

**ENVIRONMENTAL ASSESSMENT
OF
YUKON ABANDONED MINE SITES:
VAL EXPLORATION SITE**

**Report Prepared for
Public Works and Government Services Canada**

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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 Val Exploration Site, 128 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 to determine the degree and type of contamination and estimated soil volumes.

The Val exploration area is remote from any populated areas and there was minimal debris present aside from a corebox cache and isolated boxes scattered along the stream running through the site, rebar associated with the cache, and an isolated fuel barrel to the north of the site. Tests on the lone barrel sample for metals and halides indicated that the contents could be safely incinerated. The public safety risks associated with this site are negligible. A number of exploration trails were noted on the surrounding slopes, but no mining portals or adits were identified.

The probability of acid drainage on a large scale at Val was indicated to be minimal based on the abundant dolomite and limestone in the area which would likely neutralize any acidic drainage. Similar results were found for acid drainage on medium and small scales based on acid base tests. Much of the ore-grade rock was also moved to nearby Val (5 km north) and would probably account for a general lack of net-acid-generating rock at this site.

Lead, zinc and arsenic contamination were identified in soil below the main core box piles by the stream indicating these cores could be a significant source of metal contaminants to the stream environment. The presence of cores in the stream could result in the direct release of metals, as typified by elevated levels of zinc and selenium detected in the stream waters which exceeded the CCME freshwater criteria. This may pose a low to moderate risk to receiving waters supporting fish and other aquatic life to the southwest of the site. It is recommended that the core box caches and the cores in the stream be removed from the site, along with the barrel and rebar, and transported to the Vera Mine Site nearby for disposal.

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1. Introduction and Background

A number of abandoned mining exploration and development sites, including Val, 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 Val exploration site.

1.1 Location and Site Access

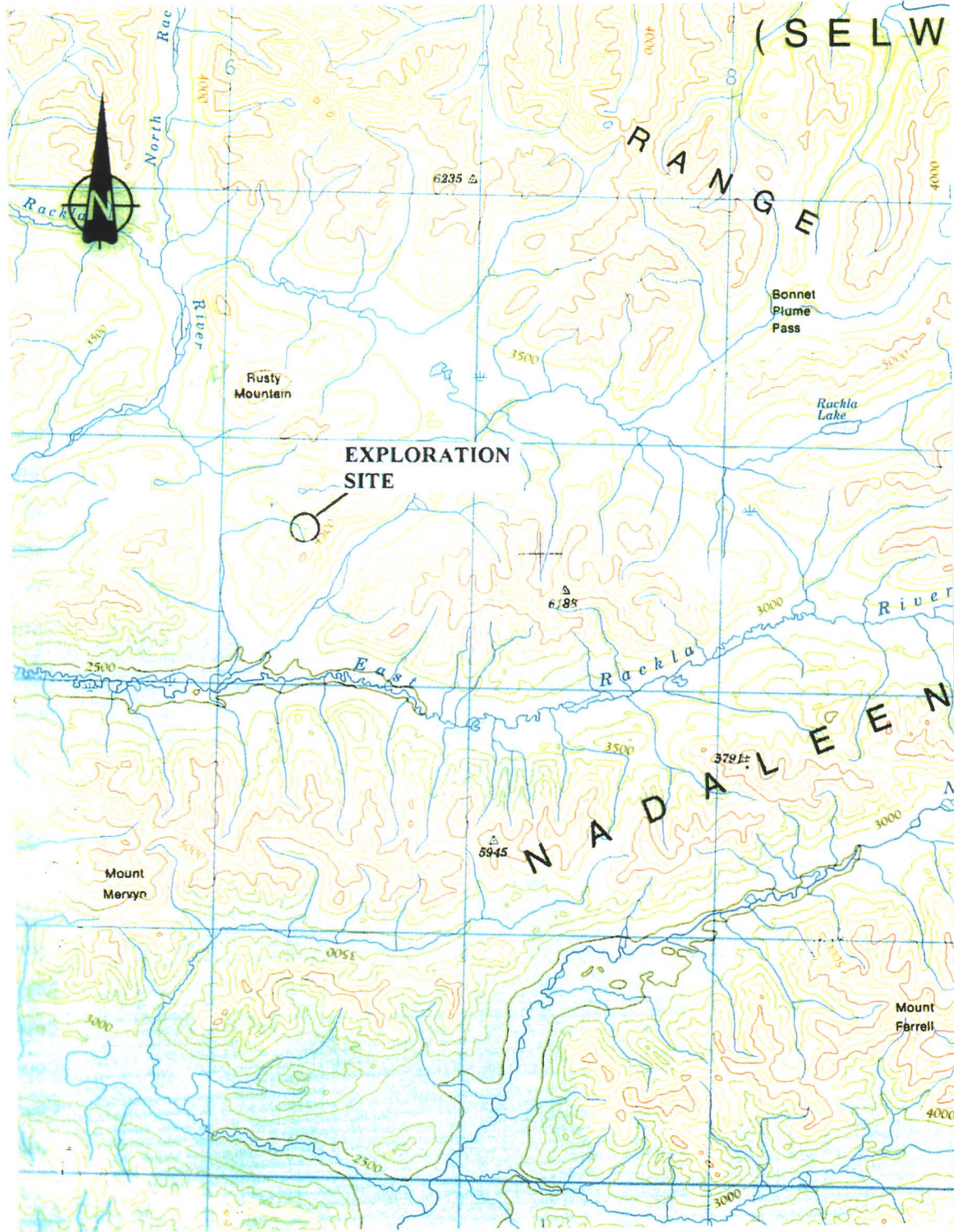
The Val site (65° 15' 36" N, 133° 41' 44" W) is located in northeastern Yukon, 128 km northeast of Mayo, at a remote location in the Selwyn Mountains, 5 km south of Rusty Mountain between the Rackla and Nadaleen Ranges (Map 1-1.). The exploration site is approximately 1450 m above sea level on the west-facing slope of an unnamed mountain (Photograph 1-1). Site access is primarily by helicopter. In the past, much of the exploration work equipment was probably taken in along winter roads past McQuesten and Kathleen Lakes along the Rackla River. Many of the trails leading into the area are now overgrown with vegetation and are poorly defined (DIAND Technical Services, 1994).

1.2 Overview of Site Development

A work history of the site was compiled by DIAND Technical Services (1994) using information supplied from DIAND Yukon Minfile record 106C 085 and the Indian and Northern Affairs Mining Recorder's Office in Mayo, Yukon. This information is summarized below.

The site was first staked in 1978 as 318 Val claims by Prism Joint Ventures, a group of resource companies including Prism Resources Ltd,. Mapping was conducted in the area along with geochemical surveys, hand trenching, and ten drill holes with a total length of 456 m. Dome Petroleum Ltd. replaced one of the companies in the venture (Siebens Oil and Gas Ltd.) in 1979 adding more Val claims and exploration, including an additional 4461 m drilled from 48 holes by 1980, and 630 m drilled from 16 holes on the Siltstone by 1981. Trenching and prospecting was completed in 1982. Interest was dropped by Dome Petroleum in 1983 and another member company, E&B Exploration Ltd., transferred its interest to Imperial Metals Ltd. By 1985, Prism had changed its name to International Prism Exploration Ltd. and continued to trench and drill geochemical anomalies in the Big Red Zone. Drilling and environmental studies along the proposed road route were completed in 1988 with International Prism purchasing 100% working interest in the property in 1989 (DIAND Technical Services, 1994). The Val Group claim made by Prism Resources Ltd. was current in March of 1992 and silver, lead and zinc were identified as the major commodities. This claim expired in 1994 (DIAND Technical Services, 1994). A small number of these (Val 295-298) have been renewed until January of 1998 (Assistant Mining Recorder, Indian and Northern Affairs Office, pers. comm.).

No permanent camp facilities were noted, and it is probable that the Vera Site camp located 5 km to the north on Rusty Mountain was used as the base for this site. This is supported by the discovery of Val-labelled coreboxes stored at the Vera site. A few abandoned coreboxes and a single fuel barrel remain along a creek ravine below the exploration mountain. Much of the physical development in the area includes access roads, drilling and trenching scattered along mountain slopes in the area. No mine adit development or large areas of waste rock are found at the site.



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



**Photograph 1-1: 1968 Aerial Photograph of Val Exploration Site
(1:55000 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 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 visited 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 Val 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; potential human safety risks; and
- 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 Val site:

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

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

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; and
- 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 compiled 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 photodocumentation, and to identify site features;

- *Buildings and other structures* were examined for hazardous materials and assessed for structural stability;
- *Non-hazardous site debris* was examined and inventoried;
- *Contaminated soil areas* were sampled and measured to determine the degree and type of contamination and to estimate soil volumes;
- *Barrels and other containers* were examined, inventoried and the contents sampled for hazardous liquid materials;
- *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.

Water

Surface water samples were collected into a pair of 250 ml acid-washed nalgene bottles by immersing them just under the water surface. A 1 ml aliquot of sulphuric acid was used to acidify each sample for preservation. These containers were labelled and placed in coolers. Sample information and transport was conducted in the same manner as for soils described above.

Barrels

Barrels to be sampled were set in an upright position and opened using a bung wrench and appropriate safety measures. A 25 mL glass sampling tube (Drum Thief, Lab Safety Supply Inc.) was inserted to just above the bottom of the barrel to obtain a vertically integrated sample. By placing a finger on the end of the tubing, some of the contents were removed and placed in a labeled 40 mL vial equipped with a Teflon lined lid. Samples were generally collected in triplicate; one set was earmarked for the determination of total chlorine (total organic halides - TOX), the second set for the analysis of metals by inductively coupled plasma spectrometry (ICP) while the third set was held for polychlorinated biphenyls (PCBs) analysis by gas chromatography, pending the TOX

results of. The barrels were then closed and labeled with the corresponding sample number using spray paint. The samples were shipped to Cantest Laboratories, Vancouver, for analysis.

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, airstrip surfaces, waste rock around the portal, 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. To provide an indication of acidic drainage, readings of pH levels using standard litmus paper were obtained at seepages and waterways.

3.1.3 Chemical Analysis

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

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).

Metals in Water

This analysis was carried out using procedures described in "Standard Methods for the Examination of Waste Water", 19th Edition, 1995, published by the American Public Health Association, and with procedures adapted from "Test Methods for Evaluating

Solid Waste” SW-846 Method 3050 or Method 3051, published by the US EPA. Elements analyzed included aluminum (Al), antimony (Sb), arsenic (As), barium (Ba), beryllium (Be), bismuth (Bi), boron (B), cadmium (Cd), calcium (Ca), chromium (Cr), cobalt (Co), copper (Cu), iron (Fe), lead (Pb), lithium (Li), magnesium (Mg), manganese (Mn), molybdenum (Mo), nickel (Ni), phosphorus (P), potassium (K), selenium (Se), silicon (Si), silver (Ag), sodium (Na), strontium (Sr), Thallium (Th), tin (Sn), Titanium (Ti), vanadium (V) and zinc (Zn)

Mercury in Water

This analysis was carried out using procedures described in “Standard Methods for the Examination of Water and Wastewater”, 19th Edition, 1995, published by the American Public Health Association.

Barrel Content Analysis - Inorganic Elements and TOX

Aliquots of the oil were ashed in a quartz vessel at 550 °C. After digesting the ash with aqua-regia the resulting solutions were analyzed for metals by ICP.

Total Organic Halogens were determined using ASTM method D808-87.

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 Val 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.

There are currently no federal or Yukon territorial regulations in place which deal specifically with used oil management; however, legislation or guidelines have been developed on a provincial basis to address the handling, treatment and disposal of used oil. These are discussed and summarized in the *Review of Ambient Air Quality Standards and Used Oil Regulations*, put out by Northwest Territories (NWT, 1993) Renewable Resources. A general overview summary of accepted levels of contaminant present in waste oil prior to incineration are summarized in Appendix F (Table 4). Some provinces, such as British Columbia, use a two-tiered approach whereby one tier applies to cement kiln operation, whereas the other applies to more conventional methods of incineration.

The available criteria specifically used for comparing fuels and waste oil investigated and analyzed at this site were generally the more stringent and commonly-used values on a provincial-wide basis. These were as follows:

- Total organic halogens (TOX): 1000 mg/L (or ppm);
- Arsenic: 5 mg/L (or ppm);
- Cadmium: 2 mg/L (or ppm);
- Chromium: 10 mg/L (or ppm);
- Lead: 100 mg/L (or ppm).

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 at Val are reported to be the Middle Proterozoic Gillespie Group dolomite and carbonate rocks of the Late Proterozoic Pinguicula Group with the economic metals at Val being lead, silver, and minor zinc apatite (DIAND Technical Services, 1994). At the nearby abandoned exploration camp, Vera, a desk was found containing a geologic column stamped, "Open File 205, June 1974, Geological Survey Ottawa". This column presumably represents the rock units in the area, but there was no mention of the Gillespie and Pinguicula Group. Nevertheless, most of the formations in the column do contain widespread dolomite and limestone.

4.2 Climate

Climate in the area is predominantly sub-alpine, to alpine on the mountain slopes, with freezing temperatures and snow arriving in late August and dissipating by late June. Based on climate information at similar altitudes in the region, annual precipitation is probably 500 to 700 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). Numerous small creeks drain off the exploration area into the East Rackla River. Many of these are small and seasonal, flowing during periods of snowmelt and heavy rains (DIAND Technical Services, 1994). The main area of debris, consisting of the abandoned coreboxes, is situated along the base of a ravine below these slopes (Photograph 4-2). A stream flows (~1 L/sec.) along this ravine to the west and eventually turns south to join the East Rackla River a few kilometres beyond. A second stream (~3 L/sec.), running along a shallow gully from the north, intersects this first stream approximately 70 m west and downstream of the main pile of coreboxes.

Surface substrate in the area consists primarily of coarse sand and silt glacial till which overlays weathered bedrock. A few pockets of sand and organic soil also occur in some of the built-up areas along the banks of the ravine.

Permafrost was not encountered in any of the shallow testpits excavated; however, it is anticipated that discontinuous frozen ground is present in the area.

4.4 Vegetation

Vegetation in the exploration areas along the mountain slopes, which rise above the tree line, is predominantly alpine, consisting of a few sparsely-spaced trees of black spruce (*Picea maritima*), and low shrubs and perennial plants including dwarf birch (*Betula* sp.), mountain aven (*Dryas* sp.) and a few grasses and sedge (*Carex* sp.). Black spruce (to 6 m high) are more prevalent along some of the drier slopes and mountain ravines. While willows (*Salix* sp.) are common along the banks of streams and in wetter areas along ravines.

4.5 Fish and Wildlife Resources

Little evidence of wildlife activity was apparent at the time of the site visit, although grizzly bears and other game, such as caribou, occur in the region and probably feed in this area during the summer months. The East Rackla River to the south is currently unclassified by the Yukon Placer Authorization (Nick de Graff, YTG Fisheries, pers.comm.), but receiving areas in its drainage consist of habitat capable of supporting spawning by trout, salmon and char. The smaller streams at the higher elevations around the exploration site are reported to be seasonal (DIAND Technical Services, 1994) and it is therefore unlikely that they would be capable of supporting fish.



Photograph 4-1: Exploration trails on slopes surrounding Val site



Photograph 4-2: Core box cache and stream running through site to the west

5. Site Description And Findings

5.1 Buildings, Infrastructure, and Equipment

Evidence of mine exploration activity was limited to a number of trails and small trenches high on the surrounding hillslopes and ridges, and core box caches in a small valley adjacent to a creek. A majority of these trenches were within 2 km of the core box cache valley, but were too numerous to document given the limited time constraints at the site. No camp facilities were observed in the area during the 1996 site investigation and it is suspected that Vera Mine site located 5 km to the north was used as a base for this exploration site. An overview of the site is presented in Map 5-1.

5.2 Non-hazardous Waste Materials

Approximately 300 core boxes in total were found scattered along the streambed for a distance of approximately 175m downstream to the west. These were apparently washed down the stream during periods of flooding from two large, collapsed, adjacent core box caches further upstream (refer to Photographs 5-2 and 5-3). Other materials included rebar and scrap wood associated with the core-box caches at the site. No evidence of staining, dumps or buried material was observed anywhere in the immediate vicinity

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). These along with

Contents of fuel barrels found in the various storage areas and potentially contaminated soil areas are discussed in the sub-sections below.

Barrel

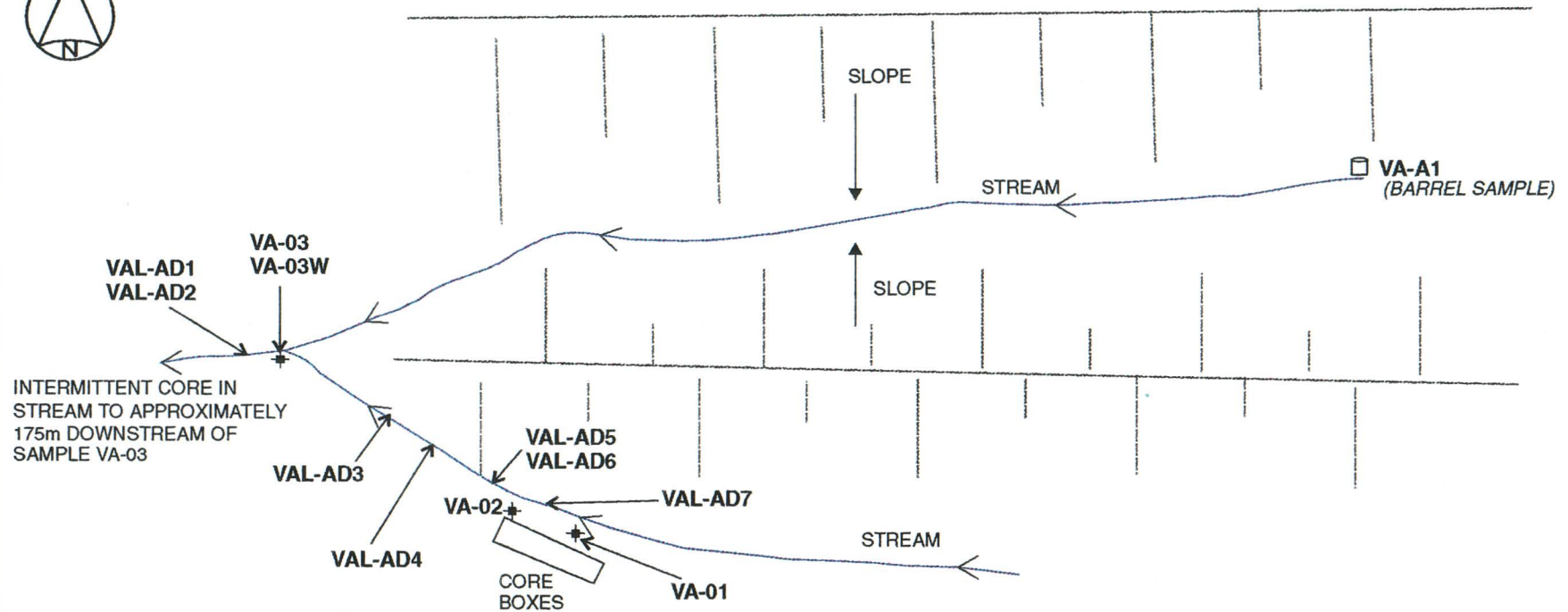
In 1993, only one 204 L barrel of jet fuel was identified at the site (DIAND Technical Report, 1994). This lone barrel (Photograph 5-1) was located at the foot of a large bowl near the top end of the ravine of the stream, described in section 4.3, draining the slopes to the northwest of the abandoned core boxes. The barrel was positioned approximately 250 m upstream of the confluence of the two streams (Map 5-1). One sample, VA-A1, was obtained from this barrel, which was 1/3 full, and analyzed for total organic halogens (TOX, e.g., chlorine and bromine) and total metals; selected results (those results for which guidelines are available for comparison) are presented in Table 5-1 below. Full analytical results are provided in Appendix A.

Table 5-1: Selected Analytical Results for Total Organic Halogens (TOX) and Metals in Barrel Sample from Val Exploration Site.

| SAMPLE | VA-A1 | General Criteria ¹ |
|------------------------|---|-------------------------------|
| (ug/g or ppm) | | |
| Total Organic Halogens | 62 | 1000 |
| Arsenic | <3 | 5 |
| Cadmium | <0.2 | 2 |
| Chromium | <0.3 | 10 |
| Lead | 1.5 | 100 |
| Description | Lone barrel in N-most stream valley floodbank, 250 m upstream of confluence, clear fluid (diesel), marked "PRISM H DIESEL MARCH 80", one-third full | |

¹ Based on guidelines for accepted levels of contaminants in waste oil for conventional incineration in most Canadian jurisdictions (see Section 3.3).

Concentrations of TOC and lead were well below accepted waste oil contaminant guidelines; levels of other metals in the sample were below detection (Table 5-1). No other hazardous materials were identified at this site.



ROYAL ROADS
UNIVERSITY

uma

LEGEND

+ Sample Location

VAL-AD1 Rock Sample

PUBLIC WORKS AND GOVERNMENT SERVICES, CANADA
ABANDONED MINING EXPLORATION SITE
VAL, YUKON

MAP 5-1: SITE PLAN

JANUARY 1997

Stained/Contaminated Soil Areas

Three sediment/soil samples were obtained along this section of the stream to assess the possible existence of metal contamination from the cores in the stream. These included duplicate samples (VA-01 and VA-01Dup) obtained from soil directly beneath the first upstream pile to the east, one sample obtained from the second pile to the west (VA-02), and a sediment/soil sample (VA-03) from the edge of a side pool at the confluence of the two streams 70 m further downstream to the west (Map 5-1) (Photograph 5-2, 5-3). Selected analytical results for total metals are presented in Table 5-2 below. Full analytical results for metals are provided in Appendix A.

Elevated concentrations of arsenic (351-365 ppm), lead (705 - 735 ppm), cadmium (8 ppm) and zinc (2400-2430 ppm) were detected in the duplicate soil samples (VA-01S and VA-01Sdup) obtained below the first core pile. The concentrations of lead and cadmium exceeded the more stringent CCME/B.C. R/P (residential/parkland) remediation criterium, while levels of arsenic and zinc exceeded the higher C/I (commercial/industrial) criteria. In soils below the second pile (VA-02), as well as in those from the downstream location (VA-03), the concentrations of most metals were less than the R/P and C/I criteria. The only exceptions were zinc concentrations, which in both samples exceeded the R/P criterium (Table 5-2). These results suggest that the rock core material may serve as a source of metal contaminants, particularly zinc, into the stream environment.

Table 5-2: Selected Analytical Results for Soils at Val Exploration Site

| Sample No. | VA-01 | VA-01 Dup | VA-02 | VA-03 | CCME/B.C. R/P Criteria | CCME/B.C. C/I Criteria |
|---------------------------------|---|--|--|--|---------------------------|---------------------------|
| Physical Tests | | | | | | |
| Moisture % | 41.9 | 41 | 28.1 | 17.8 | - | |
| Total Metals ug/g or ppm | | | | | | |
| Antimony | <20 | <20 | <20 | <20 | 20 | 40 |
| Arsenic | 365 | 351 | 0.76 | <0.05 | 20 | 50 |
| Barium | 119 | 115 | 26 | 31 | 500 | 2000 |
| Beryllium | 1 | 0.8 | <0.5 | <0.5 | 4 | 8 |
| Cadmium | 8 | 8 | 5 | 4 | 5 | 20 |
| Chromium | 16 | 15 | <2 | <2 | 250 | 800 |
| Cobalt | 6 | 6 | <2 | <2 | 50 | 300 |
| Copper | 29 | 23 | 2 | 4 | 100 | 500 |
| Lead | 735 | 705 | 53 | 246 | 500 | 1000 |
| Mercury | 0.321 | 0.313 | <0.005 | 0.006 | 2 | 10 |
| Molybdenum | <4 | <4 | <4 | <4 | 10 | 40 |
| Nickel | 15 | 13 | <2 | 3 | 100 | 500 |
| Selenium | 0.3 | 0.3 | <0.1 | <0.1 | 3 | 10 |
| Silver | 6 | 5 | <2 | <2 | 20 | 40 |
| Tin | <10 | <10 | <10 | <10 | 50 | 300 |
| Vanadium | 30 | 29 | <2 | <2 | 200 | - |
| Zinc | 2430 | 2400 | 881 | 1100 | 500 | 1500 |
| Site/Sample Descriptions | Surface soil sample beneath most easterly core box pile, 4 m south of bank stream, sandy organic soil | Surface soil sample beneath most easterly core box pile, 4 m south of bank stream, sandy organic soil, DUPLICATE | Surface soil sample beneath most 2nd core box pile to the west (of 1st.), 2 m south of bank stream, organic soil (slight sand) with detritus | Surface soil (sediment) sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, coarse - medium sand, some detritus | | |

5.4 Surface Water Quality

Duplicate water samples, VA-03W and VA-03WDup, were obtained from a point just below the confluence of the two streams, down from the main core box caches (Map 5-1) and analyzed for total metals. Selected analytical results for these samples are provided in Table 5-3 below; full analytical results are presented in Appendix A.

Table 5-3: Selected Inorganic Analysis Results for Surface Water Samples at Val

| Sample No. | VA-03W | VA-03W Dup | CCME/BC Freshwater Criteria |
|-----------------------------------|--|--|-----------------------------|
| Physical Tests | | | |
| Conductivity (umhos/cm) | 13100 | 14600 | |
| Total Metals (mg/L or ppm) | | | |
| Aluminum | <0.2 | <0.2 | 0.005-0.1 |
| Arsenic | 0.006 | 0.003 | 0.05 |
| Barium | 0.02 | 0.02 | 1.0 |
| Beryllium | <0.005 | <0.005 | 0.0053 |
| Boron | <0.1 | <0.1 | - |
| Cadmium | <0.01 | <0.01 | 0.0002-0.0018 |
| Chromium | <0.01 | <0.01 | 0.002-0.02 |
| Cobalt | <0.01 | <0.01 | 0.05 |
| Copper | <0.01 | <0.01 | 0.002-0.004 |
| Iron | 0.21 | <0.03 | 0.3 |
| Lead | <0.05 | <0.05 | 0.001-0.007 |
| Manganese | 0.04 | <0.005 | 0.1 |
| Mercury | <0.00005 | <0.00005 | 0.0001 |
| Molybdenum | <0.03 | <0.03 | 1.0 |
| Nickel | <0.02 | <0.02 | 0.025-0.15 |
| Selenium | 0.0012 | 0.0012 | 0.001 |
| Silver | <0.01 | <0.01 | 0.0001 |
| Zinc | 0.17 | 0.11 | 0.03 |
| Site/Sample Descriptions | Water sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, pH 8.14 | Water sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, DUPLICATE | |

Total metal concentrations for a majority of the analytes in the duplicate samples were found to be either below detection or at detectable levels which were well below the CCME/B.C. Freshwater criteria (for Aquatic Life). The only exceptions were concentrations of selenium which were comparable to the criteria (0.001 ppm) and zinc (0.11 and 0.17 ppm) which exceeded the Freshwater Criteria (Table 5-2). This result emphasized the importance of the coreboxes along the stream as a significant source of contaminants to the freshwater environment. This would have to be confirmed by obtaining a sample from a background location further upstream from the main rock core caches.

5.5 Waste Rock Disposal 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.

All samples were collected from the creek area below the broken core boxes where the greatest potential impact on water quality was expected. Trenches observed on the surrounding hillslopes and ridges were not sampled due to their greater distances from any water sources (particularly the creek), the extensive sampling which would be needed to properly characterize the trench network, and the limited number of samples and time budgeted for this site. In any event, the trenches were undoubtedly excavated into suspected ore zones, and it is anticipated that the core samples collected would logically reflect the nature of the ore and surrounding waste rock in these trenches.

Seven different samples of rock were collected from cores spread along the stream at varying distances downstream and west from the main cache. These included two samples collected 75 m downstream (VAL-AD1 and VAL-AD2), one obtained approximately 45 m downstream (VAL-AD3), one sample (VAL-AD4) taken approximately 30 m downstream, two samples collected 10 m below the cache (VAL-AD5 and VAL-AD6), and one obtained 5 m away from the main cache. Sampling locations are indicated on Map 5-1. Sample descriptions as well as acid-base accounting and total metal tests for acidic

drainage and metal leaching potential are provided in Appendix B. These results are summarized and discussed in terms of acid leaching potential in Section 5.5.1 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 at Val is minimal. For the medium and small scales, Acid Base Accounting (ABA) results (Appendix B) show that all seven samples have high values of xNNP (net neutralizing potential) and xNPR (net potential ratio) and are thus all net acid neutralizing. The probability of acidic drainage on these scales is therefore low (Table 5-4). Ore-grade rock which would probably be capable of generating net acidity was sent to nearby Vera, probably for logging and storage. This would account for the general lack of net-acid-generating rock.

Table 5-4: Probability Ratings of Acidic Drainage by Scale for Val

| Scale: | Small | Medium | Large |
|---------------------|-------|--------|---------|
| Probability Rating: | low | low | minimal |

As mentioned previously, total-metal contents were measured (Appendix B) to determine which metals occur at relatively high levels compared to worldwide averages.

Although this is not a definitive test for accelerated metal leaching, it may highlight metals which could preferentially leach at high levels of acidity. However, only long-term kinetic tests and on-site monitoring will demonstrate which metals will leach at detectable levels.

Based on worldwide averages, there are no metals in Val rock that occur at elevated levels. Nevertheless, the presence of core boxes in the stream indicates that even the average levels of metals in the core could be released directly into the stream. This appears to be the case as suggested by metal results for soils and water at the site.

5.6 Mine Opening (Adit)

Aside from mining exploration roads, drill sites and trenches on the surrounding slopes, no mining portals or adits were found.



Photograph 5-1: Lone barrel containing diesel , located to the north of the core box cache



Photograph 5-2: Water sample (VA-03W) taken in stream running through site 40m downstream from main core box cache



Photograph 5-3: Core boxes washed downstream from the main cache located to the east



Photograph 5-4: Main collapsed core box cache (soil sample location VE-01)



6. Conclusions And Recommendations

The preliminary environmental assessment of the Val Exploration 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 Vera exploration site area.

6.1 Health and Safety

Health and 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. The Val exploration area is remote from any populated areas and there was minimal debris present. The public safety risks associated with this site are negligible.

6.2 Environmental Risks

The major issue is the cores and boxes which are scattered along the bed and floodbanks of the stream running through the site. Based on concentrations of zinc and, in some cases, lead and arsenic which exceed the CCME/B.C. R/P remediation criteria in underlying soils below the main core box piles, these cores could be a significant source of metal contaminants to the stream environment. Although the probability of acid drainage on a small scale is low at the site, the presence of cores in the stream could result in the direct release of metals. This is probably supported by concentrations of zinc as well as selenium in the stream waters which exceeded the CCME/B.C. Freshwater criteria for Aquatic Life; this assumption, however, would have to be confirmed by obtaining a sample from a background location further upstream.

The stream itself does not appear to support any significant amount of aquatic life, but it does eventually drain into fish-bearing waters of the East Rackla River further to the west. These contaminants, therefore, present a low to moderate risk to the aquatic environment.

It is recommended, in any event, that the cores box caches along the floodbank and the cores in the stream be removed from the site. These and associated materials should be transported to the larger abandoned mine site at Vera located 5 km to the northeast, and disposed of. The rock cores should be placed in an engineered facility and the empty wooden boxes burned. Transport could be achieved to a limited degree by helicopter or, more practically, by winter roads using heavy equipment located at Vera. The lone barrel should also be transported to Vera, its contents incinerated there, and the empty barrel crushed and placed in an engineered facility.

6.3 Aesthetic Concerns

The major aesthetic concerns at Val are primarily centered around the coreboxes scattered along the stream, associated rebar and the lone drum of fuel to the north of the site. These should be treated as described above. Cleared vegetation along the exploration trails and trenches along the slopes in the valley 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. No specific recommendations are therefore warranted aside from those discussed above.

7. Class "D" Cost Estimates to Implement Recommendations

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 debris, including rock core, for disposal;

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 that cleanup work at the Val site be undertaken in conjunction with the cleanup of the Vera site.

This recommendation has been included in the following estimate:

The estimated volume of rock core/ debris to be transported off site is in the order of 10 to 15 m³, (core boxes, 1 barrel). The ultimate disposal location has been assumed to be Vera and the barrel contents are to be incinerated there. Costs for disposal at Vera are not included in the estimate.

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 be 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

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.

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.

Drever, J.I. 1982. *The Geochemistry of Natural Waters*. Prentice-Hall Inc.

Northwest Territories. Renewable Resources. 1993. Review of Ambient Air Quality Standards and Used Oil Regulations. Prepared by M.M. Dillon Ltd. for the Pollution Control Division. April, 1993.

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10. APPENDICES

- A) Sample Descriptions and Analytical Results (Soils/Sediment, Surface Water and Barrel)**
- 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 Number | VA-01 | VA-01 Duplicate | VA-02 | VA-03 |
|-----------------------------|---|--|--|--|
| Sampling Date | 960830 | 960830 | 960830 | 960830 |
| Moisture (%) | 41.9 | 41 | 28.1 | 17.8 |
| <i>Total Metals (mg/kg)</i> | | | | |
| Aluminum T-Al | 13300 | 12700 | <50 | 414 |
| Antimony T-Sb | <20 | <20 | <20 | <20 |
| Arsenic T-As | 365 | 351 | 0.76 | <0.05 |
| Barium T-Ba | 119 | 115 | 26 | 31 |
| Beryllium T-Be | 1 | 0.8 | <0.5 | <0.5 |
| Bismuth T-Bi | 36 | 23 | 34 | 44 |
| Cadmium T-Cd | 8 | 8 | 5 | 4 |
| Calcium T-Ca | 98100 | 98100 | 72500 | 112000 |
| Chromium T-Cr | 16 | 15 | <2 | <2 |
| Cobalt T-Co | 6 | 6 | <2 | <2 |
| Copper T-Cu | 29 | 23 | 2 | 4 |
| Iron T-Fe | 24900 | 22200 | 2370 | 1040 |
| Lead T-Pb | 735 | 705 | 53 | 246 |
| Lithium T-Li | 10 | 9 | <1 | 1 |
| Magnesium T-Mg | 62500 | 62900 | 45000 | 63800 |
| Manganese T-Mn | 1690 | 1410 | 1270 | 1060 |
| Mercury T-Hg | 0.321 | 0.313 | <0.005 | 0.006 |
| Molybdenum T-Mo | <4 | <4 | <4 | <4 |
| Nickel T-Ni | 15 | 13 | <2 | 3 |
| Phosphorus T-P | 776 | 719 | <50 | <50 |
| Potassium T-K | 4210 | 4210 | <200 | <200 |
| Selenium T-Se | 0.3 | 0.3 | <0.1 | <0.1 |
| Silver T-Ag | 6 | 5 | <2 | <2 |
| Sodium T-Na | 284 | 268 | <200 | <200 |
| Tin T-Sn | <10 | <10 | <10 | <10 |
| Titanium T-Ti | 207 | 156 | 2 | 2 |
| Vanadium T-V | 30 | 29 | <2 | <2 |
| Zinc T-Zn | 2430 | 2400 | 881 | 1100 |
| Location and Description | Surface soil sample beneath most easterly core box pile, 4 m south of bank stream, sandy organic soil | Surface soil sample beneath most easterly core box pile, 4 m south of bank stream, sandy organic soil, DUPLICATE | Surface soil sample beneath most 2nd core box pile to the west (of 1st.), 2 m south of bank stream, organic soil (slight sand) with detritus | Surface soil (sediment) sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, coarse-medium sand, some detritus |

A.2 Inorganic Elements Results for Surface Water Samples

| Sample No. | VA-03W | VA-03W |
|---------------------------------|--|--|
| Conductivity (umhos/cm) | 13100 | 14600 |
| Total Metals (mg/L) | | |
| Aluminum T-Al | <0.2 | <0.2 |
| 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 | <0.01 | <0.01 |
| Calcium T-Ca | 61 | 61.1 |
| 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 |
| 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 |
| Silicon T-Si | 1.58 | 1.5 |
| Silver T-Ag | <0.01 | <0.01 |
| 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 | 0.17 | 0.11 |
| Site/Sample Descriptions | Water sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, pH 8.14 | Water sample in stream centre just below (10 m W of) stream confluence, 40 m downstream (W of) core box piles, DUPLICATE |

A.3 Results, Locations and Descriptions for Barrel Samples

| Sample Number | VA-A1 |
|---------------------------------|--|
| Total Organic Halogens | 62 |
| Aluminum | <2 |
| Antimony | <2 |
| Arsenic | <3 |
| Barium | 0.20 |
| Beryllium | <0.06 |
| Cadmium | <0.2 |
| Calcium | 3.8 |
| Chromium | <0.3 |
| Cobalt | 1.3 |
| Copper | 1.5 |
| Iron | 31.9 |
| Lead | 1.5 |
| Magnesium | 0.90 |
| Manganese | 0.60 |
| Molybdenum | <0.4 |
| Nickel | <0.3 |
| Phosphorus | 10 |
| Silver | <0.3 |
| Sodium | 3110 |
| Strontium | 0.22 |
| Tin | <0.3 |
| Titanium | 0.07 |
| Vanadium | <0.1 |
| Zinc | 5.7 |
| Zirconium | <0.2 |
| Location and Description | Lone barrel in N-most stream valley floodbank, 250 m upstream of confluence, clear fluid (diesel), marked "PRISM H DIESEL MARCH 80", half full |

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 ($TAP = \%S \text{ total} * 31.25$). 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 [$SAP = (\%S \text{ sulphide} + \text{del \%S}) * 31.25$] 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 CaCO₃/1000 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 of xNNP 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 106C-05-1) reported that the main rock units at Val were the Middle Proterozoic Gillespie Group dolomite and carbonate rocks of the Late Proterozoic Pinguicula Group. The economic metals at Val are: lead, silver, and minor zinc. At the nearby abandoned exploration site named Vera (Indian and Northern Affairs, 1994, Assessment Report 106C-05-2), a desk was found containing a geologic column stamped, "Open File 205, June 1974, Geological Survey Ottawa". This column presumably represents the rock units in the area, but there was no mention of the Gillespie and Pinguicula Group. Nevertheless, most of the formations in the column do contain widespread dolomite and limestone, which are capable of neutralizing acidity (Table 1 and Section 4, Field Notes) and were tested as part of this study. Also, some core boxes at Vera were marked "Val" and apparently a few boxes contained ore-grade core, so there are geological, mineralogical, and economic similarities between Val and Vera.

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 at Val is minimal. For the medium and small scales, ABA results (Table 2) show that all seven samples have high values of xNNP and xNPR and are thus all net acid neutralizing. Thus, the probability of acidic drainage on these scales is low (Table 3). As mentioned above, ore-grade rock which probably would be capable of generating net acidity was sent to nearby Val, probably for logging and storage. This would account for the general lack of net-acid-generating rock.

| TABLE 1 | |
|-----------|--|
| Project: | Abandoned Yukon Mines |
| Location: | Val |
| Data: | Sample Description |
| SAMPLE | SAMPLE DESCRIPTION |
| VAL-AD1 | Core in creek #1; ~75 m below main core-box cache area and ~5 m below creek confluence; black and gray finely laminated slate; common core in creek bed; friable "poke chips". |
| VAL-AD2 | Core in creek #2; ~75 m below main box cache and at 5m below creek confluence; fine-grained gray rock with white quartz veins and eyes with rare, very fine (~0.1 mm) pyrite crystals. |
| VAL-AD3 | Core in creek #3; ~45 m below main box cache; finely laminated gray with minor black slate(?), with some laminae showing iron oxidation on outer surfaces; friable "poke chips"; common core in creek bed. |
| VAL-AD4 | Core in creek #4; ~30 m below main box cache; interlayered (0.1-0.5 cm thick) silicified dark gray rock (formerly slate?) and white carbonate and/or quartz. |
| VAL-AD5 | Core in creek #5; ~10 m below main box cache; dark gray finely laminated silicified hard rock (not friable) with cross-cutting white carbonate and/or quartz veins containing pyrite clusters 0.5-1.0 cm in size. |
| VAL-AD6 | Core in creek #6; ~10 m below main box cache; somewhat common core in creek bed; "snowflake" appearance with white and light gray patches predominantly carbonate and/or quartz in dark gray, silicified, laminated hard rock. |
| VAL-AD7 | Core in creek #7; ~5 m below main box cache; ~50% dark gray laminated silicified rock and at 50% intruded white carbonate (up to 0.5 cm cleavage faces) with crystal-filled vugs and pyrite grains 0.05-0.2 cm in size; intrusion caused gray rock to split into tubular pieces; can? |

Table 2

| Project: | Abandoned Yukon Mines | | | | | | | | | | | | | | | | | | | | |
|---------------|-----------------------|-------------|----------------|----------------|--------------------------|-----------|---|---|---|--|-------------------------------|--|--|--|--|--|--------|--------|--------|--------|-----------------|
| Location: | Val | | | | | | | | | | | | | | | | | | | | |
| 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 |
| VAL-AD1 | 8.50 | 0.010 | 0.005 | 0.010 | 0.0065 | 0.000 | 0 | 0 | 0 | 25 | 1.2 | 27 | 25 | 25 | 27 | 25 | 10.00 | 10.00 | 10.00 | 10.00 | 109 |
| VAL-AD2 | 8.70 | 0.005 | 0.005 | 0.010 | 0.0001 | 0.000 | 0 | 0 | 0 | 1048 | 45.0 | 1023 | 1048 | 1048 | 1023 | 1048 | 10.00 | 10.00 | 10.00 | 10.00 | 98 |
| VAL-AD3 | 8.70 | 0.010 | 0.005 | 0.005 | 0.0056 | 0.000 | 0 | 0 | 0 | 54 | 5.8 | 132 | 54 | 54 | 132 | 54 | 10.00 | 10.00 | 10.00 | 10.00 | 244 |
| VAL-AD4 | 8.50 | 0.030 | 0.020 | 0.005 | 0.0002 | 0.005 | 1 | 1 | 1 | 1065 | 43.8 | 996 | 1064 | 1064 | 995 | 1064 | 10.00 | 10.00 | 10.00 | 10.00 | 94 |
| VAL-AD5 | 8.80 | 0.600 | 0.590 | 0.005 | 0.0002 | 0.005 | 19 | 19 | 18 | 1023 | 45.8 | 1042 | 1004 | 1004 | 1023 | 1005 | 54.56 | 55.04 | 56.04 | 55.48 | 102 |
| VAL-AD6 | 8.90 | 0.140 | 0.150 | 0.005 | 0.0001 | 0.000 | 4 | 5 | 5 | 1051 | 47.3 | 1076 | 1047 | 1046 | 1071 | 1046 | 240.23 | 224.21 | 229.49 | 224.21 | 102 |
| VAL-AD7 | 8.80 | 0.790 | 0.780 | 0.005 | 0.0001 | 0.005 | 25 | 25 | 24 | 1038 | 46.2 | 1051 | 1013 | 1013 | 1026 | 1014 | 42.05 | 42.32 | 42.84 | 42.58 | 101 |
| Maximum | 8.90 | 0.790 | 0.780 | 0.010 | 0.0065 | 0.005 | 25 | 25 | 24 | 1065 | 47.3 | 1076 | 1064 | 1064 | 1071 | 1064 | 240.23 | 224.21 | 229.49 | 224.21 | 244 |
| Minimum | 8.50 | 0.005 | 0.005 | 0.005 | 0.0001 | 0.000 | 0 | 0 | 0 | 25 | 1.2 | 27 | 25 | 25 | 27 | 25 | 10.00 | 10.00 | 10.00 | 10.00 | 94 |
| Mean | 8.70 | 0.226 | 0.222 | 0.006 | 0.0019 | 0.002 | 7 | 7 | 7 | 758 | 33.6 | 764 | 751 | 751 | 757 | 751 | 53.83 | 51.65 | 52.62 | 51.75 | 121 |
| Std Deviation | 0.15 | 0.328 | 0.325 | 0.002 | 0.0029 | 0.003 | 10 | 10 | 10 | 491 | 20.6 | 469 | 487 | 486 | 464 | 487 | 84.23 | 78.33 | 80.27 | 78.33 | 54 |
| 10 Percentile | 8.50 | 0.008 | 0.005 | 0.005 | 0.0001 | 0.000 | 0 | 0 | 0 | 42 | 4.0 | 90 | 42 | 42 | 90 | 42 | 10.00 | 10.00 | 10.00 | 10.00 | 96 |
| Median | 8.70 | 0.030 | 0.020 | 0.005 | 0.0002 | 0.000 | 1 | 1 | 1 | 1038 | 45.0 | 1023 | 1013 | 1013 | 1023 | 1014 | 10.00 | 10.00 | 10.00 | 10.00 | 102 |
| 90 Percentile | 8.84 | 0.676 | 0.666 | 0.010 | 0.0060 | 0.005 | 21 | 21 | 21 | 1057 | 46.6 | 1061 | 1054 | 1054 | 1044 | 1054 | 128.83 | 122.71 | 125.42 | 122.98 | 163 |
| Count | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 |

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.

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, there are no metals in Val rock that occur at elevated levels. Nevertheless, the presence of core boxes in the stream indicates that even the average levels of metals in the core could be released directly into the stream.

TABLE 4

| Project: | Abandoned Yukon Mines | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---------------|---|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Location: | Val | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Data: | ICP Metals Data (Triple Acid Digestion) | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| SAMPLE | Ag | Al | As | Ba | Be | Bi | Ca | Cd | Co | Cr | Cu | Fe | Hg | K | Mg | Mn | Mo | Na | Ni | P | Pb | Sb | Sr | Ti | V | W | Zn | |
| | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) | (ppm) |
| VAL-AD1 | 0.1 | 87700 | 1 | 280 | 2.00 | 1 | 6200 | 0.25 | 21.0 | 108 | 71 | 59900 | 0.005 | 22600 | 24200 | 1745 | 1.0 | 17800 | 37.0 | 380 | 8 | 0.6 | 31 | 4100 | 111 | 10 | 124 | |
| VAL-AD2 | 0.1 | 2200 | 1 | 5 | 0.25 | 1 | 228000 | 0.50 | 0.5 | 9 | 3 | 5600 | 0.05 | 1000 | 137500 | 675 | 0.5 | 300 | 4.0 | 240 | 14 | 0.8 | 28 | 50 | 20 | 5 | 198 | |
| VAL-AD3 | 0.1 | 73600 | 2 | 240 | 1.50 | 1 | 13200 | 0.50 | 26.0 | 90 | 36 | 63300 | 0.03 | 28600 | 22900 | 2880 | 0.5 | 900 | 48.0 | 560 | 14 | 2.8 | 21 | 3600 | 93 | 10 | 106 | |
| VAL-AD4 | 0.1 | 1100 | 1 | 10 | 0.25 | 1 | 209000 | 0.25 | 0.5 | 11 | 5 | 2900 | 0.02 | 500 | 126000 | 420 | 0.5 | 400 | 0.5 | 220 | 12 | 0.4 | 23 | 50 | 16 | 5 | 64 | |
| VAL-AD5 | 0.1 | 3500 | 6 | 10 | 0.25 | 1 | 197000 | 0.25 | 0.5 | 19 | 7 | 12800 | 0.005 | 1100 | 118000 | 1115 | 0.5 | 800 | 1.0 | 150 | 16 | 0.4 | 26 | 100 | 18 | 10 | 60 | |
| VAL-AD6 | 0.1 | 2200 | 2 | 5 | 0.25 | 1 | 220000 | 0.25 | 0.5 | 7 | 3 | 5500 | 0.06 | 1100 | 132500 | 635 | 0.5 | 300 | 0.5 | 230 | 12 | 0.8 | 25 | 50 | 20 | 5 | 104 | |
| VAL-AD7 | 0.1 | 500 | 10 | 5 | 0.25 | 1 | 208000 | 0.25 | 0.5 | 14 | 1 | 14700 | 0.02 | 400 | 124500 | 1135 | 0.5 | 400 | 1.0 | 100 | 10 | 1.6 | 28 | 50 | 16 | 5 | 28 | |
| Maximum | 0.1 | 87700 | 10 | 280 | 2.00 | 1 | 228000 | 0.50 | 26.0 | 108 | 71 | 63300 | 0.06 | 28600 | 137500 | 2880 | 1.0 | 17800 | 48.0 | 560 | 16 | 2.8 | 31 | 4100 | 111 | 10 | 198 | |
| Minimum | 0.1 | 500 | 1 | 5 | 0.25 | 1 | 6200 | 0.25 | 0.5 | 7 | 1 | 2900 | 0.005 | 400 | 22900 | 420 | 0.5 | 300 | 0.5 | 100 | 8 | 0.4 | 21 | 50 | 16 | 5 | 28 | |
| Mean | 0.1 | 24400 | 3 | 79 | 0.68 | 1 | 154486 | 0.32 | 7.1 | 37 | 18 | 23529 | 0.027 | 7900 | 97943 | 1229 | 0.6 | 2986 | 13.1 | 269 | 12 | 1.1 | 26 | 1143 | 42 | 7 | 98 | |
| Std Deviation | 0.0 | 38653 | 3 | 124 | 0.75 | 0 | 99406 | 0.12 | 11.3 | 43 | 26 | 26362 | 0.021 | 12218 | 51191 | 849 | 0.2 | 6537 | 20.3 | 155 | 3 | 0.9 | 3 | 1855 | 41 | 3 | 55 | |
| 10 Percentile | 0.1 | 860 | 1 | 5 | 0.25 | 1 | 10400 | 0.25 | 0.5 | 8 | 2 | 4460 | 0.005 | 460 | 23680 | 549 | 0.5 | 300 | 0.5 | 130 | 9 | 0.4 | 22 | 50 | 16 | 5 | 47 | |
| Median | 0.1 | 2200 | 2 | 10 | 0.25 | 1 | 208000 | 0.25 | 0.5 | 14 | 5 | 12800 | 0.02 | 1100 | 124500 | 1115 | 0.5 | 400 | 1.0 | 230 | 12 | 0.8 | 26 | 50 | 20 | 5 | 104 | |
| 90 Percentile | 0.1 | 79240 | 8 | 256 | 1.70 | 1 | 223200 | 0.50 | 23.0 | 97 | 50 | 61260 | 0.054 | 25000 | 134500 | 2199 | 0.7 | 7660 | 41.4 | 452 | 15 | 2.1 | 29 | 3800 | 100 | 10 | 154 | |
| Count | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | 7 | |

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: VAL

Date: August 30, 1996

Comments: Overcast, ~10 degrees C, calm; ~300 core boxes scattered down creek bed for distance of ~100m; creek flow ~1L/s above confluence and ~3 L/s below confluence with major creek.

Core in Creek #1(Sample VAL-AD1): ~75 m below main cache of boxes; common rock unit.

Core #2 (VAL-AD2): ~75 m below main cache and ~5 m below creek confluence.

Core #3 (VAL-AD3): ~45 m below main cache; common rock unit.

Core #4 (VAL-AD4): ~30 m below main cache.

Core #5 (VAL-AD5): ~10 m below main area; visible pyrite ~0.5 cm in size, several pieces in creek bed.

Core #6 (VAL-AD6): "snow flake" appearance; some what common in creek bed; 10m below main cache.

Core #7 (VAL-AD7): skarn?; white carbonate intruded into slate; minor visible pyrite (~0.1-0.5 cm in size) in carbonate; ~5 m below main cache; carbonate crystals occur in vugs.

No ore (galena) found, presumed moved to Vera (Val core boxes found at Vera); minor coal and black slate (not sampled); frequent association of pyrite and carbonate as veins, vugs, and infilling (intrusion); heavy iron staining on slate is only external , rare hematite banding in core; occasional

external iron staining on carbonate suggesting iron content (ankerite); green-gray shale (VAL-AD3) friable, like "poker chips", in places.

Cut roads for drill pads: no major oxidation; generally dark gray (when wet) in appearance, unlike Vera.

B.5 LIST OF SAMPLES

| <u>CODE</u> | <u>SOURCE</u> |
|-------------|--|
| VAL-AD1 | Core in creek #1; ~75 m below main core-box cache area and ~5 m below creek confluence; black and gray finely laminated slate; common core in creek bed; friable "poker chips". |
| VAL-AD2 | Core in creek #2; ~75 m below main box cache and at 5m below creek confluence; fine-grained gray rock with white quartz veins and eyes with rare, very fine (~0.1 mm) pyrite crystals. |
| VAL-AD3 | Core in creek #3; ~45 m below main box cache; finely laminated gray with minor black slate(?), with some laminae showing iron oxidation on outer surfaces; friable "poker chips"; common core in creek bed. |
| VAL-AD4 | Core in creek #4; ~30 m below main box cache; interlayered (0.1-0.5 cm thick) silicified dark gray rock (formerly slate?) and white carbonate and/or quartz. |
| VAL-AD5 | Core in creek #5; ~10 m below main box cache; dark gray finely laminated silicified hard rock (not friable) with cross-cutting white carbonate and/or quartz veins containing pyrite clusters 0.5-1.0 cm in size. |
| VAL-AD6 | Core in creek #6; ~10 m below main box cache; somewhat common core in creek bed; "snowflake" appearance with white and light gray patches predominantly carbonate and/or quartz in dark gray, silicified, laminated hard rock. |

VAL-AD7 Core in creek #7; ~5 m below main box cache; ~50% dark gray laminated silicified rock and at 50% intruded white carbonate (up to 0.5 cm cleavage faces) with crystal-filled vugs and pyrite grains 0.05-0.2 cm in size; intrusion caused gray rock to split into tubular pieces; skarn?

C. Laboratory Reports



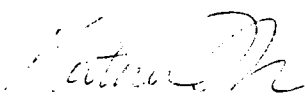
CHEMICAL ANALYSIS REPORT

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/Soil¹

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



RESULTS OF ANALYSIS - Sediment/Soil¹

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.

< = Less than the detection limit indicated.

Dup = Field duplicate.

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



RESULTS OF ANALYSIS - Sediment/Soil¹

File No. G4671r

| | VE-01S Dup <small>FIELD DUP</small> 96 08 28 | VE-02 96 08 28 | VE-03 96 08 28 | VE-04 96 08 28 | VE-05 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.

< = Less than the detection limit indicated.

Dup = Field duplicate.

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



RESULTS OF ANALYSIS - Sediment/Soil¹

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 |

Remarks regarding the analyses appear at the beginning of this report.

< = Less than the detection limit indicated.

Dup = Field duplicate.

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



RESULTS OF ANALYSIS - Sediment/Soil¹

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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RESULTS OF ANALYSIS - Sediment/Soil¹

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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RESULTS OF ANALYSIS - Sediment/Soil¹

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.
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 Dup = Field duplicate.
¹Results are expressed as milligrams per dry kilogram except where noted.



RESULTS OF ANALYSIS - Sediment/Soil¹

File No. G4671r

| | CR-05S | CR-05D | VE-01S | VE-01S Dup <i>Field duplicate</i> | 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 |

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²Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.



RESULTS OF ANALYSIS - Sediment/Soil¹

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 |
| <u>Non-halogenated Volatiles</u> | | | | | |
| 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 | - | - |
| <u>Extractables</u> | | | | | |
| EPH (C10-18) | 946 | 4960 | 3090 | <250 | <250 |
| EPH (C19-31) | 332 | 41400 | 28500 | <250 | <250 |

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²Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.



RESULTS OF ANALYSIS - Sediment/Soil¹

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.

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²Volatile Petroleum Hydrocarbons (VPH) are based on draft methodologies.



RESULTS OF ANALYSIS - Water¹

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 | CaCO ₃ | 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.

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Dup = Field duplicate.

¹Results are expressed as milligrams per litre except where noted.



RESULTS OF ANALYSIS - Water¹

File No. G4671r

VA-03W

VA-03W
Dup

96 08 30

96 08 30

Physical Tests

Conductivity (umhos/cm)
Hardness

CaCO3

13100
296

14600
298

Total Metals

Aluminum T-Al
Antimony T-Sb
Arsenic T-As
Barium T-Ba
Beryllium T-Be

0.089
<0.2
0.006
0.02
<0.005

0.009
<0.2
0.003
0.02
<0.005

Bismuth T-Bi
Boron T-B
Cadmium T-Cd
Calcium T-Ca
Chromium T-Cr

<0.1
<0.1
0.0005
61.0
<0.001

<0.1
<0.1
0.0003
61.1
<0.001

Cobalt T-Co
Copper T-Cu
Iron T-Fe
Lead T-Pb
Lithium T-Li

<0.01
0.001
0.21
0.024
<0.01

<0.01
<0.001
<0.03
0.002
<0.01

Magnesium T-Mg
Manganese T-Mn
Mercury T-Hg
Molybdenum T-Mo
Nickel T-Ni

34.8
0.040
<0.00005
<0.03
<0.02

35.2
<0.005
<0.00005
<0.03
<0.02

Phosphorus T-P
Potassium T-K
Selenium T-Se
Silicon T-Si
Silver T-Ag

<0.3
<2
0.0012
1.58
<0.0001

<0.3
<2
0.0012
1.50
<0.0001

Sodium T-Na
Strontium T-Sr
Thallium T-Tl
Tin T-Sn
Titanium T-Ti

<2
0.046
<0.1
<0.30
<0.01

<2
0.046
<0.1
<0.30
<0.01

Vanadium T-V
Zinc T-Zn

<0.03
0.170

<0.03
0.110

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METHODOLOGY

File No. G4671r

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

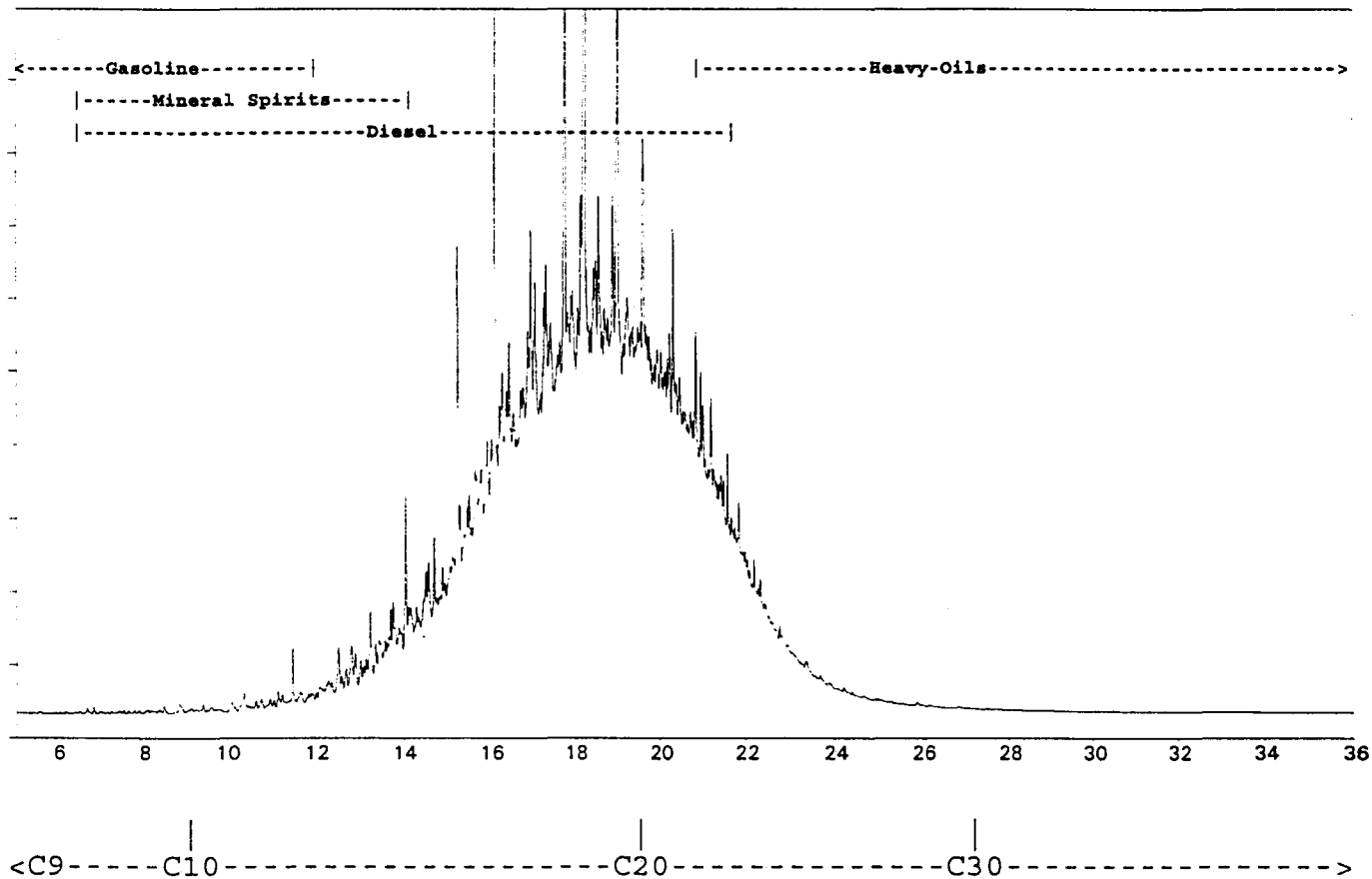
SAMPLE NAME: G4671r 8

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

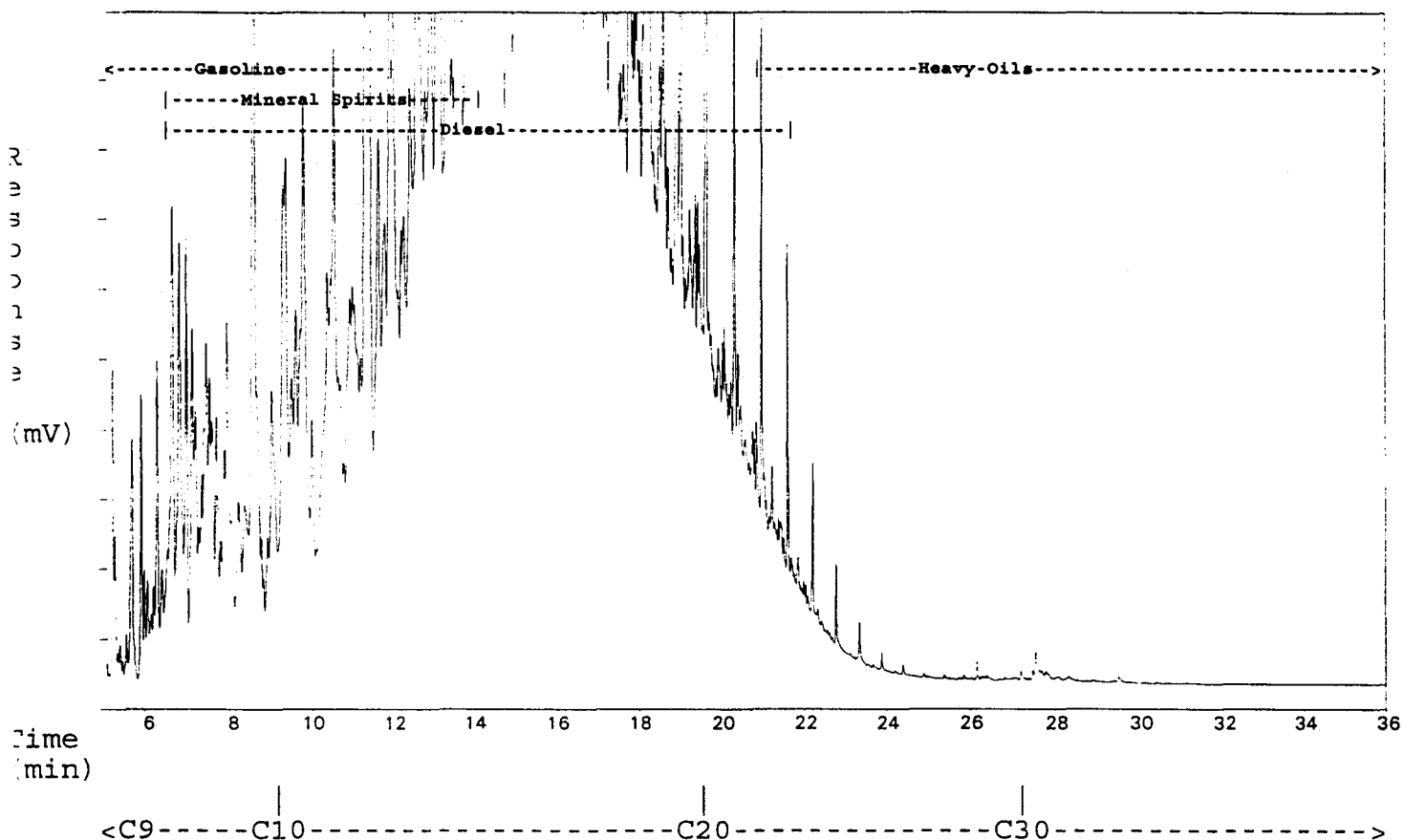
SAMPLE NAME: G4671r 9

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 |

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

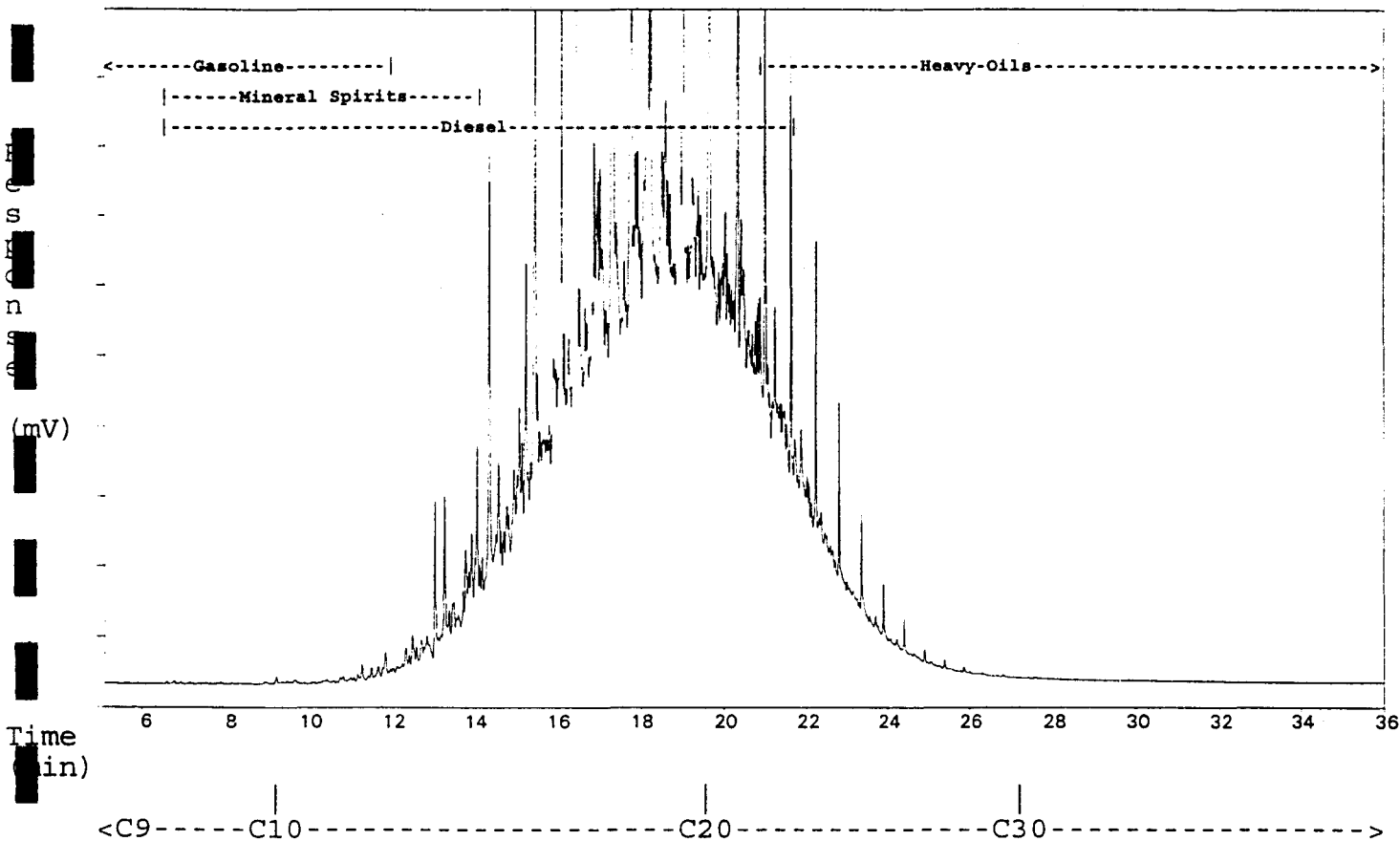
SAMPLE NAME: G4671r 13

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 |

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

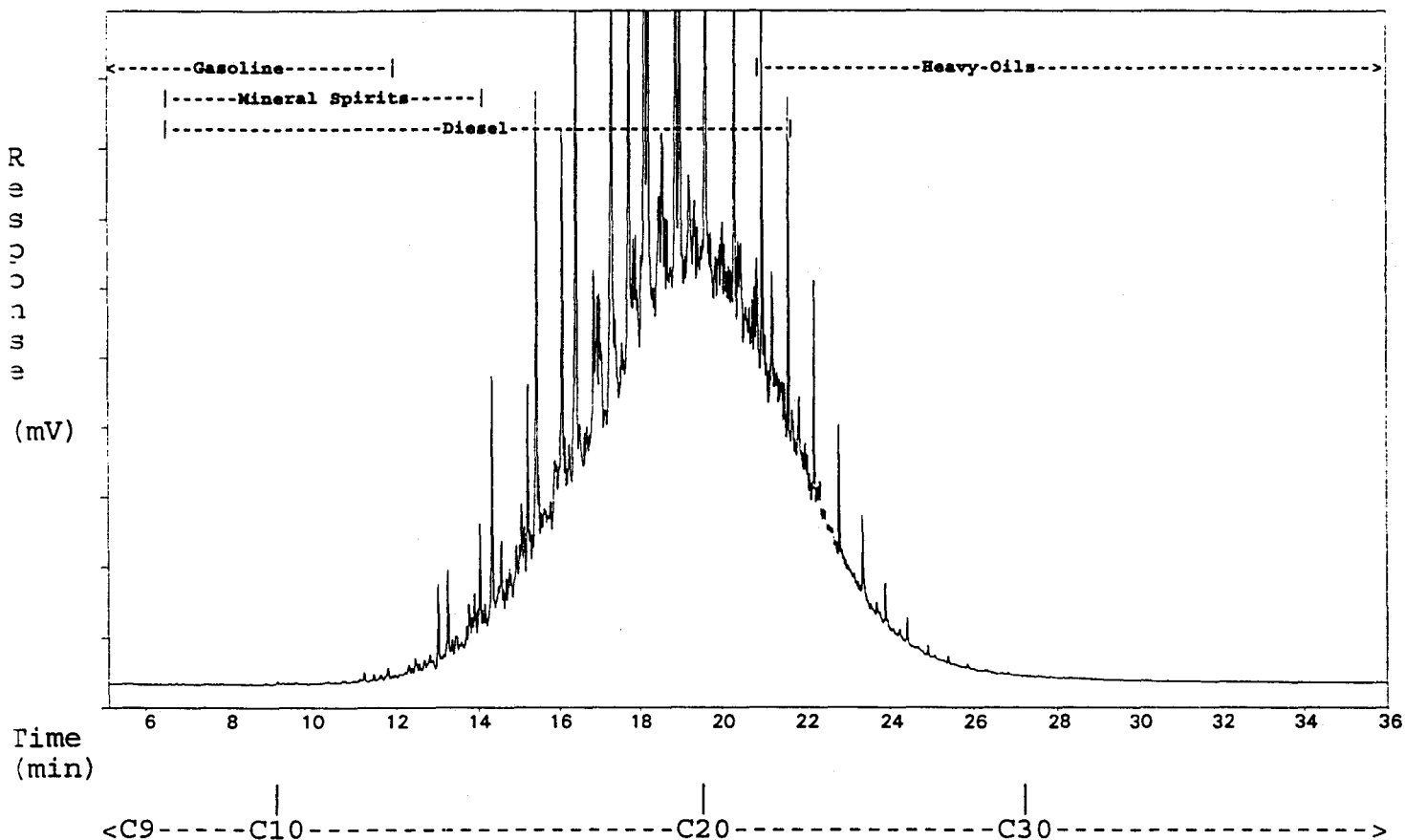
SAMPLE NAME: G4671r 14

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

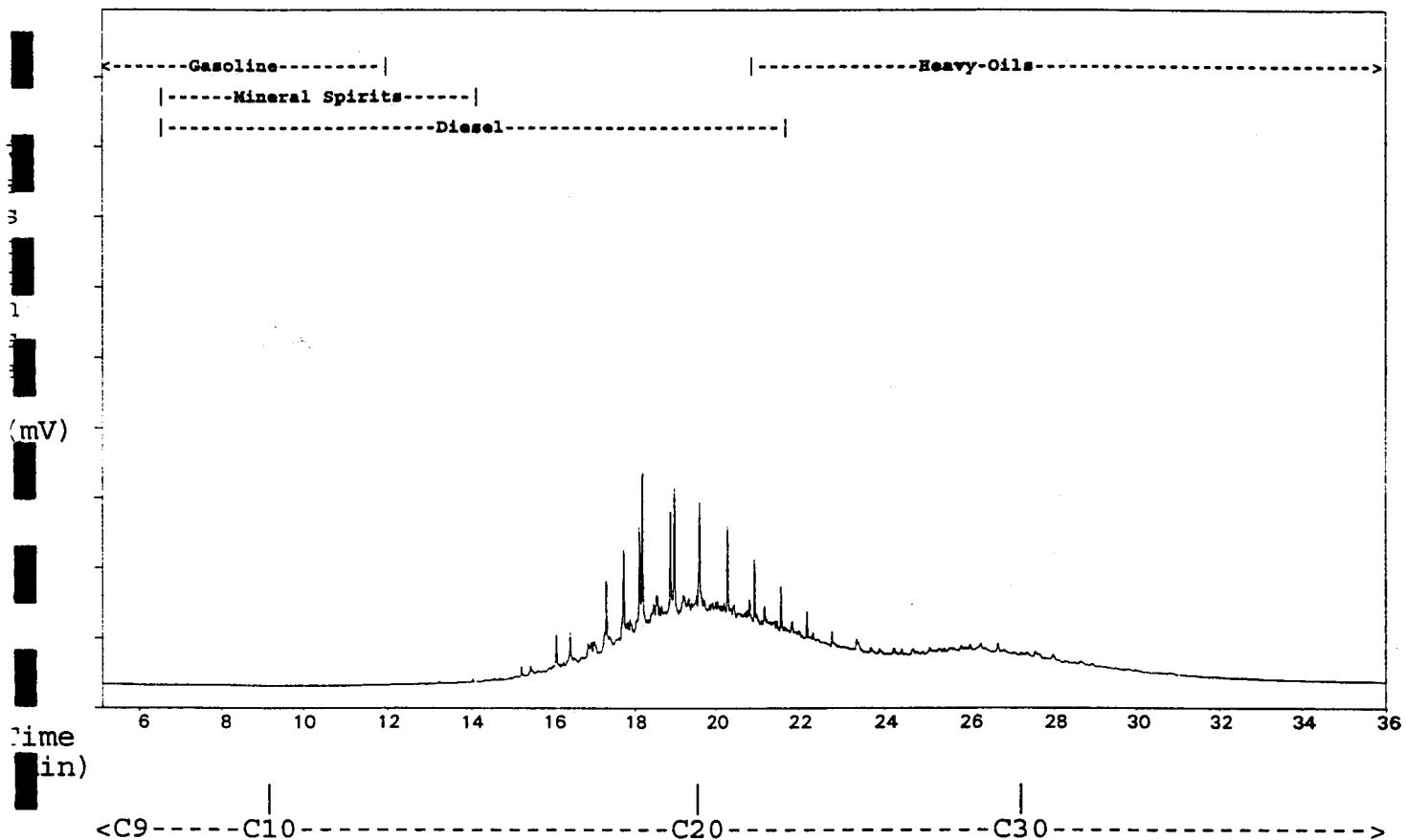
SAMPLE NAME: G4671r 22

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

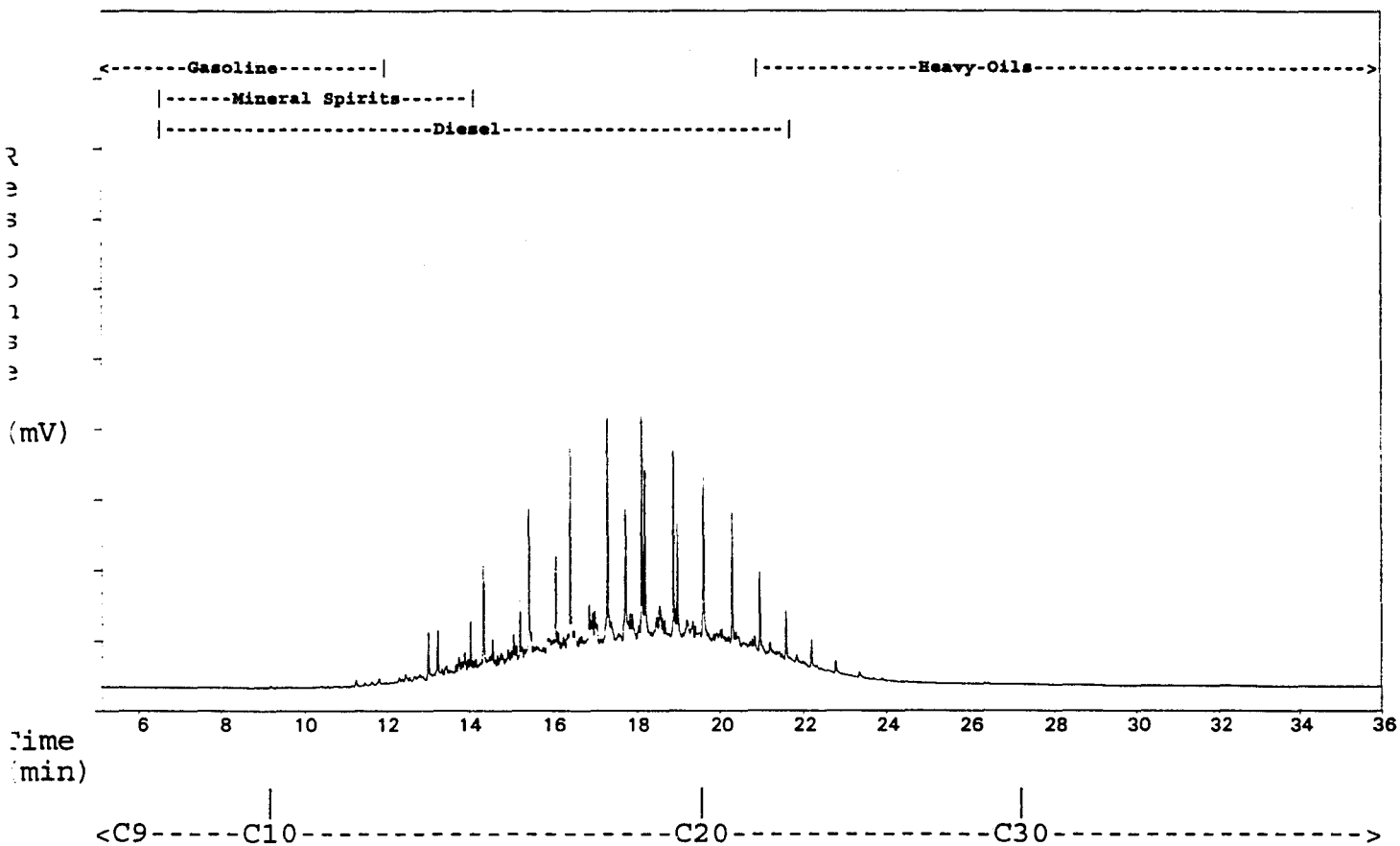
SAMPLE NAME: G4671r 23

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

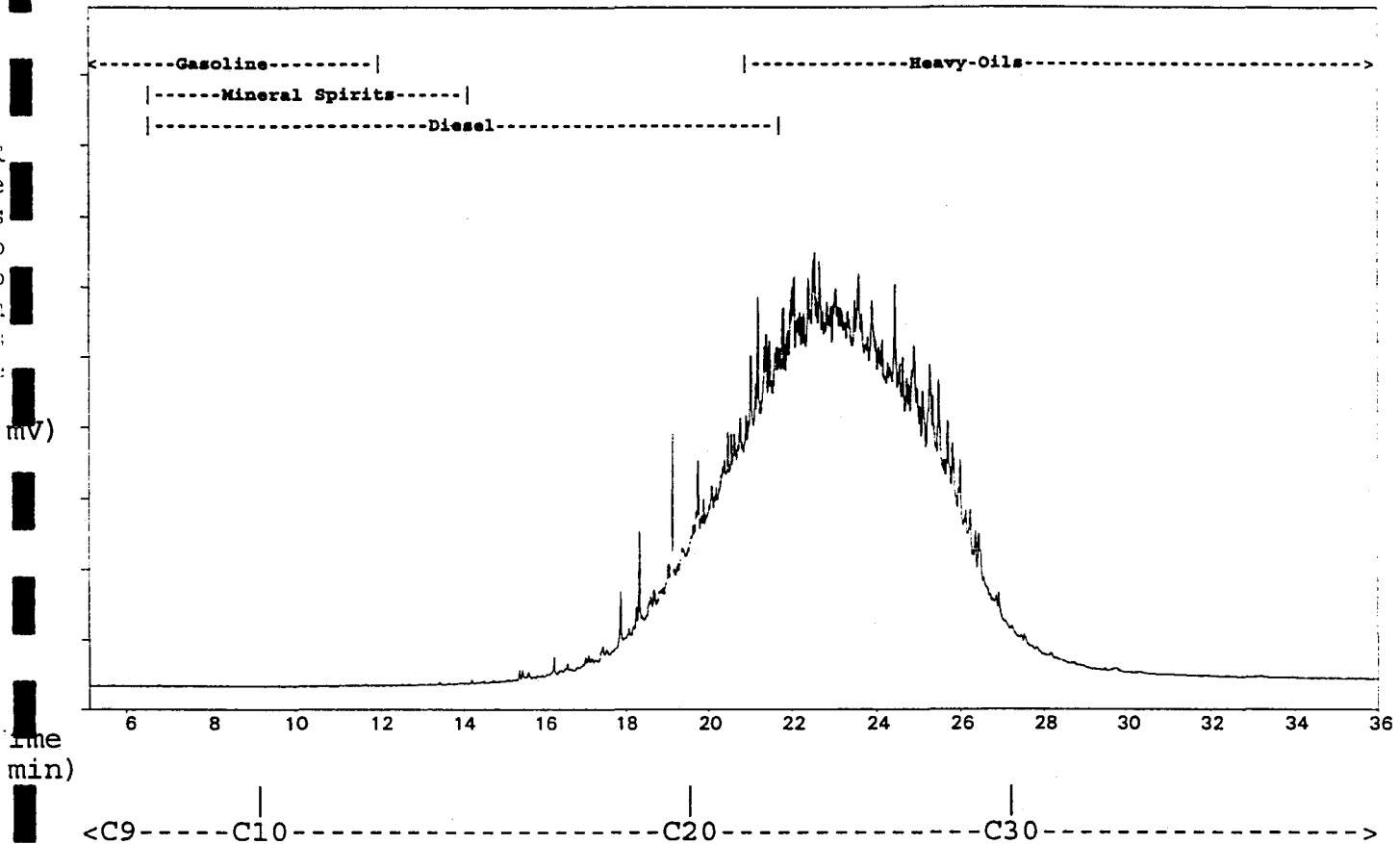
SAMPLE NAME: G4671r 33#RX5

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 (%)

| 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 |

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HYDROCARBON DISTRIBUTION REPORT

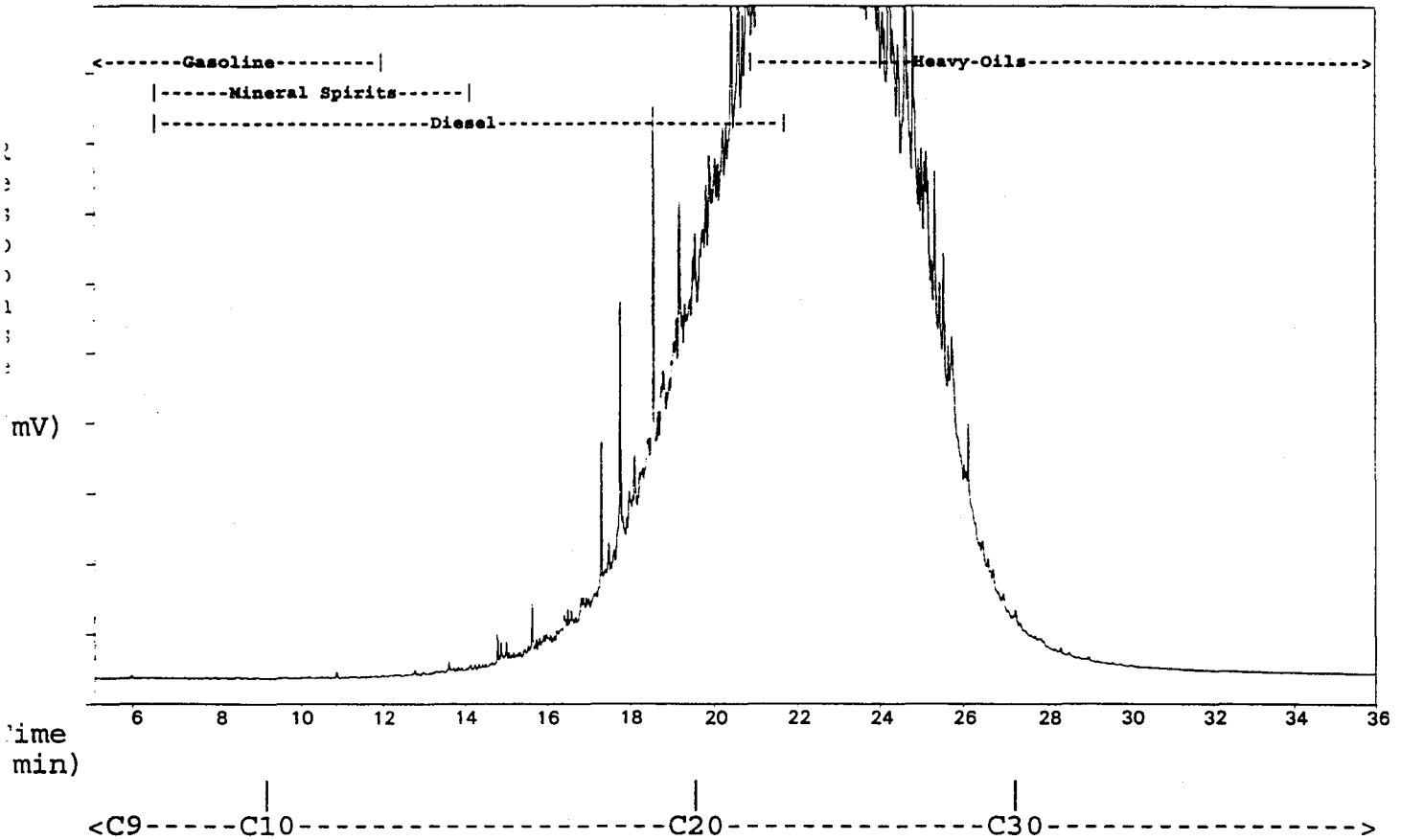
SAMPLE NAME: G4671r 32#RX5

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 |

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HYDROCARBON DISTRIBUTION REPORT

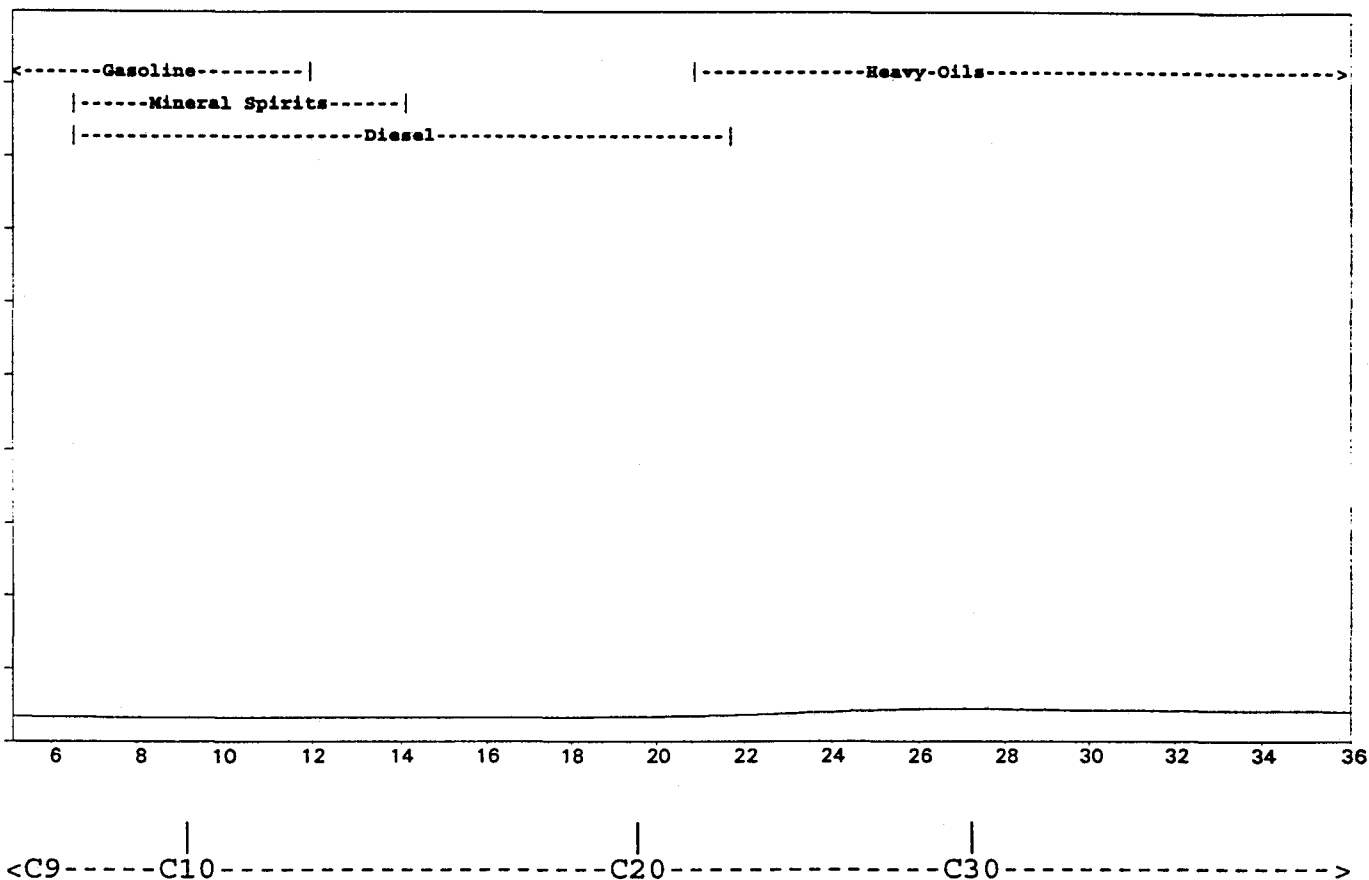
SAMPLE NAME: G4671r 34

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 |

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HYDROCARBON DISTRIBUTION REPORT

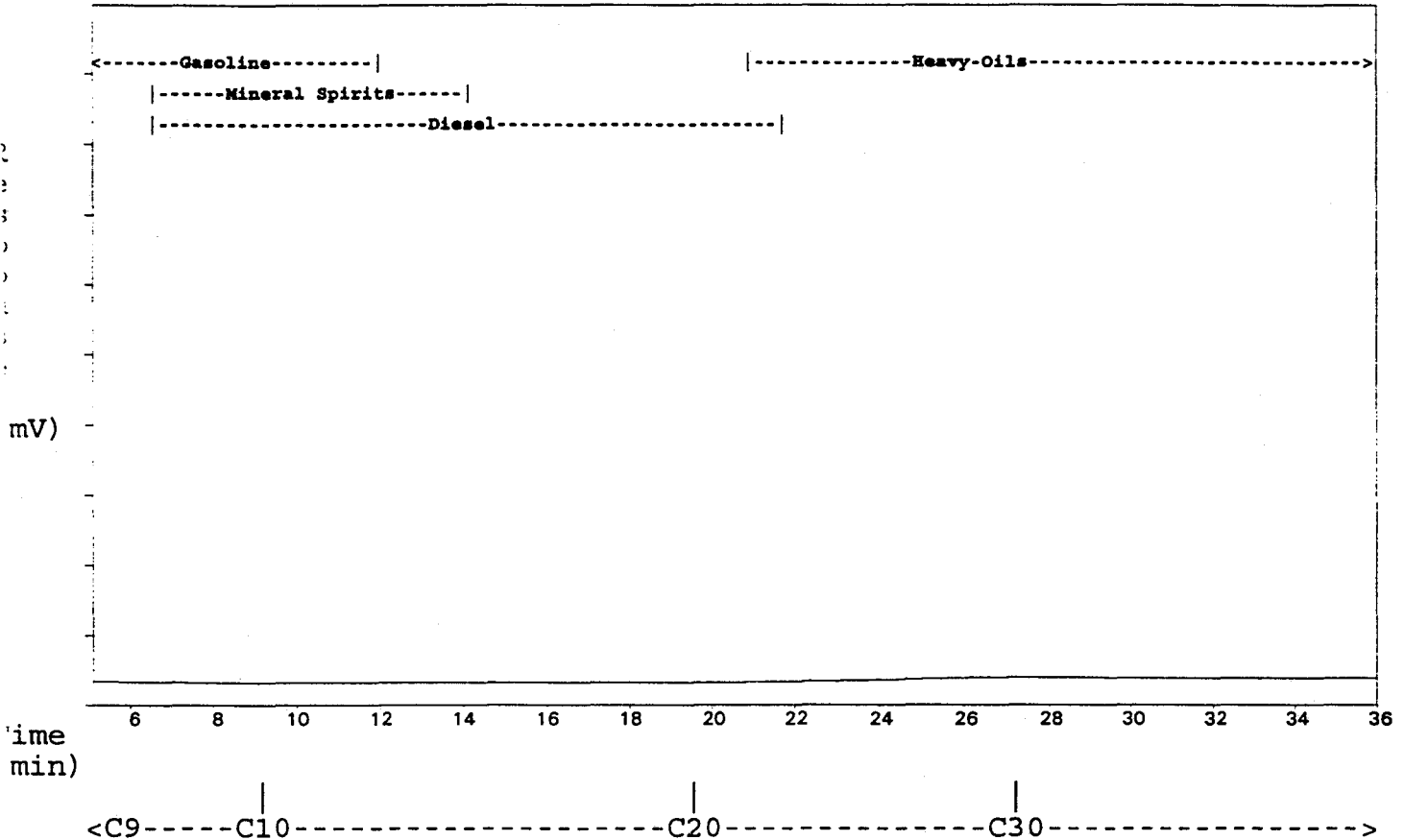
SAMPLE NAME: G4671r 48

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

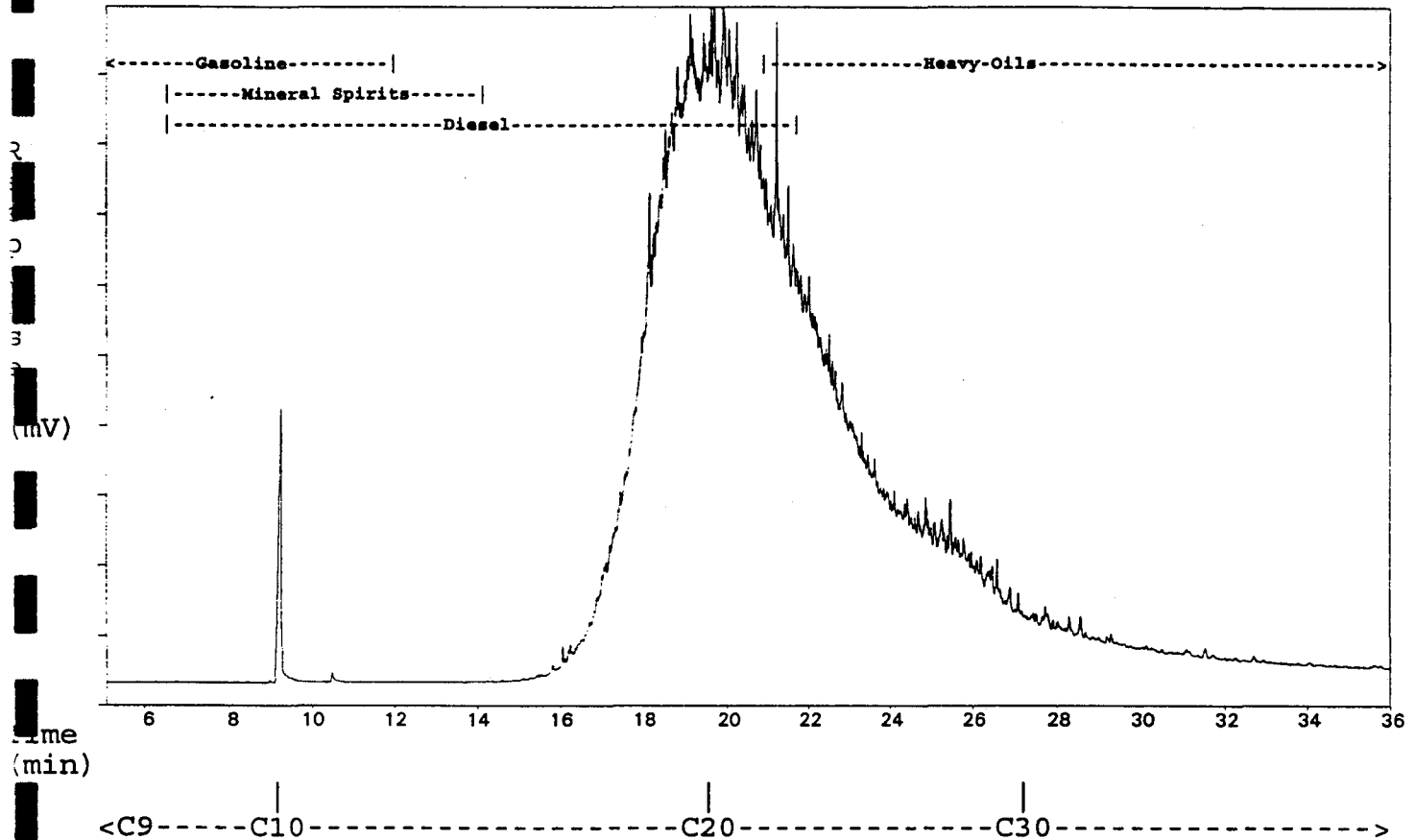
SAMPLE NAME: G4671r 49#RX2

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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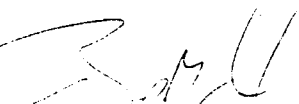
CHEMICAL ANALYSIS REPORT

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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RESULTS OF ANALYSIS - Sediment/Soil

File No. G8093

VE-15S

KA-05

Physical Tests

Moisture %

9.2

74.3

Remarks regarding the analyses appear at the beginning of this report.
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**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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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.



RESULTS OF ANALYSIS - Sediment/Soil

File No. G8093

| | VE-01S Dup | VE-01D | VE-08S | VE-15S | KA-05 |
|--|---------------|--------|--------|--------|-------|
| <u>Polycyclic Aromatic Hydrocarbons</u> | | | | | |
| 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 |
| <u>Extractables</u> | | | | | |
| EPH (C10-18) | - | 1950 | - | - | - |
| EPH (C19-31) | - | 706 | - | - | - |
| Total Extr Hydrocarbons (C10-30) | - | 2390 | - | - | - |

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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 % |
|---|------|-----------------|-------------------|
| <u>Total Metals</u> | | | |
| 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 | - |
| <u>Non-halogenated Volatiles</u> | | | |
| 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 | - |

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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 - Quality Control

File No. G8093

| | Method Blank | Matrix Spike % |
|--|-----------------|-------------------|
| <u>Polycyclic Aromatic Hydrocarbons</u> | | |
| 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 |
| <u>Extractables</u> | | |
| 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.
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.



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

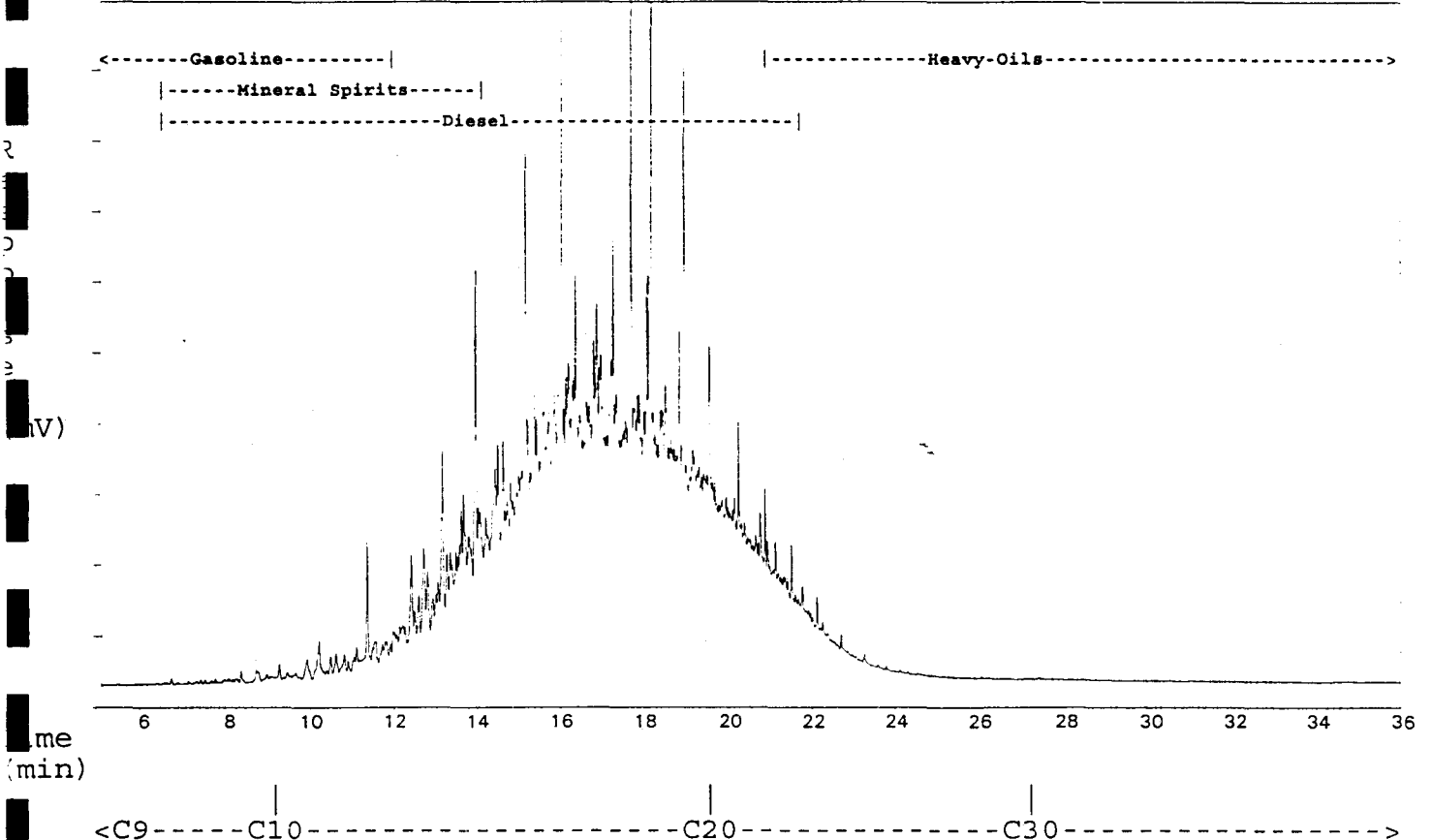
HYDROCARBON DISTRIBUTION REPORT

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 |

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.

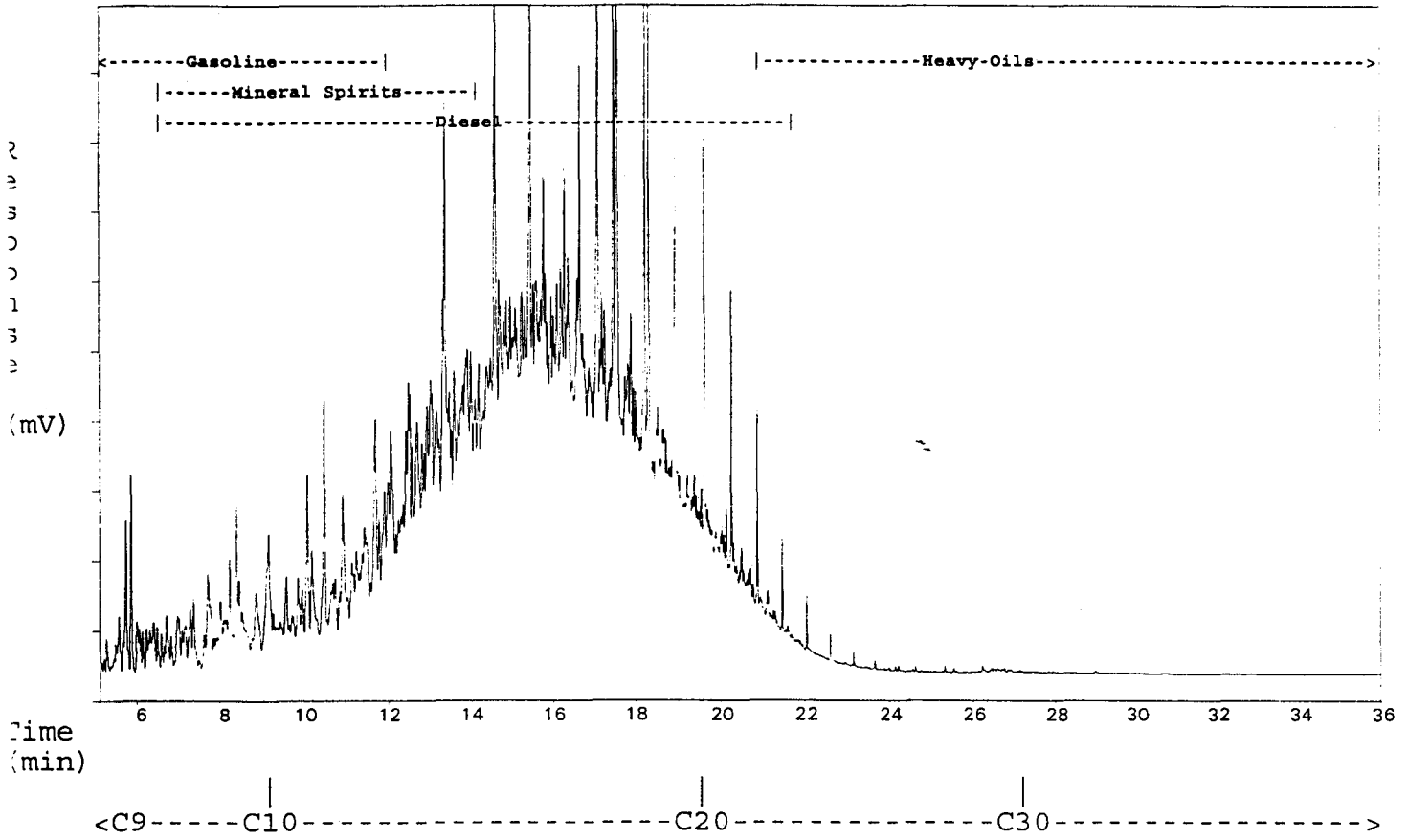
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: 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 |

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.

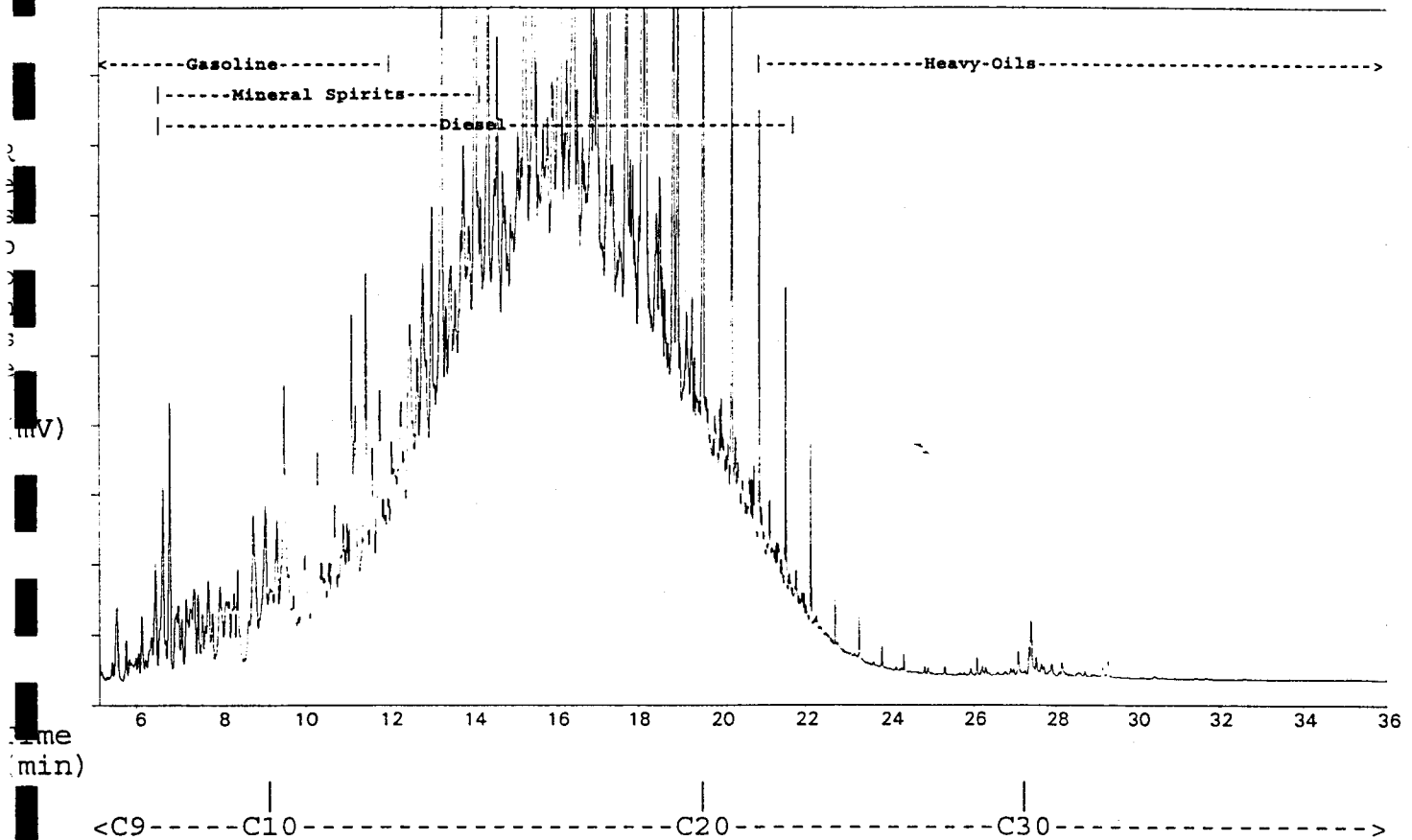
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: 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 |

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.

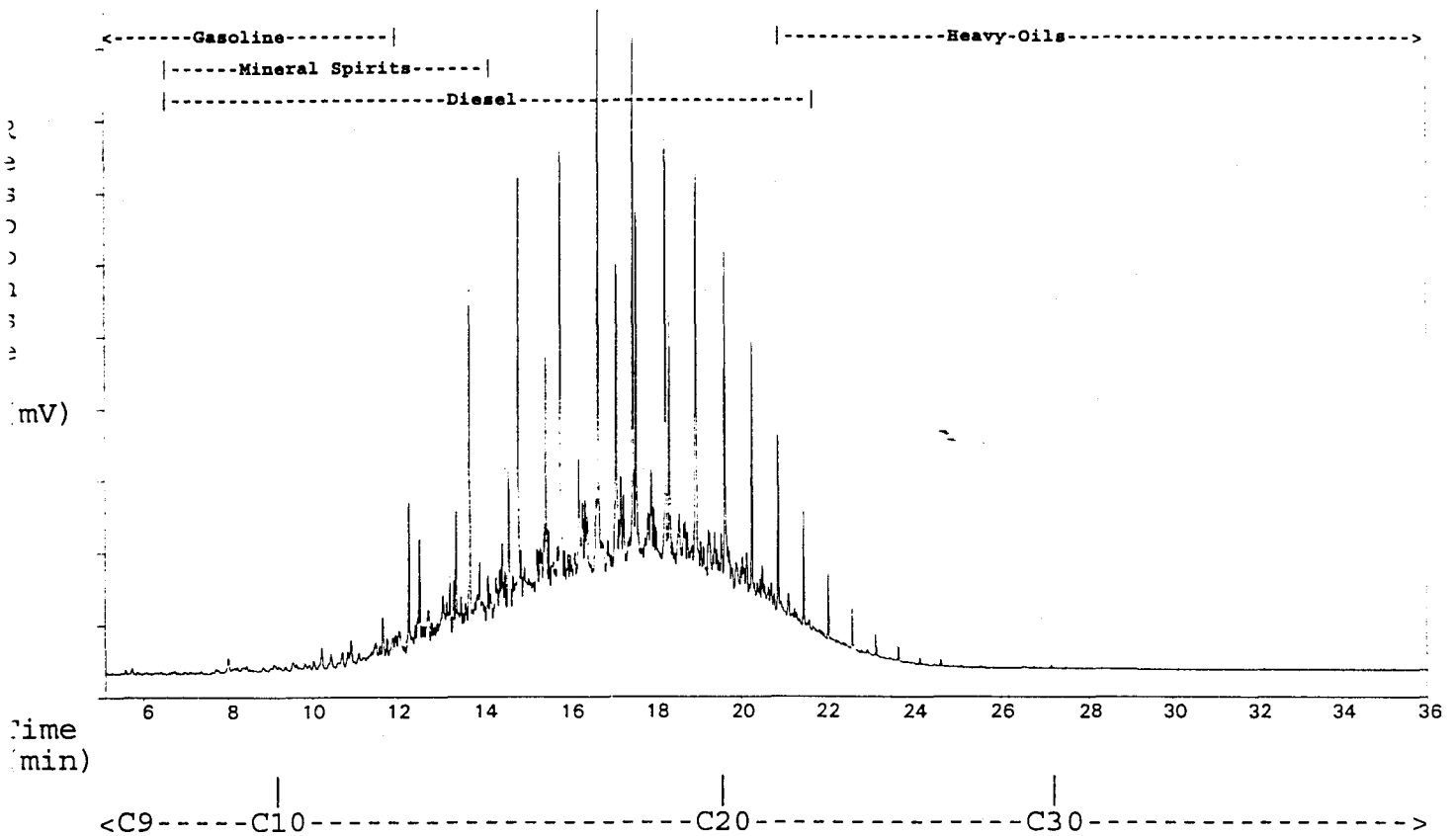
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: 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.

CANTEST

CanTest Ltd

Professional
Analytical
Services**REPORT ON:** Analysis of Oil Samples**REPORTED TO:** Royal Roads University
2005 Sooke Road
Victoria, B.C.
V9B 5X2

Att'n: Mr. Bill Dushenko

DRAFT1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7276

1 800 665 8566

| | |
|---|---------------------------------------|
| NUMBER OF SAMPLES: 11 | REPORT DATE: November 22, 1996 |
| DATE SUBMITTED: October 24, 1996 | GROUP NUMBER: 7610K |
| SAMPLE TYPE: Oil | |

TEST METHODS:

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

General Metals Scan -The analysis for metals was carried out after aliquots of the oil were ashed in a quartz vessel at 550°C. After digesting the ash with aqua-regia the resulting solutions were analyzed by Inductively Coupled Argon Plasma Spectrograph (ICAP).

Total Organic Halogens (TOX) -Determined using ASTM method D808-87.

TEST RESULTS:

(See the following pages)

CANTEST LTD.

Richard S. Jornitz, A.Sc.T.
Supervisor
Inorganic Testing

qc#13





CanTest Ltd

Professional
Analytical
Services

1523 West 3rd
Vancouver, BC
V6J 1J8

Fax: 604 731 2386

Tel: 604 734 7200

1 800 665 8588

REPORT ON: Oil Samples
REPORTED TO: Royal Roads University

Attention: Bill Dushenko

P.O. NUMBER:

NUMBER OF SAMPLES: 16

REPORT DATE:

DATE SUBMITTED:

GROUP NUMBER:

SAMPLE TYPE:

TEST METHODS:

TOX

| | |
|-------------------|----------|
| CR-A1 (A,B,C) | 614 µg/g |
| CR-A4 (A,B,C) | 519 µg/g |
| CR-A6 (A,B,C) | 242 µg/g |
| CR-C1 (A,B,C) | 116 µg/g |
| CR-B2 (A,B) | 94 µg/g |
| VE-A2 (A,B,C) | 124 µg/g |
| VE-A2 DUP (A,B,C) | 65 µg/g |
| VE-C1 (A,B,C) | 244 µg/g |
| VE-D1 (A,B,C) | 193 µg/g |
| VE-E1 (A,B,C) | 249 µg/g |
| VA-A1 (A,B,C) | 62 µg/g |

TEST RESULTS:

CANTEST LTD.

Richard S. Jornitz, A.Sc.T.
Supervisor
Inorganic Testing

qc#10



REPORTED TO: Royal Roads University

REPORT DATE: November 22, 1998

GROUP NUMBER: 7610K

Metals in Oil

| CLIENT SAMPLE IDENTIFICATION | CR-A1 (A,B,C) | CR-A4 (A,B,C) | CR-A6 (A,B,C) | CR-C1 (A,B,C) | UNITS | DETECTION LIMIT |
|------------------------------|---------------|---------------|---------------|---------------|-------|-----------------|
| CAN TEST ID: | 7610K-1 | 7610K-2 | 7610K-3 | 7610K-4 | | |
| Total Organic Halogens | 614 | 519 | 242 | 116 | µg/g | 25 |
| Aluminum Al | < | < | < | < | µg/g | 2 |
| Antimony Sb | < | < | < | < | µg/g | 2 |
| Arsenic As | < | < | < | < | µg/g | 3 |
| Barium Ba | 0.04 | < | 0.02 | < | µg/g | 0.01 |
| Beryllium Be | < | < | < | < | µg/g | 0.06 |
| Cadmium Cd | < | < | < | < | µg/g | 0.2 |
| Calcium Ca | 20 | 0.5 | 7.0 | 1.1 | µg/g | 0.1 |
| Chromium Cr | < | < | < | < | µg/g | 0.3 |
| Cobalt Co | 0.2 | < | < | < | µg/g | 0.2 |
| Copper Cu | 0.4 | < | 0.5 | < | µg/g | 0.2 |
| Iron Fe | 176 | 2 | 890 | 2.5 | µg/g | 0.3 |
| Lead Pb | 53 | 35 | < | < | µg/g | 0.8 |
| Magnesium Mg | 0.29 | < | 0.50 | 0.15 | µg/g | 0.01 |
| Manganese Mn | 4.9 | < | 6.4 | < | µg/g | 0.03 |
| Molybdenum Mo | < | < | < | < | µg/g | 0.4 |
| Nickel Ni | < | < | < | < | µg/g | 0.3 |
| Phosphorus PO4 | < | < | < | < | µg/g | 4 |
| Silver Ag | < | < | < | < | µg/g | 0.3 |
| Sodium Na | 5 | < | 2 | 2 | µg/g | 1 |
| Strontium Sr | 0.04 | < | 0.01 | < | µg/g | 0.01 |
| Tin Sn | < | < | < | < | µg/g | 0.3 |
| Titanium Ti | < | 0.07 | < | < | µg/g | 0.06 |
| Vanadium V | < | < | < | < | µg/g | 0.1 |
| Zinc Zn | 0.5 | 0.2 | 28 | 8.2 | µg/g | 0.2 |
| Zirconium Zr | < | < | < | < | µg/g | 0.2 |

Results expressed as micrograms per gram (µg/g).
 < = Less than





REPORTED TO: Royal Roads University

REPORT DATE: November 22, 1996

GROUP NUMBER: 7610K

Metals in Oil

| CLIENT SAMPLE IDENTIFICATION | CR-B2 (A,B) | VE-A2 (A,B,C) | VE-A2 DUP (A,B,C) | VE-C1 (A,B,C) | UNITS | DETECTION LIMIT |
|------------------------------|-------------|---------------|-------------------|---------------|-------|-----------------|
| CAN TEST ID: | 7610K-5 | 7610K-6 | 7610K-7 | 7610K-8 | | |
| Total Organic Halogens | 94 | 124 | 65 | 244 | µg/g | 25 |
| Aluminum Al | 3 | < | < | < | µg/g | 2 |
| Antimony Sb | < | < | < | < | µg/g | 2 |
| Arsenic As | < | < | < | < | µg/g | 3 |
| Barium Ba | 0.02 | 0.01 | < | < | µg/g | 0.01 |
| Beryllium Be | < | < | < | < | µg/g | 0.06 |
| Cadmium Cd | < | < | < | < | µg/g | 0.2 |
| Calcium Ca | 5.5 | 0.7 | 0.3 | 0.6 | µg/g | 0.1 |
| Chromium Cr | < | < | < | < | µg/g | 0.3 |
| Cobalt Co | < | < | < | 0.3 | µg/g | 0.2 |
| Copper Cu | 0.3 | < | < | < | µg/g | 0.2 |
| Iron Fe | 42 | 0.7 | 0.4 | 1.1 | µg/g | 0.3 |
| Lead Pb | < | < | < | 236 | µg/g | 0.8 |
| Magnesium Mg | 0.25 | 0.15 | 0.14 | 0.16 | µg/g | 0.01 |
| Manganese Mn | 1.60 | < | < | 0.07 | µg/g | 0.03 |
| Molybdenum Mo | < | < | < | < | µg/g | 0.4 |
| Nickel Ni | < | < | < | < | µg/g | 0.3 |
| Phosphorus PO4 | < | < | < | < | µg/g | 4 |
| Silver Ag | < | < | < | < | µg/g | 0.3 |
| Sodium Na | 5 | 9 | < | < | µg/g | 1 |
| Strontium Sr | < | < | < | < | µg/g | 0.01 |
| Tin Sn | < | < | < | < | µg/g | 0.3 |
| Titanium Ti | < | < | < | < | µg/g | 0.06 |
| Vanadium V | < | < | < | < | µg/g | 0.1 |
| Zinc Zn | < | 0.4 | < | 0.3 | µg/g | 0.2 |
| Zirconium Zr | < | < | < | < | µg/g | 0.2 |

Results expressed as micrograms per gram (µg/g).
 < = Less than





REPORTED TO: Royal Roads University
 REPORT DATE: November 22, 1996
 GROUP NUMBER: 7610K

Metals in Oil

| CLIENT SAMPLE IDENTIFICATION | VE-D1 (A,B,C) | VE-E1 (A,B,C) | VA-A1 (A,B,C) | | UNITS | DETECTION LIMIT |
|------------------------------|---------------|---------------|---------------|--|-------|-----------------|
| CAN TEST ID: | 7610K-9 | 7610K-10 | 7610K-11 | | | |
| Total Organic Halogens | 193 | 249 | 62 | | µg/g | 25 |
| Aluminum Al | < | < | < | | µg/g | 2 |
| Antimony Sb | < | < | < | | µg/g | 2 |
| Arsenic As | < | < | < | | µg/g | 3 |
| Barium Ba | 0.01 | 0.02 | 0.20 | | µg/g | 0.01 |
| Beryllium Be | < | < | < | | µg/g | 0.06 |
| Cadmium Cd | < | < | < | | µg/g | 0.2 |
| Calcium Ca | 0.5 | 13.1 | 3.8 | | µg/g | 0.1 |
| Chromium Cr | < | < | < | | µg/g | 0.3 |
| Cobalt Co | < | < | 1.3 | | µg/g | 0.2 |
| Copper Cu | 0.7 | 1.0 | 1.5 | | µg/g | 0.2 |
| Iron Fe | 0.6 | 36.6 | 31.9 | | µg/g | 0.3 |
| Lead Pb | 1.6 | < | 1.5 | | µg/g | 0.8 |
| Magnesium Mg | 0.15 | 0.60 | 0.90 | | µg/g | 0.01 |
| Manganese Mn | < | 0.41 | 0.60 | | µg/g | 0.03 |
| Molybdenum Mo | < | < | < | | µg/g | 0.4 |
| Nickel Ni | < | < | < | | µg/g | 0.3 |
| Phosphorus PO4 | < | < | 10 | | µg/g | 4 |
| Silver Ag | < | < | < | | µg/g | 0.3 |
| Sodium Na | < | 2 | 3110 | | µg/g | 1 |
| Strontium Sr | < | 0.02 | 0.22 | | µg/g | 0.01 |
| Tin Sn | < | < | < | | µg/g | 0.3 |
| Titanium Ti | < | < | 0.07 | | µg/g | 0.06 |
| Vanadium V | < | < | < | | µg/g | 0.1 |
| Zinc Zn | 0.3 | 0.2 | 5.7 | | µg/g | 0.2 |
| Zirconium Zr | < | < | < | | µg/g | 0.2 |

Results expressed as micrograms per gram (µg/g).
 < = Less than



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

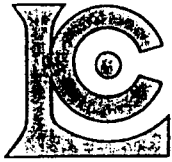
Page Number 1
Total Pages 1
Certificate Date 21-SEP-96
Invoice No. 19631399
P.O. Number
Account JGG

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:



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. #:

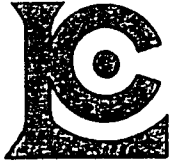
Samples submitted to our lab in Vancouver, BC.
This report was printed on 21-SEP-96.

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 |



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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

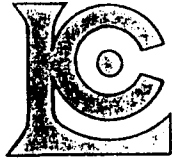
CERTIFICATE OF ANALYSIS

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 | 2091364 | 7.1 | 0.06 | 0.93 | 1.06 | 25.2 | 33 | 132 | 99 | 4.00 | |
| VE-AD10 | 2091364 | 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.

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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.#:

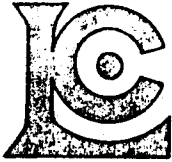
Samples submitted to our lab in Vancouver, BC.
This report was printed on 21-SEP-96.

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 |



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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

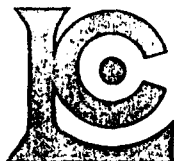
Page Number :1-A
Total Pages :1
Certificate Date: 19-SEP-96
Invoice No. :I9631400
P.O. Number :
Account :JGG

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:

Frank Buchler



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. :19631400
 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
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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. #:

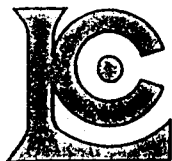
Samples submitted to our lab in Vancouver, BC.
 This report was printed on 19-SEP-96.

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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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. : 19631590
P.O. Number :
Account : JGG

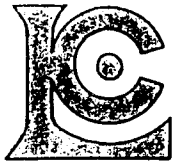
CERTIFICATE OF ANALYSIS

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:

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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. : 19631590
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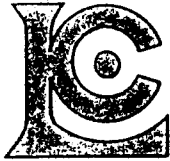
CERTIFICATE OF ANALYSIS

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 | | | | |

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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 | Mean | RSD % |
|--------------|------------|--------|------|----------|
| | Duplicates | | | |
| 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 Field Duplicates | 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 |
|--|-------------|--------------|
| Core location(near helicopter landing) | 64 - 15.60N | 133 - 41.93W |

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 | --- | 1,3-dichlorobenzene | 0.1 | 0.2 |
| ammonia | --- | --- | 1,4-dichlorobenzene | 0.1 | 0.2 |
| antimony | 20 ² | --- | ethylbenzene | 0.1 | 0.5 |
| arsenic | 5 | 5 | styrene | 0.1 | 0.5 |
| barium | 200 | 50 | toluene | 0.1 | 0.5 |
| beryllium | 4 | --- | xylenes | 0.1 | 0.5 |
| boron (hot water soluble) | 1 | --- | | | |
| boron (total) | --- | --- | Phenolic Compounds | | |
| cadmium | 0.5 | 1 | non-chlorinated ³ (each) | 0.1 | 0.1 |
| chromium (+6) | 2.5 | --- | chlorophenols ⁴ (each) | 0.05 | 1 |
| chromium (total) | 20 | 15 | | | |
| cobalt | 10 | 10 | Polyaromatic Hydrocarbons (PAHs) | | |
| copper | 30 | 25 | PAHs (Total) | | |
| cyanide (free) | 0.25 | 40 | benzo(a)anthracene | 0.1 | 0.01 |
| cyanide (total) | 2.5 | 40 | benzo(a)pyrene | 0.1 | 0.01 |
| fluoride (total) | 200 | --- | benzo(b)fluoranthene | 0.1 | 0.01 |
| iron | --- | --- | benzo(k)fluoranthene | 0.1 | 0.01 |
| lead | 25 | 10 | dibenz(a,h,)anthracene | 0.1 | 0.01 |
| manganese | --- | --- | indeno(1,2,3-c,d)pyrene | 0.1 | 0.1 |
| mercury | 0.1 | 0.1 | naphthalene | 0.1 | 0.2 |
| molybdenum | 2 | 5 | phenanthrene | 0.1 | 0.2 |
| nickel | 20 | 10 | pyrene | 0.1 | 0.2 |
| selenium | 1 | 1 | | | |
| silver | 2 | 5 | Chlorinated Hydrocarbons | | |
| sulphur (elemental) | 250 | --- | chlorinated aliphatics ⁵ (each) | 0.1 | 0.1 |
| thallium | 0.5 | --- | chlorobenzenes ⁶ (each) | 0.05 | 0.3 |
| tin | 5 | 10 | hexachlorobenzene | 0.1 | 0.1 |
| vanadium | 25 | --- | hexachlorocyclohexane | 0.01 | --- |
| zinc | 60 | 50 | Chlorinated Pesticides | --- | --- |
| | | | PCBs ⁷ | 0.1 | 0.1 |
| Aliphatic Organics | | | PCDDs and PCDFs ⁸ | 1E-05 | --- |
| non-chlorinated aliphatics (each) | 0.3 | --- | | | |
| | | | Miscellaneous Organics | | |
| Monocyclic Aromatic Hydrocarbons | | | phthalic acid esters (each) | 30 | --- |
| benzene | 0.05 | 0.5 | quinoline | 0.1 | --- |
| chlorobenzene | 0.1 | 0.1 | thiophene | 0.1 | --- |
| 1,2-dichlorobenzene | 0.1 | 0.2 | 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 |
|--|--|--|--|--|--|
| <i>Inorganics</i> | | | <i>Phenolic Compounds</i> | | |
| aluminum | --- | | non-chlorinated ^d (each) | 1 | 10 |
| ammonia | --- | | chlorophenols ^d (each) | 0.5 | 5 |
| antimony | 20 | 40 | <i>Polyaromatic Hydrocarbons (PAHs)</i> | | |
| arsenic | 30 | 50 | PAHs (Total) | | |
| barium | 500 | 2000 | benzo(a)anthracene | 1 | 10 |
| beryllium | 4 | 8 | benzo(a)pyrene | 1 | 10 |
| boron (total) | --- | --- | benzo(b)fluoranthene | 1 | 10 |
| cadmium | 5 | 20 | benzo(k)fluoranthene | 1 | 10 |
| chromium (+6) | 8 | --- | dibenz(a,h,-)anthracene | 1 | 10 |
| chromium (total) | 250 | 800 | indeno(1,2,3-c,d)pyrene | 1 | 10 |
| cobalt | 50 | 300 | naphthalene | 5 | 50 |
| copper | 100 | 500 | phenanthrene | 5 | 50 |
| cyanide (free) | 10 | 100 | pyrene | 10 | 100 |
| cyanide (total) | 50 | 500 | chrysene | --- | --- |
| fluoride (total) | 400 | 2000 | 3-methylcholanthrene | --- | --- |
| iron | --- | --- | benzo(g,h,i)perylene | --- | --- |
| lead | 500 | 1000 | dibenzo(a,h)pyrene | --- | --- |
| manganese | --- | --- | dibenzo(a,i)pyrene | --- | --- |
| mercury | 2 | 10 | dibenzo(a,l)pyrene | --- | --- |
| molybdenum | 10 | 40 | acenaphthene | --- | --- |
| nickel | 100 | 500 | acenaphthylene | --- | --- |
| selenium | 3 | 10 | anthracene | --- | --- |
| silver | 20 | 40 | fluoranthene | --- | --- |
| thallium | --- | --- | fluorene | --- | --- |
| tin | 50 | 300 | <i>Chlorinated Hydrocarbons</i> | | |
| vanadium | 200 | --- | chlorinated aliphatics ^e | 5 | 50 |
| zinc | 500 | 1500 | (each) | | |
| <i>Monocyclic Aromatic Hydrocarbons</i> | | | chlorobenzenes ^e (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 | <i>Miscellaneous Organics</i> | | |
| styrene | 5 | 50 | 2,4-D | --- | --- |
| toluene | 3 | 30 | 2,4,5-T | --- | --- |
| xylenes | 5 | 50 | Volatile Petroleum | 200 | 200 |
| | | | Hydrocarbons | | |
| | | | Light Extractable Petroleum | 1000 | 2000 |
| | | | Hydrocarbons | | |
| | | | Heavy Extractable | 1000 | 5000 |
| | | | Petroleum Hydrocarbons | | |
| | | | 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 |
| <i>Phenolic Compounds</i> 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 |
| <i>Polyaromatic Hydrocarbons</i> (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 | --- |
| <i>Chlorinated Hydrocarbons</i> | | | | |
| 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 | 0.01 | --- | | |
| hexachlorocyclohexane | | --- | | |
| chlorinated pesticides | 0.001 to 4 ²⁰ | 0.7 to 280 ²⁰ | | |
| PCBs ⁶ | 1 ng/L | --- | 0.0001 | --- |
| PCDDs and PCDFs ⁷ | --- | --- | | |
| <i>Miscellaneous Organics</i> | | | | |
| 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-dinitrophenol, 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.

Table F-4: Summary/Overview of Used Oil Specifications by Jurisdiction

| Province/ Tier | Arsenic | Cadmium | Chromium | Lead | Total Organic Halogens (TOX) | Flash Point | PCB |
|-------------------------------|---------|---------|----------|------|---------------------------------------|----------------|-----|
| B.C. : | | | | | | | |
| Kiln | 20 | 3 | 10 | 1000 | 3000 | - | 500 |
| Other | 5 | 2 | 10 | 50 | 1500 | - | 3 |
| Alberta - Permit | 5 | 2 | 10 | 100 | 1000 | - | 3 |
| Manitoba | 5 | 2 | 10 | 100 | 1000 | 38°C min. | 2 |
| Ontario | 5 | 2 | 10 | 50 | 1500 | - | 2 |
| Quebec | 5 | 2 | 10 | 100 | 1500 | 38°C min. | 3 |
| New Brunswick - Restricted | 5 | 2 | 10 | 100 | 1000 | - | 5 |
| Nova Scotia | - | 2 | 10 | | 1000 | 38°C min. | 5 |
| PEI | 5 | 2 | 10 | 100 | 1000 | 38°C min. | 5 |
| Newfoundland: | | | | | | | |
| Kiln | - | 3 | 10 | 1000 | 3000 | - | 500 |
| Other | - | 2 | 10 | 100 | 1000 | - | 5 |
| US. EPA. | 5 | 2 | 10 | 100 | 4000 | 37.5°C | - |

All units in mg/L unless otherwise noted (conversion to ppm using density of 0.80 kg/L)

New Brunswick draft levels have an unrestricted category which are very low