

**ENVIRONMENTAL ASSESSMENT OF
YUKON ABANDONED MINE SITES:
VERA MINE SITE**

Prepared for:
**PUBLIC WORKS AND
GOVERNMENT SERVICES CANADA**

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March 1997

In Association with:
uma
UMA ENGINEERING LTD.
and
**MINESITE DRAINAGE
ASSESSMENT GROUP**

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**Report Prepared for
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**By
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Applied Research Division,**

In Association With

UMA Engineering

Minesite Drainage Assessment Group

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Executive Summary

Royal Roads University - Applied Research Division (RRU-ARD), in association with UMA Engineering, Edmonton, Alta and Minesite Drainage Assessment Group (Morwijk Enterprises), Vancouver, B.C., were retained by Public Works and Government Services Canada to provide a detailed assessment of the Vera Mine Site, 133 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 27 to 29, 1996. This included photodocumentation and mapping of site features and sampling locations; examination of buildings, contents and other structures; 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 to estimate soil volumes.

The primary safety concern at the Vera site relates to the mine entrance. Over time, slope instability will result in rock falls which will block the entrance. Buildings at the site, particularly the cook shack and accommodation trailer, are suffering water damage and are rapidly deteriorating. Approximately 100 barrels located at the site contain either aviation fuel, diesel or heating oil; and their flammability represents a potential safety hazard. Most of these can be safely incinerated on site, with the exception of one old aviation fuel barrel which contains high concentrations of lead. Other potentially hazardous materials include batteries for equipment; miscellaneous maintenance supplies including antifreeze, hydraulic and lubricating oil; propane cylinders; fire extinguishers; and a barrel of lead ore (galena). The presence of explosives in a large cabinet along the trail to the mine adit could not be confirmed during the field investigation as the door was jammed.

Although acidic drainage on a small scale around the minerals and rock was rated as high, the acidic drainage is neutralized by the surrounding rock (dolomite and limestone) before migrating far. Likewise, the probability rating for acidic drainage on a large scale is minimal and the probability of acidic drainage on a medium scale, based on acid base accounting tests, is low.

Widespread elevated levels of arsenic and zinc were found in a majority of the soil samples analyzed, which is probably a reflection of both the natural mineralization and the cumulative effects of mining activities over the years. The process of identifying specific point sources of these metals was simplified by considering only those locations with anomalously high concentrations of these and/or other metals. The waste rock pile and adit are significant contaminant sources for metals including zinc, copper, lead and, in some cases, barium and silver which exceed the CCME remediation criteria. Although the potential for contaminant migration into the surrounding environment exists, this is

suggested to be limited for acid drainage based on low probability ratings and the neutralizing ability at the site. A low to moderate environmental risk exists for zinc-contaminated water from the adit reaching fish-bearing waters in the nearby valley. Localized metal leaching from acid drainage is also indicated to be occurring to soils below the corebox storage area which are contaminated with zinc, nickel and copper. This area may present a moderate environmental risk to Arctic ground squirrels which frequent this location.

A large but localized stain area identified on the floor of the mechanic/generator shop is contaminated with hydrocarbons (diesel) and copper which could pose a moderate future environmental risk to a ground squirrel colony in the camp vicinity.

A white substance found in a spring seepage from the ground near the camp was contaminated with high arsenic and zinc concentrations exceeding the CCME/B.C. soil remediation criteria. The location drains into a stream running through the camp and may pose a moderate environmental risk for foraging wildlife in the area, and receiving waters supporting fish in the valley to the west.

Other localized hydrocarbon stain areas exist at the site, including two stained areas on the adit waste rock pile from fuel and soluble oil spills, a leaky diesel fueling barrel by the core shack, and another stain by an outside work area just east of the camp. Although, these particular locations do not pose any environmental or human health risks based on either their levels, small area, or location; they do pose some aesthetic concerns.

Recommendations for the Vera site include the following:

- excavation and disposal of isolated areas of stained and contaminated soil in a lined facility on site;
- proper containerization and removal of barrel containing pure lead ore (galena);
- demolition and disposal in a facility on site of facilities including wood frame mine shacks and Atco trailers;
- collection of barrels, incineration/disposal of contents, and disposal of barrels on site;
- collection and secure disposal of rock core in a lined facility on site;
- examination of explosives cabinet and removal of any combustibles and other hazardous materials off-site;
- collection and disposal of waste and debris from other sites in a facility on site; and
- regrading of the waste rock pile at the adit to control erosion, and secure fencing of the opening to prevent entry but allow normal drainage

A substantial amount of material identified at the Vera site could potentially be salvaged. Opportunity might be given to the Contractor to apply any potential salvage costs against the total cost of the Contract. Equipment and personnel for the work would be mobilized from Mayo and helicopter transport would be used for all personnel and perishable supplies.

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1. Introduction and Background

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

1.1 Location and Site Access

The Vera site (64° 19' 04" N, 133° 45' 10" W) is located in northeastern Yukon, 133 km northeast of Mayo, on the steep slope of Rusty Mountain (Map 1-1). This area is situated between the Rackla and Nadaleen Ranges of the Wernecke Mountains (Selwyn Mountains). The entire site ranges in elevation between 1150 and 1200 m above sea level (Photograph 1-1). The main camp, tucked in the foothills on the north slope of the mountain, is apparently accessible along a poorly marked winter trail which was previously used to transport equipment to the site. This trail passes the McQuesten Lakes and Rackla River to the east and crosses several streams. An airstrip also exists just north of the main camp, but is quite steep and in extremely poor condition, making helicopter the preferable form of access to the site.

1.2 Overview of Site Development

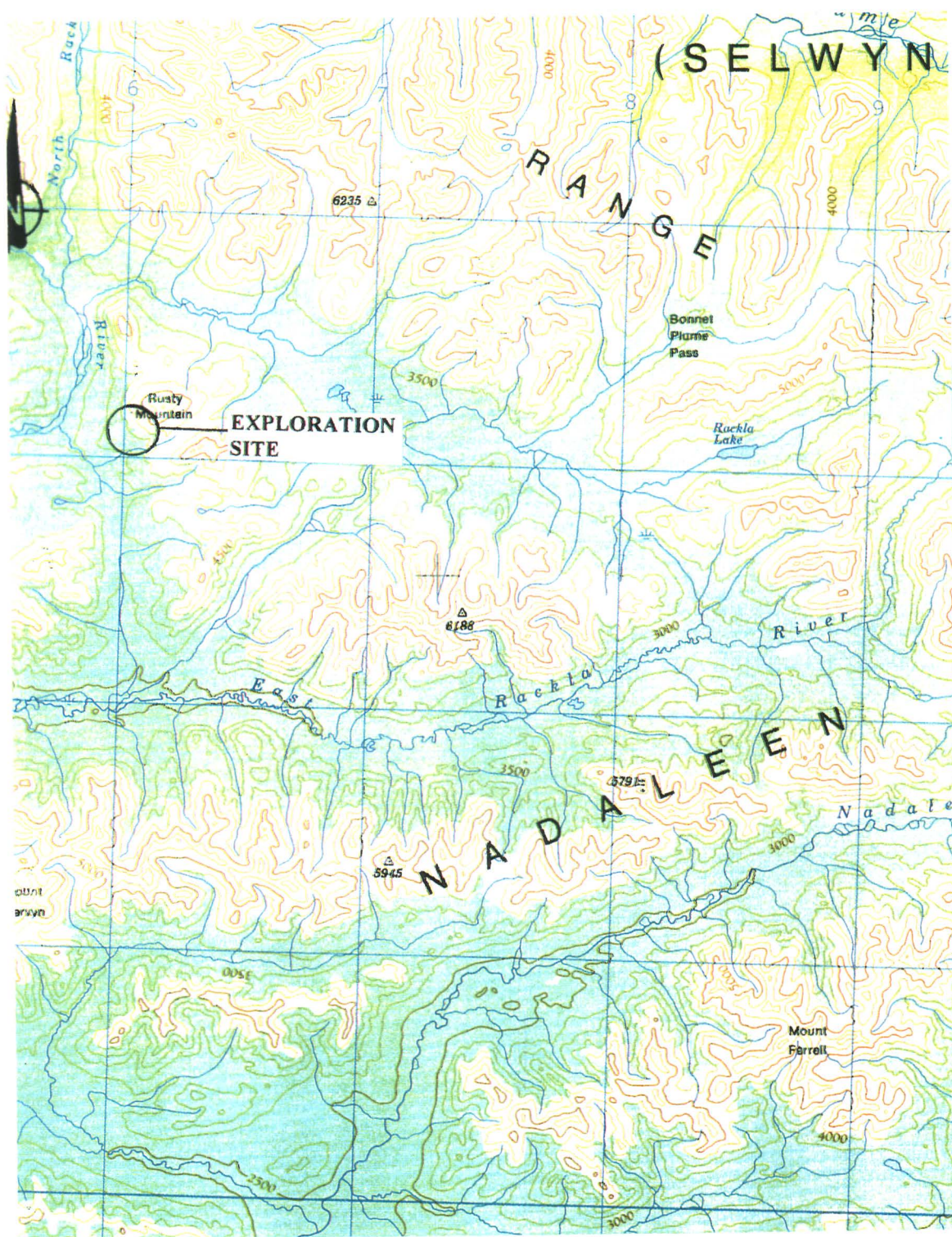
A work history of the site was compiled by DIAND Technical Services (1994) using information supplied from DIAND Yukon Minfile record 106C 083 and the Indian and Northern Affairs Mining Recorder's Office in Mayo, Yukon. This information is summarized below.

In 1978, the area was first staked as Vera claims by Prism Joint Ventures, a group of resource companies including Prism Resources Ltd. This claim was mapped, geochemically surveyed and trenched later the same year. Following the replacement of one of the companies in the venture (Siebens Oil and Gas Ltd.) with Dome Petroleum Ltd. in 1979, 69 holes totalling 5655 m were drilled between 1979 and 1980. Prospecting continued in 1981 with 720 m of underground development and an additional 545 m of underground drilling. This was completed, along with trenching in 1982.

Some changes in the member companies of the venture occurred between 1983 and 1984, including the dropping of Dome's interest and the transfer of interest by E&B Exploration Ltd. to Imperial Metals Ltd., which was later acquired in 1984 by Prism Resources Ltd. Following a name change by the latter company to International Prism Exploration in 1985, additional drilling was completed including 12 holes in 1988. At that time, environmental studies were completed along the proposed road route to the site with International Prism purchasing a 100% working interest in the property in 1989. The Vera Group claim was made by Prism in March of 1992 with silver, lead and zinc identified as the major commodities. This expired in January, 1993. Only a small portion of these claims (Vera 13-18) have been renewed by Prism and this expire in January of 1998. (Assistant Mining Recorder, Indian and Northern Affairs Office, pers. comm.).

A now-abandoned camp development, consisting of modular trailers, some wood frame shacks, heavy equipment and storage areas for fuel barrels and other materials, has been established on the north slope of Rocky Mountain. Core boxes (approximately 1700) are cached at the east end of the site near a wood construction core shack. The camp is serviced by a airstrip just to the north, which is constructed on a natural ridge which slopes upward to the east. Small exploration roads and CAT trails extend in major directions for kilometers from this area and in the slopes above to the south. The only major mine development in the area consists of an open adit and waste rock dump along

the mountainside to the west of the camp. A wooden storage shack and heavy metal explosive boxes are also found at this location.



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



**Photograph 1-1: 1968 Aerial Photograph of Vera Mine Site
(1:250000 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 mine site, and to provide recommendations and preliminary cost estimates for the remediation or mitigation of those risks. The scope of work for the project consisted of three phases described below.

2.1 Phase I - Data Collection and Review

Relevant site information was collected and reviewed including the following:

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

Much of the above information was provided in the DIAND Technical Services Report (1994) for this site. Additional information was also supplied through interviews with personnel in the Indian and Northern Affairs in the (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 from August 27 to 29, 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 Vera Site were directed specifically to the following:

- photo-documentation, Geographical Positioning Co-ordinates (GPS) of specific locations (presented in Appendix E), and mapping of relevant site features;
- inspection of buildings and infrastructure, and materials;
- 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;
- inspection of mine adit and workings; 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 Vera site:

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

- Sealing and/or prevention of access to mine openings;
- Remediation and/or removal and disposal of contaminated soils;
- Consolidation, and landfill (where feasible/practical) or removal (off-site disposal) of all non-hazardous, non-combustible solid wastes;
- Removal and disposal of hazardous solid wastes;
- Onsite flaring, or removal and off-site disposal of petroleum products and other liquid hazardous wastes;
- Draining, cleaning and disposal of drums, or other containers containing petroleum products and other liquid hazardous wastes; and
- Demolition of buildings and infrastructure (where required) to foundation level and burning of combustible non-hazardous materials in an approved location.

3. Site Assessment Methodology

3.1 Assumptions

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

Other assumptions applicable to this site include the following:

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

3.2 Methods

3.2.1 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 (particularly mine openings)* were examined for hazardous materials and assessed for structural stability;
- *Non-hazardous site debris* was examined and inventoried;
- *Barrels and other containers* were examined, inventoried and the contents sampled for hazardous liquid materials;
- *Contaminated soil areas* were sampled and measured to determine the degree and type of contamination and to estimate soil volumes;
- *Waste rock and cores* were inspected for mineralization and oxidization, and sampled to assess their acid rock drainage potential; and
- *Scale site plans* were compiled (including GPS waypoints, Appendix E) and prepared to identify the locations of structures, waterways, sampling points, and other useful information.

Specific sampling procedures are discussed in Section 3.2.2 below.

3.2.2 Sampling Methods

Soil

All soil samples were collected, transported, and stored under conditions required to maintain sample integrity. The general protocols presented in the 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-lid 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.

Test Pits

Test pits were used as a screening tool to identify areas of contamination in shallow soils. A shovel was used to excavate test pits up to a half metre depth as required. A stainless steel scoop was then used to extract a soil sample.

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 for the determination of total chlorine, the second set for the analysis of metals by inductively coupled plasma spectrometry (ICP), and the third set for polychlorinated biphenyls (PCBs) analysis by gas chromatography. 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.

3.2.3 Chemical Analysis

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

Field Screening Tests for Hydrocarbons

Millipore EnviroGard™ immunoassay test kits which were obtained from Diagnostix Inc., Mississauga, Ontario were used for the detection of total petroleum hydrocarbons (TPH). The kit utilizes the enzyme-linked immunoabsorbent assay technique which is based on antibodies that are designed to bind to specific analytes. Quantitation is achieved by comparing the colourimetric signal generated by a unknown sample with a set of standards using a portable spectrophotometer. At least 20% of the samples were also subjected to laboratory analysis as per US EPA protocols for field test kits.

Metals in Soils

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

Metals in Water

The method used included procedures described in "Standard Methods for the Examination of Waste Water", 19th Edition, 1995, published by the American Public Health Association, and 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

Procedures described in "Standard Methods for the Examination of Water and Wastewater", 19th Edition, 1995, published by the American Public Health Association were used for this analysis.

Non-Halogenated Volatiles in Soil - Headspace method

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

Volatile Petroleum Hydrocarbons in Soil

The BC Ministry of Environment Land and Parks Method, "Volatile Petroleum Hydrocarbons in Soil," was used for this analysis.

Light Hydrocarbons in Soil

Samples were analysed for carbon atoms in the C5 - C9 range in accordance with US EPA Method 3810/8015 (Publ. # SW-846, 3rd ed., Washington DC 20460).

Extractable Petroleum Hydrocarbons (EPH) in Soil

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

Light and Heavy Extractable Petroleum Hydrocarbons in Soil

This analysis was carried out as outlined in the method descriptions for Extractable Petroleum hydrocarbons and Polycyclic Aromatic Hydrocarbons. As per BC MELP Draft 3 Contaminated Sites Regulations, the concentrations for light extractable hydrocarbons (LEPH) were derived by the subtraction of naphthalene concentrations from the EPH (C10-C18) values. Similarly, heavy extractable hydrocarbons (HEPH) were calculated by subtracting the concentrations of benzo(a)anthracene, benzo(b)fluoranthene, benzo(k)fluoranthene, dibenz(a,h)anthracene, indeno(1,2,3-c,d)pyrene phenanthrene and pyrene from the EPH (C19-C32) data.

Polycyclic Aromatic Hydrocarbons (PAHs) in Soil

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

Barrel Content Analysis - Inorganic 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.

3.2.4 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.

3.2.5 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.

3.3 Assessment Criteria

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 Vera Mine 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. At the request of the client (PWGSC) contaminant levels were also compared with the commercial/industrial (C/I) criteria reflecting its past use.

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

Screening level guidance for hydrocarbons is scarce. There is considerable variance between provinces in the application of group parameters for soil screening and remediation; for example, there is no consensus between regulatory jurisdictions on criteria for oil and grease (O&G) total petroleum hydrocarbons (TPH), total extractable hydrocarbons (TEH), or volatile, light and heavy extractable hydrocarbons (VPHs, LEPHs, and HEPHs, respectively). B.C. (1995) Draft Soil Standards for VPHs, LEPHs, and HEPHs have been used in the mine assessments as screening criteria for soil analyses (see Appendix F, Table 2). There are no standards or criteria for VPHs, LEPHs, or HEPHs in sediment, groundwater, or surface water. The B.C. Draft Soil Standards for hydrocarbons are classified by land uses: agricultural, urban park, residential, commercial and industrial. For the mine site assessment, the urban park/residential criteria were used for reasons described above. In each case, however, the commercial/industrial criteria were also used as part of the assessment.

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, and 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).

3.3.1 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 unit at Vera is reported to be strongly jointed (broken) Middle Proterozoic Gillespie Group dolomite (DIAND Technical Services, 1994) with the economic minerals galena (lead sulphide), argentiferous tetrahedrite (silver-bearing copper-based sulphide), and minor sphalerite (zinc sulphide). At 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 Group. Nevertheless, formations containing dolomite and limestone, as well as some black shale and more recent igneous rock, were found and tested as part of this study.

4.2 Climate

Climate in the area is predominantly sub-alpine, to alpine on the mountain slopes, with snow arriving by late August and probably dissipating by late June. Based on climate information at similar altitudes in the region, annual precipitation is probably 500 to 700 mm with a majority falling as snow. Mean annual temperatures between 0 to -10°C may be expected for this region.

4.3 Topography, Surface Hydrology and Drainage

The main camp and airstrip are located at the base of a relatively steep north-facing slope which terminates in a bowl-shaped saddle flanked by twin peaks to the northwest and northeast. A shallow gulley runs through the centre of this saddle in a westerly direction and slopes down into a valley to intersect the North Rackla River further to the west (Photograph 4-1). The airstrip is built on a wide, flat ridge flanking the north side of this gulley. This ridge slopes upward to the east and cuts along the base of the northeast peak. Further to the north, a few kilometers beyond the ridge, the topography slopes gradually into a deep valley. The adit occurs further up the same steep north-facing slope as the camp, but further to the west. The waste rock pile at this location has been worked to form a large flat plateau (Photograph 4-2).

A small stream, referred to as the "camp stream", runs along the base of the gulley flowing west through the camp alongside the airstrip and down into the valley intersecting the North Rackla River 1 km to the west. This stream passes through a large pond at the base of a slatey outcrop to the east of the camp and picks up most of the drainage from the camp and airstrip. Low-lying areas along the edge of the stream near the camp are poorly drained and extremely wet. This is accentuated by a small spring on the east side of the camp which emerges from the base of the north-facing slope and drains into this stream. A second stream, draining the steep slopes above the camp, flows past the camp along its west side, crosses the main adit access road, and joins the camp stream just before it enters the valley leading to the North Rackla River. Emanating from the adit, a small drainage stream passes over the waste rock pile and down into the same valley further to the west.

Overburden materials consist primarily of silt, sand, gravel and cobbles which overlay weathered bedrock; bedrock exposures were also observed. Granular materials are angular and platy. In areas of overburden/fill material, distinct and severe erosion channels were observed. Specifically, these areas include the steep portion of the airstrip, south of the camp facilities near the toe of the slope and in the waste rock pile adjacent to the exploration adit.

Permafrost was not encountered in the shallow testpits excavated; however, it is anticipated that discontinuous permafrost is present at greater depths (> 50 cm).

4.4 Vegetation

Being close to the treeline, vegetation at the site consists mostly of alpine species. Included are very sparse stands of black spruce (*Picea maritima*) on nearby slopes, and in wetter areas dense clumps of willow (*Salix* sp.), alpine grasses, horsetail (*Equisetum* sp.), moss (*Spaghnum* sp.) and sedges (*Carex* sp.). The vegetation of the north-facing slope above the camp and around the adit area consisted of a number of low-lying alpine shrubs and flower plants including ground birch (*Betula* sp.), mountain heather (*Cassiope* sp.), mountain avens (*Cassiope* sp.), and crowberry (*Empetrum* sp.).

4.5 Fish and Wildlife Resources

Arctic ground squirrels inhabit the area including a few which have created burrows below the trailers. Caribou tracks and droppings were prevalent, particularly around the airstrip, indicating these animals frequently visit or pass through the site. During the site visit, mating pairs of caribou were observed migrating past the camp along the airstrip. A mother grizzly bear and its cub were chased away from the site by the helicopter pilot before the investigation team arrived, indicating grizzlies are also attracted to this area.

No specific information on fish resources exists with respect to the entire Rackla River drainage and its tributaries; the river is currently unclassified by the Yukon Placer Authorization (Nick de Graff, YTG Fisheries, pers.comm.). The series of lakes in the drainage (Kathleen Lakes), however, are classified as Type 1 habitat which, based on physical and chemical environmental characteristics, consist of streams and stream reaches used for spawning by trout, salmon and char. The Rackla River flows into the Beaver River which is also classified as Type-I habitat.



Photograph 4-1: Abandoned Vera camp area and airstrip. The main camp stream, demarcated by the dense shrub area along the airstrip edge, flows right, to the west



Photograph 4-2: Adit and waste rock pile on the slope of Rusty Mountain. A storage shack, barrel, orange explosives boxes, and exploration trails are also seen

5. Site Description And Findings

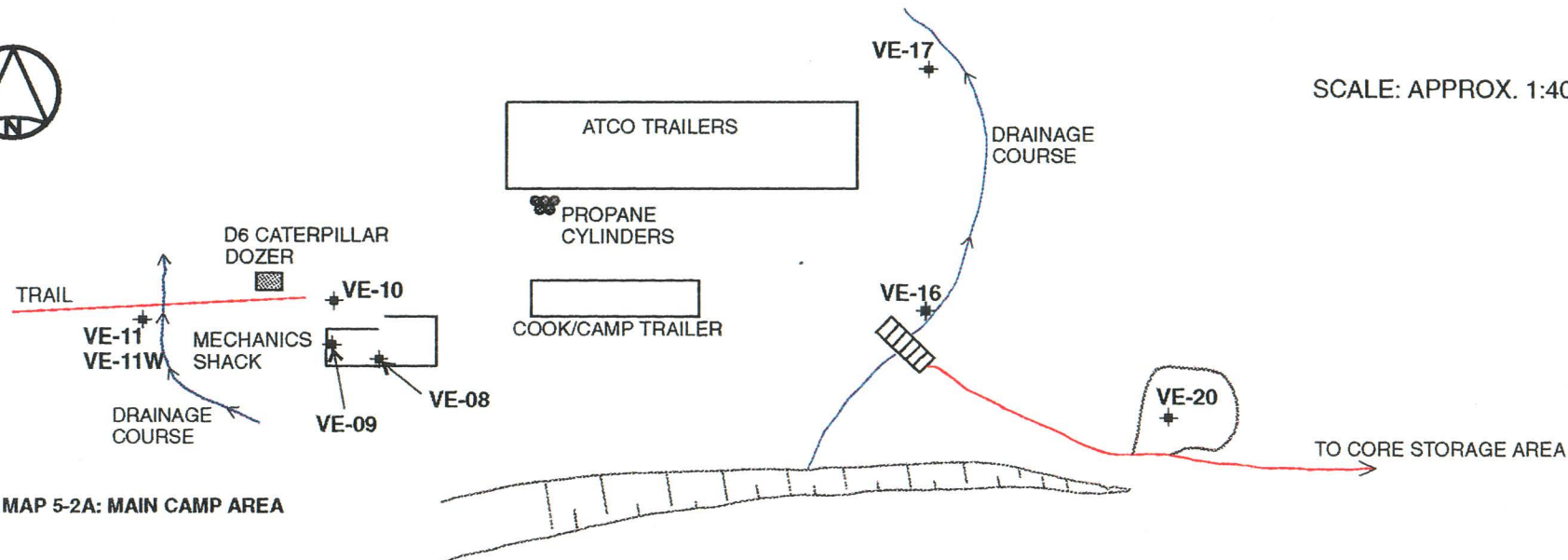
5.1 Buildings, Infrastructure and Equipment

Schematic drawings showing the location and layout of the camp facilities are provided in Maps 5-1, 5-2, and 5-3. A brief description of each facility is provided as follows:

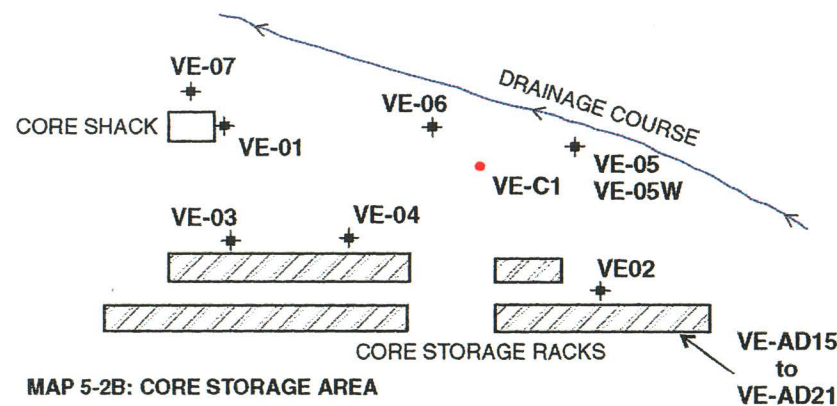
- Airstrip - very poor condition, under-designed, approximately 30 metres wide by 225 metres long. The west end of the runway slopes at approximately 3H:1V over a distance of 150 metres to an open storage area. The sloped portion of the runway is marked by numerous, deep erosion channels (Photograph 5-1). Fill height ranges from one to five metres.
- Open Storage Area - approximately 150 metres by 60 metres wide, gravel fill at west end of the runway. Area is used for the storage of fuel barrels, and wood debris.
- Mine Shack (5) - old accommodations buildings on slope by camp, approximately 4.9 metres by 4.3 metres, wood frame, plywood clad - some plywood has been removed (Photograph 5-2 and Photograph 5-6).
- Mechanics Shack - approximately 4.9 metres by 4.9 metres, wood frame, plywood clad with 4.9 metres by 3.7 metres, partially open, wood framed, working area (Photograph 5-2). Equipment and supplies still stored in and around the building. Major equipment includes a Flygt Diesel 9 kW Genset with battery, a Lincoln 225 arc welder, a Honda generator, and a D6D Caterpillar Dozer. Other miscellaneous equipment and supplies are described under hazardous materials.
- Atco Trailer (1) - Cook Shack - kitchen facilities (Photograph 5-2).



SCALE: APPROX. 1:400



MAP 5-2A: MAIN CAMP AREA



MAP 5-2B: CORE STORAGE AREA



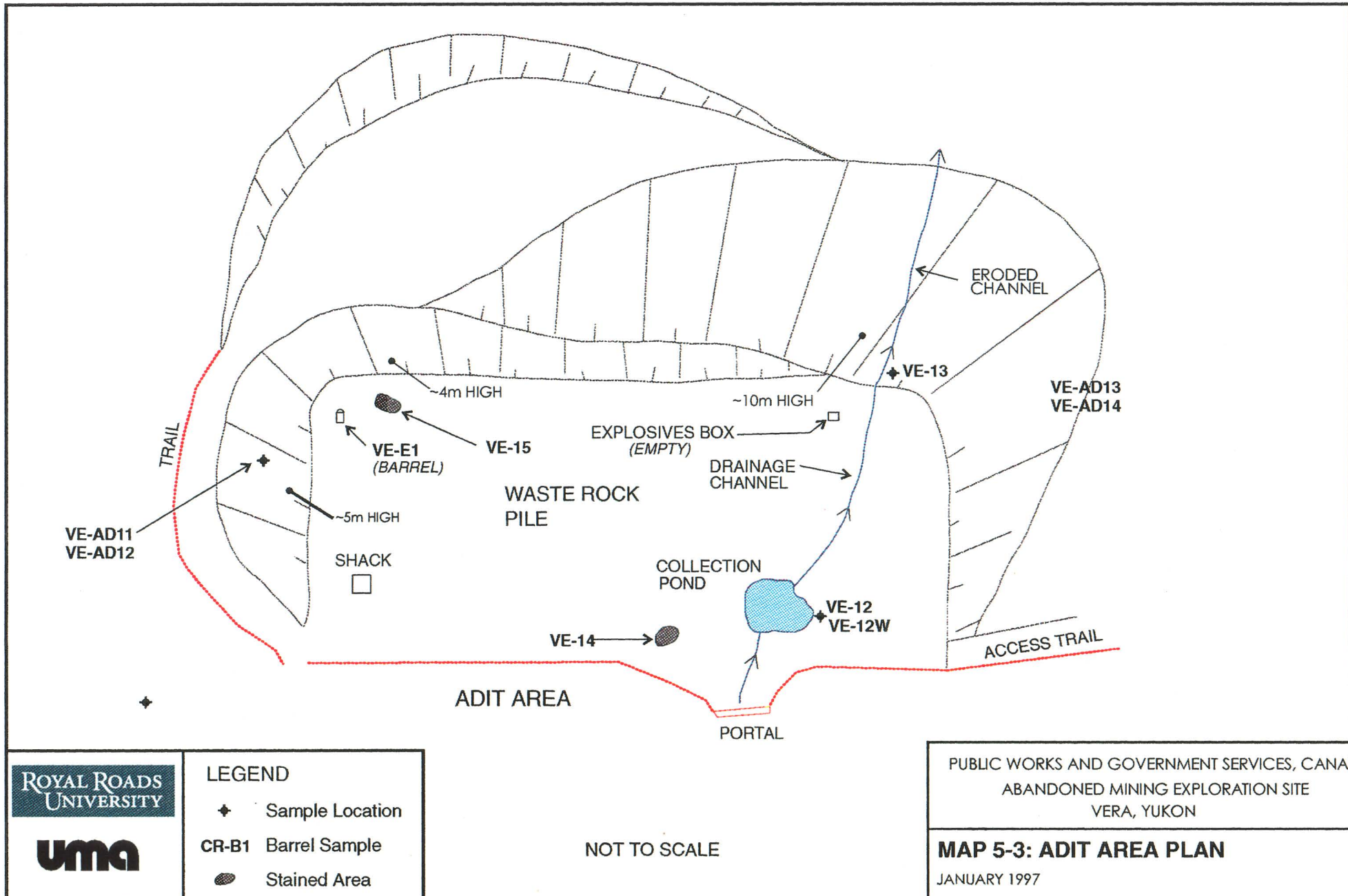
LEGEND

- ✦ Sample Location
- Barrel Sample
- VE-AD15 Rock Sample

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

MAP 5-2: OVERALL LOCATION PLAN

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- Atco Trailers (4) - each trailer approximately 3 metres by 15.8 metres, joined together to form sleeping/office accommodations; exterior propane tanks (Photograph 5-2);
- Core Shack - 2.4 metre x 3.7 metre wood frame, plywood clad shack, with core splitter, diesel stove, three fuel barrels;
- Shack (1) - located at adit, wood frame, plywood clad building approximately 3.7 metres by 4.9 metres (Photograph 4-2 and Photograph 5-3).

5.2 Non-hazardous Waste Materials

Non-hazardous waste materials were associated with the buildings, infrastructure and equipment at the site; no dumps or landfills were identified. These materials are listed along with site infrastructure and equipment in Section 5.1 above.

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 50 ppm).

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

Specific to the Vera site, hazardous waste materials identified include approximately 100 barrels containing fuel; batteries for equipment; miscellaneous maintenance supplies including antifreeze, hydraulic and lubricating oil; propane cylinders; fire extinguishers; and potentially explosives. One barrel containing ~ 50 kg of pure lead ore (galena) was also identified above the site and could be considered a health and environmental hazard. A locked explosives box was noted on the access trail to the adit; its contents, however, could not be confirmed during the site visit.

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

Barrel Storage Areas

A variety of barrels containing various types of petroleum products were reported at the site in 1993 including forty-three 204 liter (L) barrels of diesel and thirty-five 204 L of Jet B fuel (plus 6 empty) at the airstrip, three 204 L barrels of diesel and thirteen 22.7 L pails of motor and hydraulic oil in the generator shack, one 204 L of Chevron soluble oil near the adit, 100 L of diesel in one 204 L barrel (plus 2 empty) near the core shack, and twenty L of motor oil stored at the campsite (DIAND Technical Services, 1994).

The first area investigated, referred to as Barrel Stockpile A, pertained to the diesel barrels located at the base of the airstrip at the west end (Map 5-1). Approximately forty-five blue 204 L barrels marked "Chevron Prism Res. Diesel - Aug/85", most of which were full, were laid end to end along a skid; four of these were sitting in a small wood box sled just to the south (Photograph 5-4). A sample, VE-A1, was obtained from one of these barrels and archived (Map 5-1). Five additional barrels were scattered in the vicinity to the east. A lone orange barrel (sampled in duplicate as VE-A2) was sitting upright in a much larger wooden sled further to the north. This sample was analyzed for total metal content and organic halogens (TOX) (e.g: chlorine and bromine); those results for which guidelines are

available for comparison are presented in Table 5-1 below. Additional results for total metal analysis for this sample and others listed in the table are presented in Appendix A.

Table 5-1: Selected Analytical Results for Total Organic Halogens (TOX) and Metals in Barrel Samples from Vera Mine Site.

Sample	VE-A2	VE-A2 DUP	VE-C1	VE-D1	VE-E1	General Criteria ¹
Analyte (ug/g)						
Total Organic Halogens	124	65	244	193	249	1000
Arsenic	<3	<3	<3	<3	<3	5
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2	2
Chromium	<0.3	<0.3	<0.3	<0.3	<0.3	10
Lead	<0.8	<0.8	236	1.6	<0.8	100
	Barrel Pile A: at base (W end) of airstrip, ~ 51 barrels and other stockpiled materials, Barrel sample: yellowish transparent fuel (diesel), full, no markings	Barrel Pile A: Barrel sample: yellowish transparent fuel (diesel), full, no markings DUPLICATE	Barrel Pile C: north of core box storage area and E of core shack, along edge of airstrip road; Barrel sample: transparent fuel (aviation), marked "JP 4 Jet June '84", 3/4 full	Barrel Pile D: vicinity of hillside workshacks above (S of) camp, Barrel sample: dark thick amber fuel (heating oil), marked "Chevron Prism Resources Diesel, June???", filter attached	Barrel Pile E: lone barrel from red stained area at NW edge of waste rock plateau near adit, Barrel sample: dark brown viscous fluid (white upon mixing with water), marked "CHEVRON SOLUBLE OIL"	

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 TOX in both duplicate samples (VE-A1 and VE-A2) were well below accepted levels of contaminants in waste oil (for conventional incineration) in most Canadian jurisdictions, while levels of virtually all metals were below detection. Other materials in the vicinity included piled wood planks, a skid and the sleds mentioned previously. There was no evidence of fuel spillage or staining in this area.

A second area, referred to as Barrel Stockpile B, was situated 60 m southwest of Stockpile A (Photograph 5-4) and pertained to the Jet B fuel barrels previously identified in 1993 (Map 5-1). Approximately 38 orange 204 L barrels, mostly full and marked

"Vorac Prism Int. 8/88 Jet B Fuel", were identified along with 3 unmarked, blue 204 L barrels (Photograph 5-4). Most of these were laying sideways on the ground, but again there was no evidence of any fuel spillage or staining on the ground. A sample, VE-B1, was obtained from one of the orange jet-B fuel barrels and archived.

A small scattering of four 204 L barrels, referred to as Barrel Pile C, was located just to the north of the core box storage area and east of the core shack, along the north airstrip access road (Map 5-2). Two of these were empty while the other two were approximately $\frac{3}{4}$ full (Photograph 5-5). A sample, VE-C1, was obtained from one of these orange barrels marked "JP 4 Jet June'84" and analyzed for TOX and total metals. The TOX concentration was found to be well below the accepted level of contaminants in waste oil (Table 5-1). Lead was the only exception in this sample (236 $\mu\text{g/g}$) which exceeded accepted contaminant levels for waste oil (incineration). One additional 204 L barrel was found attached to the core shack and had been previously used to fuel a diesel stove within the facility. The barrel was still partially full and had leaked onto the soil surface below. This was investigated in more detail and is discussed in Section 5.3 below.

Eight blue 204 L barrels were found among the old wood frame shacks on the hillside just above the cook shack (Map 5-2). Three of these barrels were approximately half-full and contained filters; these were undoubtedly used to fuel heat stoves (now-removed) in these shacks (Photograph 5-6). A sample, VE-D1, obtained from one of these barrels, marked "Chevron Prism Resources Diesel, June??", consisted of a dark, amber viscous heating oil. Concentrations of TOC and lead were well below accepted waste oil contaminant guidelines; levels of other metals were below detection (Table 5-1).

The one blue 204 L barrel near the adit, marked "CHEVRON SOLUBLE OIL", was situated at the far northwest edge of the waste rock pile (Map 5-3). A red stain was located nearby and was investigated in more detail; this is discussed in Section 5.3 below (Photograph 5-7). A sample, VE-E1, was obtained from this barrel and analyzed for TOX and total metals. Concentrations of TOX were well below accepted guidelines for waste oil and levels of metals were below detection (Table 5-1).

Stained/Contaminated Soil Areas

General Observations: Selected analytical results for soil samples collected in various areas around the site and available environmental criteria (for comparison) are presented in the tables below. These areas included the core box storage (Table 5-2), core shack (Table 5-3), camp vicinity (Table 5-4), drainage areas by the camp (Table 5-5), and the vicinity of the mine adit (Table 5-6). These areas and sampling locations are indicated on Maps 5-1, 5-2, 5-2B, and 5-3. Full analytical results for contaminants in samples listed in each of the tables are presented in Appendix A. Results of PAH analysis conducted on selected hydrocarbon contaminated soil samples discussed here are also presented in Appendix A.

Extremely high concentrations of total arsenic were found in all of the soil samples which were analyzed at the site (Tables 5-2 to 5-6). Concentrations ranged from 29 ppm (at VE-14S in a stain near the adit, Table 5-6) to 173 ppm (at VE-16, in a spring drainage area by the camp, Table 5-5), with most levels occurring within 67 to 118 ppm. These arsenic concentrations exceeded both the CCME and B.C. Environment R/P (residential parkland) of 20 ppm, and most also exceeded the C/I (commercial/industrial) criteria of 50 ppm. Similar results were found for zinc concentrations in soil samples, ranging from 343 ppm (at VE-10S, near the camp generator shed, Table 5-4) to 8930 ppm (at VE-14S, in a stain near the adit, Table 5-6). Most of these exceeded the R/P criteria while levels in a few soils, particularly in the adit area, also exceeded the C/I criteria of 500 ppm (Tables 5-2 to 5-6).

These elevated levels of arsenic and zinc, when considered as a whole, are too widespread to be attributed to any one particular point source at the site and are a reflection of both the natural mineralization and the cumulative effects of mining activities over the years. This potentially makes the isolation and assessment of point sources of contamination more complex. The process, however, was simplified by considering only those locations with anomalously high concentrations of these and/or other metals to be potential contaminant sources.

Core Box Storage Area

Three surface soil samples, VE-02, VE-03 and VE-04, were taken at various locations below the coreboxes (Photograph 5-8), and two samples, VE-05 and VE-06, in drainage areas approximately 10 m west of the core storage (Map 5-2). Total metal results at these locations are presented in Table 5-2 below. In addition to arsenic and zinc, concentrations of molybdenum (range 18 to 39 ppm) exceeding the more stringent R/P criteria, but below the C/I criteria, were widespread in all of the samples including the drainage areas. An anomalously high concentration of zinc (2410 ppm), which exceeded the higher C/I criterium, was found in soil at VE-02, located below the second set of core boxes from the east (Photograph 5-8). This was accompanied by high concentrations of nickel (275 ppm), molybdenum (39 ppm), copper (116 ppm) and cobalt (48 ppm) which exceeded, or were comparable to the R/P criteria, but were below the C/I criteria. Sample VE-03 obtained below the west-most set of coreboxes also contained a level of nickel (112 ppm) copper (95 ppm) which exceeded and approached the R/P criterium, respectively, but were below the C/I criteria. The results suggest some localized leaching of zinc and other associated metals may be occurring from the coreboxes.

Core Shack Area

A small stain area, approximately 1.5 m², was discovered underneath the west end of the core shack; this most likely originated from a partially-filled 204 L barrel which is attached to the porch of the shack and used to fuel the diesel stove inside. Duplicate soil samples were taken at the surface (VE-01S and VE-01S Dup) of the stain, and a single sample (VE-01D) was taken from a test pit dug to a depth of 30 cm (Map 5-2B). All of the samples were initially subjected to immuno-assay field screening tests for total petroleum hydrocarbons (TPH) to obtain an idea of the magnitude of hydrocarbon contamination. The results are presented in Table 5-3 below. Concentrations of TPH were high at the surface ranging between 250-1250 ppm based on the combined results for duplicate samples; a similar range, 250-1250 ppm was reported for the test pit sample. A negative TPH result (< 50 ppm) was found for a surface sample taken in a drainage ditch 3 m to the

north of the stained area (VE-07) indicating the hydrocarbon contamination at the stain was relatively localized.

Table 5-2: Selected Analytical Results for Soils in Core Box Storage Area

Sample No.	VE-02	VE-03	VE-04	VE-05	VE-06	CCME/B.C. Criteria	CCME/B.C. C/I Criteria
Physical Tests							
Moisture %	20.5	15.5	14.1	14.5	12.7	-	
Total Metals	(µg/g or ppm)						
Antimony	<20	<20	<20	<20	<20	20	40
Arsenic	95.1	109	91.7	109	105	20	50
Barium	157	101	77	70	78	500	2000
Beryllium	0.7	0.7	0.6	0.6	0.6	4	8
Cadmium	5	2	<2	<2	2	5	20
Chromium	24	20	15	15	13	250	800
Cobalt	48	16	10	15	9	50	300
Copper	116	95	82	55	72	100	500
Lead	116	179	179	146	139	500	1000
Mercury	0.131	0.109	0.11	0.031	0.109	2	10
Molybdenum	39	21	22	18	20	10	40
Nickel	275	112	75	85	77	100	500
Selenium	1.2	0.8	0.8	0.7	0.8	3	10
Silver	<2	<2	<2	<2	<2	20	40
Tin	<10	<10	<10	<10	<10	50	300
Vanadium	69	98	77	77	64	200	-
Zinc	2410	830	567	863	692	500	1500
Site/Sample Descriptions	Surface soil sample under 2nd set of core boxes from E end of area, E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample under W-most set of core boxes, E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample just E of W-most pile of core boxes, E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample from S edge of stream running N of camp, 10 m N of VE-02, coarse-medium sand with detritus	Surface soil sample in drainage (13 m W of VE-07), sandy clay soil with root material		

Table 5-3: Selected Analytical Results for Soils in Core Shack Area

Sample No.	VE-01S	VE-01S Dup	VE-01D	VE-07	CCME/B.C. R/P Criteria	CCME/B.C. C/I Criteria
Physical Tests						
Moisture %	17.5	18.4	-	-	-	
Total Metals ($\mu\text{g/g}$ or ppm)						
Antimony	<20	<20	-	-	20	40
Arsenic	90.9	104	-	-	20	50
Barium	111	133	-	-	500	2000
Beryllium	0.8	0.8	-	-	4	8
Cadmium	<2	2	-	-	5	20
Chromium	24	23	-	-	250	800
Cobalt	14	15	-	-	50	300
Copper	73	103	-	-	100	500
Lead	146	177	-	-	500	1000
Mercury	0.044	0.066	-	-	2	10
Molybdenum	11	16	-	-	10	40
Nickel	80	110	-	-	100	500
Selenium	0.5	0.6	-	-	3	10
Silver	<2	<2	-	-	20	40
Tin	<10	<10	-	-	50	300
Vanadium	80	76	-	-	200	-
Zinc	790	859	-	-	500	1500
Hydrocarbons						
Test Kits (TPH)	>625	250-1250	250-1250	<50	-	-
Extractables						
EPH (C10-18)	7080	5810	1950	-	1000	5000
EPH (C19-31)	3050	3420	706	-	1000	5000
Site/Sample Descriptions	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils, DUPLICATE	Depth soil sample at 30 cm under core shack, stained area, strong HC odour (diesel), coarse sandy clay soils	Surface soil sample in depression 3m N of core shed, no HC odour, sandy clay soil with root material		

More precise laboratory hydrocarbon analyses were conducted on the samples obtained from the stain (Table 5-3). Concentrations of light (C10-18) and heavy (C19-31) extractable hydrocarbons in both surface samples (VE-01S) exceeded the B.C. Environment Draft R/P and C/I Standards, respectively. Levels of light extractable hydrocarbons in the depth sample (VE-01S: 1950 ppm) also exceeded the more stringent B.C. Standards, while the heavy hydrocarbon concentration in the sample (706 ppm) was below the standards. These results suggested a limited degree of vertical sub-surface

migration has occurred from the stain. Chromatographic analysis of the hydrocarbon peaks for the VE-01S surface duplicates and depth samples indicated the hydrocarbon product to be primarily diesel in composition, and therefore probably originating from the fuel supply barrels above. These peaks are presented in Appendix C. Analysis for polycyclic aromatic hydrocarbons (PAHs) was also conducted on the VE-01 samples to further characterize the hydrocarbon constituents (see Appendix A). Concentrations of PAHs in both the surface and testpit samples from the stain area were either below detection, or at concentrations well below the CCME R/P remediation criteria for soils.

Total metal concentrations were analyzed in the duplicate surface samples (VE-01S) from the stain area (Table 5-3). Aside from the high levels of arsenic, molybdenum and zinc noted earlier, concentration ranges of nickel (80-110 ppm) and copper (73-103 ppm) were comparable to the CCME/B.C. R/P criteria.

Camp Vicinity

In the mechanics shack, a large stain area approximately 16 m² was discovered on the dirt floor in the west end by the diesel generator (Photograph 5-9), and a vehicle battery was located at the southeast corner. In the stain area, samples were obtained at the surface (VE-08S) and in a 30 cm testpit (VE-08D). Surface samples were taken by the battery (VE-09), and both surface (VE-10S) and testpit samples (VE-10D) samples were taken in drainage ditches along the camp access road on the north side of the shack (Map 5-2).

All of the samples were initially subjected to immuno-assay field screening tests for total petroleum hydrocarbons (TPH) to obtain an idea of the magnitude and spread of hydrocarbon contamination from the stain. These and other analytical results are presented in Table 5-4 below. Detectable concentrations of TPH were found at the surface (125-625 ppm) and a depth of 30 cm (125-1250 ppm) in soils by the generator (VE-08S and D), as well as in VE-09 (250-1250 ppm) by the battery. Negative TPH results (< 50 ppm) were found in soil from the drainage area for both the surface (VE-10S) and 30 cm testpit samples (VE-10D, not shown) indicating the stained area was relatively contained.

Table 5-4: Selected Analytical Results for Soils in the Camp Vicinity

Sample No.	VE-08S	VE-08D	VE-09	VE-10S	VE-20S	VE-20D	CCME/BC R/P Criteria	CCME/BC C/I Criteria
Physical Tests								
Moisture %	33	-	26.5	16.4	-	-	-	
Total Metals (µg/g or ppm)								
Antimony	<20	-	<20	<20	-	-	20	40
Arsenic	118	-	82.1	65.8	-	-	20	50
Barium	166	-	125	87	-	-	500	2000
Beryllium	1.2	-	0.9	0.6	-	-	4	8
Cadmium	<2	-	<2	<2	-	-	5	20
Chromium	33	-	25	17	-	-	250	800
Cobalt	20	-	17	12	-	-	50	300
Copper	101	-	84	40	-	-	100	500
Lead	258	-	205	142	-	-	500	1000
Mercury	0.085	-	0.064	0.042	-	-	2	10
Molybdenum	11	-	8	8	-	-	10	40
Nickel	81	-	72	42	-	-	100	500
Selenium	0.8	-	0.5	0.7	-	-	3	10
Silver	<2	-	<2	<2	-	-	20	40
Tin	<10	-	<10	<30	-	-	50	300
Vanadium	92	-	71	42	-	-	200	-
Zinc	644	-	578	343	-	-	500	1500
Hydrocarbons								
Test Kits (TPH)	125-625	250-1250	250-1250	<50	<25	<25	-	-
Non-halogenated								
Benzene	-	<0.05	-	-	-	-	0.5	5
Ethylbenzene	-	<0.05	-	-	-	-	5	50
Toluene	-	<0.05	-	-	-	-	3	30
meta- & para-	-	<0.05	-	-	-	-	5	50
ortho-Xylene	-	<0.05	-	-	-	-	5	50
		<5	-	-	-	-	-	
VPH	-	<10	-	-	-	-	200	200
Extractables								
EPH (C10-18)	796	946	-	-	-	-	1000	2000
EPH (C19-31)	1030	332	-	-	-	-	1000	5000
Site/Sample Descriptions	Surface soil sample on dirt floor of generator shed, 50 cm from generator, HC odour, wet medium sand with stones	Depth soil sample at 30 cm on dirt floor of generator shed, 50 cm from generator, strong HC odour	Surface soil sample on dirt floor of generator shed, by battery, HC odour, wet medium sand with stones	Surface soil sample just N of generator shed, no HC odour, coarse sand with stones	Surface soil sample in stained area along N side of airstrip road, 45m SE of camp, adjacent to some equipment debris, HC odour	Depth soil sample at 30 cm in stained area along N side of airstrip road, 45m SE of camp, adjacent to some equipment debris, faint HC odour		

More precise laboratory hydrocarbon analysis was conducted on the surface and depth samples (VE-08S and D) in the generator stain (Table 5-4). The concentration of heavy (C19-31) extractable hydrocarbons in the surface sample (1030 ppm) exceeded the more stringent B.C. Environment Draft R/P Standard, being somewhat higher than the light extractables (C10-18). The reverse relationship was found for the depth sample; the higher concentration was found for the light extractables (946 ppm) which was also comparable to the more stringent B.C. Environment Draft R/P Standard. Chromatographic analysis of the hydrocarbon peaks for the VE-08S surface duplicates and depth samples indicated the hydrocarbon product to be primarily diesel in composition. These peaks are presented in Appendix C. Additional hydrocarbon analysis was conducted for PAHs in the surface sample (see Appendix A for the results) and BTEX (benzene, toluene, ethylbenzene and xylenes) for the depth sample (Table 5-4). Concentrations of PAHs in both the surface and testpit samples from the stain area were either below detection, or at very low concentrations and well below the more stringent CCME R/P remediation criteria for soils. Levels of BTEX in the depth sample, along with light hydrocarbons (C5-9) and volatile petroleum hydrocarbons, were all below detection (Table 5-4).

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

Total metal analysis was conducted for the surface sample from the generator stain (VE-08S), the sample obtained by the battery (VE-09), and the drainage area outside the mechanics shack (VE-10S). Aside from typically elevated concentrations of arsenic, zinc

and molybdenum discussed above, concentrations of copper (101 ppm) comparable to the CCME/B.C. R/P remediation criterium, but below the C/I criterium were found in the surface stain sample by the generator. Concentrations of the remaining total metals in the samples were below detection.

A second hydrocarbon stain, approximately 1.5 x 6 m in area, was found along the north side of the access road leading east from the camp towards the core storage area (Photograph 5-10). This location appeared to be an outside work area and contained some small wooden ties, rebar, a tin pail and wooden work boxes. A surface sample (VE-20S), as well as a depth sample (VE-20D) from a 30 cm test pit, was obtained from the stain area (Map 5-2). Field screened negative test results were found for TPHs (< 25 ppm) in these samples indicating hydrocarbon contamination was negligible (Table 5-4).

Drainage Areas by the Camp

A small stream collecting drainage from the north-facing slope above the camp flows past the west side of the accommodations area just beyond the mechanics shack and a large bulldozer. This stream flows north over the mine adit access road and joins the main stream flowing through the camp just before it flows down a side valley to the North Rackla River. A soil/sediment sample (VE-11) was obtained along the bank of the small stream just before it crosses the access road (Map 5-2). The sample was analyzed for total metals and selected results are presented in Table 5-5 below; full results are presented in Appendix A. With the exception of typically-elevated levels of arsenic discussed above, all concentrations of metals were either well below the CCME/B.C. R/P remediation criteria or below detection.

Table 5-5: Selected Analytical Results for Soils in Drainage Areas by the Camp

Sample No.	VE-11	VE-16	VE-17	CCME/B.C. R/P Criteria	CCME/B.C. C/I Criteria
Sampling Date	960828	960828	960828		
Physical Tests					
Moisture %	11.1	61.9	-		
Total Metals	(µg/g or ppm)				
Antimony	<20	<20	-	20	40
Arsenic	74.6	173	-	20	50
Barium	79	80	-	500	2000
Beryllium	0.7	3.5	-	4	8
Cadmium	<2	3	-	5	20
Chromium	18	26	-	250	800
Cobalt	14	24	-	50	300
Copper	44	576	-	100	500
Lead	160	197	-	500	1000
Mercury	0.024	0.067	-	2	10
Molybdenum	5	17	-	10	40
Nickel	47	215	-	100	500
Selenium	0.3	1.5	-	3	10
Silver	<2	17	-	20	40
Tin	<10	<10	-	50	300
Vanadium	40	48	-	200	-
Zinc	392	1960	-	500	1500
Hydrocarbons					
Test Kits (TPH)	-	<50	<50	-	-
Light Hydrocarbons (C5-9)					
VPH	-	-	-	200	200
Extractables					
EPH (C10-18)	-	<250	-	1000	2000
EPH (C19-31)	-	<250	-	1000	5000
Site/Sample Descriptions	Surface soil sample along E edge of stream (flow 1L/10 sec), W of old cat, flows from foothills near W end of camp to NW, medium-fine sand	Surface soil sample from white milky substance (soluble oil?) in seepage creek along SE edge of camp, joins stream along edge of airstrip, no odour, medium iron-rich sand	Surface soil sample (sediment) in small pond 33 m downstream (N) of VE-16, faint HC (?) odour., organic sediment		

Seepage, believed to be emanating from a small spring at the base of the slope to the east of the cook house and accommodation building, formed a small channel which joined the main stream flowing through the camp to the west. Just beyond a boardwalk bridge, a small area of the channel contained a thick white coating of what appeared to be soluble oil (Photograph 5-11). Soil/sediment samples were taken from the edge of this location (VE-16), and from a second downstream location (VE-17) 33 m away, just before its confluence with the main stream running through the camp (Map 5-2). Both samples were screened for TPH concentrations to assess the presence of hydrocarbons. Negative results (< 50 ppm) were found for samples from both locations, indicating hydrocarbon contamination was negligible (Table 5-5). This was confirmed by laboratory results for light and heavy extractable hydrocarbons analyzed in sample VE-16, which were below detection (< 250 ppm). Sample VE-16 was also analyzed for total metals; selected results are presented in Table 5-5. Anomalously high concentrations of arsenic (173 ppm) as well as zinc (1960 ppm) exceeding the CCME/B.C. C/I (commercial/industrial) soil remediation criteria were found in this sample. These were accompanied by an extremely high level of copper (576 ppm) which also exceeded the C/I criteria (500 ppm). Concentrations of molybdenum (17 ppm) and nickel (215 ppm) were also found to exceed the more stringent the R/P criteria. The results suggested that this location was a potentially significant point source of metal contamination.

Vicinity of the Mine Adit

Two soil/sediment samples were obtained in drainage from the mine adit (Map 5-3). The first, VE-12, was taken along the east edge of the adit drainage pool located directly in front (to the east) of the mine opening (Photograph 5-12), while the second, VE-13, was taken 26 m downstream from the first in sediment from small collecting pool in a dry drainage channel down the edge of the rock waste pile (Photograph 5-13). Selected total metal results are presented in Table 5-6; full analytical results are provided in Appendix A. In addition to typically high levels of arsenic reported earlier, anomalously high concentrations of zinc (4140 ppm) and lead (1450 ppm) exceeding the CCME/B.C. C/I criteria (zinc: 1500 ppm; lead: 1000 ppm) were found at VE-12 by the adit drainage pool.

Even higher concentrations of these metals were found downstream at VE-13, along with concentrations of copper (103 ppm) and silver (28 ppm) exceeding the R/P remediation criteria (Table 5-6).

Another sample, VE-14S, obtained in a hydrocarbon stain area by a work bench on the waste rock pile just to the west of the adit (Photograph 5-14), contained even higher soil concentrations of copper (401 ppm), lead (12,500 ppm) and zinc (8930 ppm) approaching or exceeding the CCME C/I criteria; as well as barium (951 ppm) exceeding the CCME R/P soil remediation criteria (Table 5-6). These results collectively suggest that the waste rock pile and adit area are a potential source of metal contaminants.

In addition to the total metal analysis, the samples were also subjected to field screening tests for TPH (Table 5-6). Negative results (< 25 ppm) were found indicating hydrocarbon contamination at this location was negligible.

The red-stained area by the lone barrel (sample VE-E) at the northwest corner of the waste rock pile was also sampled at the surface (VE-15S) and at a testpit depth of 30 cm (VE-15D) (see Photograph 5-7). Concentrations of TPH (>> 625 ppm), based on immuno-assay screening tests, suggested a significant level of hydrocarbon contamination (Table 5-6). This was confirmed by laboratory analysis for extractable hydrocarbons in which concentrations of light (C10-18) and heavy (C19-31) hydrocarbons exceeded the B.C. Environment Draft C/I Standards in both the surface and depth samples (Table 5-6). Concentrations of PAHs in the surface sample (VE-15S) from the stain area were either below detection, or at very low concentrations well below the more stringent CCME R/P remediation criteria for soils. Likewise, concentrations in the depth samples of BTEX, light hydrocarbons (C5-9) and volatile petroleum hydrocarbons, were all below detection (Table 5-6).

Table 5-6: Selected Analytical Results for Soils in the Vicinity of the Mine Adit

Sample No.	VE-12	VE-13	VE-14S	VE-14D	VE-15S	VE-15D	CCME/B.C. R/P Criteria	CCME/B.C. C/I Criteria
Physical Tests								
Moisture %	41.6	29.9	12.7	-	-	-	-	
Total Metals (µg/g or ppm)								
Antimony	<20	<20	<40	-	-	-	20	40
Arsenic	67.1	94.7	29	-	-	-	20	50
Barium	159	142	951	-	-	-	500	2000
Beryllium	1.1	1	<1				4	8
Cadmium	13	18	41	-	-	-	5	20
Chromium	30	28	5	-	-	-	250	800
Cobalt	16	15	<4	-	-	-	50	300
Copper	70	103	401	-	-	-	100	500
Lead	1450	1850	12500	-	-	-	500	1000
Mercury	0.122	0.122	0.06	-	-	-	2	10
Molybdenum	<4	<4	<8	-	-	-	10	40
Nickel	32	28	10	-	-	-	100	500
Selenium	0.4	0.3	<0.1	-	-	-	3	10
Silver	14	28	18	-	-	-	20	40
Tin	<10	<10	<60	-	-	-	50	300
Vanadium	54	47	5	-	-	-	200	-
Zinc	4140	5130	8930	-	-	-	500	1500
Hydrocarbons (µg/g or ppm)								
Test Kits (TPH)	-	-	<25	<25	>> 625	>> 625	-	
Non-halogenated Volatiles								
Benzene	-	-	-	-	-	<0.05	0.5	5
Ethylbenzene	-	-	-	-	-	<0.05	5	50
Toluene	-	-	-	-	-	<0.05	3	30
meta- & para-Xylene	-	-	-	-	-	<0.1	5	50
ortho-Xylene	-	-	-	-	-	<0.05	5	50
Light Hydrocarbons (C5-9)								
VPH	-	-	-	-	-	<10	200	200
Extractables								
EPH (C10-18)	-	-	-	-	4960	3090	1000	2000
EPH (C19-31)	-	-	-	-	41400	28500	1000	5000
Site/Sample Descriptions								
	Surface soil sample from E edge of adit drainage pool (N of adit), fine-medium sand	Surface (sediment) sample from small drainage pond, 26 m down-stream (N) of adit drainage pool and VE-12	Composite Surface soil sample from series of small stained areas N of work bench (W of adit), HC odour	Composite Depth soil sample at 30 cm (below stain zone) from series of small stained areas N of work bench (W of adit), no HC odour, medium sand	Surface soil sample from red stained area by barrel sample E1 (soluble oil) at NW edge of waste rock plateau, HC odour, coarse sand	Depth soil sample at 30 cm red stained area (below stained zone) by barrel sample E1 (soluble oil) at NW edge of waste rock plateau, HC odour		

5.4 Surface Water Quality

To assess water quality at the site, surface waters were obtained from a number of stream and drainage courses. Three of these samples were obtained from the camp stream including VE-18W (upstream to the east of the camp area), VE-05W (10 m to the north below the core box storage area) and VE-19W (downstream to the west of the camp) (Map 5-1 and 5-2B). Additional samples were collected from the stream flowing along the east side of the site beyond the mechanics shack (VE-11W, Map 5-2) and from the adit drainage pool located directly in front (to the west) of the mine opening (VE-12W, Map 5-3). Selected total metal analysis results for these samples are provided in Table 5-7 below; full analytical results are presented in Appendix A.

Total metal concentrations for a majority of the samples and analytes were found to be either below detection or at detectable levels which were well below the CCME/B.C. Freshwater criteria (for Aquatic Life). One exception was the concentrations of selenium in the three camp stream samples (VE18W, VE-05W and VE-19W) which were comparable to the Freshwater criteria (0.001 mg/L) and suggested widespread natural mineralization not attributable to any specific point source. The only other exception was an elevated concentration of zinc (0.328 mg/L) in the mine adit pool (VE-12W, see Photograph 5-12) which greatly exceeded the Freshwater Criteria. This emphasized the importance of this area, including the waste rock pile, as a potential source of metal contaminants (Table 5-7). Surface waters were generally neutral to alkaline (pH 7.1-7.9); litmus paper values (pH 5.5-6) in surface waters from the adit pool, however, indicated some acidity at this location.

Table 5-7: Selected Inorganic Analysis Results for Surface Water Samples at Vera

Sample No.	VE-05W	VE-11W	VE-12W	VE-18W	VE-19W	CCME/BC Freshwater Criteria
Physical Tests						
Conductivity (umhos/cm)	12900	13900	14700	14100	14600	-
Hardness (CaCO ₃)	138	133	136	137	147	-
Total Metals mg/L or ppm						
Aluminum	<0.2	<0.2	<0.2	<0.2	<0.2	0.005-0.1
Arsenic	<0.001	<0.001	<0.001	<0.001	<0.001	0.05
Barium	<0.01	<0.01	<0.01	<0.01	<0.01	1.0
Beryllium	<0.005	<0.005	<0.005	<0.005	<0.005	0.0053
Boron	<0.1	<0.1	<0.1	<0.1	<0.1	-
Cadmium	<0.01	<0.01	<0.01	<0.01	<0.01	0.0002-0.0018
Chromium	<0.01	<0.01	<0.01	<0.01	<0.01	0.002-0.02
Cobalt	<0.01	<0.01	<0.01	<0.01	<0.01	0.05
Copper	<0.01	<0.01	<0.01	<0.01	<0.01	0.002-0.004
Iron	<0.03	0.03	<0.03	0.08	<0.03	0.3
Lead	<0.05	<0.05	<0.05	<0.05	<0.05	0.001-0.007
Manganese	<0.005	<0.005	<0.005	0.01	<0.005	0.1
Mercury	<0.00005	<0.00005	<0.00005	<0.00005	<0.00005	0.0001
Molybdenum	<0.03	<0.03	<0.03	<0.03	<0.03	1.0
Nickel	<0.02	<0.02	<0.02	<0.02	<0.02	0.025-0.15
Selenium	0.0015	0.0007	0.0009	0.0011	0.0013	0.001
Silver	<0.01	<0.01	<0.01	<0.01	<0.01	0.0001
Zinc	0.01	0.014	0.328	0.007	<0.005	0.03
Site/Sample Descriptions	Water sample from S edge of stream running N of camp, 10 m N of VE-02, pH 7.64	Water sample along E edge of stream (flow 1L/10 sec), W of old cat, flows from foothills near W end of camp to NW, pH 7.90	Water sample from E edge of adit drainage pool (N of adit), pH 7.58	Water sample along airstrip stream, upstream from camp, below confluence of seepage from small slaty outcrop, pH 7.17	Water sample along airstrip stream, downstream from camp, 10 m below confluence of drainage from old road, pH 7.16	

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.

Twenty-one different samples of rock were collected from various areas of the site. These included samples from a short trench located 3 km east of the camp along the access road (VE-AD1 and VE-AD2); natural outcrops of partially-oxidized rock in the valley east of the camp (VE-AD3); weathered rock along the airstrip (VE-AD4 to VE-AD7); samples from various CAT/exploration trails to the north (VE-AD8 and VE-AD9) and west (VE-AD10) of the camp, and from the portal (adit) and surrounding waste-rock dump on the west (VE-AD11 and VE-AD12) and east side (VE-AD13 and VE-AD14); and various samples of rock from the core box storage area (VE-AD15 to VE-AD21). Sampling locations are indicated on Maps 5-1, 5-2, 5-2 B and 5-3. Sample descriptions, acid-base accounting and total metal tests to assess potential for acidic drainage and metal leaching 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 is minimal. For medium scales, ABA results (Appendix B) show that most samples have high values of xNNP (net neutralizing potential) and xNPR (net potential ratio) and are thus net acid neutralizing. Thus, the probability of acidic drainage on a medium scale is low (Table 5-8). However, a few samples had depressed values of xNNP and xNPR, particularly VE-AD8, -AD10, -AD12, -AD16, and -AD19, which also tended to have lower than average (but still near-neutral) pH. These samples were collected from road cuts, ore, waste rock

near the portal, and core. Therefore, the probability of some acidic drainage on a small scale around the minerals and rock is high (Table 5-8), but the acidic drainage would be neutralized by the surrounding neutralizing rock before migrating far. A more detailed analysis of acid drainage potential at the site is provided in Appendix B.

Table 5-8: Probability Ratings of Acidic Drainage by Scale for Vera

Scale:	Small	Medium	Large
Probability Rating:	high ¹	low	minimal

¹ the probability for acidic drainage around some mineral grains and rock is high, but the abundant neutralizing rock would neutralize the acidity before the drainage flowed far.

As mentioned previously, total-metal contents were measured to determine which metals occur at relatively high levels compared to worldwide averages; these results are presented in Appendix B. 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 can demonstrate which metals will leach at detectable levels.

Based on worldwide averages, the metals in Vera rock that frequently occur (>20% of samples) at elevated levels (> 5x worldwide maximum average) are: silver, cadmium, lead, antimony, tungsten, and zinc. High levels of lead were expected for VE-AD10 obtained along one of the exploration trails, because it was nearly pure galena (lead sulphide), and apparently included some minor sphalerite (zinc sulphide) based on the zinc level of 4580 ppm. Waste rock outside the portal, despite being visibly oxidized and leached, still contained significant levels of silver, copper, lead, and zinc.

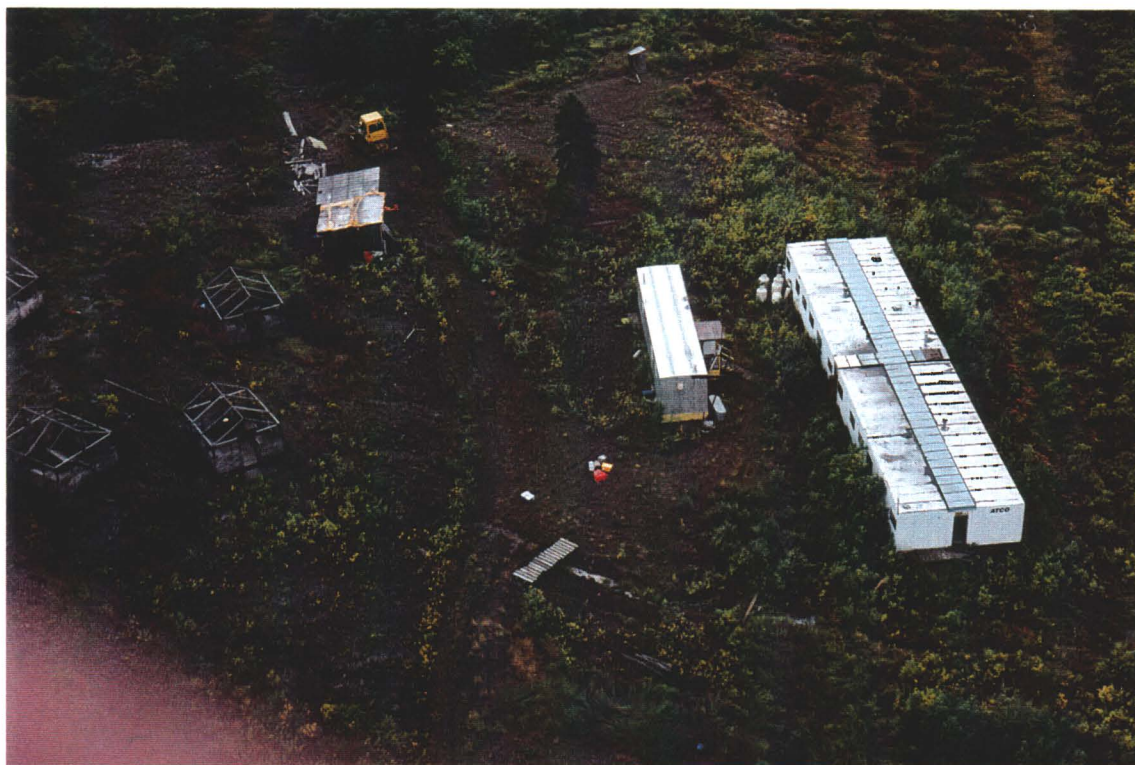
5.6 Mine Opening (Adit)

The only major mine development in the area consists of an open adit and waste rock dump along the mountainside approximately 1.5 km along the access road to the west of

the camp (Photograph 4-2, 5-12). This adit is beginning to collapse and is not safe for entry. The waste rock, which is generally gravelly silty sand with some surficial cover of gravel and cobbles, is well confined to the portal area with very little slope collapse; the west slope has been cut with equipment and is steeper than the angle of repose. The adit pool does not show any surface outflow indicating the water must be infiltrating, but an erosion channel at the crest indicates high flows will occasionally travel across surface. Surface flow into the pool from the adit is approximately ~0.25 L/s. Chemical analysis of the soils and surface waters in the area (discussed in Section 5.3 and 5.4 above) indicated that the waste rock pile and adit may be a significant potential source of metal contaminants, particularly zinc.



Photograph 5-1: Airstrip looking downslope to the west showing poor condition of grade. The open storage area can be seen further to the west



Photograph 5-2: Camp area from east showing (from right to left): four of five wood frame accommodation shacks, mechanics shack and dozer, cook shack/trailer, and four Atco trailers and propane tanks joined to form the accommodations/office buildings



Photograph 5-3: Mine shack used for equipment storage at west end of adit waste rock pile. The mine adit can be seen to the far left



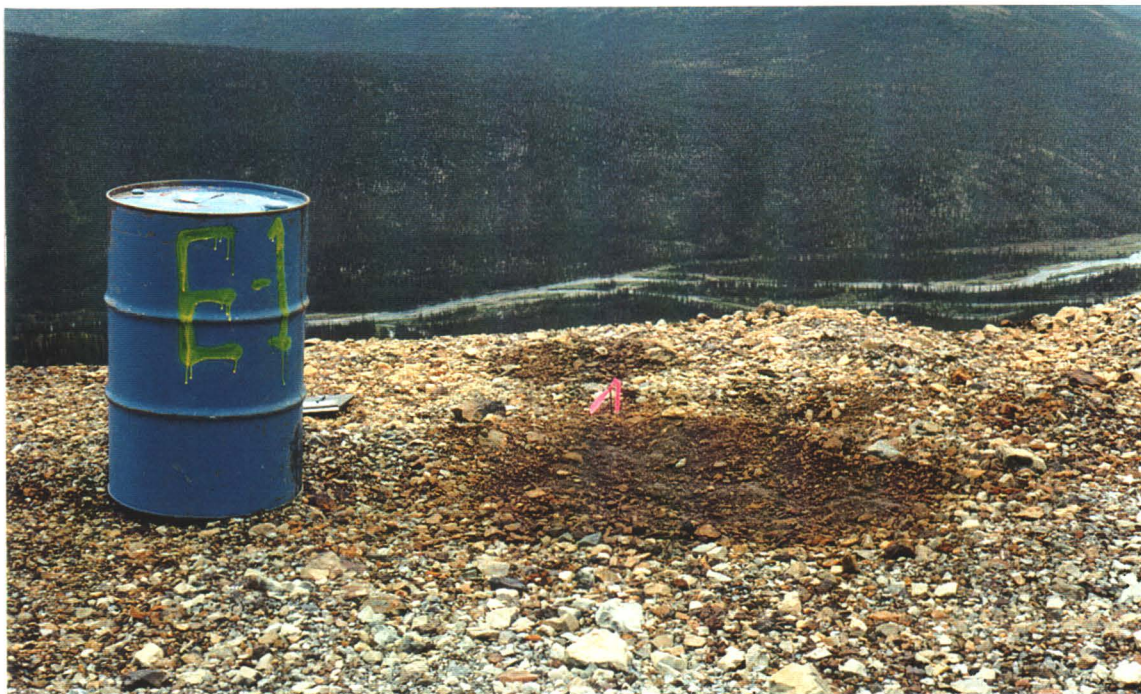
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Photograph 5-4: Barrel stockpile areas at west end of runway showing (from bottom to top): blue barrels and one lone orange barrel and sleigh from Stockpile A, wood pallets and timber, and orange barrels from Stockpile B



Photograph 5-5: Barrel Pile C situated near the core shack (right) and core box caches (in background)



←
Photograph 5-6: Blue heating oil barrel (VE-D1) associated with wood frame accommodation shacks on a slope by the camp



Photograph 5-7: Lone blue barrel containing soluble oil (VE-E1) and red stained area on mine adit waste



Photograph 5-8: Sampling locations (VE-02 and VE-03) below the corebox caches on the east side of the camp



Photograph 5-9: Hydrocarbon stained dirt floor (VE-08) in mechanics shack surrounding camp generator



Photograph 5-10: Hydrocarbon stained location (VE-20) by outside work area to the east of the camp



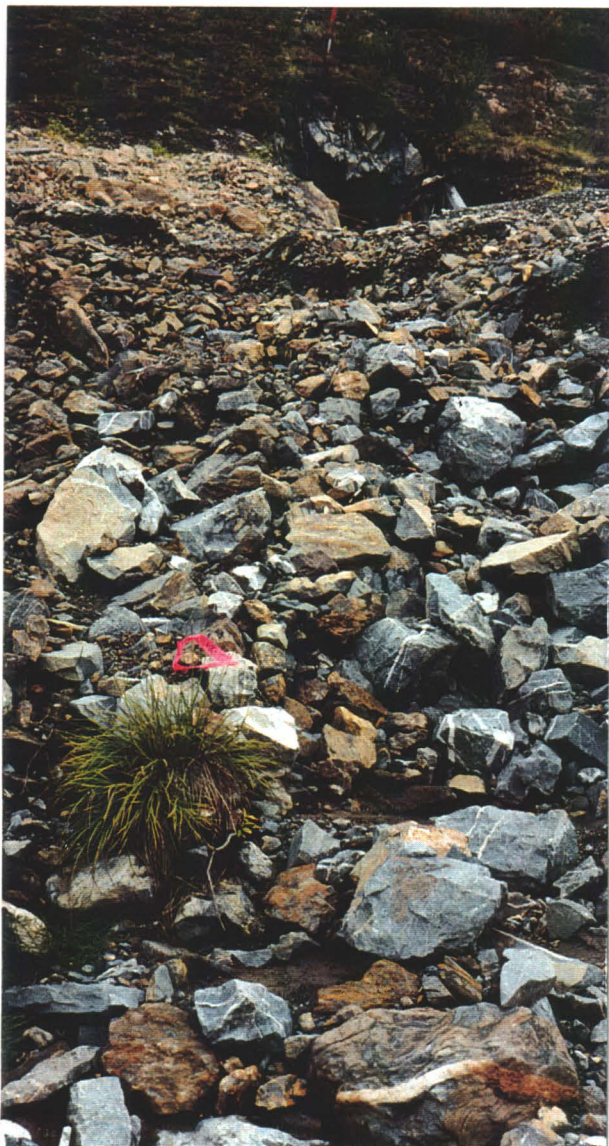


Photograph 5-11: White milky substance in ground spring seepage (VE-16) by board walk, east of main accommodations area



Photograph 5-12: Mine adit and drainage collection pool (VE-12) on waste rock pile





Photograph 5-13: Drainage pathway from mine adit water collection pool (VE-12) to seasonal drainage channel (VE-13) down east side of waste rock pile



Photograph 5-14: Stained locations by work bench (VE-14) just to the west of the mine adit



6. Conclusions And Recommendations

The preliminary environmental assessment of the Vera Mine 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 mine site area.

6.1 Health and Safety

Safety is the condition of being secure from undergoing or causing injury or loss, and may generally be referred to as the prevention of "slip-trip-fall" type injuries.

The primary health and safety concern at the Vera site relates to the instability of the adit entrance and current access; however, the site is relatively remote and, correspondingly, the risks to human safety are relatively low provided the site remains unused. For human safety, sealing of the adit is normally advisable, but to do this effectively without further compromising associated water quality would require a considerable amount of investment (in the millions of dollars) in additional work in and above the workings. Blockage of the adit using existing waste rock is not also advisable given that this particular material weathers quickly to a fine silt which would clog or seal the adit with similar effects on water quality. Blasting, likewise, will serve to fragment the existing waste rock and increase the reactive surface area available for metal leaching. It is therefore recommended a secure wire mesh fence and/or boards be erected over the entrance to limit the entry of humans or wildlife, but still allow for free drainage from the adit. This has been used effectively at a number of mines across Canada. Over time, slope instability will result in rock falls which will eventually block the entrance.

Buildings at the site, particularly the cook shack and accommodation trailer, are suffering water damage and will begin to deteriorate more rapidly as a result. It is recommended that all materials within the structures be removed and salvaged (where possible). Following the removal of any contaminated soils, the buildings should be demolished and buried in an facility on site along with any non-salvagable, non-hazardous materials. The drier north side of airstrip may be an ideal location for this facility as the grade can be used as overburden. Care should be taken during demolition, particularly around the accommodation trailers, where ground squirrel burrows occur.

Approximately 100 barrels located at barrel stockpile A, B and D at the site contain either aviation fuel, diesel or heating oil; and their flammability represents a potential safety hazard. The contents of these barrels do not contain significant levels of contaminants and should be incinerated, with the barrels crushed and disposed of in an engineered facility on site. One exception is the barrel marked VE-C1 near the corebox caches containing older aviation fuel (June 84) with a high concentration of lead which cannot be incinerated by conventional methods; this barrel and its contents should be placed in an overpack drum removed from the site and disposed of in a hazardous materials landfill.

All remaining hazardous materials including batteries, maintenance supplies (e.g., antifreeze), hydraulic and lubricating oil, propane cylinders, fire extinguishers, and (possibly) explosives should be safely packaged for transport, removed off-site and disposed of in an approved hazardous materials landfill. Some of these materials, such as the propane cylinders may be salvagable for reuse or recycling.

The presence of explosives in the large orange cabinet along the trail to the mine adit could not be confirmed during the field investigation. The Yukon WCB Chief Mine Safety Officer should be informed of the suspected presence of explosives in the magazine. If any combustibles are found, these should be removed from the site and safely disposed on advice of the WCB Officer. The cabinet and storage box should either be salvaged or buried in facility on site. Three barrels were also observed high above the adit. Two of these were empty and should be crushed and disposed of in an engineered facility on site.

The third contained approximately 50 kg of pure lead ore (galena) which was spilled around the barrel, oxidizing and actively releasing lead and other metals. This high lead content in this ore can be considered a health and environmental hazard and should be properly containerized in an overpack drum, removed from the site, and disposed of in an approved hazardous materials landfill.

6.2 Environmental Risks

Some environmental issues exist with respect to contaminants at this site. *The waste rock pile substrate and mine adit drainage* is contaminated with metals such as zinc, copper, lead and, in some cases, barium and silver. Concentrations of zinc and lead, particularly, exceed the CCME C/I (commercial/industrial) criteria. The concentration of zinc in water from the adit pool also greatly exceeded the CCME Freshwater (Aquatic Life) criteria. These results indicate that the waste rock pile and adit serve as significant contaminant sources and the potential for surface migration exists. Both the medium- (tens of metres) and large-scale (thousands of metres) probability ratings for acid drainage, however, are low to minimal based on the neutralizing ability at the site, suggesting the potential for significant contaminant migration from acid leaching in the rock pile is limited.

In terms of receptors, no wildlife or vegetation currently exists on the waste pile itself and the potential for environmental risk through direct contact is, therefore, minimal. Contaminated drainage water from the adit, however, drains from this location down to fish-bearing waters in the valley a few kilometres to the west and may pose a low to moderate environmental risk. It is recommended that the waste pile be regraded as much as possible to lessen the slopes around the adit in order to modify the drainage pathway and reduce future problems from erosion. Blockage of the portal is not advisable for reasons discussed above in Section 6.1; secure protective fencing over the portal is recommended to prevent access and allow for unimpeded drainage flow. Hydrocarbon stains exist on the waste rock pile by the work bench area and the lone soluble oil barrel (VE-E1). These stained areas are very localized and do not pose any significant environmental risks to wildlife. It is recommended that the locations either be left as is, or preferably covered with waste rock during regrading of the waste pile.

The corebox storage area (cache) contains underlying soils contaminated with zinc, nickel, copper and other metals. The probability of acid rock drainage on a small scale from rock pieces at the site is high, indicating a limited amount of metal leaching may occur at this location. Although the affected area is confined to locations immediately below the cache, it is recommended that the cores be removed and disposed of in a lined facility on site to reduce any potential for future environmental risks from contaminated soil contact by ground squirrels frequenting this location. Localized hydrocarbon-contaminated spills (soil levels exceeding the B.C. Standards) occur below the leaky diesel fuel barrel by the coreshack and the open work area further to the west. It is recommended that these soils be excavated and buried in a lined facility on site as described above. The leaky diesel fueling barrel at the core shack should also be removed and its contents incinerated. This barrel should be subsequently crushed and buried in an engineered facility at the airstrip.

Soils in the mechanic/generator shop floor in the camp vicinity are contaminated with copper and hydrocarbons (diesel) to a depth of at least 30 cm. Although the area is confined to the shop, there is a future environmental risk to the burrowing ground squirrel colony in the camp vicinity. Following the removal and demolition of the shop, it is recommended that these soils be excavated to a minimum depth of 30 cm, and buried in a lined facility on site. This facility might be ideally located on the drier north side of the airstrip where the existing grade can be used as overburden. The excavated area at the shop site should be subsequently regraded. Soil removal is preferable to scarification and fertilizer treatment at this location given the remoteness of the Vera site, and the follow-up maintenance and continued monitoring which would be required for the latter option.

Substrate mixed with the white substance occurring in the spring seepage by the camp is contaminated with arsenic and zinc concentrations exceeding the CCME/B.C. soil remediation criteria. It is unclear, given the current data, whether these contaminants originate from the white substance or from buried material in the area behind where the seepage emerges. These contaminants may pose a moderate environmental risk if grizzly bears and other animals (e.g., caribou) foraging in the area ingest these contaminants. This

area also drains into the stream flowing through the camp area and could pose a slight environmental risk to fish bearing waters located further downstream in the North Rackla River to the west. It is recommended, as precautionary measure, that the substrate (0.75 m²) be removed from the seepage and buried in a lined facility on site. An archived soil sample, taken downstream from this location, should also be analyzed to confirm the locality of the contamination. Although there were no visual indications of buried material behind the location of the seepage emergence, this should be verified using shallow testpits

6.3 Aesthetic Concerns

The major aesthetic concerns at Vera are centered around the deteriorating buildings, mining infrastructure (e.g., explosives boxes), equipment and barrels. Most of these are already recommended for demolition/salvaging/removal on the basis of human safety and/or environment risks as discussed above. Wood scraps at the site should be burned and the residue buried in an engineered lined facility on the north side of the airstrip.

Surface exploration has removed some of the vegetation in the surrounding area and created, at some locations, a minimal degree of erosion. Regrading of these areas would probably cause more environmental damage to the existing vegetation than good. It is recommended that the natural recovery, which has already begun to occur, be allowed to continue.

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:

- excavation and disposal of isolated areas of contaminated soil;
- demolition of facilities including wood frame mine shacks, Atco trailers;
- collection of barrels, incineration/disposal their contents, and crushing/disposal of the empty barrels;
- collection and secure disposal of rock core;
- burning of all combustible, non-hazardous wastes
- collection and burial of other non-hazardous, non combustible site wastes and debris;
and
- regrading of the waste rock pile at the adit, and blockage of access to the adit entrance.

It should be noted that a substantial amount of material identified at the Vera site could potentially be salvaged, such as the D6 Caterpillar Dozer, Lincoln Welder, generators, and small tools and equipment. It is recommended that the opportunity be given to the Contractor to apply any potential salvage costs against the total cost of the contract.

The Vera site is relatively remote, approximately 133 kilometres northeast of Mayo and is apparently accessible overland along a winter trail. Fixed wing access is not recommended due to the condition and design of the airstrip. For the cleanup work, it has been assumed

that equipment and personnel would be mobilized from Mayo. Helicopter transport would be used for all personnel and perishable supplies.

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 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. Persons 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

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10. APPENDICES

- A) Sample Descriptions and Analytical Results (Soils/Sediment, Surface Water and Barrels)**
- 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	VE-01S	VE-01S	VE-02	VE-03	VE-04	VE-05	VE-06
Sampling Date	960828	960828	960828	960828	960828	960828	960828
Moisture (%)	17.5	18.4	20.5	15.5	14.1	14.5	12.7
Total Metals (mg/kg)							
Aluminum T-Al	17300	15900	14300	13800	9820	10500	10500
Antimony T-Sb	<20	<20	<20	<20	<20	<20	<20
Arsenic T-As	90.9	104	95.1	109	91.7	109	105
Barium T-Ba	111	133	157	101	77	70	78
Beryllium T-Be	0.8	0.8	0.7	0.7	0.6	0.6	0.6
Bismuth T-Bi	<10	<10	<10	<10	<10	<10	<10
Cadmium T-Cd	<2	2	5	2	<2	<2	2
Calcium T-Ca	2300	2580	3860	2560	2860	2910	1930
Chromium T-Cr	24	23	24	20	15	15	13
Cobalt T-Co	14	15	48	16	10	15	9
Copper T-Cu	73	103	116	95	82	55	72
Iron T-Fe	34400	34600	76100	30900	27300	30600	25500
Lead T-Pb	146	177	116	179	179	146	139
Lithium T-Li	15	12	12	10	8	8	7
Magnesium T-Mg	5510	4690	4690	4290	3560	3760	2660
Manganese T-Mn	985	993	2500	968	787	1280	941
Mercury T-Hg	0.044	0.066	0.131	0.109	0.11	0.031	0.109
Molybdenum T-Mo	11	16	39	21	22	18	20
Nickel T-Ni	80	110	275	112	75	85	77
Phosphorus T-P	919	1040	1100	1060	905	919	909
Potassium T-K	4940	4640	3310	4870	3450	3860	3070
Selenium T-Se	0.5	0.6	1.2	0.8	0.8	0.7	0.8
Silver T-Ag	<2	<2	<2	<2	<2	<2	<2
Sodium T-Na	<200	<200	<200	<200	<200	<200	<200
Tin T-Sn	<10	<10	<10	<10	<10	<10	<10
Titanium T-Ti	248	239	286	189	124	96	105
Vanadium T-V	80	76	69	98	77	77	64
Zinc T-Zn	790	859	2410	830	567	863	692
Location and Description	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils, DUPLICAT E	Surface soil sample under 2nd set of core boxes from E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample under W-most set of core boxes, E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample just E of W-most pile of core boxes, E end of camp along airstrip access road, sandy clay soil with root material	Surface soil sample from S edge of stream running N of camp, 10 m N of VE-02, coarse-medium sand with detritus	Surface soil sample in drainage (13 m W of) VE-07, sandy clay soil with root material

Inorganic Element Results for Soils and Sediments (Continued)

Sample Number	VE-09	VE-10S	VE-14S	VE-11	VE-12	VE-13	VE-16
Sampling Date	960828	960828	960828	960828	960828	960828	960828
Moisture (%)	26.5	16.4	12.7	11.1	41.6	29.9	61.9
<i>Total Metals (mg/kg)</i>							
Aluminum T-Al	16200			11600	19000	18200	48600
Antimony T-Sb	<20	<20	<40	<20	<20	<20	<20
Arsenic T-As	82.1	65.8	29	74.6	67.1	94.7	173
Barium T-Ba	125	87	951	79	159	142	80
Beryllium T-Be	0.9	0.6	<1	0.7	1.1	1	3.5
Bismuth T-Bi	11			<10	19	17	<10
Cadmium T-Cd	<2	<2	41	<2	13	18	3
Calcium T-Ca	4670			2580	21800	25700	3230
Chromium T-Cr	25	17	5	18	30	28	26
Cobalt T-Co	17	12	<4	14	16	15	24
Copper T-Cu	84	40	401	44	70	103	576
Iron T-Fe	39500			32700	51400	51900	234000
Lead T-Pb	205	142	12500	160	1450	1850	197
Lithium T-Li	14			12	19	19	11
Magnesium T-Mg	6520			6180	17200	20000	3540
Manganese T-Mn	1320			1310	2600	3010	801
Mercury T-Hg	0.064	0.042	0.06	0.024	0.122	0.122	0.067
Molybdenum T-Mo	8	8	<8	5	<4	<4	17
Nickel T-Ni	72	42	10	47	32	28	215
Phosphorus T-P	983			547	744	688	872
Potassium T-K	5230			4230	4470	4620	1660
Selenium T-Se	0.5	0.7	<0.1	0.3	0.4	0.3	1.5
Silver T-Ag	<2	<2	18	<2	14	28	17
Sodium T-Na	<200			<200	<200	<200	<200
Tin T-Sn	<10	<30	<60	<10	<10	<10	<10
Titanium T-Ti	268			108	343	306	266
Vanadium T-V	71	42	5	40	54	47	48
Zinc T-Zn	578	343	8930	392	4140	5130	1960
Location and Description	Surface soil sample on dirt floor of generator shed, by battery, HC odour, wet medium sand with stones	Surface soil sample just N of generator shed, no HC odour, coarse sand with stones	Composite Surface soil sample from series of small stained areas N of work bench (W of adit), HC odour, medium sand	Surface soil sample along E edge of stream (flow 1L/10 sec), W of old cat, flows from foothills near W end of camp to NW, medium-fine sand	Surface soil sample from E edge of adit drainage pool (N of adit), fine-medium sand	Surface (sediment) sample from small drainage pond, 26 m downstream (N) of adit drainage pool and VE-12, medium sand	Surface sample, white milky substance in seepage creek along SE edge of camp, joins stream along edge of airstrip, no odour, medium iron-rich sand, some root material and plants

A.2 Inorganic Elements Results for Surface Water Samples

Sample No.	VE-05W	VE-11W	VE-12W	VE-18W	VE-19W
Conductivity ($\mu\text{mhos/cm}$)	12900	13900	14700	14100	14600
<i>Total Metals (mg/L)</i>					
Aluminum T-Al	<0.2	<0.2	<0.2	<0.2	<0.2
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
Cadmium T-Cd	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium T-Ca	27.1	25.7	25.3	26.8	29.5
Chromium T-Cr	<0.01	<0.01	<0.01	<0.01	<0.01
Cobalt T-Co	<0.01	<0.01	<0.01	<0.01	<0.01
Copper T-Cu	<0.01	<0.01	<0.01	<0.01	<0.01
Iron T-Fe	<0.03	0.03	<0.03	0.08	<0.03
Lead T-Pb	<0.05	<0.05	<0.05	<0.05	<0.05
Lithium T-Li	<0.01	<0.01	<0.01	<0.01	<0.01
Magnesium T-Mg	17	16.8	17.6	16.9	17.8
Manganese T-Mn	<0.005	<0.005	<0.005	0.01	<0.005
Mercury	<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
Silver T-Ag	<0.01	<0.01	<0.01	<0.01	<0.01
Sodium T-Na	<2	<2	<2	<2	<2
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	0.01	0.014	0.328	0.007	<0.005
Site/Sample Descriptions	Water sample from S edge of stream running N of camp, 10 m N of VE-02, pH 7.64	Water sample along E edge of stream (flow 1L/10 sec), W of old cat, flows from foothills near W end of camp to NW, pH 7.90	Water sample from E edge of adit drainage pool (N of adit), pH 7.58	Water sample (sediment) along airstrip stream, upstream from camp, pH 7.17	Water sample along airstrip stream, downstream from camp, pH 7.16

A.3 Hydrocarbon Results for Soils and Sediment

Sample No.	VE-01S	VE-01S D	VE-01D	VE-07	VE-08S	VE-08D	VE-09	VE-10S
TPH - Test Kits (mg/kg)	>625	250-1250	250-1250	<50	<25	250-1250	250-1250	<50
Non-halogenated Volatiles								
Benzene	-	-	-	-	-	<0.05	-	-
Ethylbenzene	-	-	-	-	-	<0.05	-	-
Toluene	-	-	-	-	-	<0.05	-	-
meta- & para-Xylene	-	-	-	-	-	<0.05	-	-
ortho-Xylene	-	-	-	-	-	<0.05	-	-
Light Hydrocarbons (C5-9)	-	-	-	-	-	<5	-	-
VPH	-	-	-	-	-	<10	-	-
Extractables								
EPH (C10-18)	7080	5810	1950	-	796	946	-	-
EPH (C19-31)	3050	3420	706	-	1030	332	-	-
PAHs								
Acenaphthene	-	0.16	0.03	-	<0.01	-	-	-
Acenaphthylene	-	<0.05	0.01	-	<0.01	-	-	-
Anthracene	-	0.27	0.03	-	<0.01	-	-	-
Benzo(a)anthracene	-	0.06	<0.01	-	<0.01	-	-	-
Benzo(a)pyrene	-	<0.05	<0.01	-	<0.01	-	-	-
Benzo(b)fluoranthene	-	<0.05	<0.01	-	<0.01	-	-	-
Benzo(g,h,i)perylene	-	<0.05	<0.01	-	<0.01	-	-	-
Benzo(k)fluoranthene	-	<0.05	<0.01	-	<0.01	-	-	-
Chrysene	-	0.2	0.03	-	0.08	-	-	-
Dibenz(a,h)anthracene	-	<0.05	<0.01	-	<0.01	-	-	-
Fluoranthene	-	0.23	0.05	-	<0.01	-	-	-
Fluorene	-	0.06	0.01	-	<0.01	-	-	-
Indeno(1,2,3-c,d)pyrene	-	<0.05	<0.01	-	<0.01	-	-	-
Naphthalene	-	0.05	0.04	-	0.03	-	-	-
Phenanthrene	-	0.09	0.04	-	0.02	-	-	-
Pyrene	-	2.12	0.28	-	0.28	-	-	-
Site/Sample Descriptions	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils	Surface soil sample under core shack at E end, stained/spill area, HC odour (diesel), moist sand/clay soils, DUPLICATE	Depth soil sample at 30 cm under core shack, stained area, strong HC odour (diesel), coarse sandy clay soils	Surface soil sample in depression on 3m N of core shed, no HC odour, sandy clay soil with root material	Surface soil sample on dirt floor of generator shed, 50 cm from generator, HC odour, wet medium sand with stones	Depth soil sample at 30 cm on dirt floor of generator shed, 50 cm from generator, strong HC odour, coarse-medium sand with rocks	Surface soil sample on dirt floor of generator shed, by battery, HC odour, wet medium sand with stones	Surface soil sample just N of generator shed, no HC odour, coarse sand with stones

A.3: Hydrocarbon Results for Soils and Sediment (Continued)

Sample No.	VE-14S	VE-14D	VE-15S	VE-15D	VE-16	VE-17	VE-20S	VE-20D
TPH - Test Kits (mg/kg)	<25	<25	>> 625	>> 625	<50	<50	<25	<25
Non-halogenated Volatiles								
Benzene	-	-	-	<0.05	-	-	-	-
Ethylbenzene	-	-	-	<0.05	-	-	-	-
Toluene	-	-	-	<0.05	-	-	-	-
meta- & para-Xylene	-	-	-	<0.1	-	-	-	-
ortho-Xylene	-	-	-	<0.05	-	-	-	-
Light Hydrocarbons (C5-9)	-	-	-	<5	-	-	-	-
VPH	-	-	-	<10	-	-	-	-
Extractables								
EPH (C10-18)	-	-	4960	3090	<250	-	-	-
EPH (C19-31)	-	-	41400	28500	<250	-	-	-
PAHs								
Acenaphthene	-	-	0.06	-	-	-	-	-
Acenaphthylene	-	-	<0.05	-	-	-	-	-
Anthracene	-	-	0.19	-	-	-	-	-
Benzo(a)anthracene	-	-	<0.05	-	-	-	-	-
Benzo(a)pyrene	-	-	<0.05	-	-	-	-	-
Benzo(b)fluoranthene	-	-	<0.05	-	-	-	-	-
Benzo(g,h,i)perylene	-	-	<0.05	-	-	-	-	-
Benzo(k)fluoranthene	-	-	<0.05	-	-	-	-	-
Chrysene	-	-	<0.05	-	-	-	-	-
Dibenz(a,h)anthracene	-	-	<0.05	-	-	-	-	-
Fluoranthene	-	-	0.17	-	-	-	-	-
Fluorene	-	-	0.24	-	-	-	-	-
Indeno(1,2,3-c,d)pyrene	-	-	<0.05	-	-	-	-	-
Naphthalene	-	-	0.12	-	-	-	-	-
Phenanthrene	-	-	3.6	-	-	-	-	-
Pyrene	-	-	0.4	-	-	-	-	-
Site/Sample Descriptions	Composite Surface soil sample from series of small stained areas N of work bench (W of adit), HC odour, medium sand	Composite Depth soil sample at 30 cm (below stain zone) from series of small stained areas N of work bench (W of adit), no HC odour, medium sand	Surface soil sample from red stained area by barrel sample E1 (soluble oil) at NW edge of waste rock plateau, HC odour, coarse sand	Depth soil sample at 30 cm red stained area (below stained zone) by barrel sample E1 (soluble oil) at NW edge of waste rock plateau, HC odour, coarse sand	Surface soil sample from white milky substance in seepage creek along SE edge of camp, joins stream along edge of airstrip, no odour, medium iron-rich sand, some root material and plants	Surface soil sample (sediment) in small pond 33 m downstream (N) of VE-16, faint HC odour?, organic sediment	Surface soil sample in stained area along N side of airstrip road, 45m SE of camp, adjacent to some equipment debris, HC odour, coarse-medium sand	Depth soil sample at 30 cm in stained area along N side of airstrip road, 45m SE of camp, adjacent to some equipment debris, faint HC odour, medium sand with stones

A.4 Results, Locations and Descriptions for Barrel Samples

Sample Number	VE-A2	VE-A2 Duplicate	VE-C1	VE-D1	VE-E1
Total Organic Halogens	124	65	244	193	249
Aluminum	<2	<2	<2	<2	<2
Antimony	<2	<2	<2	<2	<2
Arsenic	<3	<3	<3	<3	<3
Barium	0.01	<0.01	<0.01	0.01	0.02
Beryllium	<0.06	<0.06	<0.06	<0.06	<0.06
Cadmium	<0.2	<0.2	<0.2	<0.2	<0.2
Calcium	0.7	0.3	0.6	0.5	13.1
Chromium	<0.3	<0.3	<0.3	<0.3	<0.3
Cobalt	<0.2	<0.2	0.3	<0.2	<0.2
Copper	<0.2	<0.2	<0.2	0.7	1.0
Iron	0.7	0.4	1.1	0.6	36.6
Lead	<0.8	<0.8	236	1.6	<0.8
Magnesium	0.15	0.14	0.16	0.15	0.60
Manganese	<0.03	<0.03	0.07	<	0.41
Molybdenum	<0.4	<0.4	<0.4	<0.4	<0.4
Nickel	<0.3	<0.3	<0.3	<0.3	<0.3
Phosphorus	<4	<4	<4	<4	<4
Silver	<0.3	<0.3	<0.3	<0.3	<0.3
Sodium	9	<1	<1	<1	2
Strontium	<0.01	<0.01	<0.01	<0.01	0.02
Tin	<0.3	<0.3	<0.3	<0.3	<0.3
Titanium	<0.06	<0.06	<0.06	<0.06	<0.06
Vanadium	<0.1	<0.1	<0.1	<0.1	<0.1
Zinc	0.4	<0.2	0.3	0.3	0.2
Zirconium	<0.2	<0.2	<0.2	<0.2	<0.2
	Barrel Pile A: at base (W end) of airstrip, ~ 51 barrels including other stockpiled materials, Barrel sample: yellowish transparent fuel (diesel), full, no markings	Barrel Pile A: Barrel sample: yellowish transparent fuel (diesel), full, no markings DUPLICATE	Barrel Pile C: north of core box storage area and E of core shack, along edge of airstrip road; Barrel Sample: transparent fuel (aviation), marked " JP 4 Jet June '84", 3/4 full	Barrel Pile D: vicinity of hillside work shacks above (S of) camp, Barrel Sample: dark thick amber fuel (heating oil), marked "Chevron Prism Resources Diesel, June??", filter attached	Barrel E: lone barrel from red stained area at NW edge of waste rock plateau near adit, Barrel Sample: dark brown visous fluid marked "CHEVRON SOLUBLE OIL"

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 $CaCO_3$ /1000 t is declared net acid generating, although it may not be so at the time of analysis. Similarly, any sample with a TNPR or SNPR less than 1.0-2.0 is considered net acid generating. Negligible levels of sulphide (0.05%S) are considered non-acid-generating regardless of their xNNP and xNPR values. Exceptions to these criteria are known, and site-specific kinetic testwork is needed to determine site-specific criteria 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-05-2) reported that the main rock unit at Vera was the strongly jointed (broken) Middle Proterozoic Gillespie Group dolomite. The economic minerals are: galena (lead sulphide), argentiferous tetrahedrite (silver-bearing copper-based sulphide), and minor sphalerite (zinc sulphide). At 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 Group. Nevertheless, most of the formations contain dolomite and limestone as well as some black shale and more recent igneous rock, all of which were found (Table 1 and Section 4, Field Notes) and tested as part of this study.

The abundant dolomite and limestone in the area would likely neutralize any acidic drainage, and thus the probability rating for acidic drainage on a large scale is minimal. For medium scales, ABA results (Table 2) show that most samples have high values of xNNP and xNPR and are thus net acid neutralizing. Thus, the probability of acidic drainage on a medium scale is low (Table 3). However, a few samples had depressed values of xNNP and xNPR, particularly VE-AD8, -AD10, -AD12, -AD16, and -AD19, which also tended to have lower than average (but still near-neutral) pH. These samples were collected from road cuts, ore, waste rock near the portal, and core. Therefore, the probability of some acidic drainage on a small scale around the minerals and rock is high (Table 3), but the acidic drainage would be neutralized by the surrounding neutralizing rock before migrating far.

B.3 Total-Metal Contents

As explained in Section 1, total-metal contents were measured (Table 4) to determine which metals occur at relatively high levels compared to worldwide averages. This is not a sufficient condition for accelerated metal leaching, but may highlight metals which might leach at high levels. Only long-term kinetic tests and on-site monitoring will demonstrate which metals are leaching at detectable levels. Based on worldwide averages, the metals in Vera rock that

frequently occur (>20% of samples) at elevated levels (> 5x worldwide maximum average) are: silver, cadmium, lead, antimony, tungsten, and zinc. High levels of lead were expected for VE-AD10, because it was nearly pure galena (lead sulphide), which apparently include some minor sphalerite (zinc sulphide) based on the zinc level of 4580 ppm. Waste rock outside the portal, despite being visibly oxidized and leached, still contained significant levels of silver, copper, lead, and zinc.

TABLE 1	
Project:	Abandoned Yukon Mines
Location:	Vera
Data:	Sample Description
SAMPLE	SAMPLE DESCRIPTION
VE-AD1	Trench #1; oxidized brown-olive gravel.
VE-AD2	Trench #1; unoxidized dark grey sand and gravel with minor weathering to olive brown on outer surface.
VE-AD3	Natural outcrop east; 2 pieces of tabular rock (~2 x 5 x 1 cm) grey weathered to brown.
VE-AD4	East end of Airstrip; grey gravel with brown weathering in places.
VE-AD5	Airstrip ~100 m from east end; gray to olive gravel with brown minor weathering.
VE-AD6	West Airstrip, south side: black to olive gravel with minor orange-brown weathering.
VE-AD7	West Airstrip, north side; grey sand and gravel with orange-brown weathering.
VE-AD8	Cat road, ~700m north of Camp; black, lightweight gravel (coal?) with orange to yellow-white surface coatings.
VE-AD9	Cat road, 1 km north of camp; orange to dark gray gravel.
VE-AD10	Lead ore above portal; galena with outer surfaces oxidized.
VE-AD11	Waste rock; lower west slope; red-brown gravelly sand.
VE-AD12	Waste rock; upper west slope; brown gravelly sand.
VE-AD13	Waste rock; lower east slope; olive grey gravelly sand.
VE-AD14	Waste rock, upper east slope; olive gravelly sand with some orange colour.
VE-AD15	Core 88/10 196'; volcanic breccia; fine-grained gray rock in quartz and/or carbonate matrix; visible pyrite.
VE-AD16	Core box not marked; laminated fine-grained gray and green sedimentary rock; vitreous luster on black surfaces.
VE-AD17	Core 80-42 BX4; laminated sedimentary rock with lesser black laminations and more abundant light orange-tan laminations; breaks on black lustrous; shows vitreous luster.
VE-AD18	Core UG1 BX1; aphanitic, grey-black volcanic with complete orange-brown oxidation on all old surfaces.
VE-AD19	Core VE80-15 B12 256'; volcanic rock: mostly black with heavy hematite bands and one area with grey metallic luster (galena?).
VE-AD20	Core 88/1 102'; fine grained volcanic rock with minor quartz bands; some orange oxidation in places, particularly in quartz bands.
VE-AD21	Core box not marked; phaneritic igneous diorite; very minor oxidation in places.

TABLE 2

Project:	Abandoned Yukon Mines																				
Location:	Vera																				
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/N P) *100
VE-AD01	8.70	0.050	0.030	0.005	0.0014	0.014	2	1	1	771	36.6	832	769	770	831	770	10.00	10.00	10.00	10.00	108
VE-AD02	8.70	0.050	0.030	0.005	0.0023	0.013	2	1	1	18	1.4	32	16	17	31	17	10.00	10.00	10.00	10.00	177
VE-AD03	8.70	0.010	0.005	0.005	0.0072	0.000	0	0	0	88	5.0	114	88	88	114	88	10.00	10.00	10.00	10.00	129
VE-AD04	7.90	0.030	0.020	0.005	0.0058	0.000	1	1	1	5	0.1	2	4	4	2	4	10.00	10.00	10.00	10.00	45
VE-AD05	6.40	0.050	0.010	0.040	0.0054	0.000	2	0	0	0	0.1	2	-2	0	2	0	10.00	10.00	10.00	10.00	
VE-AD06	7.40	0.080	0.005	0.070	0.0023	0.003	3	0	0	7	0.1	2	5	7	2	7	2.80	10.00	10.00	10.00	32
VE-AD07	8.30	0.080	0.040	0.020	0.0093	0.011	3	2	1	27	1.1	25	25	25	23	26	10.80	17.05	15.80	10.00	93
VE-AD08	6.40	0.200	0.005	0.180	0.0065	0.008	6	0	0	1	0.1	2	-5	1	2	1	0.16	10.00	10.00	10.00	227
VE-AD09	7.50	0.020	0.010	0.010	0.0061	0.000	1	0	0	4	0.1	2	3	4	2	4	10.00	10.00	10.00	10.00	57
VE-AD10	6.80	12.500	12.400	0.040	0.0012	0.059	391	389	388	1	0.1	2	-390	-388	-387	-387	0.00	0.00	0.01	0.00	227
VE-AD11	8.40	0.470	0.430	0.030	0.0012	0.009	15	14	13	436	21.8	496	421	422	482	423	29.69	31.79	36.15	32.45	114
VE-AD12	8.10	2.780	2.620	0.140	0.0016	0.018	87	82	82	85	18.3	416	-2	3	334	3	0.98	1.03	5.05	1.04	490
VE-AD13	8.80	0.060	0.100	0.010	0.0009	0.000	2	3	3	753	34.8	791	751	750	788	750	401.60	240.96	253.26	240.96	105
Continued																					

Table 2 Continued

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/N P) *100
VE-AD14	9.10	0.050	0.040	0.005	0.0019	0.003	2	1	1	716	32.8	746	714	715	745	715	10.00	10.00	10.00	10.00	104
VE-AD15	9.20	0.160	0.130	0.005	0.0001	0.025	5	5	4	1040	46.8	1064	1035	1035	1060	1036	208.00	214.87	219.90	256.00	102
VE-AD16	7.50	2.460	2.260	0.130	0.0079	0.062	77	73	71	11	0.1	2	-66	-62	-70	-60	0.14	0.15	0.03	0.16	21
VE-AD17	9.20	0.200	0.210	0.005	0.0077	0.000	6	7	7	338	15.2	346	332	331	339	331	54.08	51.50	52.68	51.50	102
VE-AD18	9.20	0.005	0.005	0.005	0.0037	0.000	0	0	0	751	32.8	746	751	751	746	751	10.00	10.00	10.00	10.00	99
VE-AD19	7.80	1.350	1.270	0.070	0.0002	0.010	42	40	40	47	18.8	428	5	7	388	7	1.11	1.18	10.69	1.18	910
VE-AD20	8.50	0.005	0.005	0.005	0.0021	0.000	0	0	0	35	1.1	25	35	35	25	35	10.00	10.00	10.00	10.00	71
VE-AD21	8.50	0.050	0.040	0.005	0.0012	0.004	2	1	1	8	0.1	2	6	7	1	7	10.00	10.00	10.00	10.00	28
Maximum	9.20	12.500	12.400	0.180	0.0093	0.062	391	389	388	1040	46.8	1064	1035	1035	1060	1036	401.60	240.96	253.26	256.00	910
Minimum	6.40	0.005	0.005	0.005	0.0001	0.000	0	0	0	0	0.1	2	-390	-388	-387	-387	0.00	0.00	0.01	0.00	21
Mean	8.15	0.984	0.936	0.038	0.0036	0.011	31	30	29	245	12.7	289	214	215	260	216	38.54	32.31	33.98	33.97	162
Std Deviation	0.880	2.756	2.731	0.052	0.0029	0.018	86	86	85	345	15.7	356	374	373	381	373	94.42	66.13	68.53	72.24	204
10 Percentile	6.80	0.010	0.005	0.005	0.0009	0.000	0	0	0	1	0.1	2	-5	0	1	0	0.16	1.03	5.05	1.04	32
Median	8.40	0.060	0.040	0.010	0.0023	0.004	2	1	1	35	1.4	32	16	17	31	17	10.00	10.00	10.00	10.00	103
90 Percentile	9.20	2.460	2.260	0.130	0.0077	0.025	77	73	71	753	34.8	791	751	751	788	751	54.08	51.50	52.68	51.50	254
Count	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	20
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:	high ¹	low	minimal

¹ the probability for acidic drainage around some mineral grains and rock is high, but the abundant neutralizing rock would neutralize the acidity before the drainage flowed far.

Table 4

Project:	Abandoned Yukon Mines																										
Location:	Vera																										
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)
VE-AD01	0.4	9600	8	60	0.25	1	170000	4.00	4.0	46	10	39000	0.04	7400	82800	5130	5.0	300	23.0	260	80	2.2	47	100	66	20	722
VE-AD02	1.8	24400	30	100	0.50	4	5000	1.50	1.0	89	9	7000	0.06	16000	4900	290	23.0	200	14.0	170	124	4.4	7	700	388	5	298
VE-AD03	0.1	59300	10	310	1.50	4	19600	0.50	7.0	85	10	18000	0.01	39000	16600	515	1.0	900	17.0	540	22	1.4	15	1900	86	5	94
VE-AD04	0.6	59000	26	250	1.50	2	2000	3.50	15.0	93	51	28200	0.04	32100	10100	715	12.0	1300	45.0	1040	44	2.8	9	1900	249	5	442
VE-AD05	0.2	34700	28	230	1.00	2	300	0.50	3.0	62	10	7600	0.03	24900	3200	65	29.0	400	32.0	180	42	3.4	9	1300	517	5	72
VE-AD06	0.6	24500	26	100	0.50	2	2300	1.00	3.0	94	49	7300	0.10	13700	3500	105	17.0	400	26.0	630	46	2.2	11	900	461	5	122
VE-AD07	0.1	64900	8	400	1.50	8	6700	0.25	11.0	69	8	25400	0.02	45100	8500	995	1.0	1100	23.0	770	16	1.4	14	2000	86	5	88
VE-AD08	0.6	48500	14	280	1.00	6	3000	0.25	1.0	139	14	7200	0.01	28300	5900	45	23.0	2500	13.0	1280	18	2.0	23	1300	318	5	22
VE-AD09	0.1	68800	2	260	1.00	6	1400	0.50	15.0	145	29	48800	0.04	24700	17800	425	5.0	2600	43.0	730	22	1.4	14	3300	134	5	120
VE-AD10	100.0	500	50	50	5.00	10	250	50.00	5.0	30	380	4000	0.005	500	250	270	5.0	250	5.0		10000		5	250	5		4580
VE-AD11	100.0	16600	560	50	0.25	18	73500	47.50	7.0	53	877	118500	0.12	9100	56500	8920	0.5	300	7.0	240	3100	460.0	19	300	33	50	8890
VE-AD12	100.0	25600	1050	70	0.25	18	43000	175.0	11.0	43	406	124000	0.69	14800	38000	10000	0.5	400	13.0	250	7300	290.0	15	400	28	40	10000
VE-AD13	8.4	12700	46	40	0.25	1	154500	8.50	4.0	35	28	22600	0.03	8900	91400	2230	3.0	200	7.0	130	404	15.5	33	300	23	10	1730
VE-AD14	12.6	16800	36	80	0.25	1	152500	3.00	3.0	50	27	15600	0.02	13000	90000	1390	0.5	100	7.0	130	186	18.5	31	400	26	10	710
VE-AD15	0.1	600	2	5	0.25	1	206000	0.25	0.5	8	1	6800	0.005	500	123500	615	5.0	400	2.0	140	14	0.4	36	50	14	5	54
VE-AD16	0.8	76000	76	340	2.00	6	5500	0.25	41.0	81	20	27200	0.10	50200	8600	40	6.0	1500	32.0	1250	56	5.4	12	2200	151	5	54

Continued

Data:	Table 4: Continued																										
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)
VE-AD17	0.1	59100	6	330	1.50	6	69200	0.25	9.0	81	3	11400	0.01	49300	45500	510	1.0	1800	13.0	540	10	0.6	25	1900	61	5	50
VE-AD18	0.1	23900	4	160	0.50	1	149000	0.25	8.0	44	10	24900	0.03	22200	82400	1155	0.5	300	7.0	160	6	0.6	52	600	26	10	26
VE-AD19	100.0	17600	2450	10	0.25	1	3600	5.00	18.0	38	2770	250000	0.51	8800	34500	10000	0.5	500	22.0	280	616	1000.	8	200	25	50	1085
VE-AD20	2.6	71500	4	90	0.25	1	8800	0.50	26.0	80	27	93600	0.02	11300	51100	1135	9.0	2300	89.0	1040	20	5.0	8	4600	283	30	140
VE-AD21	1.6	61300	2	50	0.25	1	70000	1.50	41.0	43	150	72800	0.01	3000	43600	1890	0.5	20300	56.0	250	68	3.4	147	4900	298	30	160
Maximum	100	7600	2450	400	5.00	18	206000	175.0	41.0	145	2770	250000	.69	50200	123500	1000	29.0	20300	89.0	1280	7300	1000	147	4900	517	50	10000
Minimum	0.1	500	2	5	0.25	1	250	0.25	0.5	8	1	4000	0.005	500	250	40	0.5	100	2.0	130	6	0.4	5	50	5	5	22
Mean	20.5	36948	211	155	0.94	5	54579	14.48	11.1	67	233	45710	0.90	20133	38983	2211	7.0	1812	23.6	501	581	91.0	26	1405	156	15	1403
Standard	39.6	25014	570	125	1.09	5	69153	39.45	11.8	34	618	59282	0.175	15509	36585	3309	8.7	4313	20.9	393	1680	243.9	31	1413	161	16	2866
10 Percentile	0.1	9600	2	40	0.25	1	1400	0.25	1.0	35	8	7000	0.01	3000	3500	65	0.5	200	7.0	139	10	0.6	8	200	23	5	50
Median	0.6	25600	26	100	0.50	2	8800	1.00	7.0	62	27	24900	0.03	14800	34500	715	5.0	400	17.0	270	44	3.1	15	900	86	5	140
90 Percentile	100	68800	560	330	1.50	10	154500	47.50	26.0	94	406	118500	0.12	45100	90000	8920	23.0	2500	45.0	1061	616	307.0	47	3300	388	41	4580
Count	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21	21
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: **VERA**

Date: August 27 to August 29, 1996

August 27

Comments: Set up camp in later afternoon and evening

August 28

Comments: Some snow on ground, snowing, no wind, ~0 C; clearing and warming toward afternoon. Short trench ~3 km east of camp along CAT road; ~20 m long by 5 m wide exposing mostly brown cobbles, gravel and silty sand reflecting natural overburden; some black grey rock at head of trench maybe disturbed rock; grab samples of gravelly material ~<2 cm in size: one sample of oxidized rock (VE-AD1), one sample of black grey rock (VE-AD2); no visible seepage in trench.

CAT road east of airstrip continues for several km east; maybe access road; rock appears to be oxidized natural overburden; no samples; no visible seepage.

Natural outcrops of partially oxidized slate-like rock in valley east of camp; valley drains towards camp; ore grab sample (VE-AD3) near path has a few internal ferric-Fe specks looking like past oxidation of pyrite grains.

One lake (~50 m x ~50 m) formed at base of slaty outcrop; no iron staining; lots of vegetation and wetland; litmus pH of one seep (~500 m L/s) and lake = 7.

Camp creek (1 m wide by ~20 cm deep) above lake (flow ~5 L/s) has oxidized slaty rock in bed; litmus pH = 7; no iron precipitation.

No barrels or oil stains anywhere on east side of site.

Lake drainage and creek join below the lake.

Airstrip: east end; some oxidized and unoxidized (grey) rock over brown gravelly silty sand; one grab sample of brown oxidized and unoxidized rock (VE-AD4).

Gray slaty rock on airstrip ~100 m west of east end; sampled (VE-AD5).

Trails south and north from airstrip show some disturbance of natural ground.

West end of airstrip near base of slope mostly grey rock on south side (VE-AD6) and some light brown rock on north side (VE-AD7).

No visible seepage any where on airstrip.

CAT road North of Camp continues north for at least several km, apparently heading down into deep valley; no visible seepage noted (walked ~ first 2 km); road cuts caused some disturbance of over burden and rock, exposing some oxidized and unoxidized rock, sample collected 1 km north of camp (VE-AD9); ~700 m N of camp, deep cut by CAT (~2.5 m deep) shows mostly disturbed overburden, but cut to bedrock in places; single black boulder has signs of recent oxidation and white/yellow secondary precipitants so sampled (VE-AD7)

Snow melted, temperature rising to ~8 degrees C in afternoon.

Core Area: litmus pH camp creek = 7; core with minor sulphides and galena within 5 m of creek; 2 blue barrels and 1 orange barrel at core shack within 10 m of creek, all have liquid.

Cat road south of camp leads up to water supply collection point at creek; just disturbed overburden; no seepage visible.

Cat roads west of camp to portal: just disturbed overburden; located about 15 m vertically above portal was one barrel in small creek heavily punctured and weighted with rock, apparently water collection for drills; another, upright light blue barrel has ~50 kg of high-grade PbS ore (galena) as fist-sized pieces, and 3 inch hole on top allows rain water to run in and then drain out; some galena ore around outside of barrel showing advanced stages of weathering; sample of galena collected (VE-AD10).

Portal and surrounding waste-rock dump: Portal is collapsing, not safe for entry. Waste rock: well confined to portal area, very little slope collapse, some rock shows significant oxidation, west slope has been cut with equipment and is steeper than angle of repose; waste rock is generally red-brown (west side; VE-AD11 and -AD12) to gray (east side: VE-AD13 and -AD14); waste rock is generally gravelly silty sand with surficial cover of gravel and cobbles in places and on top; litmus pH of portal flow and pool = 5.5-6; flow of ~0.25 L/s from portal into pool with no surface outflow from pond (must be infiltrating), but erosion channel at crest indicates high flows will occasionally travel across surface.

Returned to core area: ~1700 core boxes with roughly 15 kg of rock and 10 kg of wood; seven samples of various rock units collected from core (VE-AD15 to -AD21); some core boxes say "VAL", so ore-grade core probably brought from Val to here for logging.

August 29

Comments: Stream sampling site VE-18: GPS location 64 19°45'N, 133 44°12'W; flow ~2 L/s, stream sediments gravel to cobbles with little fine material; stream banks well anchored by vegetation; litmus pH 5.5; just 15m below confluence of seep (0.25 L/s) from small slaty outcrop.

Stream sampling site VE 19: GPS location 64 19°40'N, 133 44°77'W, altitude 1420 m; flow ~15 L/s; stream sediment is gravel to boulders; ~10 m below confluence of drainage from old road and ~10 m above confluence with first natural stream; steep gradient on stream; banks well anchored by vegetation.

LIST OF SAMPLES

<u>CODE</u>	<u>SOURCE</u>
VE-AD 1	Trench #1; oxidized brown-olive gravel.
VE-AD 2	Trench #1; unoxidized dark grey sand and gravel with minor weathering to olive brown on outer surface.
VE-AD 3	Natural outcrop east; 2 pieces of tabular rock (~2 x 5 x 1 cm); grey weathered to brown.
VE-AD 4	East end of Airstrip; grey gravel with brown weathering in places.
VE-AD 5	Airstrip ~100 m from east end; gray to olive gravel with brown minor weathering.

- VE-AD 6 West Airstrip, south side: black to olive gravel with minor orange-brown weathering.
- VE-AD 7 West Airstrip, north side; grey sand and gravel with orange-brown weathering.
- VE-AD 8 Cat road, ~700m north of Camp; black, lightweight gravel (coal?) with orange to yellow-white surface coatings.
- VE-AD 9 Cat road, 1 km north of camp; orange to dark gray gravel.
- VE-AD 10 Lead ore above portal; galena with outer surfaces oxidized.
- VE-AD 11 Waste rock; lower west slope; red-brown gravelly sand.
- VE-AD 12 Waste rock; upper west slope; brown gravelly sand.
- VE-AD 13 Waste rock; lower east slope; olive-grey gravelly sand.
- VE-AD 14 Waste rock, upper east slope; olive gravelly sand with some orange colour.
- VE-AD 15 Core 88/10 196'; volcanic breccia; fine-grained gray rock in quartz and/or carbonate matrix; visible pyrite.
- VE-AD 16 Core box not marked; laminated fine-grained gray and green sedimentary rock; vitreous luster on black surfaces.
- VE-AD 17 Core 80-42 BX4; laminated sedimentary rock with lesser black laminations and more abundant light orange-tan laminations; breaks on black lustrous; shows vitreous luster.
- VE-AD 18 Core UG1 BX1; aphanitic, grey-black volcanic with complete orange-brown oxidation on all old surfaces.
- VE-AD 19 Core VE80-15 B12 256'; volcanic rock: mostly black with heavy hematite bands and one area with grey metallic luster (galena?).

- VE-AD 20 Core 88/1 102'; fine grained volcanic rock with minor quartz bands; some orange oxidation in places, particularly in quartz bands.
- VE-AD 21 Core box not marked; phaneritic igneous diorite; very minor oxidation in places.

C. Laboratory Reports



CHEMICAL ANALYSIS REPORT

Date: November 19, 1996

ASL File No. G4671r

Report On: Soil And Water Analysis

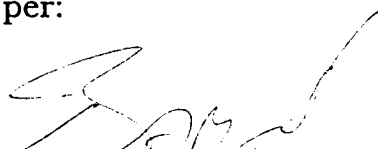
Report To: **Royal Roads University**
Applied Research Division
2005 Sooke Road
Victoria, BC
V9B 5Y2

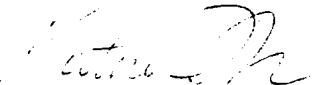
Attention: **Mr. William Dushenko, PhD**

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

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

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Dup = Field duplicate.

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**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

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Dup = Field duplicate.

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**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.

< = 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

		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

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

		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 Field Duplicate	VE-08S
	96 08 27	96 08 27	96 08 28	96 08 28	96 08 28
<u>Non-halogenated Volatiles</u>					
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	-	-	-
<u>Extractables</u>					
EPH (C10-18)	5160	58700	7080	5810	796
EPH (C19-31)	2070	4980	3050	3420	1030

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

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Dup = Field duplicate.

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

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

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

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Dup = Field duplicate.

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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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Dup = Field duplicate.

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

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)

13100

14600

Hardness

CaCO₃

296

298

Total Metals

Aluminum T-Al

0.089

0.009

Antimony T-Sb

<0.2

<0.2

Arsenic T-As

0.006

0.003

Barium T-Ba

0.02

0.02

Beryllium T-Be

<0.005

<0.005

Bismuth T-Bi

<0.1

<0.1

Boron T-B

<0.1

<0.1

Cadmium T-Cd

0.0005

0.0003

Calcium T-Ca

61.0

61.1

Chromium T-Cr

<0.001

<0.001

Cobalt T-Co

<0.01

<0.01

Copper T-Cu

0.001

<0.001

Iron T-Fe

0.21

<0.03

Lead T-Pb

0.024

0.002

Lithium T-Li

<0.01

<0.01

Magnesium T-Mg

34.8

35.2

Manganese T-Mn

0.040

<0.005

Mercury T-Hg

<0.00005

<0.00005

Molybdenum T-Mo

<0.03

<0.03

Nickel T-Ni

<0.02

<0.02

Phosphorus T-P

<0.3

<0.3

Potassium T-K

<2

<2

Selenium T-Se

0.0012

0.0012

Silicon T-Si

1.58

1.50

Silver T-Ag

<0.0001

<0.0001

Sodium T-Na

<2

<2

Strontium T-Sr

0.046

0.046

Thallium T-Tl

<0.1

<0.1

Tin T-Sn

<0.30

<0.30

Titanium T-Ti

<0.01

<0.01

Vanadium T-V

<0.03

<0.03

Zinc T-Zn

0.170

0.110

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

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



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

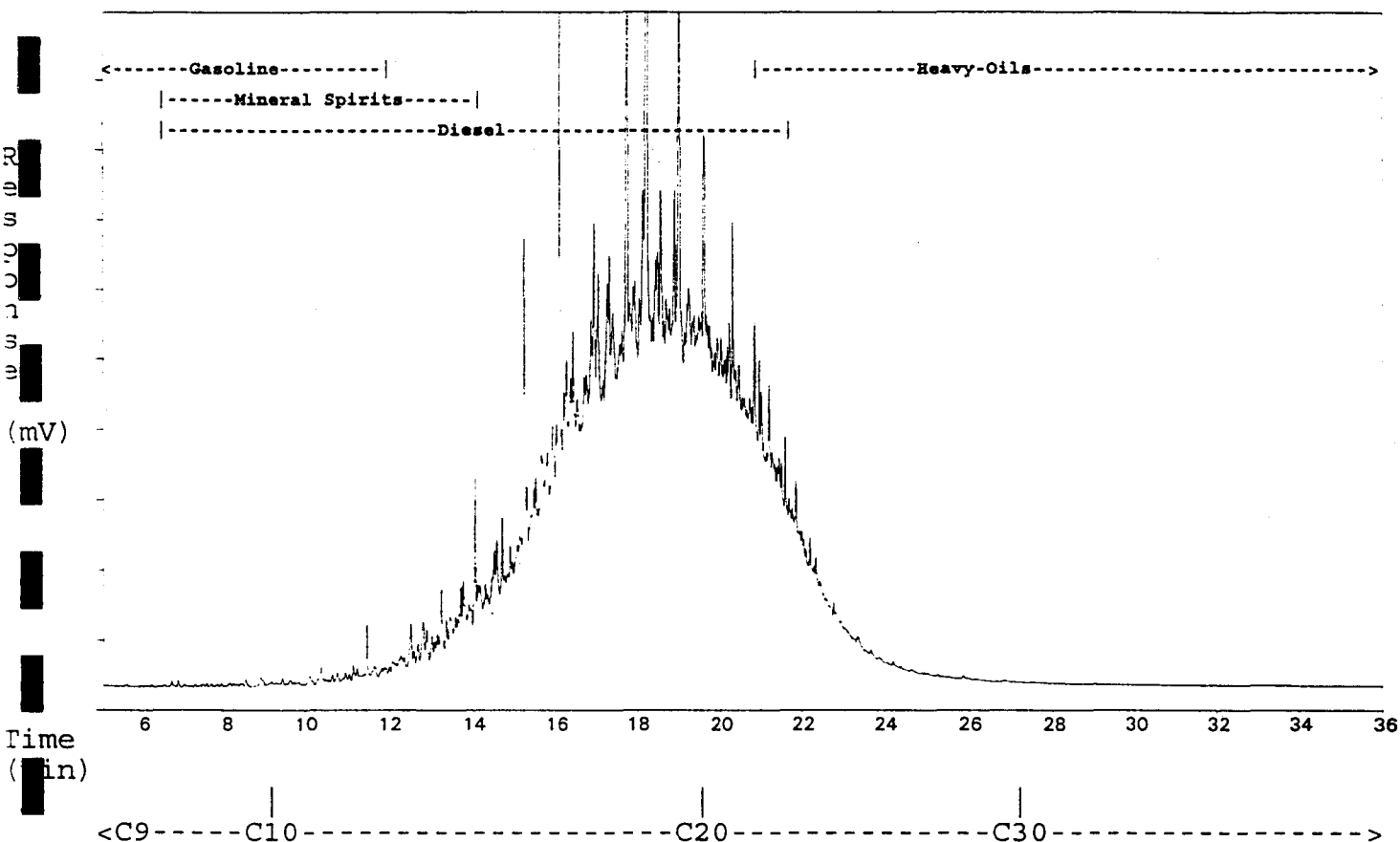
SAMPLE NAME: G4671r 8

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

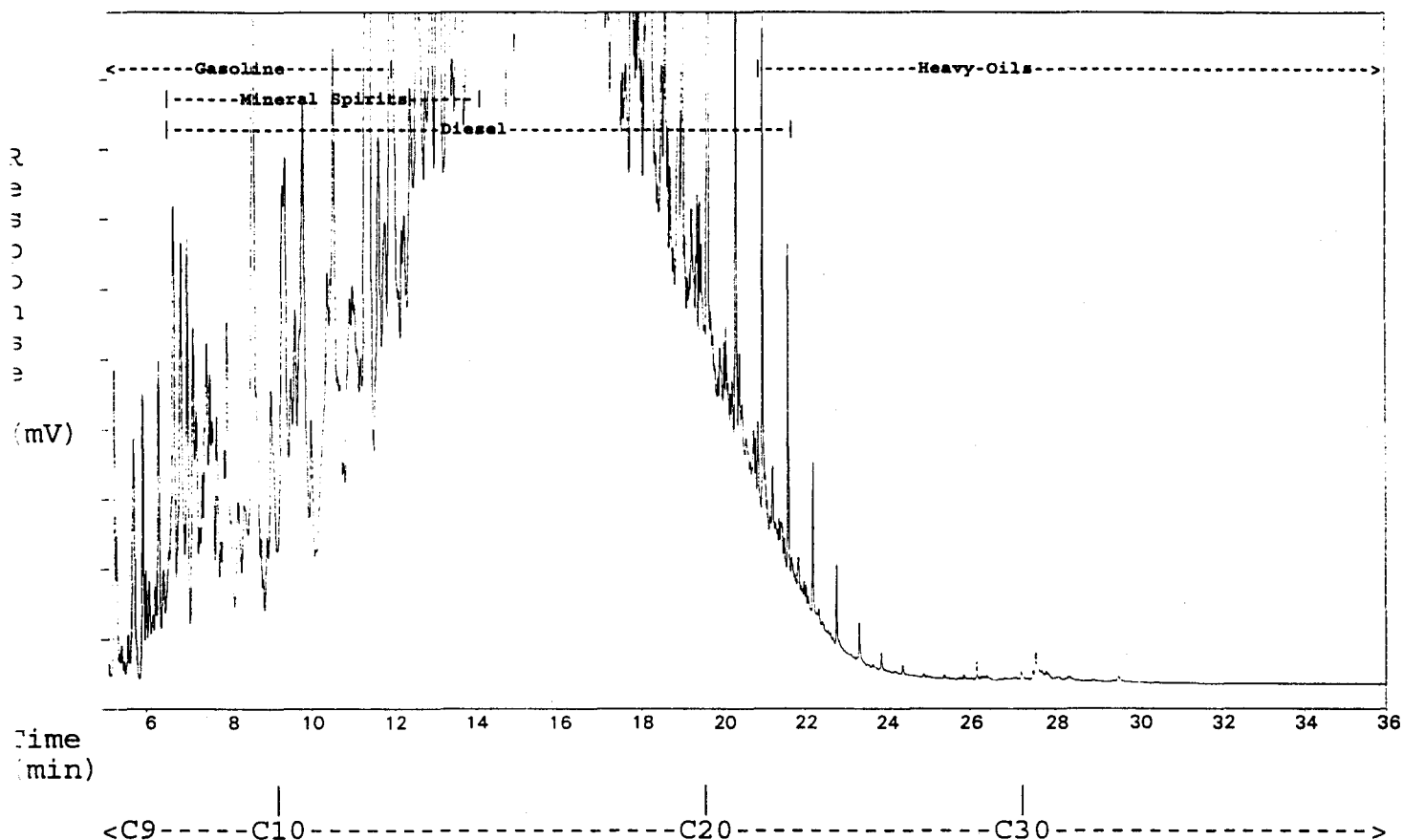
SAMPLE NAME: G4671r 9

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

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HYDROCARBON DISTRIBUTION REPORT

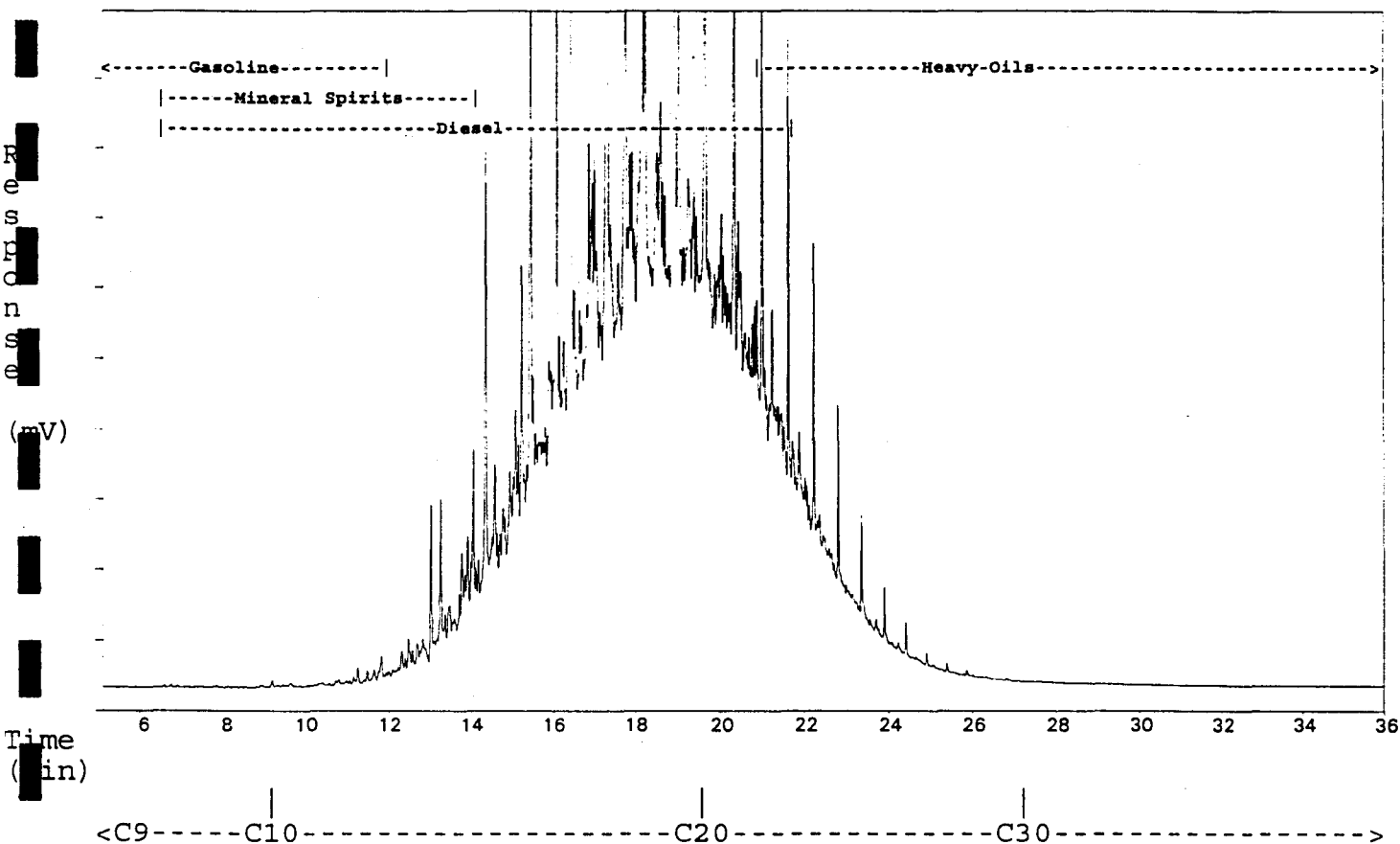
SAMPLE NAME: G4671r 13

VE-01S

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

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

Sequence file: TEH15NOV



ASL Sample ID: G4671r 13* 8.0Dilution

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

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HYDROCARBON DISTRIBUTION REPORT

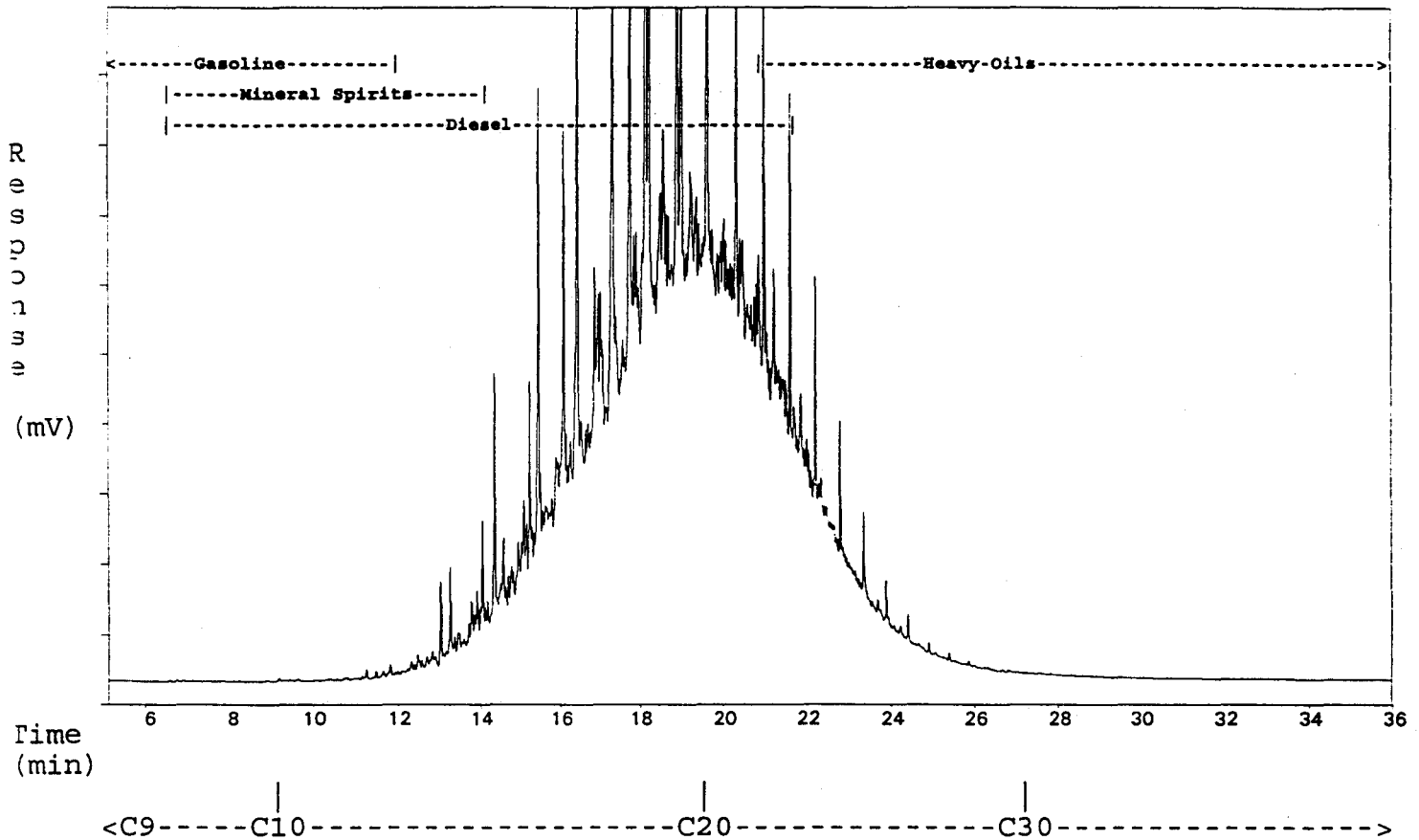
SAMPLE NAME: G4671r 14

VE-01S Dup

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

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

Sequence file: TEH15NOV



ASL Sample ID: G4671r 14*

8.0Dilution

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

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

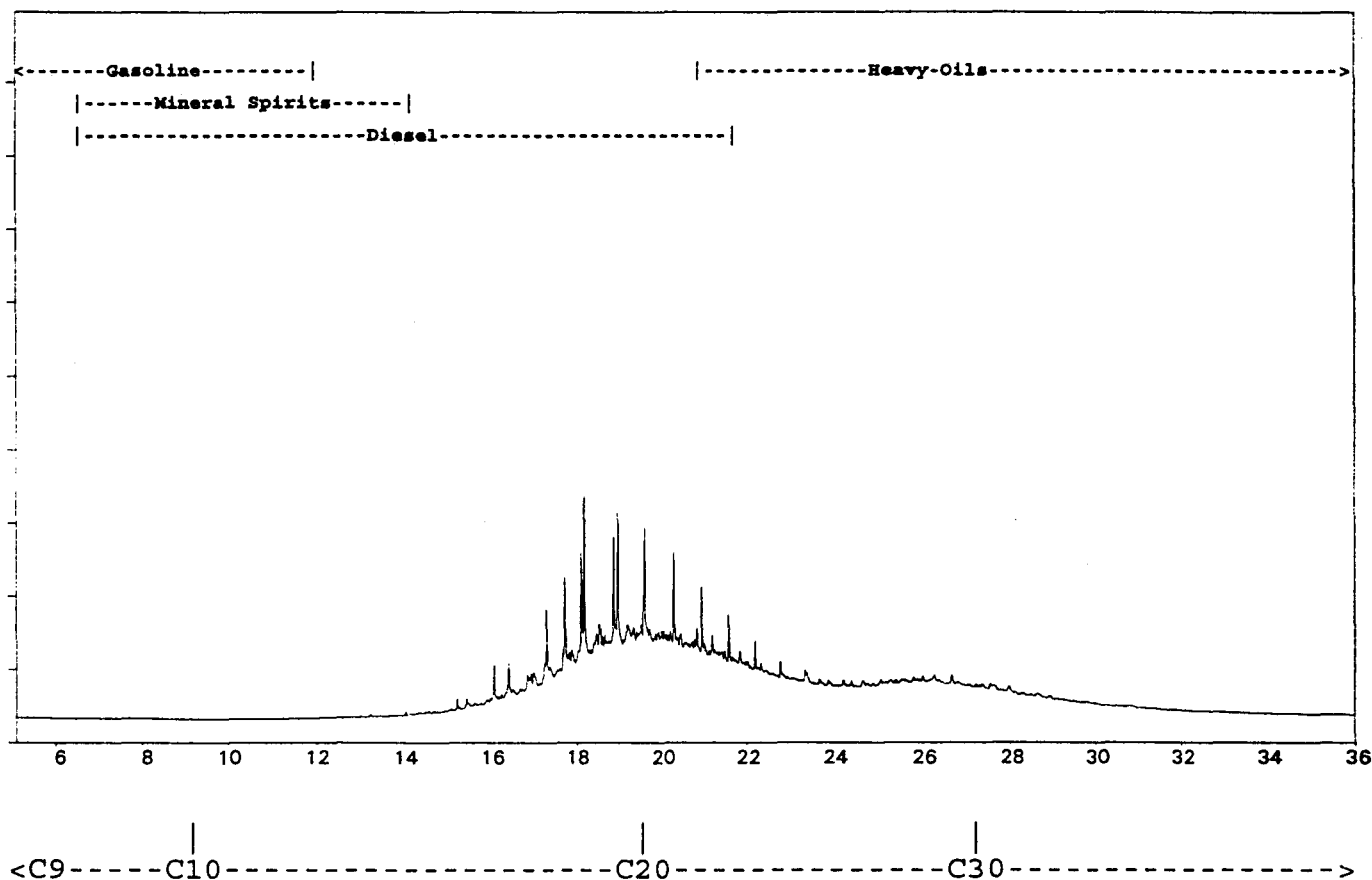
SAMPLE NAME: G4671r 22

VE-08S

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

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

Sequence file: TEH15NOV



ASL Sample ID: G4671r 22* 8.0Dilution

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

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HYDROCARBON DISTRIBUTION REPORT

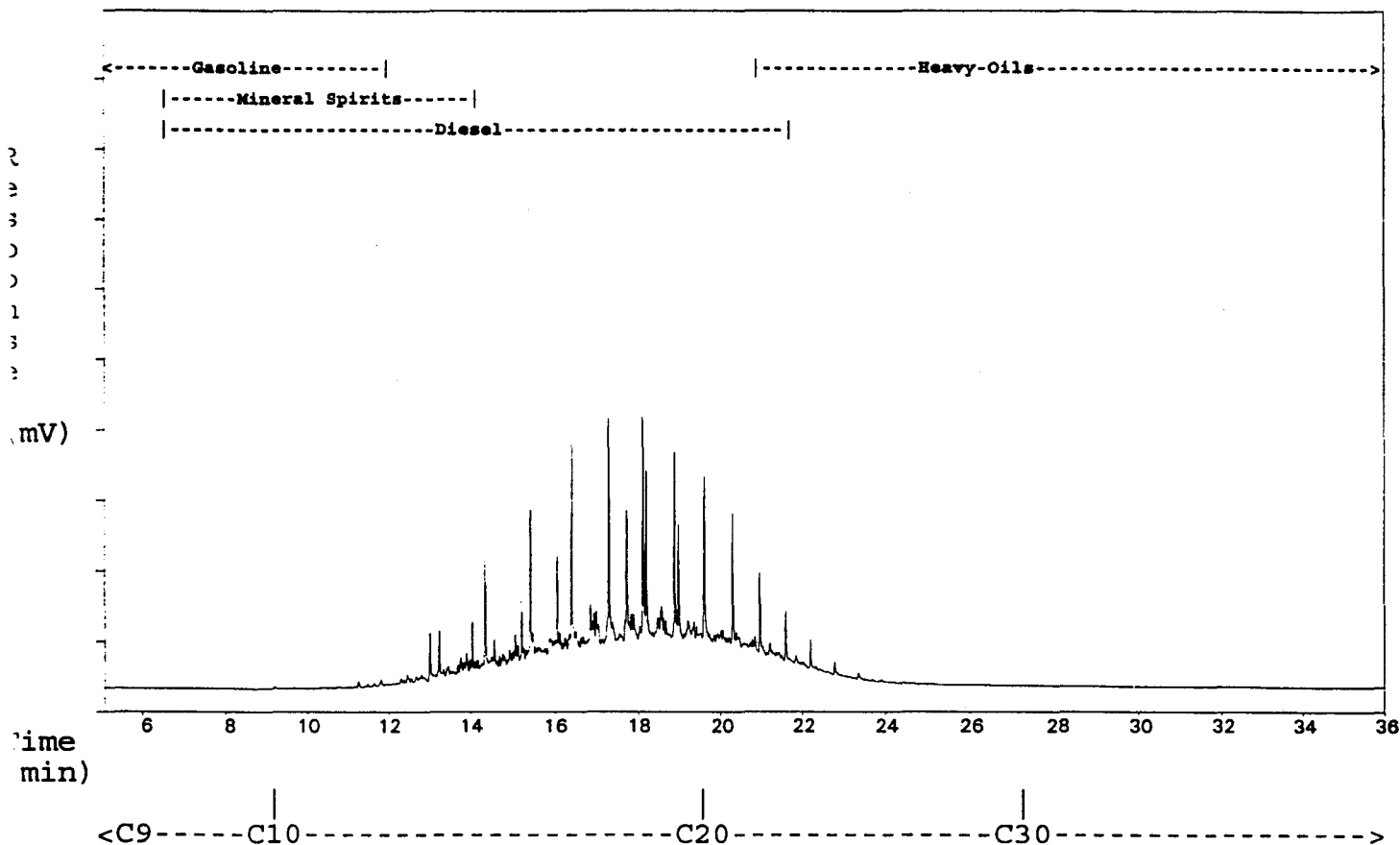
SAMPLE NAME: G4671r 23

VE-08D

Sample acquired: NOV 15, 1996 22:59:03

File Name: C:\TEH2\TEH15NOV.09R , Sample Name: G4671r 23

Sequence file: TEH15NOV



ASL Sample ID: G4671r 23*

8.0Dilution

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

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HYDROCARBON DISTRIBUTION REPORT

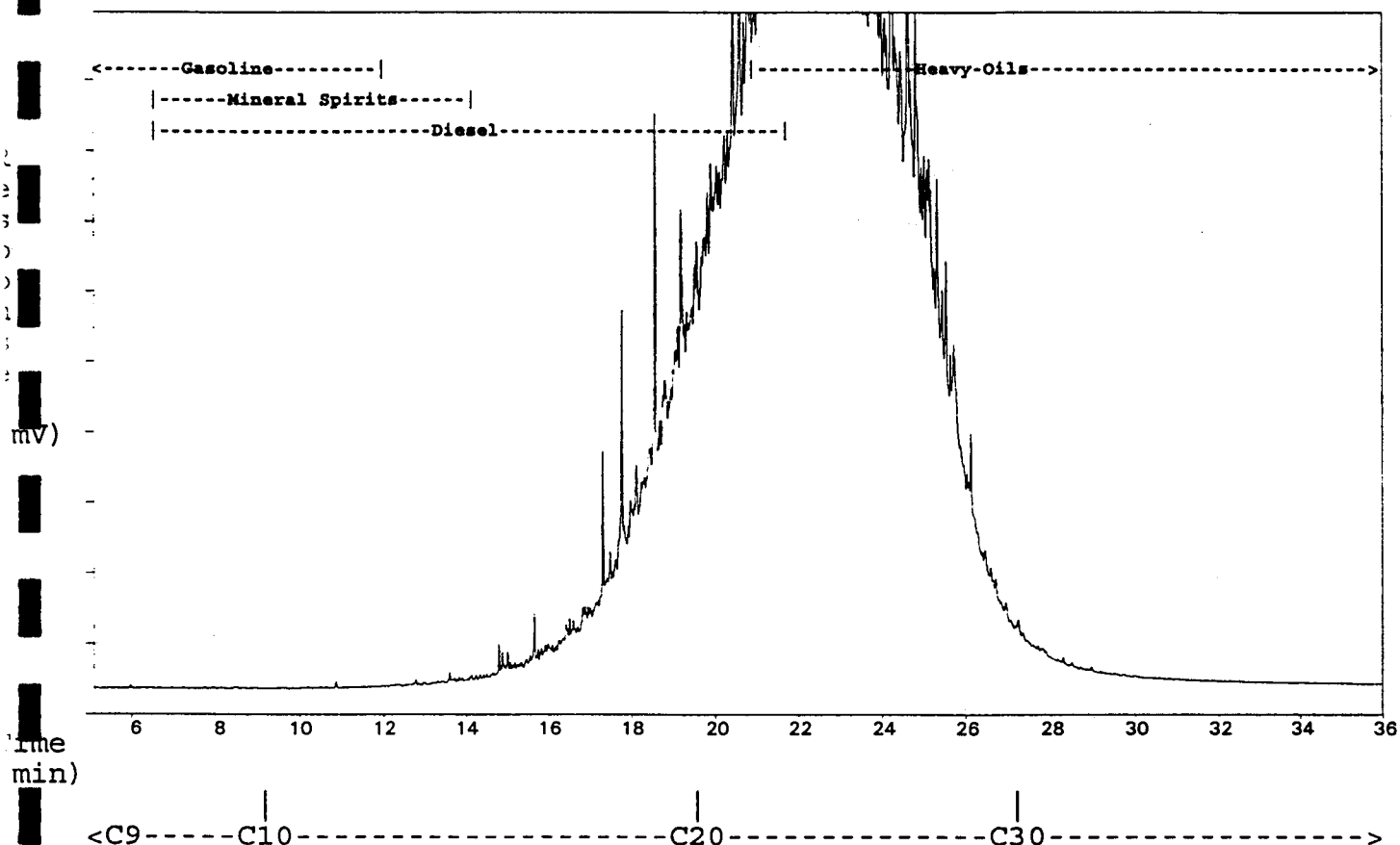
SAMPLE NAME: G4671r 32#RX5

VE-15S

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

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

Sequence file: TEHNOV17



ASL Sample ID: G4671r 32#RX5*

40.0Dilution

HYDROCARBON RANGE (by Carbon#)

RELATIVE AMOUNT (%)

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

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

HYDROCARBON DISTRIBUTION REPORT

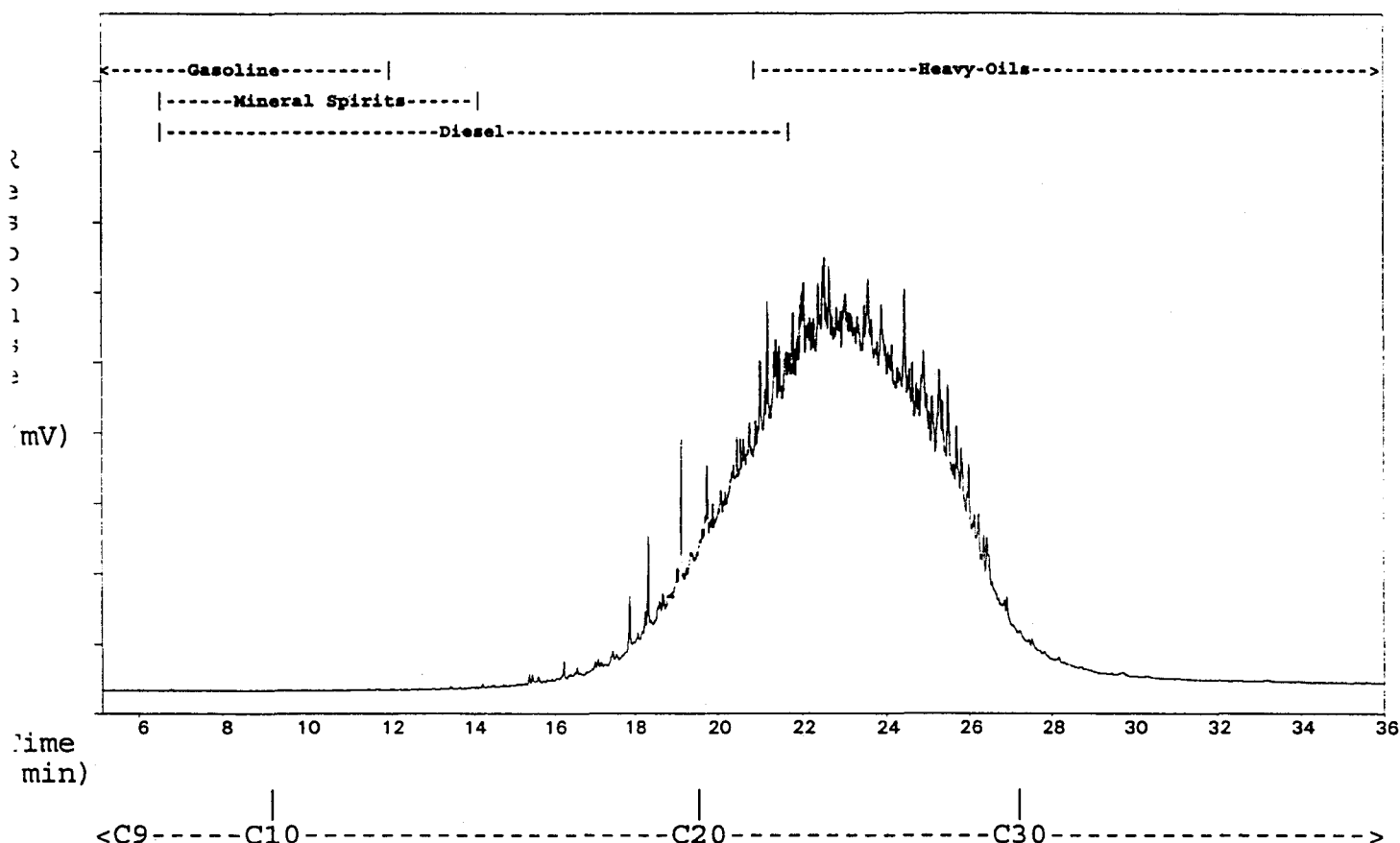
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VE-15D

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

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

Sequence file: TEHNOV17



ASL Sample ID: G4671r 33#RX5*

40.0Dilution

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

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

HYDROCARBON DISTRIBUTION REPORT

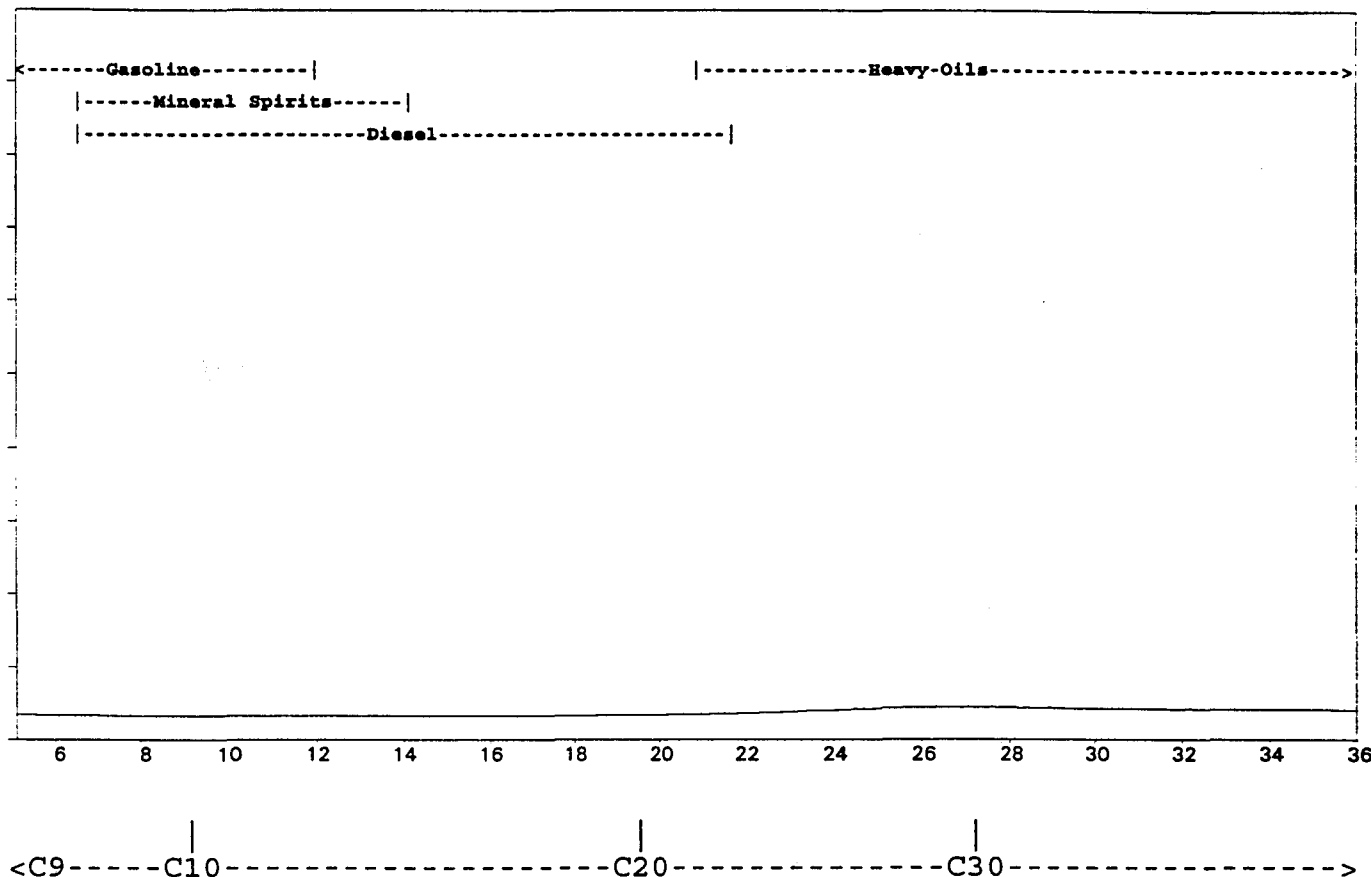
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VE-16

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

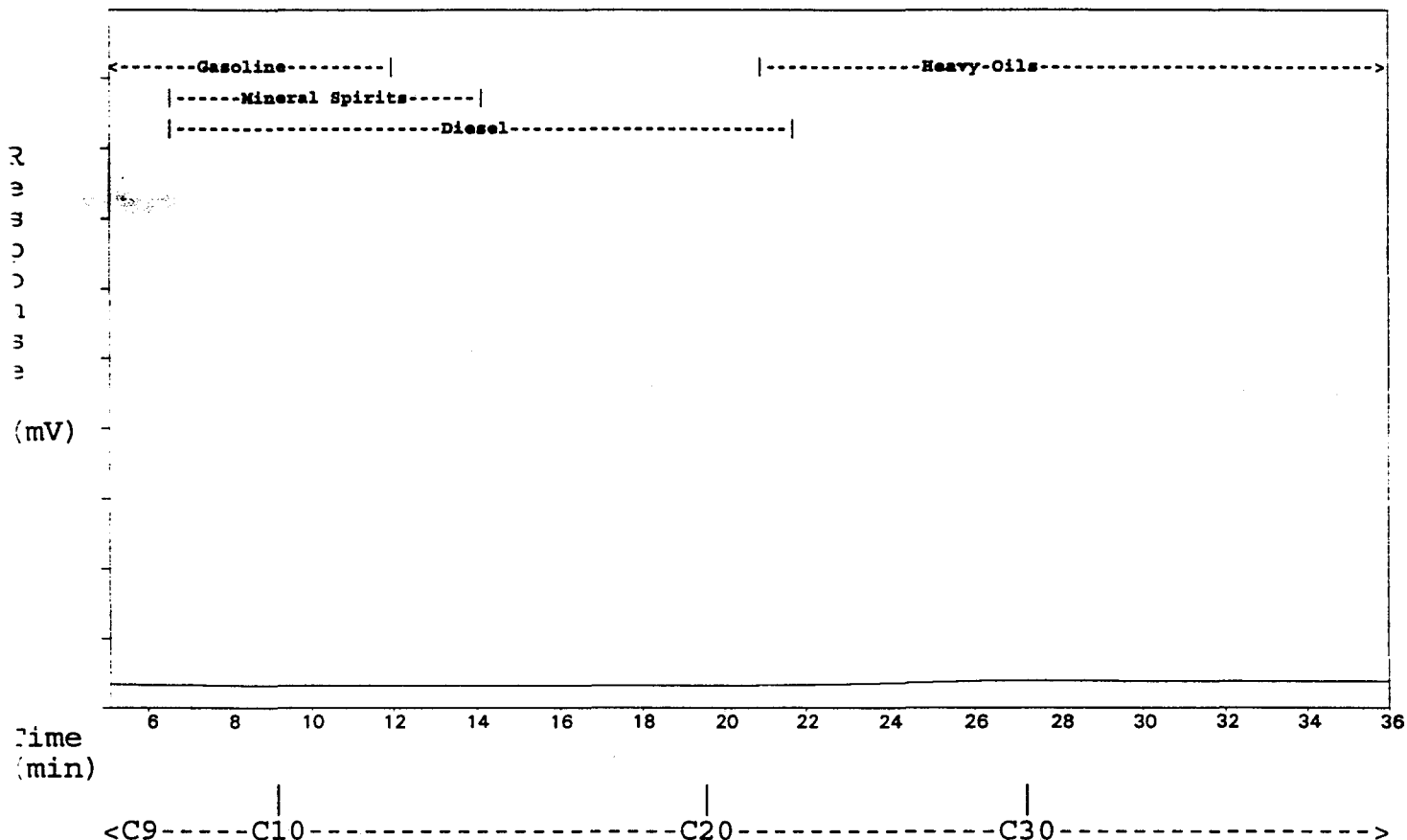
SAMPLE NAME: G4671r 48

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

**RESULTS OF ANALYSIS - Sediment/Soil**

File No. G8093

CR-01-D1 CR-01-D2 CR-03-D1 CR-05D VE-01S

Polycyclic Aromatic Hydrocarbons

Acenaphthene	0.06	0.14	0.38	9.05	0.22
Acenaphthylene	0.04	0.05	0.20	3.33	<0.05
Anthracene	<0.05	0.06	0.23	1.46	0.34
Benzo(a)anthracene	0.04	0.02	<0.05	0.09	0.07
Benzo(a)pyrene	0.03	0.01	<0.05	<0.05	<0.05
Benzo(b)fluoranthene	0.06	0.02	<0.05	<0.05	<0.05
Benzo(g,h,i)perylene	0.05	0.01	<0.05	<0.05	<0.05
Benzo(k)fluoranthene	0.02	<0.01	<0.05	<0.05	<0.05
Chrysene	0.11	0.02	0.07	<0.05	0.23
Dibenz(a,h)anthracene	<0.01	<0.01	<0.05	<0.05	<0.05
Fluoranthene	0.01	0.03	0.23	0.58	0.34
Fluorene	0.03	0.27	0.43	26.7	0.08
Indeno(1,2,3-c,d)pyrene	0.04	<0.01	<0.05	<0.05	<0.05
Naphthalene	0.04	0.05	0.78	4.02	<0.05
Phenanthrene	<0.05	0.34	0.15	36.4	0.14
Pyrene	0.24	0.20	0.80	1.80	2.56

Extractables

EPH (C10-18)	5410	6970	23500	-	-
EPH (C19-31)	1300	1050	3400	-	-
LEPH	5400	6970	23500	-	-
HEPH	1300	1050	3400	-	-
Total Extr Hydrocarbons (C10-30)	5970	7080	23700	-	-

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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-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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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>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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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

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



METHODOLOGY

File No. G8093

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

Moisture

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

Non-halogenated Volatiles in Sediment/Soil - Headspace Method

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

Metals in Sediment/Soil

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

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

Polycyclic Aromatic Hydrocarbons in Sediment/Soil

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



METHODOLOGY (cont'd)

File No. G8093

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

Extractable Petroleum Hydrocarbons in Sediment/Soil

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

Light and Heavy Extractable Petroleum Hydrocarbons in Soil

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

Total Extractable Hydrocarbons in Sediment/Soil

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

End of Report



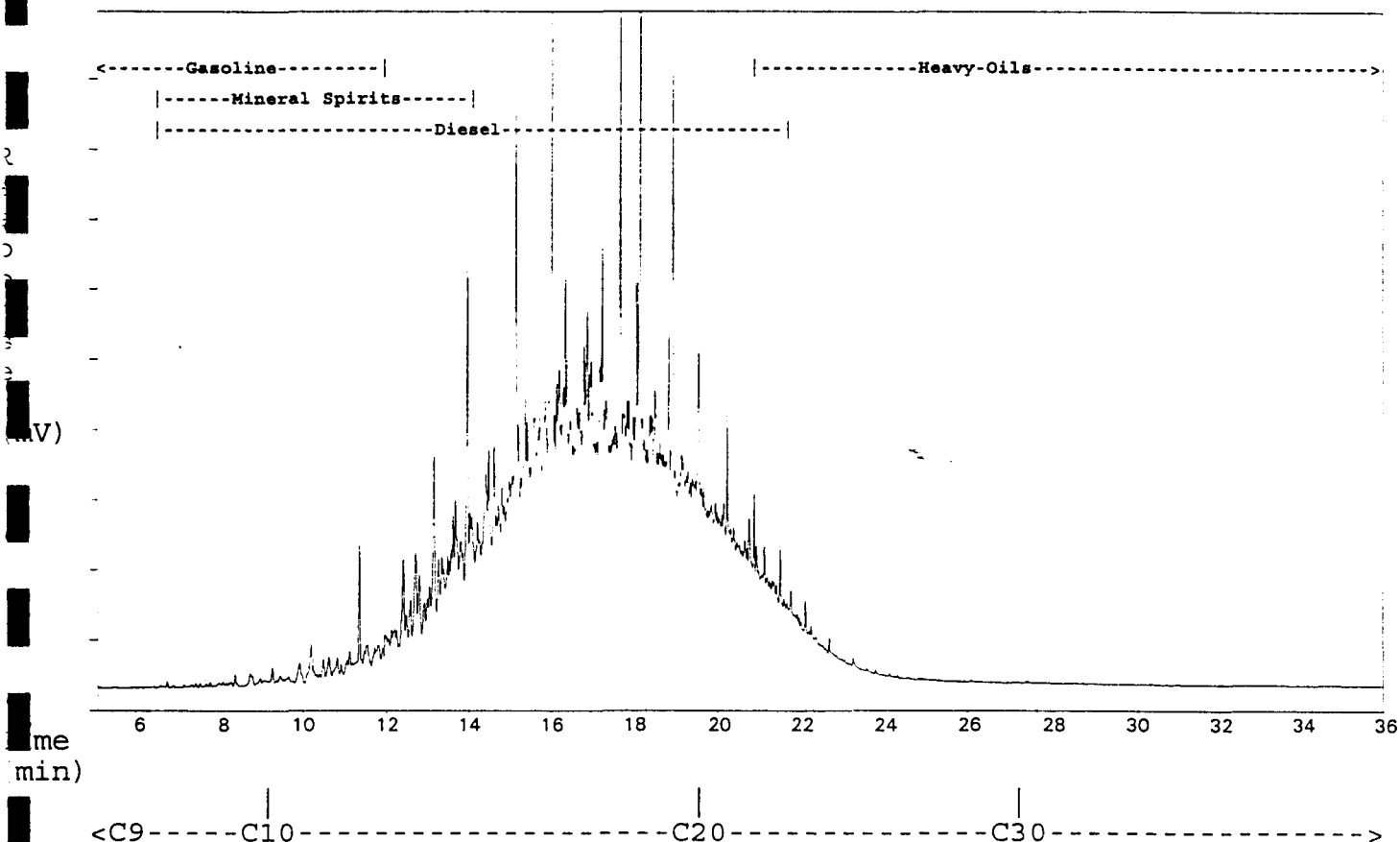
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-01-D1

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

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

Sequence file: Merry Christmas



ASL Sample ID: G8093 1* 8.0Dilution

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

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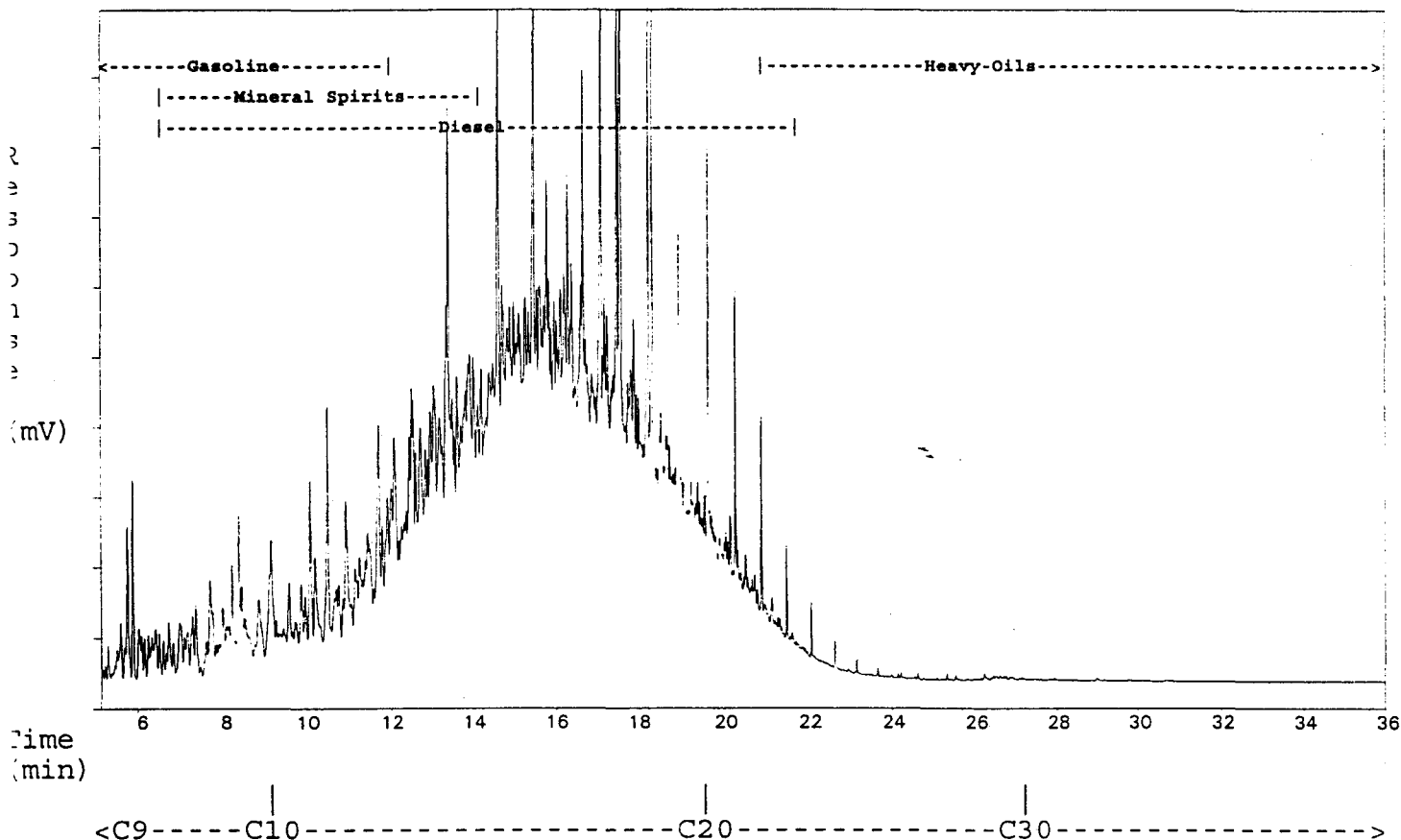
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-01-D2

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

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

Sequence file: Merry Christmas



ASL Sample ID: G8093 2* 8.0Dilution

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

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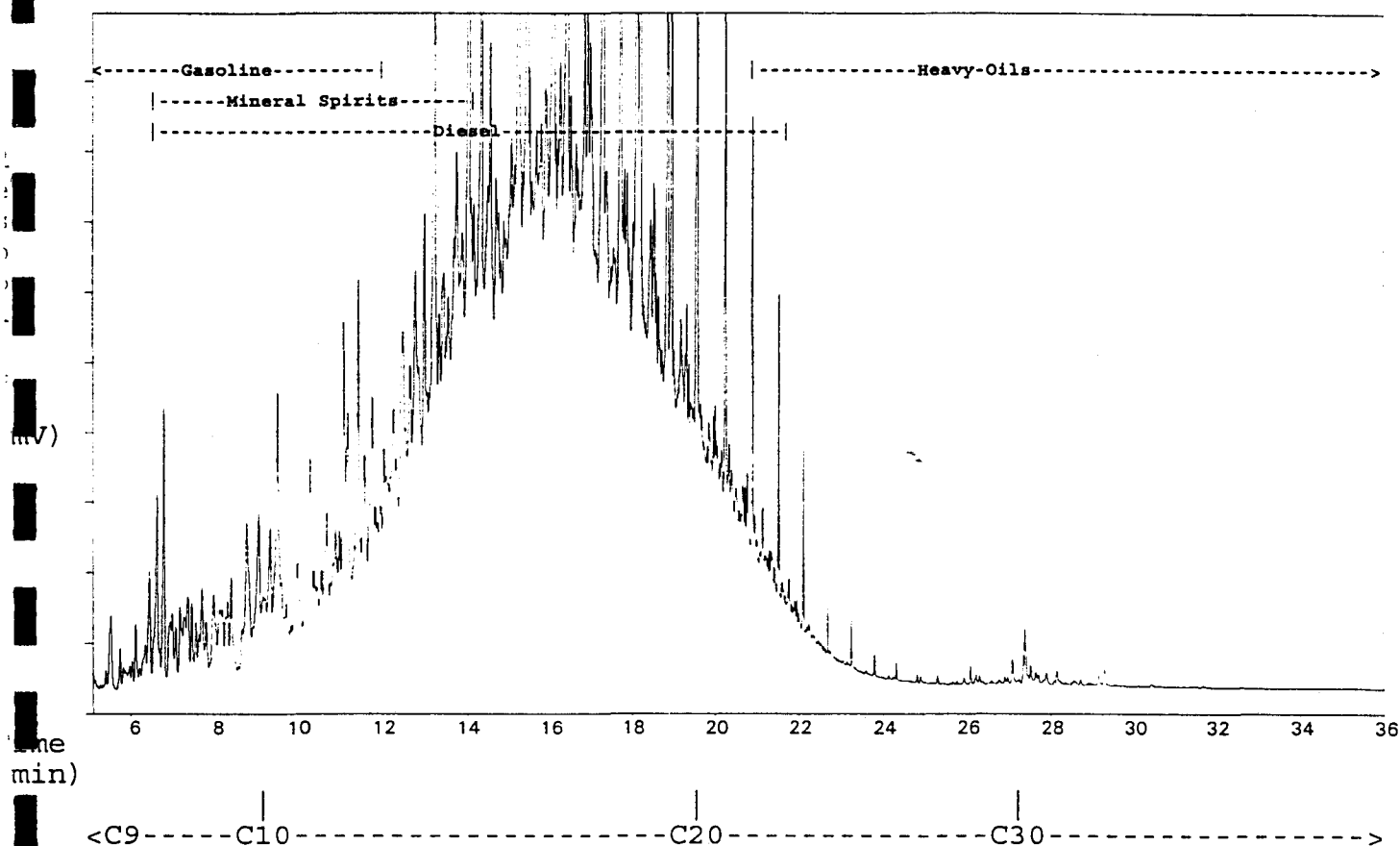
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: CR-03-D1

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

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

Sequence file: Merry Christmas



ASL Sample ID: G8093 3* 8.0Dilution

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

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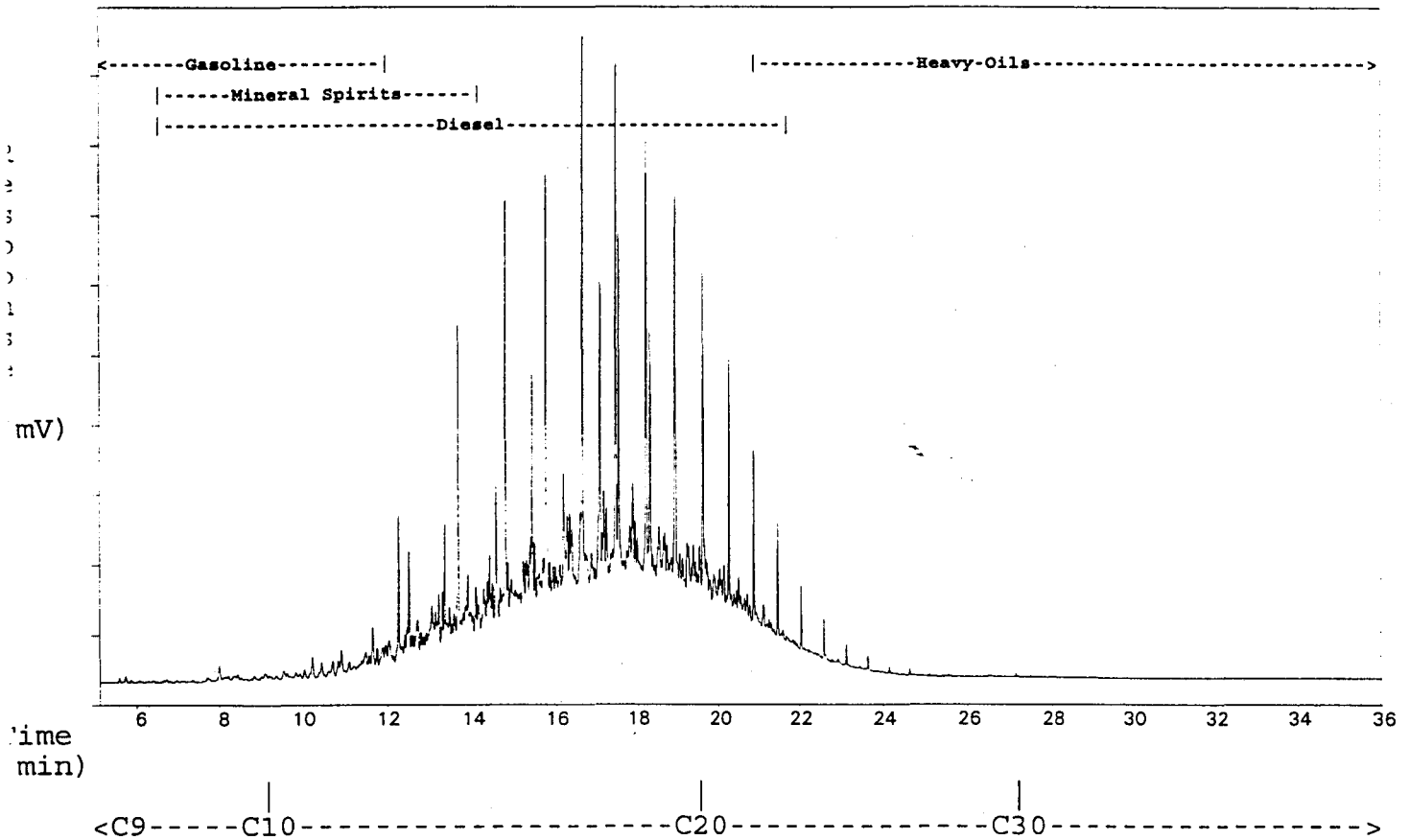
HYDROCARBON DISTRIBUTION REPORT

SAMPLE NAME: VE-01D

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

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

Sequence file: Merry Christmas



ASL Sample ID: G8093 7* 8.0Dilution

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

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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

CanTest Ltd

Professional
Analytical
Services

REPORT ON: Oil Samples
REPORTED TO: Royal Roads University

1523 West 3rd Ave
Vancouver, BC
V6J 1J8

Fax: 604 731 1111

Tel: 604 734 7278

1 800 665 8566

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

CANTEST

REPORTED TO: Royal Roads University

REPORT DATE: November 22, 1996

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



CANTEST

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



CANTEST

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	

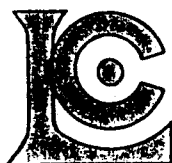
NOTE: * HYDROCHLORIC ACID SOLUBLE SULFATE

NOTE: ** UNITS = KILOGRAMS CaCO3 EQUIVALENT PER METRIC TONNE (Kg/MT)

NOTE: *** NITRIC ACID SOLUBLE SULFIDE

CERTIFICATION:

Sard / Cepad



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:

Said / Lina



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

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British Columbia, Canada V7J 2C1
PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

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

A9631589

Comments: ATTN:KEVIN A.MORIN

CERTIFICATE

A9631589

(JGG) - MORWIJK ENTERPRISES LTD.

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

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

SAMPLE PREPARATION

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

ANALYTICAL PROCEDURES

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



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18: MORWIJK ENTERPRISES LTD.

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VANCOUVER, BC
V6B 5Z5

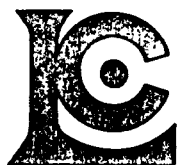
Project : ABANDONED YT MINES.
Comments: ATTN:KEVIN A. MORIN

Page Number : 1-A
Total Pages : 1
Certificate Date: 19-SEP-96
Invoice No. : 19631400
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: *Kevin A. Morin*



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
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Account :JGG

CERTIFICATE OF ANALYSIS

A9631400

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

CERTIFICATION:



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

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

To: MORWIJK ENTERPRISES LTD.

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

Comments: ATTN:KEVIN A. MORIN

CERTIFICATE

A9631400

(JGG) - MORWIJK ENTERPRISES LTD.

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

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

SAMPLE PREPARATION

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

ANALYTICAL PROCEDURES

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



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212 Brooksbank Ave., North Vancouver
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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-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:

Hart Bickler



Chemex Labs Ltd.

Analytical Chemists * Geochemists * Registered Assayers

212 Brooksbank Ave., North Vancouver
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PHONE: 604-984-0221 FAX: 604-984-0218

to: MURWIK 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: 24-SEP-96
Invoice No. : 19631590
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS

A9631590

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

CERTIFICATION:

Handwritten signature



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VANCOUVER, BC
V6B 5Z5

A9631590

Comments: ATTN:KEVIN A.MORIN

CERTIFICATE

A9631590

(JGG) - MORWIJK ENTERPRISES LTD.

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

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

SAMPLE PREPARATION

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

ANALYTICAL PROCEDURES

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



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To: MORWIJK ENTERPRISES LTD.

2401 - 289 DRAKE ST.
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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 VE-AD10	2091364 2091364	7.1 6.8	0.06 0.04	0.93 12.40	1.06 12.50	25.2 < 0.2	33 391	132 1	99 -390	4.00 0.00	

NOTE: * HYDROCHLORIC ACID SOLUBLE SULFATE

NOTE: ** UNITS = KILOGRAMS CaCO3 EQUIVALENT PER METRIC TONNE (Kg/MT)

NOTE: *** NITRIC ACID SOLUBLE SULFIDE

CERTIFICATION:

Said
Kevin A. Morin



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PHONE: 604-984-0221 FAX: 604-984-0218

To: MORWIJK ENTERPRISES LTD.

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

A9631589

Comments: ATTN:KEVIN A.MORIN

CERTIFICATE

A9631589

(JGG) - MORWIJK ENTERPRISES LTD.

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

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

SAMPLE PREPARATION

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

ANALYTICAL PROCEDURES

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



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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-A
Total Pages : 1
Certificate Date: 19-SEP-96
Invoice No. : 19631400
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	< 2	>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
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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-B
Total Pages : 1
Certificate Date: 19-SEP-96
Invoice No. : I9631400
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS A9631400

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

CERTIFICATION: 11



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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.

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

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

CERTIFICATE OF ANALYSIS

A9631590

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

CERTIFICATION:

Hart Bickler



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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
P.O. Number :
Account : JGG

CERTIFICATE OF ANALYSIS

A9631590

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

CERTIFICATION:

Handwritten signature



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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 Assay HF ICP digestion charge
290	2	

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

Results are expressed as mg/kg or ppm

RSD = Relative Standard Deviation

D.3.3 Polycyclic Aromatic Hydrocarbons

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

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

	Method Blank	Matrix Spike %	VE-01S 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
Airstrip (approx. east end)	64 - 19.51N	133 - 43.15W
Airstrip (approx. west end)	64 - 19.46N	133 - 44.43W
Entrance to adit	64 - 19.08N	133 - 45.33W
Core shack	64 - 19.44N	133 - 44.26W
Camp area	64 - 19.45N	133 - 44.46W

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	---	xylene	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	---	---

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 ⁴ (each)	1	10
ammonia	---		chlorophenols ⁴ (each)	0.5	5
antimony	20	40			
arsenic	30	50	<i>Polyaromatic Hydrocarbons (PAHs)</i>		
barium	500	2000	PAHs (Total)		
beryllium	4	8	benzo(a)anthracene	1	10
boron (total)	---	---	benzo(a)pyrene	1	10
cadmium	5	20	benzo(b)fluoranthene	1	10
chromium (+6)	8	---	benzo(k)fluoranthene	1	10
chromium (total)	250	800	dibenz(a,h,-)anthracene	1	10
cobalt	50	300	indeno(1,2,3-c,d)-pyrene	1	10
copper	100	500	naphthalene	5	50
cyanide (free)	10	100	phenanthrene	5	50
cyanide (total)	50	500	pyrene	10	100
fluoride (total)	400	2000	chrysene	---	---
iron	---	---	3-methylcholanthrene	---	---
lead	500	1000	benzo(g,h,i)-perylene	---	---
manganese	---	---	dibenzo(a,h)pyrene	---	---
mercury	2	10	dibenzo(a,i)pyrene	---	---
molybdenum	10	40	dibenzo(a,l)pyrene	---	---
nickel	100	500	acenaphthene	---	---
selenium	3	10	acenaphthylene	---	---
silver	20	40	anthracene	---	---
thallium	---	---	fluoranthene	---	---
tin	50	300	fluorene	---	---
vanadium	200	---			
zinc	500	1500	<i>Chlorinated Hydrocarbons</i>		
			chlorinated aliphatics ²	5	50
			(each)		
<i>Monocyclic Aromatic Hydrocarbons</i>			chlorobenzenes ⁶ (each)	2	10
benzene	0.5	5	hexachlorobenzene	2	10
chlorobenzene	1	10	hexachloro-cyclohexane	---	---
1,2-dichlorobenzene	1	10	chlorinated pesticides		
1,3-dichlorobenzene	1	10	PCBs ⁷	5	50
1,4-dichlorobenzene	1	10	PCDDs and PCDFs ⁸	0.001	---
ethylbenzene	5	50	<i>Miscellaneous Organics</i>		
styrene	5	50	2,4-D	---	---
toluene	3	30	2,4,5-T	---	---
xylene	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
Phenolic Compounds non-chlorinated ² (each)	---	---		
chlorophenols ³ (each)	0.2 to 18 ¹⁹	<0.3 to 900 ^{19,20}	0.02 to 0.9 ²⁴	0.3 to 30 ²⁴
Polyaromatic Hydrocarbons (PAHs)				
PAHs (Total)				
benzo(a)anthracene	---	---	0.1	---
benzo(a)pyrene	---	0.01	0.01	
benzo(b)fluoranthene	---	---		
benzo(k)fluoranthene	---	---		
dibenz(a,h)anthracene	---	---		
indeno(1,2,3-c,d)pyrene	---	---		
naphthalene	---	---	1	---
phenanthrene	---	---	0.3	---
pyrene	---	---	0.02	---
acenaphthene			6	---
anthracene			0.1	---
fluoranthene			0.2	---
fluorene			12	---
Chlorinated Hydrocarbons				
chlorinated aliphatics ⁴ (each)	---	---		
dichloroethane, 1,2-	100	5 ^{16,18}		
dichloromethane	---	50		
trichloroethylene	20	50 ¹⁶		
tetrachloroethylene	260 ¹⁸	---		
chlorobenzenes ⁵ (each)	0.0065 to 15 ¹⁹	≤ 1 to 200 ^{16,19}		1 to 50 ²⁴
hexachlorobenzene	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	---	---		
Miscellaneous Organics				
2,4-D	4	100 ¹¹		
2,4,5-T	---	280; ≤ 20	---	20

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

n.a.: not applicable.

1. ---: not established.

2: Set equal to CCME Agricultural Remediation Criterion

3: Including 2,4-dimethylphenol, 2,4-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