	14	14	5
Copper	T-Cu	62	62	62	56	23
Iron	T-Fe	41500	25900	33600	32700	11000
Lead	T-Pb	<50	<50	<50	<50	<100
Lithium	T-Li	16	23	22	24	9
Magnesium	T-Mg	35300	37700	33500	25700	3980
Manganese	T-Mn	635	689	590	552	2660
Mercury	T-Hg	<0.005	0.020	<0.005	0.010	0.109
Molybdenum	T-Mo	<4	<4	<4	<4	<8
Nickel	T-Ni	30	23	28	29	9
Phosphorus	T-P	476	871	452	428	921
Potassium	T-K	2280	622	976	1260	2430
Selenium	T-Se	<0.1	<0.1	<0.1	<0.1	0.4
Silver	T-Ag	<2	<2	<2	<2	<4
Sodium	T-Na	<200	<200	<200	<200	<400
Tin	T-Sn	<10	<10	<10	<10	<20
Titanium	T-Ti	92	20	42	120	104
Vanadium	T-V	77	45	58	74	40
Zinc	T-Zn	1820	62	311	78	454

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
Dup = Field duplicate.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		CR-05S	CR-05D	CR-06S	CR-06D	VE-01S
		96 08 27	96 08 27	96 08 27	96 08 27	96 08 28
Physical Tests						
Moisture	%	7.0	64.9	82.2	70.0	17.5
Total Metals						
Aluminum	T-Al	9450	-	10300	11000	17300
Antimony	T-Sb	<20	-	<40	<20	<20
Arsenic	T-As	0.55	-	1.59	1.89	90.9
Barium	T-Ba	66	-	342	157	111
Beryllium	T-Be	<0.5	-	<1.0	<0.5	0.8
Bismuth	T-Bi	27	-	<20	20	<10
Cadmium	T-Cd	<2	-	<4	<2	<2
Calcium	T-Ca	82300	-	48800	34900	2300
Chromium	T-Cr	18	-	17	23	24
Cobalt	T-Co	10	-	6	7	14
Copper	T-Cu	62	-	27	30	73
Iron	T-Fe	18700	-	13800	18100	34400
Lead	T-Pb	<50	-	<100	<50	146
Lithium	T-Li	12	-	8	14	15
Magnesium	T-Mg	36800	-	11500	15200	5510
Manganese	T-Mn	407	-	2420	1020	985
Mercury	T-Hg	<0.005	-	0.071	0.034	0.044
Molybdenum	T-Mo	<4	-	<8	<4	11
Nickel	T-Ni	17	-	11	14	80
Phosphorus	T-P	286	-	1190	671	919
Potassium	T-K	<200	-	2630	1470	4940
Selenium	T-Se	<0.1	-	0.6	0.3	0.5
Silver	T-Ag	<2	-	<4	<2	<2
Sodium	T-Na	<200	-	<400	<200	<200
Tin	T-Sn	<10	-	<20	<10	<10
Titanium	T-Ti	4	-	169	133	248
Vanadium	T-V	8	-	42	52	80
Zinc	T-Zn	146	-	76	45	790

Remarks regarding the analyses appear at the beginning of this report.
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Dup = Field duplicate.
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RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		VE-01S Dup Field Dup	VE-02	VE-03	VE-04	VE-05
		96 08 28	96 08 28	96 08 28	96 08 28	96 08 28
Physical Tests						
Moisture	%	18.4	20.5	15.5	14.1	14.5
Total Metals						
Aluminum	T-Al	15900	14300	13800	9820	10500
Antimony	T-Sb	<20	<20	<20	<20	<20
Arsenic	T-As	104	95.1	109	91.7	109
Barium	T-Ba	133	157	101	77	70
Beryllium	T-Be	0.8	0.7	0.7	0.6	0.6
Bismuth	T-Bi	<10	<10	<10	<10	<10
Cadmium	T-Cd	2	5	2	<2	<2
Calcium	T-Ca	2580	3860	2560	2860	2910
Chromium	T-Cr	23	24	20	15	14
Cobalt	T-Co	15	48	16	10	14
Copper	T-Cu	103	116	95	82	55
Iron	T-Fe	34600	76100	30900	27300	30600
Lead	T-Pb	177	116	179	179	146
Lithium	T-Li	12	12	10	8	8
Magnesium	T-Mg	4690	4690	4290	3560	3760
Manganese	T-Mn	993	2500	968	787	1280
Mercury	T-Hg	0.066	0.131	0.109	0.110	0.030
Molybdenum	T-Mo	16	39	21	22	18
Nickel	T-Ni	110	275	112	75	85
Phosphorus	T-P	1040	1100	1060	905	919
Potassium	T-K	4640	3310	4870	3450	3860
Selenium	T-Se	0.6	1.2	0.8	0.8	0.7
Silver	T-Ag	<2	<2	<2	<2	<2
Sodium	T-Na	<200	<200	<200	<200	<200
Tin	T-Sn	<10	<10	<10	<10	<10
Titanium	T-Ti	239	286	189	124	96
Vanadium	T-V	76	69	98	77	77
Zinc	T-Zn	859	2410	830	567	863

Remarks regarding the analyses appear at the beginning of this report.
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RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		VE-06	VE-08S	VE-08D	VE-09	VE-11
		96 08 28	96 08 28	96 08 28	96 08 28	96 08 28
Physical Tests						
Moisture	%	12.7	33.0	11.8	26.5	11.1
Total Metals						
Aluminum	T-Al	10500	21500	-	16200	11600
Antimony	T-Sb	<20	<20	-	<20	<20
Arsenic	T-As	105	118	-	82.1	74.6
Barium	T-Ba	78	166	-	125	79
Beryllium	T-Be	0.6	1.2	-	0.9	0.7
Bismuth	T-Bi	<10	12	-	11	<10
Cadmium	T-Cd	2	<2	-	<2	<2
Calcium	T-Ca	1930	4630	-	4670	2580
Chromium	T-Cr	13	33	-	25	18
Cobalt	T-Co	9	20	-	17	14
Copper	T-Cu	72	101	-	84	44
Iron	T-Fe	25500	48100	-	39500	32700
Lead	T-Pb	139	258	-	205	160
Lithium	T-Li	7	17	-	14	12
Magnesium	T-Mg	2660	7510	-	6520	6180
Manganese	T-Mn	941	1670	-	1320	1310
Mercury	T-Hg	0.109	0.085	-	0.064	0.023
Molybdenum	T-Mo	20	11	-	8	5
Nickel	T-Ni	77	81	-	72	47
Phosphorus	T-P	909	1030	-	983	547
Potassium	T-K	3070	7680	-	5230	4230
Selenium	T-Se	0.8	0.8	-	0.5	0.3
Silver	T-Ag	<2	<2	-	<2	<2
Sodium	T-Na	<200	<200	-	<200	<200
Tin	T-Sn	<10	<10	-	<10	<10
Titanium	T-Ti	105	393	-	268	108
Vanadium	T-V	64	92	-	71	40
Zinc	T-Zn	692	644	-	578	392

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RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		VE-12	VE-13	VE-15S	VE-15D	VE-16
		96 08 28	96 08 28	96 08 28	96 08 28	96 08 28
Physical Tests						
Moisture	%	41.6	29.9	10.0	7.5	61.9
Total Metals						
Aluminum	T-Al	19000	18200	-	-	48600
Antimony	T-Sb	<20	<20	-	-	<20
Arsenic	T-As	67.1	94.7	-	-	173
Barium	T-Ba	159	142	-	-	80
Beryllium	T-Be	1.1	1.0	-	-	3.5
Bismuth	T-Bi	19	17	-	-	<10
Cadmium	T-Cd	13	18	-	-	3
Calcium	T-Ca	21800	25700	-	-	3230
Chromium	T-Cr	30	28	-	-	26
Cobalt	T-Co	16	15	-	-	24
Copper	T-Cu	70	103	-	-	576
Iron	T-Fe	51400	51900	-	-	234000
Lead	T-Pb	1450	1850	-	-	197
Lithium	T-Li	19	19	-	-	11
Magnesium	T-Mg	17200	20000	-	-	3540
Manganese	T-Mn	2600	3010	-	-	801
Mercury	T-Hg	0.122	0.122	-	-	0.067
Molybdenum	T-Mo	<4	<4	-	-	17
Nickel	T-Ni	32	28	-	-	215
Phosphorus	T-P	744	688	-	-	872
Potassium	T-K	4470	4620	-	-	1660
Selenium	T-Se	0.4	0.3	-	-	1.5
Silver	T-Ag	14	28	-	-	17
Sodium	T-Na	<200	<200	-	-	<200
Tin	T-Sn	<10	<10	-	-	<10
Titanium	T-Ti	343	306	-	-	266
Vanadium	T-V	54	47	-	-	48
Zinc	T-Zn	4140	5130	-	-	1960

Remarks regarding the analyses appear at the beginning of this report.
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Dup = Field duplicate.
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RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		VA-01	VA-01 Dup	VA-02	VA-03	KA-01
		96 08 30	96 08 30	96 08 30	96 08 30	96 08 30
Physical Tests						
Moisture	%	41.9	41.0	28.1	17.8	15.3
Total Metals						
Aluminum	T-Al	13300	12700	<50	414	1170
Antimony	T-Sb	<20	<20	<20	<20	<20
Arsenic	T-As	365	351	0.76	<0.05	<0.05
Barium	T-Ba	119	115	26	31	58
Beryllium	T-Be	1.0	0.8	<0.5	<0.5	<0.5
Bismuth	T-Bi	36	23	34	44	42
Cadmium	T-Cd	8	8	5	4	647
Calcium	T-Ca	98100	98100	72500	112000	100000
Chromium	T-Cr	16	15	<2	<2	<2
Cobalt	T-Co	6	6	<2	<2	6
Copper	T-Cu	29	23	2	4	142
Iron	T-Fe	24900	22200	2370	1040	36000
Lead	T-Pb	735	705	53	246	20700
Lithium	T-Li	10	9	<1	1	<1
Magnesium	T-Mg	62500	62900	45000	63800	33600
Manganese	T-Mn	1690	1410	1270	1060	15000
Mercury	T-Hg	0.321	0.313	<0.005	0.006	7.53
Molybdenum	T-Mo	<4	<4	<4	<4	<4
Nickel	T-Ni	15	13	<2	3	8
Phosphorus	T-P	776	719	<50	<50	<50
Potassium	T-K	4210	4210	<200	<200	<200
Selenium	T-Se	0.3	0.3	<0.1	<0.1	<0.1
Silver	T-Ag	6	5	<2	<2	89
Sodium	T-Na	284	268	<200	<200	<200
Tin	T-Sn	<10	<10	<10	<10	<10
Titanium	T-Ti	207	156	2	2	5
Vanadium	T-V	30	29	<2	<2	<2
Zinc	T-Zn	2430	2400	881	1100	61500

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[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

		KA-02	KA-03	KA-04	KA-05
		96 08 30	96 08 30	96 08 30	96 08 30
Physical Tests					
Moisture	%	14.3	73.2	78.8	66.7
Total Metals					
Aluminum	T-Al	1230	4750	-	-
Antimony	T-Sb	<20	<40	-	-
Arsenic	T-As	3.54	1.56	-	-
Barium	T-Ba	38	133	-	-
Beryllium	T-Be	<0.5	<1.0	-	-
Bismuth	T-Bi	33	<20	-	-
Cadmium	T-Cd	403	<4	-	-
Calcium	T-Ca	66600	39400	-	-
Chromium	T-Cr	3	7	-	-
Cobalt	T-Co	5	6	-	-
Copper	T-Cu	50	16	-	-
Iron	T-Fe	35700	5760	-	-
Lead	T-Pb	9460	<100	-	-
Lithium	T-Li	<1	2	-	-
Magnesium	T-Mg	19800	3930	-	-
Manganese	T-Mn	9850	554	-	-
Mercury	T-Hg	2.05	0.090	-	-
Molybdenum	T-Mo	<4	<8	-	-
Nickel	T-Ni	6	7	-	-
Phosphorus	T-P	187	1200	-	-
Potassium	T-K	455	1130	-	-
Selenium	T-Se	<0.1	0.7	-	-
Silver	T-Ag	46	<4	-	-
Sodium	T-Na	<200	<400	-	-
Tin	T-Sn	81	<20	-	-
Titanium	T-Ti	24	234	-	-
Vanadium	T-V	7	11	-	-
Zinc	T-Zn	42000	232	-	-

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
Dup = Field duplicate.
[1]Results are expressed as milligrams per dry kilogram except where noted.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

	CR-05S	CR-05D	VE-01S	VE-01S Dup FIELD DUP.	VE-08S
	96 08 27	96 08 27	96 08 28	96 08 28	96 08 28
Non-halogenated Volatiles					
Benzene	-	<0.3	-	-	-
Ethylbenzene	-	<1	-	-	-
Toluene	-	<0.4	-	-	-
meta- & para-Xylene	-	23.2	-	-	-
ortho-Xylene	-	14.5	-	-	-
Light Hydrocarbons (C5-9)	-	2150	-	-	-
VPH[2]	-	1670	-	-	-
Extractables					
EPH (C10-18)	5160	58700	7080	5810	796
EPH (C19-31)	2070	4980	3050	3420	1030

Remarks regarding the analyses appear at the beginning of this report.
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Dup = Field duplicate.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

	VE-08D	VE-15S	VE-15D	VE-16	KA-04
	96 08 28	96 08 28	96 08 28	96 08 28	96 08 30
Non-halogenated Volatiles					
Benzene	<0.05	-	<0.05	-	-
Ethylbenzene	<0.05	-	<0.05	-	-
Toluene	<0.05	-	<0.05	-	-
meta- & para-Xylene	<0.05	-	<0.1	-	-
ortho-Xylene	<0.05	-	<0.05	-	-
Light Hydrocarbons (C5-9)	<5	-	<5	-	-
VPH[2]	<10	-	<10	-	-
Extractables					
EPH (C10-18)	946	4960	3090	<250	<250
EPH (C19-31)	332	41400	28500	<250	<250

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
Dup = Field duplicate.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil[1]

File No. G4671r

	KA-05
	96 08 30
Non-halogenated Volatiles	
Benzene	<0.2
Ethylbenzene	<0.2
Toluene	<0.2
meta- & para-Xylene	<0.2
ortho-Xylene	<0.2
Light Hydrocarbons (C5-9)	<5
VPH[2]	<10
Extractables	
EPH (C10-18)	30300
EPH (C19-31)	56900

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
Dup = Field duplicate.
[1]Results are expressed as milligrams per dry kilogram except where noted.
[2]Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.

RESULTS OF ANALYSIS - Water[1]

File No. G4671r

			VE-05W	VE-11W	VE-12W	VE-18W	VE-19W
			96 08 30	96 08 30	96 08 30	96 08 30	96 08 30
Physical Tests							
Conductivity (umhos/cm)			12900	13900	14700	14100	14600
Hardness		CaCO3	138	133	136	137	147
Total Metals							
Aluminum	T-Al		<0.005	0.013	0.030	0.070	0.007
Antimony	T-Sb		<0.2	<0.2	<0.2	<0.2	<0.2
Arsenic	T-As		<0.001	<0.001	<0.001	<0.001	<0.001
Barium	T-Ba		<0.01	<0.01	<0.01	<0.01	<0.01
Beryllium	T-Be		<0.005	<0.005	<0.005	<0.005	<0.005
Bismuth	T-Bi		<0.1	<0.1	<0.1	<0.1	<0.1
Boron	T-B		<0.1	<0.1	<0.1	<0.1	<0.1
Cadmium	T-Cd		<0.0002	<0.0002	0.0015	<0.0002	<0.0002
Calcium	T-Ca		27.1	25.7	25.3	26.8	29.5
Chromium	T-Cr		<0.001	<0.001	<0.001	<0.001	<0.001
Cobalt	T-Co		<0.01	<0.01	<0.01	<0.01	<0.01
Copper	T-Cu		<0.001	<0.001	0.003	<0.001	<0.001
Iron	T-Fe		<0.03	0.03	<0.03	0.08	<0.03
Lead	T-Pb		<0.001	<0.001	0.013	0.001	<0.001
Lithium	T-Li		<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium	T-Mg		17.0	16.8	17.6	16.9	17.8
Manganese	T-Mn		<0.005	<0.005	<0.005	0.010	<0.005
Mercury	T-Hg		<0.00005	<0.00005	<0.00005	<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03	<0.03	<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02	<0.02	<0.02	<0.02
Phosphorus	T-P		<0.3	<0.3	<0.3	<0.3	<0.3
Potassium	T-K		<2	<2	<2	<2	<2
Selenium	T-Se		0.0015	0.0007	0.0009	0.0011	0.0013
Silicon	T-Si		1.51	1.39	1.35	1.47	1.69
Silver	T-Ag		<0.0001	<0.0001	0.0001	<0.0001	<0.0001
Sodium	T-Na		<2	<2	<2	<2	<2
Strontium	T-Sr		0.022	0.021	0.014	0.022	0.022
Thallium	T-Tl		<0.1	<0.1	<0.1	<0.1	<0.1
Tin	T-Sn		<0.30	<0.30	<0.30	<0.30	<0.30
Titanium	T-Ti		<0.01	<0.01	<0.01	<0.01	<0.01
Vanadium	T-V		<0.03	<0.03	<0.03	<0.03	<0.03
Zinc	T-Zn		0.010	0.014	0.328	0.007	<0.005

Remarks regarding the analyses appear at the beginning of this report.
< = Less than the detection limit indicated.
Dup = Field duplicate.
[1]Results are expressed as milligrams per litre except where noted.

RESULTS OF ANALYSIS - Water[1]

File No. G4671r

			VA-03W	VA-03W Dup
			96 08 30	96 08 30
Physical Tests				
Conductivity (umhos/cm)			13100	14600
Hardness		CaCO3	296	298
Total Metals				
Aluminum	T-Al		0.089	0.009
Antimony	T-Sb		<0.2	<0.2
Arsenic	T-As		0.006	0.003
Barium	T-Ba		0.02	0.02
Beryllium	T-Be		<0.005	<0.005
Bismuth	T-Bi		<0.1	<0.1
Boron	T-B		<0.1	<0.1
Cadmium	T-Cd		0.0005	0.0003
Calcium	T-Ca		61.0	61.1
Chromium	T-Cr		<0.001	<0.001
Cobalt	T-Co		<0.01	<0.01
Copper	T-Cu		0.001	<0.001
Iron	T-Fe		0.21	<0.03
Lead	T-Pb		0.024	0.002
Lithium	T-Li		<0.01	<0.01
Magnesium	T-Mg		34.8	35.2
Manganese	T-Mn		0.040	<0.005
Mercury	T-Hg		<0.00005	<0.00005
Molybdenum	T-Mo		<0.03	<0.03
Nickel	T-Ni		<0.02	<0.02
Phosphorus	T-P		<0.3	<0.3
Potassium	T-K		<2	<2
Selenium	T-Se		0.0012	0.0012
Silicon	T-Si		1.58	1.50
Silver	T-Ag		<0.0001	<0.0001
Sodium	T-Na		<2	<2
Strontium	T-Sr		0.046	0.046
Thallium	T-Tl		<0.1	<0.1
Tin	T-Sn		<0.30	<0.30
Titanium	T-Ti		<0.01	<0.01
Vanadium	T-V		<0.03	<0.03
Zinc	T-Zn		0.170	0.110

Remarks regarding the analyses appear at the beginning of this report.
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Dup = Field duplicate.
[1]Results are expressed as milligrams per litre except where noted.

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

Moisture

This analysis is carried out gravimetrically by drying the sample to constant weight at 103 C.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050 or Method 3051, published by the United States Environmental Protection Agency (EPA). The procedures involve a digestion using a 1:1 ratio of nitric acid and hydrochloric acid, along with hotplate or microwave heating. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010).

Method Limitation: The stated acid digestion will provide excellent results for total recoverable metals; however, it is only partially effective on mineralized or non-environmentally available metals.

Non-halogenated Volatiles in Sediment/Soil - Headspace Method

This analysis is carried out in accordance with U.S. EPA Methods 3500/3810 and 8020/8015 (Publ. # SW-846, 3rd ed., Washington, DC 20460) and British Columbia Ministry of Environment, Lands and Parks Method "Volatile Petroleum Hydrocarbons in Soil". The procedure involves extracting the sample with methanol. An aliquot of this methanol extract is then added to a sealed vial containing a constant volume of water. This vial is sealed and heated, causing the volatile compounds to partition into the gaseous headspace above the sample. A portion of this headspace is then analysed by capillary column gas chromatography with photo-ionization detection in conjunction with flame ionization detection.

Extractable Petroleum Hydrocarbons in Sediment/Soil

This analysis is equivalent to British Columbia Ministry of Environment, Lands and Parks Method for "Extractable Petroleum Hydrocarbons in Soil by GC/FID", January 1996 but does not provide correction for Polycyclic Aromatic Hydrocarbons (PAHs). The procedure involves a hexane/acetone solvent extraction followed by analysis of the extract by capillary column

gas chromatography with flame ionization detection.

Conventional Parameters in Water

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

Metals in Water

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

Mercury in Water

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

End of Report

HYDROCARBON DISTRIBUTION REPORT

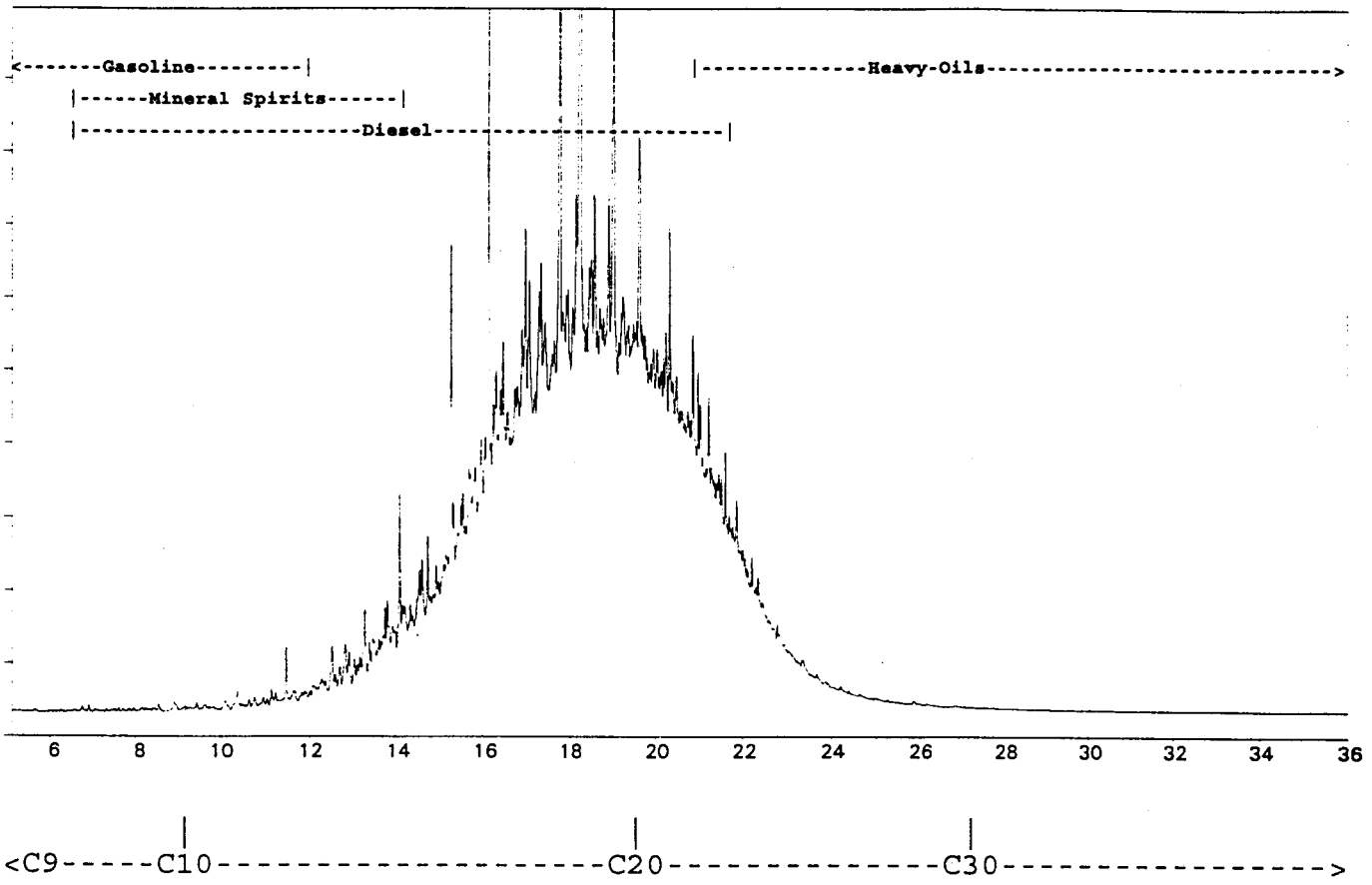
SAMPLE NAME: G4671r 8

CR-05S

Sample acquired: NOV 15, 1996 18:54:08

File Name: C:\TEH2\TEH15NOV.04R , Sample Name: G4671r 8

Sequence file: TEH15NOV



ASL Sample ID: G4671r 8* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.2
C10-C19	(beg-nC10 to beg-nC20)	77.9
C20-C30	(beg-nC20 to beg-nC31)	21.9
C31-C40	(beg-nC31 to beg-nC41)	0.0

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

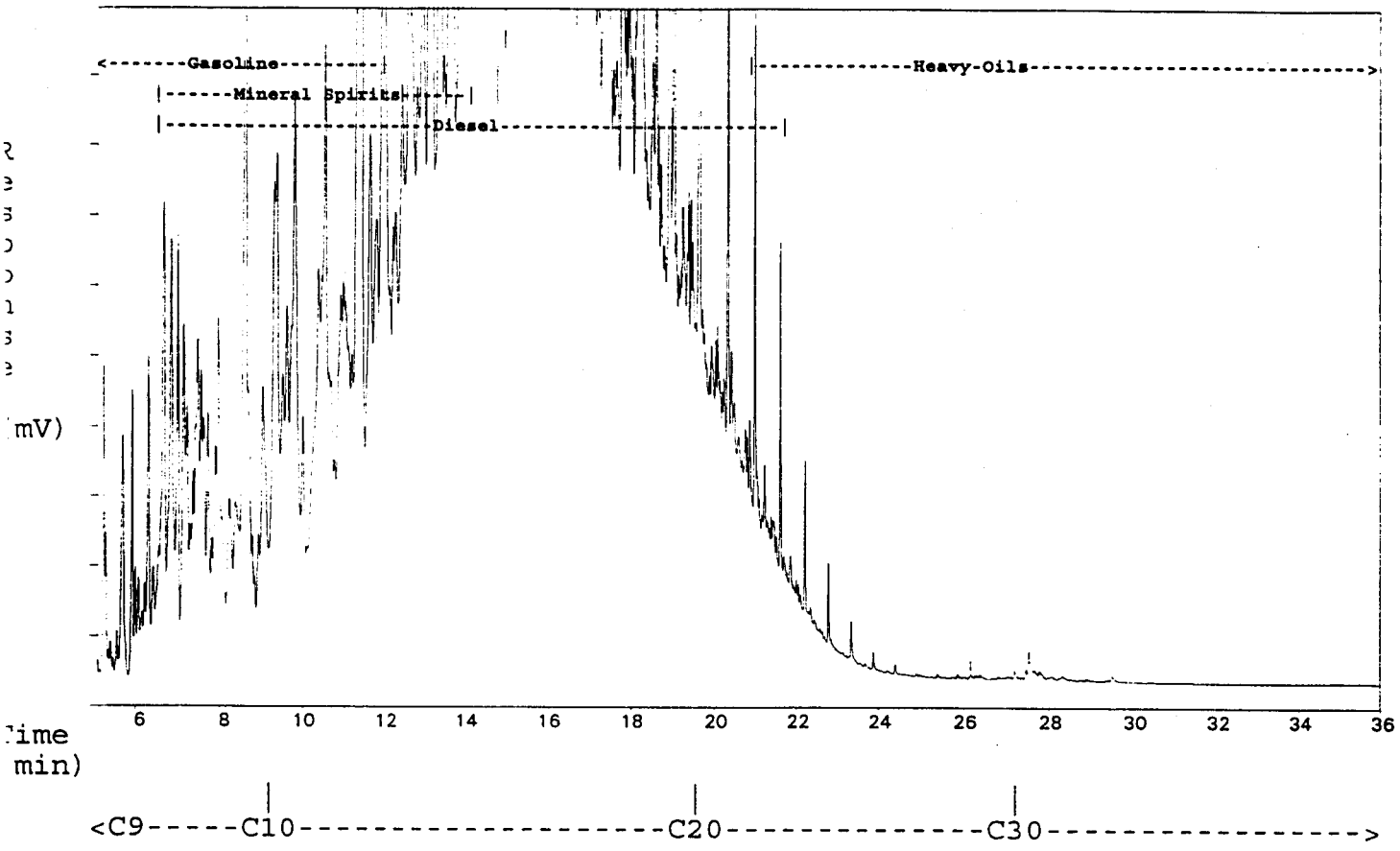
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G4671r 9 CR-05D

Sample acquired: NOV 15, 1996 19:43:22

File Name: C:\TEH2\TEH15NOV.05R , Sample Name: G4671r 9

Sequence file: TEH15NOV



ASL Sample ID: G4671r 9* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	6.6
C10-C19	(beg-nC10 to beg-nC20)	87.8
C20-C30	(beg-nC20 to beg-nC31)	5.4
C31-C40	(beg-nC31 to beg-nC41)	0.2

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HYDROCARBON DISTRIBUTION REPORT

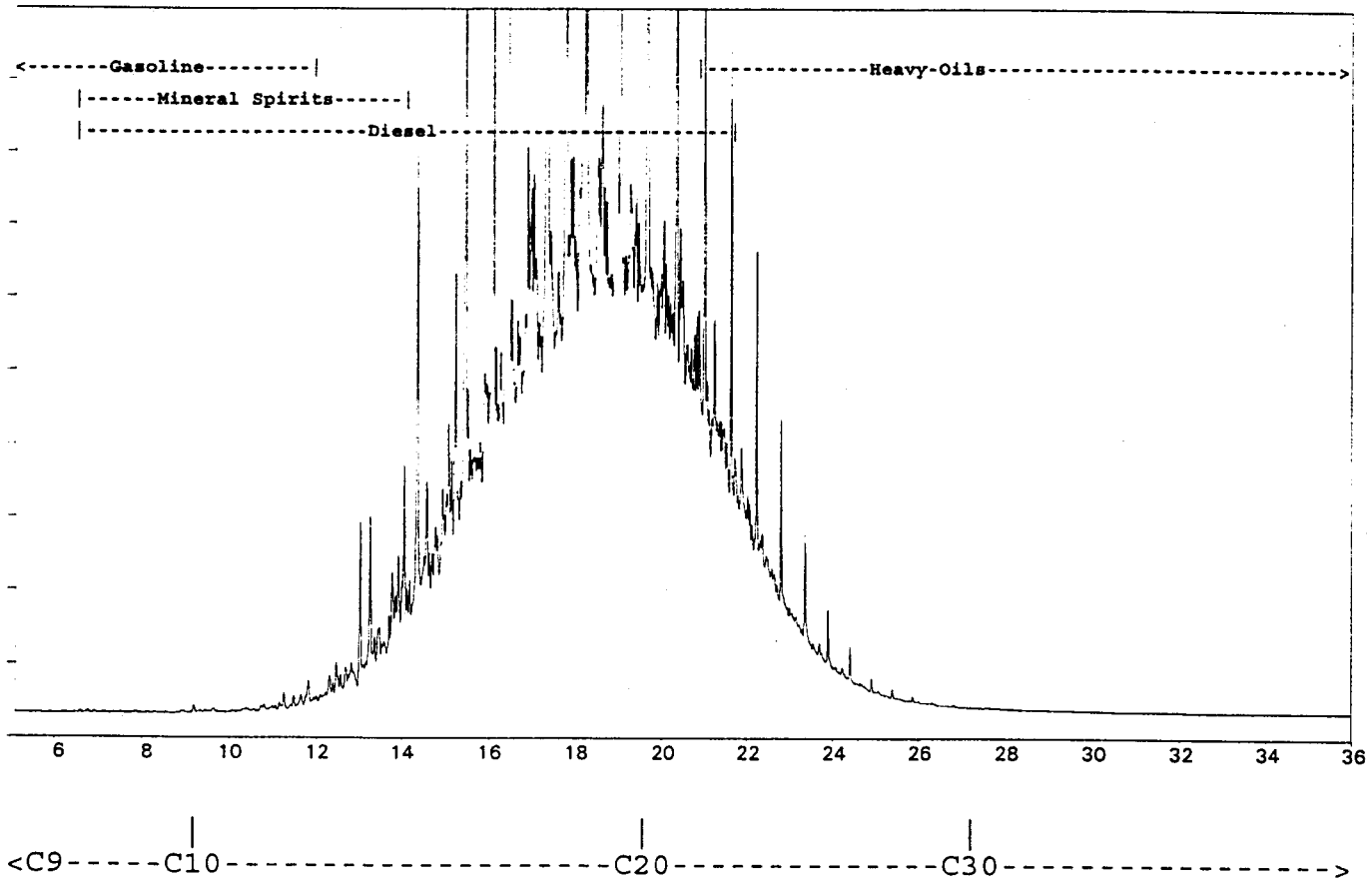
SAMPLE NAME: G4671r 13

VE-01S

Sample acquired: NOV 15, 1996 20:32:23

File Name: C:\TEH2\TEH15NOV.06R , Sample Name: G4671r 13

Sequence file: TEH15NOV



ASL Sample ID: G4671r 13* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	75.8
C20-C30	(beg-nC20 to beg-nC31)	23.9
C31-C40	(beg-nC31 to beg-nC41)	0.2

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HYDROCARBON DISTRIBUTION REPORT

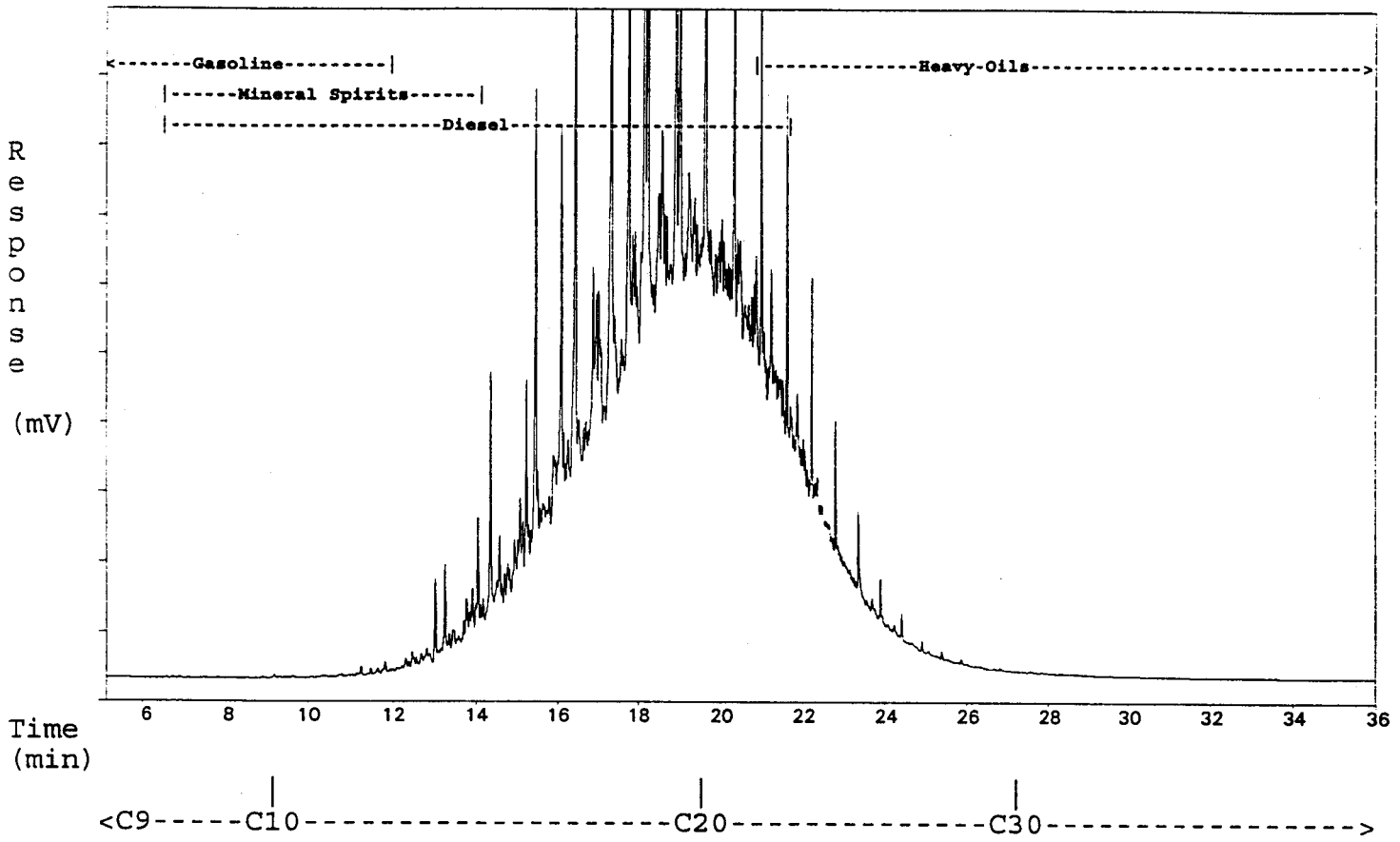
SAMPLE NAME: G4671r 14

VE-01S Dup

Sample acquired: NOV 15, 1996 21:21:35

File Name: C:\TEH2\TEH15NOV.07R , Sample Name: G4671r 14

Sequence file: TEH15NOV



ASL Sample ID: G4671r 14* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	70.0
C20-C30	(beg-nC20 to beg-nC31)	29.6
C31-C40	(beg-nC31 to beg-nC41)	0.4

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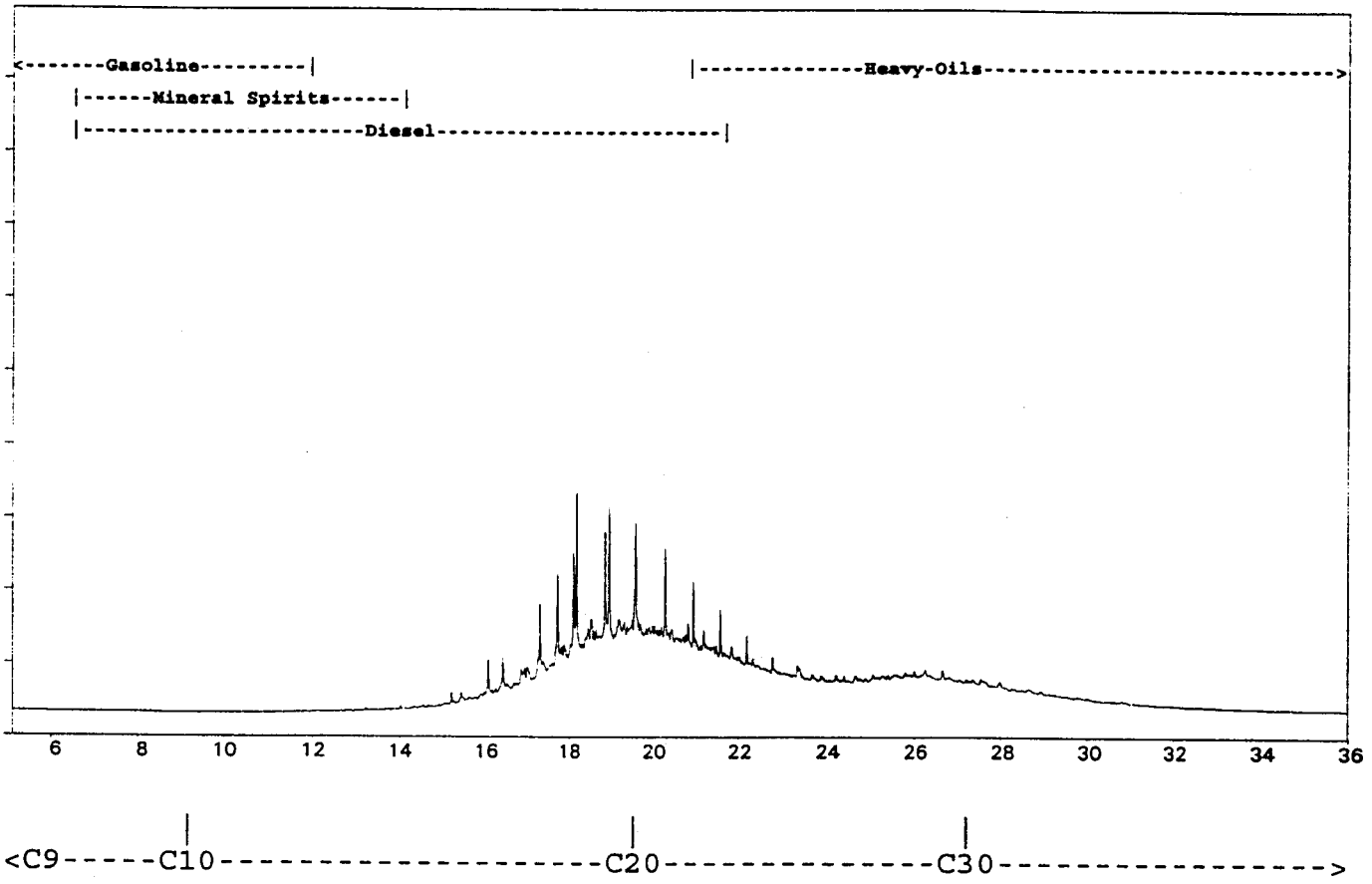
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G4671r 22 VE-08S

Sample acquired: NOV 15, 1996 22:10:16

File Name: C:\TEH2\TEH15NOV.08R , Sample Name: G4671r 22

Sequence file: TEH15NOV



ASL Sample ID: G4671r 22* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	44.2
C20-C30	(beg-nC20 to beg-nC31)	41.0
C31-C40	(beg-nC31 to beg-nC41)	14.8

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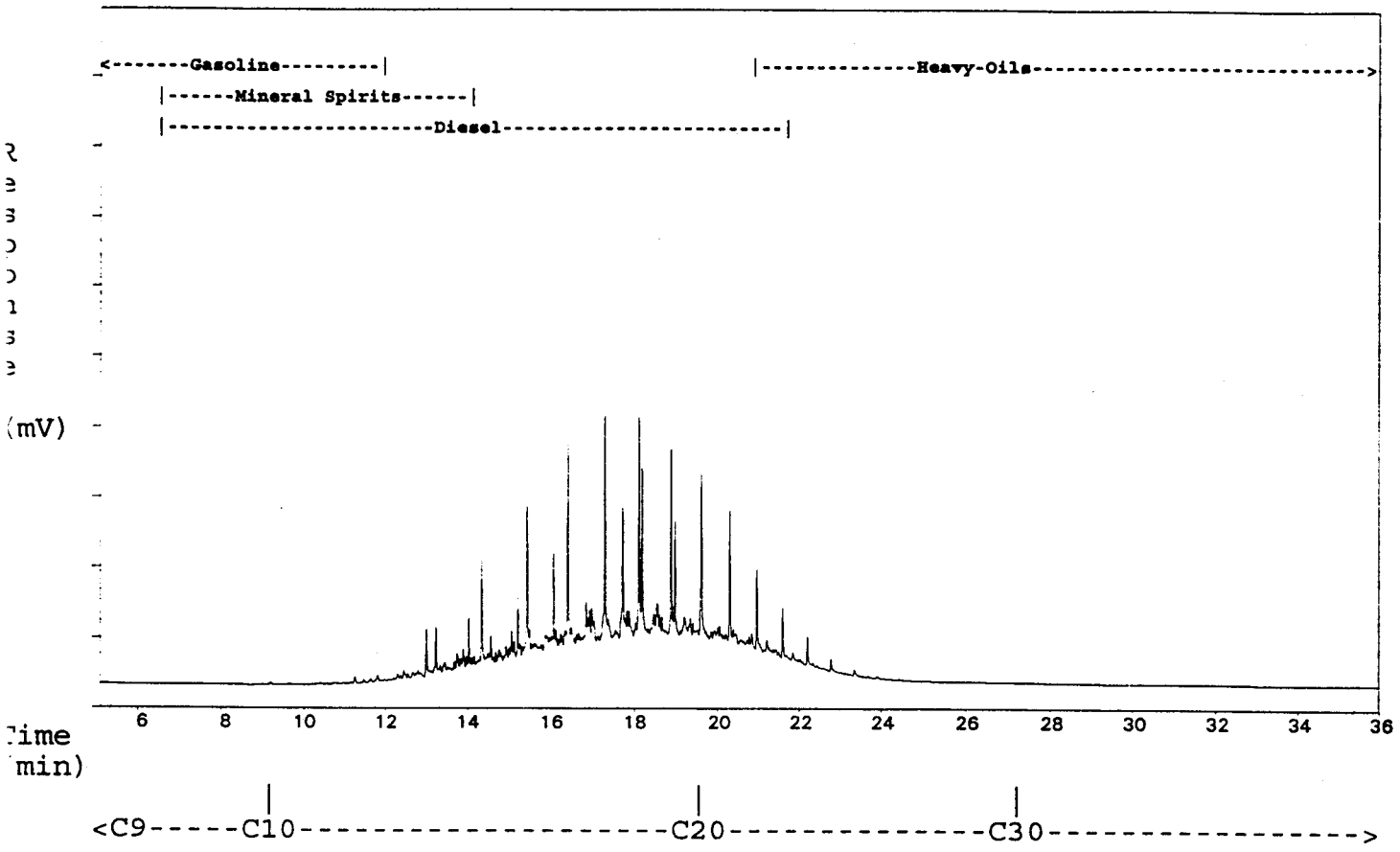
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G4671r 23 VE-08D

Sample acquired: NOV 15, 1996 22:59:03
File Name: C:\TEH2\TEH15NOV.09R , Sample Name: G4671r 23
Sequence file: TEH15NOV



ASL Sample ID: G4671r 23* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.1
C10-C19	(beg-nC10 to beg-nC20)	80.6
C20-C30	(beg-nC20 to beg-nC31)	19.3
C31-C40	(beg-nC31 to beg-nC41)	0.1

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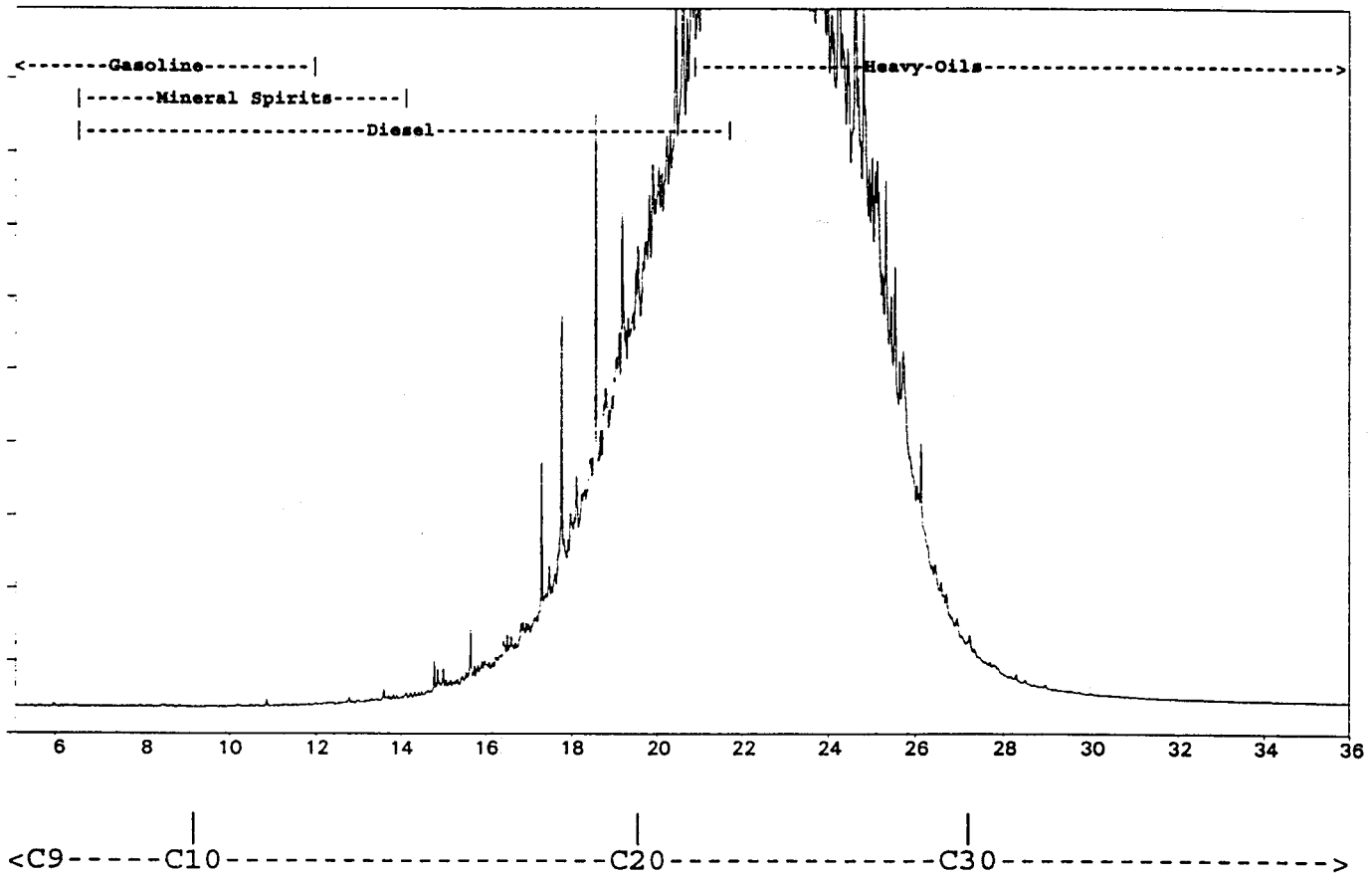
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: G4671r 32#RX5 VE-15S

Sample acquired: NOV 18, 1996 00:56:23

File Name: c:\TEH\TEHNOV17.16R , Sample Name: G4671r 32#RX5

Sequence file: TEHNOV17



ASL Sample ID: G4671r 32#RX5* 40.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	20.9
C20-C30	(beg-nC20 to beg-nC31)	76.3
C31-C40	(beg-nC31 to beg-nC41)	2.8

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

HYDROCARBON DISTRIBUTION REPORT

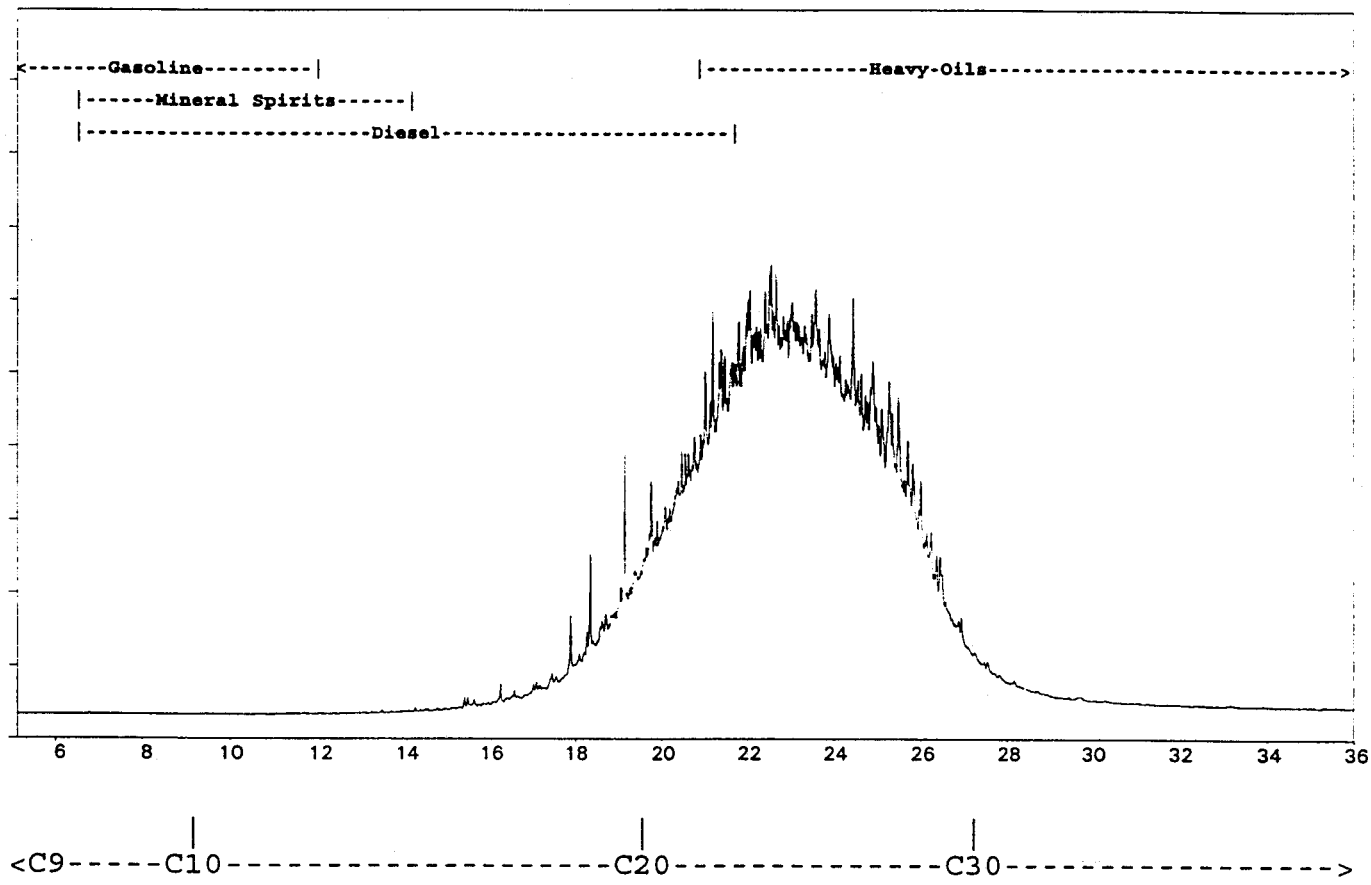
SAMPLE NAME: **G4671r 33#RX5**

VE-15D

Sample acquired: NOV 18, 1996 01:48:43

File Name: c:\TEH\TEHNOV17.17R , Sample Name: G4671r 33#RX5

Sequence file: TEHNOV17



ASL Sample ID: G4671r 33#RX5* 40.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	14.5
C20-C30	(beg-nC20 to beg-nC31)	79.1
C31-C40	(beg-nC31 to beg-nC41)	6.4

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

HYDROCARBON DISTRIBUTION REPORT

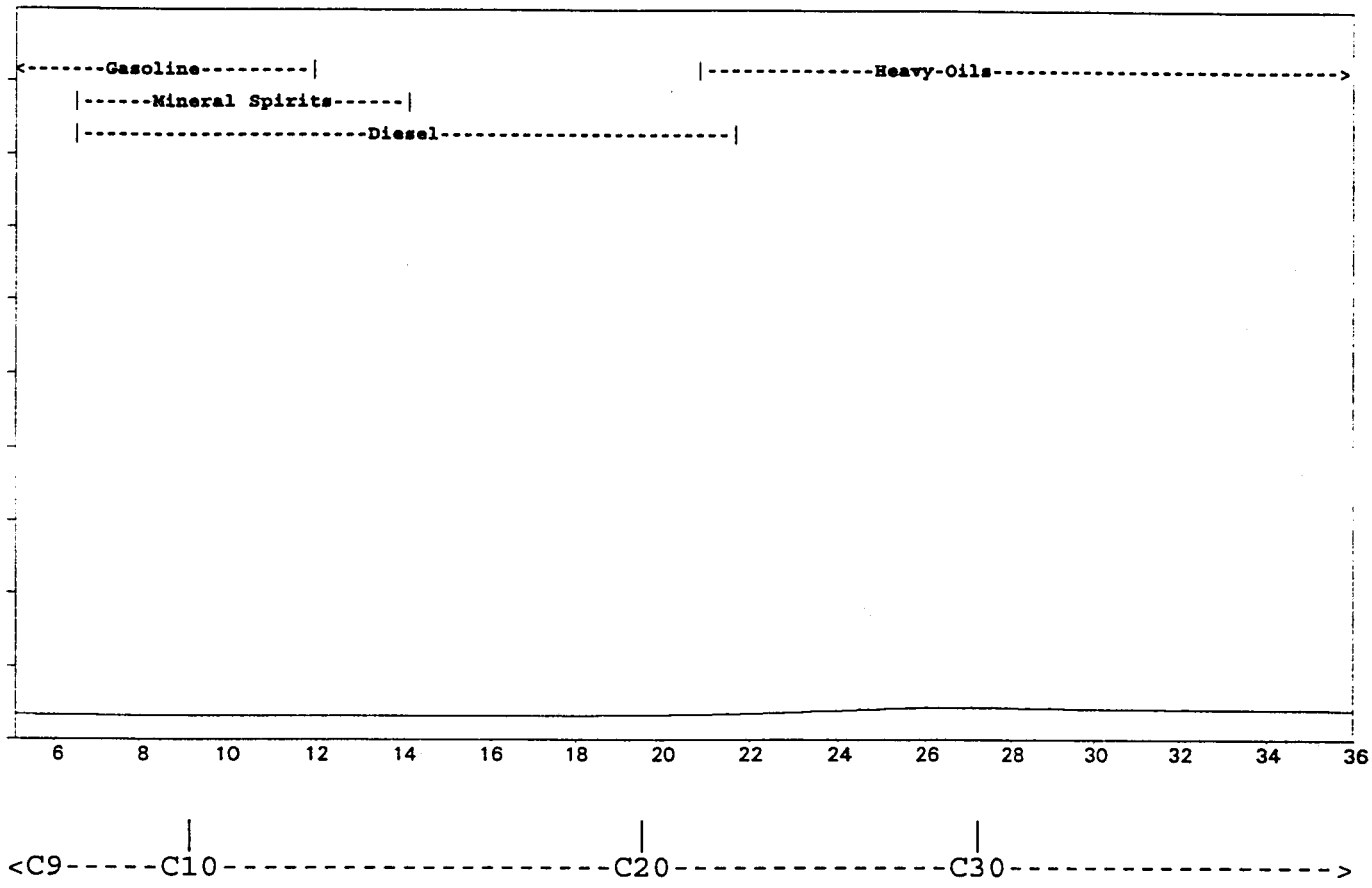
SAMPLE NAME: G4671r 34

VE-16

Sample acquired: NOV 16, 1996 01:24:25

File Name: C:\TEH2\TEH15NOV.12R , Sample Name: G4671r 34

Sequence file: TEH15NOV



ASL Sample ID: G4671r 34* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.1
C10-C19	(beg-nC10 to beg-nC20)	0.0
C20-C30	(beg-nC20 to beg-nC31)	55.1
C31-C40	(beg-nC31 to beg-nC41)	44.8

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

HYDROCARBON DISTRIBUTION REPORT

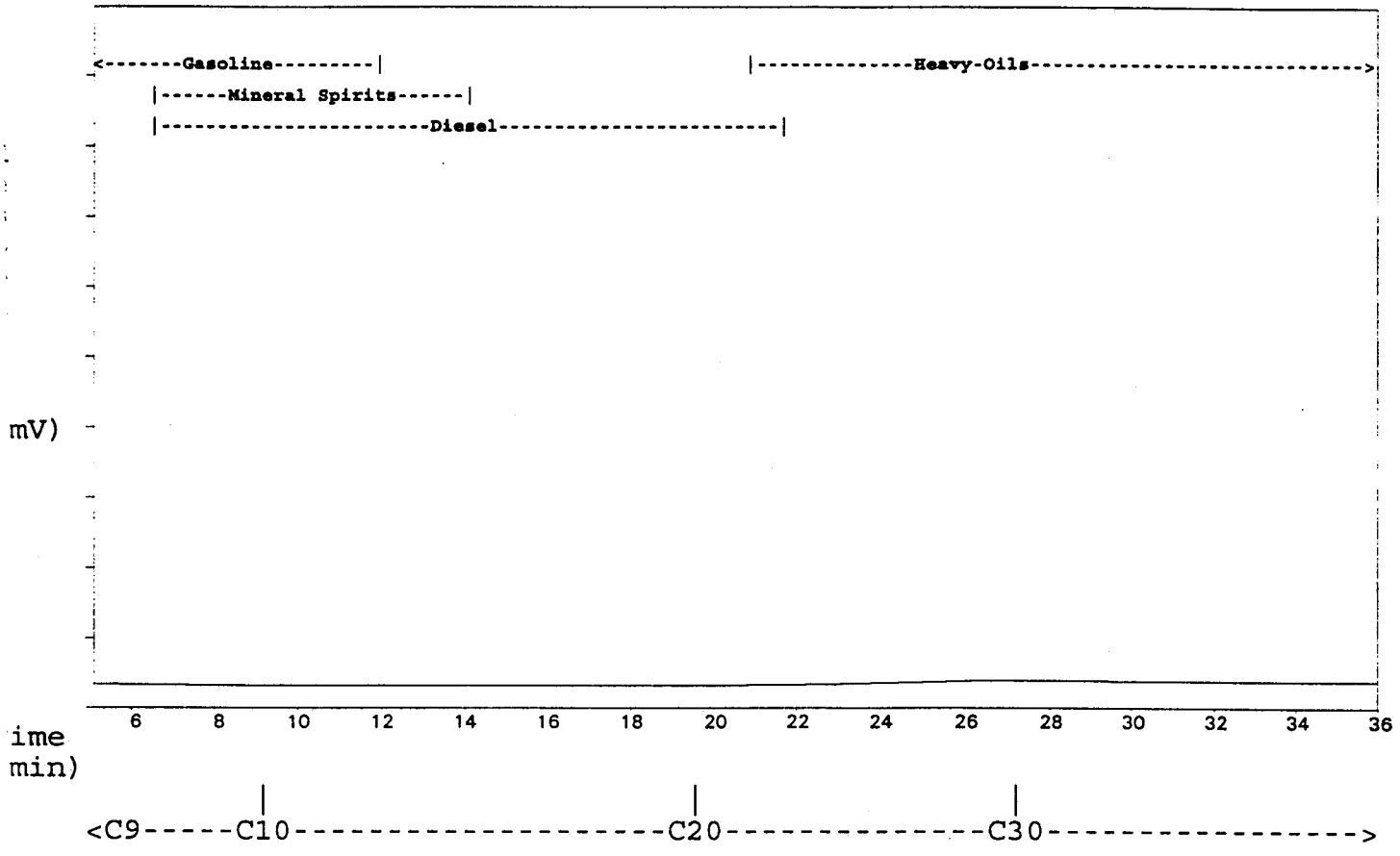
SAMPLE NAME: **G4671r 48**

KA-04

Sample acquired: NOV 16, 1996 02:12:43

File Name: C:\TEH2\TEH15NOV.13R , Sample Name: G4671r 48

Sequence file: TEH15NOV



ASL Sample ID: G4671r 48* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	1.1
C10-C19	(beg-nC10 to beg-nC20)	0.0
C20-C30	(beg-nC20 to beg-nC31)	82.1
C31-C40	(beg-nC31 to beg-nC41)	16.9

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HYDROCARBON DISTRIBUTION REPORT

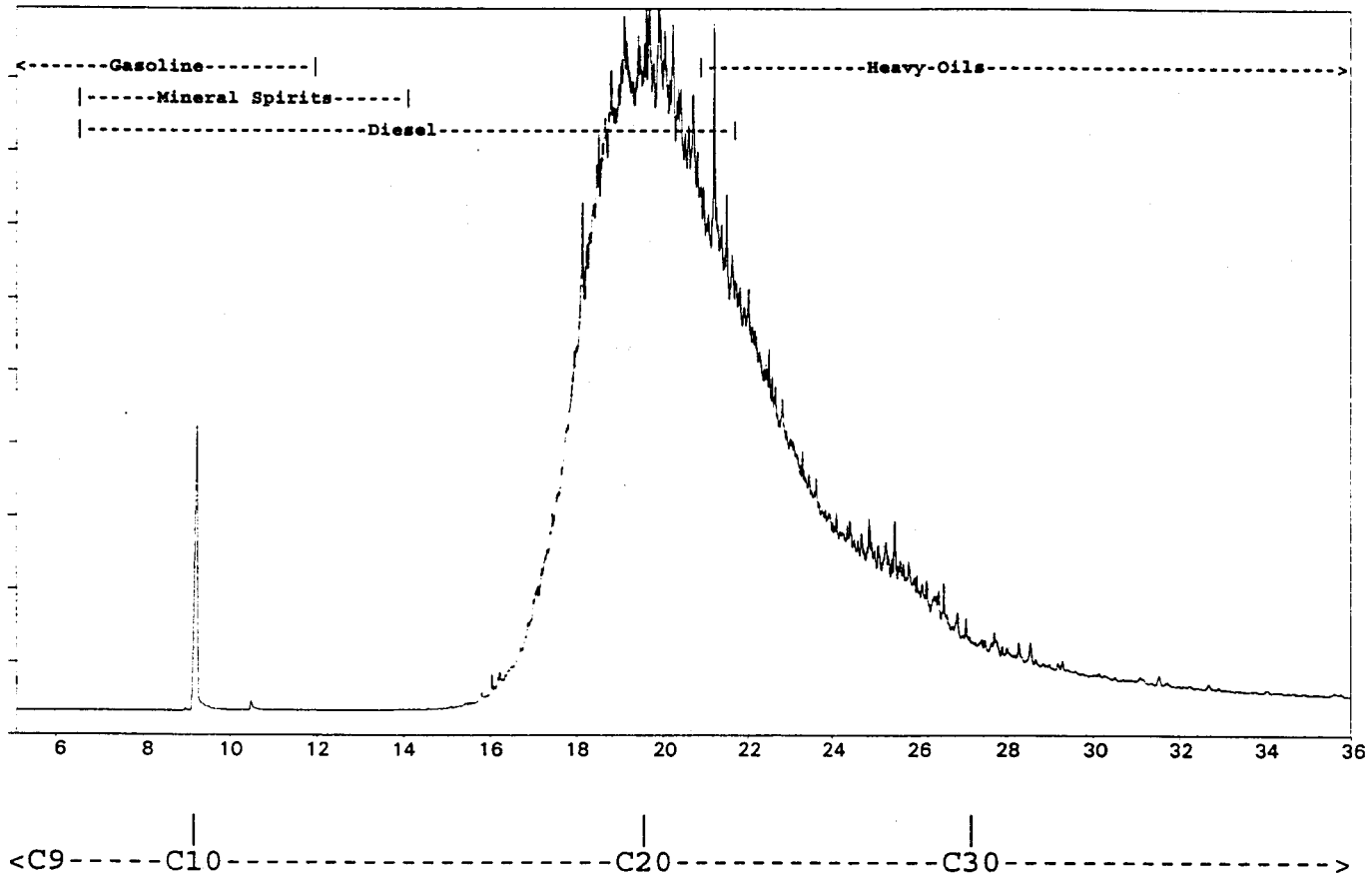
SAMPLE NAME: G4671r 49#RX2

KA-05

Sample acquired: NOV 18, 1996 00:56:23

File Name: c:\TEH\TEHNOV17.15R , Sample Name: G4671r 49#RX2

Sequence file: TEHNOV17



ASL Sample ID: G4671r 49#RX2* 16.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.0
C10-C19	(beg-nC10 to beg-nC20)	44.8
C20-C30	(beg-nC20 to beg-nC31)	47.6
C31-C40	(beg-nC31 to beg-nC41)	7.5

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1988 Triumph Street, Vancouver, B.C., Canada V5L 1K5

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CHEMICAL ANALYSIS REPORT

Date: January 7, 1997

ASL File No. G8093

Report On: Sediment/Soil Analysis

Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

Attention: **Mr. William Dushenko**, PhD

Received: December 19, 1996

ASL ANALYTICAL SERVICE LABORATORIES LTD.
per:

Katherine Thomas, B.Sc.
Project Chemist

Brent A. Makelki, B.Sc.
Project Chemist

REMARKS File No. G8093

It was necessary to increase the detection limits for some of the Non-halogenated Volatiles for the samples identified as "CR-01-D2" and "CR-03-D1." These samples contain hydrocarbon material that interfered with the quantification of these compounds.

The detection limits for several of the Total Metals in the sample identified as "VE-14S" were raised due to the elevated levels of Lead and Zinc found in this sample.

The detection limits for the Polycyclic Aromatic Hydrocarbons for several of the submitted samples had to be raised by a factor of five due to the presence of other hydrocarbon material in these samples.

The detection limit for the Polycyclic Aromatic Hydrocarbons for the sample identified as "KA-05" had to be raised by a factor of 50 due to the peat-like nature of this sample.

Quality Assurance/Quality Control

An extensive quality assurance/quality control program is routinely incorporated with the sample analysis. This program includes the analysis of quality control samples to define precision and accuracy, and to demonstrate contamination control for the type of samples and parameters under investigation. Quality control samples may include method blanks, sample replicates, certified and standard reference materials, and analyte or matrix spikes. For this project, the following quality control analyses were carried out:

- Method Blanks (n=1);
- Matrix Spikes (n=1);

The quality control data are reported at the end of this report. This data indicated the following:

Method Blank and Matrix Spike results for all parameters analysed demonstrated that precision, accuracy, and contamination control met acceptance criteria.

RESULTS OF ANALYSIS - Sediment/Soil File No. G8093

	CR-01-D1	CR-01-D2	CR-03-D1	CR-05D	VE-01S
Physical Tests					
Moisture %	5.9	13.1	38.3	64.5	16.3
Non-halogenated Volatiles					
Benzene	<0.05	<0.05	<0.05	-	-
Ethylbenzene	<0.05	<0.3	<0.2	-	-
Toluene	<0.05	<0.1	<0.05	-	-
meta- & para-Xylene	<0.05	<2	<1	-	-
ortho-Xylene	<0.05	<0.1	<0.2	-	-
Light Hydrocarbons (C5-9)	6	173	215	-	-
VPH	20	162	183	-	-

Remarks regarding the analyses appear at the beginning of this report.
Results are expressed as milligrams per dry kilogram except where noted.
< = Less than the detection limit indicated.
EPH = Extractable Petroleum Hydrocarbons.
VPH = Volatile Petroleum Hydrocarbons.
Volatile Petroleum Hydrocarbons are based on draft methodologies.
HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.
Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil File No. G8093

		VE-01S Dup	VE-01D	VE-08S	VE-10S	VE-14S
Physical Tests						
Moisture	%	17.9	12.6	28.3	16.4	12.7
Total Metals						
Antimony	T-Sb	-	-	-	<20	<40
Arsenic	T-As	-	-	-	65.8	29.0
Barium	T-Ba	-	-	-	87	951
Beryllium	T-Be	-	-	-	0.6	<1
Cadmium	T-Cd	-	-	-	<2	41
Chromium	T-Cr	-	-	-	17	5
Cobalt	T-Co	-	-	-	12	<4
Copper	T-Cu	-	-	-	40	401
Lead	T-Pb	-	-	-	142	12500
Mercury	T-Hg	-	-	-	0.042	0.060
Molybdenum	T-Mo	-	-	-	8	<8
Nickel	T-Ni	-	-	-	42	10
Selenium	T-Se	-	-	-	0.7	<0.1
Silver	T-Ag	-	-	-	<2	18
Tin	T-Sn	-	-	-	<30	<60
Vanadium	T-V	-	-	-	42	5
Zinc	T-Zn	-	-	-	343	8930

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Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil File No. G8093

		VE-15S	KA-05
Physical Tests			
Moisture	%	9.2	74.3

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Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil File No. G8093

	CR-01-D1	CR-01-D2	CR-03-D1	CR-05D	VE-01S
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.06	0.14	0.38	9.05	0.22
Acenaphthylene	0.04	0.05	0.20	3.33	<0.05
Anthracene	<0.05	0.06	0.23	1.46	0.34
Benzo(a)anthracene	0.04	0.02	<0.05	0.09	0.07
Benzo(a)pyrene	0.03	0.01	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	0.06	0.02	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	0.05	0.01	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	0.02	<0.01	<0.05	<0.05	<0.05
Chrysene	0.11	0.02	0.07	<0.05	0.23
Dibenz(a,h)anthracene	<0.01	<0.01	<0.05	<0.05	<0.05
Fluoranthene	0.01	0.03	0.23	0.58	0.34
Fluorene	0.03	0.27	0.43	26.7	0.08
Indeno(1,2,3-c,d)pyrene	0.04	<0.01	<0.05	<0.05	<0.05
Naphthalene	0.04	0.05	0.78	4.02	<0.05
Phenanthrene	<0.05	0.34	0.15	36.4	0.14
Pyrene	0.24	0.20	0.80	1.80	2.56
Extractables					
EPH (C10-18)	5410	6970	23500	-	-
EPH (C19-31)	1300	1050	3400	-	-
LEPH	5400	6970	23500	-	-
HEPH	1300	1050	3400	-	-
Total Extr Hydrocarbons (C10-30)	5970	7080	23700	-	-

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Volatile Petroleum Hydrocarbons are based on draft methodologies.
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Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Sediment/Soil File No. G8093

	VE-01S Dup	VE-01D	VE-08S	VE-15S	KA-05
Polycyclic Aromatic Hydrocarbons					
Acenaphthene	0.16	0.03	<0.01	0.06	<0.5
Acenaphthylene	<0.05	0.01	<0.01	<0.05	<0.5
Anthracene	0.27	0.03	<0.01	0.19	<0.5
Benzo(a)anthracene	0.06	<0.01	<0.01	<0.05	<0.5
Benzo(a)pyrene	<0.05	<0.01	<0.01	<0.05	<0.5
Benzo(b)fluoranthene	<0.05	<0.01	<0.01	<0.05	<0.5
Benzo(g,h,i)perylene	<0.05	<0.01	<0.01	<0.05	<0.5
Benzo(k)fluoranthene	<0.05	<0.01	<0.01	<0.05	<0.5
Chrysene	0.20	0.03	0.08	<0.05	<0.5
Dibenz(a,h)anthracene	<0.05	<0.01	<0.01	<0.05	<0.5
Fluoranthene	0.23	0.05	<0.01	0.17	<0.5
Fluorene	0.06	0.01	<0.01	0.24	<0.5
Indeno(1,2,3-c,d)pyrene	<0.05	<0.01	<0.01	<0.05	<0.5
Naphthalene	0.05	0.04	0.03	0.12	<0.5
Phenanthrene	0.09	0.04	0.02	3.60	1.5
Pyrene	2.12	0.28	0.28	0.40	<0.5
Extractables					
EPH (C10-18)	-	1950	-	-	-
EPH (C19-31)	-	706	-	-	-
Total Extr Hydrocarbons (C10-30)	-	2390	-	-	-

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Volatile Petroleum Hydrocarbons are based on draft methodologies.
HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.
Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Quality Control

File No. G8093

		Method Blank	Matrix Spike %
Total Metals			
Antimony	T-Sb	<20	-
Arsenic	T-As	<0.05	-
Barium	T-Ba	<1	-
Beryllium	T-Be	<0.5	-
Cadmium	T-Cd	<2	-
Chromium	T-Cr	<2	-
Cobalt	T-Co	<2	-
Copper	T-Cu	<1	-
Lead	T-Pb	<50	-
Mercury	T-Hg	<0.005	-
Molybdenum	T-Mo	<4	-
Nickel	T-Ni	<2	-
Selenium	T-Se	<0.1	-
Silver	T-Ag	<2	-
Tin	T-Sn	<30	-
Vanadium	T-V	<2	-
Zinc	T-Zn	<1	-
Non-halogenated Volatiles			
Benzene		<0.05	89
Ethylbenzene		<0.05	86
Toluene		<0.05	87
meta- & para-Xylene		<0.05	87
ortho-Xylene		<0.05	89
Light Hydrocarbons (C5-9)		<5	-
VPH		<10	-

Remarks regarding the analyses appear at the beginning of this report.
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Volatile Petroleum Hydrocarbons are based on draft methodologies.
HEPH & LEPH = Heavy and Light Extractable Petroleum Hydrocarbons.
Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

RESULTS OF ANALYSIS - Quality Control

File No. G8093

	Method Blank	Matrix Spike %
Polycyclic Aromatic Hydrocarbons		
Acenaphthene	<0.01	105
Acenaphthylene	<0.01	96
Anthracene	<0.01	99
Benzo(a)anthracene	<0.01	103
Benzo(a)pyrene	<0.01	97
Benzo(b)fluoranthene	<0.01	92
Benzo(g,h,i)perylene	<0.01	103
Benzo(k)fluoranthene	<0.01	91
Chrysene	<0.01	94
Dibenz(a,h)anthracene	<0.01	102
Fluoranthene	<0.01	102
Fluorene	<0.01	97
Indeno(1,2,3-c,d)pyrene	<0.01	104
Naphthalene	<0.01	96
Phenanthrene	<0.01	98
Pyrene	<0.01	106
Extractables		
EPH (C10-18)	<250	-
EPH (C19-31)	<250	-
Total Extr Hydrocarbons (C10-30)	<40	77

Remarks regarding the analyses appear at the beginning of this report.
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VPH = Volatile Petroleum Hydrocarbons.
Volatile Petroleum Hydrocarbons are based on draft methodologies.
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Heavy and Light Extractable Petroleum Hydrocarbons are based on draft methodologies.

METHODOLOGY File No. G8093

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

Moisture

This analysis is carried out gravimetrically by drying the sample to constant weight at 103 C.

Non-halogenated Volatiles in Sediment/Soil - Headspace Method

This analysis is carried out in accordance with U.S. EPA Methods 3500/3810 and 8020/8015 (Publ. # SW-846, 3rd ed., Washington, DC 20460) and British Columbia Ministry of Environment, Lands and Parks Method "Volatile Petroleum Hydrocarbons in Soil". The procedure involves extracting the sample with methanol. An aliquot of this methanol extract is then added to a sealed vial containing a constant volume of water. This vial is sealed and heated, causing the volatile compounds to partition into the gaseous headspace above the sample. A portion of this headspace is then analysed by capillary column gas chromatography with photo-ionization detection in conjunction with flame ionization detection.

Metals in Sediment/Soil

This analysis is carried out using procedures adapted from "Test Methods for Evaluating Solid Waste" SW-846 Method 3050 or Method 3051, published by the United States Environmental Protection Agency (EPA). The procedures involve a digestion using a 1:1 ratio of nitric acid and hydrochloric acid, along with hotplate or microwave heating. Instrumental analysis is by atomic absorption spectrophotometry (EPA Method 7000) and/or inductively coupled plasma - optical emission spectrophotometry (EPA Method 6010).

Method Limitation: The stated acid digestion will provide excellent results for total recoverable metals; however, it is only partially effective on mineralized or non-environmentally available metals.

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

This analysis is carried out using a procedure adapted by ASL from U.S. EPA Methods 3500, 3630, and 8270 (Publ. #SW-846 3rd ed., Washington, DC 20460). The procedure involves a microwave assisted extraction with dichloromethane followed by a clean-up using silica gel column chromatography. This clean-up procedure has been found to effectively

remove aliphatic and heterocyclic hydrocarbons which could potentially interfere with the analysis. The final extract is analysed by capillary column gas chromatography with mass spectrometric detection.

Extractable Petroleum Hydrocarbons in Sediment/Soil

This analysis is equivalent to British Columbia Ministry of Environment, Lands and Parks Method for "Extractable Petroleum Hydrocarbons in Soil by GC/FID", January 1996 but does not provide correction for Polycyclic Aromatic Hydrocarbons (PAHs). The procedure involves a hexane/acetone solvent extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection.

Light and Heavy Extractable Petroleum Hydrocarbons in Soil

This analysis is carried out as outlined in the method descriptions for Extractable Petroleum Hydrocarbons and Polycyclic Aromatic Hydrocarbons. The concentration of naphthalene has been subtracted from EPH (C10-18) to obtain the LEPH result. Concentrations of benzo[a]anthracene, benzo[b]fluoranthene, benzo[k]fluoranthene, dibenz[a,h]anthracene, indeno[1,2,3-c,d]pyrene, phenanthrene, pyrene and benzo[a]pyrene have been subtracted from EPH (C19-31) to obtain the HEPH result.

Total Extractable Hydrocarbons in Sediment/Soil

This analysis is carried out in accordance with U.S. EPA Method 3500/8015 (Publ. # SW-846 3rd ed., Washington, DC 20460). This procedure involves hexane/acetone extraction followed by analysis of the extract by capillary column gas chromatography with flame ionization detection.

End of Report

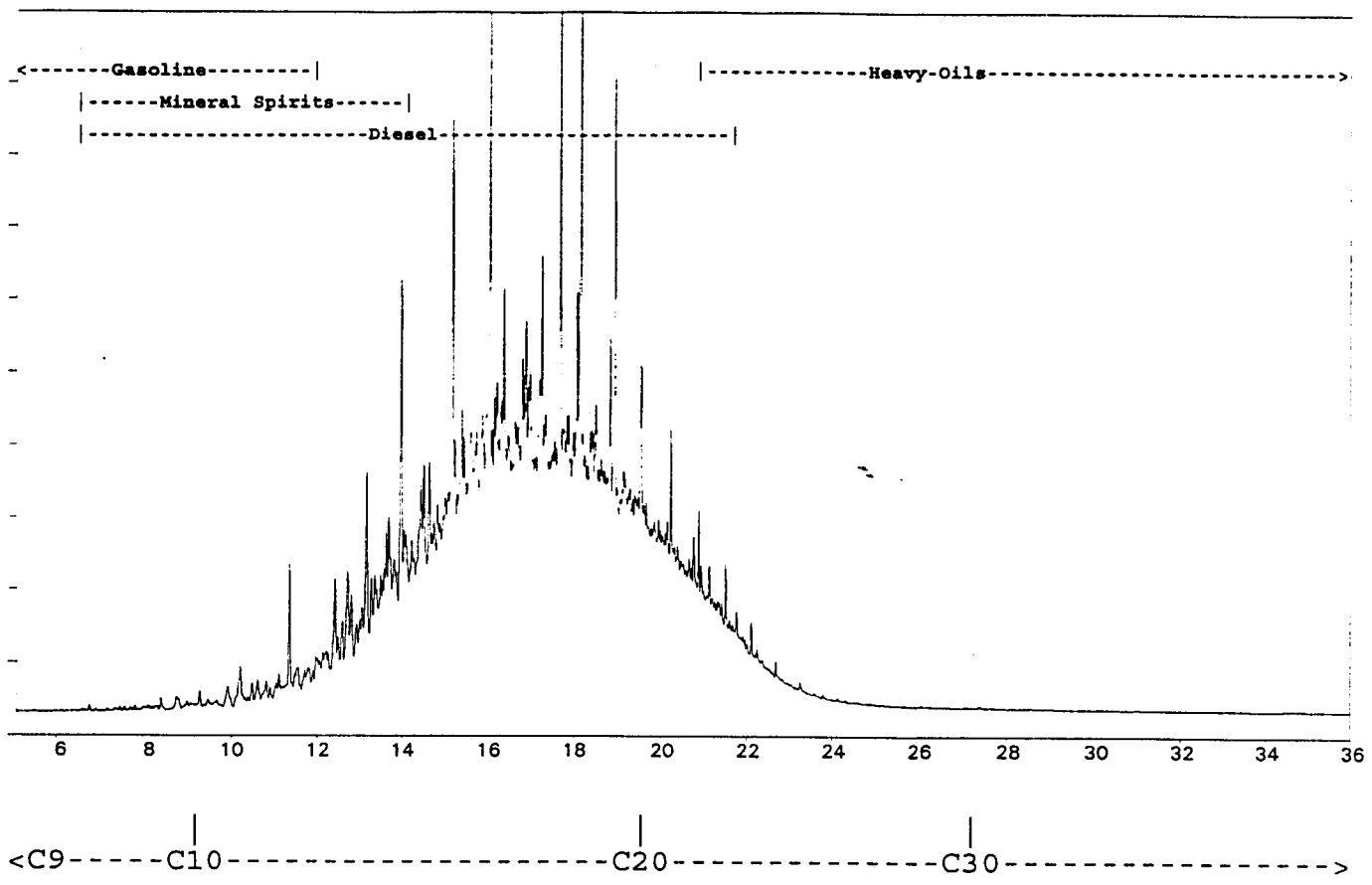
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-01-D1

Sample acquired: DEC 25, 1996 20:36:01

File Name: C:\TEH\DEC24\TEHDEC24.81R , Sample Name: G8093 1

Sequence file: Merry Christmas



ASL Sample ID: G8093 1* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.2
C10-C19	(beg-nC10 to beg-nC20)	86.6
C20-C30	(beg-nC20 to beg-nC31)	12.8
C31-C40	(beg-nC31 to beg-nC41)	0.4

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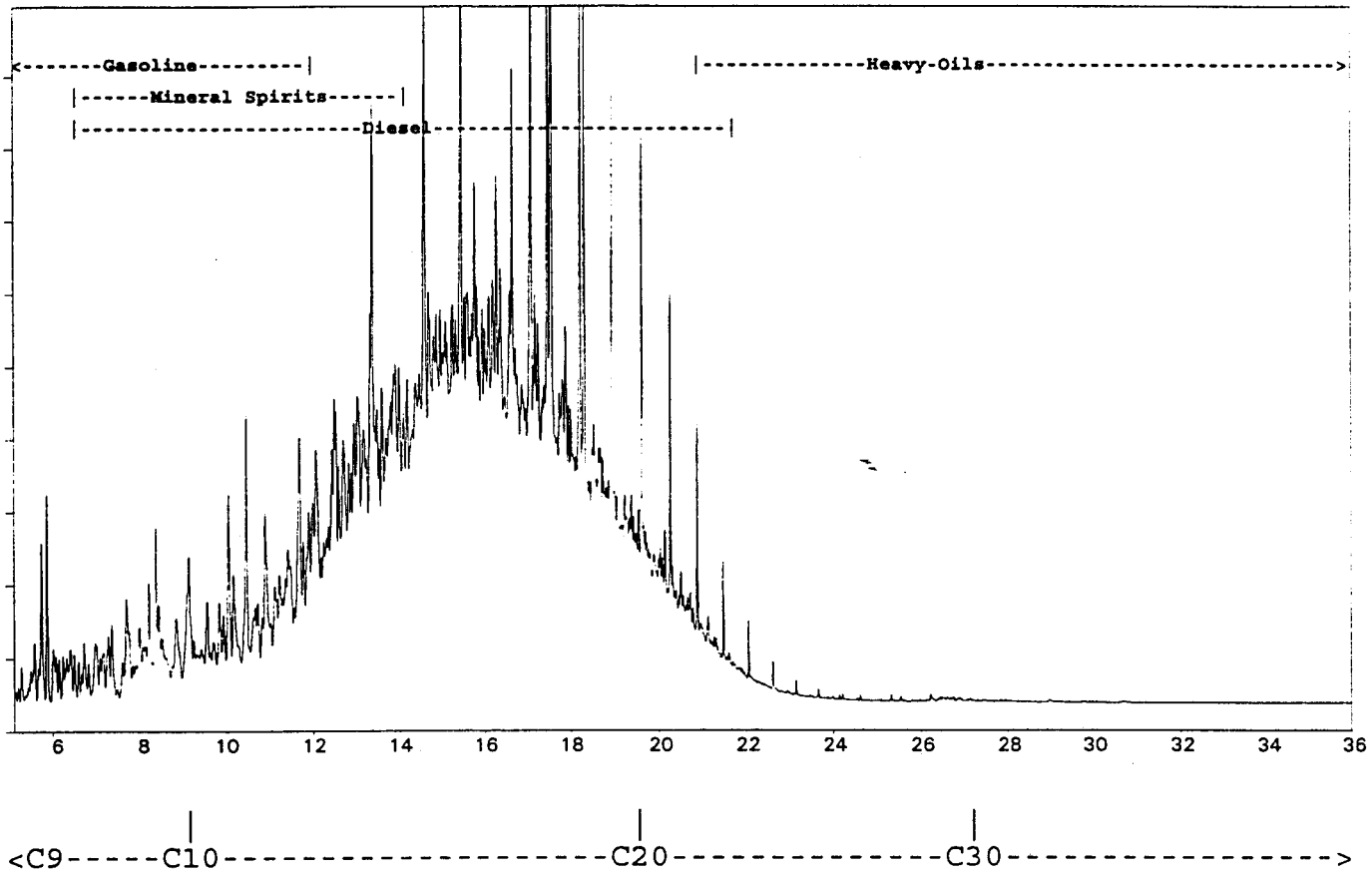
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-01-D2

Sample acquired: DEC 25, 1996 20:36:01

File Name: C:\TEH\DEC24\TEHDEC24.82R , Sample Name: G8093 2

Sequence file: Merry Christmas



ASL Sample ID: G8093 2* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	4.5
C10-C19	(beg-nC10 to beg-nC20)	90.0
C20-C30	(beg-nC20 to beg-nC31)	5.2
C31-C40	(beg-nC31 to beg-nC41)	0.2

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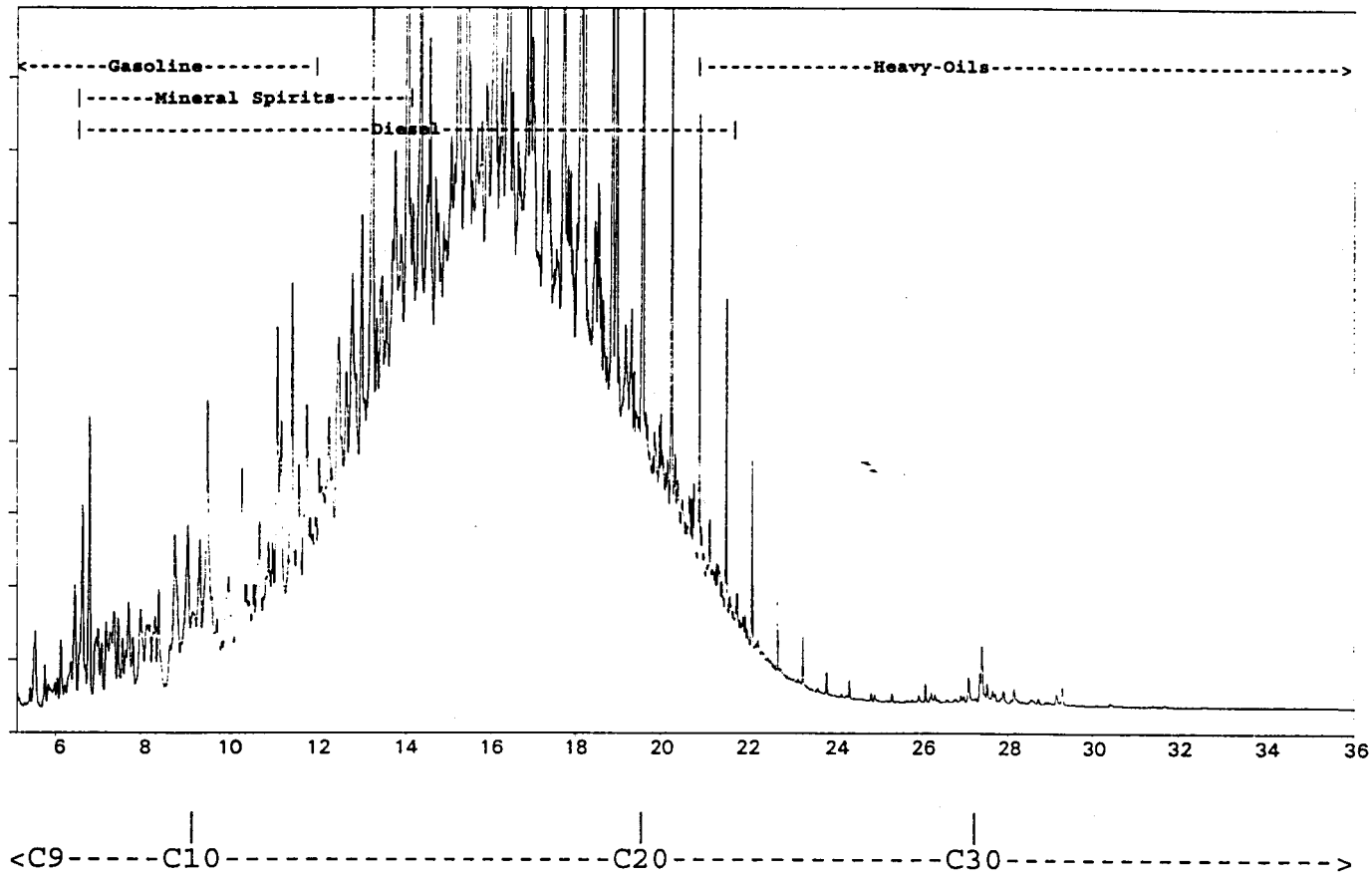
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-03-D1

Sample acquired: DEC 25, 1996 21:28:13

File Name: C:\TEH\DEC24\TEHDEC24.83R , Sample Name: G8093 3

Sequence file: Merry Christmas



ASL Sample ID: G8093 3* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	3.2
C10-C19	(beg-nC10 to beg-nC20)	88.9
C20-C30	(beg-nC20 to beg-nC31)	7.3
C31-C40	(beg-nC31 to beg-nC41)	0.7

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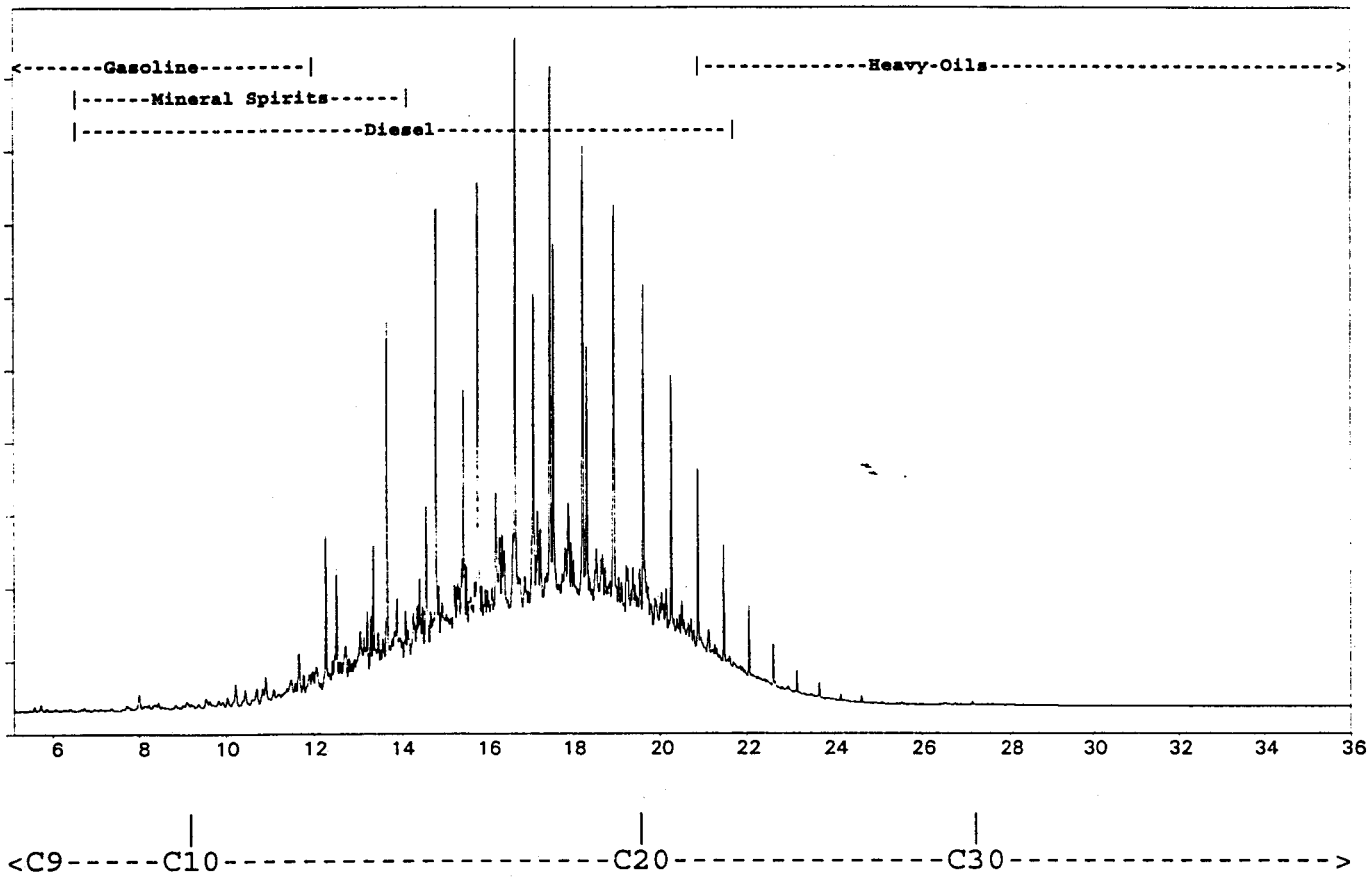
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: VE-01D

Sample acquired: DEC 25, 1996 21:28:13

File Name: C:\TEH\DEC24\TEHDEC24.84R , Sample Name: G8093 7

Sequence file: Merry Christmas



ASL Sample ID: G8093 7* 8.0Dilution

HYDROCARBON RANGE (by Carbon#)		RELATIVE AMOUNT (%)
C9	(beg-nC9 to beg-nC10)	0.5
C10-C19	(beg-nC10 to beg-nC20)	85.4
C20-C30	(beg-nC20 to beg-nC31)	13.6
C31-C40	(beg-nC31 to beg-nC41)	0.5

The Hydrocarbon Distribution Report is intended to assist you in characterizing the hydrocarbon product present in a given sample. The scale at the top of the chromatographic trace represents the hydrocarbon range of common petroleum products. Comparison of this report with those of reference standards may also assist you in the identification of the hydrocarbon product detected in your sample. The second part of the report is a table that expresses the relative amounts of hydrocarbon product present in the ranges specified. Percent values are relative to the sum of all chromatographic peaks between the retention times of the alkanes n-C9 and n-C40, and are based solely on the areas of those peaks.

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A. MORIN

Certificate Date 21-SEP-96
Invoice No. I9631399
P.O. Number
Account JGG

CERTIFICATE OF ANALYSIS A9631399

SAMPLE	PREP CODE		PASTE pH	S % * Sulfate	S % *** Sulfide	S % Total	CO2 % inorg	Max Pot Acid **	Neutral Poten**	Net Neu Poten**	Ratio NP/MPA	
VAL-AD1	208	226	8.5	0.01	< 0.01	0.01	1.2	1	25	24	25.00	
VAL-AD2	208	226	8.7	0.01	< 0.01	< 0.01	45.0	1	1048	1047	1048.0	
VAL-AD3	208	226	8.7	< 0.01	< 0.01	0.01	5.8	1	54	53	54.00	
VAL-AD4	208	226	8.5	< 0.01	0.02	0.03	43.8	1	1065	1064	1065.0	
VAL-AD5	208	226	8.8	< 0.01	0.59	0.60	45.8	19	1023	1004	53.84	
VAL-AD6	208	226	8.9	< 0.01	0.15	0.14	47.3	4	1051	1047	262.8	
VAL-AD7	208	226	8.8	< 0.01	0.78	0.79	46.2	25	1038	1013	41.52	
KA-AD1	208	226	8.8	0.01	0.02	0.04	33.6	1	649	648	649.0	
KA-AD3	208	226	8.8	< 0.01	< 0.01	< 0.01	8.6	1	177	176	177.00	
KA-AD4	208	226	8.5	0.07	0.01	0.08	27.9	3	603	600	201.0	
KA-AD5	208	226	8.2	0.02	0.26	0.28	40.8	9	918	909	102.00	
KA-AD6	208	226	8.7	< 0.01	0.05	0.05	40.5	2	910	908	455.0	
KA-AD7	208	226	8.7	< 0.01	0.10	0.08	46.6	3	995	992	331.7	
KA-AD8	208	226	8.9	0.01	< 0.01	0.01	26.1	1	588	587	588.0	
KA-AD9	208	226	8.7	0.04	5.47	5.54	28.2	173	596	423	3.45	
VE-AD01	208	226	8.7	< 0.01	0.03	0.05	36.6	2	771	769	385.5	
VE-AD02	208	226	8.7	< 0.01	0.03	0.05	1.4	2	18	16	9.00	
VE-AD03	208	226	8.7	< 0.01	< 0.01	0.01	5.0	1	88	87	88.00	
VE-AD04	208	226	7.9	< 0.01	0.02	0.03	< 0.2	1	5	4	5.00	
VE-AD05	208	226	6.4	0.04	0.01	0.05	< 0.2	2	0	-2	0.00	
VE-AD06	208	226	7.4	0.07	< 0.01	0.08	< 0.2	3	7	4	2.33	
VE-AD07	208	226	8.3	0.02	0.04	0.06	1.1	2	27	25	13.50	
VE-AD08	208	226	6.4	0.18	< 0.01	0.20	< 0.2	6	1	-5	0.17	
VE-AD09	208	226	7.5	0.01	0.01	0.02	< 0.2	1	4	3	4.00	
VE-AD11	208	226	8.4	0.03	0.43	0.47	21.8	15	436	421	29.07	
VE-AD12	208	226	8.1	0.14	2.62	2.78	18.3	87	85	-2	0.98	
VE-AD13	208	226	8.8	0.01	0.10	0.06	34.8	2	753	751	376.5	
VE-AD14	208	226	9.1	< 0.01	0.04	0.05	32.8	2	716	714	358.0	
VE-AD15	208	226	9.2	< 0.01	0.13	0.16	46.8	5	1040	1035	208.0	
VE-AD16	208	226	7.5	0.13	2.26	2.46	< 0.2	77	11	-66	0.14	
VE-AD17	208	226	9.2	< 0.01	0.21	0.20	15.2	6	338	332	56.33	
VE-AD18	208	226	9.2	< 0.01	< 0.01	< 0.01	32.8	1	751	750	751.0	
VE-AD19	208	226	7.8	0.07	1.27	1.35	18.8	42	47	5	1.12	
VE-AD20	208	226	8.5	< 0.01	< 0.01	< 0.01	1.1	1	35	34	35.00	
VE-AD21	208	226	8.5	< 0.01	0.04	0.05	< 0.2	2	8	6	4.00	

NOTE: * HYDROCHLORIC ACID SOLUBLE SULFATE
NOTE: ** UNITS = KILOGRAMS CaCO3 EQUIVALENT PER METRIC TONNE (Kg/MT)
NOTE: *** NITRIC ACID SOLUBLE SULFIDE

CERTIFICATION: Sarah Leung

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

A9631399

Comments: ATTN:KEVIN A. MORIN

CERTIFICATE A9631399

(JGG) - MORWIJK ENTERPRISES LTD.

Project: ABANDONED YT MINES.
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 21-SEP-96.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
208	35	Assay ring to approx 150 mesh
226	35	0-3 Kg crush and split
3202	35	Rock - save entire reject

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
1119	35	Paste pH	POTENTIOMETER	0.0	14.0
1379	35	Sulfate S %: Acid or H2O leach	GRAVIMETRIC	0.01	100.00
1066	35	S %: HNO3-bromide digestion	GRAVIMETRIC	0.01	100.00
1380	35	S %: Leco furnace	LECO-IR DETECTOR	0.01	100.0
368	35	CO2 %: Inorganic	LECO-GASOMETRIC	0.2	100.0
1117	35	Maximum potential acidity	CALCULATION	1	4000
1118	35	Neutralization potential	TITRATION	-1000	1000
1970	35	Net neutralization potential	CALCULATION	-2000	2000
1971	35	Neutraliz. pot. acidity ratio	CALCULATION	-10.0	1000.0

Chemex Labs Ltd.

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212 Brooksbank Ave., North Vancouver
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To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A.MORIN

Page Number : 1
Total Pages : 1
Certificate Date: 21-SEP-96
Invoice No. : 19631589
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS A9631589

SAMPLE	PREP CODE	PASTE pH	S % * Sulfate	S % *** Sulfide	S % Total	CO2 % inorg	Max Pot Acid **	Neutral Poten**	Net Neu Poten**	Ratio NP/MPA
KA-AD2	209 1364	7.1	0.06	0.93	1.06	25.2	33	132	99	4.00
VE-AD10	209 1364	6.8	0.04	12.40	12.50	< 0.2	391	1	-390	0.00

NOTE: * HYDROCHLORIC ACID SOLUBLE SULFATE
NOTE: ** UNITS = KILOGRAMS CaCO3 EQUIVALENT PER METRIC TONNE (Kg/MT)
NOTE: *** NITRIC ACID SOLUBLE SULFIDE

CERTIFICATION:

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

A9631589

Comments: ATTN:KEVIN A.MORIN

CERTIFICATE A9631589

(JGG) - MORWIJK ENTERPRISES LTD.

Project: ABANDONED YT MINES.
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 21-SEP-96.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
209	2	High grade assay ring
1364	2	High grade crush and split
3202	2	Rock - save entire reject

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
1119	2	Paste pH	POTENTIOMETER	0.0	14.0
1379	2	Sulfate S %: Acid or H2O leach	GRAVIMETRIC	0.01	100.00
1066	2	S %: HNO3-bromide digestion	GRAVIMETRIC	0.01	100.00
1380	2	S %: Leco furnace	LECO-IR DETECTOR	0.01	100.0
368	2	CO2 %: Inorganic	LECO-GASOMETRIC	0.2	100.0
1117	2	Maximum potential acidity	CALCULATION	1	4000
1118	2	Neutralization potential	TITRATION	-1000	1000
1970	2	Net neutralization potential	CALCULATION	-2000	2000
1971	2	Neutraliz. pot. acidity ratio	CALCULATION	-10.0	1000.0

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
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To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A. MORIN

Certificate Date: 19-SEP-96
Invoice No. :I9631400
P.O. Number :
Account :JGG

CERTIFICATE OF ANALYSIS A9631400

SAMPLE	PREP CODE		As ppm	Sb ppm	Hg ppb	Ag ppm AAS	Al % (ICP)	Ba ppm (ICP)	Be ppm (ICP)	Bi ppm (ICP)	Ca % (ICP)	Cd ppm (ICP)	Co ppm (ICP)	Cr ppm (ICP)	Cu ppm (ICP)	Fe % (ICP)
VAL-AD1	299	285	1	0.6	< 10	< 0.2	8.77	280	2.0	< 2	0.62	< 0.5	21	108	71	5.99
VAL-AD2	299	285	1	0.8	50	< 0.2	0.22	< 10	< 0.5	< 2	22.8	0.5	< 1	9	3	0.56
VAL-AD3	299	285	2	2.8	30	< 0.2	7.36	240	1.5	< 2	1.32	0.5	26	90	36	6.33
VAL-AD4	299	285	1	0.4	20	< 0.2	0.11	10	< 0.5	< 2	20.9	< 0.5	< 1	11	5	0.29
VAL-AD5	299	285	6	0.4	< 10	< 0.2	0.35	10	< 0.5	< 2	19.70	< 0.5	< 1	19	7	1.28
VAL-AD6	299	285	2	0.8	60	< 0.2	0.22	< 10	< 0.5	< 2	22.0	< 0.5	< 1	7	3	0.55
VAL-AD7	299	285	10	1.6	20	< 0.2	0.05	< 10	< 0.5	< 2	20.8	< 0.5	< 1	14	1	1.47
KA-AD1	299	285	2	11.0	930	14.4	0.64	80	< 0.5	< 2	21.5	>500	15	11	42	8.46
KA-AD3	299	285	1	0.8	350	4.2	0.52	10	< 0.5	< 2	6.82	74.5	14	9	10	>25.0
KA-AD4	299	285	1	2.0	120	7.2	0.59	30	< 0.5	< 2	20.3	50.0	11	22	16	12.35
KA-AD5	299	285	1	0.8	140	< 0.2	0.77	40	< 0.5	6	>25.0	1.5	5	22	9	0.74
KA-AD6	299	285	2	0.4	70	< 0.2	1.16	110	< 0.5	< 2	18.65	1.5	2	32	1	1.18
KA-AD7	299	285	1	0.4	10	< 0.2	0.08	10	< 0.5	< 2	22.4	1.5	1	4	5	2.15
KA-AD8	299	285	1	10.0	20	< 0.2	4.04	230	1.0	< 2	13.20	0.5	10	48	32	2.22
KA-AD9	299	285	16	15.0	6420	57.6	0.84	180	< 0.5	< 2	11.00	426	14	50	216	8.71
VE-AD01	299	285	8	2.2	40	0.4	0.96	60	< 0.5	< 2	17.00	4.0	4	46	10	3.90
VE-AD02	299	285	30	4.4	60	1.8	2.44	100	0.5	4	0.50	1.5	1	89	9	0.70
VE-AD03	299	285	10	1.4	10	< 0.2	5.93	310	1.5	4	1.96	0.5	7	85	10	1.80
VE-AD04	299	285	26	2.8	40	0.6	5.90	250	1.5	2	0.20	3.5	15	93	51	2.82
VE-AD05	299	285	28	3.4	30	0.2	3.47	230	1.0	2	0.03	0.5	3	62	10	0.76
VE-AD06	299	285	26	2.2	100	0.6	2.45	100	0.5	2	0.23	1.0	3	94	49	0.73
VE-AD07	299	285	8	1.4	20	< 0.2	6.49	400	1.5	8	0.67	< 0.5	11	69	8	2.54
VE-AD08	299	285	14	2.0	10	0.6	4.85	280	1.0	6	0.30	< 0.5	1	139	14	0.72
VE-AD09	299	285	2	1.4	40	< 0.2	6.88	260	1.0	6	0.14	0.5	15	145	29	4.88
VE-AD11	299	285	560	460	120	>100.0	1.66	50	< 0.5	18	7.35	47.5	7	53	877	11.85
VE-AD12	299	285	1050	290	690	>100.0	2.56	70	< 0.5	18	4.30	175.0	11	43	406	12.40
VE-AD13	299	285	46	15.5	30	8.4	1.27	40	< 0.5	< 2	15.45	8.5	4	35	28	2.26
VE-AD14	299	285	36	18.5	20	12.6	1.68	80	< 0.5	< 2	15.25	3.0	3	50	27	1.56
VE-AD15	299	285	2	0.4	< 10	< 0.2	0.06	< 10	< 0.5	< 2	20.6	< 0.5	< 1	8	< 1	0.68
VE-AD16	299	285	76	5.4	100	0.8	7.60	340	2.0	6	0.55	< 0.5	41	81	20	2.72
VE-AD17	299	285	6	0.6	10	< 0.2	5.91	330	1.5	6	6.92	< 0.5	9	81	3	1.14
VE-AD18	299	285	4	0.6	30	< 0.2	2.39	160	0.5	< 2	14.90	< 0.5	8	44	10	2.49
VE-AD19	299	285	2450	>1000	510	>100.0	1.76	10	< 0.5	< 2	0.36	5.0	18	38	2770	>25.0
VE-AD20	299	285	4	5.0	20	2.6	7.15	90	< 0.5	< 2	0.88	0.5	26	80	27	9.36
VE-AD21	299	285	2	3.4	10	1.6	6.13	50	< 0.5	< 2	7.00	1.5	41	43	150	7.28

CERTIFICATION: Ian Pardoe

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers
212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A. MORIN

Page Number : 1-B
Total Pages : 1
Certificate Date: 19-SEP-96
Invoice No. : I9631400
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS A9631400

SAMPLE	PREP CODE		K % (ICP)	Mg % (ICP)	Mn ppm (ICP)	Mo ppm (ICP)	Na % (ICP)	Ni ppm (ICP)	P ppm (ICP)	Pb ppm AAS	Sr ppm (ICP)	Ti % (ICP)	V ppm (ICP)	W ppm (ICP)	Zn ppm (ICP)	
VAL-AD1	299	285	2.26	2.42	1745	1	1.78	37	380	8	31	0.41	111	10	124	
VAL-AD2	299	285	0.10	13.75	675	< 1	0.03	4	240	14	28	< 0.01	20	< 10	198	
VAL-AD3	299	285	2.86	2.29	2880	< 1	0.09	48	560	14	21	0.36	93	10	106	
VAL-AD4	299	285	0.05	12.60	420	< 1	0.04	< 1	220	12	23	< 0.01	16	< 10	64	
VAL-AD5	299	285	0.11	11.80	1115	< 1	0.08	1	150	16	26	0.01	18	10	60	
VAL-AD6	299	285	0.11	13.25	635	< 1	0.03	< 1	230	12	25	< 0.01	20	< 10	104	
VAL-AD7	299	285	0.04	12.45	1135	< 1	0.04	1	100	10	28	< 0.01	16	< 10	28	
KA-AD1	299	285	0.23	3.10	>10000	< 1	0.01	7	280	2100	58	0.02	41	20	>10000	
KA-AD3	299	285	0.12	0.64	>10000	< 1	0.01	7	430	168	76	< 0.01	37	60	>10000	
KA-AD4	299	285	0.22	1.73	>10000	< 1	0.01	6	360	164	35	0.02	30	40	7420	
KA-AD5	299	285	0.34	1.02	620	1	0.03	7	440	8	406	0.03	40	< 10	136	
KA-AD6	299	285	0.62	10.25	1415	< 1	0.03	6	260	62	99	0.04	25	< 10	212	
KA-AD7	299	285	0.04	10.95	3630	< 1	0.02	1	260	24	57	< 0.01	20	10	288	
KA-AD8	299	285	2.09	5.60	860	< 1	0.05	11	420	42	133	0.22	57	< 10	176	
KA-AD9	299	285	0.37	4.78	>10000	< 1	0.03	11	320	3000	88	0.03	24	20	>10000	
VE-AD01	299	285	0.74	8.28	5130	5	0.03	23	260	80	47	0.01	66	20	722	
VE-AD02	299	285	1.60	0.49	290	23	0.02	14	170	124	7	0.07	388	< 10	298	
VE-AD03	299	285	3.90	1.66	515	1	0.09	17	540	22	15	0.19	86	< 10	94	
VE-AD04	299	285	3.21	1.01	715	12	0.13	45	1040	44	9	0.19	249	< 10	442	
VE-AD05	299	285	2.49	0.32	65	29	0.04	32	180	42	9	0.13	517	< 10	72	
VE-AD06	299	285	1.37	0.35	105	17	0.04	26	630	46	11	0.09	461	< 10	122	
VE-AD07	299	285	4.51	0.85	995	1	0.11	23	770	16	14	0.20	86	< 10	88	
VE-AD08	299	285	2.83	0.59	45	23	0.25	13	1280	18	23	0.13	318	< 10	22	
VE-AD09	299	285	2.47	1.78	425	5	0.26	43	730	22	14	0.33	134	< 10	120	
VE-AD11	299	285	0.91	5.65	8920	< 1	0.03	7	240	3100	19	0.03	33	50	8890	
VE-AD12	299	285	1.48	3.80	>10000	< 1	0.04	13	250	7300	15	0.04	28	40	>10000	
VE-AD13	299	285	0.89	9.14	2230	3	0.02	7	130	404	33	0.03	23	10	1730	
VE-AD14	299	285	1.30	9.00	1390	2	0.01	7	130	186	31	0.04	26	10	710	
VE-AD15	299	285	0.05	12.35	615	< 1	0.04	2	140	14	36	< 0.01	14	< 10	54	
VE-AD16	299	285	5.02	0.86	40	6	0.15	32	1250	56	12	0.22	151	< 10	54	
VE-AD17	299	285	4.93	4.55	510	1	0.18	13	540	10	25	0.19	61	< 10	50	
VE-AD18	299	285	2.22	8.24	1155	< 1	0.03	7	160	6	52	0.06	26	10	26	
VE-AD19	299	285	0.88	3.45	>10000	< 1	0.05	22	280	616	8	0.02	25	50	1085	
VE-AD20	299	285	1.13	5.11	1135	9	0.23	89	1040	20	8	0.46	283	30	140	
VE-AD21	299	285	0.30	4.36	1890	< 1	2.03	56	250	68	147	0.49	298	30	160	

CERTIFICATION:

Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

212 Brooksbank Ave., North Vancouver
British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Comments: ATTN:KEVIN A. MORIN

CERTIFICATE A9631400

(JGG) - MORWIJK ENTERPRISES LTD.

Project: ABANDONED YT MINES.
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 19-SEP-96.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
299	35	Pulp; prepped on other workorder
285	35	ICP - HF digestion charge
287	35	Special dig'n with organic ext'n

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
13	35	As ppm: HNO3-aqua regia digest	AAS-HYDRIDE/EDL	1	10000
22	35	Sb ppm: HCl-KClO3 digest, extrac	AAS-BKGD CORR	0.2	1000
20	35	Hg ppb: HNO3-HCl digestion	AAS-FLAMELESS	10	100000
578	35	Ag ppm: 24 element, rock & core	AAS	0.2	100.0
573	35	Al %: 24 element, rock & core	ICP-AES	0.01	25.0
565	35	Ba ppm: 24 element, rock & core	ICP-AES	10	10000
575	35	Be ppm: 24 element, rock & core	ICP-AES	0.5	1000
561	35	Bi ppm: 24 element, rock & core	ICP-AES	2	10000
576	35	Ca %: 24 element, rock & core	ICP-AES	0.01	25.0
562	35	Cd ppm: 24 element, rock & core	ICP-AES	0.5	500
563	35	Co ppm: 24 element, rock & core	ICP-AES	1	10000
569	35	Cr ppm: 24 element, rock & core	ICP-AES	1	10000
577	35	Cu ppm: 24 element, rock & core	ICP-AES	1	10000
566	35	Fe %: 24 element, rock & core	ICP-AES	0.01	25.0
584	35	K %: 24 element, rock & core	ICP-AES	0.01	10.00
570	35	Mg %: 24 element, rock & core	ICP-AES	0.01	15.00
568	35	Mn ppm: 24 element, rock & core	ICP-AES	5	10000
554	35	Mo ppm: 24 element, rock & core	ICP-AES	1	10000
583	35	Na %: 24 element, rock & core	ICP-AES	0.01	10.00
564	35	Ni ppm: 24 element, rock & core	ICP-AES	1	10000
559	35	P ppm: 24 element, rock & core	ICP-AES	10	10000
560	35	Pb ppm: 24 element, rock & core	AAS	2	10000
582	35	Sr ppm: 24 element, rock & core	ICP-AES	1	10000
579	35	Ti %: 24 element, rock & core	ICP-AES	0.01	10.00
572	35	V ppm: 24 element, rock & core	ICP-AES	1	10000
556	35	W ppm: 24 element, rock & core	ICP-AES	10	10000
558	35	Zn ppm: 24 element, rock & core	ICP-AES	2	10000

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Analytical Chemists * Geochemists * Registered Assayers

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To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
VANCOUVER, BC
V6B 5Z5

Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A.MORIN

Page Number : 1-A
Total Pages : 1
Certificate Date: 24-SEP-96
Invoice No. : I9631590
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS A9631590

SAMPLE	PREP CODE		Ag ppm AAS	Al % (ICP)	Ba ppm (ICP)	Be ppm (ICP)	Bi ppm (ICP)	Ca % (ICP)	Cd ppm (ICP)	Co ppm (ICP)	Cr ppm (ICP)	Cu ppm (ICP)	Fe % (ICP)	K % (ICP)	Mg % (ICP)	Mn ppm (ICP)
KA-AD2	299	290	>200	0.25	< 100	< 10	< 20	0.20	4430	10	20	370	4.25	< 0.1	0.05	1370
VE-AD10	299	290	>200	0.05	< 100	< 10	< 20	< 0.05	50	< 10	30	380	0.40	< 0.1	< 0.05	270

CERTIFICATION: Ian Bichler

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Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A.MORIN

Page Number :1-B
Total Pages :1
Certificate Date: 24-SEP-96
Invoice No. :I9631590
P.O. Number :
Account :JGG

CERTIFICATE OF ANALYSIS A9631590

SAMPLE	PREP CODE		Mo ppm (ICP)	Na % (ICP)	Ni ppm (ICP)	Pb % AAS	Sr ppm (ICP)	Ti % (ICP)	V ppm (ICP)	Zn ppm (ICP)	As %	Hg %
KA-AD2	299	290	< 10	< 0.05	< 10	>10.00	< 10	< 0.05	< 10	>100000	< 0.01	0.001
VE-AD10	299	290	< 10	< 0.05	< 10	>10.00	< 10	< 0.05	< 10	4580	< 0.01	< 0.001

CERTIFICATION:

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V6B 5Z5

A9631590

Comments: ATTN:KEVIN A.MORIN

CERTIFICATE A9631590

(JGG) - MORWIJK ENTERPRISES LTD.

Project: ABANDONED YT MINES.
P.O. # :

Samples submitted to our lab in Vancouver, BC.
This report was printed on 24-SEP-96.

SAMPLE PREPARATION

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION
299	2	Pulp; prepped on other workorder
290	2	Assay HF ICP digestion charge

ANALYTICAL PROCEDURES

CHEMEX CODE	NUMBER SAMPLES	DESCRIPTION	METHOD	DETECTION LIMIT	UPPER LIMIT
1263	2	Ag ppm: high grade 24 element	AAS	0.5	200
4031	2	Al %: A22 ICP package	ICP-AES	0.05	30.0
4032	2	Ba ppm: A22 ICP package	ICP-AES	100	50000
4033	2	Be ppm: A22 ICP package	ICP-AES	10	10000
4034	2	Bi ppm: A22 ICP package	ICP-AES	20	50000
4035	2	Ca %: A22 ICP package	ICP-AES	0.05	30000
4036	2	Cd ppm: A22 ICP package	ICP-AES	10	10000
4037	2	Co ppm: A22 ICP package	ICP-AES	10	100000
4038	2	Cr ppm: A22 ICP package	ICP-AES	10	100000
4039	2	Cu ppm: A22 ICP package	ICP-AES	10	100000
4040	2	Fe %: A22 ICP package	ICP-AES	0.05	30.0
4041	2	K %: A22 ICP package	ICP-AES	0.1	20.0
4042	2	Mg %: A22 ICP package	ICP-AES	0.05	30.0
4043	2	Mn ppm: A22 ICP package	ICP-AES	10	100000
4044	2	Mo ppm: A22 ICP package	ICP-AES	10	100000
4045	2	Na %: A22 ICP package	ICP-AES	0.05	20.0
4046	2	Ni ppm: A22 ICP package	ICP-AES	10	100000
4075	2	Pb %: high grade 24 element	AAS	0.001	10.00
4047	2	Sr ppm: A22 ICP package	ICP-AES	10	100000
4048	2	Ti %: A22 ICP package	ICP-AES	0.05	20.0
4049	2	V ppm: A22 ICP package	ICP-AES	10	50000
4050	2	Zn ppm: A22 ICP package	ICP-AES	20	100000
331	2	As %: HClO4-HNO3 digestion	AAS	0.01	100.0
344	2	Hg %: Aqua regia-MIBK	AAS	0.001	100.00

D. QUALITY ASSURANCE/QUALITY CONTROL (QA/QC)

D.1 Introduction

In order to ensure the integrity of the samples and the quality of the data obtained, the quality assurance/quality control (QA/QC) program was developed to cover all aspects of the program such as, sampling, analysis, data interpretation and evaluation. The program included:

- documentation of sampling (date, time, site identification, site conditions, sampling equipment, sample type, chain-of-custody forms, etc.);
- use of pre-cleaned sampling scoops and containers;
- sample preservation and storage;
- collection of field duplicates;
- analysis of quality control samples to define precision and accuracy and to demonstrate contamination control for the samples and analytes; and.
- data validation.

D.2 Field Program

Prior to sampling, the sampling program and required analytical suites were reviewed with Analytical Services Laboratory (ASL). Pre-cleaned and appropriately sized sample containers were provided by the laboratory along with coolers for storage and transport. All the soil samples were collected, transported, and stored under conditions required for maintaining sample integrity as described in the general protocols presented in Guidance Manual on Sampling, Analysis, and Data Management for Contaminated Sites (CCME, 1993). Test portions of the samples were collected with stainless steel scoops, which have been pre-cleaned, baked and wrapped in aluminum foil to preclude contaminants and placed into the containers. The sample containers were labeled and placed in coolers and

shipped to the laboratory. Time and date of sampling were indicated on the containers and the chain-of custody forms destined which accompanied the samples to ensure that time sensitive analytes such as volatile hydrocarbons were analyzed quickly.

Field duplicates samples were collected from four soil and one water sampling location. In addition, a duplicate sample was obtained from a barrel. These samples were subsequently analyzed to monitor the precision of the sampling and analytical programs.

D.3 Laboratory Analysis

The laboratory QA/QC program included the analysis of field duplicates, a method blank and a matrix spike. The results obtained are discussed in the following sections.

D.3.1 Inorganic Elements (Metal)

Two pairs of soil field duplicates (Table D.1) were analyzed to monitor the precision of the field sampling and analytical processes; one pair of water samples (Table D.2) was also analyzed. Agreement between the duplicates can be measured either by direct comparison or by calculating the relative standard deviation (RSD), which is simply the standard deviation of the duplicates divided by the mean (expressed as a percentage). Values of RSD less than 30% indicate reasonable to good precision, while those exceeding this value are fair to poor. Generally, good precision was indicated for all analytes based on the RSD for detectable analytes; non-detectable analytes had similar detection limit values. The only exception was the RSD for arsenic in the water samples (47%) which indicated poor precision for this particular analyte.

Table D.1: Inorganic Elements Results for Soil Field Duplicate Samples

Total Metals	VE-01S	VE-01S	Mean	RSD	BD 96-04	BD 96-05	Mean	RSD (%)
	Concentration (mg/kg)			(%)	Concentration (mg/kg)			(%)
Aluminum T-Al	17300	15900	16600	**6.0**	13300	12700	13000	**3.3**
Antimony T-Sb	<20	<20			<20	<20		
Arsenic T-As	90.9	104	97.45	**9.5**	365	351	358	**2.8**
Barium T-Ba	111	133	122	**13**	119	115	117	**2.4**
Beryllium T-Be	0.8	0.8	0.8	**0.0**	1	0.8	0.9	**16**
Bismuth T-Bi	<10	<10			36	23	29.5	**31**
Cadmium T-Cd	<2	2	2		8	8	8	**0.0**
Calcium T-Ca	2300	2580	2440	**8.1**	98100	98100	98100	**0.0**
Chromium T-Cr	24	23	23.5	**3.0**	16	15	15.5	**4.6**
Cobalt T-Co	14	15	14.5	**4.9**	6	6	6	**0.0**
Copper T-Cu	73	103	88	**24**	29	23	26	**16**
Iron T-Fe	34400	34600	34500	**0.4**	24900	22200	23550	**8.1**
Lead T-Pb	146	177	161.5	**14**	735	705	720	**2.9**
Lithium T-Li	15	12	13.5	**16**	10	9	9.5	**7.4**
Magnesium T-Mg	5510	4690	5100	**11**	62500	62900	62700	**0.5**
Manganese T-Mn	985	993	989	**0.6**	1690	1410	1550	**13**
Mercury	0.044	0.066	0.055	**28**	0.321	0.313	0.317	**1.8**
Molybdenum T-Mo	11	16	13.5	**26**	<4	<4		
Nickel T-Ni	80	110	95	**22**	15	13	14	**10**
Phosphorus T-P	919	1040	979.5	**8.7**	776	719	747.5	**5.4**
Potassium T-K	4940	4640	4790	**4.4**	4210	4210	4210	**0.0**
Selenium T-Se	0.5	0.6	0.55	**13**	0.3	0.3	0.3	**0.0**
Silicon T-Si	-	-			-	-		
Silver T-Ag	<2	<2			6	5	5.5	**13**
Sodium T-Na	<200	<200			284	268	276	**4.1**
Tin T-Sn	<10	<10			<10	<10		
Titanium T-Ti	248	239	243.5	**2.6**	207	156	181.5	**20**
Vanadium T-V	80	76	78	**3.6**	30	29	29.5	**2.4**
Zinc T-Zn	790	859	824.5	**5.9**	2430	2400	2415	**0.9**

RSD = Relative Standard Deviation

Table D.2: Inorganic Elements Results for Water Field Duplicate Sample

	VE-01S	VE-01S Dup.	Mean	RSD
	Concentration (mg/L or ppm)			%
Aluminum T-Al	<0.2	<0.2		
Antimony T-Sb	<0.2	<0.2		
Arsenic T-As	0.006	0.003	0.0045	**47**
Barium T-Ba	0.02	0.02	0.02	**0.0**
Beryllium T-Be	<0.005	<0.005		
Bismuth T-Bi	<0.1	<0.1		
Boron T-B	<0.1	<0.1		
Cadmium T-Cd	<0.01	<0.01		
Calcium T-Ca	61	61.1	61.05	**0.1**
Chromium T-Cr	<0.01	<0.01		
Cobalt T-Co	<0.01	<0.01		
Copper T-Cu	<0.01	<0.01		
Iron T-Fe	0.21	<0.03		
Lead T-Pb	<0.05	<0.05		
Lithium T-Li	<0.01	<0.01		
Magnesium T-Mg	34.8	35.2	35	**0.8**
Manganese T-Mn	0.04	<0.005		
Mercury	<0.00005	<0.00005		
Molybdenum T-Mo	<0.03	<0.03		
Nickel T-Ni	<0.02	<0.02		
Phosphorus T-P	<0.3	<0.3		
Potassium T-K	<2	<2		
Selenium T-Se	0.0012	0.0012	0.0012	**0.0**
Silicon T-Si	1.58	1.5	1.54	**3.7**
Silver T-Ag	<0.01	<0.01		
Sodium T-Na	<2	<2		
Strontium T-Sr	0.046	0.046	0.046	**0.0**
Thallium T-Tl	<0.1	<0.1		
Tin T-Sn	<0.30	<0.30		
Titanium T-Ti	<0.01	<0.01		
Vanadium T-V	<0.03	<0.03		
Zinc T-Zn	0.17	0.11	0.14	**30**

RSD = Relative Standard Deviation

D.3.2 Extractable Petroleum Hydrocarbons in Soils

The RSDs for extractable petroleum hydrocarbons EPH (C10-18) and EPH (C19-31) concentrations in the field duplicate sample analyzed were 14% and 8.1%, respectively (Table D.3). This indicated good precision.

Table D.3: Extractable Petroleum Hydrocarbons (EPH) Results for Soil Replicates

	VE-01S	VE-01S Duplicates	Mean	RSD %
EPH (C10-18)	7080	5810	6445	14
EPH (C19-31)	3050	3420	3235	8.1

Results are expressed as mg/kg or ppm
RSD = Relative Standard Deviation

D.3.3 Polycyclic Aromatic Hydrocarbons

The quality control samples for PAH analysis included a method blank, a matrix spike and one field duplicate soil sample. Method blank and spike results (Table D.4) indicated that accuracy and interference control were acceptable. Good agreement was also found for the replicates on the basis of relative standard deviations (RSD) or similar detection limit values (Table D.4).

Table D.4: Quality Control Data for Polycyclic Aromatic Hydrocarbon Analysis

	Method Blank	Matrix Spike %	VE-01S	VE-01S Field Duplicates	Mean	RSD %
Acenaphthene	<0.01	105	0.22	0.16	0.19	22
Acenaphthylene	<0.01	96	<0.05	<0.05		
Anthracene	<0.01	99	0.34	0.27	0.31	16
Benzo(a)anthracene	<0.01	103	0.07	0.06	0.07	11
Benzo(a)pyrene	<0.01	97	<0.05	<0.05		
Benzo(b)fluoranthene	<0.01	92	<0.05	<0.05		
Benzo(g,h,i)perylene	<0.01	103	<0.05	<0.05		
Benzo(k)fluoranthene	<0.01	91	<0.05	<0.05		
Chrysene	<0.01	94	0.23	0.2	0.22	9.9
Dibenz(a,h)anthracene	<0.01	102	<0.05	<0.05		
Fluoranthene	<0.01	102	0.34	0.23	0.29	27
Fluorene	<0.01	97	0.08	0.06	0.07	20
Indeno(1,2,3-c,d)pyrene	<0.01	104	<0.05	<0.05		
Naphthalene	<0.01	96	<0.05	0.05		
Phenanthrene	<0.01	98	0.14	0.09	0.12	31
Pyrene	<0.01	106	2.56	2.12	2.34	13

D.3.4 Barrel Samples

Most of the analytes in the duplicate sample analyzed were below detection. Poor precision was obtained for total organic halogens (44%), calcium (63%) and iron (42%).

Table D.5: Results for Duplicate Barrel Samples

Sample	VE-A2	VE-A2 Duplicate	Mean	RSD %
Total Organic Halogens	124	65	94	44
Aluminum	<2	<2		
Antimony	<2	<2		
Arsenic	<3	<3		
Barium	0.01	<0.01		
Beryllium	<0.06	<0.06		
Cadmium	<0.2	<0.2		
Calcium	0.7	0.3	0.45	63
Chromium	<0.3	<0.3		
Cobalt	<0.2	<0.2		
Copper	<0.2	<0.2		
Iron	0.7	0.4	0.5	42
Lead	<0.8	<0.8		
Magnesium	0.15	0.14	0.145	5
Manganese	<0.03	<0.03		
Molybdenum	<0.4	<0.4		
Nickel	<0.3	<0.3		
Phosphorus	<4	<4		
Silver	<0.3	<0.3		
Sodium	9	<1		
Strontium	<0.01	<0.01		
Tin	<0.3	<0.3		
Titanium	<0.06	<0.06		
Vanadium	<0.1	<0.1		
Zinc	0.4	<0.2		
Zirconium	<0.2	<0.2		

E. Geographic Positioning System (GPS) Co-ordinates for Field Investigation

Location	Latitude	Longitude
Drill hole below disturbed trench area	64 - 17.14N	134 - 12.01W
Debris area (walking in direction towards wood helipad)	64 - 17.18N	134 - 11.71W

F. ENVIRONMENTAL QUALITY CRITERIA

Table F-1: CCME (1991) Interim Environmental Quality Criteria for Contaminated Sites - Assessment Criteria

SUBSTANCE	SOIL (µg/g)	WATER (µg/L)	SUBSTANCE	SOIL (µg/g)	WATER (µg/L)
Inorganics			**Monocyclic Aromatic Hydrocarbons (cont)**		
aluminum	---[1]	---			
ammonia	---	---	1,3-dichlorobenzene	0.1	0.2
antimony	20[2]	---	1,4-dichlorobenzene	0.1	0.2
arsenic	5	5	ethylbenzene	0.1	0.5
barium	200	50	styrene	0.1	0.5
beryllium	4	---	toluene	0.1	0.5
boron (hot water soluble)	1	---	xylenes	0.1	0.5
boron (total)	----	---			
cadmium	0.5	1	***Phenolic Compounds***		
chromium (+6)	2.5	---	non-chlorinated[3] (each)	0.1	0.1
chromium (total)	20	15	chlorophenols[4] (each)	0.05	1
cobalt	10	10			
copper	30	25	***Polyaromatic Hydrocarbons (PAHs)***		
cyanide (free)	0.25	40	PAHs (Total)		
cyanide (total)	2.5	40	benzo(a)anthracene	0.1	0.01
fluoride (total)	200	---	benzo(a)pyrene	0.1	0.01
iron	---	---	benzo(b)fluoranthene	0.1	0.01
lead	25	10	benzo(k)fluoranthene	0.1	0.01
manganese	---	---	dibenz(a,h,)anthracene	0.1	0.01
mercury	0.1	0.1	indeno(1,2,3-c,d)pyrene	0.1	0.1
molybdenum	2	5	naphthalene	0.1	0.2
nickel	20	10	phenanthrene	0.1	0.2
selenium	1	1	pyrene	0.1	0.2
silver	2	5			
sulphur (elemental)	250	---	***Chlorinated Hydrocarbons***		
thallium	0.5	---	chlorinated aliphatics[5] (each)	0.1	0.1
tin	5	10	chlorobenzenes[6] (each)	0.05	0.3
vanadium	25	---	hexachlorobenzene	0.1	0.1
zinc	60	50	hexachlorocyclohexane	0.01	---
			Chlorinated Pesticides	---	---
Aliphatic Organics			PCBs[7]	0.1	0.1
non-chlorinated aliphatics (each)	0.3	---	PCDDs and PCDFs[8]	1E-05	---
Monocyclic Aromatic Hydrocarbons			***Miscellaneous Organics***		
benzene	0.05	0.5	phthalic acid esters (each)	30	---
chlorobenzene	0.1	0.1	quinoline	0.1	---
1,2-dichlorobenzene	0.1	0.2	thiophene	0.1	---
			2,4-D	---	---
			2,4,5-T	---	---

1: --- not evaluated by CCME or too little information (Notes are shown at the end of Table 1-3)

Table F-2: Relevant Soil Remediation Criteria/Standards

Substance	CCME /B.C. Residential/ Parkland	CCME/B.C. Commercial/ Industrial	Substance	CCME /B.C. Residential/ Parkland	CCME/B.C. Commercial/ Industrial
Inorganics			***Phenolic Compounds***		
aluminum	---		non-chlorinated[3] (each)	1	10
ammonia	---		chlorophenols[4] (each)	0.5	5
antimony	20	40			
arsenic	30	50	***Polyaromatic Hydrocarbons (PAHs)***		
barium	500	2000	PAHs (Total)		
beryllium	4	8	benzo(a)anthracene	1	10
boron (total)	---	---	benzo(a)pyrene	1	10
cadmium	5	20	benzo(b)fluoranthene	1	10
chromium (+6)	8	---	benzo(k)fluoranthene	1	10
chromium (total)	250	800	dibenz(a,h,)-anthracene	1	10
cobalt	50	300	indeno(1,2,3-c,d)-pyrene	1	10
copper	100	500	naphthalene	5	50
cyanide (free)	10	100	phenanthrene	5	50
cyanide (total)	50	500	pyrene	10	100
fluoride (total)	400	2000	chrysene	---	---
iron	---	---	3-methylcholanthrene	---	---
lead	500	1000	benzo(g,h,i)-perylene	---	---
manganese	---	---	dibenzo(a,h)pyrene	---	---
mercury	2	10	dibenzo(a,i)pyrene	---	---
molybdenum	10	40	dibenzo(a,l)pyrene	---	---
nickel	100	500	acenaphthene	---	---
selenium	3	10	acenaphthylene	---	---
silver	20	40	anthracene	---	---
thallium	---	---	fluoranthene	---	---
tin	50	300	fluorene	---	---
vanadium	200	---			
zinc	500	1500	***Chlorinated Hydrocarbons***		
			chlorinated aliphatics[5] (each)	5	50
Monocyclic Aromatic Hydrocarbons			chlorobenzenes[6] (each)	2	10
benzene	0.5	5	hexachlorobenzene	2	10
chlorobenzene	1	10	hexachloro-cyclohexane	---	---
1,2-dichlorobenzene	1	10	chlorinated pesticides		
1,3-dichlorobenzene	1	10	PCBs[7]	5	50
1,4-dichlorobenzene	1	10	PCDDs and PCDFs[8]	0.001	---
ethylbenzene	5	50	***Miscellaneous Organics***		
styrene	5	50	2,4-D	---	---
toluene	3	30	2,4,5-T	---	---
xylenes	5	50	Volatile Petroleum Hydrocarbons	200	200
			Light Extractable Petroleum Hydrocarbons	1000	2000
			Heavy Extractable Petroleum Hydrocarbons	1000	5000
			Non-aqueous phase liquids	not present	not present

(All values in µg/g dry weight; notes are shown at the end of Table 1-3)

Table F-3: CCME (1991) and BCMELP (1995) Water Criteria

Substance	CCME (1991)		BCMELP (1995) (where different from CCME Criteria)	
	Freshwater Aquatic Life[9]	Drinking Water[10,11]	Aquatic Life	Drinking Water
General parameters				
oxygen, dissolved	5 to 9.5 mg/L	---		
pH	6.5 to 9	6.5 to 8.5		
conductivity	---	---		
sodium adsorption ratio	---	---		
total dissolved solids	---	≤ 500 mg/L[12,13]		
Inorganics				
aluminum	5 to 100[14]	---	5 to 50[23]	200
ammonia	1.37 to 2.2 mg/L[15]	---	131 to 1840[23]	---
antimony	---	---		
arsenic	50	25[16]		
barium	---	1000[16]	1000	
beryllium	---	---	5.3	---
boron (hot water soluble)	---	---		
boron (total)	---	5000[10]		
cadmium	0.2 to 1.8[17]	5		
chromium (+6)	---	---		
chromium (total)	2 to 20	50	2	
cobalt	---	---	50	---
copper	2 to 4[17]	≤ 1000[10]	2 to 8[17]	1000
cyanide (free)	5	---		
cyanide (total)	---	200[10]		
fluoride (total)	---	1500[10]	200 to 300[17]	
iron	300	≤ 300[16]		300
lead	1 to 7[17]	10[16]	3 to 11[17]	
manganese	---	≤ 50[16]	100	50
mercury	0.1	1		
molybdenum	---	---	1000	n.e.
nickel	25 to 150[17]	---		
selenium	1	10		
silver	0.1	---		
sulphur (elemental)	---	---		
thallium	---	---		
tin	---	---		
vanadium	---	---		
zinc	30	≤ 5000[16]		5000
Monocyclic Aromatic Hydrocarbons				
benzene	300	5		
ethylbenzene	700	≤ 2.4		2.4
styrene	---	---		
toluene	300	≤ 24		
xylenes	---	≤ 300		300

(all values in µg/L)

Table F-3 (continued)

Substance	CCME (1991)		BCMELP (1995) (where different from CCME Criteria)	
	Freshwater Aquatic Life[9]	Drinking Water[10,11]	Aquatic Life	Drinking Water
Phenolic Compounds				
non-chlorinated[2] (each)	---	---		
chlorophenols[3] (each)	0.2 to 18[19]	<0.3 to 900[19,20]	0.02 to 0.9[24]	0.3 to 30[24]
Polyaromatic Hydrocarbons (PAHs)				
PAHs (Total)				
benzo(a)anthracene	---	---	0.1	---
benzo(a)pyrene	---	0.01	0.01	
benzo(b)fluoranthene	---	---		
benzo(k)fluoranthene	---	---		
dibenz(a,h,)anthracene	---	---		
indeno(1,2,3-c,d)pyrene	---	---		
naphthalene	---	---	1	---
phenanthrene	---	---	0.3	---
pyrene	---	---	0.02	---
acenaphthene			6	---
anthracene			0.1	---
fluoranthene			0.2	---
fluorene			12	---
Chlorinated Hydrocarbons				
chlorinated aliphatics[4] (each)	---	---		
dichloroethane, 1,2-	100	5 [16,18]		
dichloromethane	---	50		
trichloroethylene	20	50 [16]		
tetrachloroethylene	260 [18]	---		
chlorobenzenes[5] (each)	0.0065 to 15[19]	≤ 1 to 200[16,19]		1 to 50[24]
hexachlorobenzene				
hexachlorocyclohexane	0.01	---		
chlorinated pesticides	0.001 to 4[20]	0.7 to 280[20]		
PCBs[6]	1 ng/L	---	0.0001	---
PCDDs and PCDFs[7]	---	---		
Miscellaneous Organics				
2,4-D	4	100 [11]		
2,4,5-T	---	280; ≤ 20	---	20

Footnotes to Tables F-1, F-2, and F-3:

n.a.: not applicable.

1. ---.: not established.

2: Set equal to CCME Agricultural Remediation Criterion

3: Including 2,4-dimethylphenol, 2.4.-dinotriphenol, 2-methyl 4,6-dinitrophenol, nitrophenol (2-,4-), pentachlorophenol.

4: Including chlorophenol isomers, di- to tetrachlorophenols, pentachlorophenol.

5: Including chloroform, dichloroethane(1,1- 1,2-), dichloroethene (1,1- 1,2-), dichloromethane, 1,2-dichloropropane, 1,2-dichloropropene, 1,1,2,2-tetrachlorethane, tetrachloroethene, carbon tetrachloride, trichloroethane (1,1,1- 1,1,2-), trichloroethene.

6: Including all tri- and tetrachlorobenzene isomers, pentachlorobenzene

7: Include Aroclor mixtures 1242, 1248, 1254, 1260.

8: PCDDs and PCDFs as expressed in 2,3,7,8-TCDD toxic equivalents (NATO I-TEFs).

9: Guidelines for heavy metals and trace ions are reported as total concentrations in an unfiltered sample.

10:Drinking water guidelines expressed as maximum acceptable concentrations in unfiltered samples at the point of consumption.

11: Several parameters also have aesthetic objectives; these are indicated by a "<" symbol.

12: Guideline under review for addition to the GCDWQ or possible changes in value.

13: Approximately equal to a conductivity of 1dS/m.

14: Under review: number shown is a modification of previous guideline.

15: Tentative value due to insufficient evidence.

16: A modification of the previous Guidelines for Canadian Drinking Water Quality (Health and Welfare Canada, 1989) is proposed.

17: Guidelines vary with hardness.

18: Tentative Drinking Water Guideline due to insufficient evidence.

19: Criteria vary depending on number and positions of chlorines; see CCME(1991) for additional details.

20: Values vary across individual pesticides; see CCME(1991) for additional details.

21: Values reported include analytes not covered by CCME R/P Criteria.

22: BCMELP (1995) Criteria for Managing Contaminated Sites in British Columbia are identical to CCME (1991) Remediation Criteria for Soils.

23: Value varies depending on pH.

24: Criteria vary depending on number and positions of chlorines; see BCMELP(1989) for additional details.